ORIGINAL ARTICLE

Factors Predicting Outcome of Cardiopulmonary Resuscitation among Elderly Malaysians: A retrospective study

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SUMMARY

Cardiopulmonary resuscitation (CPR) has been standard treatment for all cardiac arrest patients that arrive at the Emergency Department. However it is unclear whether prolonging resuscitation among the elderly victims will provide any benefit or improve outcome. This study is to evaluate factors that can influence outcome of CPR among the elderly, such as time of arrest, duration of CPR, lactate levels and age (among elderly age groups). 89 patients fit the inclusion criteria from January 2007 to January 2009, and all underwent CPR. Lactate levels (p=0.047) and duration of CPR performed (p=0.019) had significant relation to outcome. Time of arrest to CPR and age had no significance. Of 89 patients studied, 4 (4.5%) survived to hospital discharge. The remaining 85 (95.5%) died either in the emergency department, the wards or the Intensive Care Unit. Among the survivors, only 2 (2.3%) functional (independent on activities of daily life) patients were identified. Among the survivors, the mean lactate level was 4.0 mmol/L. The mean lactate levels among the dead were 9.84 mmol/L. The mean length of CPR among the survivors was 5.42 minutes and for the non-survivors, 19.28 minutes. This study reports certain factors such as duration of resuscitation and initial lactate levels that can be valuable tools in decision making when resuscitating an elderly.

KEY WORDS:
CPR, Elderly, Lactate, Age, Duration, Time

INTRODUCTION

Cardiopulmonary resuscitation (CPR) has been a standard intervention for respiratory or cardiac arrest of any nature including natural death [1]. While CPR can save lives when done appropriately, it is commonly used and continued in elderly patients that is unlikely to benefit from such intervention. This study determines factors that can influence outcome of CPR in elderly and can be an initial step in the decision making during resuscitation. The ultimate goal is to set the duration for a successful resuscitation of an elderly, as compared to resuscitating a new born which is at most 10 minutes[2].

The stigma with our Malaysian population is the fear of prolonging death and dying in hospital. Many elderly patients with return of spontaneous circulation (ROSC) reach the Intensive Care Unit (ICU) only to be labeled 'Do Not Resuscitate' (DNR). Some patients are supported with intensive life sustaining techniques which may be against the patient's own will. This is a burden to the health system and ICU which frequently lacks beds and medical equipment needed for more salvageable patients.

We conducted an epidemiological study of in-hospital and out-of-hospital CPR in the elderly treated at Pusat Perubatan Universiti Kebangsaan Malaysia (PPUKM) from 2007 through 2009. We analyzed trends in incidence, survival to hospital discharge, time of resuscitation, initial lactate levels, race, sex, defibrillation attempts, usage of adrenaline and background illnesses which are associated with survival.

MATERIALS AND METHODS

Sample collection

This is a retrospective study. Log books pertaining to resuscitated patients (patients who were triaged to red zone which needs immediate attention) from January 2007 to January 2009 were collected from the Emergency Department archives section. Patients 65 years and above were studied and their records retrieved from the records office. From the patients chart, another selection process was done whereby patients who underwent cardiopulmonary resuscitation were selected. These data were then collected and the following factors were selected based on a study by Murphy, Murray, Robinson BE *et al:*[3] The factors were age, sex, race, estimated time prior to CPR, length of CPR to get ROSC, initial lactate levels recorded, (as early as possible that can be obtained, when the patient first arrived at ED). Other factors selected were initial ECG rhythm, location of arrest, witnessed or not witnessed and amount of adrenaline used.

This study involved patients who presented to the Emergency Department PPUKM. The outcome of the cardiopulmonary resuscitation was either favorable (survival up to hospital discharge) or unfavorable (did not survive). Among the unfavourable would be those who regained ROSC (return of spontaneous circulation) but then died during current admission and those who did not regained ROSC at all. Death due to hospital acquired disease, or prolonged stay in hospital was not counted as unfavourable outcome. The inclusion

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criteria of the patients are as follows:

1. Elderly patients of 65 years and above as defined by the World Health Organization (WHO).
- Any resuscitation attempted as defined in the Ulstein Data Templates (2004)[4], including total number of resuscitation attempts and episodes of resuscitation that included any defibrillation attempt, chest compression and ventilation.

The exclusion criteria include resuscitation not attempted as defined in the Ulstein Reporting Templates (2004)[4] where resuscitation was not attempted because a 'Do Not Actively Resuscitate' (DNAR) order was present, attempt was considered futile (or meaningless) or signs of circulation were present.

