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Outcomes of pediatric in-hospital cardiac arrest in the emergency department of a tertiary referral hospital in Tanzania: a retrospective cohort study

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Abstract

Background Cardiopulmonary resuscitation (CPR) is an emergency procedure performed to restore heart function to minimize anoxic injury to the brain following cardiac arrest.

Despite the establishment of emergency department and training on Pediatric Advanced Life Support (PALS) at Muhimbili National Hospital (MNH) the outcomes of pediatric in-hospital cardiac arrest have not been documented. We ought to determine the outcomes and factors associated with 24-h survival after pediatric in-hospital cardiac arrests at MNH in Tanzania**.**

Methods We conducted a retrospective study of all patients aged 1 month to 18 years who had in-hospital cardiac arrests (IHCA) prompting CPR in the Emergency Medicine Department (EMD) at MNH, Tanzania from January 2016 to December 2019. Data was collected from electronic medical record (Wellsoft) system using a standardized and pre-tested data collection form that recorded clinical baseline, pre-arrest, arrest, and post-arrest parameters. Bivariate and multivariable logistic regression analyses were performed to assess the influence of each factor on 24-h survival.

Results A total of 11,951 critically ill patients were screened, and 257 (2.1%) had cardiac arrest at EMD. Among 136 patients enrolled, the median age was 1.5 years (interquartile range: 0.5–3 years) years, and the majority 108 (79.4%) aged ≤ 5 years, and 101 (74.3%) had been referred from peripheral hospitals. Overall stained return of spontaneous circulation was achieved in 70 (51.5%) patients, 24-h survival was attained in 43 (31.3%) of patients, and only 7 patients (5.2%) survived to hospital discharge. Factors independently associated with 24-h survival were CPR event during the day/evening ($p=0.033$), duration of CPR ≤ 20 min ($p=0.000$), reversible causes of cardiac arrest being identified ($p=0.001$), and having assisted/mechanical ventilation after CPR ($p=0.002$).

Conclusion In our cohort of children with cardiac arrest, survival to hospital discharge was only 5%. Factors associated with 24-h survival were CPR events during the daytime, short duration of CPR, recognition of reversible causes of cardiac arrest, and receiving mechanical ventilation. Future studies should explore the detection of decompensation, the quality of CPR, and post-cardiac arrest care on the outcomes of IHCA.

Keywords Cardiac arrest, Cardiopulmonary resuscitation, Outcome, Pediatrics, Emergency medicine, Tanzania

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Background

Cardiac arrest is a life-threatening event, which has a wide-ranging negative impact on the health care system. Cardiac arrest can occur both inside the hospital and out of the hospital as a result of various medical emergencies. The outcomes of in-hospital cardiac arrest after cardiopulmonary resuscitation is quite good among the pediatric population [1].

In-hospital cardiac arrest (IHCA) is defined as a cardiac arrest that occurs in a hospital (whether the patient is admitted or not) and for which resuscitation is attempted with chest compressions, defibrillation, or both [2].

In high income countries (HIC), the outcome of children after cardiac arrest is better than that of adults, but in low- and middle-income countries (LMIC) the outcome is very poor with 24-h survival ranging from 0–16% [3, 4].

Inadequate resources and late presentation with advanced stage of diseases are major challenges to healthcare providers in sub-Saharan African hospitals [4]. The outcomes of IHCA in children remain poor, and understanding of the factors that influence outcome after IHCA is lacking, specifically in sub-Saharan Africa populations. The purpose of this study was to evaluate the outcomes of pediatric in-hospital cardiac arrest at Muhimbili National Hospital (MNH) in Tanzania, using the Utstein-style reporting guidelines [5] and compare outcomes with those in other settings.

Methods

Study design

This was a retrospective cohort study of all pediatric patients underwent CPR at the Emergency Medicine Department (EMD) from 1st January 2016 to 31st December 2019.

Study setting

The study was conducted at the EMD at MNH in Dar es salaam, Tanzania. MNH is a National referral, and teaching hospital [6]. The EMD receives patients mainly from Dar es salaam and coastal regions, as well as those referred from other regions. The department serves between 150–200 patients per day; approximately one quarter of the patients are less than 18 years of age.

