Survival after In-hospital Cardiac Arrest among Paediatric Patients-A Descriptive Study

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ABSTRACT

Introduction: Cardiac arrest in children is a fatal incident usually ending in death or very poor neurological results. Western countries that have reliable data have put in place, mechanisms to anticipate cardiac arrest due to common condition and also effective response for a cardiac arrest in vulnerable children. The prevalence and survival of paediatric cardiopulmonary arrest are not well-studied in a developing country like India. Moreover, data regarding the effectiveness of CardioPulmonary Resuscitation (CPR) and the survival of children after suffering cardiac arrest in the hospital is also scarce from developing countries. Data on the precipitating events, survival and predictors of adverse outcome of cardiac arrest in our patient population can potentially help us in planning for the delivery of better care to our patients. The differences in data from India and rest of the world are highlighted.

Aim: To identify underlying aetiology, precipitating factors, the outcome in terms of survival, and the predictors of survival among hospitalised paediatric patients developing cardiac arrest.

Materials and Methods: This prospective descriptive study was conducted from October 2012 to June 2014 in JIPMER, a tertiary care teaching institute in Puducherry, India. A total of 137 cases were included in the study. There clinical baseline, pre-arrest, arrest, post-arrest parameters were recorded. Final outcome of the patient as survival or death was also recorded. For the survivors Paediatric Cerebral Performance Category

(PCPC) measure of cognitive function was recorded. The result obtained from the study was analysed using SPSS 20.0.

Results: Total 137 patients included in the study after qualified the inclusion criteria and majority 77 (56.2%) patients were infants. Infections was major 103 (75.18%) underlying aetiology. 126 cases (92%) of the observed cardiac arrest occurred in Paediatric Intensive Care Unit (PICU). Return of Spontaneous Circulation (ROSC) was achieved in 82 children (59.8%) and 27 children (19.7%) survived to hospital discharge. A 77.8% of the survivors had normal to mild disability and one patient (<1%) had severe disability at discharge. Most common observed rhythm at the time of cardiac arrest was bradycardia 100 (72.9%) cases. At the time of arrest, prolonged CPR, multiple doses of adrenaline, venous blood gas disturbances were predictors of poor outcome. In the post-arrest period, presence of hypotension, prolonged capillary refilling time, low SpO_2, hypothermia and lab parameters like thrombocytopenia and liver dysfunction were associated with poor outcome.

Conclusion: In paediatric CPR prevalence of survival is absolutely excellent. Independent association between many parameters and hospital mortality is established. Subsequent research should focus on whether each of these association establish as cause and effect in future. In paediatric cardiac arrest clinical epidemiologist determining the efficiency of present day interventions like therapeutic hypothermia is crucial to recognise these associations in their research methodology.

INTRODUCTION

Cardiac arrest is a devastating event, which has extensive negative impact on the health care system. CPR a lifesaving procedure is required to bring back the heart function at the time of cardiac arrest. It can occur both inside the hospital and out of the hospital due to many medical emergencies. The rate of in hospital cardiac arrests is almost 100-fold greater than out-of-hospital arrests among paediatric population [1]. After analysing the global statistical data on cardiac arrest among children in PubMed search there is obvious geographical imbalance suggesting all published research is from North America, Western Europe and few countries of the Asia pacific like China [1,2]. In India the outcome of cardiac arrest is poor due to inadequate pre-medical Emergency Medical System (EMS), shortage of EMS protocols, scarcity of medical resources, equipment and infrastructure, inadequate emergency medical personnel training, paucity of awareness and competence of CPR among bystanders and in the community as compared to western countries, where EMS systems are an essential part of the health care facility which commonly adminsters CPR to every victim of cardiac arrest. Data on the precipitating events, survival and predictors of adverse

outcome of cardiac arrest in our patient population will help policy makers and health care facilitator, identify the changes to be made to optimise health care system interventions and improve in hospital cardiac arrest outcome. Although, in-hospital cardiac arrest it is somewhat common, but there is inadequate data highlighted on this issue in developing country like India that to prospective study in a tertiary hospital of southern India. Hence, an attempt has been made to study prevalence and survival of paediatric cardiopulmonary arrest which can be used to create a guidelines for setting up EMS, preparing emergency protocols, imparting technical assistant and training in our population in future.

