APACHE II scores as predictors of cardio pulmonary resuscitation outcome: Evidence from a tertiary care institute in a low-income country

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ABSTRACT

Aim: The aim of this study was to demonstrate that APACHE II scores can be used as a predictor of the cardio-pulmonary resuscitation (CPR) outcome in hospitalized patients. **Methods:** A retrospective chart review of patients admitted, from 2002 to 2007, at the Aga Khan University Hospital, Karachi, was done for this study. Information was collected on 738 patients, constituting all adults admitted in general ward, ICU, CICU and SCU during this time, and who had under-went cardiac arrest and received cardiopulmonary resuscitation during their stay at the hospital. Patient characteristics, intra-arrest variables such as event-witnessed, initial cardiac rhythm, pre arrest need for intubation and vasoactive drugs, duration of CPR and survival details were extracted from patient records. The APACHE II score was calculated for each patient and a descriptive analysis was done for demographic and clinical features. The primary outcome of successful CPR was categorized as survival >24 h after CPR versus survival <24 h after CPR. Multivariable logistic regression was used to assess the association between the explanatory variables and successful CPR. **Results:** Patients with APACHE II scores less than 20 had 4.6 times higher odds of survival compared to patients with a score of >35 (AOR: 4.6, 95% CI: 2.4-9.0). Also, shorter duration of CPR (AOR: 2.9, 95% CI: 1.9-4.4), evening shift (AOR: 2.1, 95% CI: 1.3-3.5) and Male patients (AOR: 0.6, 95% CI: (0.4-0.9) compared to females were other significant predictors of CPR outcome. **Conclusion:** APACHE II score, along with other patient characteristics, should be considered in clinical decisions related to CPR administration.

Key words: *APACHE II scores, cardiopulmonary resuscitation, outcome*

INTRODUCTION

Outcome of cardio-pulmonary resuscitation (CPR) has not changed from the last three decades[1] despite enormous advancement in this field. A meta-analysis conducted to evaluate the survival rates of CPR in 113 studies (around 26095 patients) found survival till discharge from the hospital in approximately 15% of the cases and a 1 year survival rate of 5%.[2] Main reasons for this poor outcome are inappropriate selection of patients for administering CPR and lack of prudent post-resuscitation management leading to death after initial survival. In such cases, this life saving procedure either goes to waste or lengthens the hospital stay only to prolong the dying process and indirectly causes significant additional economic burden. Thus CPR should be performed on carefully selected population and once these subjects revive from instant resuscitation efforts it should be realized that they will need vigilant post-resuscitation management to maintain the initial outcome of CPR.

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Estimated prediction about the outcome of Cardio-pulmonary resuscitation can be utilized by physicians to make decisions about its application or augment their confidence in making dialogue with the family. Pre-arrest factors like severity of illness and co-morbids play an important role in such predictions. Knaus *et al.*,[3] have developed a scoring system, APACHE II, which accurately computes severity of illnesses in ICU patients and can be potentially used to gauge the outcome of cardiopulmonary resuscitation.

There are very few studies[4-7] on this issue in current literature that used APACHE II scoring to predict the outcome of CPR. Three of these studies involved only ICU patients and their study size was also very small (<250 cases). Also, there is relative paucity of such information from our part of the world.

The aim of our study is to demonstrate that APACHE II score can be used as a predictor of the CPR outcome in hospitalized patients and also to emphasize the importance of post-resuscitation management in patients who were initially revived by CPR.

METHODS

Medical records of all adult patients who under-went cardiac arrest and received cardiopulmonary resuscitation were reviewed retrospectively between June 2002 to June 2007 at the Aga Khan University, hospital. We examined the records of cardiac arrest or respiratory arrest patients and retrieved the full inpatient medical records. Patient characteristics, intra-arrest variables such as event-witnessed, initial cardiac rhythm, pre arrest need for intubation and vasoactive drugs, duration of CPR and survival details were extracted from patient records. All adult patients (age 16 or above), admitted in general ward, ICU, CICU and SCU were included in the study. The study was approved by the Ethical Review Committee (ERC) of the Aga Khan University (AKU). Patients in which complete protocol of CPR was not performed, because of not having full consent (i.e consent for all procedures of CPR that include chest compression, defibrillation, airway/ETT, bagging) and patients transferred to other facilities after CPR were excluded from the study.

