Clinical Investigation

A prospective study to determine the circumstances, incidence and outcome of cardiopulmonary resuscitation in a referral hospital in India, in relation to various factors

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ABSTRACT

Background and Aims: Cardiac arrest has multifactorial aetiology and the outcome depends on timely and correct interventions. We decided to investigate the circumstances, incidence and outcome of cardiopulmonary resuscitation (CPR) at a tertiary hospital in India, in relation to various factors, including extensive basic life support and advanced cardiac life support training programme for all nurses and doctors. **Methods:** It has been over a decade and a half with periodical updates and implementation of newer guidelines prepared by various societies across the world about CPR for both in-hospital and out-of hospital cardiac arrests (IHCA and OHCA). We conducted a prospective study wherein all cardiac arrests reported in the hospital consecutively for 12 months were registered for the study and followed their survival up to 1-year. Statistical analysis was performed by using Chi-square test for significant differences in proportions applied to various parameters of the study. **Results:** The main outcome measures were; (following CPR) return of spontaneous circulation, survival for 24 h, survival from 24 h to 6 weeks or discharge, alive at 1-year. For survivors, an assessment was made about their cerebral performance and overall performance and accordingly graded. All these data were tabulated. Totally 419 arrests were reported in the hospital, out of which 413 were in-hospital arrests. Out of this 260 patients were considered for resuscitation, we had about 27 survivors at the end of 1-year follow-up (10.38%). **Conclusion:** We conclude by saying there are many factors involved in good clinical outcomes following IHCAs and these variable factors need to be researched further.

Key words: Cardiac arrest, Cardiopulmonary resuscitation(CPR), outcome,tertiary hospital.

INTRODUCTION

No attempt from human beings has gained as much importance as cardiopulmonary resuscitation (CPR). However till 1950s, the efforts were individualistic. Only when it was proved in 1954 that the external cardiac compressions were equal in efficiency when compared to internal cardiac compressions, then a sea of change appeared in the technique.[1] When defibrillation was introduced in 1960, we had some definitive way of doing the technique. Over next 30 years, we kept on evolving the protocols for CPR technique. During this period, there was introspection as to how many people survived with the help of CPR. It was in 1990, when members of resuscitation council from all over the globe met at a place called Utstein Abbey (small island near Norway) and came to a consensus on reporting of cardiac arrests, resuscitation methods and outcomes following CPR.[2,3] They put forth their views in the form of recommendations which was aptly termed "Utstein style" of reporting. The following study incorporated many of the recommendations of "Utstein style" reporting of data for cardiac arrests in both out-of-hospital and in-hospital setting.

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In-hospital cardiac arrest (IHCA) has not received the same level of focused research as out-of-hospital cardiac arrest (OHCA).[1,4] There is no significant change in overall survival rate from 1992 to 2005 all over the world.[5]

In developing countries like India, not many outcome studies have been done; that too a prospective study is rare. We undertook this prospective study to assess the efficiency and outcome of CPR at a tertiary hospital.

METHODS

This prospective study was done at a tertiary hospital at Hyderabad in India. This is a 350 bedded multispecialty, and tertiary care hospital with 60 acute care beds. The hospital has code blue announcement for any cardiac arrest in the noncritical areas. Cardiac arrest was defined by the absence of a detectable pulse (pulselessness), by the patient unresponsiveness, or by any arrest rhythms noticed on monitors. The cardiac arrest event was intimated by public address system to the entire hospital to mobilise maximum possible help. The resuscitation in well-monitored areas like Intensive Care Units (ICUs), operation theaters (OTs), and cardiac catheterisation laboratory (CATH LAB) was managed by the available physician and anaesthesiologist in that area, and code blue announcement was not done.

