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ORIGINAL ARTICLE

Retrospective Analysis of 2.154 Cardiopulmonary Arrest Assistance Provided by a Mobile Emergency Service From 2018-2022

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Abstract

Background: It is estimated that 1 in 10 patients will survive a cardiopulmonary arrest (CPA), with half of them occurring in an out-of-hospital setting. Mobile pre-hospital care services aim to reduce morbidity and mortality resulting from CPA.

Objective: To analyze five years of data regarding response time for assistance, mortality, and characteristics of victims of out-of-hospital CPA cases treated by a public mobile emergency service in Southern Brazil.

Methods: Data collected between 2018 and 2022 included the number of CPA cases, victim profile (age and sex), and details of each incident (day of the week, month, shift, city area, time elapsed before initiating basic life support [BLS], and mortality prior to arrival at the referral hospital). Pearson's Chi-square and Mann-Whitney U tests were used with a significance level of 5%.

Results: The victims' profile was mostly elderly (60%) and men (55.9%). The mortality rate from CPA was 87.3%, with over half of the cases (51.11%) requiring more than 15 minutes to initiate assistance. A longer response time was significantly associated with higher CPA mortality rates ($p < 0.05$).

Conclusion: The data showed a profile of victims that was mostly male and elderly. In more than half of the cases, BLS initiation took over 15 minutes, a delay that was linked to the high mortality rate of CPA, highlighting the association between mortality and time to assistance.

Keywords: cardiopulmonary arrest; emergency medical system; cardiopulmonary resuscitation.

Introduction

Cardiovascular diseases are associated with high morbidity and mortality rates, not only in Brazil but worldwide, consistently ranking among the leading causes of disability and death.[1] Within this context, it is estimated that approximately 40-50% of all cardiovascular-related deaths are due to cardiopulmonary arrest (CPA), underscoring CPA as a significant global public health challenge.[2,3] Studies indicate that the global average incidence of CPA in adults is 95.9 per 100,000 inhabitants,[4] with a survival rate of only 1 in 10 patients.[5] CPA events in out-of-hospital settings are the leading cause of death in industrialized countries.[6] It is estimated that around 220,000 CPA cases occur per year in the country, half of which are in out-of-hospital settings.[7]

According to the American Heart Association and the American College of Cardiology, CPA is "the sudden cessation of cardiac activity, with loss of contractile function of the heart muscle and absent blood circulation, so that the victim becomes unresponsive, with no normal breathing and no signs of circulation".[8]

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Central Illustration: Retrospective Analysis of 2.154 Cardiopulmonary Arrest Assistance Provided by a Mobile Emergency Service From 2018-2022

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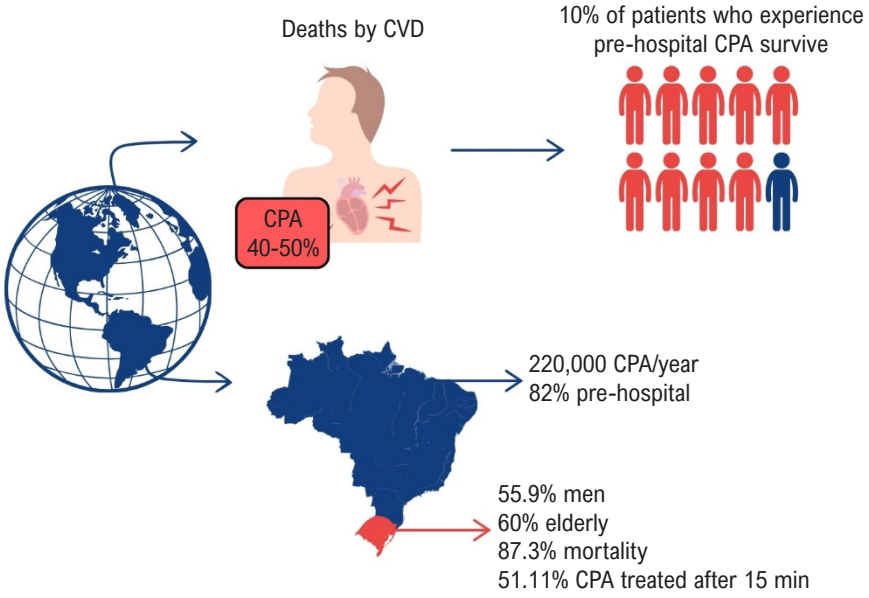

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Summary of the main findings of the study. CVD: cardiovascular disease; CPA: cardiopulmonary arrest.