MATERIALS AND METHODS

A prospective descriptive study was conducted in the Paediatric Emergency, PICU and general wards of Paediatric Department of JIPMER, a tertiary care teaching institute Puducherry, India from October 2012 to June 2014 (one year and nine months). The reported survival after cardiac arrest in the literature varies from 9-47% [2]. Considering an expected survival rate of 20% in our study population with a 5% margin of error with an alpha error of 5% and

90% power, the estimated sample size comes to 135. All children from day one to 12 years of age developed in-hospital cardiac arrest in paediatric general ward, Emergency and PICU were included in the study. Children developed cardiac arrest within six hours of admission in paediatric emergency care, preterm neonates, children with terminal illness receiving compassionate care, children in whom CPR is not initiated or children with brain death.

Data Collection

Patients with in hospital cardiac arrest in ward, emergency and in PICU satisfying inclusion criteria were enrolled in the study after getting informed consent from parents or legal guardian. Cardiac arrest was defined according to American Heart Association (AHA) 2004 protocol [3]. Only initial cardiac arrest satisfying the inclusion criteria was taken for the study, subsequent arrest was not included in the study. CPR was provided according to Paediatrics Advance Life Support (PALS) 2010 AHA guideline [4].

Baseline characteristics such as age, sex, weight, height were recorded. Aetiology, initial admission clinical parameters such as pulse rate, respiratory rate, Blood Pressure, SpO_2, Random Blood Sugar (RBS), Capillary Refilling Time (CRT), rhythm, intubation at admission, Venous Blood Gas analysis (VBG), haemoglobin levels, Total Leucocyte Count (TLC), differential count and platelet counts were recorded. Clinical and biochemical parameters (VBG) recorded in the case record within a period of one hour before arrest were also recorded as pre-arrest variables. Similarly, on admission Liver Function Test (LFT), Renal Function Test (RFT) and serum electrolytes were also collected.

Cardiac arrest characteristics such as location of arrest (PICU, Emergency Department and General ward), first documented rhythm during arrest, whether arrest is witnessed or not, ROSC, CPR duration, adrenaline (dosing and frequency), other medications used during resuscitation (sodium bicarbonate, calcium and atropine) and their dosing and frequency were recorded in the performa.

Post-resuscitation phase haemodynamic parameters were monitored from zero to 24 hours. Temperature, BP, pulse rate, rhythm, CRT, SpO_2, Glasgow Coma Scale (GCS), pupillary reaction was recorded at ROSC, 12 hours and 24 hours post-resuscitation. RBS was taken at arrest, two hours and six hours of post-resuscitation. For patients who had ROSC, LFT, RFT, serum electrolytes, haemoglobin levels, TLC, differential count and platelet counts were also collected. Time intervals such as PICU stay, ventilation days and duration of hospital stay were also recorded. Final outcome of the patients as survival or death was also recorded. For the survivors PCPC measure of cognitive function was recorded. Normal (PCPC score 1) and mild disability (PCPC score 2) at hospital discharge was defined as good neurological function [5].

STATISTICAL ANALYSIS

The data obtained from the study was analysed using SPSS 20.0 (IBM Corporation, New York, and U.S.A) software. The various clinical and lab parameters recorded were summarised using mean/median (continuous data) and proportions (binary data). The data of survivors were compared with non-survivors to identify significant association with the primary outcome (survival/death). Continuous variables with normal distribution were compared using student t-test and those not normally distributed using Mann-Whitney U test. Chi-square test or Fisher's test was used for analysing categorical variables. A multivariate logistic regression analysis has done to predict the independent variables that effecting the final outcome (survival or death) among patients with in hospital cardiac arrest. Three models were created for pre-arrest, arrest and post-arrest variables. All statistics were two-tailed, and a $p<0.05$ was considered to be significant.

