Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 04, 2021

Assessment of Post-Cardiac Arrest Care and Survival Rate in Pediatric Intensive Care Unit

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ABSTRACT

Background: The true incidence of pediatric intensive care unit cardiac arrest is unknown. Post-cardiac arrest care has significant potential to reduce early mortality caused by hemodynamic instability and later morbidity. **Aims and objectives:**To determine overall survival rate for cardiac arrest in pediatric intensive care unit and to justify whether survival rate affected by any factor related to resuscitation procedure or affected by individual factors.**Subjects and Methods:**This Prospective cohort study was conducted at PICU In Pediatrics Department, Zagazig University Hospitals including 48 patients admitted to PICU and arrested either on admission or after a while of admission . The duration of the study ranged from 6-12 months. **Results**: Neurological causes were the most common cause of arrest in our PICU either due to intractable convulsions or combined with DCL. 66.7%, 12.5% and 8.3% of patients were arrested due to intractable convulsions, sepsis, and metabolic causes respectively. All our patients were on mechanical ventilation, and 58.3% of them received inotropes. There was statistically significant relation between patients' outcome and PIM-2 score which was significantly lower among survivors also. There was statistically significant relation between patients' outcome and number of CPR cycles and CPR outcome. **Conclusion**: The more CPR/duration the less risk of mortality by 3.9 folds reduction.
Keywords: Post-Cardiac Arrest Care, Survival Rate, Paediatric Intensive Care Unit.

Introduction

Cardiac arrest is defined as the cessation of functional mechanical activity of the heart, determined clinically by absent central pulses, unresponsiveness and apnea. Absence of blood flow leads to non-perfusion of vital organs, including the brain, kidneys and the heart muscle. Cardiac arrest is a potentially devastating event, associated with death or severe neurological complications in survivors. It may occur both in previously healthy children and in children with underlying diseases or abnormalities **(1)**.

The true incidence of pediatric cardiac arrest is unknown, but Out Hospital Cardiac Arrest (OHCA) events are estimated at 9 per 100,000 person years, whereas arrest within intensive care units is thought to occur 0.94 times per 100 admissions. A large proportion (40-55%) of OHCAs in children occur in infants compared with other age categories. In children, respiratory and cardiovascular failures are the major causes of cardiac arrest, but cardiac arrhythmias may not be as uncommon **(2)**.

Although the process of cardiac arrest and resuscitation is a continuum, it may be seen to consist of four phases: prearrest; no flow; low flow, and ROSC. The prearrest phase may be associated with respiratory failure or shock states, which can result in asphyxia or ischaemia and so lead to inadequate delivery of

substrate for cellular metabolism. This phase, if untreated, leads to established cardiac arrest, with the cessation of mechanical activity of the heart, absent pulses and a no-flow state (arrest) **(3)**.

The low-flow phase ensues when CPR is instituted. The main goal of intervention at this stage is to optimize cerebral, coronary and other vital organ perfusion. Effective, uninterrupted chest compression at this stage is key to a successful outcome **(4)**.

Hemodynamic instability is common after cardiac arrest. Death due to multiorgan failure is associated with a persistently low cardiac index during the first 24 hours after resuscitation. Vasodilation occurs from loss of sympathetic tone and from metabolic acidosis **(5).**

Fluid administration as well as vasoactive (e.g. norepinephrine), inotropic (e.g. dobutamine), and inodilator (e.g. milrinone) agents should be titrated as needed to optimize blood pressure, cardiac output, and systemic perfusion. Although mechanical circulatory support improves hemodynamics in patients not experiencing cardiac arrest, it has not been associated with improved clinical outcome and routine use of mechanical circulatory support after cardiac arrest is not recommended **(6)**.

Appiah et al (7) described the characteristics, course and outcomes of children admitted to a Pediatric Intensive Care Unit (PICU) following cardiac arrest. They found that mortality was lower than predicted in children admited to the PICU following cardiac arrest. The majority of survivors had good neurological outcomes.

Post-cardiac arrest care has significnat potential to reduce early mortality caused by hemodynamic instability and later morbidity and mortality from multiorgan failure and brain injury **(8).** **Bardai et al (2)** have reported wide ranges in survival from 2% to 24%.

We aimed at this study to determine overall survival rates for cardiac arrest in pediatric intensive care unit and to justify whether survival rate affected by any factor related to resuscitation procedure or affected by individual factors.

