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ORIGINAL ARTICLE

Cardiopulmonary resuscitation: outcome and its predictors among hospitalized adult patients in Pakistan

Nadeem Ullah Khan · Junaid A. Razzak · Humaid Ahmed · Muhammad Furqan · Ali Faisal Saleem · Hammad Alam · Anwar ul Huda · Uzma Rahim Khan · Rifat Rehmani

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Abstract
Introduction Our aim was to study the outcomes and predictors of in-hospital cardiopulmonary resuscitation (CPR) among adult patients at a tertiary care centre in Pakistan.
Methods We conducted a retrospective chart review of all adult patients (age ≥14 years), who underwent CPR following cardiac arrest, in a tertiary care hospital during a 5-year study period (June 1998 to June 2003). We excluded patients aged 14 years or less, those who were declared dead on arrival and patients with a "do not resuscitate" order. The 1- and 6-month follow-ups of discharged patients were also recorded.
Results We found 383 cases of adult in-hospital cardiac arrest that underwent CPR. Pulseless electrical activity was the most common initial rhythm (50%), followed by asystole (30%) and ventricular tachycardia/fibrillation (19%). Return of spontaneous circulation was achieved in 72% of patients with 42% surviving more than 24 h, and 19% survived to discharge from hospital. On follow-up, 14% and 12% were found to be alive at 1 and 6 months, respectively. Multivariable logistic regression identified three independent predictors of better outcome (survival >24 h): non-intubated status [adjusted odds ratio (aOR): 3.1, 95% confidence interval (CI): 1.6–6.0], location of cardiac arrest in emergency department (aOR: 18.9, 95% CI: 7.0–51.0) and shorter duration of CPR (aOR: 3.3, 95% CI: 1.9–5.5).
Conclusion Outcome of CPR following in-hospital cardiac arrest in our setting is better than described in other series. Non-intubated status before arrest, cardiac arrest in the emergency department and shorter duration of CPR were independent predictors of good outcome.

Keywords Cardiopulmonary resuscitation · Cardiac arrest · Emergency care · Karachi · Pakistan

Introduction

Cardiopulmonary resuscitation (CPR) for cardiac arrest is a frequently performed medical intervention. Studies of CPR among hospitalized patients revealed survival to discharge ranging from 6% in cancer patients in the USA [1] to as high as 43% in monitored bed patients in Sweden [2]. Multiple reasons have been described for this variation including differences in inclusion/exclusion criteria, differences in the setting in which the CPR was performed and problems with definitions of common variables [2, 3]. To overcome the problem of data comparability, the in-hospital Utstein style data collection recommendations were published in 1997 and revised in 2004 [4]. These recommendations defined "a set of data elements that are essential or desirable for documenting in-hospital cardiac arrest" and suggested guidelines for "reviewing, reporting, and conducting research" on this topic [3].

There are limited data on the outcomes of CPR from low and middle income countries [5–9]. The differences in resources and the disease pattern in low and middle income

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N. U. Khan · J. A. Razzak (✉) · H. Ahmed · M. Furqan · A. F. Saleem · H. Alam · A. u. Huda · U. R. Khan · R. Rehmani
Section of Emergency Medicine, Department of Medicine, Aga Khan University Hospital,
P.O. Box 3500, Stadium Road,
Karachi 74800, Pakistan
e-mail: junaid.razzak@aku.edu

countries are likely to have an impact on the eventual outcome of CPR [5–9]. A previous study done in Pakistan showed CPR outcomes similar to the outcomes seen in more developed settings [6]. However, this study did not use the Utstein style making comparisons difficult. We conducted this study to define the outcomes and predictors of cardiopulmonary resuscitation in an adult in-patient population at a tertiary care teaching hospital in Pakistan.

