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# The Outcome and Hospital Discharge Rate after Pediatric in Hospital CPR During Nights and Weekends

Mustafa Ali Mohamed Ahmed, Sara Memarian, Iran Malekzadeh, Masoud Ghahvechi-Akbari and Behdad Gharib*

Children's Medical Center, Tehran University of Medical Sciences, Tehran, Iran

*** Corresponding author**

**Behdad Gharib, MD**
Children's Medical Center, Tehran University of Medical Sciences, Tehran, Iran
**Tel:** +98 912 1883481
**Fax:** +98 21 6693 0024
**Email:** behdad_gharib@hotmail.com

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## Abstract

**Background:** Cardiopulmonary Resuscitation (CPR) is considered as the most important skill for physicians. The practice of effective CPR depends on the quality of the CPR training, team work skills and hospital management. Because of complexity and several variables involved, the outcome of CPR may vary in the different times of day and different days of the week.

**Methods:** This study is a cross sectional and the data were provided from the medical records. All the patients who underwent CPR from July 2021 to Feb 2022 in the Children's Medical Center Hospital were included. The ward, disease, gender and age, the time of the day and the day of the week in which CPR event happened and the Survival to Discharge from Hospital (SDH), had been registered. We compared The SDH rate of CPRs between different days of the week (working days and weekends) and also different working shifts (morning, afternoon and night) were compared.

**Results:** The rate of SDH of the patients who underwent CPR was to 21.2%. There wasn't a significant difference between SDH during working days and weekends and during the morning, afternoon and night shifts.

**Conclusion:** The SDH rate was lower in the night shifts and during the weekends but the difference wasn't significant. It is recommended to improve the medical team CPR skills in all shifts specially in the evening and night shifts. Also, an appropriate dissemination of health care staff in working shifts should be done to increase the success rate of CPR procedure.

**Keywords:** Cardiopulmonary resuscitation, Cross-sectional studies, Delivery of health care, Medical records, Patient discharge, Physicians

## Introduction

More than 20,000 infants and children have a cardiac arrest per year in the United States (US) alone (1). In 2015 the emergency medical service in US, documented Out-of-Hospital Cardiac Arrest (OHCA) occurred in more than 7000 infants and children (2). Because many of these events are a result of progressive respiratory failure and circulatory shock, early warning systems and rapid response teams have been developed for earlier recognition, treatment and transfer to Pediatric Intensive Care Unit (PICU) (3).

Despite the important advances in the prevention, cardiac arrest remains a substantial public health problem and a leading cause of death in many parts of the world (4). In US and Canada, approximately 350,000 people per year (nearly half of them In-Hospital) suffers a cardiac arrest and receive resuscitation (5).

In the pediatric chain of survival, cardiac arrest care has largely focused on the management of the cardiac arrest itself, highlighting high-quality Cardiopulmonary Resuscitation (CPR), early defibrillation, and effective teamwork (6). In some researches the survival rate of the CPR has been reported to be different during the weekdays and holidays and also during the day *vs.* the evening and night. Researchers have suggested some reasons to justify these differences such as, understaffing, less experienced staff and less diagnostic or treatment facilities (7).

In this study the outcomes of CPR and the effect of time of day and the day of the week on its outcome has been studied. This research has been conducted at Children's Medical Centre in Tehran which is the largest pediatric hospital in Iran.

## Materials and Methods

The study is a retrospective, cross sectional that was carried out from July 2021–Feb 2022. It was conducted at Children's Medical Centre, a tertiary university hospital in Tehran, Iran.

To investigate the outcome, the file of the patients who underwent CPR for at least 2 *min* in the three different working shifts, including: the day (7 *am*-1 *pm*), evening (1 *pm*-7 *pm*), night (7 *pm*-7 *am*), and also the weekdays (Saturday to Thursday) and holidays (Fridays and national holidays) were reviewed. Incomplete records were excluded.

The collected data was entered into SPSS 23 (IBM Corp., Armonk, NY, USA). The frequency command was used to determine the frequency of data. To describe qualitative variables, the number and percentage and quantitative variables, mean and standard deviation were used if the distribution of variables was normal.

To assess the correlation between the outcome and patient related and hospital associated variables, Chi-square and Fisher exact tests were used. Two-sided p-value less than 0.05 was used to determine the level of significant. This study has been approved by the board of medical ethics at Tehran University of Medical Sciences (Ethics code: "IR.TUMS.CHMC.REC.1400.153").

## Results

Of 264 patients, 15.5% were neonates (0–28 day), 11.45% of patients in the early infancy (1–3 months), 25% in the late infancy (4–12 months), 22.7% in the early childhood (12–60 months), 25% in the middle -late childhood (60–216 months), and 145 (54.9%) were male, 119 (45.1%) were female (Table 1).

