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Outcome of cardiorespiratory arrest in patients with respiratory diseases in emergency department: A prospective observational study

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Abstract:

Introduction: Cardiopulmonary arrest (CPA) is the cessation of effective ventilation and circulation. It is also known as cardiac arrest or circulatory arrest. In adults, it is most likely to be caused by a primary cardiac event. The most common electrical mechanism which is responsible for 50 to 80% of cardiopulmonary arrest is ventricular fibrillation (VF). The cardiopulmonary arrest could be reversed by two main interventions, i.e., early CPR and early automated external defibrillation (AED). **Objective:** To study the rate of survival to discharge after in-hospital cardiac arrest and its associated factors in an emergency department of a tertiary care hospital.

Materials and Methods: This is a prospective and observational study was conducted in the Tertiary Care Teaching Hospital over a period of 1 year. It is a 700-bedded tertiary care referral hospital, located in Hyderabad, India, with an average of 100 emergency cases per day. Patients elder than 12 years, who have sustained cardiac arrest after reaching the ED but before being admitted into the specialty wards were included. Who suffered witnessed cardiac arrest, after arrival in the emergency department. A semi-structured questionnaire was used to collect data (socio demographic details, chief complaints, comorbidities). Initial documented rhythm, duration of CPR, use of defibrillator, and presumed cause of cardiac arrest and others were collected from the case records.

Results: Of 60 patients, 15 (25%) were discharged fully conscious, whereas 45 (75%)

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patients died. Age, sex, comorbidities, and cause of arrest did not show any statistically significant association with the outcome (P>0.05 for all). The duration of CPR was significantly lower in survivors (3.80 ±1.90 min) compared with non survivors (10.31 ± 6.41 min) (P<0.001). GCS was significantly higher in survivors group compared with non-survival groups (11.38±0.3 vs 3.68±1.20, P<0.001). Length of hospital and ICU stay was significantly longer in survivors compared to non-survivors in table 2.

Conclusion: These results suggest that out-of-hospital cardiac arrest among patients has a very poor prognosis, especially when efforts at resuscitation continue for longer than 20 minutes and require more than two doses of epinephrine.

Keywords: Cardiopulmonary resuscitation, Cardiorespiratory arrest, Emergency department.

Introduction

Cardiopulmonary arrest (CPA) is the cessation of effective ventilation and circulation. It is also known as cardiac arrest or circulatory arrest. In adults, it is most likely to be caused by a primary cardiac event. The most common electrical mechanism which is responsible for 50 to 80% of cardiopulmonary arrest is ventricular fibrillation (VF). While, 20% to 30% which represents the less common causes of dysrhythmias involve Pulseless electrical activity (PEA), and asystole. Pulseless sustained ventricular tachycardia (VT) is a less common mechanism. This condition could progress to sudden death if it not treated promptly. Nevertheless, a cardiopulmonary arrest (CPA) could be reversed by cardiopulmonary resuscitation and/or cardioversion or defibrillation, or cardiac pacing. [1]

The *American Heart Association's* AHA periodically releases updates and recommendations for adult basic life support (BLS) and the quality of cardiopulmonary resuscitation (CPR) on adults. Despite the causes, early induction of cardiopulmonary resuscitation (CPR) along with cardiac monitoring will determine which pulseless arrest pathway one has to follow. Evidence suggests that more than 400000 people die of cardiopulmonary arrest in the U.S every year. [2]

There are various causes for cardiopulmonary arrest in adults which varies by age and population. However, patients diagnosed with cardiac disease are more susceptible to having a cardiac arrest. Furthermore, it can be classified into different categories, which include cardiac, respiratory, and traumatic causes. But 75% of cardiac arrest incidents are believed to be due to coronary artery diseases. [3]

Cardiac arrest is divided into out-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA). However, the incidence of cardiopulmonary arrest worldwide is not well described. In the U.S, more than 290,000 IHCA occur in adults annually, whilst 326,000 cases of OHCA among adults occur yearly. Half of these are unwitnessed. [4]

Men and women in middle-age have different susceptibilities to cardiopulmonary arrest; however, the sex differences decrease with increasing age. The difference in risk for

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cardiopulmonary arrest collateral the variations in age-related risks for other features of coronary heart disease (CHD) between males and females. As the gender gap for signs of coronary heart disease closes in the 6th to 8th decades, the excess risk of arrest in males progressively narrows. In spite of the lower incidence among younger women, CHD risk factors such as diabetes (DM), cigarette smoking, hyperlipidemia, and hypertension (HTN) are very highly influential. [5]

