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Determinant factors of death in out-of-hospital cardiac arrest victims

Fatores determinantes de óbito em vítimas de parada cardíaca extra-hospitalar

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ABSTRACT

Objective: To investigate the determinants of death in victims of cardiac arrest occurring in out-of-hospital settings. **Methods:** In this retrospective study, we analyzed 261 care records of people who had cardiac arrest in an extra-hospital environment in 2018 and were served by the Ambulance Service (SAMU-192), in a city in the state of São Paulo, Brazil. **Results:** The mean age of all patients was 71 years (SD 18.7), and most were male (142; 54.4%). Despite the ambulance team arriving in less than 10 minutes for 150 cases (57.5%), only 56 patients (19.1%) did not die on site. Death was associated with increasing age ($p < 0.001$; OR = 1.04; CI = 1.02–1.06) and the cardiac arrest occurring at home ($p < 0.001$; OR = 5.60; CI = 2.48–2.61). Conclusion: Elderly people who had cardiac arrest at home had a greater chance of death. The results also showed that laypeople aren't equipped to assist in an out-of-hospital cardiac arrest. **Implications for the practice:** Constant improvement of nursing staff through CPR training is essential to ensure their skills are adequate for emergency care.
Keywords: out-of-hospital cardiac arrest; cause of death; ambulances; emergency nursing; emergency medical services.

RESUMO

Objetivo: investigar os fatores determinantes do óbito em vítimas de parada cardíaca ocorrida em ambiente extra-hospitalar. **Métodos:** neste estudo retrospectivo, foram analisados 261 registros de atendimento de pessoas que sofreram parada cardíaca em ambiente extra-hospitalar em 2018 e foram atendidas pelo Serviço de Atendimento Móvel de Urgência (SAMU-192) em uma cidade do estado de São Paulo, Brasil. **Resultados:** a média de idade dos pacientes foi de 71 anos (DP = 18,7), e a maioria era do sexo masculino (142; 54,4%). Embora a equipe de ambulância tenha chegado em menos de dez minutos em 150 casos (57,5%), apenas 56 pacientes (19,1%) não foram a óbito no local. O óbito esteve associado ao aumento da idade ($p < 0,001$; OR = 1,04; IC = 1,02–1,06) e à ocorrência da parada cardíaca no domicílio ($p < 0,001$; OR = 5,60; IC = 2,48–2,61). **Conclusão:** idosos que sofreram parada cardíaca em casa apresentaram maior probabilidade de óbito. Os resultados também mostraram que leigos não estão preparados para prestar assistência em casos de parada cardíaca extra-hospitalar. **Implicações para a prática:** o aprimoramento contínuo da equipe de enfermagem por meio de treinamentos em reanimação cardiopulmonar (RCP) é essencial para garantir a adequação das habilidades no atendimento de emergências.
Palavras-chave: parada cardíaca extra-hospitalar; causa de óbito; ambulâncias; enfermagem em emergência; serviços médicos de emergência.

INTRODUCTION

Cardiac arrests that occur outside hospitals are an important worldwide health problem and also one of the major causes of death in developed countries.[1,2] The prevalence of cardiorespiratory arrest is affected by different factors, including systemic diseases, but particularly cardiovascular diseases.[3]

Each year, there are approximately 420,000 and 275,000 cardiac arrests in the United States and Europe, respectively.[4,5]

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A systematic review of 60 research studies illustrated significant variation in cardiac arrest incidence and outcomes across different populations worldwide.[6] The global incidence of cardiac arrests was 55 per 100,000 individuals per year, with a survival rate ranging from 2% to 11%.[7] Non-uniformity in clinical care probably contributes to this survival disparity.[8]

In Brazil, there are about 200,000 cases of cardiac arrests each year, half of them occurring in hospitals, and the others occur outside hospital settings, such as at home, in shopping malls, airports, stadiums, among others.[9] However, there are no official data or studies on the magnitude of cardiac arrest in Brazil.

In the literature, the occurrence of sudden cardiac arrest in an out-of-hospital setting is related to "sudden cardiac death." Sudden cardiac death is defined as an "unexpected death caused by cardiac causes that occurs within a short period (usually 1 hour after the onset of symptoms)".[10] Sudden cardiac death is the first clinical evidence of pre-existing heart disease, mainly coronary artery disease, in about 80% of cases.[11,12]

Survival after out-of-hospital cardiac arrest has increased considerably in the last 15 years due to improvements in care systems and innovative treatments.[13] However, only about 12% of such patients survive in the United States.[14] Among persons experiencing sudden cardiac arrest, only 25% to 30% of the cases achieve return of spontaneous circulation and arrive alive at a hospital.[13] Unfortunately, 60% to 70% of these patients who reach the hospital eventually die.[13,14] Frequently, death after prolonged cardiac arrest results from recurrence of the event or the effects of extended anoxia.[15]