Methods

Study design: retrospective cohort

Study setting The study was conducted at the Aga Khan University Hospital, which is a 545-bed tertiary care teaching hospital, located in Karachi, Pakistan. The bed capacity of the emergency department (ED), intensive care unit (ICU), coronary care unit (CCU) and wards/floors at the time of the study was 23, 21, 16 and 422, respectively. In addition there are 60 beds with cardiac monitors. An average of 23,000 adult patients were admitted to the hospital annually during the study period. For patients in cardiac arrest, there is a dedicated round-the-clock "code team" with overhead and mobile paging system. The code team comprises a senior medical or cardiology resident, an anaesthesia resident and trained nursing staff. Most of the residents are certified to perform CPR and provide advanced cardiac life support. According to hospital policy nursing staff cannot give any medications to patients in cardiac arrest without physician orders. Only physicians are credentialed to perform cardiac defibrillation. Defibrillators at the study site are monophasic.

Study population The cases were selected through a computerized search of the hospital information management system for the diagnosis of cardiac arrest or the procedure of "endotracheal intubation" and "CPR". A research assistant collected the data on patient and event characteristics and outcome as per the guidelines of the in-hospital Utstein style using a standard questionnaire. The research assistants were medical graduates with 1 year internship and were trained by the principal investigator in data retrieval from medical records. The completed questionnaires were rechecked by the principal investigator for missing information. Blinding of abstractors and inter-rater reliability assessment were not done. The study was approved by the Ethical Review Committee of the Aga Khan University.

Inclusion criteria The study population consisted of adult patients (age >14 years) of Aga Khan University Hospital who underwent CPR between June 1998 and June 2003 anywhere in the hospital. Our definition of cardiac arrest was the same as described in the Utstein style, i.e. "the cessation of cardiac mechanical activity ... confirmed by the absence of detectable pulse, unresponsiveness, and/or apnea (or agonal respirations)". For those patients who had more than one arrest during the admission, we included only the first episode.

Exclusion criteria Patients who were declared dead on arrival in the hospital and those who had an advance directive of no CPR or no endotracheal intubation were excluded. Patients less than 14 years of age were also excluded.

Statistical analysis Data were entered into SPSS version 14 for analysis. Outcome was analysed by calculating the percentage of patients with return of spontaneous circulation (ROSC), patients alive for more than 24 h, patients discharged alive and patients alive at 1 and 6 months. The patients' and events' characteristics were defined in percentages. Descriptive statistics were computed for categorical variables by computing their frequencies. The sample size required to study 18% survival (as reported in a previous study) with a power of 80% and α=5% was calculated to be 216. The sample size based on the review of 5-year patient records was 383. The primary outcome of successful CPR was dichotomized as survival ≥24 h after CPR versus survival <24 h after CPR. Secondary outcome data of survival to hospital discharge versus death were also dichotomized. To assess univariate associations between the outcomes and potential predictors, odds ratios (ORs) and their 95% confidence intervals (CIs) were computed by logistic regression analysis. All significant factors on univariate analysis were considered for inclusion in the multivariable logistic model.

Results

A total of 383 patients met the inclusion criteria. The mean age was 54 years (SD±17) with 61% being males. Almost half of the patients were admitted with a non-cardiac medical diagnosis to the hospital (52%, n=198). Hypertension (43%, n=163) and ischaemic heart disease (37%, n=142) were the most common pre-existing conditions, respectively. The intensive care unit (33%, n=128) was the most common site of cardiac arrest followed by the emergency department (18%, n=70), monitored beds (17%, n=65), coronary care unit (13%, n=51) and general beds (13%, n=48) (Table 1).

The initial cardiac rhythm was pulseless electrical activity (PEA) in almost half of the patients (50%, n=191), followed by asystole (30%, n=114) and ventricular fibrillation (VF)/ventricular tachycardia (VT) (19%, n=71). There was no initial rhythm recorded for seven patients (Table 1). Mortality rates for asystole, PEA and VT/VF

Table 1 Descriptive characteristics of patients and events (n=383; June 1998 and June 2003). *VF* ventricular fibrillation, *VT* ventricular tachycardia, *COPD* chronic obstructive pulmonary disease

