DOI: 10.7860/JCDR/2016/14773.7012

Original Article

Anaesthesia Section

Evaluation of Cardiopulmonary Resuscitation (CPR) for Patient Outcomes and their Predictors

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ABSTRACT

Introduction: Cardiac arrest continues to be a common cause of in-hospital deaths. Even small improvements in survival can translate into thousands of lives saved every year.

Aim: The aim of our prospective observational study was to elicit the outcomes and predictors of in-hospital cardiopulmonary resuscitation among adult patients.

Settings and Design: All in-hospital adult patients (age >14) who suffered cardiac arrest & were attended by a Code Blue Team between 1st January 2012 & 30th April 2013 were part of the study.

Materials and Methods: The cardiopulmonary resuscitation (CPR) was assessed in terms of: Response time, Presenting initial rhythm, Time to first defibrillation, Duration of CPR and Outcome (Return of spontaneous circulation (ROSC), Glasgow outcome scale (GOS) at discharge).

Statistical Analysis: Age, GOS and mean response time were analysed using t-test and ANOVA. Logistic regression was applied to determine the significance of the various factors in determining mortality.

Results: ROSC was achieved in 44% of a total of 127 patients included in our study. Asystole/Pulseless electrical activity (PEA) was the most common presenting rhythm (87.5%). The survival to discharge was seen in 7.1% patients of whom only 3.9% patients had good neurological outcome. Regression and survival analysis depicted achievement of ROSC during CPR, absence of co-morbidities and shorter response time of code blue team as predictors of good outcome.

Conclusion: We found poor outcome of CPR after in-hospital cardiac arrest.

This was mainly attributed to an initial presenting rhythm of Asystole/PEA in most cases and delayed response times.

Keywords: Asystole, Code blue team, Pulseless electrical activity

INTRODUCTION

Despite important advances, sudden cardiac arrest (SCA) continues to be a leading cause of death in many parts of the world [1]. SCA has many aetiologies (cardiac/non cardiac), circumstances (witnessed/unwitnessed) and settings (out of hospital or in-hospital). This heterogeneity necessitates a core set of coordinated actions to provide a universal strategy for successful resuscitation [2].

Cardiac arrest can be seen both in and out of the hospital. In the United States and Canada, approximately 350,000 people/year (approximately half of them in-hospital) suffer a cardiac arrest and receive attempted resuscitation [3]. In developed countries one in five of every 1000 in-hospital patients, are estimated to suffer from cardiac arrest, and less than 20% of such patients survive to discharge [4].

Hospitals all over the world have thus evolved Cardiopulmonary Resuscitation (CPR) teams, popularly termed Code Blue Teams which function in the in-hospital settings, based on previously approved standardized hospital protocols like the American Heart Association (AHA) CPR guidelines. The goal of code blue team's intervention is to support and restore effective oxygenation, ventilation and circulation that is return of spontaneous circulation (ROSC) with return of intact neurological function [5]. Effective chest compressions and early defibrillation are major determinants for the outcome of CPR [6]. In spite of the development of high quality CPR and early defibrillation as major modalities for the treatment of CPR, the outcome remains poor [7,8]. But small step by step improvements in survival can help save thousands of lives every year [9]. Hence, we proposed to evaluate predictors of favourable outcomes in patients in our institute.

MATERIALS AND METHODS

After approval by the Institutional Ethics Committee (IEC), the study was conducted in an urban 1100 bedded tertiary care teaching hospital. All in-hospital adult patients who suffered cardiac arrest between 1st January 2012 to 30th April 2013 and were attended by a code blue team were included in this prospective observational study. Patients who suffered out of the hospital cardiac arrest and < 14 years of age were excluded from the study. Cardiac arrest was defined as unresponsive adult patient who either is not breathing normally or has absence of breathing with the absence of carotid pulse or signs of circulation [2].

Patients who suffered cardiac arrests were attended by the code blue team. The first person to detect the cardiac arrest triggered code blue alarm. Health care professionals including doctors and staff nurses who were part of the code blue team i.e.; comprising of 3 postgraduate doctors & 3 paramedical staff led by the on duty anesthesiologist were the first to respond to an in-hospital cardiac arrest on a 24 hour basis. The CPR was assessed in terms of: Response time, Presenting Initial Rhythm, Time to first Defibrillation, CPR duration and Outcome. Mean response time was recorded as the time from the arrest to the arrival of the code blue team. Presenting initial rhythm was the first rhythm to be recorded on the monitor. Time to first defibrillation was the time from the arrival of the code blue team to the time taken to receive first defibrillation shock. ROSC was defined as the presence of a palpable carotid pulse. CPR duration was described from the start of the CPR till the ROSC was achieved. Outcome was measured in terms of ROSC, Survival to discharge and Clinical Status at Discharge assessed using Glasgow Outcome Scale (GOS) [10].