RESULTS

During the study period there were 5049 admissions to the Paediatric Department. Out of this there were only 382 (7.5%). reported cardiac arrests. Totally 137 patients satisfying the inclusion criteria were included in the study [Table/Fig-1]. Most common involved population 77 (56.2%) were infants (less than one year) [Table/Fig-1]. Total patients who had in-hospital cardiac arrest, 80 (58.4%) were males and 57 (41.6%) were females [Table/Fig-1]. Among survivors, majority were in the age group between one month to six months and survival rate was higher among males (14.6%). Infections contributed to 103 cases (75.18%) of the underlying aetiology in children having cardiac arrest [Table/Fig-1]. Most common infection identified was sepsis without focus (33.9%), followed by pneumonia (30%) [Table/Fig-2]. The most common site of occurrence of cardiac arrest was in PICU in 126 (91.97%) patients [Table/Fig-3]. Due to the high preponderance of PICU arrest, 88.3% of the study children were receiving mechanical ventilation at the time of cardiac arrest. Out of 137 children who had cardiac arrest in our study, ROSC was achieved only in 82 children (59.8%) [Table/Fig-3] and out of these 61 (74.3%) children were alive after 12 hours of post-resuscitation, 56 (68.29%) were alive at 24 hours of post-arrest period. Only 27 children (19.7%) out of 137 children who had cardiac arrest, survived to hospital discharge. Median duration of CPR was 20 minutes and median number of adrenaline doses was three [Table/Fig-3]. Children with low BP and prolonged CRT, VBG disturbances like metabolic and respiratory acidosis with hypoxia one hour before the occurrence of cardiac arrest had poor outcome [Table/Fig-4]. At the time of arrest, need of prolonged CPR, use of multiple doses of adrenaline were also predictors of poor outcome [Table/Fig-3]. Most common observed rhythm at the time of cardiac arrest was bradycardia in 100 (72.9%) cases followed by asystole in 26 (19%), shockable rhythms (VT/VF) eight (5.8%) and Pulseless Electrical Activity (PEA) in three (2.1%) cases [Table/Fig-3]. In the post-arrest period, presence of low BP, prolonged CRT, low SpO_2 and hypothermia at 12 hours and 24 hours post-cardiac arrest were independently associated with poor outcome [Table/Fig-5]. In addition, lab parameters like low platelet count, deranged Prothrombin Time/International Normalised Ratio (PT/INR) and liver dysfunction in the post-resuscitation phase

Characteristics	Survivors (n=27)	Non-survivors (n=110)	Total	p-value
Age				
1 to 28 days	3 (18.8%)	13 (81.2)	16 (100%)	
1 to < months	12 (29.3%)	29 (70.7%)	41 (100%)	
6 months to <1 year	3 (15%)	17 (85%)	20 (100%)	
1 to <3 years	1 (4.3%)	22 (95.7%)	23 (100%)	0.231
3 to <6 years	4 (28.6%)	10 (71.4%)	14 (100%)	
6 to 12 years	4 (17.4%)	19 (82.6%)	23 (100%)	
Sex				
Male	20 (25%)	60 (75%)	80 (100%)	
Female	7 (12.3%)	50 (87.7%)	57 (100%)	0.0316
Aetiology				
Infections	19 (18.5%)	84 (81.5%)	103 (100%)	0.197
Heart disease	3 (27.3%)	8 (72.7%)	11 (100%)	0.453
Fulminant hepatic failure	1 (14.3%)	6 (85.7%)	7 (100%)	0.583
Envenomation	2 (33.3%)	4 (66.7%)	6 (100%)	0.337
Status epilepticus	1 (20%)	4 (80%)	5 (100%)	1.00
Haematological malignancies	1 (33.3%)	2 (66.7%)	3 (100%)	0.485
Diabetic Ketoacidosis (DKA)	0 (0.0)	2 (100%)	2 (100%)	0.644

[Table/Fig-1]: Demographic characteristics, aetiology of underlying illness resulting in cardiac arrest of study population and relation to outcome.
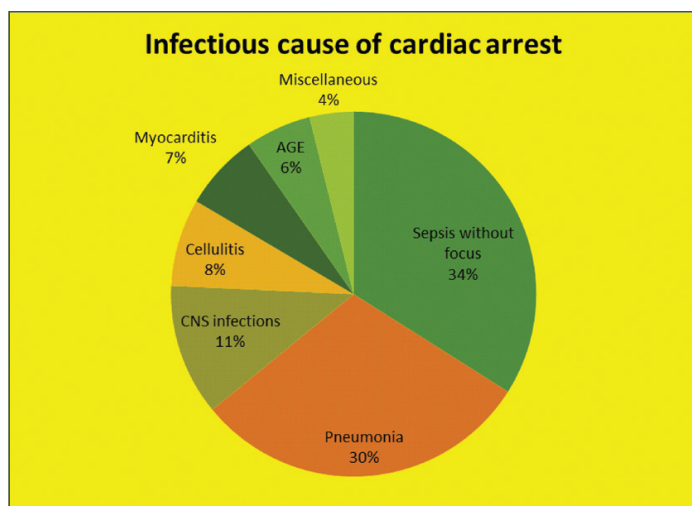
[Table/Fig-2]: Case distribution of children with infectious aetiology.
CNS: Central nervous system