Parameters	Values	Parameters	Values
Age (mean; 95% CIs)	54 (52.2, 55.6)	Immediate precipitating cause	
Gender		Metabolic	108 (28; 0.24, 0.33)
Female	149 (39; 0.34, 0.43)	Cardiac (arrhythmias/ischaemia)	127 (33; 0.29, 0.38)
Male	234 (61; 0.55,0.65)	Hypoxia/acute respiratory insufficiency	60 (16; 0.12, 0.2)
		Hypotension	40 (10; 0.08, 0.14)
Reason for admission		Others (sepsis/unknown)	48 (13; 0.09, 0.16)
Cardiac	116 (30; 0.25,0.34)	Location where code ran	
Medical (non-cardiac)	198 (52; 0.47, 0.57)	Intensive care unit	128 (33; 0.28, 0.38)
Surgical (non-cardiac)	54 (14; 0.10, 0.17)	Emergency room	70 (18; 0.15, 0.22)
Trauma	9 (2; 0.0117, 0.04)	Special care unit	65 (17; 0.13, 0.21)
Day care procedure	6 (1.6; 0.006, 0.03)	Coronary care unit	51 (13; 0.10, 0.17)
Pre-existing conditions[a]		Floor	48 (13; 0.09, 0.16)
Hypertension	163 (43)	Diagnostic and therapeutic area	11 (3; 0.09, 0.16)
Ischaemic heart disease	142 (37)	Operation theatre	5 (1.3; 0.005, 0.03)
Diabetes	137 (36)	Recovery room	2 (1; 0.0002, 0.02)
End-stage diseases	62 (16)	Initial rhythm at time of CPR	
Hyperlipidaemia	45 (12)	Pulseless electrical activity	191 (50; 0.45, 0.54)
Chronic renal failure	43 (11)	Asystole	114 (30; 0.25, 0.34)
Malignancy	39 (10)	VF or VT	71 (19; 0.15, 0.23)
COPD	22 (6)	Unknown	7 (2; 0.008, 0.04)
Pulmonary tuberculosis	14 (4)	Event monitored or witnessed or both	
		Monitored	323 (84; 0.80, 0.88)
CPR intervention in place at time of arrest[a]		Unmonitored	60 (16; 0.12, 0.19)
Intravenous access	358 (94)	Event time intervals (mean; 95% CIs)	
ECG monitoring	291 (76)	Interval from collapse to CPR start time	2 min (0.12, 4.34)
Invasive airway	176 (46)	Interval from collapse to defibrillation	8 min (4.17, 11.47)
Intra-arterial catheter	85 (22)	Interval from collapse to advanced airway achieved	11 min (7.53, 13.83)
Implantable defibrillator	3 (1)	Interval from collapse to 1st dose of epinephrine	9 min (3.9, 14)
		Duration of CPR	
		≤10 min	169 (44; 0.39, 0.49)
		>10 min	214 (56; 0.51, 0.61)

[a] Variable with multiple responses

were 61% (n=70), 58% (n=110) and 49% (n=35), respectively (Table 2). The time of initiation of CPR did not differ between those with shockable rhythm (VT/VF) and those without (PEA/asystole) (p=0.261).

Evidence of return of spontaneous circulation (ROSC) was observed in 75% (n=287) of patients with 19% (n=74) sustaining ROSC for less than 20 min, 13% (n=51) for more than 20 min but less than 24 h and 42% (n=167) for more than 24 h. Nineteen percent (n=73) survived to hospital discharge (Fig. 1).

A third of cardiac arrests occurred between 8 a.m. and 4 p.m. (n=134). There was no difference between the 24-h survival between cardiac arrests during day shifts versus evening (4 p.m. to 11 p.m.)/night shifts (11 p.m. to 8 a.m.) (44 vs 41%, p=0.42).

Univariate logistic regression with 24-h survival and survival to discharge was done as shown in Tables 2 and 3. There was no difference in the determinants of survival for these two outcomes. Multivariable logistic regression identified the following three factors as independent predictors of survival in our patient population: non-intubated status [adjusted odds ratio (aOR):3.1, 95% CI: 1.59–6.05 and aOR:4.38, 95% CI:1.87–10.3)], location of cardiac arrest, i.e. emergency department (aOR: 18.94, 95% CI:7.03–51.04 and aOR: 12.9, 95% CI:4.3–38.7) and shorter duration of CPR (aOR:3.25, 95% CI:1.94–5.45 and aOR:1.80, 95% CI:0.99–3.2) in both primary (survival >24 h vs survival <24 h after CPR) and secondary (survival to hospital discharge versus death) outcomes, respectively.

