Predictors of mortality and neurological dysfunction in cardiac arrest: A retrospective single centre study

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Abstract

***Objective*: The aim of this study was to identify the mortality rate of cardiac arrest in our institution and to determine the association between clinical available variables with early mortality and neurological outcomes.**

***Design, setting, and patients*: We performed a retrospective study including all adult patients with the first diagnosis of "cardiac arrest" admitted to the intensive care unit of a Portuguese tertiary hospital, from 2015 to 2020. Outcomes were early mortality, including in-hospital and 1 month after discharge mortality, and neurological function after cardiac arrest as defined by the Cerebral Performance Category score scale.**

***Results*: 114 patients were included, 32 suffered from out-of-hospital cardiac arrest, and 82 from in-hospital cardiac arrest. In multivariate logistic analysis, a Glasgow Coma Score after the return of spontaneous circulation less than five and the existence of another cause for cardiac arrest than ST-segment elevation myocardial infarction demonstrated to be predictive factors of early mortality. The poor neurological outcome was associated with a total cardiopulmonary resuscitation length greater than five minutes and a Glasgow Coma Score after the return of spontaneous circulation less than five.**

***Conclusions*: Cardiac arrest is still an important cause of morbimortality in our society. Efforts should be made to optimize its approach, minimizing the cardiorespiratory arrest length to reduce mortality and improve the neurologic prognosis of survivors.**

Key words: Heart disease risk factors, arrhythmias, cardiac, coronary disease, myocardial infarction, brain death.

Introduction

Recent international out-of-hospital and in-hospital cardiac arrest data show that despite a decrease in coronary artery disease and stroke mortality, the burden of cardiovascular disease remains on top of society's health problems. (1-3) Cardiac arrest is estimated to be responsible for about half of cardiovascular mortality, and in about half of these, it is the first manifestation of previously unknown heart disease. (3,4)

A high variation between different regions and countries regarding in-hospital survival and survival with functional recovery has been reported. (2,5) In recent years, there has been a considerable improvement in the survival rate in patients with cardiac arrest treated in upper-quartile hospitals, unlike what happens in lower-quartile hospitals. (5) This fact suggests that survival depends on modifiable factors, so with the potential for improvement. (2) The existence of a rapid response, the quality of resuscitation, and post-cardiac arrest care have been associated with lower mortality rates from cardiac arrest. (6,7)

Early identification of predictors for mortality and poor neurological outcomes in cardiac arrest survivors may provide critical information for physicians and then facilitate the clinical approach. (8)

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Several models have tried to identify the predictive variables of mortality in cardiac arrest, with the most mentioned being the initial cardiac rhythm, the patient's age, and whether the arrest was witnessed. However, few models have been rigorously validated, so the utility of these model predictors remains uncertain for certain populations. (8,9)

Among patients with cardiac arrest in the setting of ST-segment elevation myocardial infarction (STEMI), timely percutaneous coronary intervention is considered the most important predictor of survival. (10,11) However, for non-ST-segment elevation myocardial infarction (NSTEMI) patients, recent guidelines suggest that emergent cardiac catheterisation should be considered only if there is a high probability of acute coronary occlusion. (7,8)

On the other hand, brain health has been a concern among survivors since ischemic brain damage leads to high disability in some patients. The time until the return of spontaneous circulation (ROSC) has been identified as one of the predictors of a worse neurological prognosis. (12,13) However, it is known that systematic, brain-oriented intensive care is effective to maximize neurologic recovery. (7,14)

The aim of this study was to identify the mortality rate of out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA) in our institution and to determine the association between clinical available variables with early mortality and neurological outcomes. In the subgroup analysis, we intend to study the impact on mortality of performing emergent coronary angiography in NSTEMI patients.

Methods

We performed a retrospective review of all adult patients (older than 18 years) with the first diagnosis of "cardiac arrest" admitted to the intensive care unit (ICU) of a Portuguese tertiary hospital, from 31 May 2015 to 31 May 2020. Patient selection and information collection were obtained through the medical records. Outcomes were early mortality, including in-hospital and 1 month after discharge mortality, and neurological function after cardiac arrest as defined by the Cerebral Performance Category (CPC) score scale, (15-17) described in **Figure 1**.