Characteristics	Survivors (n=27) n (%)	Non-survivors (n=110) n (%)	p-value
Location of arrest			
PICU (n=126)	23 (85.2)	103 (93.6)	0.161
General Ward (n=6)	3 (11.1)	3 (2.7)	
Emergency (n=5)	1 (3.7)	4 (3.6)	
Rhythm at arrest			
Bradycardia (n=100)	21 (77.8)	79 (71.8)	0.161
Asystole (n=26)	4 (14.8)	22 (20.0)	
VT/VF (n=8)	1 (3.7)	7 (6.4)	
PEA (n=3)	1 (3.7)	2 (1.8)	
ROSC			
Yes (n=82)	27 (100.0)	55 (50.0)	0.0001
No (n=55)	0 (0.0)	55 (50.0)	
CPR duration			
0 to 5 minutes (n=39)	15 (55.6)	24 (21.8)	0.0001
5 to 10 minutes (n=10)	3 (11.1)	7 (6.4)	
10 to 15 minutes (n=14)	5 (18.5)	9 (8.2)	
15 to 20 minutes (n=15)	2 (7.4)	13 (11.8)	
20 to 30 minutes (n=40)	2 (7.4)	38 (34.5)	
30 to 45 minutes (n=16)	0 (0.0)	16 (14.5)	
More than 45 minutes (n=3)	0 (0.0)	3 (2.7)	
1. Adrenaline			
1 Dose (n=28)	12 (44.4)	16 (14.5)	0.003
2 Doses (n=30)	6 (22.2)	24 (21.8)	
3 Doses (n=79)	9 (33.3)	70 (63.6)	
2. Calcium			
1 Dose (n=36)	3 (11.1)	23 (20.9)	0.210
2 Doses (n=21)	2 (7.4)	19 (17.3)	
3 Doses (n=2)	0 (0.0)	2 (1.8)	
No Calcium (n=82)	22 (16.1)	66 (60.0)	
3. NaHCO₃/ATROPINE			
NaHCO₃ (n=19)	1 (3.7)	18 (16.4)	0.120
Atropine (n=13)	4 (14.8)	9 (8.2)	
NaHCO₃ and Atropine (n=4)	2 (7.4)	2 (1.8)	
NO NaHCO₃/Atropine (n=101)	20 (74.1)	81 (73.6)	

[Table/Fig-3]: In-hospital arrest event parameters, CPR duration, medications used during resuscitation and their relation to outcome.
CPR: CardioPulmonary Resuscitation, PICU: Paediatric intensive care unit, VT: Ventricular tachy-cardia, VF: Ventricular fibrillation, PEA: Pulseless electrical activity, ROSC: Return of spontaneous circulation, NaHCO₃: Sodium bicarbonate, NO: Nitric oxide