Statistical Analysis

Mann Whitney and Wilcoxon tests (independent variable sampling) were employed to evaluate the trend and significance for specific objectives. SPSS Version 16 statistical software was used to analyze the data. The sample size includes all patients in the inclusion criteria. The PPUKM ethics board committee approved this study as a retrospective review on human subjects. We evaluated all factors recorded and correlated to the outcome for significance (P<0.05).

RESULTS

We identified 89 patients who underwent CPR, of whom 4 (4.5%) survived to discharge. 39 (43.8%) patients were male and 50 (56.2%) were female. Among the 39 male patients, 1 (1.1%) survived to discharge and the other 38 died (42.7%). Out of 50 female patients who were involved in this study, 3 had survived (3.4%) and 47 (52.8%) died (Table I). In total, 4 (4.5%) patients were discharged from the hospital alive and only two (2.3%) were functional survivors. The sole male survivor had good quality of life and independent on daily life activities. One of the three female patients survived with good neurological outcome. The other two female patients that survived to hospital discharge were in a vegetative state and were requested to be discharged home from ICU by the respective family members.

Estimated time from arrest to CPR

As shown in Table II, the majority of patients who were resuscitated fell in the range of 0-5 minutes. Total of 51 patients (57.3%) were resuscitated in the range of 0-5 minutes and among them 3 patients survived. Ten (11.2%) patients were resuscitated in the range of 6-10 minutes and one survived. None of the 28 patients (31.5%) that were resuscitated after more than 10 minutes of arrest survived.

Fifty four (96.4%) out of 56 patients from whom the lactate levels were obtained died and the remaining 2 (3.6%) patients survived. The mean lactate level among the dead is 9.84 mmol/L and the standard deviation is 0.68. Maximum lactate recorded is 23 mmol/L and minimum is 2 mmol/L (Figure 1). The two patients that survived to hospital discharge had a lactate of 3.6 mmol/L and 4.4 mmol/L. The median is 4 mmol/L. The significance of lactate levels and outcome of cardiopulmonary resuscitation was 0.047. (p<0.05)

Duration of CPR in relation to the outcome of CPR

The number of samples in the study of this parameter is 86 patients. A small number of data (n=3) is missing due to the incomplete documentation. Mean duration of CPR among survivors is 5.42 minutes and 21 minutes among the dead (Table III). This is found to be significant (p=0.019)

Relationship between age and outcome of CPR

In our study the mean age of survivors was 72.4 years and that of non survivors was 74.98 years. The mean age of total patients that were resuscitated was 75 years. As shown in Table IV none of the survivors came from the age groups of 80 and above. In addition no patient above 90 years old obtained any recordable ROSC during the resuscitation period. The correlation between different age groups and outcome of CPR is not significant (p=0.96), (p>0.05)

Other parameters recorded and the outcome of CPR

Initial ECG rhythm in 76 patients are divided into 4 different rhythms: ventricular fibrillation, bradycardia / bradyarryhtmia, pulseless electrical activity (PEA) and asystole. ECG rhythm in this study did not show any significant relationship with outcome (P =0.325). Ten patients had a ventricular fibrillation as initial rhythm but only one survived to hospital discharge (10%). Two patients with bradyarrythmias and one patient who had initial rhythm of asystole survived to hospital discharge. Out of twenty one patients with bradycardia, 19 died (90.5%) and 2 (9.5%) survived. However the data did not correlate significantly with outcome due to inadequate sample of survivors and significant missing data resulting from inadequate documentation in the case notes. No patient with PEA survived to discharge (Table V).

Outcome after cardiac arrest is known to be influenced by immediate access to resuscitation. Forty two (47.7%) of the patients arrested pre hospital and 46 (52.3%) arrested in hospital. Data from one patient was missing (1.1%). Out of 42 patients arrested out of hospital, 41 (97.6%) patients died and 1(2.4%) survived to hospital discharge. A total of 46 patients arrested in hospital and 3 (6.5%) survived to hospital discharge. According to the data tabulated there was no significant relationship with location of arrest (p >0.05) (Table VI).

There was also no significance between witnessed and non-witnessed cardiac arrest to the outcome of CPR in the elderly (p =0.57). Out of 52 witnessed arrest, 49 (94.2%) died and 3 (5.7%) survived to hospital discharge. Total of non-witnessed arrest is 37 with 1(2.7%) survived to hospital discharge and 36 (97.3%) succumbed to death (Table VII).