The department is staffed by emergency physicians, residents in the emergency medicine program, medical officers who have been trained on Pediatric Advanced Life Support (PALS), whereas majority of nursing staffs are trained on Basic Life Support (BLS). The EMD has a customized electronic medical record developed by KLAS, Wellsoft Corporation that is integrated with the hospital health information system. The cardiac arrest management protocol at the EMD is adapted from the Pediatric Advanced Life Support of the American Heart Association (AHA) [7].

Inclusion and exclusion criteria

All patients from 1 month to 18 years of age who had a cardiac arrest from 1st January 2016 to 31st December 2019 in the EMD were included in the study. Patients who arrived in the EMD in cardiac arrest, or attained ROSC after out-hospital cardiac arrest and re-arrest in EMD, those with terminal illness and received compassionate care, patients in whom CPR was not initiated or who were brain dead were excluded.

Study procedure

A standardized and pretested data collection was used to retrieve data from the EMD electronic medical record. Data was retrieved from the database using computer generated codes such as cardiac arrest, CPR medications given during CPR and death. Medical record numbers were used to track patient files from MNH medical records for those who were admitted to record their outcomes.

The Utstein-style reporting guidelines was used to record 4 sets of variables; patient variables, hospital variables, event/arrest variables, and outcome variables. Collected data included patient demographics, pre-existing conditions, use of vasoactive drugs prior arrest, use of mechanical ventilation before, and after cardiac arrest, level of consciousness, identified reversible causes of cardiac arrest, first documented rhythm, duration of chest compressions, number of doses of epinephrine during the CPR, defibrillation attempted, and the day and time of arrest. Daytime/evening was defined as 7:00 AM to 6:59 PM and night time as 7:00 PM to 6:59 AM.

Outcomes

The primary outcome was 24-h survival following cardiac arrest at the EMD. The secondary outcomes variable included sustained ROSC defined as return of signs of circulation lasting more than 20 min without need of chest compression, and survival to hospital discharge.

Statistical analysis

Data were entered into Epidata version 3.1 software and analysed using to Stata version 14.0 (STATA CORP, TEXAS USA). Categorical variables were summarized using frequencies, and percentage and for continuous variables median and Interquartile Range (IQR) were used. Bivariate analysis was performed to evaluate the influence of each of the independent variables on 24-h survival. Variables with p-value ≤ 0.2 at the bivariate analysis were included at multivariate logistic analysis. Adjusted odds ratio (AOR) and 95% confidence intervals

were calculated, variables with $P < 0.05$ was considered to be statistically significant.

Results

A total of 11,951 critically ill patients aged 1 month to 18 years presented to the EMD from January 2016 to December 2019 were screened. Of these 257 patients (2.1%) had cardiac arrests at the EMD, and 136 patients fulfilled enrollment criteria (Fig. 1).

Patients' characteristics and clinical status prior to cardiac arrest

Of the 136 patients enrolled, the median age was 1.5 (IQR 0.5–3) years and 108 (79.4%) were children aged ≤ 5 years. The majority of children who had in-hospital cardiac arrest 101 (74.3%) had been referred from peripheral hospitals. A total of 66 (48.5%) had hypoxia and 30.1% of the patients had preexisting diseases (Table 1).

Cardiac arrest event and cardiopulmonary resuscitation characteristics

Majority of the cardiac arrests occurred during weekdays 103 (75.7%), and daytime 75 (69.1%). The first documented rhythms were non-shockable rhythms 83(95.4%), while bradycardia constituted about 38 (27.9%), only 2.9% of the patients had shockable rhythms. Median duration of CPR was 23 (IQR 7–30) minutes, and median number of epinephrine was 3 (IQR 1–5) doses (Table 2). In this cohort, pneumonia was the most (31.6%) underlying condition followed by sepsis/septic shock (29.4%) among patient who had cardiac arrest in the EMD (Fig. 2).

Outcomes of pediatric in-hospital cardiac arrest

Overall, 70 (51.5%) patients sustained ROSC for more than 20 min in the EMD, and 43 (31.6%) were alive at 24 h, while only 7 (5.2%) survived to hospital discharge (Table 3).

