Original article

Outcomes of in-hospital, out of intensive care and operation theatre cardiac arrests in a tertiary referral hospital

Murali Chakravarthy^{1*}, Sona Mitra², Latha Nonis³¹Chief Consultant, ²Research Fellow, Department of Anaesthesia, Critical Care, Pain Relief, ³Senior Executive, Department of Nursing, Fortis Hospitals, Bengaluru – 560076, India.

KEYWORDS

Cardiac arrest
 Cardiopulmonary resuscitation
 Code blue
 Intensive care unit
 Return of spontaneous circulation

ABSTRACT

Objective: Cardiac arrest in the hospital wards may not receive as much attention as it does in the operation theatre and intensive care unit (ICU). The experience and the qualifications of personnel in the ward may not be comparable to those in the other vital areas of the hospital. The outcome of cardiac arrest from the ward areas is a reasonable surrogate of training of the ward nurses and technicians in cardiopulmonary resuscitation. We conducted an audit to assess the issues surrounding the resuscitation of cardiac arrest in areas other than operation theatre and ICU in a tertiary referral hospital.

Aims of the audit: To assess the outcomes of cardiac arrest in a tertiary referral hospital. Areas such as wards, dialysis room and emergency room were considered for the audit.

Methods: This is a retrospective observational audit of the case records of all the adult patients who were resuscitated from 'code blue'. Data for 2 years from 2007 was analysed by a research fellow unconnected with the resuscitations.

Results: Twenty-two thousand three hundred and forty-four patients were admitted as in-patients to the hospital during the 2 years, starting May 2007 through May 2009. One hundred code blue calls were received during this time. Twenty-two of the total calls received were false. Among the 78 confirmed cardiac arrests 69 occurred in the wards, 2 in emergency room, 1 in cardiac catheterisation laboratory and 3 in dialysis room. Twenty-eight patients were declared dead after unsuccessful cardiopulmonary resuscitation. Among the 50 who were resuscitated with a return of spontaneous rhythm 26 died. Twenty-four patients were discharged (survival rate of 30%). The survival decreased significantly as the age progressed beyond 60. The resuscitation rates were better in day shifts in contrast to the night. Higher survival was noted in patients who received resuscitation in less than a minute.

Conclusion: A overall survival to discharge rate of 30% was noted in this audit. Higher survival rates might be attributable to high rate and degree of training at the time of their employment, which was repeated at yearly interval.

Copyright © 2012, Cardiological Society of India. All rights reserved.

Introduction

The basic techniques of cardiopulmonary resuscitation (CPR) have been established since 1960 when Kouwenhoven, Jude and Knickerbocker described closed chest massage.¹ There have been a number of studies after that, which have reported outcome and the predictors affecting outcome.^{2–5} Cardiopulmonary resuscitation is a frequently performed

medical intervention in healthcare facilities. Successful cardiopulmonary resuscitation after in-hospital cardiac arrest depends on basic and advanced life support systems, the ability to immediately defibrillate the arrested heart, and the quality of the CPR intervention (Beuret et al.; Jorgenson 1997). But studies show a wide range of 'survival on discharge' (3–27%), which could be due to differences in the settings in which the CPR is performed and differences in inclusion/exclusion criteria.^{5–8} To overcome this problem, the in-hospital Utstein style data collection (Utstein template) recommendation were published in 1997 and revised in 2004.^{5,6} These

*Corresponding author.

E-mail address: mailchakravarthy@gmail.com

recommendations defined a set of data elements that are essential for documenting in-hospital cardiac arrests and suggested guidelines for reviewing, reporting, and conducting research on this topic.⁷ In the present audit, we sought to determine how well CPR is utilised at our institution by estimating the incidence and the outcome from in hospital cardiac arrest and also predict the factors affecting the outcome. Key factors include presenting rhythm, time to definite therapy, episode being witnessed, provision of basic life support, time from collapse to defibrillation, age, gender, location of arrest, and associated risk factors. The purpose of this audit is to identify and facilitate necessary improvements both in the prevention of in-hospital cardiac arrest, and in the organisation, delivery, and outcomes from pre-arrest, resuscitation, and post resuscitation care in the hospital and providing feedback to relevant staff at all levels across the hospital. Twenty-two thousand three hundred and forty-four patients were admitted to the hospital during the period of May 2007–2009. Seventy-eight cardiac arrests were encountered during this period of time. Twenty-four patients were discharged home.