Once the diagnosis of cardiopulmonary arrest is confirmed, then basic life support (BLS) and defibrillation can be carried out by the public, physicians, paramedical personnel, trained laypersons, and nurses. There is an increasing demand for specialized skills such as Advanced Life Support (ALS), post-resuscitation care, and long-term management of post cardiopulmonary arrest patients. The cardiopulmonary arrest could be reversed by two main interventions, i.e., early CPR and early automated external defibrillation (AED). The first step involves recognition of the cardiopulmonary arrest and the BLS measures. If defibrillation is available for public use, then it should be activated and used if needed. Next, advanced life support (ALS) measures are used, involving IV/IO medication administration. If spontaneous circulation returns, then the case will undergo post-resuscitation care along with subsequent long-term management. The identification of a cardiopulmonary arrest victim includes ensuring that the patient is unresponsive, pulseless, and having abnormal breathing. Once the patient is identified, immediate CPR and activation of the Emergency Medical Services (EMS) should be done promptly. Nowadays, public access to defibrillation has been adding another layer of response.

Materials and Methods

This is a prospective and observational study was conducted in the Tertiary Care Teaching Hospital over a period of 1 year. It is a 700-bedded tertiary care referral hospital, located in Hyderabad, India, with an average of 100 emergency cases per day.

Inclusion criteria: Patients elder than 12 years, who have sustained cardiac arrest after reaching the ED but before being admitted into the specialty wards. The average duration of stay in ED varied from less than one day to eight days based on the underlying cause and clinical condition of the patient.

Exclusion criteria: Patients who had unwitnessed arrest, no proper case records, no bystanders to provide history, and those who were discharged against medical advice.

Cardiac arrest was defined as the cessation of cardiac mechanical activity confirmed by the absence of detectable pulse, unresponsiveness and/or apnea (agonal respirations). [6] In instances where the patient suffered multiple cardiac arrests, only the initial in-hospital arrest at ED was recorded. This was to avoid falsely elevated rate of successful cardiopulmonary resuscitation (CPR). Return of spontaneous circulation (ROSC) was defined as return of cardiac activity associated with significant respiratory effort after cardiac arrest which can be identified by resumption of breathing, coughing, or movement and a palpable pulse or a measurable blood pressure. [7] Sustained ROSC was defined as maintaining for more than 20

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min. The resuscitation was performed by consultants and residents posted in ED. CPR was given based on American Heart Association Guidelines 2022. All the ED consults and residents were Advanced Cardiac Life Support certified.

A pre-tested semi-structured questionnaire was used to collect data on socio demographic details, chief complaints, comorbidities. Information related to initial documented rhythm, duration of CPR, use of defibrillator, adrenaline usage and presumed cause of cardiac arrest were collected from case records. Those patients who have survived, were followed up till discharge and the neurological status of them were assessed using Glasgow Coma Scale.

The outcomes of CPR were categorized as ROSC, survival to admission (Sustained ROSC) and survival to discharge. The initial documented rhythms are classified as VF, pulseless VT [VT (p)], pulseless electrical activity (PEA), and asystole. The arrests were classified into presumed cardiac origin and non-cardiac origin, with the latter resulting from external causes, respiratory diseases, malignant tumors, strokes, trauma, and any other non-cardiac causes based on history and review of medical records.

Statistical Analysis

All the collected data was entered in SPSS V25.0 and analyzed for Windows software. Chi square test/Fisher Exact was used to analyze the association among socio-demographic variables, co-morbidities, presumed cause of arrest, and CPR outcome. Univariate and multivariate analysis was performed to identify the individual predictors of CPR outcome.

Results

After CPR, 10 (20%) of 50 patients were discharged fully conscious, whereas 40 (80%) patients died; 20 of them died immediately, whereas 20 patients developed hypoxic encephalopathy and died during hospitalization. There was no statistically significant association between age, sex, and associated comorbidities and the outcome of CPR. However, there was a significant inverse relation between the duration of CPR and its outcome (Table 1).

Table 1 Demographic data among patients with cardiorespiratory arrest (survivors and non survivors) in emergency room

	Survivors (n=10) [n (%)]	**Non survivors (n=40) [n (%)]**	**P value**
Age (years)	50.35±10.37	54.74±11.38	0.397
Sex			
Males	6 (60)	19 (47.5)	
Females	4 (40)	21 (52.5)	0. 07

Table 2: Clinical data among patients with cardiorespiratory arrest (survivors and non survivors) in emergency room

	Survivors (n=10) [n (%)]	**Non survivors (n=40) [n (%)]**	**P value**

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Duration of CPR (min)	3.80±1.90	10.31±6.41	<0.001
Length of hospital stay (days)	5.44±2.16	8.87±4.54	<0.001
Length of ICU stay (days)	3.76±2.94	7.73±3.83	<0.001
GCS	11.38±0.3	3.68±1.20	<0.001

The duration of CPR was significantly lower in survivors (3.80 ±1.90 min) compared with non survivors (10.31 ± 6.41 min) (P<0.001). GCS was significantly higher in survivors group compared with non-survival groups (11.38±0.3 vs 3.68±1.20, P<0.001). Length of hospital and ICU stay was significantly longer in survivors compared to non-survivors in table 2.