In this scenario, cardiopulmonary resuscitation (CPR) maneuvers are crucial to saving lives, restoring organ function, and improving patient prognosis.[16]

Among the measures instituted for early patient care, basic life support (BLS) stands out. BLS includes all stages of cardiopulmonary resuscitation (CPR) performed in an out-of-hospital setting by skilled and trained laypersons. As a result, BLS contributes to minimizing cardiac arrest sequelae and increasing a victim's chances of survival. BLS providers rapidly identify cardiac arrest, call emergency response teams, and initiate early CPR followed by prompt defibrillation.[7]

In practice, timely CPR maneuvers, followed by defibrillation and rapid and efficient establishment of advanced support, increase the likelihood of immediate recovery and the chances of survival for cardiac arrest patients.[17]

However, the success of these maneuvers relies on structured ambulance services. In Brazil, the Ambulance Service (SAMU-192), launched in 2003 by the Ministry of Health to coordinate a regional and organized network of emergency care services, provides ambulance assistance for critically ill patients in any emergency.[18,19] However, despite the existence of this service, there are limited publications on its operations. Hence, it is difficult to evaluate the baseline care it provides by region. Therefore, this study set out to answer the following question: What factors are associated with mortality in cardiac arrest patients who experience cardiac arrest in out-of-hospital settings? Thus, this study aimed to investigate the determinants of death in victims of cardiac arrest occurring in out-of-hospital settings.

METHODS

The study was an observational, retrospective study conducted at the Ambulance Service (SAMU-192) in Botucatu, a city in the interior of São Paulo, Brazil. The data were collected between August and December 2019, based on the manual selection of a total of 6,416 attendance files held by SAMU teams, dated from January 1 to December 31, 2018. These records referred to cases of cardiac arrest.

A non-probabilistic convenience sample was composed of all adult patients aged 18 years or older, of both sexes, who experienced cardiac arrest in an out-of-hospital environment in 2018, in Botucatu, São Paulo State, Brazil, and were treated by the Ambulance Service (SAMU-192).

The Ambulance Service (SAMU-192) provides rapid assistance to critically ill individuals requiring emergency care, who can contact the service through the national toll-free number 192. A physician at the station answers calls to this number and, after evaluating the situation, classifies each case as urgent or emergent, according to its complexity and the patient's signs and symptoms.

The study's data collection instrument, which adopted the variables from the service's original forms, was developed using Microsoft Excel®. The variables collected by the researchers included: age, sex, place of rescue, type of ambulance, duration of symptoms, rescue area, day of the week, time of day, and interval from the emergency call to the arrival of the emergency team.

A descriptive analysis of all variables was initially conducted. Mean and standard deviation (SD) were calculated for continuous variables, and frequency and percentages for categorical variables.

The Student's *t*-test or the Mann-Whitney *U*-test, depending on the normality and homogeneity of the data, was used to relate the study outcome (death/survival) to continuous variables. The correlation between the study outcome and categorical variables was assessed using Pearson's chi-square or Fisher's exact test.

Statistical analysis was performed to test the association between mortality and the studied variables. Logistic regression was applied using a logit model with a binary response. The odds ratio (OR) was also calculated, representing the likelihood of a variable's occurrence associated with mortality, estimated with 95% confidence intervals.

The data were analyzed using R software version 3.6.2 and the Statistical Package for the Social Sciences (SPSS) version 20.0, running on the Windows platform. The statistical significance level was set at 5% for all analyses.

The study was approved by the Research Ethics Committee under protocol no. 3.245.834.

RESULTS

Based on the inclusion criteria, 261 files were selected for the study sample. The ages of the study participants ranged from 0 to 102 years (SD ± 18.79); the mean age was 71 years (SD ± 18.7), and almost half, 142 (54.4%), of the study sample were male. During the study period, 219 (83.9%) rescues involved people over 56 years of age.

A total of 205 patients died. The mean age of patients who died was significantly higher than that of survivors (mean 73 ± 17.9 vs. 62.3 ± 19.5 years, respectively; $p < 0.001$). Most patients, 178 (68.2%), had cardiac arrest symptoms for less than 1 hour, which was also the duration with the highest incidence of death, 137 (64.8%) (Table 1).

Table 1. Clinical characteristics of cardiac arrest victims who occurred in an out-of-hospital setting. Botucatu, SP, Brazil, 2020.