In term of the pre-existing medical condition; 63 (23.9%) patients had sepsis; 56 (21.2%) patients had congenital heart diseases, 39 (14.8%) patients had neurodevelopmental problems, 31 (11.7%) patients had oncology related diseases, 21 (8%) patients had immunologic disorders (genetic immunodeficiencies), 17 (6.8%) patents had inborn error of metabolism, 9 (3.4%) had pulmonary diseases (non-infectious), 12 (4.5%) patients had gastrointestinal related diseases, 6 (2.3%) patients had rheumatic diseases, 5 (1.9%) patients had neonatal sepsis, and 5 (1.9%) patients had chronic kidney diseases (Table 1).

Out of 264 total patients, 194 (73.5%) had experienced cardiopulmonary event in the Intensive Care Unit (ICU); the second largest group were in the Emergency Department (ED) and they were 53 (20.1%) patients; and 17 (6.4%) patients were in other wards of the hospital (Table 2).

### *Time of event and working days*

The time of event has been classified into three groups according the shift rotation of the medical team. Of 264 CPR events, 123 (46%) events happened during

**Table 1.** The frequency of CPR events in the different wards of the hospital

| Variables (n=264) | Frequency | Percentage |
|---|---|---|
| **Age in months** | | |
| Neonate (0-28 days) | 41 | 15.5 |
| Early infancy (1-3 month) | 30 | 11.4 |
| late infancy (4-12 month) | 3-66 | 25 |
| Early childhood (12-60 month) | 60 | 22.7 |
| Middle-late childhood (>60 month) | 66 | 25 |
| **Sex** | | |
| Male | 145 | 54.9 |
| Female | 119 | 45.1 |
| **Morbidity** | | |
| Infectious disease | 63 | 23.9 |
| Inborn error of metabolism | 17 | 6.4 |
| Immunologic disorders | 21 | 8.0 |
| Hepatic and GI disorders | 12 | 4.5 |
| Neuromuscular diseases | 39 | 14.8 |
| Neonatal sepsis | 5 | 1.9 |
| Congenital heart disease | 56 | 21.2 |
| Blood-related disorders | 31 | 11.7 |
| Lung disease | 9 | 3.4 |
| Kidney diseases | 5 | 1.9 |
| Rheumatic diseases | 6 | 2.3 |

**Table 2.** Characteristic of the patients

| Total number = 264 | Number | Percentage |
|---|---|---|
| Wards | | |
| Intensive care unit (ICU) | 194 | 73.5 |
| Emergency department | 53 | 20.1 |
| In-patient ward | 17 | 6.4 |

the time of night shift (19:00 to 07:00) and 25 patients had SDH, 80 (30.3%) events happened in the morning shift (07:00 to 13:00) and 18 patients had SDH and 61 (23.1%) events occurred during the afternoon shift (13:00 to 19:00) and 13 patients had SDH (Table 3).

**Table 3.** Comparing the time of the day and the day of the week on the occurrence of the CPR event

| Variables (n=264) | Frequency | Percentage |
|---|---|---|
| **Time of shift** | | |
| Morning shift (07:00–13:00) | 80 | 30.3 |
| Afternoon shift (13:00–19:00) | 61 | 23.1 |
| Night shift (19:00–07:00) | 123 | 46.6 |
| **According the day** | | |
| Weekday | 211 | 79.9 |
| Weekend and Holidays | 53 | 20.1 |

A total of 211 (79.9%) patients had undergone CPR during weekdays and 53 (20.1%) patients had the event during the weekends or holidays. Nearly 85% (n= 45) of those who had CPR event in weekend or holidays didn't survive to SDH *vs.* 15% (n=8) of survival to be discharged. In the weekdays 18.2% (n=48) had survival to discharge *vs.* 61.8% (77.25%) (n=163) with unsuccessful outcome. The differences between the daytime, evening time and night time and weekdays and weekends were not significant.

### *Outcome of cardiopulmonary resuscitation*

A total 264 patients underwent CPR, 208 (78.8%) of them didn't SDH and 56 (21.2%) patients had survived to be discharged from hospital.

### *Factors associated with CPR outcome*

Chi-Square test of independence was used to identify factors associated with CPR outcome (for samples less than 5, Fisher exact test was utilized). Accordingly, patient and hospital related factors were assessed for CPR Outcome. From that variable that were assessed to determine the association, the admitting ward (x2=37.78, p-value<0.001), having neurological comorbidity x2=13,71, p-value<0.001), pulmonological comorbidity x2=6.57, p-value= 0.010), and sepsis (x2=5.05, p-value=0.025) were significantly associated with the CPR outcome (Table 4).

