

Pediatric Out-of-Hospital Cardiac Arrest in Rhode Island: Concepts and Controversies

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ABSTRACT

Pediatric out-of-hospital cardiac arrest (POHCA) is an infrequently encountered event by emergency medical providers, both across Rhode Island and nationally. The etiologies of these events differ from those in adult cardiac arrests and overall outcomes remain poor. The skills required by emergency medical providers to care for these patients are performed and practiced infrequently. Pediatric patients are also at further risk of serious adverse events secondary to challenges with airway management and variation in equipment sizing and weight-based medication dosing. Recent changes to Rhode Island Emergency Medical Services protocols, particularly the requirement for all non-traumatic cardiac arrests to be managed on scene for a minimum of 30 minutes, have led to discussion and controversy. As we aim to improve the quality of care delivered during these resuscitations through education, research and collaborative protocol development, it is important to recognize and remain focused on the unique aspects of these pediatric patients.

KEYWORDS: Pediatrics, Cardiac Arrest, Emergency Medical Services

INTRODUCTION

Pediatric out-of-hospital cardiac arrests make up less than 10% of Emergency Medical Service (EMS) resuscitations in the field and are often associated with poor outcomes.¹ Adult literature for out-of-hospital cardiac arrests (OHCA) has demonstrated improvement in outcomes following longer durations of cardiopulmonary resuscitation (CPR) prior to transport.² This approach stems from an understanding that, in adults, high-quality and minimally-interrupted CPR and early defibrillation are the key to improved survival. As a result, some EMS systems have altered protocols to encourage aggressive on-scene resuscitation in cases of adult OHCA. This approach has been recently been applied to the pediatric population and, in the updated 2017 Rhode Island EMS protocols, 30 minutes of on-scene CPR for POHCA was endorsed. This change has resulted in further discussion and some controversy, given the heterogeneity of pediatric patients and the differences in the pathophysiology of pediatric and

adult cardiac arrests. In this article, we aim to examine the relevant literature and discuss the potential controversies that exist in the prehospital management of POHCA.

The American Heart Association (AHA) recently released new statistics reporting an annual incidence of EMS-assessed POHCA of approximately 7,000 cases compared to nearly 340,000 in adults.³ With these relatively low numbers, despite medical advances and efforts to increase training in pediatric resuscitation, POHCA events have continued poor neurologically-intact survival rates. This is in stark contrast to increases in survival outcomes from pediatric in-hospital cardiac arrests, where data from the Get With the Guidelines-Resuscitation registry reported a nearly threefold improvement from 2000–2009 with no worsening in neurologic outcomes.⁴

While there is a steadily growing body of literature regarding POHCA, it remains limited when compared to adult studies. Most published studies are retrospective and observational in nature, while some include the extrapolation of more robust adult data to the pediatric population.⁵ The primarily cardiac etiology and larger numbers of adult arrests makes these events easier to study and therefore protocolize, whereas the etiology of pediatric arrests varies based on age, pathophysiology, and mechanism, resulting in more complicated and variable management for medical providers.

Rhode Island is unique given its small geographic size, with a population of only 1,059,639 according to 2016–2017 estimates. Children under 18 years of age make up 19.7% of the population. There are currently 87 licensed EMS agencies in RI with 4,779 licensed practitioners and in 2017 there were 183,902 documented EMS calls reported. Due to its geography, most areas of Rhode Island have short transport times to the closest emergency department. However, there is only a single Level 1 Pediatric Trauma Center, which can be distant from more rural areas. This information must be considered when determining optimal EMS protocols.

POHCA ETIOLOGY

One of the factors complicating improvement in POHCA care may be the variable etiology of these arrests. The most common causes of POHCA's are trauma, sudden infant death syndrome (SIDS), respiratory disease and submersion.⁶⁻⁸ The majority of cardiac rhythms found in the field are asystole

and PEA, with shockable rhythms making up less than 10% of pediatric arrests. This is significant and likely affects neurologically-intact survival rates, as evidence demonstrates that the presence of a shockable rhythm, such as ventricular fibrillation or ventricular tachycardia, on initial evaluation is associated with improved outcomes in children and adults.⁶⁻⁹

The majority of pediatric out-of-hospital cardiac arrests occur in children under the age of five years, with patients less than one year of age making up nearly half of these events.¹⁰ SIDS is a common cause in this age group and etiology can often not be determined. However, many experts suspect there is a respiratory component given the decline in infant deaths following the Back-to-Sleep movement.¹¹ Pediatric arrests in the less than one-month age group in particular have further considerations due to the higher risk of sepsis, undiagnosed congenital heart defects, inborn errors of metabolism and increased vulnerability to respiratory illnesses.^{3,11} As such, particularly in the infant age group, it may be difficult to immediately elucidate the cause of cardiac arrests in the field, and therefore the approach to these arrests may be more difficult to protocolize.

PEDIATRIC RESUSCITATION CHALLENGES IN THE FIELD

Other challenges unique to pediatrics can occur during resuscitations in the field. While the new EMS protocols exclude trauma in their 30-minute on-scene CPR recommendations, external findings of non-accidental trauma can be subtle or non-existent, such as in cases of abusive head trauma. This leaves a significant population at risk and could lead to delays in identification and initiation of appropriate care.