Patients and Methods

This Prospective cohort study was conducted at PICU In Pediatrics Department, Zagazig University Hospitals. This study was conducted on 48 patients admitted to PICU and arrested either on admission or after a while of admission except patients who labeled don't resuscitate (DOR). The duration of the study ranged from 6-12 months.

Inclusion criteria:

Any patient admitted to PICU and arrested either on admission or after a while of admission .

Exclusion criteria:

- Any patient arrested outside the unit.
- Any patient's parents refused resuscitation as in terminal cases.
- Any patient's parents refused enrolling in the study.

All Patient demographics were included (age, sex, body weight, height, BMI, causes of admission, cause of arrest and PIM-2 score). Also Arrest-specific characteristics(e.g. witnessed versus non-

witnessed arrest) were documented. Resuscitation-specific information (e.g. whether CPR is initiated by a bystander and use of an automated external defibrillator AED, number of CPR cycles/case).

All patients were subjected to Full general examination,the associated factors in predicting mortality such as presence of shock, need for mechanical ventilation, and Glasgow coma scale were also recorded. Any patient with tachycardia and signs of poor end organ perfusion, as defined by poor peripheral pulses with normal central pulses, prolonged capillary refill or flash refill, altered sensorium, cool extremities, and decreased urine output was considered to have "presence of shock." Glasgow coma scale <8 was considered as low Glasgow coma scale. The length of stay in PICU was recorded with vital signs documentation and monitoring (HR, RR, Bl.Pr, Temp, Input and output charts) .

Laboratory Investigations including: Hemoglobin, WBCs, Platelet count, Blood glucose, Sodium, Potassium, Calcium, PH, Co2, and HCO3, Arterial blood gas analysis was done within 1 h of PICU admission.

The patients were followed-up throughout their stay in PICU and during the hospital stay to record their final outcome. The primary outcome was recorded either "discharged" or "death."

Ethical considerations: The IRB "institutional review board" of Zagazig University's school of medicine accepted the research plan. All participants signed a written informed consent form (parents). To gather all data on the patient and the outcomes of investigations conducted during the study period, a file with the same number was created. They were told that any information collected would be kept strictly private, and that the study findings would be utilized only for research purposes. They have the option of declining without affecting their management strategy.

Statistical analysis: The data was coded, entered, and analyzed using Microsoft Excel software throughout the history, clinical examination, laboratory investigations, and outcome measures. The data was tabulated and analyzed using SPSS (statistical package for social science). Independent samples Student's t-test was used to compare between two groups of normally distributed variables while Mann-Whitney U Test is a statistical test for comparing two groups with quantitative variables that do not have a normal distribution. The Chi-square test (X2) or fisher were performed to compare and correlate two qualitative variables.Binary logistic regression was used to predict the odds of being a case based on the values of the independent variables (predictors).The results were considered statistically significant and highly statistically significant when the significant probability (P value)was < 0.05* and <0.001** respectively.

Results

This study included 48 arrested patients.66.7%, 12.5% and 8.3% of patients were arrested due to intractable convulsions, sepsis, and metabolic causes respectively.

Cardiopulmonary resuscitation succeed in 44 patients (91.7%), failed in 4 patients (8.3%), illustrated in **Figure(1)**

Mean age ranged from 6 months to 9 years with mean 6.094 years. Body weight ranged from 6 to 25 kg with mean 19.5 kg. male gender represented (72.9%) of the studied patients. PIM-2 score ranged from 1.89 to 72.14 with median 5.05.**Table (1).**

Convulsion alone was the cause of admission in 58.3%, convulsion combined to DCL occurred in 25% while refractory statue epilepticus associated with meningitis occurred in 2.1%. Meningitis alone was

cause of admission in 10.4%, all were on mechanical ventilation, and 58.3% received inotropes. So neurological causes were the most common cause of arrest in our PICU.**Table (2)**

There was statistically non-significant change in hemoglobin, white blood cell count, platelet count, or blood glucose among survivors after arrest.On the other hand, there is significant hypernatremia and hypercalcemia after recovery while there was statistically significant post arrest hypokalemia, There was significant hypercapnia and metabolic acidosis after recovery from arrest.**Table (3)**

There was statistically significant relation between patients' outcome and PIM-2 score which was significantly lower among survivors. **Table (4)**

There was statistically significant relation between patients' outcome and number/duration of CPR cycles. All survivors had from 1 to 3 CPR cycles . Non-survivors underwent from 4 to 7 CPR cycles. Among non-survivors, 4 did not survive CPR while one survived CPR cycles. **Table (5)**

