Applicability of Adult Guidelines for Withholding or Terminating Resuscitation for Prehospital Traumatic Cardiopulmonary Arrest in Pediatrics

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Introduction
Cardiopulmonary arrest in a prehospital setting places a heavy burden on the health care system. The incidence of pediatric prehospital cardiopulmonary arrest is 19.7 per 100,000 people. Of the known cases, 22 to 29% of prehospital cardiopulmonary arrest attributed to trauma. Prehospital death represents 34% of all traumatic mortality. While survivors with good neurological outcomes range from 31 to 59%, this rate is much lower for patients with traumatic cardiopulmonary arrest (TCPA) (0–6.8%), except one study, which found rates of up to 55%. Emergency medical services (EMS) routinely transport trauma patients regardless of cardiopulmonary status, except those with clear signs of death.

Should cardiopulmonary resuscitation (CPR) be attempted on all patients regardless of the circumstances? This is a very critical and sensitive issue for which studies have been performed to understand the predictors of outcomes that can help to decrease the morbidity and mortality rates of prehospital TCPA.
Another challenging question is when should resuscitation be terminated. Salvageable and nonsalvageable classification of victim aids in making this decision, preserving and customizing precious human and financial resources according to the futility of the condition as well as minimizing the risks to health care personnel and the public. Therefore, the development and utilization of sensible guidelines for withholding or terminating resuscitation of TCPA patients based on the best available evidence should be pursued.

The National Association of EMS Physicians and the American College of Surgeons Committee on Trauma (NAEMSP/ACSCOT) published guidelines in 2003 for withholding or terminating resuscitation in adult prehospital TCPA patients. These guidelines have 14 recommendations containing procedures, policies, and clinical elements. The clinical criteria for the termination of care include an absence of pulse, unorganized electrocardiogram (ECG), fixed pupils (all observed at the scene) and CPR time that exceeds 15 minutes.

After validation by many studies, these guidelines have become acceptable and applicable for adults. In pediatrics, however, there remains a gap in the necessary research due to the paucity of pediatric data. Until now, there has been only one study assessing the applicability of these guidelines to a pediatric population. The study concluded, 100% of the mortality of prehospital pediatric TCPA patients can be predicted when all four clinical criteria for termination of resuscitation are met.

The main objective of this study is to assess the applicability of the adult guidelines for withholding or terminating resuscitation for prehospital TCPA in a pediatric population.

Study Design and Methods

This paper presents a retrospective cohort study for all trauma patients of less than 18 years of age who arrived with no pulse at the emergency department (ED) of King Abdulaziz Medical City (KAMC); using a trauma registry database from May 2001 to February 2011. A full-time data registrar using a data-collection sheet designed by the trauma registry collected the data. A daily report of discharged trauma patients was sent to the trauma register for cross-validation with admitted cases. The quality of data entry was monitored by an annual audit review of 5% of the files through the medical records department. Some variables were not part of the registry database and were instead collected by reviewing patient charts.

The estimated Riyadh population in 2009 was approximately 6,084,965; one-third of the residents were younger than 15 years. Definitive care of major trauma patients was centralized at KAMC, which is the only level-one trauma center in Riyadh. It is a teaching-tertiary-care hospital with a total bed capacity of 699 and a 24-bed ED covered by a pediatric ED consultant and a trauma team. There has been an average of 350 to 450 pediatric trauma patients seen annually for the past 10 years, as per the trauma registry.

Results

A total of 4,582 trauma patients younger than 18 years were available for review from the trauma registry between May 2001 and February 2011. A total of 143 patients had arrived at KAMC ED with no pulse. Among these patients, 39 patients were excluded, 32 drowning and seven patients were missing on important data. The remaining 104 patients met the inclusion criteria for the study; there were no patients who survived more than 24 hours from the time of arrival at the ED. There were 101 patients dying in the ED, 2 in the OR, and 1 in the pediatric intensive care unit (this was the only patient who had reactive pupils at the initial assessment). Of the 104 patients, 60 were pronounced dead upon arrival at the emergency room, while 44 received CPR with varying levels of resuscitative measures. The duration of CPR in ED ranged from 2 to 45 minutes, with a median of 12 minutes using a wide range of epinephrine doses, ranging from zero up to eight doses (average of two doses).