Variables	Patients n = 261 n (%)	Survivors n = 56 n (%)	Deaths n = 205 n (%)	p
Age				
< 25	4 (1.5)	1 (1.8)	3 (1.5)	
25|-35	11 (4.2)	5 (8.9)	6 (2.9)	
36|-45	10 (3.8)	6 (10.7)	4 (2.0)	
46|-55	17 (6.5)	4 (7.1)	13 (6.3)	
56|-65	41 (15.7)	11 (19.6)	30 (14.6)	
66|-75	51 (19.5)	14 (25.0)	37 (18.0)	
76|-85	55 (21.1)	7 (12.5)	48 (23.4)	
86|-95	55 (21.1)	8 (14.3)	47 (22.9)	
> 96	17 (6.5)	0 (0.0)	17 (8.3)	
Mean ± SD	71,0 ± 18.7	62.3 ± 19.5	73,4 ± 17.9	< 0.001[1]
Min-Max	0 – 102	0 – 93	1 – 102	
Sex				
Male	142 (54.4)	31 (55.4)	111 (54.1)	
Female	119 (45.6)	25 (44.6)	94 (45.9)	0.872[2]
Time of symptom onset (hour)				
1 to 3	178 (68.2)	41 (73.3)	137 (66.8)	
4 to 24	9 (3.4)	1 (1.8)	8 (3.9)	0.166[2]
Unknown	28 (10.7)	4 (7.1)	24 (11.7)	
Not informed	46 (17.6)	10 (17.9)	36 (17.6)	

[1]Mann–Whitney U test; [2]Bilateral Pearson's Chi-square test.

Table 2 details the emergency care provided by the ambulance support team. Most rescues, 225 (86.5%), were performed by the advanced life support ambulance, mainly at the victims' homes, 212 (81.2%), and adjacent to public roads, 17 (6.5%). Cardiorespiratory arrests occurred mainly in the morning, totaling 104 cases (39.8%). Although the SAMU team took less than 10 minutes to arrive in 150 (57.5%) of the rescues, 112 (54.6%) patients died. Nevertheless, the mean arrival time was significantly longer among those who died than among survivors (mean 10.6 ± 7.2 vs. 8.6 ± 6.2 minutes; $p = 0.019$).

Table 2. Characteristics of emergency rescues performed by the ambulance support team. Botucatu, SP, Brazil, 2020.

Variables	Patients n = 261 n (%)	Survivors n = 56 n (%)	Deaths n = 205 n (%)	p
Ambulance				
ALS*	225 (86.2)	35 (62.5)	190	
BLS**	36 (13.8)	21 (37.5)	15 (7.3)	< 0.001[1]
Time				
Dawn	46 (17.6)	8 (14.3)	38 (18.5)	
Morning	104 (39.8)	23 (41.1)	81 (39.5)	
Afternoon	48 (18.4)	12 (21.4)	36 (17.6)	0.835[1]
Night	63 (24.1)	13 (23.2)	50 (24.4)	
Day of the week				
Weekends	74 (28.4)	50 (87.6)	62 (30.2)	
Weekdays	187 (71.6)	44 (78.5)	143 (69.8)	0.139[1]
Area				
Urban area	246 (83.9)	49 (87.6)	160 (96.4)	
Rural area	5 (1.9)	1 (1.8)	4 (2.0)	0.333[2]
Not informed	10 (3.8)	6 (10.7)	4 (2.0)	
Rescue scenario				
Home	212 (81.2)	33 (58.9)	179 (87.3)	
Public road	17 (6.5)	15 (26.8)	2 (1.0)	
Non-hospital health unit	15 (5.7)	1 (1.8)	14 (6.9)	
Bus station	2 (0.8)	2 (3.6)	0 (0.0)	
Work	2 (0.8)	1 (1.8)	1 (0.5)	
Hospital	1 (0.4)	0 (0.0)	1 (0.5)	< 0.001[2]
Rural area	2 (0.8)	1 (1.8)	1 (0.5)	
Not informed	10 (3.8)	3 (5.4)	7 (3.4)	
Arrival time (minutes)				
<10	150 (57.5)	38 (67.9)	112 (54.6)	
10|-20	93 (35.6)	15 (26.8)	78 (38.0)	
20|-30	11 (4.2)	2 (3.6)	9 (4.4)	
30|-40	3 (1.1)	1 (1.8)	2 (1.0)	
40 or +	4 (1.5)	0 (0.0)	4 (2.0)	
Mean ± SD	10.1 ± 7.0	8.6 ± 6.2	10.6 ± 7.2	0.019[3]

[1]Bilateral Pearson's Chi-square test; [2]Fisher's exact test; [3]Mann–Whitney U test.
*ALS: Advanced Life Support; **BLS: Basic Life Support.

Table 3 shows the data from the logistic regression analysis. For each year added to the patient's age, the chance of death increases by 4% (p < 0.001). Additionally, cardiac arrest at home increases the likelihood of death by 460% (p < 0.001).

Table 3. Logistic regression to identify the Odds Ratio for variables associated with mortality. Botucatu, SP, Brazil.