Methods

This study is a retrospective observational audit conducted on the patient data obtained in our patients who received CPR during the 2 years period from March 2007 to April 2009. We received Institutional Review Board approval to perform a retrospective medical records review on adult patients who received CPR at our hospital. Such of the cardiac arrests resuscitated in the operation theatres and intensive care units (ICUs) were excluded from the audit. Ours is a multi-specialty hospital conducting cardiac, neurosurgical, orthopaedic and minimal access general surgery. The hospital was commissioned in July 2006. The hospital has wards distributed on the 6th and 7th floors of the hospital building. A standardised protocol termed 'code 555' is in place at the hospital for treating individuals with cardiorespiratory collapse. A phone call to 555 from any of the house phones by any of the staff (nurses, doctors or technicians) would automatically dial the emergency room staff, who by pressing buttons 1–4 would dial automatically dial the 'code phone' manned by a registrar from medical ICU, coronary care unit, anaesthesiology and nursing supervisor who are all located within the hospital. This phone call also informs the phone holder from where the code has been raised. The receiver will immediately rush to the location from where the code has been raised and attend to the victim of cardiorespiratory arrest. At the time of appointment, the employees of the hospital (nurses, technicians, lift operators among others), resident doctors, and registrars were trained to provide basic life support. A review and recertification of their basic life support talent was made at 1 year interval. After the victim had been attended to, depending on the decision of the leader of the resuscitation team, the patient would be transferred to medical ICU for further care. After the patient transfer, the nursing supervisor, who is also a member of the code team, would fill up the code report form. This form mentions details of the

patient, details of concomitant diseases, location of cardiac arrest, time taken to start resuscitation, the initial rhythm, drugs administered, whether the code was successful or not, therapeutic manoeuvres employed among others.

Formation of emergency response (code blue) team (ERT): The hospital standard operating protocol (SOP) guided the formation and standardisation of the function of ERT. An ERT was formed and all its members were advanced cardiac life support providers. The ERT consisted of anaesthesiologist, intensivists, intensive care nurse, and ward nurse. The nurse assigned to the team was responsible for knowing the location of the crash cart. A separate SOP guided the maintenance of crash carts. The crash cart would not be opened unless there was a cardiopulmonary arrest. The ward nurse would check the equipment on every day. Utmost care would be given to the check of defibrillators. Presence of a well charged battery, cleanliness of paddles, constant supply of electrocardiogram cable, jelly, and recording paper are assured every day. Defibrillator check is performed during every shift and the result of the test is pasted in the log book. It was made certain that other resuscitative equipments such as functioning laryngoscope, availability of endotracheal tubes and other support equipments were available. Emergency drugs commonly used during resuscitation were kept handy in the crash cart. The contents were checked only if the crash cart seal was found broken.

The recommendations of the 2005 American Heart Association (AHA) cardiopulmonary resuscitation (CPR) guidelines were used by all the resuscitators.⁹

A research fellow unconnected with the study collected the data. The details about the patients, event characteristics, and outcome were noted as per the guidelines of in-hospital Utstein style using a standard questionnaire. The research assistant was a medical graduate and was trained by the principal investigator in data retrieval from medical records.

The following data were obtained from all patient records—patient demographics, diagnosis, cardiac arrest characteristics (which included time of the day, physical location at the time of the arrest, whether arrest was witnessed or monitored, whether it was respiratory or cardiac arrest), days in the hospital prior to arrest and survival on discharge. The study population consisted of adults who underwent CPR between March 2007 to April 2009 at a location other than ICU and operation theatre. Our definition of cardiac arrest was the same as described in the Utstein style template; the cessation of cardiac mechanical activity confirmed by the absence of detectable pulse, unresponsiveness and/or apnoea (agonal respirations).^{6,7} In instances where the patient suffered multiple cardiac arrests, only the initial in-hospital arrest was recorded during the period of hospitalisation. This was done to avoid falsely elevated rate of successful CPR. Patients who had 'do not resuscitate' or 'do not intubate or ventilate' were not included in this audit.

