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Investigate the Factors Involved in the Prognosis of Hospitalized Children Undergoing Cardiopulmonary Resuscitation (CPR) in the Hospital PICU

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Abstract

Introduction: Cardiorespiratory arrest (CPA) in children is uncommon, but with poor prognosis. Identifying factors predictive of clinical outcome in children under CPR can be effective in dealing with these children. The aim of this study was to investigate the factors involved in the prognosis of hospitalized children undergoing cardiopulmonary resuscitation (CPR) in the pediatric intensive care unit (PICU) of Amir Kabir Hospital, Arak.

Materials and methods: This cross-sectional study for 6 months in 2014, on the children admitted to the PICU of Amir Kabir Hospital, Arak, Iran, due to cardiorespiratory arrest, undergone CPR was performed. Children demographic and clinical factors were recorded. Clinical outcomes for children, as LTS (Long-term survivors, children who are discharged alive), STS (Short-term survivors, children who survived for more than 24 hours of the onset of cardiac arrest and have not been released yet), and NS (Nonsurvivors, children who died within 24 hours of the onset of cardiac arrest), was considered. Data were analyzed with t-test and chi-aqaure in SPSS 19.

Results: Among 52 children, 28 (53.8%), 6 (11.5%) and 18 (34.6%) of the children have LTS, STS and NS outcomes, respectively. Normal pupillary reflexes (p=0.001), less consumption of adrenaline during CPR (p=0.001) and a shorter duration of CPR (p=0.0001) are predictive of survival for children under CPR. However, age (p=0.4), sex (p=0.714), type of heart rhythm (p=0.364), type of underlying disease (p=0.66), the GCS (p=0.228) and the number of medical personnel working in child CPR (p=0.287) There was no significant correlation with clinical outcome.

Conclusion: Our study showed that the presence of pupillary reflexes, adrenaline less and shorter duration of CPR, the factors predictive of survival for children under the CPR. However, due to differences in the results of studies in this area, further studies in the future and with regard to more demographic, clinical and epidemiological factors is recommended.

Keywords: Cardiopulmonary resuscitation; Outcome; Cardiopulmonary arrest

Introduction

Cardiopulmonary arrest (CPA) is a sudden uncommon occurrence in children [1]. Eisenberg et al. reported incidence of CPA about 12.7 per 100,000 in children [2]. Cardiopulmonary arterial disease is the result of severe dysfunction of the respiratory system and blood circulation [3]. Patients with emergency CPAs generally have poor prognosis, however, according to the reports, the result of cardiopulmonary resuscitation (CPR) is variable in children or infants [2,4-8]. This may be due to limitations in reports in reports in this area [9]. However, in general, cardiac arrest in children is accompanied with worse prognosis in comparison with adults [10]. This difference in prognosis can be due to differences in the pathogenesis of cardiac arrest, between children and adults. The most common cause of cardiac arrest is in adults is heart disease, while respiratory failure in children is the most common cause of this condition [9], however, in different age groups in children, various underlying conditions are the cause of cardiac arrest. [9], for example, Asphyxia is the most common cause of cardiac arrest at birth, while in infancy and childhood, respiratory diseases, sepsis and trauma are more prevalent [9].

Evidences suggest that survival rate of children undergoing cardiopulmonary resuscitation vary from 15% to 65% [4,6,7,11-15] This variable range of survival rates clearly indicates the involvement of different factors in effectiveness of CPR. Since many of these factors can vary from hospital to hospital, better understanding of these factors can help to improve the prognosis of children undergoing CPR. In addition, the recognition of the mortality rate and the long-term survival of children can be helpful in long-term planning to improve the prognosis of these children. Therefore, the aim of this study was to investigate the factors involve in prognosis of infants and children undergoing CPR in PICU of Amir Kabir Hospital (Arak, Iran).

Material and Methods

This cross-sectional study was performed on infants and children (both sexes undergoing cardiopulmonary resuscitation (CPR) at PICU of Amir Kabir Hospital, (Arak, Iran) for 6 months. The CPR process includes: ventilation, cardiac chest compression, and medications during CPR, in all children based on guidelines of the American Heart Association and the American Academy of Pediatrics [3,12,16,17]. CPR was performed by expert physicians and nurses at the PICU. The following definitions are considered based on guidelines [18]:

Respiratory tract: lack of spontaneous breathing.

Cardiac arrest: the absence of a heart beat and a heart beat in auscultation and touch.

Cardio-respiratory arrest: Absence of spontaneous breathing and heart rate (both together).

After obtaining informed consent from parents of infants and children, the following information was obtained in two sections regarding the subject and the CPR process:

Information before CPR: age, gender, underlying disease, Glasgow Coma score (GCS).

Information on the onset and during CPR: ECG at the start of CPR, pupil reflexes, adrenaline dose during CPR, recovery time, Cardio-pulmonary, number of medical staff (physicians and nurses).

