Prevalence, Outcomes, and Risk Factors for Cardiorespiratory Arrest in the Intensive Care Unit: An Observational Study

Antônio da Silva Menezes Jr[1], Angélica L Braga[2], Viviane de Souza Cruvinel[3]

Abstract

Background: Cardiorespiratory arrest is defined as an abrupt halt in the cardiac mechanical activity that is accompanied by the loss of a detectable pulse, the cessation of breathing, and the loss of consciousness. The aim of this study is to create a clinical–epidemiological profile of patients who experienced cardiorespiratory arrest and were admitted to the intensive care unit to evaluate the associated factors and their impact on the prognosis of these patients.

Patients and methods: From January to December 2019, the medical records of 135 patients who received cardiopulmonary resuscitation were reviewed for this cross-sectional observational study. The information was collected according to the Utstein model.

Results: A low return of spontaneous circulation of 22.2% was observed, with a predominance of females (53.3%) and older patients (68.9%), multiple comorbidities at admission (68.4%), and asystole as the predominant rhythm. Female sex and age >60 years were statistically significant ($p = 0.017$), as was the association between sex and comorbidities ($p = 0.036$), with heart disease being the most prevalent in females ($p = 0.036$).

Conclusion: In this study, even though the resuscitation maneuver time (start of resuscitation following arrest) was very short and the defibrillation was performed promptly, there was a high prevalence of cardiac arrest and low survival rates after cardiopulmonary resuscitation.

Keywords: Advanced critical care practitioner, Cardiac arrest, Cardiac massage, Cardiopulmonary arrest, Cardiopulmonary resuscitation, Case-control study, Epidemiological factors, Intensive care unit.

Indian Journal of Critical Care Medicine (2022): 10.5005/jp-journals-10071-24201

Highlights

Using the Utstein model to develop a clinical–epidemiological profile of ICU patients who had a cardiorespiratory arrest, we found significant associations with female sex and age >60 years. Prognosis may be improved by the early identification of triggering factors, careful planning of the intervention, and a strong focus on follow-up treatment.

Introduction

Cardiac arrest is defined as an abrupt halt in the cardiac mechanical activity shown by the loss of a measurable pulse, the inability to breathe, and the loss of consciousness.[1] When performing cardiopulmonary resuscitation (CPR) on patients in an effort to restore spontaneous circulation and reverse cardiorespiratory arrest, it is critical that it be done as part of a fast, appropriate, coordinated, and standardized intervention.[2]

Approximately 100,000 instances of cardiorespiratory arrest are reported in hospitals throughout Brazil each year.[1–5] It continues to be one of the most common cardiovascular crises, although a cardiorespiratory arrest may also occur with noncardiac causes, with a high incidence as well as high rates of morbidity and mortality.[3] There is a paucity of information in the literature on the occurrence of cardiorespiratory arrest in Brazil. Cardiopulmonary resuscitation (CPR) has been the gold standard for the treatment of cardiorespiratory arrest since its debut and recommendation in the 1960s. It is also the most frequently utilized procedure. The protocol for the treatment of a person who has had a cardiorespiratory arrest consists of a rational and reasoned series of actions that increases the likelihood of reversing the original process that caused the event toward restoring the pulse and respiration and protecting the brain function. It is now recognized that early CPR and defibrillation are critical in the effective treatment of a patient in cardiorespiratory arrest. The information base in Brazil is inadequate when it comes to the profile, prognosis, and treatment of patients receiving CPR in a hospital setting.[5] Records are essential in terms of ethical and legal considerations, as well as being tools for assessing treatments and quality indicators.[3] The Utstein model is employed in the context of a cardiorespiratory arrest to standardize records, allowing for a systematic and sufficient comparison of findings during CPR.[6]

The Utstein model for recording cardiac arrests was developed in 1990 and is a collection of essential and desirable data that should be collected during the treatment of patients undergoing cardiorespiratory arrest. It has been endorsed by the International Alliance of Resuscitation Committees. Research projects and studies that have already been published may benefit from recommendations like these in order to provide consistent and reliable information on which treatment decisions can be based. In our nation, however, they are seldom used in practice.