Physiologically, the absence of blood flow caused by cardiovascular system failure can result in severe organ and tissue damage, including disruption of brain and respiratory function.[9] The extent of damage from CPA is strongly time-dependent; earlier intervention is associated with a lower risk of sequelae. However, it is well understood that, without prompt intervention, CPA often progresses to fatality.[4,8]

Rapid-response emergency medical services that enable early intervention in CPA cases are essential for reducing the risk of fatal or irreversible harm.[10,11] In Brazil, mobile pre-hospital services within the public health sector provide care for individuals experiencing severe health emergencies, integrated with the Unified Health System (SUS) network of health facilities. Currently, SAMU (Brazilian Mobile Emergency Care Service) is the main mobile service available for pre-hospital emergency care in the main cities of Brazil. The aim is to reduce the number of deaths and sequelae related to delays in CPA assistance, in addition to serving as an efficient tool for planning and managing public services.[12]

However, there is currently limited data on the profile of pre-hospital CPA care in Brazil, and collecting this data could be highly beneficial for global comparisons, planning enhanced strategies, and improving mobile emergency services nationwide. According to information from the cardiometer of the Brazilian Society of Cardiology, the three states with the highest rate are São Paulo, Rio de Janeiro, and Rio Grande do Sul. Based on this data, this study aimed to perform a retrospective analysis of five years of data on response times, mortality, and victim characteristics for out-of-hospital CPA cases treated by a public mobile emergency service in southern Brazil.

Method

The study has a retrospective design where data from 01/01/2018 to 12/31/2022, related to pre-hospital assistance for CPA, were collected from the database provided by the Mobile Emergency Care Service (SAMU) of the city of Porto Alegre (POA), Rio Grande do Sul, which has a population density of 2,690.50 inhabitants/km².[13] All pre-hospital records with complete information were included, specifically those detailing the number of CPA cases, victim profile (age and sex), and characteristics of the incident (day of the week, month, shift, city area, time to initiate basic life support [BLS], and mortality up to arrival at the referral hospital).

Statistical analysis

Statistical analysis was performed with GraphPad Prism software version 9.0 for Windows and R version 4.1.2. The Kolmogorov-Smirnov test was used, and the non-normality of the data was verified; therefore, the continuous variables were described using the median and interquartile range. Categorical variables were expressed as absolute numbers and percentages, and associations were verified using Pearson's chi-square test. The Mann-Whitney U test was used to compare medians between two groups. The p-value was considered significant when < 0.05. The study was approved by the Research Ethics Committee of Moinhos de Vento Hospital (CAAE 51136021.0.0000.5330) and the Municipal Health Department of Porto Alegre (CAAE 51136021.0.0000.5330).

Results

The quantitative survey of CPA assistance provided by SAMU/POA over five years totaled 2,154 cases. The profile of patients receiving pre-hospital care showed a median age of 68 years (IQR 56-79) (39 cases were excluded due to missing information). Among cases with age data, elderly individuals comprised approximately 60% of the sample. In addition to being elderly, these patients were mostly male, accounting for 55.9% of all cases (Table 1).

The stratification of cases per year showed a gradual and linear increase, progressing from 351 cases in 2018 to 483 cases in 2022, which represents a 37.6% increase (Figure 1). In terms of geographic distribution, a higher concentration of CPA cases was found in the central area of the city (25.88%).

Analysis by month revealed that July had the highest number of cases (244), followed by June (200) and August (197), all occurring during the winter season (Figure 2).

The median time from SAMU notification to the start of pre-hospital care was 16 minutes (IQR 11-23). When stratified, more than half of the assistance started after 15 minutes (Figure 3).

The mortality rate caused by CPA from 2018 to 2022 was 87.3% (1881 cases). Regarding annual mortality, 2022 had the highest rate, with 90.27% (Figure 4).