Results

Twenty-two thousand three hundred and forty-four patients were admitted as in-patients to the hospital during the

2 years, starting May 2007 through May 2009. During this period, there were 100 cardiac arrest calls received by the ERT during the study period. About 1 per week was the average 'code blue' call received by the ERT. Twenty-two of the total calls received were false; they were: gasping in 13, generalised tonic clonic seizures in 2 and chest pain in 7 patients. Among the 78 confirmed cardiac arrests, 47 were observed in males and 31 in females. Sixty-nine of these cardiac arrests occurred in the wards, 2 in emergency room, 1 in cardiac catheterisation laboratory and 3 in dialysis room. Twenty-eight patients (35%) did not have return of spontaneous circulation (ROSC) and were declared dead subsequently. Returns of spontaneous circulation occurred in 50 patients (65%) and were admitted to the ICU. Twenty-six of these 50 died subsequently, 24 patients were discharged (survival rate of 30%). Thirty-two males and 22 females died. Table 1 shows the pre-existing and existing characteristics in those patients. Table 2 shows the initial cardiac rhythm that was noted by the ERT. A majority of them were in pulseless electrical activity (39%), the next common rhythm was asystole (37%). Table 3 shows the manoeuvres conducted at the time of resuscitation. Nearly every patient (93%) received endotracheal intubation. Those not requiring intubation survived to discharge. Nineteen patients received intravenous injection of sodium

bicarbonate, 17 of them died. Figure 1 shows the survival rate based on age. Table 4 shows the survival decreased significantly as the age progressed beyond 60. There was one survivor among the 14 who were above the age of 80 years. Table 5 shows the survival rate and associated co-morbidities. The best survival of 64% was among those who had no or 1 co-morbidity. The survival decreased to 9.6% if the patients had 2 co-morbidities. There were no survivors among those who had <2 co-morbidities. Survival at various locations of cardiac arrest can be seen in Table 6. The survival in cardiac catheterisation laboratory was 60%, 30% in the ward, and none in the emergency room and dialysis room. Twenty-five

Figure 1 Survival rate based on age.

Table 1

Patient characteristics.

Hypertension	23
Ischaemic heart disease	21
Heart disease	33
Diabetes mellitus	23
Hyperlipidaemia	39
Chronic renal failure	13
Malignancy	6
Chronic obstructive pulmonary disease	11
Neurological dysfunction	11
Sepsis	6
Head injury	2
Electrolyte abnormality	2
Post coronary artery bypass surgery status	14
Post valve surgery	3
Post coronary angioplasty	6
Others	11

Table 2

The initial cardiac rhythm.

Pulseless electrical activity	31
Asystole	29
Ventricular fibrillation/tachycardia	18
Bradycardia	2

Table 3

Manoeuvres during resuscitation.

Intubation	73
Atropine	43
Adrenaline	47
Sodium bicarbonate	19
Direct current shock	16

Table 4

Variables affecting survival.

	n	Survivors
Age (yr)		
<60	19	8
>60	42	15
>80	14	1
Male	47	15
Female	31	9

Table 5

Survival rate and number of co-morbidities/patients.

No. of co-morbidities/patients	n	Survived	% survival
Up to 1	25	16	64
2	50	8	9.6
>2	3	0	0

Table 6

Survival rate and location of cardiac arrest.

Location	n	Survivors	% survival
Wards	69	23	30
Cardiac catheterisation laboratory	5	3	60
Emergency room	1	0	0
Dialysis room	3	0	0

patients had cardiac arrest in the day shift and 12 of them survived (48% survival), while 53 during evening or night shift; 11 (20%) survived. Twenty-seven patients received resuscitation within 1 minute, 12 survived (44%), but 51 patients received resuscitation after 1 minute. The survival in that group was 12 (23%).

Discussion

We describe our first 2 years data of out of intensive care cardiac arrests encountered in 22,344 in-patients. The comorbidities in the subjects studied are described in Table 1. The ERT managed the 'code blue' services 24 hours daily and all 7 days of the week. Twenty-two percent of the calls attended by ERT after 'code blue' were not cardiac arrests. The incidence of false cardiac arrest of 22% appears to be in synchrony with the other reports. In a report on false cardiac arrest calls, Kenward et al.¹⁰ found 150 incidents of false cardiac arrests among 512 calls (29%). The authors point out that the incidence of this depends on the training and knowledge level of the individual raising the call. They also relevantly point out that the survival among the patients for whom false cardiac arrest alarm is lower than the general hospital population, but higher than those who suffer cardiac arrest. This data may not reflect the total number of cardiac arrests in the hospital, since the ICUs usually manage such events on their own, without calling for the ERTs. The male:female distribution in our audit was 47:31. But Ahmed et al. reported a ratio of 18:24; this observation suggests absence of any particular gender preference when cardiac arrest occurs.¹¹