Variables	Odds Ratio (OR)	CI 95% limit Inf.	CI 95% limit Sup.	p
Age	1.04	1.02	1.06	< 0.001
Arrival time	1.03	0.97	1.10	0.267
Male	1.47	0.71	3.06	0.302
Night-day time arrest	0.95	0.46	1.96	0.885
Arrest at home	5.60	2.48	2.61	< 0.001
Weekend arrest	1.36	0.59	3.15	0.470
Onset of symptom less than one hour	0.65	0.29	1.46	0.299

DISCUSSION

In this study, most cardiac arrests managed by SAMU occurred at home and involved elderly patients. The unstructured home environment and poor housing conditions might contribute to the risk of death and the progression of disabilities, especially among the elderly.[20] However, a high prevalence of cardiac arrests among older people in out-of-hospital settings is not confined to Brazil.[21,22]

In a recent study, the mean age of 9,834 patients with cardiac arrest in out-of-hospital settings in Paris and its surroundings was 70 years (SD ± 17 years).[23]

Cardiorespiratory arrests were more prevalent among male individuals. A survey conducted in Osaka, Japan, also showed that 57% of 2,326 out-of-hospital cardiac arrest patients were male.[24]

A national study carried out by the SAMU Advanced Support Service in Belo Horizonte also confirmed this finding. In that study, 1,165 records of people who received resuscitation maneuvers in out-of-hospital settings were analyzed, and the results showed that most participants were male.[25]Although an ambulance is the recommended transport for this type of emergency, a small proportion of rescues did not receive this service since ambulances were unavailable at the time of the call.

Cardiac arrests predominantly occurred in the morning. The risk of cardiac arrest increases in the first three hours after waking due to an increase in heart rate and blood pressure. This increase usually contributes to greater vascular tone and platelet aggregation.[26]

Moreover, most patients had cardiac arrest symptoms that lasted less than one hour before the SAMU team arrived, a period that also recorded the highest number of deaths. Difficulties in identifying a cardiac arrest and calling the emergency service, combined with the lack of basic life support skills, may have contributed to deaths during this period.

The time from an emergency call to the arrival of an emergency response team is crucial in determining a patient's outcome. The SAMU team arrived in less than ten minutes in more than half of the cases. When assistance is provided within four minutes, the survival rate is 75%; from four to twelve minutes, it is 15%; and only 5% after fifteen minutes.[9] A study conducted in four cities in Serbia found that the average time to identify an out-of-hospital cardiac arrest was 5.5 minutes, and the call response interval was 7 minutes.[27]

Logistic regression analysis was performed to determine the main sociodemographic and clinical variables associated with mortality, addressing the study's second specific objective.

Age was positively associated with death among cardiac arrest patients; each additional year of age increased the risk by 4%. A study conducted on 1,673 out-of-hospital cardiac arrest patients found that those aged over 75 years had worse survival rates than younger patients, confirming this association.[28]

The analysis also showed that experiencing a cardiac arrest at home increased the risk of death.

There is often difficulty in recognizing cardiac arrest symptoms at home in time to contact an ambulance service. According to the American Heart Association, the survival of patients with out-of-hospital cardiac arrest also depends on the skills of community members. Therefore, governments should train the public to recognize cardiac arrest and initiate CPR maneuvers while waiting for medical teams to arrive. Unfortunately, in developing countries, government-led training programs for laypeople on cardiac arrest recognition and immediate management are not considered a public health priority.

A recent meta-analysis of 141 studies conducted by Chinese researchers showed an increase in the survival of patients with out-of-hospital cardiac arrest over the last 40 years; however, survival was higher among patients who had undergone CPR maneuvers.[29]

Furthermore, another study comparing health-related quality of life outcomes among cardiac arrest survivors found worse outcomes for patients who experienced cardiac arrest in hospital settings.[30]

CONCLUSION AND IMPLICATIONS FOR THE PRACTICE

This analysis verified that cardiac arrests occurring at home among older adults were associated with mortality. It also showed that laypeople are not adequately equipped to assist when an out-of-hospital cardiac arrest occurs. Could outcomes be improved by increasing hospital availability (reducing arrival times) or by equipping the public to perform CPR?

Indeed, a well-established urgent and emergency care service in out-of-hospital settings contributes to favorable health outcomes in a country, but it cannot prevent all deaths.

Assistance in cardiac arrests outside hospital settings involves managers, professionals, and the general public, each at a different level of action. Constant improvement of nursing staff through CPR training is essential to ensure their skills are adequate for emergency care.

As time is crucial for reducing disability and death, the development of educational initiatives for the population should be encouraged.

One of this study's limitations was that data were analyzed from a single center. Moreover, limited research focused on the same theme within the country hampered regional comparisons. Furthermore, the study did not examine participants' comorbidities or places of residence as predictive factors of death.

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