There was statistically significant relation between patients' outcome and post-arrest arrhythmia. Forty percent of non-survivors had heart block versus 2.3% within survivors. **Table (6)**

There was significant relation between number of non survivals and (number of CPR cycles and high PIM2 score). **Table (7)**

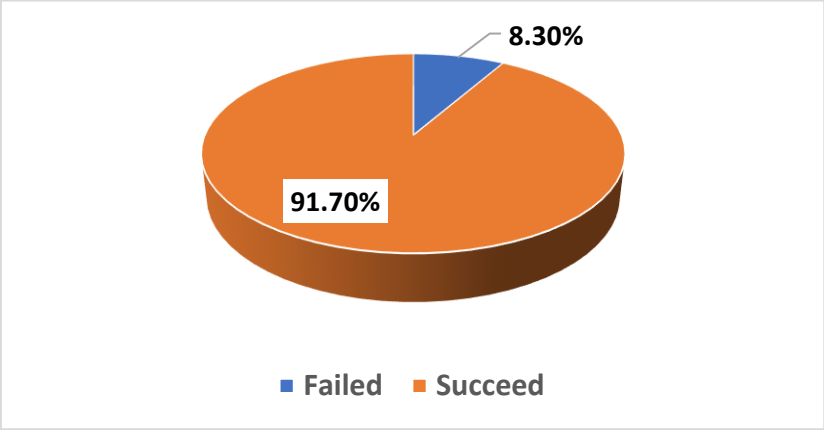

Figure (1) Pie chart showing distribution of the studied patients according to outcome of CPR

Table (1) Distribution of the studied patients according to demographic data:

Parameter	N=48	%
Age (year):		
Mean ± SD	6.094 ± 1.844	

Range	0.5 – 9	
Weight (kg):		
Mean ± SD	19.5 ± 4.04	
Range	6 – 25	
Gender:		
Female	13	(27.1%)
Male	35	(72.9%)
PIM-2 score:		
Median	5.05	
Range	1.89 – 72.14	

Table (2) Distribution of the studied patients according to cause of admission and life-saving interventions:

Parameter	N=48	%
Cause of admission:		
Accident + post operative	2	4.2%
Convulsions	28	58.3%
Convulsions and DCL	12	25.0%
Meningitis	5	10.4%
Meningitis + refractory status epilepticus	1	2.1%
AED:		
No	41	85.4%
Yes	7	14.6%
MV	48	100%
Inotropes:		
No	20	41.7%
Yes	28	58.3%

Table (3) Relation between patient outcome and blood chemistry findings among the studied patients before and after arrest:

	Before	After	T	P
	Mean ± SD	Mean ± SD		
Hemoglobin (g/dL)	10.11 ± 1.4	10.08 ± 1.19	-0.137	0.892
TLC (10^3/mm^3)	15.12 ± 4.7	16.35 ± 5.27	-1.502	0.14
Platelet count(10^3/mm^3)	277.02 ± 71.9	299.7 ± 84.33	-1.867	0.069
Blood glucose (mg/dL)	121.05 ± 53.08	121.0 ± 50.71	0.018	0.986
Sodium (mg/dL)	138.26 ± 8.36	143.02 ± 2.49	-3.423	0.001**
Potassium (mg/dL)	4.03 ± 0.35	3.44 ± 0.33	8.366	<0.001**
Calcium (mg/dL)	2.62 ± 1.27	5.48 ± 2.43	-7.272	<0.001**
PH	7.27 ± 0.24	7.31 ± 0.06	-1.355	0.183
Co2	38.33 ± 3.74	40.17 ± 3.96	-2.477	0.017*

Table (4) PIM-2 score among the studied patients:

	Died	Survivors	T	P
	N=5	N=43		
Mean ± SD	50.31 ± 15.98	4.54 ± 1.48	6.403	0.003*

Table (5) Relation between patient outcome and cause of admission and life saving intervention of the studied patients:

	Died	**Survivors**	χ^2	**P**
	N=5(%)	**N=43(%)**		
CPR Cycles:				
Once	0 (0)	36 (83.7)		
Twice	0 (0)	4 (9.3)		
Three	0 (0)	3 (7.0)	34.382	<0.001**
Four	4 (80)	0 (0)		
Five to Seven	1 (20)	0 (0)		
CPR result:				
Failed	4 (80)	0 (0)	Fisher	<0.001**
Succeed	1 (20)	43 (100)		

Table (6) Incidence and Type of arrhythmia after arrest of the studied patients:

	Died	**Survivors**	χ^2	**P**
	N=5(%)	**N=43(%)**		
Arrhythmias:		/		
No	0 (0)	42 (97.7)		
Heart block	2 (40)	1 (2.3)		
Gallop rhythm	3 (60)	0 (0)	MC	<0.001**

Table (7) Binary regression analysis of factors associated with death among the studied patients:

PIM-2 Score	1.342	.998	3.828	.000	.
Number of cycles of CPR	1.363	1.000	3.907	.000	.