The resuscitation team managed resuscitation in outside critically monitored areas. The resuscitation team consisted of an anaesthesiologist, resident doctor, and an ICU trained nurse. The anesthesiologist acted as a team leader. As a protocol, all nursing staff were trained in basic life support (BLS) techniques and all doctors were trained in advanced cardiac life support (ACLS) techniques. This was done as a routine teaching programme in the hospital. This definitely helped the study in getting trained help. In the case of cardiac arrest, the team ran from their workplace to the scene, where BLS performed by nurses, and other medical professionals were supplemented with ACLS. Oxygen and and bag-valve-masks were available in the wards; a nurse brought medications and a defibrillator to the scene from the concerned floor ICU if Automated external defibrillators (AED) were not available. The nurses in the wards were not allowed to defibrillate. At the place of cardiac arrest the study team documented the following facts: Age, sex, location, and initial cardiac rhythm. The aetiology of cardiac arrest was defined as either cardiac or noncardiac. The initial cardiac rhythm was recorded as ventricular fibrillation (VF), ventricular tachycardia (VT), Asystole or pulseless electrical activity (PEA). The outcomes of interest were immediate survival after arrest (through arrest), arrest to 24 h, 24 h to discharge or 6 weeks (whichever is earlier) and alive at 1-year. The immediate survival was defined as the restoration of spontaneous circulation (ROSC) for more than 20 min. In this study, we kept our focus on assessing the efficacy of CPR as a useful measure and the factors, which determine the post CPR outcome by analysing the cardiac arrest, collected data.

All consecutive cardiac arrests that happened over 1-year were recorded, and the survivors were followed-up for another 1-year from the time of arrest to note whether they were alive. The study team till the discharge/final outcome monitored patient's progress in the hospital. Those who had survived to hospital discharge were reviewed by the study team along with a neurologist to determine the neurological status at the end of 1-year. The outcome of brain injury was assessed as per the Glasgow-Pittsburgh cerebral performance and overall performance categories [Table 1].[3,4]

Table 1: Outcome of brain injury: The Glasgow-Pittsburgh CPC and OPC

CPC	OPC
Good cerebral performance. Conscious, alert able to work and lead a normal life. May have minor psychological or neurological deficits	Good overall performance. Healthy, alert, capable of normal life. Good cerebral performance (CPC 1) plus no or only mild functional disability from noncerebral organ system abnormalities
Moderate cerebral disability. Conscious, sufficient cerebral function for part-time work in sheltered environment or independent activities of daily life	Moderate overall disability. Conscious. Moderate cerebral disability alone (CPC 2) or moderate disability from noncerebral system dysfunction alone or both
Severe cerebral disability. Conscious. Dependent on others for daily support because of impaired brain function	Severe overall disability. Conscious. Severe cerebral disability alone (CPC 3) or severe disability from noncerebral organ system dysfunction alone or both
Coma, vegetative state. Not conscious, unaware of surroundings, no cognition. No verbal or psychological interactions with the environment	Severe overall disability. Conscious. Severe cerebral disability alone (CPC 4) or severe disability from noncerebral organ system dysfunction alone or both
Death. Certified brain dead or dead by traditional criteria	Severe overall disability. Conscious. Severe cerebral disability alone (CPC 5) or severe disability from noncerebral organ system dysfunction alone or both

CPC – Cerebral performance categories; OPC – Overall performance categories

For all out-of-hospital and IHCAs where resuscitation was done in the hospital the following details were collected [Table 2].

There were exclusion criteria for enrolment as mentioned below

i. False alarms, ii. Near arrest, iii. Unlikely to survive, iv. Patients who left hospital without completing the treatment or against medical advice, v. Lost to follow-up, vi. Patients who had multiple cardiac arrests (only the initial IHCA were recorded to avoid falsely raising the state of initial success in CPR).

The statistical analysis was performed by using Chi-square test for significant differences in proportions applied to various parameters of the study. A P value < 0.05 was considered as statistically significant.