Table 3: Distribution of Comorbidities

Comorbidities	Survivors (n=10) [n (%)]	Non survivors (n=40) [n (%)]	P value
Diabetes mellitus	4 (40)	15(37.5)	0.38
Hypertension	4 (40)	13 (32.5)	0.44
Renal diseases	1 (10)	4 (10.0)	0.36
Liver diseases	0	3 (7.5)	0.05
Obesity	2 (20.0)	14 (35.0)	0.43
Ischemic heart diseases	2 (20.0)	4 (10.0)	0.51
Cerebrovascular stroke	2 (20.0)	4 (10.0)	0.64
Hepatitis C virus	1 (10.0)	3 (7.5)	0.28

P value <0.05 was significant. Data were presented with mean ± standard deviation or frequency and percentage. CPR, cardiopulmonary resuscitation; GCS, Glasgow coma scale.

Table 4: Comparison between survivors and non survivors after cardiopulmonary resuscitation regarding the underlying respiratory disease-causing cardiorespiratory arrest

The underlying respiratory disease-causing cardiorespiratory arrest	Survivors (n=10) [n (%)]	Non survivors (n=40) [n (%)]	P value
Acute exacerbation of COPD	4 (40.0)	5 (12.5)	
ILD	0	2 (5.0)	
Pneumonia	1 (10.0)	7 (17.5)	
Pulmonary embolism	2 (20.0)	2(5.0)	
Obesity hypoventilation syndrome	0	2 (5.0)	
Overlap syndrome	2 (20.0)	0	
Acute severe bronchial asthma	0	3 (7.5)	
Bronchiectasis	0	4 (10.0)	
Overlap syndrome	1 (10.0)	4 (10.0)	0.303

P value <0.05 was significant. COPD, chronic obstructive pulmonary disease; ILD, interstitial lung disease.

Table 5: Comparison between survivors and non survivors after cardiopulmonary resuscitation regarding frequency of cardiorespiratory arrest in studied patients

Frequency of cardiorespiratory arrest	Survivors (n=10)	Non survivors (n=40)	P value
1 (n=27)	8 (29.6)	19 (70.3)	0.001

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2–3 (n=15)	3 (20)	12 (80)	
>3 (n=4)	0	4 (100)	

Discussion

In this study, the rate of survival to hospital dis-charge of patients requiring CPR in the emergency department was 20 percent. This disappointingly low survival rate is similar to the rates in previous studies of cardiopulmonary resuscitation in patients, which range from 0 to 23 percent. This rate is also similar to those associated with out-of-hospital arrests in adults in whom asystole or electromechanical dissociation was initially recorded by medical personnel. In adults, survival rates of 5 to 10 percent are seen. [8]

The use of larger doses of epinephrine, which have been associated with an increase in the rate of return of spontaneous circulation, [9] does not appear to have had an influence on survival to hospital discharge. This echoes the results of other studies. In our patients, the most common causes of arrest were the sudden infant death syndrome, trauma, and near-drowning. This is similar to the pattern found in previous pediatric studies and has not changed over the past 10 years. [10]

The predictors we identified for short-term survival (i.e., for admission to the ICU) were similar to the predictors of survival to hospital discharge except for the arterial-blood gas indicators. Fisher and Wrape [11] noted that an initial pH of less than 7.0 was a predictor of poor outcome, but other researchers found that metabolic and acid–base variables during resuscitation did not significantly affect long-term outcome. Similarly, in our study, initial blood gas values did not significantly affect survival to hospital discharge, and a child's long-term survival, especially as a neurologically intact person, should be the goal of pediatric resuscitation efforts. [12]

The predictors of survival to hospital discharge we identified included a short interval between the arrest and arrival at the hospital, a palpable pulse on presentation, comparatively fewer doses of epinephrine, and a relatively short duration of resuscitation in the emergency department. Other factors operating be-fore arrival at the hospital, such as a short time from the arrest to the beginning of effective CPR, have been shown to improve the outcome of pediatric resuscitation efforts. [13] In our study, the application of advanced CPR before arrival did not improve long-term survival. However, in 10 of the 50 patients in our study who received advanced CPR before arrival, the treatment consisted only of bag–valve–mask ventilation and chest compressions. For many of these patients there were long intervals between the arrest and arrival at the hospital. There are, however, inherent inaccuracies involved in measuring that interval and in assessing the quality of prehospital resuscitation; where possible, we relied on the emergency medical service's records of treatment and the timing of events.