[1–3]Department of Medicine, Faculty of Medicine, Pontifical Catholic University of Goiás (PUC-GO), Goiânia, Goiás, Brazil

Corresponding Author: Antônio da Silva Menezes Jr, Department of Medicine, Faculty of Medicine, Pontifical Catholic University of Goiás (PUC-GO), Goiânia, Goiás, Brazil, Phone: +(062) 982711177, e-mail: a.menezes.junior@uol.com.br

Knowing the enormous number of cardiac arrests that occur in Brazil and throughout the globe, we understand the significance of providing appropriate treatment during CPR since its introduction in the country.[2]

The prognosis of patients in cardiorespiratory arrest is influenced by a number of variables, including appropriate treatment provided throughout patients' care while in cardiac arrest. It is possible that such variables are inherent to the patient himself/herself or linked to the process of providing treatment for the patient.

Improved outcomes were achieved via early identification of the triggering factors, tailored management in each clinical situation, and a focus on return to spontaneous circulation. These factors contributed to the overall prognosis of patients. The development of international protocols and algorithms made it possible to standardize and organize medical treatment worldwide. Even though differences in training exist in Brazil, data records and outcomes are considerable and often contradictory,[3] just as data records and results in other regions of the globe are conflicting.

This study is aimed to describe the clinical–epidemiological profile of patients admitted to the intensive care units who required CPR and evaluate the factors associated with cardiorespiratory arrest and their impact on the prognosis of these patients.

MATERIALS AND METHODS

An analysis of the medical records of 135 patients who received CPR in the ICU of a public hospital between January and December 2019 was performed in this cross-sectional, observational study. Patients had to be older than 18 years of age and not in the postoperative phase of cardiac surgery to be included.

Age, sex, clinical history, diagnosis on admission (using ICD-10 codes), the proportion of deaths, hospitalization time, duration of CPR, initial rhythm on the electrocardiogram during cardiorespiratory arrest, drugs administered, need for intubation, and procedures performed were among the information gathered from medical records, according to the Utstein model's orientations: chest compression and defibrillation.

According to the guidelines of Resolution 466/2012 of the National Health Council, the present study was submitted to the Research Ethics Committee of the University and the hospital and was accepted under approval numbers 3,774,759 and 3,902,175, respectively.

Statistical Analysis

The data were tabulated using Microsoft® Program® Excel 2007, and the statistical analysis was performed using SPSS® for Windows®, IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, New York: IBM Corp. The significance level was set at 5% ($p < 0.05$). Each variable was compared to the outcome variable (death or survival) to determine how they behaved in a certain situation. The Chi-square test was used to determine the impact of the variables age and sex in relation to the variables of the sociodemographic profile to determine their relationship. Univariate logistic regression analysis was performed to examine the relationship between the survival and the variables of the sociodemographic profile in this study. It was undertaken because of several issues, including incorrectly completed medical records, investigation of only one hospital center, failure to evaluate the quality of CPR provided, and a lack of information on the time that passed between the discovery of cardiorespiratory arrest and the start of CPR maneuvers.

RESULTS

The study population had more females [53.3% (72)] and had more older people over the age of 60 years [68.9% (93)]. The majority of patients (64.4% or 87 individuals) had multiple comorbidities at the time of their admission to the hospital ($N = 74$). The majority of those in the sample (54.8%) were admitted to the hospital for a duration less than or equal to 10 days.

The length of the CPR process in 40.7% ($n = 55$) of the patients was less than or equal to 20 minutes [10 cycles, these CPR processes were terminated because of return of spontaneous circulation (ROSC)]. The most common first rhythm of cardiorespiratory arrest was asystole (31.9%), followed by pulseless electrical activity (PEA) (19.3%), ventricular fibrillation (VF) (9.6%), and ventricular tachycardia without pulse (VTP) (1.5%).

Ninety-three percent (126) of patients were given medications and included in the CPR protocol (epinephrine and amiodarone), and 83% (112) were put on invasive mechanical ventilation.

The administration of cardiac compression was documented in the majority of patient medical records (98.5%), and spontaneous circulation was restored in only 22.5% (30) of those patients. Only 15 people underwent defibrillation, according to the records (11.1%). The overall survival (ROSC) rate was poor, at just 22.2% (30) of the sample. Female sex and age >60 years were significantly associated with a need for CPR ($p = 0.017$) (Table 1).