Factors associated with 24-h survival

Overall patients who had CPR event during the day or evening hours had three times odds of 24-h survival compared to those who had CPR event during the night. Furthermore, the duration of CPR of less than 20 min was associated with high odds of survival (AOR = 13.51, 95% CI: 13.80–48.00, p value < 0.001). Identification of reversible causes of cardiac arrest and having assisted/mechanical ventilation after CPR (AOR = 7.38, 95% CI: 2.32–23.47, p value 0.001), had significantly higher odds of 24 h survival compared to not having these factors (Table 4).

Discussion

In this retrospective cohort study, we utilize the Utstein reporting guidelines [5] to determine the outcomes and factors associated with 24-h survival after in-hospital cardiac arrest among acutely ill pediatric patients

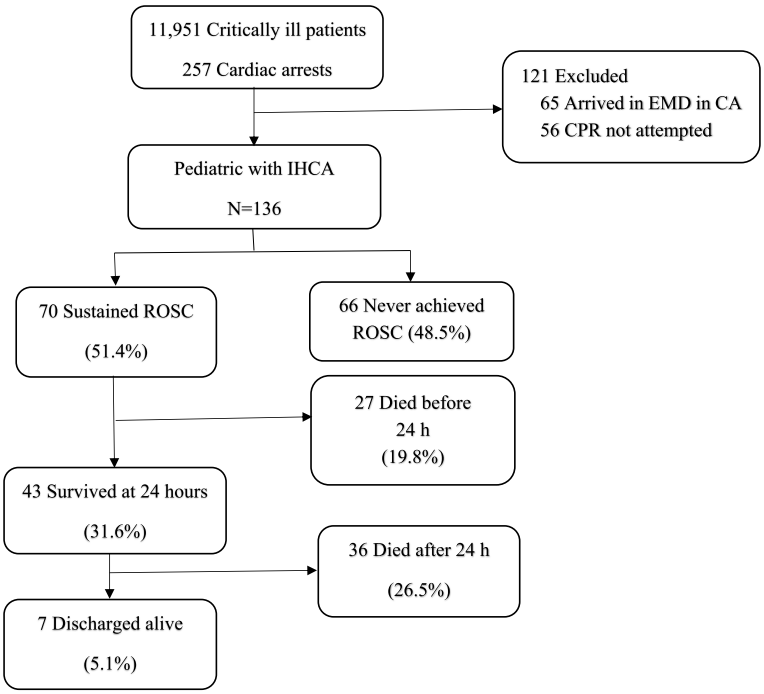

Fig. 1 Outcomes for pediatric in-hospital cardiac arrest

Table 1 Socio-demographics and clinical characteristics at admission

Variable	Frequency (*N* = 136)	Percent (%)
Age in years		
≤ 1	68	50.0
1–5	40	29.4
6–12	18	13.2
13–18	10	7.4
Sex		
Male	70	51.5
Referred	101	74.3
Altered level of consciousness	87	64
Pre-arrest vital signs		
Temperature (< 35oC or > 37.5oC)	48	35.3
Tachycardia[a]	92	67.6
Bradycardia[a]	10	7.4
Tachypnoea[a]	47	34.6
Bradypnoea[a]	32	23.5
Hypoxia	66	48.5
Hypoglycemia	28	20.6
Hyperglycemia	31	22.8
Preexisting conditions		
Cardiac	18	43.9
Neurologic	4	9.7
Gastrointestinal	3	7.3
Renal	3	7.3
Haematologic/Oncologic	2	4.9
Respiratory	1	2.4
Endocrine/Diabetes	1	2.4
Genetic/Metabolic	1	2.4
Others	8	19.5
None	95	69.8
Interventions in place prior cardiac arrest		
Yes	123	90.4
No	13	9.6
Cardiac monitor	119	87.5
Intravenous vasopressors	6	4.4
Assisted/Mechanical ventilation	45	33.1