When analyzing the relationship between time to assistance and mortality, a correlation between CPA mortality and the time taken to begin pre-hospital care (adjusted $p < 0.00625$) is observed (Table 2).

A comparison of median response times revealed a statistically significant difference between individuals who died and those who survived, with shorter median times observed in the survivor group ($p < 0.001$) (Table 3).

Regarding the association between age, sex, city region and death, no significant associations were found ($p > 0.05$). Regarding the day shift, the highest percentage of deaths occurred in the early morning shift (94.8%) (Figure 5).

Discussion

This study conducted a retrospective analysis of five years of data on out-of-hospital CPA cases treated by a public mobile emergency service. The main findings of the study are summarized in the Central Figure.

SAMU/POA's response time, defined as the interval from CPA call entry at the Regulation Center to team arrival on the scene, averaged around 15 minutes in more

Table 1 – Profile of patients assisted by Porto Alegre's SAMU from 2018 to 2022.

Age group (years)*	n (%)
<14	16 (0.76)
15 - 24	22 (1.0)
25 - 64	809 (38.2)
>65	1269 (60.0)
Sex	
Female	983 (44.1)
Male	1245 (55.9)

**Test performed: Kolmogorov-Smirnov (p>0.05)*

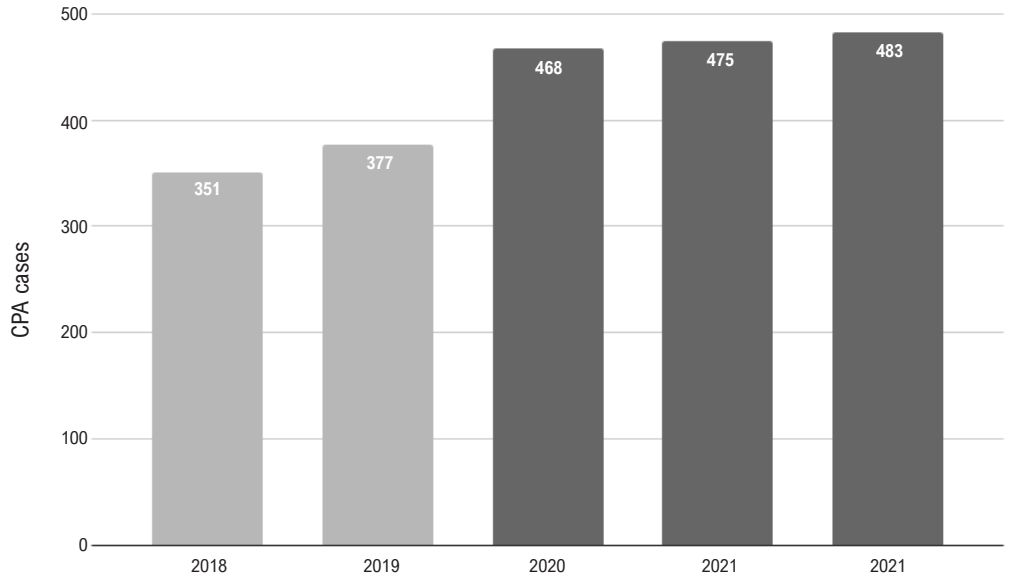

Figure 1 – Cases of pre-hospital CPA treated by SAMU/POA from 2018 to 2022.
CPA: cardiopulmonary arrest