DISCUSSION

Race does not have any significant effect on the outcome (p = 0.765, p>0.05). All survivors were Chinese; however this is inconclusive due to its higher population in the study (64%). This might be attributed to the predominantly Chinese population (84% Chinese, 10% Malay, 6% Indian)[5] in Cheras, Kuala Lumpur, where the hospital is located. Northern American studies showed the African American and lower socioeconomic groups may be associated with lower survival

Table I: Demography of patients studied

Parameter		Survived	Dead	Total
Sex	Male	1(1.1%)	38(42.7%)	39(43.8%)
	Female	3(3.4%)	47(52.8%)	50(56.2%)
				Total: N=89
Race	Malay	0	18(20.2%)	18(20.2%)
	Chinese	4(4.5%)	57(64.0%)	61(68.5%)
	Indian	0	9 (10.1%)	9 (10.1%)
	Others	0	1 (1.1%)	1 (1.1%)
				Total: N=89

Table II: Time of arrest to CPR with the outcome

Time of arrest to CPR	Alive patients	Dead	Total
0-5 minutes	3 (3.3%)	48 (54.0%)	51 (57.3%)
6-10 minutes	1 (1.1%)	9 (10.1%)	10 (11.2%)
11-29 minutes	0	23 (25.9%)	23 (25.9%)
30 minutes and above	0	5 (5.6%)	5 (5.6%)
Total	4 (4.5%)	85 (95.5%)	89 (100%)

Table III: Mean duration of CPR in relation to the outcome of CPR

	Survived to Hospital Discharge	Dead
Number of patients	4 (4.9%)	82 (95.1%)
Mean Time (minutes)	5.42	21

Table IV: Outcome of CPR among different elderly age groups

Age (Years)	Dead	Survived To Discharge	Total
65-69	22	2	24
70-74	23	0	23
75-79	21	2	23
80-84	9	0	9
85-89	4	0	4
90 and above	4	0	4
Total	83	4	87

Table V: Initial ECG rhythm

Parameter Studied		Survived to Discharge	Dead	Total
Initial ECG rhythm	Ventricular Fibrillation	1	9	10
	Bradyarrythmia / Bradycardia	2	19	21
	PEA	0	18	18
	Asystole	1	26	27
				Total: N=76

Table VI: Location of Arrest compared to outcome on CPR

Parameter studied		Survived to discharge	Dead	Total
Location of Arrest	Out of hospital	1	41	42
	In hospital	3	43	46
				Total: N=88

Table VII: Witnessed and non-witnessed arrest compared to outcome of CPR

Parameters studied		Survived to discharge	Dead	Total
Witness Arrest	Witnessed	3	49	52
	Non-witnessed	1	36	37
				Total: N=89

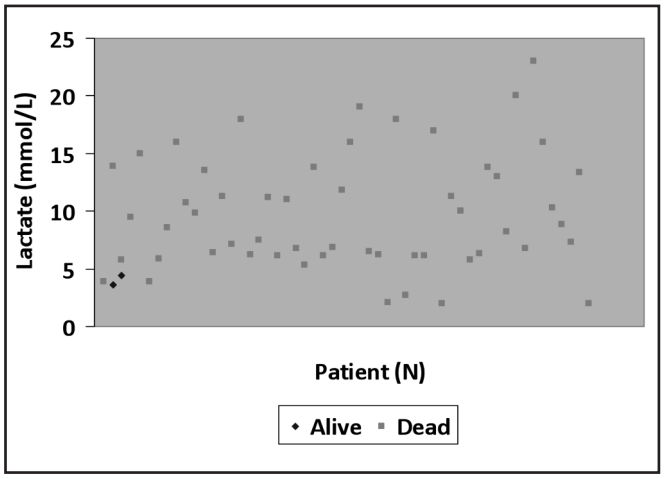

Fig. 1: Lactate levels (in mmol/L) in relation to number of patients.