Return of spontaneous circulation occurred in 65% of the patients who suffered cardiac arrest in our audit. The rate of ROSC appears to vary from one institution to other. Peters et al. have reported an incidence of 76% in their series.¹² The rate of ROSC is higher in patients who are monitored, well oxygenated and haemodynamically not unstable. The incidence of survival to discharge was 30% in this audit. This appears better than the rate (21%) reported by Cohn et al.¹³ They also identified a few predictors of survival after cardiac arrest. 'Predictors of successful resuscitation included a primary cardiac admission diagnosis, monitoring at the time of the arrest, a longer duration of resuscitation and the absence of the need for endotracheal intubation. Patients with ventricular tachycardia/fibrillation were more likely to survive to hospital discharge than those with asystolic or pulseless electrical activity (45 vs 12 vs 20%, $P=0.01$). The sole independent predictor of survival to hospital discharge was the absence of the need for endotracheal intubation (odds ratio 0.14, 95% confidence interval 0.02–0.88, $P<0.01$).¹³ The observation in the present audit appears to differ from that of Cohn et al. Despite finding >70% of the patients in either asystole or pulseless activity, the survival to discharge was reasonable. The discharge ratio in this study is 26%. The data on survival rate to hospital discharge for patients with in-hospital cardiac arrest in the United States of America has been documented by the National Cardiopulmonary Resuscitation

Registry as 17%.¹⁴ The better incidence of discharge in our study may be due to the fact that it was a prerequisite for all the doctors and nurses in providing basic life support prior to their appointment. Nearly every patient received endotracheal intubation. All those who did not require endotracheal intubation survived. It has been observed by others that patients not requiring pre-hospital endotracheal intubation survive in comparison to those who require it.¹⁵ The number of patients not requiring endotracheal intubation is relatively small in our audit.

Nineteen patients received sodium bicarbonate injection and 17 of them died. This observation has been made earlier by other authors. Use of sodium bicarbonate during resuscitation of cardiac arrest is controversial.¹⁶ We currently however do not use sodium bicarbonate injection or infusion as earlier.

The survival was inversely related to the age. Best survival to discharge was observed in patient <60 years of age; the worst outcome was observed in those over the age of 80 years. Eight patients survived in the group of 11 patients under the age of 60 years (73%) in comparison to 1 in the group of 14 among patients aged over 80 years (7%). Similar observation can be found in the literature. Age, used as a continuous variable, was strongly related to survival (odds ratio=0.984; $P<0.0001$) in a study by Parish et al.^{17,18} Presence of comorbidities prevented successful outcome after CPR. A survival rate of 64% has been shown in our audit in patients with no co-morbidities. It significantly decreased to 9.6% in patients with >2 co-morbidities. Association of multiple comorbidities in the pre-arrest stage has been shown to adversely affect the outcome.¹⁹ The survival to discharge varied with the location of the cardiac arrest.

Among the four locations studied—wards, cardiac catheterisation laboratory, emergency room, and dialysis room, the outcome was best in the cardiac catheterisation laboratory followed by wards. The outcome was worst in the emergency room and dialysis room. It may not be possible to arrive at any significant inference from the data about location in our audit. The majority of our cardiac arrests occurred at the wards. However, it has been documented that survival after cardiac arrest in the dialysis room is significantly lower in comparison to the other areas of the hospital; this finding does not come as a surprise considering the illness of the patients nursed there.²⁰ The data in this audit confirmed the better outcome during day shifts in comparison to those in night shifts, weekends and holidays.²¹

Weakness of the audit

The drawbacks of retrospective studies apply to our audit. The data collected in this audit belonged to elective surgical patients and not to patients suffering from trauma and/or sepsis. The data may therefore not be a true reflection of the prevailing situation in the society. Therapeutic hypothermia which is now recommended strongly in patients having ROSC was not applied to our patients for logistic reasons. Therefore the outcome may be distorted.