The APACHE II score was calculated for each patient. The scores range from 0 to 71, and are based on several measurements; higher scores imply a more severe disease and a higher risk of death. The point score is calculated from 12 routine physiological measurements including values for blood pressure, body temperature, heart rate, respiratory rate, oxygen saturation, hematocrit, WBC count, arterial pH, serum sodium, potassium, creatinine concentration, and Glasgow coma score), information about previous health status and some information obtained at admission (such as age).

Statistical analysis

All analyses were conducted using the Statistical package for Social Science, (SPSS) (Release 17.0, standard version, copyright © SPSS; 1989-02). All *P* values were two sided and considered as statistically significant if <0.05.

A descriptive analysis was done for demographic and clinical features. The results are presented as means±standard deviation for quantitative variables and as frequencies (Percentages) for qualitative variables. The primary outcome of successful CPR was categorized as survival >24 h after CPR versus survival <24 h after CPR. Secondary outcome of CPR was survival up to hospital discharge versus death before discharge from the hospital. In univariate analysis, differences in proportions for outcomes were assessed by using the Chi-square test or Fisher exact test where appropriate. For contrasts of continuous variables, independent sample *t*-test was used to assess the difference of means. Odds Ratios (OR) and their 95% Confidence Intervals (CI) were estimated using multivariable logistic regression, with survivors of >24 h as an outcome. The likelihood ratio test used to assess the association between the explanatory variables and the successful CPR. Univariable analyses were performed to examine the effect of each variable on the successful CPR. In Univariable analysis $P<0.25$ was used as the level of significance in order not to exclude important variables from the model. Multivariable models were then constructed, including variables that showed an effect in the univariate analyses.

RESULTS

There were 738 records of in-hospital cardiac or respiratory arrest during the study period. Of these 14 records were excluded because of incomplete chart review. The mean age of the 724 study patients was 55.70 (±17.52) years (range 16-91), comprised of 476 (65.7%) male and 248 934.3%) female. Electromechanical dissociation (EMD), also known as pulseless electrical activity (PEA), was the most frequent single arrest type with occurrence in 388 (53.6%) patients, and asystole was the second most frequent type of arrest 206 (28.5%). Hypertension 213 (23.8%) and Diabetes 200 (22.3%) were the most common pre existing conditions. The intensive care unit 302 (41.7%) was the most common location of cardiac arrest. The event was monitored in 608 (84%) patients. Return of spontaneous circulation (ROSC) was observed in 333 (46%) of the patients and, overall, 44 (6.07%) of the patients were able to survive till hospital discharge [Table 1]. Univariate logistic regression with 24 h survival and survival to discharge was done as shown in [Table 2]. Univariate analysis revealed that CPR duration less than 15 minutes ($P<0.001$), survival during evening shift as compared to night shift ($P=0.06$), patient who already have cardiac disease ($P=0.01$), patients who have been intubated ($P=0.02$) or on vasoactive ($P=0.02$) and patients resuscitated between 1500 and 2300 Hrs ($P=0.006$) have better chance of survival after successful CPR. Survival among patients with APACHE II scores greater than 24 was significantly less than in patients who have APACHE II score less than 24.