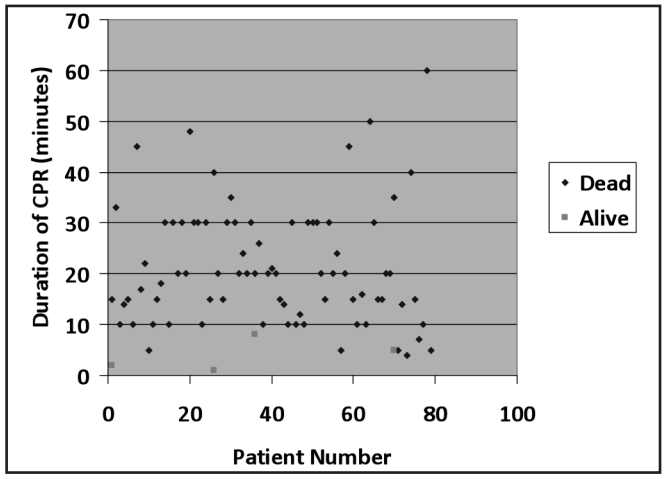

Fig. 2: Distribution of duration of CPR according to outcome.

after CPR and may be associated with delayed defibrillation[6,14]. Further work in this area is needed and comparison with the socioeconomic group status and a wider population need to be studied.

Even though there were more female survivors (n=3), compared to male survivors (n=1), the gender of the patient still has no significant relationship with the outcome of CPR (p value=0.519). This is due to the large number of female patients that fits the inclusion criteria in this study compared to male patients. However this correlates with previous studies which showed an association between older age, male and poorer survival[7, 8].

The estimated length of time from arrest to CPR intervention has no significant influence on the outcome (p=0.45). Estimation is only possible due to the lack of accurate documentation of the timing and lack of credible witnesses. However, majority of patients who were resuscitated fell in the range of 0-5 minutes. A total of 51 patients (57.3%) were resuscitated in the range of 0-5 minutes and among them three patients survived. All the patients that were resuscitated in the range of 0-5 minutes were witnessed arrest and it took the responder 0-5 minutes to respond for CPR. A total of 10 (11.2%) patients were resuscitated in the range of 6-10 minutes and one survived. None of the 28 patients (31.5%) that were resuscitated after more than 10 minutes of arrest survived.

In comparison, R J Brison *et al* studied patient characteristics, circumstances and community response among the Ontario community in Canada. They described the cases of out-of-hospital cardiac arrest and the evaluation of the effect on survival by the introduction of pre hospital defibrillation. This is to identify the factors that can predict survival of cardiac arrests that underwent CPR[9]. The average ambulance response time for witnessed cases in that study was 7.8 minutes, in comparison to our present study where the average time prior to CPR is at 10 minutes. The overall survival rate in the study by Brison *et al* (2.5%) did not differ much compared to our study which was 4.5%. However, Brison *et.al*. took into account patients who were initially in VF (Ventricular Fibrillation), which was a rhythm than needed defibrillation whereas in our study involves all patients that needed CPR. Nevertheless as proven by Brison *et al*, earlier arrival of ambulance at scene will give better outcome. Given a larger sample size and a more accurate documentation of time, we would be able to prove that earlier intervention of CPR would provide significant positive results. This is based on the evidence in our study that all survivors fall in the range of less than 10 minutes delay between arrest and CPR intervention. The drawback to our study is that we cannot detail the specific length of time taken for CPR intervention into a minute to minute basis.

Lactate levels were collected from 56 patients out of a total of 89. A large number of missing data (n=33) in this current study is mainly due to no blood sample was taken for the determination of lactate levels and incomplete documentation. In some instances lactate levels were not taken during CPR. Another reason of this missing data is that CPR was done elsewhere in the hospital (other than the emergency department), where the arterial blood gas (ABG) machine that readily measures lactate levels is not available. Despite the missing data, there is a significant correlation between lactate levels and outcome of CPR (p=0.047). This could be comparable to the cohort study by M Mullner, *et al*. where arterial lactate concentrations and out-of-hospital data concerning cardiac arrest and cardiopulmonary resuscitation were collected retrospectively.10 In the 167 patients studied, a weak association between total duration of cardiac arrest and admission levels of lactate ($r = 0.49$, $P < 0.001$) could be shown, as with our study where a weak correlation of p=0.047 was detected. Our study also shows that mortality is higher with a lower lactate level as compared to the study done by Mullner *et al*[10]. None of the patients with lactate above 16.3 mmol/L in our study survived to hospital discharge (Figure 1). A lower level of lactate among the survivors in our study is probably due to the elderly population and accounts to all ECG rhythms, including non-shockable (PEA, bradyarrythmia and asystole) in comparison to the previous study by Mullner *et al*. which considered ventricular

fibrillation rhythms only. Lactate clearance was measured after 24 hours and effective lactate clearance is associated with improved outcome in post-CPR patients [11]. Unfortunately lactate levels were taken only once, and were not compared with another lactate level which is needed for measurement of lactate clearance. This is be due to the small percentage of survival after 24 hours and since this is a retrospective study determining lactate exactly after 24 hours is not a routine protocol.