[a] Stratified according to age

Table 2 Event characteristics following pediatric in-hospital cardiac arrest

Variable	Frequency (*N* = 136)	Percent (%)
Day of arrest		
Weekdays	103	75.7
Weekend	33	24.3
Time of the arrest		
Day	75	69.1
Night	61	44.9
First-documented rhythm		
Asystole	28	20.6
PEA	17	12.5
Bradycardia	38	27.9
Ventricular Tachycardia	3	2.2
Ventricular Fibrillation	1	0.7
Unknown	49	36.0
Defibrillation provided	4	2.9
Reversible causes of CA identified	78	57.3
Epinephrine doses administered		
≤ 2 doses	56	41.2
> 2 doses	80	58.8
Duration of CPR in Minutes		
≤ 20 min	65	47.8
> 20 min	71	52.2
Assisted/Mechanical Ventilation after CPR		
Yes	58	42.6
No	78	57.4
Number of cardiac arrests		
One time	85	62.5
Two times	39	28.7
Three times	12	8.8

CPR Cardiopulmonary Resuscitation, *PEA* Pulseless Electrical Activity

presenting to an urban emergency department of a tertiary referral hospital in Tanzania. In this study we found one in two patients attained sustained ROSC, and 3 out of 10 patients were alive at 24 h following IHCA, a higher survival rate than that observed in other studies in sub-Saharan countries [4, 8]. These difference in the survivals between this study and other studies in sub-Saharan countries may be because this study was conducted in a facility with advanced pediatric life support training, and with more resuscitation resources. We found a very low survival to hospital discharge at only 5% is a low rate than most reported studies in medium and high-income countries [9–13], we believe this finding is contributed by inadequate post resuscitation care after the initial survival, also delayed presentation, and advanced pathophysiology of underlying diseases at presentation.

In our study, half of the patients (50%) were infants. This observation is similar to the meta-analysis done by Young KD et al. where younger age group with respiratory conditions contributed to higher percentage of cardiac arrest [3]. This high proportion of infants who had IHCA may be attributable to the high prevalence of respiratory infections in this age group and their tendency to decompensate rapidly. However, age, and sex were not associated with 24-h survival in the multivariate analysis.

Interestingly, the survival was higher among those patients who had cardiac arrest event during day or evening, had duration of CPR ≤ 20 min, those who

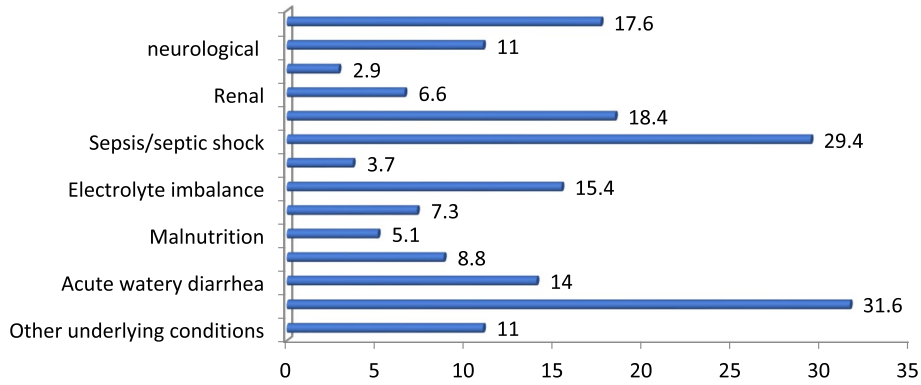

Fig. 2 Underlying diseases in pediatric patients who had IHCA at EMD

Table 3 Outcomes of pediatric in-hospital cardiac arrest

Study outcomes	Frequency (*N* = 136)	Percent (%)	95% CI
Primary outcome			
24-h survival	43	31.6	24.4–40.0
Secondary outcomes			
Sustained ROSC > 20 min	70	51.5	43.0–59.9
Survived to hospital discharge	7	5.2	2.5–10.5

ROSC Return of Spontaneous Circulation

received ≤ 2 doses of epinephrine, among those with identified reversible cause of cardiac arrest, and patients who had mechanical ventilated after CPR.

Patients who had IHCA during the daytime and evening hours were more likely to survive at 24 h compared to those who had cardiac arrest during nighttime. The lower survival rate among patients who had cardiac arrests at nighttime are consistent with other studies [9, 11, 14]. Lower survival rate at nighttime is an important, yet underrecognized concern. In our hospital, there is only one attending physician available during nighttime, and the resuscitation rooms are shared by residents and medical officers. In addition, there are smaller number of nursing officers allocated during nighttime compared to day/evening time, perhaps influencing the recognition and response to deteriorating patients and those experiencing cardiac arrest. In addition, medical errors are more common [15], and there is reduced ability in performing psychomotor skills at night [16].