## Discussion

In this retrospective, cross-sectional study, the prevalence of "not survived to discharge" rate from the hospital was 78.8% and the survival to discharge rate was 21.2%. Bimerew *et al* conducted a metanalysis

**Table 4.** The rate of survival to discharge rate of each category in terms of age, gender, time of CPR, comorbidities and the day of the week

| Variables (n= 264) | Outcome | | Chi square | p-value |
|---|---|---|---|---|
| | Non alive discharge | Survived to discharge | | |
| **Age** | | | | |
| Neonate (0-28 days) | 31 | 10 | | |
| Early infancy (1-3 month) | 22 | 8 | | |
| Late infancy (4-12 month) | 45 | 21 | 9.988 | 0.763 |
| Early childhood (12-60 month) | 52 | 8 | | |
| Middle-late childhood (>60 month) | 57 | 9 | | |
| **Gender** | | | | |
| Male | 115 | 30 | 0.53 | 8 |
| Female | 93 | 26 | | |
| **CPR Date** | | | | |
| Weekday | 163 | 48 | 1.485 | 0.223 |
| Weekend | 45 | 8 | | |
| **Time of Event** | | | | |
| Morning shift (07:00–13:00) | 62 | 18 | | |
| Evening shift (13:00–19:00) | 48 | 13 | 0.138 | 0.933 |
| Night shift (19:00–07:00) | 98 | 25 | | |
| **Ward** | | | | |
| Intensive care unit | 170 | 24 | | |
| Other wards | 12 | 5 | 37.789 | <0.0001 |
| Emergency ward | 26 | 27 | | |
| **Comorbidities** | | | | |
| Immunologic disorders | | | | |
| Yes | 19 | 2 | Fisher's exact test | 0.264 |
| No | 189 | 54 | | |
| Neurologic problem | | | | |
| Yes | 22 | 17 | 13.71 | <0.0001 |
| No | 186 | 39 | | |
| Gastrointestinal problem | | | | |
| Yes | 11 | 1 | Fisher's exact test | 0.470 |
| No | 197 | 55 | | |
| Neonatal sepsis | | | | |
| Yes | 4 | 1 | Fisher's exact test | 0.999 |
| No | 204 | 55 | | |
| Renal problem | | | | |
| Yes | 4 | 1 | Fisher's exact test | 0.999 |
| No | 204 | 55 | | |
| Pulmonology problem | | | | |
| Yes | 4 | 5 | Fisher's exact test | 0.022 |
| No | 204 | 51 | | |
| Inborn error of metabolism | | | | |
| Yes | 15 | 2 | Fisher's exact test | 0.539 |
| No | 193 | 54 | | |
| Congenital heart disease | | | | |
| Yes | 41 | 15 | 1.321 | 0.250 |
| No | 167 | 41 | | |
| Rheumatologic problem | | | | |
| Yes | 5 | 1 | Fisher's exact test | 0.999 |
| No | 203 | 55 | | |
| Oncology related disorders | | | | |
| Yes | 26 | 5 | 0.543 | 0.461 |
| No | 182 | 51 | | |
| Infectious disease | | | | |
| Yes | 56 | 7 | 5.05 | 0.025 |
| No | 152 | 49 | | |

from studies published in 2016 to 2020 with a total sample size of 28,479 children. The pooled prevalence of SDH was found to be 46%. More than half of the children who underwent CPR in the hospital, didn't survive to be discharged from hospital. The lowest survival rate was in Asia and the low- and middle-income countries. The pooled prevalence of SDH in Asia was 34%, and the lowest rate in this region was 20.9% (8).

Comparing the results of the present study show the need for more training and supervision; however, the differences in hospital setting and the types of the admitted patients, sample size and duration of the study should be considered. Part of the difference between the SDH of the developed and low-middle income countries can be attributed to the better equipment such as Extracorporeal Membrane Oxygenation (ECMO) and better training and staffing.

Bhanji *et al* studied survival rate after in hospital cardiac arrest in children during nights and weekends in 354 hospitals of North America. They found that 70.4% have had a return of circulation lasting more than 20 minutes, 58% survived for 24 hours and the rate of SDH was 36.2%. The outcome was worse at night shifts *vs.* the day and the evenings. Also, the difference was significant between weekend daytime and weekday daytime, but not between weekend night time and weekday night time (9).