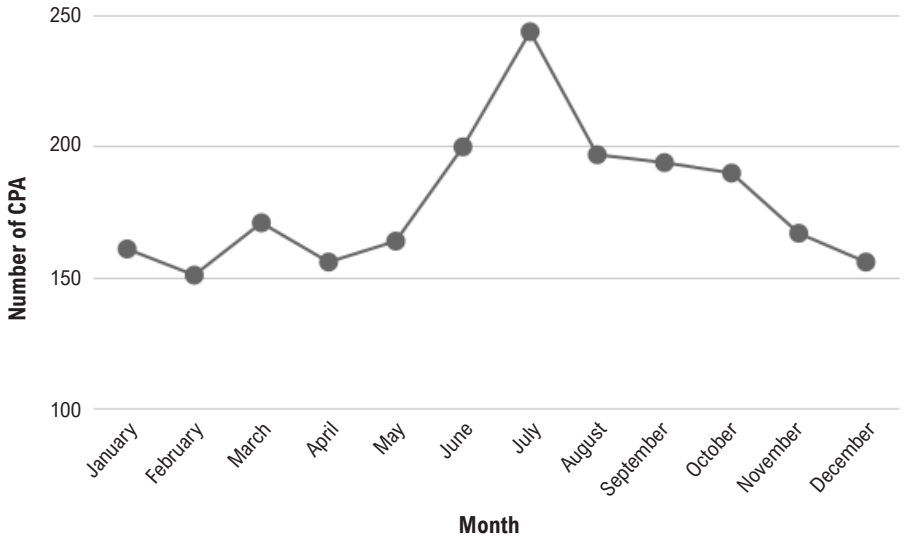

Figure 2 – Seasonal behavior during the months of the year for occurrences of pre-hospital CPA treated by SAMU/POA from 2018 to 2022.
CPA: cardiopulmonary arrest

than half of the cases. This response time is faster than the SAMU State service in Rio Grande do Sul, where the average from January to July 2023 was approximately 22.5 minutes.[14] In comparison to the data collected from SAMU/POA, evaluated by Ciconet et al. in the period from January to December 2013, this showed a response time of 17 minutes. Our results showed an improvement in terms of the time the patient was left

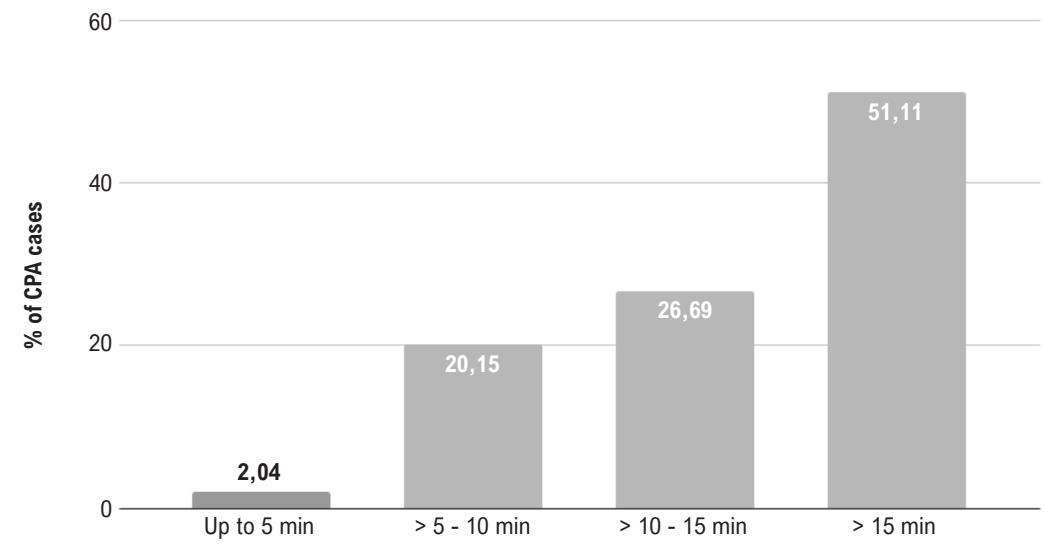

Figure 3 – Stratification of the time of onset of assistance in cases of pre-hospital CPA by SAMU/POA from 2018 to 2022.
CPA: cardiopulmonary arrest