Discussion

In-hospital cardiac arrest (CA) is a major public health issue which almost ends up with death both in adults and children. The global prevalence of in-hospital cardiac arrest is not well documented especially in PICU. But, each year, nearly 1 million cases of cardiac arrest were recorded in Europe and United States. Similarly, about 2–6% of children admitted to pediatric intensive care units are estimated to be victims of cardiac arrest. About 60% of cardiac arrest cases among the pediatric population occurs in younger children or infants. Probability of survival after in-hospital cardiac arrest is low. More than 75% of the victims are estimated to die. One-third of the survivors will have neurological malfunctions. Hence, it is a threatening condition for families of the patient and healthcare providers. Furthermore, it is associated with devoting huge amounts of healthcare resources (**9).**

This study included 48 patients with arrest.66.7%, 12.5% and 8.3% of patients were arrested due to intractable convulsions, sepsis, and metabolic causes respectively. Five patients (10.4%) died after failed CPR, and 43 patients (89.6%) survived. Mean age ranged from 6 months to 9 years with mean 6.094 years. Body weight ranged from 6 to 25 kg with mean 19.5 kg. male gender represented (72.9%) of the studied patients. PIM-2 score ranged from 1.89 to 72.14 with median 5.05.

There is statistically non-significant relation between patients' outcome and either gender, age or body weight. Survivors were younger, lower body weight while 76.7% of them were males versus 40% among non-survivors.

And that was supported by study of **Berg et al., (10)**, as they reported that as regard comparisons of these characteristics among children who survived to hospital discharge and those who died. Ninety-eight (98%) were <1 year old.

The current study showed that as regard number of CPR cycles either the patient recovered or died. Three quarters of patients underwent one till survival, 8.3%, 6.3%, 8.3% and 2.1% underwent 2, 3, 4 and 7 respectively. The outcome of cardiopulmonary resuscitation which succeed in 44 patients (91.7%). As regard distribution of patients according to post-arrest arrhythmias. About 88% had no arrhythmias, 6.3% had Gallop rhythm, 6.3% of them had heart block. five patients died (10.4%).

There was statistically significant relation between patients' outcome and PIM-2 score which was significantly lower among survivors. There was statistically significant relation between patients' outcome and number of CPR cycles and CPR outcome. All survivors had cycles from 1 to 3 while non survivors underwent from 4 to 7 cycles . Among non-survivors, 4 did not survive CPR while one survived CPR . There was statistically significant relation between patients' outcome and post-arrest arrhythmia. Forty percent of non-survivors had heart block versus 2.3% within survivors .Increasing number of cycles of CPR/duration significantly reduce risk of mortality by 3.9 folds .

In the study of **Berg et al., (10)**, the PICU mortality rate for these 10,078 admissions was 2.3% (227 PICU deaths) and overall hospital mortality rate was 2.7% (275 hospital deaths). A total of 139 (1.4%) received CPR for ≥ 1 minute and/or defibrillation within the initial PICU admission. Only 4 had defibrillation without chest compressions. Twenty-eight (28%) of these children received CPR on multiple occasions for a total of 182 CPR events (1.8 CPR events/100 admissions). The incidence of index CPR events (i.e., number of index CPR events per 100 ICU admissions) ranged across sites from 0.6 to 2.3 per 100 admissions ($p < 0.001$). Among the 139 children with a CPR event, 31 (22%) failed to attain return of circulation during the initial CPR event, 91 (65%) attained return of spontaneous circulation for >20 minutes, and 17 (12%) attained return of circulation via ECLS instituted during CPR.