In earlier studies, patients with a respiratory arrest who still had a palpable pulse had a better outcome than those with a cardiac arrest and patients who needed comparatively

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fewer doses of resuscitative drugs also had improved survival. [15] None of our patients who were given more than two doses of epinephrine survived to hospital discharge, a relation identical to that found in previous studies. [16]

A short duration of resuscitation in the emergency department was a strong predictor of survival in our study; no patients who required such resuscitation for more than 20 minutes survived to hospital discharge. A review of the literature identified five previous studies in which the duration of resuscitation after a pediatric cardiopulmonary arrest had been assessed. Zaritsky et al. [17] noted that all survivors of cardiopulmonary arrest, inside or outside the hospital, underwent CPR for less than 10 minutes. Gillis et al. [18] found no survivors if CPR after an in-hospital cardiac arrest lasted more than 15 minutes. Barzilay et al. [19] found significantly improved survival after both in-hospital and out-of-hospital arrests if the duration of CPR was less than 5 minutes; and in the study by Nichols et al., [20] the threshold was 15 minutes. Innes et al. [21] found that no patients survived if CPR after an in-hospital or out-of-hospital cardiopulmonary arrest lasted more than 30 minutes.

Variations in the patient populations may account for some of the differences in outcome seen in these studies. Only a small proportion (range, 0 to 27 per-cent) of patients had out-of-hospital arrests, which have a poorer outcome than do in-hospital arrests. In addition, there were different proportions of patients who had respiratory arrest only (range, 0 to 50 percent), as opposed to cardiac arrest. In a recent study of 50 patients who had an out-of-hospital cardiac arrest with a median resuscitation time of 25 minutes after arrival in the emergency department, there was no evidence of effective restoration of cerebral function, even in patients who survived. [22]

In a study of patients who drowned, or nearly drowned, in Seattle, Quan et al. [23] suggested that efforts at resuscitation lasting more than 25 minutes are not warranted. Bonnin et al. and Kellermann et al. [24] recommended that resuscitative efforts be terminated when normothermic adults with out-of-hospital cardiac arrests do not regain spontaneous circulation after 25 minutes of standard advanced cardiac life support (or 20 minutes if there has been no palpable pulse whatsoever during the attempted resuscitation). The current data suggest that after out-of-hospital cardiac arrests in normothermic patients, attempts at effective cardiopulmonary resuscitation in the emergency department for longer than 20 minutes are futile.

In contrast to adult patients, in whom a cardiac dysrhythmia is often the precipitating event in an arrest, 20 patients usually have an arrest secondary to hypoxia. If the hypoxic insult has been of sufficient duration and severity to stop the heart, the severe anoxia undergone by the central nervous system often precludes a neurologic recovery except in the setting of hypothermia. In earlier studies of the neurologic outcome of out-of-hospital cardiac arrests in patients, all survivors of arrest had serious neurologic disabilities, as was the case in our study. Some patients who survived required extremely expensive care, and many remained in a vegetative state. In one study, patients discharged from the hospital in a

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persistent vegetative state either died or, at best, showed only minimal awareness after an average of 4.5 years. [25]

Gray et al.25 [26] have shown that prolonged efforts at resuscitation after out-of-hospital arrests in adults are futile in all but exceptional cases, such as those involving recurrent but not persistent arrest, or in cases of hypothermia. In our study, there were nine patients who had nearly drowned; they had a mean temperature of 32°C (range, 25 to 37) on arrival in the emergency department, and none survived. Submersion victims warmer than 30 to 32°C do not have the benefit of hypothermic protection, and cool water thus does not offer the protection provided by icy water. In Seattle, where icy water temperatures are uncommon, Quan et al. found no protective effect provided by moderate hypothermia. Thus, except for cases of profound hypothermia (temperature, less than 30°C) and of recurrent but not persistent arrest, prolonged efforts at resuscitation are not indicated in pediatric patients after an out-of-hospital cardiopulmonary arrest. [27]

Conclusion

These results suggest that out-of-hospital cardiac arrest among patients has a very poor prognosis, especially when efforts at resuscitation continue for longer than 20 minutes and require more than two doses of epinephrine. Treating a patients with a cardiopulmonary arrest takes place in an emotionally charged situation, and the decision to stop efforts at resuscitation is difficult. However, the results of our study and previous studies suggest that except when treating patients with severe hypothermia (temperature, less than 30°C) or with recurrent but not persistent arrest, resuscitative efforts in the emergency department after an out-of-hospital cardiac arrest should be limited to 20 minutes and two doses of epinephrine.

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