In this study, analysis of the resuscitation parameters showed that, patients with shorter CPR duration (≤ 20 min) were more likely to 24-h survival, coinciding with the findings reported in other studies [1, 10, 17]. The goal of effective CPR is to optimize coronary and cerebral perfusion pressure and blood flow to critical organs during the low flow phase of CA. During this phase, the only source of coronary and cerebral perfusion comes from the blood pressure generated by good chest compressions. Longer duration of arrest results in a longer period of low cardiac output with increased potential for organ injury. It is unlikely that patients with prolonged duration of CPR and requirement of a greater number of epinephrine doses had effective mechanical activity of the heart. These findings highlight the importance of implementing early resuscitation measures to prevent further deterioration of the heart mechanical function.

Patients who had identifiable reversible causes of CA were more likely to survive at 24 h than those who had no reversible causes recognised. There is a paucity of data reporting this association in pediatric patients with IHCA who underwent CPR. In this study, 78 (57.5%) of patient who underwent CPR had their reversible causes of CA identified. To what extent the recognition of cause of cardiac arrest influences survival has not been thoroughly investigated in pediatric population. In a study conducted in adults, patients suffering an IHCA showed a substantial survival benefit if the causes of arrest were recognized by the emergency team. This finding supports the AHA recommendation that cardiac arrest in children may be associated with a reversible condition, rapid recognition, immediate high-quality CPR, and correction of contributing factors and potentially reversible causes offer the best chance for a successful resuscitation [7].

Patients who required mechanical ventilation after ROSC had better 24-h survival than those who were not mechanically ventilated. This finding is in keeping with a study conducted in Egypt in a similar population of patients [18]. Post-cardiac arrest derangements in partial pressure of carbon dioxide ($PaCO_2$) are common. Alterations in $PaCO_2$ could affect outcome by exacerbating the ischemic insult through hypocarbia induced cerebral vasoconstriction or through hypercarbia- induced cerebral vasodilation and edema,

Table 4 Bivariate and multivariate analysis for factors associated with 24-h survival following pediatric in-hospital cardiac arrest in the EMD

Study variables	24-h Survival n/N (%)	Unadjusted OR UOR (95%CI)	*p* value	Adjusted OR AOR (95%CI)	*p* value
Sex					
Male	20/70(28.6)	0.78(0.38–1.61)	0.503	N/A	
Female	23/66(34.8)	Ref			
Referral Status					
Referred	28/101(27.7)	0.53(0.24–1.19)	0.128	N/A	
Not referred	15/35(42.8)	Ref			
Preexisting conditions					
Yes	13/41(31.7)	1.01(0.46–2.21)	0.988	N/A	
No	30/122(24.6)	Ref			
Assisted/Mechanical vent before CPR					
Yes	17/45(37.7)	1.52(0.71–3.23)	0.279	N/A	
No	26/91(28.6)	Ref			
Monitoring					
Yes	41(95.4)	3.94(0.86–18.08)	0.078	N/A	
No	2(4.7)	Ref			
Day of arrest					
Weekdays	37/103(36.0)	2.52(0.95–6.67)	0.062	5.52(1.30–24.28)	0.021
Weekend	6/33(18.2)	Ref		Ref	
Time of the arrest					
Day/Evening	30/75(40.0)	2.46(1.14–5.30)	0.021	5.02(1.12–22.48)	0.033
Night time	13/61(21.3)	Ref		Ref	
First-documented rhythm					
Yes	33/87(38.0)	2.38(1.05–5.40)	0.038	2.25(0.66–7.63)	0.194
No	10/49(20.4)	Ref		Ref	
Defibrillation					
Yes	2/4(50.0)	2.22(0.30,16.31)	0.433	N/A	
No	41/132(31.1)	Ref			
Epinephrine given					
Yes	39/131(29.7%)	0.11(0.01–0.98)	0.048	0.09(0.01–2.81)	0.175
No	4/5(80.0%)	Ref		Ref	
Duration of CPR					
≤ 20 min	37/65(57.0)	14.31(5.42–37.75)	0.001	13.51(3.80–48.06)	< 0.001
> 20 min	6/71(8.4)	Ref		Ref	
Reversible causes of CA					
Yes	35/78(45.0)	11.31(4.80–26.69)	0.001	7.38(2.32–23.47)	0.001
No	8/58(14.0)	Ref		Ref	
MV after CPR					
Yes	33/54(76.7)	11.31(4.80–26.69	0.001	15.95(3.26–78.05)	0.001
No	10/82(12.2)	Ref		Ref	