Table 2: Patient data collection sheet

Details
Name
Age
Sex
Hospital number
In patient number
Diagnosis
Cause of arrest- (cardiac, respiratory, cardio-respiratory, others, not known, no information)
If it's cardiac arrest-VF/VT/asystole/PEA
Area of arrest-out of hospital/inside of hospital
If it's inside hospital-emergency room/ICU/OT/CATH LAB/ diagnostics area/special ward/general ward/nonward areas like corridor, stairs, lift...
Whether resuscitation was attempted?
If resuscitation was attempted, did the patient show ROSC?-through arrest
Did he survive from ROSC to next 24 h?
Did he survive from 24 h to discharge or 6 weeks-whichever is earlier?
Did he survive from discharge-6 weeks to 1-year?
Was he alive at 1-year?
If he was alive, what was his cerebral performance and overall performance status in leading active life?

VF – Ventricular fibrillation; VT – Ventricular tachycardia; PEA – Pulseless electrical activity; ICU – Intensive care unit; OT – Operation theatre; CATH LAB – Cardiac catheterization laboratory; ROSC – Return of spontaneous circulation

RESULTS

In all there were 419 cardiac arrests reported to the team. Out of this 413 were in-hospital arrests (all witnessed arrests). We had statistically significant results in survival of cardiac arrest secondary to VF/VT when compared to others ($P < 0.001$). Most cardiac arrests happened in the age group of 35–65 years in either sex. Female patients had better survival in the immediate period ($P = 0.003$) when compared to male patients, however survival at 24 h, 6 weeks and 1-year did not show any statistical difference.

There were 6 outside hospital arrests (resuscitation done inside hospital).

Out of the 413 inside hospital arrest cases, there were 267 males and 146 females. The number of victims considered for resuscitation was 260 out of 413 (62.95%) [Table 3] and the rest 153 were not considered. A total of 161 patients survived out of 260 patients (61.92%) through initial cardiac arrests [ROSC]. 56 arrested victims survived for next 24 h out of 161 patients who showed ROSC (34.78%). 29 of these 56 arrested victims who survived for initial 24 h went on to survive (51.78%) for next 6 weeks or discharged from hospital. 27 of these 29 patients were alive at 1-year (93.10%). At the end of 1-year, a total of 27 survivors were alive out of initial 260 cardiac arrests (10.38%) considered for resuscitation. Out of the 27 survivors 26 of them had good cerebral and overall performance condition (as per the Glasgow-Pittsburgh cerebral performance and overall performance categories). However, one person had severe cerebral and overall disability (as per the above mentioned scale). To sum up, for every 10 cardiac arrests where resuscitation was attempted the immediate survivors were 6.2, at

Table 3: Survival by place of onset of arrest (inside of hospital)

Area	Total number of arrests	Att. res (yes)	Att. res (no)	Through arrest (ROSC)	Arrest to 24 h	24 h to 6 weeks/dis	Alive at 1-year
ER	12	12	0	8	2	1	1
ICU, OT, CATH LAB	362	225	137	136	47	24	22
Diagnostics	1	1	0	1	1	0	0
Special ward	23	12	11	10	4	2	2
General ward	10	5	5	1	1	1	1
Non ward	5	5	0	5	1	1	1
Total	413	260	153	161	56	29	27

ER – Emergency room; ICU – Intensive care unit; OT – Operation theatre; CATH LAB; Cardiac catheterization laboratory; ROSC – Return of spontaneous circulation

the end of 24 h 2.1 were alive, 1.1 patients survived for 6 weeks or discharge and at the end of 1-year 1.03 were alive.The chances of survival were better when cardiac arrests happened in the well-monitored areas like ICU, OT, and CATH LAB [Table 3]. The results were better in only cardiac or respiratory arrests than cardio respiratory arrest [Table 4]. In cardiac arrests, the rhythm disturbances like VF and VT carried good chances of survival when compared to Asystole and PEA. Out of 178 arrests of cardiac origin; the initial rhythm was VF in 21 arrests, VT in 18, asystole in 129 and PEA in 10 [Table 5]. At the end of 1-year, 10 patients of VF and 6 patients of VT origin have survived. The survival chances were better when underlying aetiologies were cardiac problem, sepsis and poisoning [Table 6].