Duration of CPR was a significant (p=0.019) factor for the outcome of resuscitation among the elderly. We measured the sum of in-hospital and out-hospital CPR which was done by trained professionals. Mean duration of CPR among survivors is 5.42 minutes and among the dead is 21 minutes (Table III). This correlates with previous studies in which duration of CPR and arrest influences outcome [9, 12]. A shorter time to achieve ROSC translates into arrest within the electrical phase. In all survivors arrest was witnessed and they were resuscitated below 10 minutes. None of the survivors had a second arrest after the first ROSC (post CPR). It can be concluded that the duration of no ROSC was in the range of the electrical phase of arrest. The electrical phase or first phase of arrest is when the heart is amenable to prompt resuscitation and defibrillation [13]. During the second phase, the "circulatory phase," the fibrillating myocardium has used up much of its energy stores, and chest compressions are necessary to perfuse or "prime" the heart before defibrillation is likely be successful. This second phase is usually the time in which pre hospital care providers arrive. The survivors are resuscitated within the 1st and second phase. Duration of CPR with effective chest compression and early return of spontaneous circulation produces a good outcome in arrest patients. The earlier return of spontaneous circulation after CPR correlates well with better outcome. Prolonged duration of the resuscitative effort was associated with poor outcome. Among the patients who had multiple CPR, the length was calculated as the sum of length of all CPR. Out of 28 patients who had a ROSC, 6 of them were resuscitated below 10 minutes (including the 4 survivors). Among the four survivors, two functional survivors were resuscitated within 1 and 2 minutes. Both functional survivors were witnessed in-hospital arrest.

Age is not a significant factor in predicting the outcome in arrest patient (p=0.96). In this study the majority of patients is within the 70-80 years of age and there was a few (n=3) outliers that exceed the 90 years of age (nonagenarians). The range of 25th to 75th percentile of patients is between 69 – 79 patients. Previous studies also showed poor correlation between age and outcome of CPR [3,7]. The insignificant result can also be considered in the view of the topic of this study. For instance we did not compare with younger patients. The scope of this study is on the elderly (age of 65 years and above). Further comparison is needed to compare the elderly and younger age groups in terms of CPR outcome.

Large amount of adrenaline use did not improve resuscitation. (p=0.45). There is a wide discrepancy between the average of adrenaline used in survivors (1.4 mg) and the average of adrenaline used in non-survivors (5.69 mg). This is due to the prolonged length of CPR in the non survivors, whereas among the discharged patients, ROSC is on average obtained in 1 cycle of CPR. A previous study showed increasing cumulative dose of adrenaline is independently associated with poor neurological outcome[15]. It could be questioned whether excessive usage of adrenaline or its normal usage itself in resuscitation could be detrimental[16].

In previous studies, most common presenting arrhythmia during arrest was VF (45%), while survival is greatest in those presenting with AVB (AV block)(57.1%)[17]. In our study the most presenting arrhythmia is asystole and the survival is greatest in bradyarrythmias. This can be compared with the study done previously as which AV block is a subset of bradyarrythmias.

CONCLUSION

Halting a prolonged CPR among the elderly should be considered especially if no ROSC is obtained after 21 minutes (mean CPR length among non-survivors) and initial lactate levels more than 9.84 mmol/L (average of non-survivors 9.84). However a definite conclusion cannot be made from this small sample size and further studies should be made. Age alone should not be a factor to stop or not to perform resuscitation at, given the clinical judgment of good pre-arrest background. Even though time from arrest to intervention should be considered (which in majority obtained from bystanders or relatives) it should not be a factor to stop resuscitation, unless it is clear that the victim is beyond salvaging (e.g rigor mortis).

Further prospective studies with larger sample sizes will be required to assess the prognostic factors among elderly population. The scope of study can be widened to all adult population that underwent CPR. This is to compare the outcome of CPR between the elderly population and the adult group in terms of age, lactate, length of CPR and time of arrest prior to CPR intervention. Other parameters mainly the earliest ECG rhythm, prior medical illness, race, sex, amount of adrenaline, number of defibrillation, pre-hospital CPR and witnessed vs. non-witnessed arrest should be studied prospectively.

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