CA Cardiac Arrest, *CPR* Cardiopulmonary Resuscitation, *PEA* Pulseless Electrical Activity, *UOR* Unadjusted Odds Ratio, *AOR* Adjusted Odds Ratio, *CI* Confidence Interval, *MV* Mechanical Ventilation, N/A Not Applicable

lungs may also be damaged from trauma due to chest compressions, aspiration of blood/gastric content or development of pneumonia. Data extrapolated from pediatric critical care suggest that during post-cardiac arrest care, use of mechanical ventilation lung protective strategies, including low inspiratory volume and positive end-expiratory pressure, are warranted to minimize lung injury and hemodynamic compromise [19]. Assessment of patient immediate post-cardiac arrest to further establish the adequacy of oxygenation

and ventilation is necessary to provide assisted ventilation as needed.

Study limitations

This was a single site retrospective cohort study with a small sample size that was carried out in a tertiary hospital in Tanzania, where the population and resuscitation measures may not be representative of the whole country which limits the generalizability of our findings. Furthermore, given the retrospective nature of the study we relied on documented evidence of clinical care and hence we are unable to comment on impact of quality of CPR, which might influence survival outcomes.

We only analyzed factors in the first 24 h after ROSC, which may be the most important but not the only ones. Other factors that might affect the survival at discharge but may appear in the following days, such as nosocomial infections or multiple organ failure, and post-cardiac arrest care were not studied.

Conclusions

In our cohort of children with cardiac arrest, survival to hospital discharge was only 5%. Factors associated with 24-h survival were CPR event during daytime, recognition of reversible causes of cardiac arrest short duration of CPR ≤ 20 min and receiving mechanic ventilation. Future studies should explore detection of decompensation, the quality of CPR, and post cardiac arrest care on the outcomes of IHCA.

Abbreviations

AHA	American Heart Association
APCU	Acute Pediatric Care Unit
BLS	Basic Life Support
CA	Cardiac Arrest
CPR	Cardiopulmonary Resuscitation
ECG	Electrocardiogram
EMD	Emergency Medical Department
EMR	Electronic Medical Record System
HIC	High Income Countries
ICU	Intensive Care Unit
IHCA	In-Hospital Cardiac Arrest
LMIC	Low- and Middle-Income Countries
MNH	Muhimbili National Hospital
PALS	Pediatric Advance Life Support
PEA	Pulseless Electrical Activity
RBG	Random Blood Glucose
ROSC	Return of Spontaneous Circulation
uOR	Unadjusted Odds Ratio
aOR	Adjusted Odds Ratio
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

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Authors' contributions

DM conceived and contributed to the conception and design of the study, data collection, analyzed and interpreted the data, and drafted initial manuscript and successive drafts. RN, PM, DM, TSL and HRS was involved in the study design, conceptualization, interpretation together with critical review of the manuscript. They also guided DM in the whole research process; and in writing the manuscript. All authors have read and approved the manuscript.

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This was a non-funded study; the principal investigator used his own funds to support the data collection and logistics.