Table 1: Characteristics of patients who received cardiopulmonary resuscitation

Characteristics	No. of patients *n*=724	%
Age, years	55.70±17.52	
<40	154	21.3
40-64	298	41.2
≥65	272	37.6
Gender		
Male	476	65.7
Female	248	34.3
Disease		
Cardiac	202	27.9
Non-cardiac	522	72.1
Comorbids		
None	234	32.3
≤2 comorbid	328	45.3
>2 comorbid	162	22.4
Principle diagnosis		
CVS	202	27.9
Infectious	98	13.5
Resp	90	12.4
GIT	84	11.6
CNS	72	9.9
Malignancies	66	9.1
Others	57	7.9
Metabolic	30	4.1
Trauma	24	3.3
Psychiatric	1	0.1
Event was monitored	608	84
Initial cardiac rhythm of the patient		
Vt/vf	115	15.9
Asystole	206	28.5
EMD	388	53.6
Unknown	15	2.1
Time of arrest		
7:00-15:00	252	34.8
15:00-23:00	200	27.6
23:00-7:00	235	32.5
Intervention in place before arrest		
None	52	7.2
Intubation	150	20.7
Vasoactive	165	22.8
Vasoactive/Intubation	64	8.8
Intravenous access	293	40.5
Location of patient 24 hrs before cardiac arrest		
ICU	302	41.7
CCU	162	22.4
SCU	138	19.1
Floor	122	16.9
CPR duration		
≤15 min	357	49.3
>15 min	367	50.7
APACHE score before 24 hrs		
<20	145	20
20-24	157	21.7
25-29	168	23.2
30-34	111	15.3
>35	143	19.8

(*contd*...)

Table 1: (*Contd*...)

CPR - Cardiopulmonary resuscitation

Table 2: Univariate analysis of factors associated with successful CPR

Characteristics	Survived >24 h (*n*=133, 18.4%)	Died in <24 h (*n*=591, 81.6%)	Odd ratio (95% CI)	*P* value
Gender				
Female	55 (22.2)	193 (77.8)	1.0	
Male	78 (16.4)	398 (83.6)	0.68 (0.46-1.01)	0.05
Disease				
Non-cardiac	84 (16.1)	438 (83.9)	1.0	
Cardiac	49 (24.3)	153 (75.7)	1.67 (1.12-2.48)	0.01
Initial rhythm of the patient recorded				
Unknown	5 (33.3)	10 (66.7)	1.0	
Vt/vf	30 (26.1)	85 (73.9)	0.70 (0.22-2.23)	0.55
Asystole	38 (18.4)	168 (81.6)	0.45 (0.14-1.40)	0.16
EMD	60 (15.5)	328 (84.5)	0.36 (0.12-1.10)	0.07
Time of arrest				
7:00-15:00	42 (16.7)	210 (83.3)	1.0	
15:00-23:00	55 (27.5)	145 (72.5)	1.89 (1.20-2.98)	0.006
23:00-7:00	33 (14)	202 (86)	0.81 (0.49-1.34)	0.42
Duration of CPR				
>15 min	41 (11.2)	326 (88.8)	1.0	
≤15 min	92 (25.8)	265 (74.2)	2.76 (1.84-4.12)	<0.001
Intervention in place before arrest				
None	15 (28.8)	37 (71.2)	1.0	
Intubation	22 (14.7)	128 (85.3)	0.42 (0.20-0.89)	0.02
Vasoactive drugs	25 (15.2)	140 (84.8)	0.44(0.21-0.91)	0.02
Vasoactive+ Intubation	13 (20.3)	51 (79.7)	0.62 (0.26-1.47)	0.28
Intravenous access	58 (19.8)	235 (80.2)	0.60 (0.31-1.18)	0.14
APACHE before 24 hrs				
≥35	16 (11.2)	127 (88.8)	1.0	
<20	45 (31)	100 (69)	3.57 (1.90-6.69)	<0.001
20-24	31 (19.7)	126 (80.3)	1.95 (1.01-3.74)	0.04
25-29	28 (16.7)	140 (83.3)	1.58 (0.82-3.07)	0.17
30-34	13 (11.7)	98 (88.3)	1.05 (0.48-2.29)	0.89
Length of hospital stay	13 ± 11.05	6.13 ± 10.18	1.05 (1.04-1.08)	<0.001

Multivariate logistic regression [Table 3] identified the following five factors as independent predictors of survival in our patients: Shorter duration of CPR (adjusted odd