Children were grouped into one of the following groups based on the outcome of CRP [9]:

Long-term survivors (LTS): children who discharged alive from the hospital.

Short-term survivors (STS), children who have survived for more than 24 hours, but have not yet been discharged.

Non-survivors (NS), children who died within 24 hours of heart attack.

LTS children were followed up for 3 months (at the end of each month) for their survival. Factors that measured including: type of cardiac rhythm in the onset of CPR in the form of asystole and other rhythms such as bradycardia, ventricular fibrillation, etc., the presence or absence of pupil's response to light, and the duration of the CPR. The duration of CPR was defined as the time of starting CPR until self-establishing the blood circulation or the presence of symptoms such as cardiac output, blood pressure, or sinus rhythm [19]. GCS was calculated according to Table 1. According to this criterion, scores 13 to 15 represent mild brain damage, 9 to 12 indicate moderate brain injury and score less than 9 indicate severe brain damage [20]. The underlying illness is considered as the presence or absence of the items in Table 2 [9]. Finally, the obtained data were analyzed using SPSS 19 software. In all stages of the project, ethical considerations such as getting informed consent, possibility of optional withdraw from the project and the confidentiality of the information. This research project was approved by the Ethics Committee of the Arak Medical University Research Council with the issue number 2027 and the Code of Ethics 21-171-93.

Opening the eyes		
1	Spontaneous	
2	By calling	
3	By pain	
4	Lack of ability to open eyes	
Vocal response		
Children		**Infants**
1	Alert	Related words: smile, fix and follow
2	Confused	Crying
3	Disproportionate	Persistent stimulation
4	Unclear	Without calm, agitate
5	Lacking vocal response	Lacking vocal response
Movement response		
1		Obey
2		Localization of pain
3		Distance
4		Flaction
5		Extension
6		Lacking movement response

Table 1: Glasgow coma score (GCS) Criteria.

Sepsis
Central nervous system disease: Perinatal asphyxia, meningitis, acute encephalopathy, intrahepatic hemorrhage, hydrocephalus, corpus callosum agenesis, brain tumors, Guillain Barre syndrome, microcephaly
cardiovascular disease: Congenital heart disease, Myocarditis, Cardiac Tamponade, Cardiac Rheumatic disease
Respiratory system disease: Pneumonia, Bronchitis, Respiratory distress syndrome, Pneumothorax, Foreign body aspiration
Gastrointestinal disease: Acute gastroenteritis, Severe malnutrition, Extrahepatic biliary atresia, Necrotizing Enterocolitis, Intestinal volvulus
Others: Prematurity, Sepsis, Multiple malformation syndrome, Chronic renal failure, Immune deficiency, Malignant tumors (Extracranial), etc. unknown

Table 2: Underlying diseases studied in children under study.

Results

The present study conducted in a six months period in 2014. The study population consist of children admitted to the PICU of Amir Kabir Hospital in Arak. 52 children were enrolled in the study. The mean age of children was 11.5 ± 8.88 months. The mean GCS and the mean number of adrenaline intake during CPR were 5.67 ± 1.65 and 2.67 ± 1.75, respectively. Also, the average CPR and the mean number of medical staff present in the CPR were 23.03 ± 16.1 minutes and 4.73 ± 1.28, respectively (Table 3). Among 52 children, 31 (59.6%) were girls and 21 (40.4%) were boys. The most common underlying conditions in children was congenital heart disease and sepsis with frequency of 12 (23.1%) and 10 (19.2%) respectively. Also, for 5 (9.6%) children, underlying illness was unknown. 2 (3.8%), 5 (9.6%) and 45 (86.5%) of the children had respectively VF, sinus, and asystole rhythms in their cardiac system. Concerning the outcomes of children, 28 (53.8%), 6 (11.5%) and 18 (34.6%) children had LTS, STS and NS consequences, respectively (Table 4) (Figure 1).

Three-month follow up of children with LTS and STS outcomes showed that children, 6 (21.4%) of 28 children with LTS and 2 (33.3%) of 6 children with STS finally died.

Frequency and mean of study variables based on the three types of outcomes presented in Table 5. Based on these results, the pupil reflex status (p=0.001), the amount of adrenaline consumed during CPR (p=0.001) and the duration of CPR (p=0.0001) were associated with the clinical outcomes of children underwent CPR. Normal pupil reflexes, fewer adrenalin use during CPR, and a shorter CPR, predict the survival of children underwent CPR. 28 (100%), 3 (50%) and 16 (88.8%) of children with LTS, STS and NS respectively had normal pupil reflexes. The mean number of adrenaline consumed in the LTS, STS and NS groups was 1.89 ± 1.25, 3.66 ± 2.16, 3.55 ± 1.78, respectively. Also, the mean CPR duration in the groups of LTS, STS and NS was 13.66 ± 12.5, 31.5 ± 14.4 and 34.33 ± 13.33, respectively.