Discussion

Our study found that only one of five patients with in-hospital cardiac arrest was discharged alive from the hospital. This survival rate is within the range of survival

Table 2 Univariate analysis of the factors associated with successful CPR (June 1998 and June 2003). *PEA* pulseless electrical activity, *VF* ventricular fibrillation, *VT* ventricular tachycardia

Variables	Survived >24 h (n=162) n (%)	Died in <24 h (n=221) n (%)	p value	OR (95% CI)
Age				
60 years or less	89 (55)	129 (58)		1.00
More than 60 years	72 (45)	92 (42)	0.55	1.13 (0.75–1.7)
Gender				
Female	60 (37)	89 (40)	0.52	1.0
Male	102 (63)	132 (60)		1.15 (0.755–1.739)
Reason for admission				
Non-cardiac	95 (59)	172 (78)		1.0
Cardiac	67 (41)	49 (22)	0.00	2.48 (1.586–3.865)
Pre-existing conditions				
Two or more comorbidities	60 (37)	86 (39)		1.0
No or one comorbidity	102 (63)	135 (61)	0.71	1.08 (0.713–1.645)
ECG monitoring before cardiac arrest				
Yes	108 (67)	183 (83)		1.0
No	54 (33)	38 (17)	0.001	2.40 (1.49–3.88)
Advanced airway before cardiac arrest				
Yes	38 (23)	138 (62)		1.0
No	124 (77)	83 (38)	0.001	5.42 (3.445-8.544)
Intra-arterial catheter before cardiac arrest				
Yes	15 (9)	70 (32)		1.0
No	147 (91)	151 (68)	0.001	4.54 (2.488-8.296)
Immediate precipitating cause				
Non-cardiac	93 (57)	163 (74)		1.0
Cardiac	69 (43)	58 (26)	0.001	2.08 (1.353-3.212)
Location where code ran				
ICU	22 (14)	106 (48)	0.001	1.0
Emergency room	62 (38)	8 (4)	0.04	37.3 (15.68–88.9)
CCU	16 (10)	35 (16)	0.04	2.203 (1.04–4.66)
Monitored bed	27 (17)	38 (17)	0.001	3.423 (1.74–6.72)
General bed	24 (15)	24 (11)	0.001	4.818 (2.32–9.98)
Other areas (OR, D & T, others)	11 (6)	10 (4)	0.001	5.300 (2.01–14.0)
Initial rhythm at time of CPR				
Non-shockable (PEA/asystole)	126 (78)	186 (84)		1.0
Shockable (VF/pulseless VT)	36 (22)	35 (16)	0.11	1.52 (0.90–2.547)
Event was monitored or not				
Event was monitored	123 (76)	200 (90)		1.0
Event was not monitored	39 (24)	21 (10)	0.001	3.02 (1.697–5.372)
Duration of CPR				
>10 min	66 (42)	143 (66)		1.0
≤10 min	92 (58)	73 (34)	0.001	2.73 (1.788–4.171)
Time shift				
Evening and night	109 (67)	140 (63)		1.0
Morning	53 (33)	81 (37)	0.42	0.84 (0.548–1.288)
Interval between collapse and start of CPR (n=365)				
Start after 1 min	14 (9)	24 (11)		1.0
Start within 1 min	138 (91)	189 (89)	0.53	1.25 (0.62–2.5)
Interval between collapse and defibrillation (n=124)				
Attempted after 3 min	18 (39)	42 (54)		1.0
Attempted within 3 min	28 (61)	36 (46)	0.11	1.81 (0.9–3.8)
Interval between collapse and advanced airway (n=90)				
Secured after 5 min	24 (43)	16 (47)		1.0
Secured within 5 min	32 (57)	18 (53)	0.69	1.18 (0.50–2.79)
Interval between collapse and 1st dose of epinephrine (n=174)				
Administered after 2 min	34 (46)	38 (38)		1.0
Administered within 2 min	40 (54)	62 (62)	0.29	0.72 (0.39–1.32)