Characteristics	Survivors (n=27) n(%)	Non-survivors (n=110) n(%)	p-value
Pulse rate			
Normal	11 (40.7)	30 (27.3)	0.561
Tachycardia	8 (29.6)	40 (36.4)	
Bradycardia	8 (29.6)	40 (36.4)	
SpO₂			
≤94	16 (59.3)	73 (66.4)	0.506
95 to 100	11 (40.7)	37 (33.6)	
Blood pressure			
Normal	16 (59.3)	23 (20.9)	0.001
Hypotension	10 (37.0)	86 (78.2)	
Hypertension	1 (3.7)	1 (0.9)	
CRT			
Normal	11 (40.7)	10 (9.1)	0.001
Prolonged	16 (59.3)	100 (90.9)	
Rhythm			
Normal	26 (96.3)	107 (97.3)	0.001
Abnormal	1 (3.7)	3 (2.7)	
Bicarbonate			
22 to 29	7 (25.9)	7 (6.4)	0.006
15 to <22	7 (25.9)	21 (15.3)	
Less than 15	11 (40.7)	78 (70.9)	
More than 29	2 (7.4)	4 (3.6)	
Base excess			
Less than -5	7 (25.9)	7 (6.4)	0.001
-5 to -10	7 (25.9)	17 (15.5)	
-11 to -15	8 (29.6)	18 (16.4)	
More than -15	5 (18.5)	64 (58.2)	
Positive base excess	0 (0.0)	4 (3.6)	
PCO₂			
35 TO 45	11 (40.7)	22 (20.0)	0.001
Less than 35	10 (37.0)	18 (16.4)	
More than 45	6 (22.2)	70 (63.6)	
pH before arrest**			
7.35 to 7.45	12 (44.4)	15 (13.6)	0.0001
7.25 to 7.34	11 (40.7)	8 (8.2)	
7.11 to 7.24	2 (7.4)	19 (17.3)	
7.0 to 7.10	0 (0.0)	22 (20)	
Less than 7	0 (0.0)	43 (39.1)	
More than 7.45	0 (0.0)	2 (1.8)	

[Table/Fig-4]: Pre-arrest clinical, haemodynamic characteristics and blood gas parameters relation with outcome*.
*Pre-arrest variables are those recorded within one hour prior to cardiac arrest
**In two survivor cases, report of VBG could not obtained. We have analysed the data with 25 cases only. In one case of non-survivors group we have analysed the data with 109 VBG value, as patient report was not obtained.
CRT: Capillary refilling time, VBG: Venous blood gas

were associated with poor outcome [Table/Fig-6]. In our study, 21 (77.8%) of the survivors had normal to mild disability at discharge and only one patient (3.7%) had severe disability at discharge [Table/Fig-7]. Results of logistic regression models during pre-arrest, arrest, post-arrest are shown in [Table/Fig-8]. They were used to determine the independent predictors for outcome among the pre-arrest, arrest and post-arrest clinical parameters respectively. During pre-arrest, variables such as prolonged CRT, respiratory acidosis and liver dysfunction were associated with mortality. During arrest, resuscitation parameter like requirement of large number of adrenaline doses were associated with poor survival. During post-arrest vitals like CRT, BP, SpO₂, Temperature and pulse rate were found to influence the survival [Table/Fig-8].

Characteristics	Survivors n(%)	Non-survivors n(%)	p-value
Blood Pressure			
12 hours of post-arrest			
Normal	27 (100.0)	18 (52.9)	
Hypotension	0 (0.0)	14 (41.2)	0.001
Hypertension	0 (0.0)	2 (5.9)	
Blood Pressure			
24 hours of post-arrest	27 (100.)	23 (79.3)	
Normal	0 (0.0)	5 (17.2)	0.001
Hypotension	0 (0.0)	1 (3.5)	
Hypertension			
Pulse Rate			
12 hours of post-arrest			
Normal	17 (62.9)	22 (64.7)	
Tachycardia	10 (37.1)	11 (32.3)	0.001
Bradycardia	0 (0.0)	1 (3.0)	
Pulse Rate			
24 hours of post-arrest			
Normal	17 (62.9)	23 (79.3)	
Tachycardia	10 (37.1)	6 (20.7)	0.001
Bradycardia	0 (0.0)	0 (0.0)	
SpO_2			
12 hours of post-arrest			
Less than 94%	2 (7.5)	11 (32.3)	0.001
95 to 100%	25 (92.5)	23 (67.4)	
SpO_2			
24 hours of post-arrest			
Less than 94%	2 (7.5)	21 (72.4)	0.001
95 to 100%	25 (92.2)	8 (27.3)	
CRT			
12 hours of post-arrest			
Normal	26 (96.3)	15 (44.2)	0.001
Prolonged	1 (3.7)	19 (55.8)	
CRT			
24 hours of post-arrest			
Normal	27 (100.0)	21 (72.4)	0.001
Prolonged	0 (0.0)	8 (27.3)	
Temperature			
12 hours of post-arrest			
Normal	27 (100.0)	29 (85.3)	0.001
Hypothermia	0 (0.0)	5 (14.7)	
Temperature			
12 hours of post-arrest			
Normal	27 (100.0)	29 (85.3)	0.001
Hypothermia	0 (0.0)	5 (14.7)	