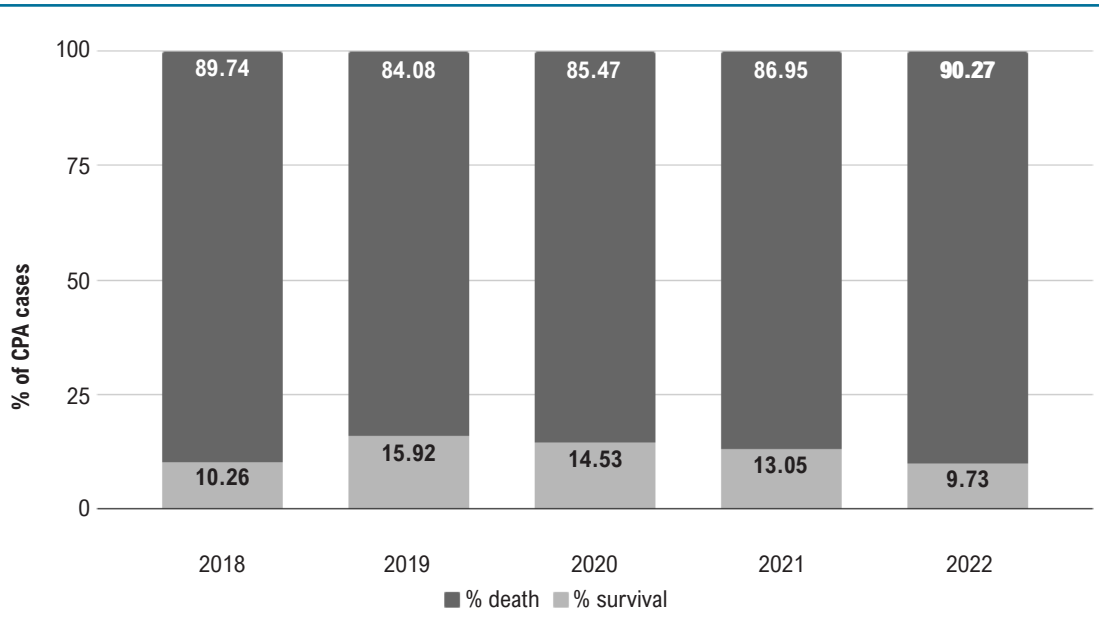

Figure 4 – Percentage of death and survival in cases of pre-hospital CPA treated by SAMU/POA from 2018 to 2022.
CPA: cardiopulmonary arrest

without assistance.[12] However, compared to response times in countries like Australia, Germany, and the USA (ranging from 9.3 to 11 minutes), our indicator suggests potential for improvement.

The response time indicator assesses the quality of the pre-hospital component and directly contributes to reducing mortality rates in emergency care cases.[15-18] Moreover, according to recommendations by the

Table 2 – Association between mortality due to CPA and time to start pre-hospital care by SAMU/POA in the period from 2018 to 2022.

Time (min) to start care	% death	% survival	Adjusted p-value*
Up to 5	63.64	36.36	< 0.00625
> 5 - 10	79.49	20.51	
> 10 - 15	83.48	16.52	
> 15	94.82	5.18	

**Test performed: Pearson's Chi-Square*

Table 3 – Analysis of time to start pre-hospital CPA care by SAMU/POA in the period from 2018 to 2022.

Endpoint	Time (min) to start care [median (IQR)]	p-value*
Death	17 (12 - 24)	<0.001
Survival	12 (9 - 15)	