Availability of data and materials

The original data set will be availed by the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Approval was obtained from both Makerere University School of Medicine Research and Ethics Committee (SOMREC) with approval number # REC REF2020-002 and MNH directorate of Research, Training and Consultancy with approval number MNH/TRCU/Permission/2020/009. A request for waiver of obtaining informed consent was obtained from Makerere University School of Medicine Research and Ethics Committee and MNH directorate of Research, Training and Consultancy to collect and use files from the records department respectively. All the information was kept confidential and use for the purpose of this study only.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Zeng J, Qian S, Zheng M, Wang Y, Zhou G, Wang H. The epidemiology and resuscitation effects of cardiopulmonary arrest among hospitalized children and adolescents in Beijing: an observational study. Resuscitation. 2013;84(12):1685–90.
2. Morrison LJ, Neumar RW, Zimmerman JL, Link MS, Newby LK, McMullan PW Jr, et al. Strategies for improving survival after in-hospital cardiac arrest in the United States: 2013 consensus recommendations: a consensus statement from the American Heart Association. Circulation. 2013;127(14):1538–63.
3. Yung BM, Browne-Yung K, Marsh K. Outcome of cardiopulmonary resuscitation in hospitalized African children. J Trop Pediatr. 2001;47(2):108–10.
4. Olotu A, Ndiritu M, Ismael M, Mohammed S, Mithwani S, Maitland K, et al. Characteristics and outcome of cardiopulmonary resuscitation in hospitalised African children. Resuscitation. 2009;80(1):69–72.
5. Jacobs I, Nadkarni V, Bahr J, Berg RA, Billi JE, Bossaert L, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries: a statement for healthcare professionals from a task force of the International Liaison

Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, Inter-American Heart Foundation, Resuscitation Councils of Southern Africa). Circulation. 2004;110(21):3385–97.
6. About us – Muhimbili National Hospital. Dar es Salaam, Tanzania: MNH; 2018. Available from: http://www.mnh.or.tz/index.php/about-us. Cited 2018 July 13.
7. De Caen AR, Berg MD, Chameides L, Gooden CK, Hickey RW, Scott HF, et al. Part 12: pediatric advanced life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2015;132(18_suppl_2):S526–S42.
8. Edwards-Jackson N, North K, Chiume M, Nakanga W, Schubert C, Hathcock A, et al. Outcomes of in-hospital paediatric cardiac arrest from a tertiary hospital in a low-income African country. Paediatr Int Child Health. 2019;40(1):11–15.
9. Bhanji F, Topjian AA, Nadkarni VM, Praestgaard AH, Hunt EA, Cheng A, et al. Survival rates following pediatric in-hospital cardiac arrests during nights and weekends. JAMA Pediatr. 2017;171(1):39–45.
10. Ganesan RG, Das S, Parameswara N, Biswawal N, Pabhu A. Survival after In-hospital Cardiac Arrest among Paediatric Patients-A Descriptive Study. J Clin of Diagn Res. 2018;12(2):SC04–9.
11. López-Herce J, del Castillo J, Cañadas S, Rodríguez-Núñez A, Carrillo A. In-hospital pediatric cardiac arrest in Spain. Revista Española de Cardiología (English Edition). 2014;67(3):189-95.
12. López-Herce J, Del Castillo J, Matamoros M, Cañadas S, Rodriguez-Calvo A, Cecchetti C, et al. Factors associated with mortality in pediatric in-hospital cardiac arrest: a prospective multicenter multinational observational study. Intensive Care Med. 2013;39(2):309–18.
13. Wu E-T, Li M-J, Huang S-C, Wang C-C, Liu Y-P, Lu FL, et al. Survey of outcome of CPR in pediatric in-hospital cardiac arrest in a medical center in Taiwan. Resuscitation. 2009;80(4):443–8.
14. Peberdy MA, Ornato JP, Larkin GL, Braithwaite RS, Kashner TM, Carey SM, et al. Survival from in-hospital cardiac arrest during nights and weekends. JAMA. 2008;299(7):785–92.
15. Hendey GW, Barth BE, Soliz T. Overnight and postcall errors in medication orders. Acad Emerg Med. 2005;12(7):629–34.
16. Kuhn G. Circadian rhythm, shift work, and emergency medicine. Ann Emerg Med. 2001;37(1):88–98.
17. Berg RA, Nadkarni VM, Clark AE, Moler F, Meert K, Harrison RE, et al. Incidence and outcomes of cardiopulmonary resuscitation in PICUs. Crit Care Med. 2016;44(4):798–808.
18. Eltayeb AA, Monazea EM, Elsayeh KI. Cardiac arrest in children: relation to resuscitation and outcome. The Indian Journal of Pediatrics. 2015;82(7):612–8.
19. Topjian AA, de Caen A, Wainwright MS, Abella BS, Abend NS, Atkins DL, et al. Pediatric Post-Cardiac Arrest Care: A Scientific Statement From the American Heart Association. Circulation. 2019;140(6):e194–233.

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