[Table/Fig-5]: Haemodynamic parameters, vital parameters during post-cardiac arrest (0 to 24 hours) compared with outcome.*
CRT: Capillary refilling time

Characteristics	Survivors (n=27) n (%)	Non-survivors (n=55) n (%)	p-value
GCS			
At 12 hours of post-arrest			
GCS<5	11 (40.7)	28 (82.4)	0.0001
GCS≥5	16 (59.3)	6 (17.6)	
GCS			
At 24 hours of post-arrest			
GCS<5	6 (22.2)	20 (68.9)	0.0001
GCS≥5	21 (77.8)	9 (31.1)	
Pupil			
At 12 hours of post-arrest			
PERL	26 (96.3)	28 (82.4)	0.0001
Not Reacting	1 (3.7)	6 (17.6)	
Pupil			
At 24 hours of post-arrest			
PERL	27 (100.0)	27 (93.1)	0.0001
Not Reacting	0 (0.0)	2 (6.9)	
LFT			
Normal	27 (100)	45 (81.8)	0.0001
Deranged	0 (0.0)	10 (18.2)	
PT/INR			
Normal	26 (96.3)	41 (74.5)	0.0001
Deranged	1 (3.7)	14 (25.5)	
Albumin			
Normal	21 (77.8)	39 (70.9)	0.0001
Low	6 (22.2)	16 (29.1)	
Platelet			
Normal	21 (77.8)	21 (38.2)	0.0001
Thrombocytopenia	6 (22.2)	34 (61.8)	

[Table/Fig-6]: Organ dysfunction after arrest and relationship to mortality in patients with ROSC*.
*Totally 82 patients had ROSC after arrest, 55 died during arrest. Post-arrest LFT, RFT, PT/INR, Platelet count and hemoglobin analysis was done for patients who had ROSC.
ROSC: Restoration of spontaneous circulation, GCS: Glasgow coma scale, LFT: Liver function test, RFT: Renal function test, PT/INR: Prothrombin time/International normalised ratio

PCPC score		Survivors (n=27) n(%)
Normal	(score=1)	12 (44.5)
Mild disability	(score=2)	9 (33.3)
Moderate disability	(score=3)	5 (18.5)
Severe disability	(score=4)	1 (3.7)
Coma/vegetative state	(score=5)	0
Brain Death	(score=6)	0

[Table/Fig-7]: Paediatric cerebral performance category (PCPC) scale at discharge.

DISCUSSION

According to our study, the prevalence of cardiac arrest among the total admissions during the study period was 7.5 %. The study by Zeng J et al., the prevalence of cardiopulmonary arrest among hospitalised patients was observed to be 0.18% [1].

In our study, more than half of the patients (56.2%) and series by Meert KL et al., 66.2% were infants [2]. This observation is similar to the meta-analysis done by Young KD and Seidel JS where younger age group with respiratory cause contributed to higher percentage of cardiac arrest [6]. This high proportion of infants in various paediatric series on cardiac arrest may be attributable to the high prevalence of infections, especially respiratory infection in this age group and their tendency to decompensate rapidly.

The most common causes of in-hospital cardiac arrests are respiratory failure (asphyxia) and circulatory shock by Meaney PA et al., [7]. As per Meert KL et al., respiratory diseases were more likely to cause arrest among survivors arrest [2]. According to our study, infections were the underlying aetiology that contributed to 75% of the study children. Most common infection identified was sepsis without focus (33.9%), followed by pneumonia (30%). These observed differences in underlying aetiology may be a reflection of the local epidemiology and the setting in which the studies were carried out.

Overall, 92% of the observed cardiac arrest occurred in PICU. Due to the high preponderance of PICU arrest, 88.3% of the study