**Test performed: Mann-Whitney U. IQR: Interquartile Range*

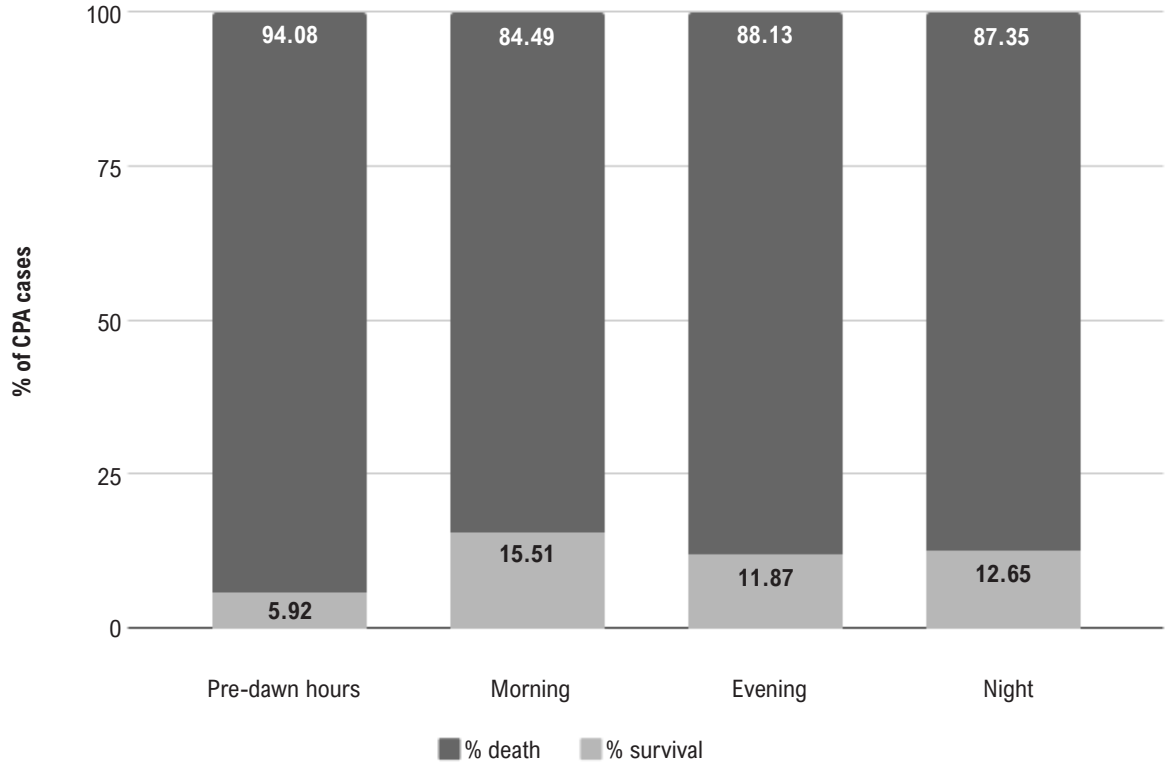

Figure 5 – Percentage of death and survival, stratified by shift, in cases of pre-hospital CPA treated by SAMU/POA from 2018 to 2022.
CPA: cardiopulmonary arrest

Brazilian Rescue and Salvage Association, the ideal time to maximum benefit from first aid care is within 10 minutes.[19] Reducing mobile service response times involves various measurable and controllable factors that could be optimized. Some of these measurable factors include the duration of the call, time for the team to leave the base, and travel time, which can be worked on in educational programs to improve the performance of advanced cardiopulmonary resuscitation (CPR) and defibrillation techniques.[20-22] While there are no studies specifically addressing the time required to release an ambulance, response times to the scene have been documented. Another point to consider is the challenge in diagnosing CPA over the phone for regulating physicians, as callers often provide limited information, impacting vehicle selection and response time.[23] Moreover, emergency call systems could also be restructured to enable pre-trained lay volunteers in CPR to respond, which may decrease the time required to initiate assistance for a CPR victim.[15,24] The primary challenge, however, lies in expanding access to CPR training and maintaining skill proficiency, as skills may degrade quickly (within 3-6 months) if not regularly used or practiced.[25-27]

The mortality rate resulting from CPR during the five years studied (87.3%) is higher than that found in international literature, which reports a rate ranging from 60 to 80%[28] and nationally between 75 and 84%.[29-31]

An important factor in improving CPA survival rates is the rapid initiation of CPR, as each minute without intervention reduces survival likelihood by 10%.[32] According to El-Zein et al., 2023, CPR performed by trained first responders is linked to increased victim survival, as it is associated with faster response times.[17] These findings indicate a direct link between response time for initiating BLS and CPA-related morbidity and mortality. In this study, the association between delayed BLS initiation and higher mortality rates suggested a worse outcome for CPA victims. This result is supported by the CPA chain of survival, which highlights the importance of early initiation of chest compressions and, if possible, the use of an automated external defibrillator.[33] It is well-established that if any step in the intervention chain is delayed, survival rates are adversely impacted, with BLS being most effective when started immediately after collapse. The higher mortality rates observed during the early morning shift are in line with the findings of Lin et al. (2019), who reported worse outcomes during this shift.[34] Factors contributing to delayed or suboptimal BLS in the early morning include fewer witnesses, lower staffing in emergency services, and potentially decreased employee alertness due to shift fatigue, which may impact care quality.[35]