According to Table 2, the comparison between sex and the category of comorbidities confirmed that women were more likely than men to have cardiac comorbidities ($p = 0.036$).

We found that the duration of hospitalization did not have a statistically significant relationship with the percentage of survivors in the study population ($p = 0.068$). As previously stated, other factors, such as sex, age, and type of comorbidity did not show statistical significance in association with the survival rate ($p > 0.05$)

Table 1: The relationship between sex, age, and cardiopulmonary resuscitation

	Male		Female		
Factor/sex	n	%	n	%	p
Age					
≤60 years old	26	41.3	16	22.2	
>60 years old	37	58.7	56	77.8	
Total	63	100.0	72	100.0	0.017

Table 2: Comparison between sex and category of comorbidities

	Male		Female		
Factor/sex	n	%	n	%	p
Comorbidities					
Heart	1	1.8	10	14.9	
Multiple	38	67.9	49	73.1	
Neoplastic	2	3.6	2	3.0	
Neurological	2	3.6	1	1.5	
Lungs	2	3.6	2	3.0	
Kidneys	3	5.4	0	0.0	
Others	8	14.3	3	4.5	
Total	56	100.0	67	100.0	0.036

on logistic regression. Table 3 depicts the connections that have been discussed.

Patients with shockable rhythms—VTP and VF—had a better chance of survival (OR 2.09) ($p = 0.04$) compared to those who did not. The most substantially related rhythm was VF, which was associated with a survival rate of 31.6% ($n = 6$) and an absence of return to spontaneous circulation in patients who did not have this rhythm ($p = 0.04$) (Table 4).

The use of drugs specified in the CPR protocol had no statistically significant effect on survival rates, nor did the use of invasive mechanical ventilation ($p > 0.05$), as shown in Table 5.

According to Table 6, 80% of defibrillations were done on females and 20% (3) on male patients, and this association was statistically significant ($p = 0.004$). This result is consistent with the fact that females (28%) were discovered to have the highest proportion of shockable rhythms (VF and VTP) compared to males (7%) (Table 6).

DISCUSSION

Our finding that the majority of patients undergoing CPR were being female is not consistent with the literature, which indicates that patients are mainly male, with an incidence ranging from 51.6 to 72.4%.[5,7,8] Despite the fact that women's survival was not significantly different from men's, the length of CPR was much longer in women than in men, favoring neurological damage in women.[5] Sex did not seem to make a difference in survival, according to the results of the logistic regression analysis. However, there was no difference in the length of time required for CPR based on sex in our study. A statistically significant difference ($p = 0.004$) was found when comparing defibrillation in both sexes. The greatest percentage of patients was found to be female ($p = 0.004$). This result is consistent with the finding that females had the highest proportion of shockable rhythms (VF and TVP) (28% compared to 7% in men).

The studies presented mean ages ranging from 60 to 70 years,[1,7,8] consistent with our analysis, which found that the majority of patients was over the age of 60 years, while another author reported a mean age of 59 ± 17.6 years, with ages ranging from 16 to 94 years,[5] which is consistent with our epidemiological analysis.

For example, in terms of the most commonly associated comorbidities, the authors report that 48.3% of patients had systemic arterial hypertension, 28% had diabetes mellitus, 15% had heart failure, 7.8% had cancer, and 6.7% had myocardial ischemia,[5] or that HIV infection was the most common comorbidity[2] due to wide geographical disparities in the epidemiological profile. Our study patients had many comorbidities (cardiac, multiple, renal, pulmonary, neoplastic, and others). Statistical significance was found for female sex and cardiac diseases, such as arterial hypertension, without these factors having an effect on survival.

A variety of variables, including the location of the CPR site, the length of CPR, the etiology of cardiorespiratory arrest, the initial heart rhythm, and the patient's comorbidities, all influence the patient's chances of survival.[9] In our study, the use of cardiac compression was documented in the medical records of the vast majority of patients undergoing CPR (98.5%), with just 22.5% of those patients achieving spontaneous circulation after receiving cardiac compression. In another study, 12 patients out of 213 who received CPR were able to be discharged, indicating that the procedure is safe (5.6%). When CPR was performed, only one out of four patients had spontaneous circulation restored.