Demographic and Characteristics of Sample Cohort (Nonsurvivors)

Approximately, 38.5% of the patients were between 13 and 18 years of age with a mean of 9.8 years; 80 (76%) are males. Most of the hospital admissions were victims of blunt trauma (94.2%) and the majority of the injuries were due to motor vehicle collisions (n = 48; 46.2%) and pedestrians being hit by cars (n = 43; 40.2%). The maximum length of stay in the ED was 3 hours. Nearly, 85.6% of patients died within the first hour of admission (n = 89), transportation were private vehicle (n = 46; 47.2%) or ambulance (n = 51; 52.6%) (Table 1). Asystole was the initial heart rhythm for the majority of patients (n = 85; 87.6%), while the remaining 12
patients were as follows: pulseless electrical activity, 7 (7.2%); sinus, 2 (2.1%); unidentified rhythm, 3 (3.1%); and 7 patients had missing initial rhythm data. Nearly, all patients died in the ED (n = 101), with the exception of three patients who were transferred to the operating room (2.9%). Most of the patients in cohort group were pronounced dead upon arrival at the ED (n = 60; 57.7%); CPR was initiated for the remaining patients (n = 44; 42.3%) with mean duration of 11.8 minutes (SD = 11) and a median epinephrine doses of two (►Table 2).

Pupil reactivity was not documented for 13 patients, all of whom were pronounced death upon arrival at the ED. Only one patient had positive pupil reactivity (►Table 1). The mean injury severity score was 72.21 (SD = 10.7), which indicates very severe injury for our entire cohort group. The Glasgow coma score and the revised trauma score were 3 and 0, respectively, for all patients included in this study. The range of Pediatric Trauma Score was 6 to 3, with a mean of 0.28 (SD = 1.1) (►Table 3).

**Applicability of Adult Guidelines for Withholding or Terminating Resuscitation for Prehospital Traumatic Cardiopulmonary Arrest**

In this study group, majority of patients (n = 92) met four clinical criteria (apnea, no pulse, fixed pupils, and disorganized rhythm), 11 patients met three criteria (apnea, no pulse, and fixed pupils). Only one patient met two criteria (apnea, no pulse). All of them died within 24 hours from arrival at ED (►Fig. 2).

**Discussion**

In recent years, the Kingdom of Saudi Arabia, and particularly the city of Riyadh, has witnessed global improvements in its health care system, especially for services related to medical transportation and prehospital medical care; this has led to increase in the number of critically ill patients who arrive at emergency facilities. Our institution, as the only level-one trauma center in Riyadh, receives many patients with cardiopulmonary arrest where heroic intensive medical care measures are provided based on the knowledge that pediatric patients are more likely to survive to discharge than adults (6.4 vs. 4.5%, respectively). These efforts will affect other patients who are in need of emergency care management at the same time.

In our review of pediatric patients younger than 18 years who arrived at ED apneic with no pulse (total number = 104), all died whether they received resuscitative measures or not. This is similar to the results of previous reports. Broides et al studied 35 patients; 20 of them received CPR, while 15 patients showed signs of death did not. None of the patients survived or regained consciousness, even when intensive measures were used in resuscitation (including open thoracotomy).

The mean age of our cohort group was 9.8, which is similar to the mean age group of nonsurvivors (141 out of 169 patients) in a previous retrospective study that ran over
11 years. In contrast to another study that found that children and adolescents were twice more likely to survive to hospital discharge than infants and adults.

A recent focus in prehospital care is to determine which patients might benefit from intensive resuscitation efforts following TCPA and in whom such attempts are futile. The decision to terminate resuscitation is not simple; it is influenced by many factors including ethical issues, economic considerations and the need to minimize risks to health care providers. It should be stated clearly that the principal goal of restricting the use of CPR during trauma is not based on financial considerations, but on considerations of the futility of such efforts.