Variable	Odds ratio	95% CI	p-value
Low BP pre-arrest	12.11	10.35-13.87	0.001
Prolonged CRT pre-arrest	16.73	14.03-19.43	0.0001
Prolonged CPR duration	20.42	19.70-21.14	0.0001
Failure of ROSC	22.56	21.36-23.76	0.0001
More doses of Adrenaline	12.94	10.34-15.54	0.002
Low pH pre-arrest	40.08	39.59-40.57	0.0001
High $PaCO_2$ pre-arrest	12.01	10.29-13.73	0.001
Low PaO_2 pre-arrest	6.55	5.57-7.53	0.011
Low HCO_3 pre-arrest	7.37	5.80-8.92	0.007
High base excess at pre-arrest	19.24	17.92-20.56	0.001
Low BP 12 hour post-arrest	21.23	20.39-22.07	0.0001
Low BP 24 hour post-arrest	14.30	12.86-15.74	0.003
Prolonged CRT 12 hours post-arrest	22.79	22.11-23.47	0.0001
Prolonged CRT 24 hours post-arrest	18.28	17.18-19.38	0.0001
Low SpO_2 12 hours post-arrest	10.27	7.53-13.01	0.016
Low SpO_2 24 hours post-arrest	11.88	9.94-13.82	0.003
Hypothermia 12 hours post-arrest	7.64	3.54-11.74	0.022
Hypothermia 24 hours post-arrest	8.65	5.53-11.77	0.013
Prolonged PT/INR post-arrest	5.03	1.43-8.63	0.025
Liver dysfunction post-arrest	4.83	1.27-8.39	0.028
Low platelet post-arrest	8.80	6.72-10.88	0.003
Tachycardia 24 hour post-arrest	9.31	6.97-11.65	0.01

[Table/Fig-8]: Model-multivariate regression analysis for pre-arrest, arrest, post-arrest variables independently associated with mortality (R2=0.494).
BP: Blood pressure, CRT: Capillary refilling time, CPR: Cardiopulmonary resuscitation, ROSC: Return of spontaneous circulation, HCO_3: Bicarbonate, PT/INR: Prothrombin time/International normalised ratio

children were receiving mechanical ventilation at the time of cardiac arrest. A study based in China suggested arrest in PICU contributes 81% [1]. This may be a due to the fact that seriously ill patients were transferred to PICU before the occurrence of significant deterioration of their vital parameters.

As per our study, ROSC was achieved only in 82 children (59.8%) and 27 children (19.7%) survived to hospital discharge. Reis AG et al., who studied 129 children had ROSC of 64%, with a survival rate of 16% [8]. According to De Mos N et al., of 91 children who had cardiac arrest, ROSC attained in 75 (82%) children, 23 (25%) to hospital discharge [9]. Nadkarni VM et al., showed ROSC of 52% with 27% survival along with good neurological outcome in 18% of about 880 patients studied [10].

We also compared the various clinical parameters and other characteristics of survivors and non-survivors to identify important predictors of outcome. Among the variables recorded at the time of hospital admission, presence of prolonged CRT, metabolic acidosis, respiratory acidosis and haematological disturbances like deranged PT/INR, low platelet count and liver dysfunction were independently associated with poor survival. These parameters indicate signs of physiological decompensation irrespective of aetiology and hence, may be general predictors of poor outcome. Factors associated with survival after in hospital cardiac arrest from a European study by Lopez Herce J et al., showed that, duration of CPR more than 10 minutes, occurrence of cardiac arrest in PICU and inotrope infusion before the arrest were associated with poor outcome [11].

In our study, analysis of the resuscitation parameters showed that median duration of CPR was 20 minutes and median number of adrenaline doses was three. We also looked at clinical, laboratory and resuscitation parameters during cardiac arrest and their influence on final outcome. It was observed that children with low BP and prolonged CRT one hour before the occurrence of cardiac arrest had poor outcome [Table/Fig-8]. In addition, need for prolonged CPR

(more than 20 minutes), multiple doses of adrenaline (more than three doses), and VBG disturbances like metabolic and respiratory acidosis with hypoxia was also predictors of poor outcome [Table/Fig-8]. Even though use of sodium bicarbonate (13.8%) and calcium gluconate (35.7%) was observed in our study, majority of the children did not receive sodium bicarbonate or calcium gluconate during the arrest. Use of these medications had no influence on the final outcome; however, there was increased frequency of use of calcium during the arrest among non-survivors. Totally 35.7% of our study population received calcium during resuscitation which was lower compared to the study by Srinivasan V et al., where calcium was used in 45% of cardiac arrest victims [12]. Calcium use was associated with higher mortality in their study. In our children, of the 35.7% who received calcium during resuscitation, 32.1% belonged to non-survival group though the difference did not show statistical significance.