It was also found that between age (p=0.4), sex (p=71414), type of rhythm (p=364), underlying disease (p=0.66), GCS level (p=0.228) and the number of active medical staff in the children CPR (p=0.287) and the clinical outcome of the children did not have a significant relationship.

Minimum	Maximum	Mean ± Std	Variable
3	46	11.5 ± 8.87	Age (months)
3	8	5.67 ± 1.65	GCS
0	8	2.67 ± 1.75	Adrenaline (number)
3	60	23.03 ± 16.1	CPR duration (minutes)
2	7	4.73 ± 1.28	Staff

Table 3: Demographic results of children.

Variable		Frequency
Gender	Male	31 (59.6%)
	Female	21 (40.4%)
Underlying Disease	CHD	12 (23.1%)
	Sepsis	10 (19.2%)
	Seizure	4 (7.6%)
	Brian Tumor	4 (7.6%)
	Intracerebral hemorrhage	3 (5.8%)
	Pneumonia	3 (5.8%)
	Metabolic disorder	3 (5.8%)
	Other Disease	1 (1.9%)
	Unknown	5 (9.6%)
Heart Rhythm	Asystole	45 (86%)
	Sinus	5 (9.6%)
	Ventricular fibrillation	2 (3.8%)
Presence of pupil reflex	yes	47 (90.4%)
Consequence	LTS	28 (53.8%)
	STS	6 (11.5%)
	NS	18 (34.6%)

Table 4: Clinical results of children.

CHD: Congenital Heart Disease. Other disease: Burn, drowning, septic shock, foreign body aspiration, Status Epilepticus, methadone poisoning, pulmonary edema and stroke.

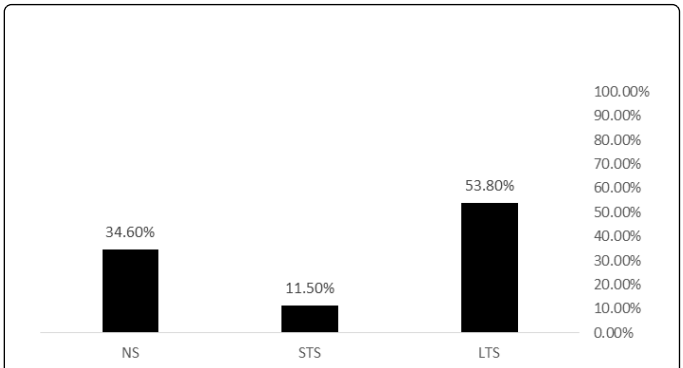

Figure 1: Frequency of consequences LTS, STS, NS among 52 children.

Consequence				
LTS	STS	NS	Variable	
28 patients	6 patients	18 patients		
10.21 ± 8.13	15.33 ± 15.9	12.22 ± 6.94	Age Mean (months ± Std)	
(42.8%)12/(57.1%)16	(50%)3/(50%)3	(33.3%)6/(66.6%)12	Gender (female/male)	
6 ± 1.58	6.83 ± 1.72	5.44 ± 1.68	GCS (Mean ± Std)	
(17.8%)5	(16.6%)1	(33.3%)6	CHD	
(21.4%)6	(16.6%)1	(16.6%)6	Sepsis	
(10.7%)3	0	(5.5%)1	Seizure	

(10.7%)3	0	(5.5%)1	Brian Tumor	Underlying disease
(7.1%)2	(16.6%)1	0	Intracerebral hemorrhage	
(7.1%)2	0	(5.5%)1	Pneumonia	
(7.1%)2	0	(5.5%)1	Metabolic disorder	
0	0	(5.5%)1	foreign body aspiration,	
(3.5%)1	0	0	Status Epilepticus	
(3.5%)1	0	0	methadone poisoning	
0	0	(5.5%)1	pulmonary edema	
(3.5%)1	0	0	Brain trauma	
0	0	(5.5%)1	Burn	
(3.5%)1	0	0	drowning,	
0	0	(5.5%)1	Septic Shock	
(10.7%)3	(33.3%)2	0	Unknown	
(10.7%)3	(16.6%)1	(5.5%)1	Asystole	Heart Rhythm
(3.5%)1	(16.6%)1	0	Sinus	
(85.7%)24	(66.6%)4	(94.4%)17	Ventricular fibrillation	
(100%)28	(50%)3	(88.8%)16	Presence of pupil reflex	
1.89 ± 1.25	3.66 ± 2.16	3.55 ± 1.78	Number of adrenalin (Mean ± Std)	
1396 ± 12.5	31.5 ± 14.4	34.33 ± 13.31	CPR duration (Mean ± Std)	
4.67 ± 1.21	5.5 ± 0.83	4.55 ± 1.46	Staff (Mean ± Std)	

Table 5: Relationship between demographic and clinical factors with the CPR consequences.