Hessulf F *et al* in a study of 26595 patients, showed that the survival rate decreased during the evening and night *vs.* the day. And this difference is more pronounced in the small hospitals (<99 beds) compared to the large hospitals (>400 beds) and also in non-academic *vs.* academic hospitals. They also found lower survivals in the weekends compared to the weekday's admission (7).

However, in the present study the rate of survival to discharge was lower in the weekends *vs.* the weekdays, but the difference wasn't significant. In Iran there is one official holiday per week (Fridays), apart from national days off. Present study result may indicate that the quality of the medical team and treatment facilities in Children's Medical Center Hospital which is an academic one with more than 400 beds, were not different during the week.

In terms of age group, patients were categorized into five age-groups; neonates (0 – 28 days), early infancy (1–3 month), late infancy (4-12 months), early childhood (13–60 months) and late childhood (> 60 months). Forty-one (15.5%) patients were newborns, 30 (11.4%) in early infancy period, 66 (25%) in late infancy period, 60 (22.7%) in their early childhood period and 66 (25%) patients were older than 5 years (middle to late childhood). Seventy five percent of the neonatal group, 73% of the early infants and 69% of the late infants didn't survive to be discharged from hospital. The highest mortality rate fallowing CPR event were observed in the early and middle-to-late childhood patients and about 86% of them didn't survive to be discharged.

Al-Eyadhy A *et al* showed that younger age was associated with better survival rate in CPR. They reported that a younger age resulted in a better survival outcome after CPR and children older than 48 months had significantly more mortality than younger age (10).

Almost 73.5% (194 patients) of the present study group were staying in ICU when they had CPR event and their survival to discharge had been 12%, which is lower than some studies; such as the one conducted in India which had a survival rate of up to 45% (11).

Shimoda-Sakano MT *et al* found that 80.2% of the pediatric CPR events occurred in the ICU. In their study which was conducted in Brazil, they showed that CPR events which happened at nights had lower survival rate (12). Berg RA *et al* conducted a study on 10078 children admitted in ICU between December 2011 to April 2013, and showed that the survival to hospital discharge was 45%. In their research the highest survival to hospital discharge rate belong to non-cardiac surgical patients (55%) and the lowest survival to hospital discharge rate happened in cardiac-medical patients (41%) (13).

In the present study the SDH was significantly different among the admitting wards and the highest SDH rate belong to the Emergency Department (ED) with the SDH rate of 51%, and the lowest SDH rate occurred in the ICU (with the SDH rate of 12%). These results may indicate the worse condition of the patients who were transferred to the ICU and the readiness of the ED team. As the number of the ICU beds are limited, only the most critical patients are transferred to ICU. This situation may partly explain the reason of high mortality of the ICU.

Regarding the background medical condition, patients with neurology and pulmonology problems had significantly higher SDH (43.5 and 55.5%, respectively). It is suggested that children have better tolerance of hypoxia versus perfusion arrest (10) and it may justify better SDH of patients with respiratory diseases.

The number of patients with congenital heart diseases (non-surgical), was 21.2% (n=56) of the total study population, and among them 26.8% had SDH (after CPR) and the difference was not significant. In a study which has been conducted in 23 North American cardiac ICUs from Aug 2014 to July 2016 with 15,908 patients (6,498 medical, 9,410 surgical), cardiac medical patients had lower survival after cardiac arrest (37.75%) *vs.* those of cardiac surgical patients (62.5%) (14).

Patients with sepsis were the largest group and consisted 23.9% (63 patients) of the total study population, of which 11% (n=7) survived to be hospital discharged. In a study performed in Brazil and published in 2023, the lower survival rate was associated with liver disease, shock and complex chronic conditions (12). Assar S *et al*, conducted a study in Iran on 279 pediatric patients who underwent CPR. They found that SDH rate of those with infection as their background disease was 18.7%. Patients with respiratory diseases had the highest SDH (51.5%) and those with gastrointestinal problem had the lowest SDH (6.1%) (15) which was similar to the present study.

## Conclusion

It seems that in order to improve CPR outcome, measures such as improving the related skills of the medical team; formation an experienced CPR team; retraining and up to dating medical and nursing knowledge and techniques; formation of hospital resuscitation committees to review the existing problems in performed CPRs; appropriate distribution of therapeutic equipment and staff on all three working shifts in order to mitigate the circadian effects; daily calibration of equipment used in CPR; review and standardization the physical space of CPR room; reacting more intensely with appropriate measures to patients with sepsis and chronic conditions should be implemented. As present study was a single center and retrospective with limited sample size, the results should be considered with caution. More researches should be conducted with consideration of more variables such as first documented rhythm, medications used during CPR and CPR duration.

## Conflict of Interest

There was no conflict of interest in this manuscript.

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