Group comparisons between survivors and non-survivors were performed using the student-T test or Mann-Whitney U-test for continuous variables and Pearson chi-square test or Fisher test for categorical variables. For early mortality and neurological outcomes, multivariate logistic regression analysis with forward stepwise selection was performed to assess the association between the variables with statistically significant differences between the two groups. Correct adjustment of the model was analysed through Hosmer and Lemeshow test, receiver operating characteristic (ROC) curves, and area under the ROC curve (AUC) statistics. A p-value less than 0.05 was considered significant. Statistical analyses were performed using SPSS software (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

Results

Among the one hundred and fourteen patients admitted to our ICU with the diagnosis of cardiac arrest, 63.2% (n=72) were non-survivors and 36.8% (n=42) were discharged alive from the hospital and survived at least one month after. **Table 1** describes their main baseline characteristics.

We analysed 28.1% (n=32) OHCA patients and 71.9% (n=82) IHCA patients, with no significant difference in early mortality rate between them (59.4% and 64.6%, respectively [p-value=0.60]).

The time of cardiopulmonary resuscitation (CPR) until ROSC was 12.6±11.9 minutes for survivors and 13.6±10.4 minutes for non-survivors (p-value=0.66). Twenty-one point one percent (n=24) of survivors and 50% (n=57) of non-survivors presented with a non-defibrillable rhythm (asystole or pulseless electrical activity) (p-value=0.01).

As a potential underlying cause, 11.4% (n=13) of survivors and 7% (n=8) of non-survivors had the diagnosis of STEMI (p-value<0.01).

After the ROSC, Glasgow Coma Scale/Score (GCS) was 8.5±4.1 among survivors and 6.3±4.2 for non-survivors (p-value=0.02).

Univariate logistic regression analysis found the following factors associated with higher mortality: age greater than 75 years old (p-value<0.01), a non-defibrillable rhythm at presentation (p-value=0.03), total CPR time greater than 5 minutes (p-value=0.02), GCS after ROSC lesser than 5 (p-value<0.01), and another cause for cardiac arrest than STEMI (p-value<0.01). In multivariate logistic regression (**Table 2**), only GCS after ROSC less than 5 (OR=3.63, 95% CI 1.25-10.56, p-value=0.02) and another cause for cardiac arrest than STEMI (OR=4.88, 95% CI 0.98-24.34, p-value=0.05) proved to be predictive factors of early mortality. The ROC curve for the multivariate logistic regression model of early mortality (Hosmer and Lemeshow test: p-value=0.088; AUC=0.775, p-value<0.01) is presented in **Figure 2**.

Regarding the predictors of poor neurological prognosis, we analysed 88 patients, of which 59.9% (n=52) were classified with CPC lesser than 3 (positive outcome), and 40.1% (n=36) with CPC equal

or greater than 3 (negative outcome). Univariate logistic regression analysis found the following factors associated with negative neurological outcome: total CPR time greater than 5 minutes (p-value<0.01) and GCS after ROSC lesser than 5 (p-value<0.01), confirmed in multivariate logistic model (OR=9.09, 95% CI 1.01-81.88, p-value=0.05; OR=7.73, 95% CI 2.56-23.4, p-value<0.01, respectively) (**Table 3**). The ROC curve for the multivariate logistic regression model of poor neurological prognosis (Hosmer and Lemeshow test: p-value=0.296; AUC=0.785, p-value<0.01) is presented in **Figure 3**.

Analytic parameters at admission (pH, lactate, bicarbonate, calcium, magnesium, potassium, phosphate, and haemoglobin) and comorbidities (arterial hypertension, diabetes mellitus, coronary artery disease, and heart failure) showed no significant difference in mortality or neurological prognostic.

In the analysis of the subgroup of acute coronary syndromes (ACS) (n=35), we observed 21 patients with STEMI and 14 patients with NSTEMI. Of NSTEMI patients, 12 were submitted to emergent coronary angiography, of which 7 required percutaneous coronary intervention. We observed no significant difference between mortality in NSTEMI patients submitted to emergent coronary angiography versus the conservative approach (p-value=1.00).

Discussion

In this retrospective observational single-centre study of OHCA and IHCA patients, our risk prediction model identified a lower GCS after ROSC and the existence of another cause for cardiac arrest than STEMI as important factors determining survival outcomes. Other factors like patient age, CPR length, and the cardiac rhythm at presentation showed less importance.

The neuroprognostication post-cardiac arrest has been highly debated and remains changeling. Our study identified a higher CPR length and a lower GCS after ROSC as major predictors of a poor prognosis. However, it has been described that survival with good neurological outcomes is possible with prolonged CPR, especially if associated with high-quality CPR. (18)

Regarding NSTEMI patients, our results strengthen the idea that the conservative approach seems not to be worse than the invasive one. Furthermore, a recent multicentre trial of successfully resuscitated OHCA patients suggests that the composite of death or severe neurologic deficit was more frequent in an immediate strategy than in a delayed one. (19)

Some limitations of this study include the fact that it was a retrospective analysis, with small sample size and a unicentric cohort, limiting external validation. In addition, the collection of information was carried out through medical records, some with scarce information, which may constitute a significant registration bias.