Most common observed rhythm during arrest was bradycardia (72.9%) followed by asystole (19%) and shockable rhythms (VT/VF) (5.8%). In their study from U.S.A, Nadkarni VM et al., showed PEA or asystole to be the most common rhythm during arrest [10]. According to NRCPR database arrhythmogenic arrest (VT/VF) contributes 10% of the total rhythm in paediatric cardiac arrest [10]. In our study occurrence of VT/VF was less than that reported by The National Registry CardioPulmonary Resuscitation (NRCPR) database. This difference may be attributable to the difference in the aetiology of underlying illness resulting in cardiac arrest in different settings. In a tertiary care center handling general paediatric patients, with few children having underlying heart disease, the population of patients with shockable rhythms may not be high. In our study, children with underlying heart disease constituted only 8% of the study population. Even though we looked at other parameters such as place of arrest, time of arrest, CPR given by nurse and type of rhythm, these parameters did not influence the final outcome. NRCPR study describes time and day of week as predictors of outcome in adults, but in our study, timing of arrest did not influence the outcome [10].

The post-resuscitation phase after cardiac arrest is a crucial phase where reperfusion injuries can influence the outcome. Out of the 82 children who had return of spontaneous circulation, 61 (74.3%) were alive at 12 hours and 56 (68.29%) were alive at 24 hours. We analysed the serial vital parameters after cardiac arrest to identify the prognostic factors after cardiac arrest in our population. Hypotension in the post-resuscitation phase was associated with poor survival as shown in a study done by Kilgannon JH et al., [13]. De Mos N et al., showed that presence of kidney injury at admission along with epinephrine infusion before arrest was associated with poor outcome [9]. Calcium used at the time of arrest also related to poor survival in their series.

Fever, near normal pH, low lactate levels, two responsive pupils in the first 12 hours following arrest were shown to improve survival by Meert KL et al., [2]. In our study, among the vital parameters analysed, low BP, prolonged CRT, low SpO_2 and hypothermia at 12 hours and 24 hours post-cardiac arrest were independently associated with poor outcome [Table/Fig-8]. In addition, low GCS and tachycardia at 24 hours were also predictors of poor outcome. Lab parameters associated with poor survival rates were low platelet count, deranged PT/INR and liver dysfunction [Table/Fig-8]. These identified derangements in vital parameters indicated poor cardiopulmonary function following cardiac arrest. Persistent decompensation of vital parameters in the immediate post-arrest phase indicates poor prognosis in our study. Even though pupillary response and hyperglycaemia following post-arrest phase showed significant association with mortality in univariate analysis, they did not achieve statistical significance in multivariate analysis.

We also looked at neurological status of the survivors by Pediatric cerebral performance score at discharge (PCPC) and found that 77.8% of the survivors had normal to mild disability at discharge. Only one patient (<1%) had severe disability at discharge. The reported frequency

of good neurologic outcome from other series ranged from 14% to 76.7% [2,7,14,15]. The relatively good neurological outcome observed in our study may be attributed to the fact that most arrests happened in the PICU where immediate CPR could be initiated. Moreover, the ICU setting ensured good monitoring and supportive management in the post-resuscitation phase in most of these children.

LIMITATION

We excluded cardiac arrest occurring within six hours of hospital admission due to logistical reasons primarily due to difficulty in collecting data. This could have missed those children having cardiac arrest in the emergency and thus might have resulted in under reporting of cardiac arrests from the emergency. Children from surgical wards were not included in the study. Hence, aetiological profile primarily reflects children with medical problems. Severity of illness scoring was not done at the time of admission to calculate and compare the predicted and observed mortality in children. Follow up of children including mortality at one month and neurological status post discharges were not assessed.

CONCLUSION

In Paediatric population the prevalence of in-hospital cardiopulmonary arrest is low. Among children with in-hospital cardiac arrest approximately one-fifth cases sustained return of circulation and survived to hospital discharge. Over three fourths had satisfactory neurological outcomes based on PCPC scale measurements in survivors. Many parameters are independently correlated with hospital mortality. Forthcoming research should assess whether each of these correlations constitute as cause and effect. Clinical researcher determining the effectiveness of modern interventions like therapeutic hypothermia in paediatric cardiac arrest is essential to recognise these conclusions in their research methodology.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.