Conclusion

A reasonable rate of successful discharge may be achieved with appropriate training of the ERT. Despite the best efforts to resuscitate, favourable outcome may not be possible in elderly patients with multiple co-morbidities who suffer cardiac arrest.

References

1. Kouwenhoven WB, Jude JR, Knickerbocker GG. Closed-chest cardiac massage. *JAMA* 1960;173:1064–7.
2. Hershey CO, Fisher L. Why outcome of cardiopulmonary resuscitation in general wards is poor. *Lancet* 1982;1:31–4.
3. Peatfield RC, Taylor D, Sillet RW, McNicol MW. Survival after cardiac arrest in Hospital. *Lancet* 1977;1:1223–5.
4. Bedell SE, Delebanco TL, Cook EF, Epstein FH. Survival after cardiopulmonary resuscitation in the hospital. *NEJM* 1983;309:569–76.
5. Khan NU, Razzak JA, Ahmed H, et al. Cardiopulmonary resuscitation: outcome and its predictors among hospitalized adult patients in Pakistan. *Int J Emerg Med* 2008;1:27–34.
6. Cummins RO, Chamberlain D, Hazinski MF, et al. Recommended guidelines for reviewing, reporting, and conducting research on in-hospital resuscitation: the in-hospital 'Utstein Style'. *Circulation* 1997;95:2213–39.
7. Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries. *Resuscitation* 2004;63:233–49.
8. Idris AH, Berg RA, Bierens J, et al. American Heart Association. Recommended guidelines for uniform reporting of data from drowning: the "Utstein style". *Circulation* 2003;108:2565–74.
9. Hazinski MF, Nadkarni VM, Hickey RW, O'Connor R, Becker LB, Zarisky A. Major changes in the 2005 AHA Guidelines for CPR and ECC reaching the tipping point for change. *Circulation* 2005;112(24 Suppl):IV206–11.
10. Kenward G, Robinson A, Bradburn S, Steeds R. False cardiac arrests: the right time to turn away? *Postgrad Med J* 2007;83:344–7.
11. Ahmed A, Ali M, Khan EA, Khan MU. An audit of perioperative cardiac arrests in a Southeast Asian university teaching hospital over 15 years. *Anaesth Intensive Care* 2008;36:710–6.
12. Peters R, Boyde M. Improving survival after in-hospital cardiac arrest: the Australian experience. *Am J Crit Care* 2007;16:240–6.
13. Cohn AC, Wilson WM, Yan B, et al. Analysis of clinical outcomes following in-hospital adult cardiac arrest. *Intern Med J* 2004;34:398–402.
14. Peberdy MA, Kaye W, Ornato JP, Larkin GL, Nadkarni V, Mancini ME. Cardiopulmonary resuscitation of adults in the hospital: a report of 14,720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. *Resuscitation* 2003;58:297–308.
15. Studnek JR, Thestrup L, Vandeventer S, et al. The association between prehospital endotracheal intubation attempts and survival to hospital discharge among out-of-hospital cardiac arrest patients. *Acad Emerg Med* 2010;17:918–25.
16. Geraci MJ, Klipa D, Heckman MG, Persoff J. Prevalence of sodium bicarbonate-induced alkalemia in cardiopulmonary arrest patients. *Ann Pharmacother* 2009;43:1245–50.
17. Snyder JE, Loschner AL, Kepley HO. The effect of patient age on perceived resuscitation outcomes by practitioners. *N C Med J* 2010;71:199–205.
18. Parish DC, Dane FC, Montgomery M, Wynn LJ, Durham MD. Resuscitation in the hospital: differential relationships between age and survival across rhythms. *Crit Care Med* 1999;27:2137–41.
19. Sandroni C, Nolan J, Cavallaro F, Antonelli M. In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. *Intensive Care Med* 2007;33:237–4.
20. Lafrance JP, Nolin L, Sénécal L, Leblanc M. Predictors and outcome of cardiopulmonary resuscitation (CPR) calls in a large haemodialysis unit over a seven-year period. *Nephrol Dial Transplant* 2006;21:1006–12.
21. Horimoto Y, Yoshizawa M, Okazaki A, Hasumi K. Five years experience of cardiopulmonary resuscitation in a children's hospital. *Resuscitation* 1985;13:47–55.