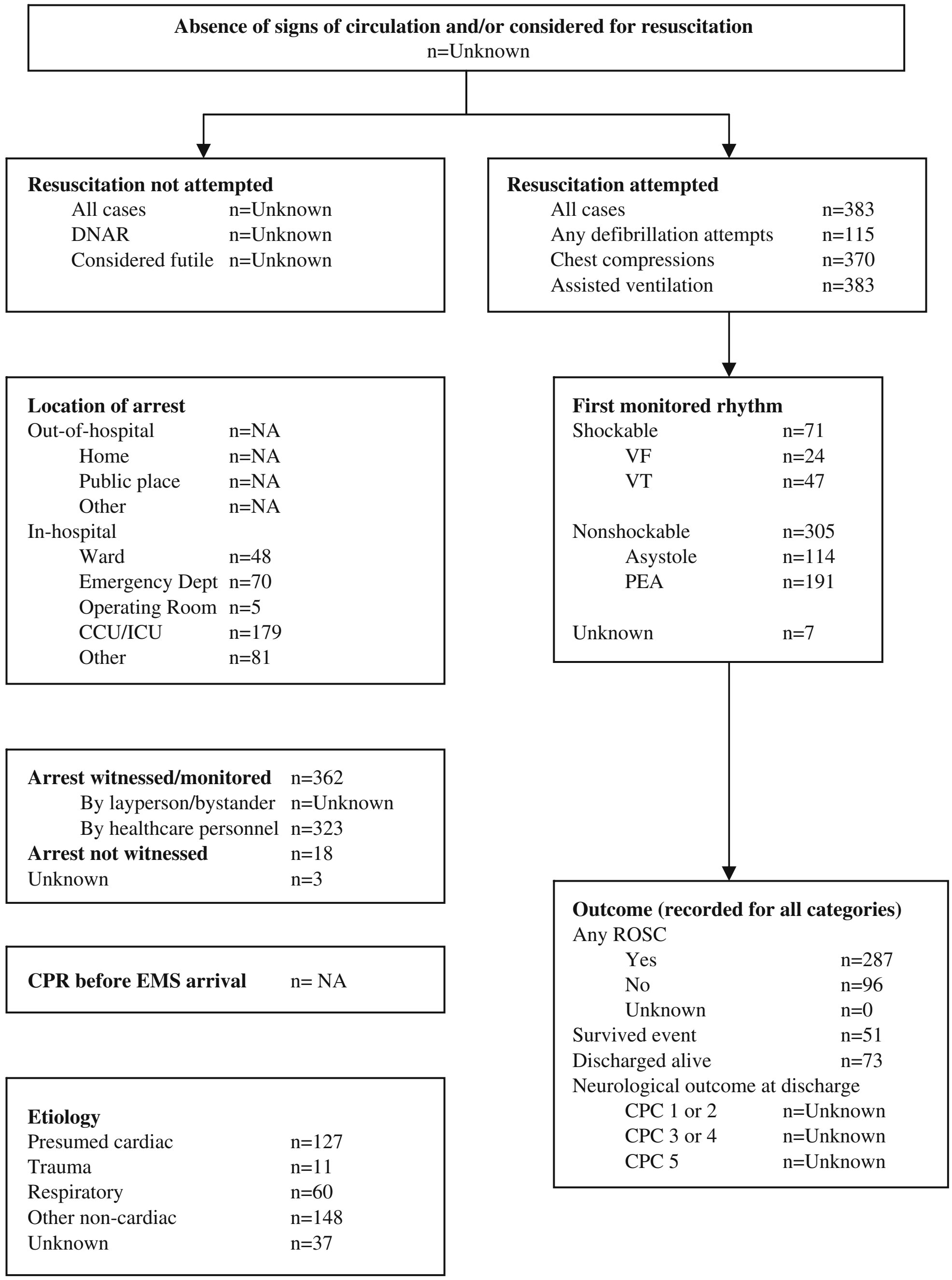

Fig. 1 Utstein core data elements for CPR

reported in numerous other studies where figures varied from 5.3 to 22.5% [7–9, 10–13]. Multiple reasons are likely to explain this variability including the quality of care, availability of hospital support services, types and acuity of illnesses seen at a given facility and the selection of patients for the institution of CPR. Interestingly the survival from CPR has remained somewhat constant over the past two decades. According to a review of the literature published in 1987, the survival at that time was 15% (range: 3–27%). A meta-analysis published in 1992 revealed survival to discharge ranging from 6.6 to 24.3% [11]. Among high income countries, the highest survival of 43% was reported from Sweden [2] in monitored bed patients. In Pakistan, on the other hand, a previous study showed a survival rate of 18% [6]. However, the patient population is perhaps different in recent studies with an increasing age and severity of illness of the hospitalized patient. In addition, the previous studies differed in their design and methodology, rendering them incomparable to newer Utstein style-based studies. Thus, variations observed in the outcome of Utstein style-based studies are more likely to identify the impact of hospital and patient-based variables in determining the outcome.

Our study highlighted that age, gender, pre-existing conditions and time of day at which the patient developed

Table 3 Univariate analysis of the factors associated with survival to discharge (June 1998 and June 2003). *PEA* pulseless electrical activity, *VF* ventricular fibrillation, *VT* ventricular tachycardia

Variables	Death (*n*=299) *n* (%)	Hospital discharge (*n*=84) *n* (%)	*p* value	Univariate logistic regression OR (95% CI)
Age				
60 years or less	173 (58)	45 (54)		1.00
More than 60 years	126 (42)	38 (46)	0.55	1.16 (0.71–1.9)
Gender				
Female	121 (40.5)	28 (33)		1.0
Male	178 (59.5)	56 (67)	0.23	1.36 (0.81–2.3)
Reason for admission				
Non-cardiac	231 (77)	36 (43)		1.0