Prehospital care should be provided to all pulseless patients unless the most obvious signs of death (rigor mortis, dependent lividity or decapitation) are present.

In a recent position paper, NAEMSP/ACSCOT recommended specific criteria for withholding or terminating resuscitation efforts after traumatic injury based on adult studies; therefore, they have limited applications for care in pediatric trauma patients. Two studies have addressed the pediatric population in particular. In a 7-year case-control series, Hazinski et al found no functional survivors among 38 pediatric victims of blunt trauma, who arrived at the ED in pulseless cardiac arrest or with severe hypotension. Eleven of the 12 patients who were transferred to PICU died; the single survivor demonstrated profound neurologic impairment 6 years after hospitalization. The mean hospital

![Fig. 2](image-url) Applicability of clinical criteria for withholding or terminating resuscitation for prehospital cardiopulmonary arrest.
unreimbursed care cost for the 38 studied patients was $3,514 per patient. Sirbaugh et al conducted a retrospective study and found that only two patients survived out of 41 patients, who arrived with no detectable vital signs. Although, these two studies have several limitations, such as small sample sizes and selection biases, the reported poor outcomes are consistent with outcomes reported in other series.

In our current study, we tested the applicability of the guidelines that have been used for adults since 2003 on our pediatric population. These guidelines assist in making the decision to continue or terminate the resuscitation of trauma patients with TCPA based on clinical assessments, mechanism of injury, arrest duration, and initial electrocardiograph activity. Previous data have suggested that all children who were initially without a pulse require CPR on arrival at the ED, but there were no survivors in this group of patients; this dismal outcome is similar to the outcome of our study. The termination of care is an important issue in the pediatric trauma population, but data are scarce regarding the appropriateness of such an action. The clinical criteria for the termination of care in a pediatric population and the examination of the clinical relevance of such criteria as described in the adult guidelines are still needed. Capizzi et al examined the applicability of adult guidelines for termination of resuscitation for a pediatric population. In his study, a total of 30 patients who received CPR upon initial presentation were reviewed. Approximately, 80% met all four documented criteria, none of them survived. All nonsurvivors had CPR times greater than 15 minutes. Alternatively, none of the survivors met all four criteria.

In our study, 92 patients met the four clinical criteria, and there were no survivors. Eleven patients met three of the four criteria. Ten of the above-mentioned patients had undocumented ECG rhythms, while one had a sinus rhythm. This patient was a victim of blunt trauma and sustained a closed head injury. She died in the ED after 48 minutes of CPR. A 14-year-old victim of penetrating trauma who was pulseless and aperic with sinus rhythm and reactive pupils was resuscitated for 32 minutes using four doses of epinephrine, but unfortunately, she died in the operating theater within less than 24 hours, which suggests that our results may have general applicability to the pediatric trauma population. The main reason "limitations of our study" is the lack of an electronic EMS data collection system in our region, which has greatly hindered our efforts to obtain prehospital information, and some patients were excluded due to a lack of data. The study group was relatively small, but in comparison to previous studies, our population was large enough to yield a reasonable conclusion. This study examined data collected from a single trauma center; therefore, our results need to be reproduced in other trauma centers to validate our findings.

Conclusions and Recommendations

This study confirms the poor outcomes of pediatric trauma patients who arrive at the ED with no pulse, and no-trauma patients who arrived at the ED with no pulse, survived to hospital discharge. Our data indicate that adopting the adult guidelines for withholding or terminating resuscitative efforts for pediatric patients who meet the clinical criteria is justifiable. The clinical criteria of the adult guidelines can predict 100% of the mortality in this patient group when all four criteria were met. A multicenter prospective cohort study should be conducted to lend more weight to the conclusions of this study. Furthermore, efforts should be undertaken to improve prehospital services in our region because trauma is a major national health problem in Saudi Arabia.

References

15 Hopson LR, Hirsh E, Delgado J, et al; National Association of EMS Physicians Standards and Clinical Practice Committee; American College of Surgeons Committee on Trauma. Guidelines for