GLASGOW OUTCOME SCALE:

GOS 1 –DEAD

GOS 2 - VEGETATIVE STATE

GOS 3 - SEVERE DISABILITY

Able to follow commands/ unable to live independently

GOS 4 - MODERATE DISABILITY

Able to live independently; unable to return to work or school

GOS 5- GOOD RECOVERY

Able to return to work or school

We further divided the patients into 3 groups for delineating outcomes as per GOS Scale for facilitating statistical analysis:

Group A – GOS 1 (poor neurological outcome)

Group B – GOS 2,3 (poor to moderate neurological outcome)

Group C – GOS 4,5 (good neurological outcome)

STATISTICAL ANALYSIS

The data collected was recorded and analysed using IBM Statistical Package for the Social Sciences (SPSS) software. Results of parametric variables were expressed as mean ± standard deviation. Age, GOS and mean response time were analysed using t-test and ANOVA. Logistic regression was applied to determine the significance of the various factors in determining mortality. All tests were evaluated for 95% confidence intervals. The $p < 0.05$ was considered statistically significant.

RESULTS

A total of 127 patients were included in the study. The most common age group of patients having cardiac arrest was 21-40 years. Cardiac arrest was found to be more common among females (53.5%) than in males (46.4%).

Based on co-morbidities majority of the patients were admitted with a non-cardiac medical diagnosis to the hospital. Out of 127 patients 34.6% were admitted with burns, 11% with carcinomas and only 0.8% patients were admitted with the primary diagnosis of coronary artery disease. Good neurological outcome was observed in patients having lower respiratory infections, poisoning, heat stroke and pregnancy related disorder as the primary diagnosis. Diabetes Mellitus and hypertension were the most common preexisting conditions with 18.9% and 18.1% patients respectively while ischemic heart disease was seen in only 3.9% of the patients [Table/Fig-1]. Good neurological outcome (GOS C) was seen in 50% of patients having ARF (acute renal failure) and in 20 % of patients having CAD (coronary artery disease) as co-morbidity. Poor neurological outcome (GOS A) of 91% and 66 % was seen in patients with hypertension and diabetes as co-morbidities respectively [Table/Fig-2].

Mean response time in Group A was 2.6±1.1 minutes, in Group B was 3.2±1.0 minutes and in Group C was 2.8 ± 0.8 minutes which showed no statistically significant correlation among the three groups in achieving better neurological outcome [Table/Fig-3]. Mean response time positively correlated with the chances of survival by using survival analysis [Table/Fig-4].

Fifty eight patients were on monitoring aids prior to the cardiac arrest while the rest of the 69 patients were without monitoring aids. Asystole/Pulseless electrical activity (PEA) was the predominant initial rhythm in most of the patients (87.4%) whereas only 12.6% patients had Ventricular fibrillation/ Ventricular tachycardia (VF/VT) as the initial rhythm. It was seen that ROSC was achieved in 43.2% of patients presenting with asystole or PEA and in 50% of patients presenting with VT/VF. But no statistical significance could be elicited between presenting initial rhythm and neurological status at discharge [Table/Fig-5].

Out of the 16 patients who were given defibrillation, 11 patients received defibrillation in ≤ 5 minutes while 5 patients received defibrillation after > 5 minutes. Out of 11 patients who received defibrillation in≤ 5 minutes, 7 patients (63.6%)achieved ROSC while only 1 out of 5 patients (20%) receiving defibrillation >5 minutes was able to achieve ROSC [Table/Fig-6]. Chi-square test showed no statistical significance among these 2 groups with regard to neurological outcome.