In the previous study, the median duration of the initial CPR event was 9 minutes before recoveryof patient (IQR 3, 30) for the 135 CPR events with chest compressions ≥1 minute (range: 1–122 minutes). Among the 90 patients receiving CPR for poor perfusion with bradycardia and/or hypotension, the median duration of the initial CPR event was 8 minutes (IQR 3, 30); 17 (19%) did not attain return of circulation, 61 (68%) attained return of spontaneous circulation for >20 minutes, and 12 (13%) had return of circulation by ECLS (extracorporeal life support) during CPR. Among the 45 patients receiving CPR for pulselessness, the median duration of the initial CPR event was 14 minutes (IQR 3, 28); 14 (31%) did not attain return of circulation, 28 (62%) attained return of spontaneous circulation for >20 minutes, and 3 (7%) had return of circulation via ECLS during CPR. Shorter duration CPR was associated with higher survival rates (**10)**.

Foglia et al., (11) revealed that there were 1.2 CPR events per 1000 patient days. CPR was performed in 113 of 5046 (2.2%) infants admitted to the NICU during the study period. The median duration of chest compressions was 2 min (interquartile range 1, 6 min). Adrenaline was administered in 34 (30%) CPR events. Of 113 infants with at least one CPR event, 69 (61%) survived to hospital discharge. Factors independently associated with decreased survival to hospital discharge were inotrope treatment prior to

CPR (adjusted Odds Ratio [aOR] 0.14, 95% Confidence Interval [CI] 0.04, 0.54), and adrenaline administration during CPR (aOR 0.14, 95% CI 0.04, 0.50).

Conclusion

The more number of CPR cycles/duration the higher incidence of survival.

Conflicts of interest: None.

References:

1. **Kleinman ME, De Caen AR, Chameides L, et al. (2010):** Pediatric basic and advanced life support: 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Circulation; 122(16 Suppl 2): S466-S515.

2. **Bardai A, Berdowski J, Van Der Werf C, et al. (2011):** Incidence, causes, and outcomes of out-of-hosptal cardiac arrest in children: A comprehensive, prospective, population-based study in the Netherlands. J Am CollCardiol; 57: 1822-1828.

3. **Topjian AA, Berg RA, Nadkarni VM, et al (2008):** Pediatric cardiopulmonary resuscitation: Advances in science, techniques, and outcomes. Pediatrics;122:1086–1098.

4. **Bennett KS, Clark AE, Meert KL, et al. (2013):** Early oxygenation and ventilation measurements after pediatric cardiac arrest: Lack of association with outcome. Crit Care Med; 41(6): 1534-1542.

5. **Bor-Seng-Shu, E., Kita, W. S., Figueiredo, E. G., Paiva, W. S., Fonoff, E. T., Teixeira, M. J., &Panerai, R. B. (2012):** Cerebral hemodynamics: concepts of clinical importance. Arquivos de neuro-psiquiatria, 70(5), 352-356.

6. **Gaieski DF, Band RA, Abella BS, et al. (2009):** Early goal-directed hemodynamic optimization combined with therapeutic hypothermia in comatose survivors of out-of-hospital cardiac

7. **Appiah, J., Salie, S., Argent, A., & Morrow, B. (2018).** Characteristics, course and outcomes of children admitted to a paediatric intensive care unit after cardiac arrest. Southern African Journal of Critical Care, 34(2), 58-64.

8. **Neumar RW, Nolan JP, Adrie C, et al. (2008):** Post-cardiac arrest syndrome: epidemiology, pathophysiology, treatment, and prognostication. A consensus statement from the International Liaison Committee on Resuscitation; the American Heart Association Emergency Cardiovascular Care Committee; the Council on Cardiovascular Surgery and Anesthesia; the Council on Cardiopulmonary, Perioperative, and Critical Care; the Council on Clinical Cardiology; and the Stroke Council. Circulation; 118:2452–2483.

9. **Arjunan P, Ramakrishnan TV, Gandhamaneni S. (2020).** Characteristics and survival rates of patients experience in-hospital cardiac arrest: a retrospective study in a tertiary care Indian hospital. Bangladesh J Med Sci.;19(3):537–42.

10. **Berg, R. A., Sutton, R. M., Reeder, R. W., Berger, J. T., Newth, C. J., Carcillo, J. A., ... & CPCCRN PICqCPR Investigators. (2018).** Association between diastolic blood pressure during pediatric in-hospital cardiopulmonary resuscitation and survival. Circulation, 137(17), 1784-1795.

11. **Foglia, E. E., Langeveld, R., Heimall, L., Deveney, A., Ades, A., Jensen, E. A., &Nadkarni, V. M. (2017).** Incidence, characteristics, and survival following cardiopulmonary resuscitation in the quaternary neonatal intensive care unit. Resuscitation, 110, 32-36.