Cardiac	68 (23)	48 (57)	0.001	4.53 (2.72–7.54)
Pre-existing conditions				
No or one comorbidity	178 (59.5)	59 (70)		1.0
Two or more comorbidities	121 (40.5)	25 (30)	0.76	1.60 (0.95–2.7)
ECG monitoring before cardiac arrest				
Yes	238 (80)	53 (63)		1.0
No	61 (20)	31 (37)	0.002	2.3 (1.35–3.85)
Advanced airway before cardiac arrest				
Yes	163 (54.5)	13 (15.5)		1.0
No	136 (45.5)	71 (84.5)	0.001	6.54 (3.5-12.33)
Intra-arterial catheter before cardiac arrest				
Yes	82 (27)	3 (4)		1.0
No	217 (73)	81 (96)	0.001	10.2 (3.13-33.20)
Immediate precipitating cause				
Non-cardiac	217 (73)	39 (46)		1.0
Cardiac	82 (27)	45 (54)	0.001	3.05 (1.85–5.03)
Location where code ran				
ICU	122 (41)	6 (7)	0.001	1.0
Emergency room	26 (9)	44 (52)	0.001	34.4 (13.3–89.2)
CCU	42 (14)	9 (11)	0.008	4.35 (1.5–13)
Monitored bed	56 (19)	9 (11)	0.032	3. 3 (1.1–9.6)
General bed	38 (13)	10 (12)	0.002	5.35 (1.8–15.7)
Other areas (OR, D & T, others)	15 (5)	6 (7)	0.001	8.1 (2.32–28.50)
Initial rhythm at time of CPR				
Non-shockable (PEA/asystole)	249 (83)	63 (75)		1.0
Shockable (VF/pulseless VT)	50 (17)	21 (25)	0.08	1.7 (0.93–2.96)
Event was monitored or not				
Event was monitored	262 (88)	61 (73)		1.0
Event was not monitored	37 (12)	23 (27)	0.001	2.7 (1.48–4.8)
Duration of CPR				
10 min or more	174 (60)	35 (43)		1.0
10 min or less	118 (40)	47 (57)	0.007	1.9 (1.21–3.25)
Time shift				
Morning	106 (35.5)	28 (33)		1.0
Evening and night	193 (64.5)	56 (67)	0.71	1.09 (0.65–1.83)
Interval between collapse and start of CPR (*n*=365)				
Start after 1 min	30 (10)	8 (10)		1.0
Start within 1 min	255 (90)	72 (90)	0.89	0.94 (0.41–2.15)
Interval between collapse and defibrillation (*n*=124)				
Attempted after 3 min	51(50.5)	9 (39)		1.0
Attempted within 3 min	50 (49.5)	14 (61)	0.32	1.6 (0.63–3.99)
Interval between collapse and advanced airway (*n*=90)				
Secured after 5 min	22 (43)	18 (46)		1.0
Secured within 5 min	29 (57)	21 (54)	0.77	1.13 (0.48–2.61)
Interval between collapse and 1st dose of epinephrine (*n*=174)				
Administered after 2 min	53 (39)	19 (51)		1.0
Administered within 2 min	84 (61)	18 (49)	0.17	1.67 (0.8–3.47)