We had statistically significant results in survival of cardiac arrest secondary to VF/VT when compared to others ($P < 0.001$). Female patients had better immediate survival ($P = 0.003$) when compared to male patients, however survival at 24 h, 6 weeks and at 1-year did not show any statistical difference.

Other parameters like survival by place of arrest, age, underlying disease and cardiac arrest outside hospital did not have statistically significant effect on the survival with the available sample size.

There were very small numbers of cardiac arrests, which happened outside hospital and considered for resuscitation. Out of which 5 were males and 1 female. For all these arrests, there were no bystander resuscitation helpers. None of the patients survived to be discharged from the hospital. Maximum arrests were because of cardio respiratory arrests. Immediate survivors were 5 out of 6 (83.3%), out of 5 patients only 2 were alive at the end of 24 h (40%), and none of them survived to be discharged. The group size is too small to come to any conclusion. However, the outcome will be poor if there are no bystander CPR personnel.

DISCUSSION

There has always been discussion about declining CPR success rate, optimism about its value, cost-effectiveness in elderly patients with respect to possible outcome and means to improve CPR outcome. We collected exhaustive data over 2 years and took time in analysing, organising, and comparing the data with other studies. We went through many meta-analysis data to get an idea about the prevailing facts.[5]

There are many studies with post CPR survival rates varying from 5.3% to 32.2%.[6-9] The survival rate in our study was comparable to the rates reported by others (10.38%).[10,11] However, the immediate survival rate of 61.92% in our study was much higher than reported by Tok *et al*. of 27.2%.[10] The reason for this could have been, the BLS training programme taken on war footing by the hospital for 1-year prior to study. In the present study, all of the patients who were resuscitated had their cardiac arrests witnessed by medical staff and monitored in the ICU, OT, CATH LAB and in most of these situations; patients have been resuscitated within few minutes (probably < 4 min, since the immediate survival rate is around 61.92%).

In one of the retrospective studies published from India, the authors have analyzed 215 resuscitations done in their 125-bedded community hospital.[12] They have quoted a survival to discharge statistics of 14.4%, which is definitely higher than what we have registered in our study (10.38%). They required 5.5 resuscitation attempts needed for one live discharge after IHCAs. We required 9.6 resuscitation attempts for one live discharge. Also, they have mentioned a shorter duration of CPR, VF or VT as abnormal presenting rhythm and female sex as good prognostic factors for a better outcome. In our study, female sex had statistically significant survival only in immediate survival ($P = 0.003$) but survival at 24 h, 6 weeks and at 1-year was not significant. In another retrospective

Table 4: Survival by aetiology of cardiac arrest (inside of hospital)

Aetiology	Total number of arrests	Through arrest (ROSC)	Arrest to 24 h	24 h to 6 weeks/dis	Alive at 1-year	Survival (%) by aetiology at 1-year
Cardiac	178	116	32	18	16	59.25
Respiratory	18	9	8	5	5	18.51
Cardio-respiratory	63	35	16	6	6	22.22
Not known	1	1	0	0	0	0
Others	0	0	0	0	0	0
No information	0	0	0	0	0	0
Total	260	161	56	29	27	100%

ROSC – Return of spontaneous circulation

Table 5: Survival by type of cardiac rhythm (inside of hospital)

Rhythm	Total number of arrests	Through arrest (ROSC)	Arrest to 24 h	24 h to 6 weeks/dis	Alive at 1-year
VF	21	19	11	10	10
VT	18	17	14	8	6
Asystole	129	76	7	0	0
PEA	10	4	0	0	0
Total	178	116	32	18	16

VF – Ventricular fibrillation; VT – Ventricular tachycardia; PEA – Pulseless Electrical Activity; ROSC – Return of spontaneous circulation