Co-morbidities	Sex		Total (N)	Percentage
	Male	Female		
ARF	1	1	2	1.6%
CAD	4	1	5	3.9%
CKD	3	2	5	3.9%
DCM	1	1	2	1.6%
DM	17	7	24	18.9%
Downs Syndrome	0	1	1	0.8%
HTN	12	11	23	18.1%
NA	30	33	63	49.6%
TB	0	1	1	0.8%
Thyroid disorder	0	1	1	0.8%
Total	68	59	127	100.00%

[Table/Fig-1]: Distribution of subjects according to Co-morbidities

ARF- acute renal failure, CAD - coronary artery disease,
CKD –chronic kidney disease, DCM – dilated cardiomyopathy,
DM – diabetes mellitus, HTN – hypertension, NA- not applicable (this includes patients having primary diagnosis but without any co-morbidity), TB - tuberculosis

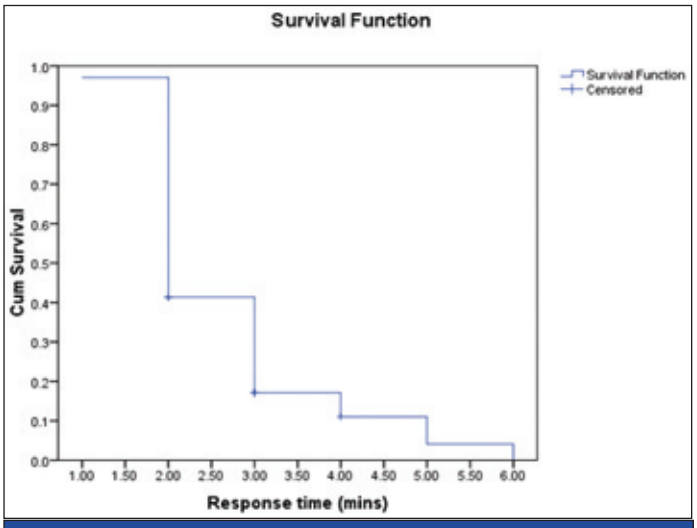
Co-morbidities	Number of patients (n)	Group A	Group B	Group C
CAD	5	4(80%)		1 (20%)
CKD	5	5 (100%)		
ARF	2	1(50%)		1(50%)
DM	24	16(66%)	6	2 (8.3%)
Downs Syndrome	1	1(100%)		
HTN	23	21 (91%)	1	1 (4.3%)
DCM	2	1(50%)	1 (50%)	
TB	1	1(100%)		
Thyroid disorder	1		1(100%)	

[Table/Fig-2]: Distribution of subjects according to Co-morbidities among groups A,B,C

ARF- acute renal failure, CAD - coronary artery disease,
CKD –chronic kidney disease, DCM – dilated cardiomyopathy,
DM – diabetes mellitus, HTN – hypertension, NA- not applicable, TB - tuberculosis

Neurological Status GOS	Number of patients (N)	Response Time Mean±S D	Std. Error
Group-A	107	2.6 ± 1.1	0.1
Group-B	14	3.2 ± 1.0	0.3
Group-C	6	2.8 ± 0.8	0.3
Total	127	2.7 ± 1.1	0.1

[Table/Fig-3]: Response time among patients with reference to neurological outcome (GOS)



[Table/Fig-4]: Survival Analysis

Neurological Status GOS	Rhythm		Chi Square	p-value
	Asystole/ PEA n=111(87.4%)	VF/VT n=16 (12.6%)		
Group-A	94	13	2.741	0.254
Group-B	13	1		
Group-C	4	2		

[Table/Fig-5]: Relation between Presenting initial rhythm and GOS

GOS – Glasgow outcome scale, PEA – pulseless electrical activity, VF – ventricular fibrillation, VT- ventricular tachycardia

Mean time taken to achieve ROSC in Group A was 19.5 ± 10.2 minutes, in Group B was 21.1 ± 16.1 minutes and in Group C was 21± 11.2 minutes, which showed no statistically significant correlation among the three groups in achieving better neurological outcome (p-value – 0.899).

ROSC was observed in a total of 56 patients (44%). Out of these 42 patients (75%) survived for < 24 hours and 14 patients (25%) survived for >24 hours. Finally only 9 patients (7.1%) survived to discharge.

Out of the 127 patients in our study, only 6 patients (4.7%) were in Group C showing a good neurological outcome, 14 patients (11%) were in Group B and 107 patients (84.3%) were in Group A having a GOS of 1 reflecting a poor outcome [Table/Fig-7].

Using Binary logistic regression analysis predictors of survival were determined. ROSC achieved during CPR, absence of co-morbidities and shorter response times were found to be predictors of a favourable outcome.

ROSC Achieved	Time to 1st Defibrillation		Total	Pearson Chi-Square	p-value
	<=5mins n=11	>5mins n= 5			
Yes	7	1	8	2.618	0.106
	87.5%	12.5%	100.0%		
No	4	4	8		
	50.0%	50.0%	100.0%		
Total	11	5	16		
	68.8%	31.2%	100.0%		

[Table/Fig-6]: Relation between Time to 1st defibrillation to ROSC

Outcome (GOS)		Number of patients n=127
1	A	107 (84.3%)
2,3	B	14 (11%)
4,5	C	6 (4.7%)

[Table/Fig-7]: Distribution of patients according to Glasgow Outcome Scale (GOS)

DISCUSSION

The main aim of the study was to evaluate the outcomes and predictors of in- hospital cardiopulmonary resuscitation among adult patients.