Table 3: Predictors of successful to be survived >24 h following CPR

	Adj. odd ratio (95% CI)	*P* value
Gender		
Female	1.0	
Male	0.57 (0.37-0.88)	0.01
Disease		
Non-cardiac	1.0	
Cardiac	1.82 (1.18-2.82)	0.007
Time of arrest		
7:00-15:00	1.0	
15:00-23:00	1.85 (1.14-3.001)	0.01
23:00-7:00	0.79 (0.47-1.33)	0.38
Duration of CPR		
>15 min	1.0	
≤15 min	2.87 (1.88-4.39)	<0.001
APACHE before 24 hrs		
≥35	1.0	
<20	4.64 (2.38-9.04)	<0.001
20-24	2.50 (1.26-4.95)	0.009
25-29	1.91 (0.96-3.82)	0.06
30-34	1.22 (0.54-2.74)	0.62

ratio: 2.87, 95% CI: 1.88-4.39), APACHE II score less than 20 (adjusted odd ratio: 4.64, 95% CI: 2.38-9.04), and APACHE score between 20 to 24 (adjusted odd ratio: 2.50, 95% CI: 1.26-4.95) as compared to greater than 24 APACHE scores, and evening shift (adjusted odd ratio: 2.11, 95% CI: 1.26-3.53). Male patients had less chance of survival (adjusted odd ratio: 0.57, 95% CI: (0.37-0.88) compared to females.

DISCUSSION

Our study highlighted that APACHE II score can be used as a predictor of survival in admitted adult patient undergoing cardiac arrest and CPR in both ICU and non ICU setting. Ideally, APACHE II severity score is supposed to be based on the worst variables during the initial 24 hours of ICU admission. We have used the last available data within 24 hours before arrest. Scores below 24 reached statistical significance for better outcome. Higher score were associated with poor immediate survival, though not statistically significant, and there was 100% mortality at and above score of 42. This finding is consistent with other studies which found that an increasing APACHE II score was associated with a decreased rate of survival to discharge following CPR.[4,5] Other predictive scoring systems used to predict outcome in cardiac arrest patient undergoing CPR like PAM score, PAR score and APACHE III were compared in one study and but they were unable to effectively discriminate between survivors and non survivors for both immediate and survival to discharge following in hospital CPR.[8] We think that APACHE II requires simpler manual calculations compared to APACHE III and IV and is a useful and easily applicable tool to predict survival in the inpatient setting. These predictive scoring systems have been in use since 1980 to predict prognosis but few studies have used this specifically for cardiac arrest patients and in patients outside the ICU setting.

We found that evening shift was significantly associated with survival compared to night shift. We do not know the exact reason for this but possibilities are that night shift is covered by on-call teams who have more patients load compared to day time healthcare providers. A previous study from Pakistan did not find time of the day to be significantly associated with change in survival.[9] The study included emergency department (ED) patients which were excluded in our study, which might have contributed for the difference in findings. Other studies[10-14] have found morning and evening shift to be associated with better survival compared to night shift in consistent with our findings.

Male patients were less likely to survive then females in both univariate and multivariate analysis. This is in contrast to previous studies which did not show difference in outcome with respect to gender.[13,15-18]

ICU patients have a poor outcome compared to non ICU patient. This could be related to severity of illness or multiple co-morbidities in ICU patients and is consistent with studies both from Pakistan and other countries.[2,9]

Cardiac diseases and shorter duration of CPR was strongly associated with better immediate survival. Acute myocardial infarction has been shown to be a significant positive predictor of survival in other studies.[19,20] We did not look separately for acute myocardial infarction patient but rather all patients with cardiac disease as the reason for admission were grouped together for comparison. Our study was based on information collected from hospital records which makes our results vulnerable to certain limitations. This was a single centre study from a tertiary care private hospital to which many patients may not have access to due to financial reasons. This could affect the generalisability of the findings to other patients in public hospitals. Being a retrospective chart review, quality of information recorded for some patient could be compromised. Missing information was an issue in 14 patients due to non availability of records.

CONCLUSION

APACHE II Score of less than 24, female gender, cardiac disease, duration of CPR <15 min and evening shift were associated with better immediate survival in our setting.

Therefore, we recommend that APACHE II score, along with other patient characteristics, should be considered in clinical decisions related to CPR administration.

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