It should also be noted that the period evaluated by the study may have reflected the COVID-19 pandemic (2020 to 2022), which had its beginning and peak exactly during this time interval. Plausible explanations for the increased number of cases during this period include the difficulties accessing health services and their overcrowding during the pandemic. Furthermore, the indications of social isolation led the population to lack health monitoring related to other previously existing diseases and subsequent abandonment of the regular use of medications to treat them.[36,37]

Regarding the victim profile, data indicate that most cases involved elderly individuals and males, aligning with previous studies that identified older age and male gender as predominant factors in CPA incidents.[38-40] This finding may be related to the greater propensity of men to develop heart disease when compared to women. Data show that approximately 1 in 9 men will experience CPA before age 70, compared to 1 in 30 women. Additionally, at 45 years of age, men have an 11% risk of CPA occurrence, while women have a 3% risk.[41]

Seasonal analysis of out-of-hospital CPA assistance in Porto Alegre revealed higher case numbers in 2020, 2021, and 2022, as well as during the coldest months (June, July, and August). This period corresponds to the cool season in Porto Alegre, lasting for three months (from May 23 to August 22), which includes July, which is considered the coldest month of the year in the city.[42] This finding is in line with other publications that also found an increased number of cases of CPA in colder months, probably due to factors associated with vasoconstriction, increased blood pressure and blood viscosity and increased levels of cholesterol and plasma fibrinogen.[43-46] Analysis of CPA distribution across Porto Alegre's planning regions revealed that Region 1 (Center), the city's most populated area, had the highest number of cases, which was anticipated.[47] Furthermore, downtown Porto Alegre has a high urbanization profile and consequently a high circulation of people.[47]

It is important to bring to the discussion that Emergency Care should flow at all levels of the SUS. SAMU, through its Advanced Life Support and BLS units, meets the population's needs by providing timely assistance coordinated via Medical Regulation

Centers. The National Emergency Care Policy aims to develop strategies to improve quality of life and health, including preventing injuries, safeguarding health, fostering health education, and supporting autonomy and equity for individuals and communities, in line with societal responsibilities. In this regard, Emergency Education projects, with a pedagogical approach for training professionals, social agents, and the general public, should be integrated with SAMU's Emergency Education Centers.

SAMUs operate under decentralized management, so the findings in this study should not be generalized to other regions of Brazil, given variations in service infrastructure and the vast regional diversity of the country. However, to date, this study has the longest record time at a national level to describe the panorama of CPA assistance provided by a Mobile Emergency Service. These data show the importance of gathering, recording, and analyzing this type of information to inform interventions and programs aimed at reducing high CPA mortality rates. Collecting real-world evidence presents operational challenges that can affect data quality, such as incomplete or improperly filled pre-hospital CPA forms and the lack of geolocation tracking of SAMU/POA ambulances en-route to victims. Such gaps can impact the quality of the information obtained, but this is intrinsic to the study of secondary data. On the other hand, recognizing these circumstances gives rise to the possibility of interventions to improve them.

Conclusion

CPA data from a mobile emergency service in Southern Brazil showed that the victims were predominantly elderly men. More than half of the patients required more than 15 minutes to begin BLS, and this fact is linked to the high mortality rate from CPA, which was associated with the time taken to begin assistance, worsening concomitantly with the delay in the arrival of the emergency medical service. Addressing these challenges can help government actions more effectively target improvements in emergency medical care for CPA victims. Moreover, this data analysis further raises the discussion about the need for programs aimed at training first responders (lay people) in the face of CPA, aiming to initiate BLS early. Finally, this study highlights the significant role of SAMU/POA in providing high-quality emergency assistance to the public in out-of-hospital settings.

Author Contributions

Conception and design of the research: Carvalho RB; acquisition of data: Carvalho RB, Barrionuevo F; analysis and interpretation of the data: Carvalho RB, Almeida RP, Marmett B, Souza LA, Alves FD; statistical analysis: Carvalho RB, Almeida RP, Marmett B; obtaining financing: Barrionuevo F; writing of the manuscript: Carvalho RB, Almeida RP, Souza LA, Alves FD; critical revision of the manuscript for intellectual content: Carvalho RB, Marmett B, Souza LA, Barrionuevo F, Alves FD.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

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Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee on Animal Experiments of the Hospital Moinhos de Vento under the protocol number 51136021.0.0000.5330.

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