Discussion

Each year, 16,000 children die in the United States due to unexpected cardiovascular events, more than a half of these children are under the age of one year. Children who need cardiopulmonary resuscitation (CPR) usually only have respiratory arrest. Cardiac Pulmonary Prognosis is poor in children. Only 10 to 15 percent of these children survive, and most of those who survived are suffering from persistent disabilities. The ability to diagnose or predict conditions before cardiopulmonary arrest and appropriate start of treatment can not only save the patient's life, but also preserve the quality of life of the patients [21-23]. According to our study, the prevalence of children who were discharged alive from the hospital after the CPR was 53.8% that is more than two other types, and the prevalence of children who died within 24 hours of the onset of CPR was 34.6% that is more than children who survived more than 24 hours after CPR. Our study showed that the status of the pupil's reflexes, the amount of adrenaline consumed during CPR, and the duration of CPR, can be predictive of the outcome of children under the CPR. As normal pupil reflexes, fewer adrenalin use during CPR and shorter CPR, can predict the better survival of children under CPR.

Akçay et al. [9] In 2006, in Turkey, examined the prognosis of 67 children admitted in hospital for CPR. Based on the results of this study, 14.9% of the children survived at least 24 hours after the start of CPR (STS state) 68.7% of children died within 24 hours of the onset of CPR and 16.4% of the children were discharged alive from the hospital. In this study, as our study, the outcome of STS was the third most common consequence of patients. However, in our study, most of the children were discharged from hospital, while in Akçay et al. study, the majority of children with died during the first 24 hour of starting the CPR. In Suominen P et al., study [15], a five-year retrospective study, the percentage of children discharged from the hospital after CPR is similar to that of Akcay et al. [9] and contrary to our study. However, the abundance of LTS in our study was in concordnace with results of Davies CR [12], Gillis J [13], Innes PA [14] and Suominen P [15] studies. In all of these studies, percentage of LTS was 15 to 45 percent.

In our study, congenital heart disease with 23.1% was the most common cause of underlying illness in children with CPR. Suominen P [15] also considered the most common underlying disease in children with CPR as congenital heart diseases, while in Akçay study [9], sepsis, was considered as the most common underlying cause with abundance of 21.2%. In our study, there was no significant relationship between age and CPR outcome. This finding was consistent with the study of Akcay A [9] and studies by Suominen P [15] Nichols DG [11] and

Zaritsky A [24]. We also found no relation between gender and outcome of CPR in our study. Schindler MB [25], Slonim AD [26] and Robinson GR [27] also obtained similar results to our study.

According to the study of Akcay A [9] and similar to our study, CPR duration less than 5 minutes and the presence of pupils responsive to light at the onset of CPR are positive predictors of the survival probability of children. According to our study, the demographic and clinical factors such as age, Gender, GCS, underlying disease, heart rhythm, and the number of active saff in CPR ward cannot be useful in predicting the outcomes of children under CPR. Although these findings were similar to the results of the Akcay A [9] study, Friesen RM [5] and Mullie A [28] obtained different results. Friesen RM et al. [5], in a retrospective study, found that underlying diseases had a significant association with prognosis in children who undergone CPR. Also results demonstrated that none of the children with sepsis who underwent CPR, did not discharge from hospital alive. Mullie A et al. [28] examined the relationship between GCS and the outcome of CPR, and results showed that GCS could be helpful in predicting the outcome of patients before they needed CPR. Investigation of factors that are likely to interact with the outcomes of CPR in children is helpful as it can be effective in tracking and caring for children who may be at greater risk.

As a conclusion and based on the various studies that have been done so far on the relationship between children's clinical factors with CPR, it can be stated that various clinical factors can play a role in predicting the clinical outcomes of children undergone CPR, However, the exact role of these factors is still unclear and there are differences between studies. Since the role of these factors can be influenced by various factors, especially factors related to each health center, such as the level of facilities, it seems that the role of different factors in predicting the outcome of CPR should be define for each treatment center separately. In our study, according to the study method (selection of children admitted to the PICU), we did not investigate the association of factors such as the incidence of cardiopulmonary arrest (outpatient, pediatric emergency or pediatric department, etc.) with the outcome of patients. In addition, the lack of correlation between levels of blood factors such as pH and electrolyte levels with the outcomes of children under CPR was subject to study constraints, which recommends future studies taking into account these factors.

Conclusion

Our study showed that the presence of pupil reflexes and the lower number of adrenaline and shorter CPR duration are predictive factors for the survival of children undergone CPR. However, due to differences in the results of studies in this field, further studies in the future are recommended, considering the demographic, epidemiologic and clinical factors.

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