In our study, a positive correlation between response time and probability of survival was elucidated, on performing a survival analysis. Therefore shorter the response time, better were the chances of survival. The most common initial rhythm in our study was Asystole/PEA (87.4%) out of which only 43.2% of patients achieved ROSC. A total of only 44% patients (out of 127) achieved immediate return of spontaneous circulation. This could be attributed to an increased number of patients presenting with Asystole/PEA as their initial rhythm. Survival to discharge rate was only 7.1% out of which only 3.9% patients showed good neurological outcome. ROSC achieved during CPR and the absence of concurrent co-morbidities in the patients was found to be predictors of favourable outcome.

In a study published in 2002 by Huang et al., it was found that the prognostic factors of survival to discharge were a shorter time between collapse and arrival of the resuscitation team and the time of collapse to confirmation of arrest [11]. AHA-ACLS guidelines [1] similarly state that shorter response time leads to better outcome, which has been corroborated by the findings of survival analysis of our study.

In most of the studies the predominant initial rhythm was Asystole/ PEA. In a study by Huang et al., bradycardia and PEA was recorded as the initial rhythm in 51.4% patients, Asystole/PEA in 35% and VF/ VT was recorded in only 13.6% patients [11]. Khan et al., observed initial cardiac rhythm to be PEA in almost half of their patients (50%), followed by Asystole (30%) and VF/VT (19%) [12]. The large number of patients with Asystole/PEA (87.5%) as the presenting rhythm in our study as compared to others could be attributed to delay in recognition of cardiac arrest by primary responders especially in unmonitored areas. Hence, this prolonged response time could have led to deterioration of a shock able rhythm, to a non-shock able rhythm by the time code blue team arrived.

A wide variation of ROSC was seen among various studies ranging from 30.4% to 75% [9,11-13]. We observed ROSC in 44% patients. Our results are in accordance with the survival rates (7.2% and 7.38%) reported by Mohamed et al., and Glorimar et al., respectively [14,15]. Mohamed et al., undertook a study for six months (June 2002 to November 2002) during which time they identified 207 cardiopulmonary arrests. 49 patients (23.7%) achieved return of spontaneous circulation (ROSC) within 24 hours and 15 patients (7.2%) were discharged alive. The poor survival to discharge observed in our study reflects consonance with majority of studies reporting poor survival of patients suffering from in-hospital arrests. However, studies have reported varying rates of survival to hospital discharge ranging from 12% to 40% [16-18].

In 2012, Wallmuller et al., evaluated the relationship between cause and outcome of in-hospital cardiac arrest covering a 17.5-year period [19]. Cardiac arrest of cardiac origin occurred in 63% of a total of 1041 patients. 376 patients (36%) were discharged in good neurological condition. Overall, patients with cardiac causes had a significantly better outcome than those with non-cardiac causes (44% vs. 23%, p < 0.01). A study by Rajaram et al., in 1999 also showed a 14.4% survival to discharge with good neurological outcome in 64% of patients [9]. These results are in variance to our results in which good neurological outcome (i.e. a GOS score of 4 or 5) was observed in only 6 patients (3.9%). Studies in literature have reported cardiac causes as the common underlying primary diagnosis associated with good outcome following CPR. However, due to the presence of a specialized cardiac sub-center of our hospital, patients with primary cardiac disease were primarily referred to this center. A predominance of non-cardiac patients, most of who were not on any monitoring aids prior to the cardiac arrest explains the poor neurological outcomes found in our study.

LIMITATION

The limitation of our study is that we did not find any positive correlation of other factors with outcome measures due to small sample size and likely observer bias in reporting data and timelines in data collection form. Future studies with larger sample size incorporating standardized training of providers with structured retraining of code blue team would help overcome the lacunae in the study.

CONCLUSION

In conclusion, we observed poor outcomes in significant number of patients suffering from in-hospital cardiac arrest. These can be attributed to presence of co-morbidities, absence of ROSC during CPR and longer response time.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **May 03, 2015**
Date of Peer Review: **Jun 18, 2015**
Date of Acceptance: **Aug 28, 2015**
Date of Publishing: **Jan 01, 2016**