Conclusion

In conclusion, these results demonstrate the importance of implementing protocols for the management of cardiac arrest patients, whether in or out-of-hospital context. The main focus should be on reducing cardiorespiratory arrest time and on a holistic approach to the post-arrest patient. In addition, since neurological consequences are an important condition of morbidity in these patients, a referral for cardiac and cognitive rehabilitation is essential.

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Table 1. Patients' baseline characteristics

	Total (n=114)	Survivors (n=42)	Non-survivors (n=72)	p-value
Age (years), mean (SD)	67.1 (14.0)	61.7 (14.5)	70.2 (12.8)	<0.01
Female, n (%)	41 (36.0)	15 (13.2)	26 (22.8)	0.97
Arterial hypertension, n (%)	77 (67.5)	33 (28.9)	44 (38.6)	0.06
Coronary artery disease, n (%)	13 (11.4)	7 (6.1)	6 (5.3)	0.16
Diabetes mellitus, n (%)	54 (47.4)	19 (16.7)	35 (30.7)	0.72
Heart failure, n (%)	35 (30.7)	11 (9.6)	24 (21.1)	0.43

Legend: SD=standard deviation.

Table 2. Multivariate logistic regression model of early mortality

	p-value	OR [95% CI]
Age greater than 75 years old	0.12	
Non-defibrillable rhythm	0.63	
CPR time greater than 5 minutes	0.14	
GCS after ROSC lesser than 5	0.02	3.63 [1.25-10.56]
Another cause for CA than STEMI	0.05	4.88 [0.98-24.34]

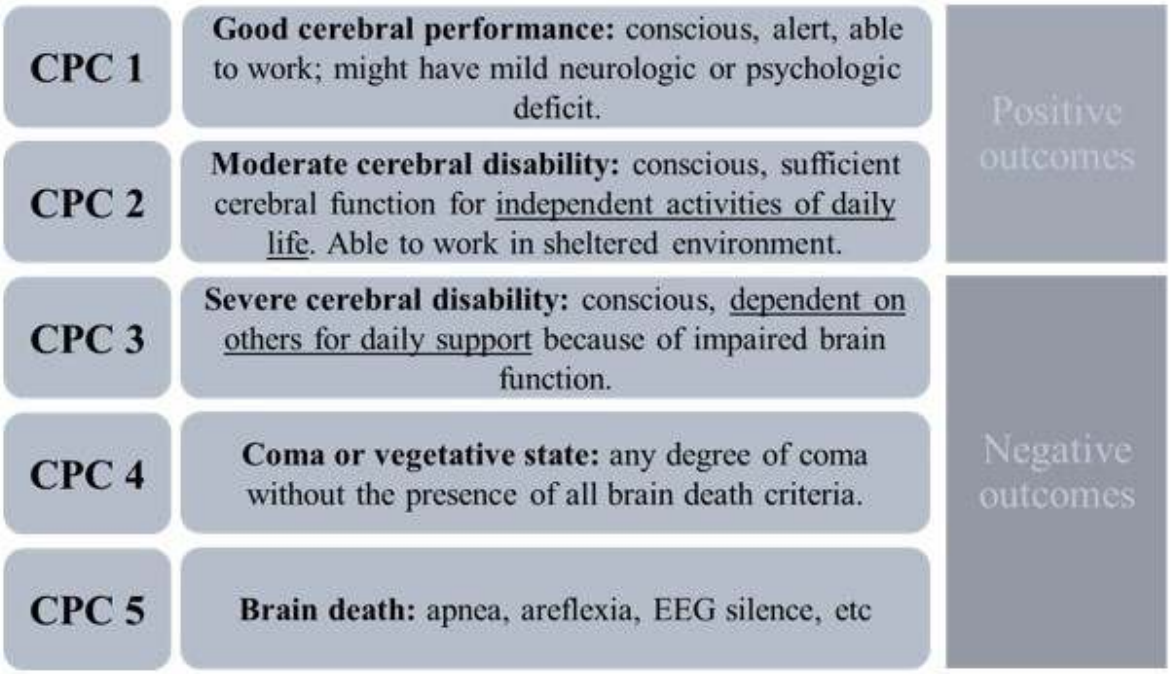
Legend: CPR=cardiopulmonary resuscitation; GCS=Glasgow coma scale; ROSC=return of spontaneous circulation; CA=cardiac arrest; STEMI=ST-segment elevation myocardial infarction; OR=odd ratio; CI=confidence interval.