Along with more subtle clinical findings, procedures in pediatric patients are also complex. Technical variables including equipment sizing and medication dosing, which vary based on patient age and size, often make a difficult situation even more stressful to medical providers and create the potential for adverse safety events.¹² Given the variation in pediatric anatomy, definitive airway management is also often more difficult than in the adult patient. The evidence around the effect of an advanced airway on survival after OHCA is mixed; however, with several studies supporting the use of bag and mask ventilation over endotracheal intubation in the prehospital setting and others refuting this claim.^{10,13-15} With any method of airway management, however, prehospital providers have limited training and hands-on experience in pediatric patients. Published data regarding the ability of prehospital providers to manage the pediatric airway reveal that the majority has little or no experience with these critical procedures.^{10,16} There is further evidence that pediatric continuing education is limited for many providers, and that rarely utilized pediatric skills, especially those learned outside of the clinical environment,

deteriorate quickly.¹⁷⁻¹⁸ This lack of exposure to POHCA, minimal ongoing experience with important management guidelines and procedures, and limited pediatric continuing education can lead to critical delays and errors in care.

PEDIATRIC RESUSCITATION EFFORTS/PEDIATRIC ARREST AND 30-MINUTE CPR IN THE FIELD

In the spring of 2017, Rhode Island updated the state EMS protocols, including updates to the pediatric cardiac arrest protocol. This updated protocol states, "Regardless of proximity to a receiving facility, absent concern for provider safety or a traumatic etiology for cardiac arrest, resuscitative efforts should continue for a minimum of 30 minutes prior to moving the patient to the ambulance or transporting the patient." This change is supported by adult literature that demonstrates improved outcomes for patients 18 years and older receiving 30 minutes of CPR for out-of-hospital cardiac arrests.² These improved outcomes are largely felt to be due to the detrimental impact of patient transport on high-quality CPR, along with the primarily cardiac etiology of adult arrests. The pediatric literature is less clear.

As previously stated, outcomes for POHCA in general are poor;¹ Tijssen et al, however, found that pediatric out-of-hospital cardiac arrests had improved outcomes with prehospital CPR times ranging from 10–35 minutes.¹⁹ Banerjee et al found improved neurologic outcomes in early on-scene management of POHCA in a single county after initiation of targeted pediatric training and physiologic-driven procedures with on-scene resuscitation time average approximately 17 minutes.²⁰ Young et al, however, found no good neurologic outcomes in survivors who received greater than 31 minutes of CPR. A recent large retrospective study in Japan that examined POHCA and CPR duration found favorable 30-day survival with good neurologic outcome occurred in <1% of patients who received prehospital CPR of 42 minutes duration or longer. It is notable that this study only looked at ROSC obtained in the field, excluding the analysis of over 80% of POHCA in which ROSC was not obtained. In addition, epinephrine was administered less than 50% of the time in those POHCA in which ROSC was obtained, which does not follow standard protocols in the US.⁶ As such, it is possible that the extrapolation of an adult protocol to the pediatric population may result in unintended harm by potentially delaying access to more definitive care by focusing only on the aspect of prolonged scene time and not on pediatric specific resuscitation training and high-quality CPR.

Discussion of length of on-scene resuscitation for pediatric cardiac arrest creates a paradox, where one group of POHCA patients, such as older children and adolescents who have anatomical and physiologic similarities to adult patients, may benefit from prolonged on-scene resuscitation, while another, younger children and infants, may not. It is without question that the delivery of high-quality CPR is the primary

factor in improving survival from cardiac arrest and education and training around this is critical. Other interventions that have been reported to increase survival from out of hospital cardiac arrest, and should be considered for use across Rhode Island include, dispatcher-assisted CPR, "pit-crew" approaches to teamwork, and real-time CPR feedback. In particular, RI lacks a system of formalized telecommunicator CPR, a resource which many states use to provide instructions to families over the phone, initiating resuscitation earlier, which can lead to improved outcomes. The challenge is in crafting resuscitation protocols that identify those who will benefit from protocols encouraging aggressive on-scene resuscitation, and those who would not. In Rhode Island, while it may take significant time, the development of a robust registry of POHCA cases may give valuable guidance to policymakers as well as pediatric emergency medicine and EMS physicians.

CONCLUSION

Pediatric out-of-hospital cardiac arrests require prehospital providers to give careful thought to the etiology of the event while simultaneously delivering high quality resuscitative care. Acknowledging this complex process may prove relevant in the discussion around the utility of longer on-scene resuscitative efforts. The relative rarity of these events also highlights the importance of education for prehospital providers on specific skills and knowledge for pediatric patients.

Given the complexities of pediatric out-of-hospital cardiac arrests, and the scarcity of literature currently available on this topic, careful deliberation regarding the protocolizing of pediatric prehospital care must be given. Only through the recognition of the unique qualities of pediatric patients, the continued collaboration between prehospital and pediatric experts, the encouragement of ongoing pediatric specific training, and the call for increased prehospital pediatric-specific research, will we improve the outcomes for all children.

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Conflicts of Interest

There are no conflicts of interest.

Financial Support and Sponsorship

None.

Disclaimers

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Departments of Emergency Medicine and Pediatrics, Alpert Medical School of Brown University.

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