cardiac arrest do not significantly affect the outcome of CPR. In the literature age remains a controversial variable in predicting outcome. Many studies [10–12, 15, 16] support the idea that it can predict outcome while others [17–21] argue that age per se does not exert any significant effect on the outcome of cardiac arrest and should not be used as a criterion to make the decision about the potential benefits of CPR. Our study complemented other studies which did not observe any difference in outcome with respect to gender of the victim [5, 8, 14–16].

In our study we did not find any significant change in survival relative to the time of the day at which CPR was performed. In other studies the time of the day of cardiac arrest has been shown to affect the outcome of cardiac arrest with better survival among patients who underwent cardiac arrest and CPR during morning or evening shifts [7, 8, 10, 12, 22, 23]. Brindley et al. [20] and Rakić et al. [12] suggested that it could be because of the increase in the number of unwitnessed arrests in the night, but Matot et al. [22] found that prognosis remains poor independent of the witnessed status of the event.

Univariate analysis showed that cardiac aetiology either for admission to the hospital or as a precipitating cause for cardiac arrest was associated with better outcome similar to studies from Turkey and the UK [11, 24]. We also observed that VF/VT as the initial rhythm has a better outcome than other rhythms, but the association is not significant, whereas Cooper et al. [10] and Grubb et al. [24] reported this observation as significant. As expected patients who had evidence of advanced medical interventions in place such as endotracheal intubation and intra-arterial catheter had a poor outcome. This is contrary to findings in other studies where patients intubated prior to cardiac arrest were more likely to survive [8, 25, 26]. Bedel et al. [19] and Huang et al. [27] also found that previously intubated patients had reduced survival and related this fact to co-existing illnesses.

In the final multivariate model we found that patients undergoing CPR in the ED, on the regular floor/ward, operating room and in the recovery room had a better survival than those in whom CPR was performed in the ICU, CCU or in a monitored bed. This is presumably because patients in these settings had a greater severity of illness and are likely to have more multiple co-existing conditions than patients in other parts of the hospital. Our final model also showed that CPR of “less than 10 min duration” is an independent predictor of survival to more than 24 h, which complements the finding of others [7, 8, 10, 11, 13, 28].

There are several limitations to our study. First, it was a single-centre study done in a private hospital in Pakistan. The findings are likely to be different in non-teaching private hospitals and in state-run hospitals with a much larger load of patients and limited resources. Second, this was a retrospective review of data and sometimes the exact timing of individual interventions was not recorded, thus making it difficult to correlate outcomes with individual interventions. Finally, we could not access information about the functional outcome in patients who were discharged alive from the hospital.

Conclusion

The outcome of CPR in this single-hospital study from a low income country showed a survival rate comparable to the more developed countries. Successful CPR was most likely to occur in certain settings (e.g. ED) and in patients with a CPR of less than 10 min duration.

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