Table 6: Survival related to underlying disease in patients considered for resuscitation (inside of hospital)

Disease	Number of cases	Survival
Acute MI + pulmonary oedema + cardiogenic shock	50	11
Post cardio thoracic surgery	21	6
Chronic heart disease + cardiomyopathy	10	0
Malignancies	7	0
End stage renal disease	14	1
Chronic liver disease	10	0
Chronic lung disease	16	1
Head injury	18	1
Polytrauma	12	0
Burns+sepsis	7	0
Poisoning	4	2
GI bleed+hypovolaemia	5	0
Stroke	11	0
Multi organ failure	51	0
Pulmonary thromboembolism	3	0
Prematurity	2	0
Sepsis	6	2
Others	13	3
Total	260	27

MI – Myocardial infarction; GI – Gastrointestinal

study from India, 44 consecutive cardiac arrests were analysed.[13] They predicted renal failure, sepsis, cancer and ionotropic support as poor prognosticators of outcome. In our study, we could not do statistical analysis because sample size was small. Age and place of onset of arrest could not be analysed in view of smaller sample size.

In our study, the limitations have been documentation of time of arrest, time of first defibrillation, total duration of CPR and response time for resuscitation team. Our hospital doesn't use or have an automatic recording system that registers all the events including cardiac arrests. The data analysis shows a high percentage (61.92%) of arrest victims showing immediate return of spontaneous circulation. This could be because of immediate availability of BLS trained medical professionals in almost all areas of the hospital. This success rate did not improve survival to discharge, probably because of the aetiology of the underlying event or need for more aggressive training in ACLS for medical professionals.

Nearly 60% of patients who survived for 1-year had cardiac cause as aetiology. All of them had either VF or VT as source for arrest. Invariably everyone required defibrillation. In noncritical areas like wards, diagnostics and the corridors the resuscitation cart was not readily available. It was kept in nearby areas in ICU's. Maybe if we were to keep the resuscitation cart in these areas, results would have been better.

In one of the studies,[14] a CPR outcome analysis was done from 2004 to 2006 (retrospective), before implementation of Australian Resuscitation Council (ARC) 2006 guidelines and a prospective study was done over 3 years from 2006 to 2009 after implementation of ARC 2006 guidelines.[14] They have reported survival to discharge improvement from 25% (before ARC 2006 guidelines implementation) to 36% (after ARC 2006 guideline implementation). Of course, both the results of survival to discharge are much higher than our results (10.38%). The authors stated that they were not sure whether the change in guidelines has improved survival to discharge rate, or the intense training programme has made a difference. They stated that the limiting factor for their study was that they did not follow the survived patients for 1-year.

Thigpen *et al.*'s study of IHCAs reported an improvement in the survival to discharge rate from 17.5% to 28%. Although there have been more recent changes, the fundamental changes implemented in 2006 have been maintained in the 2010 ARC revisions.[15]

Valuable time is lost in the process of waiting for a defibrillator. One more option would be to place AED in unmonitored areas since nurses are not trained in use of manual defibrillators and ACLS. Training the nondoctoral staff in handling the conventional and automated versions of defibrillators will help the arrested victims a lot.[16,17] This will also counter the shortage of trained manpower (efflux of trained personnel for greener pastures). In one of the published data from AED-use in the Chicago airport has shown effective resuscitations with a 1-year survival rate of nearly 50%.[16,17] In this study, all survivors had VF as their first rhythm, and they were

all defibrillated within 7 min. It might be difficult to achieve this success in hospital setting in view of many nonmonitored areas and co-morbid conditions where circulatory arrest might be a sign of dying heart instead of transient myocardial infarction. Nevertheless, early defibrillation is crucial and must be stressed.

CONCLUSION

There are many factors involved in good clinical outcomes following IHCAs and these variable factors need to be researched further. The best way to improve survival rate after cardiac arrests is to impart regular training and updates in CPR to all personnel.

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