Table 3. Multivariate logistic regression for poor neurological prognosis (CPC>3)

	p-value	OR [95% CI]
Age greater than 75 years old	0.96	
Non-defibrillable rhythm	0.48	
CPR time greater than 5 minutes	0.05	9.09 [1.01-81.88]
GCS after ROSC lesser than 5	<0.01	7.73 [2.56-23.4]
Another cause for CA than STEMI	0.08	

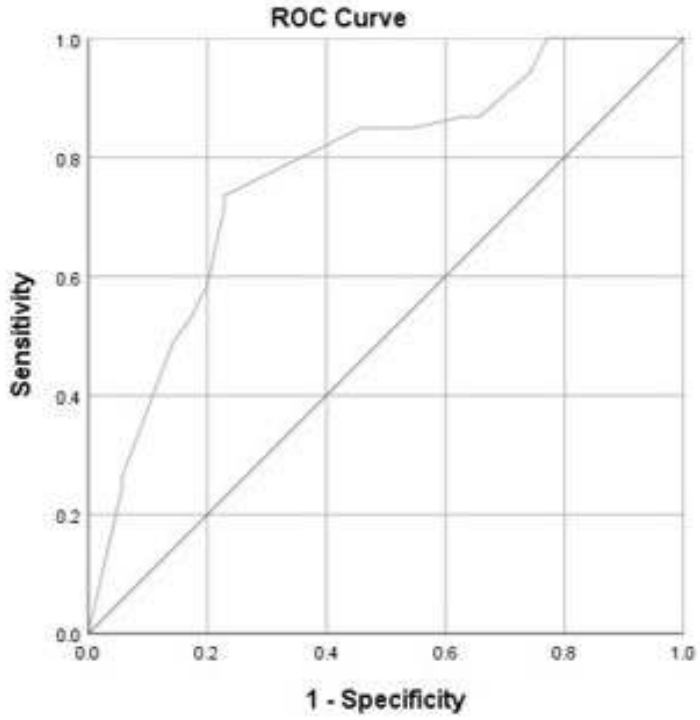
Legend: CPC=cerebral performance category; CPR=cardiopulmonary resuscitation; GCS=Glasgow coma scale; ROSC=return of spontaneous circulation; CA=cardiac arrest; STEMI=ST-segment elevation myocardial infarction; OR=odd ratio; CI=confidence interval.

Figure 1. Cerebral Performance Category (CPC) score/scale



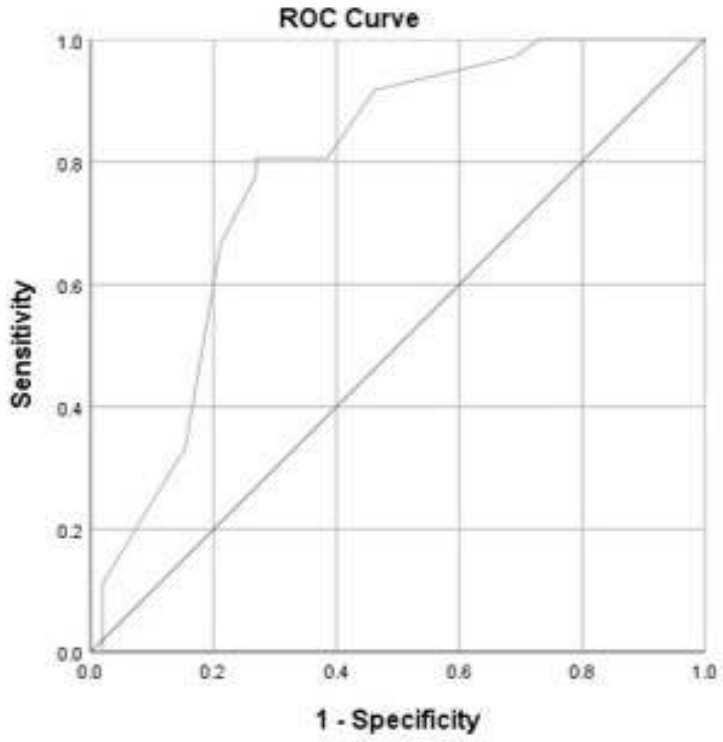
Adapted from Grossestreuer et al. Resuscitation 2016;109:21-4.

Figure 2. ROC curve for multivariate logistic regression model of early mortality



Legend: ROC=receiver operating characteristic.

Figure 3. ROC curve for multivariate logistic regression model of poor neurological prognosis



Legend: ROC=receiver operating characteristic.

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