The initial rhythm of in-hospital CPR and the survival rate of patients in our database revealed that both shockable rhythms, VTP and VF, were associated with a greater chance of survival (OR 2.09) ($p = 0.04$), with VF being the most effective in terms of statistical

Table 3: The relationship between survival and sex, age, comorbidity, and duration of hospitalization

Factor/survival	No		Yes		
	n	%	n	%	p
Sex					
Male	51	48.6	12	40.0	
Female	54	51.4	18	60.0	
Total	105	100.0	30	100.0	0.408
Age					
≤60 years old	36	34.3	6	20.0	
>60 years old	69	65.7	24	80.0	
Total	105	100.0	30	100.0	0.142
Comorbidities					
Heart	10	10.6	1	3.4	
Multiple	64	68.1	23	79.3	
Neoplastic	3	3.2	1	3.4	
Neurological	2	2.1	1	3.4	
Lungs	3	3.2	1	3.4	
Kidneys	2	2.1	1	3.4	
Others	10	10.6	1	3.4	
Total	94	100.0	29	100.0	0.574
Hospitalization duration (days)					
≤10 days	62	59.0	12	40.0	
>10 days	43	41.0	18	60.0	
Total	105	100.0	30	100.0	0.068

Table 4: Relationship between initial CPR rhythm and survival

Factor/survival	Não		Sim				CI 95%	
	n	%	n	%	p	OR	Inferior	Superior
Initial pace of CPR								
PEA	22	33,8	4	21,1				
u/l	35	53,8	8	42,1				
VF	7	10,8	6	31,6				
VTP	1	1,5	1	5,3				
Total	65	100,0	19	100,0	0,040	2,09	1,03	4,24

CPR, cardiopulmonary resuscitation; OR, odds ratio; PEA, pulseless electricity activity; VF, ventricular fibrillation; VTP, ventricular tachycardia without pulse

Table 5: Recommended drug use and invasive mechanical ventilation and survival rate

Factor/survival	No		Yes		p	OR	CI 95%	
	n	%	n	%			Lower	Upper
Drug use								
No	7	6.7	2	6.7		1.00	0.22	4.56
Yes	98	93.3	28	93.3		1.00	0.90	1.11
Total	105	100.0	30	100.0	1.000	1.00	0.20	5.09
Invasive ventilation								
No	22	21.0	1	3.3		6.29	0.88	44.74
Yes	83	79.0	29	96.7		0.82	0.73	0.92
Total	105	100.0	30	100.0	0.051	7.69	0.99	59.60

CI, confidence interval; OR, odds ratio

Table 6: Relationship between cardiac defibrillation, initial rhythm of cardiopulmonary resuscitation, and sex

Factor/sex	Male		Female		p
	n	%	n	%	
Defibrillation					
No	34	91.9	21	63.6	
Yes	3	8.1	12	36.4	
Total	37	100.0	33	100.0	0.004
Initial rhythm of CPR					
PEA	16	39.0	10	23.3	
u/l	22	53.7	21	48.8	
VF	3	7.3	10	23.3	
VTP	0	0.0	2	4.7	
Total	41	100.0	43	100.0	0.068

CPR, cardiopulmonary resuscitation; PEA, pulseless electrical activity; VF, ventricular fibrillation; VTP, ventricular tachycardia without pulse

significance, considering a survival rate of 31.6% ($n = 6$) vs. a 10.8% absence of return to spontaneous circulation.

When comparing the first and second periods (before and after the adoption of the cardiorespiratory arrest protocol), the survival rate of shockable rhythms increased two-fold, whereas the survival rate of non-shockable beats decreased.[10] Patients with shockable first rhythms were more likely to live than those with non-shockable initial rhythms, with survival rates of 23.8 and 10.3%, respectively. Patients with sepsis, hypotension, and acute renal failure were found in higher proportions among the deceased than among those who survived.[10–13]

We found that the most common first rhythm of cardiorespiratory arrest was likewise asystole (31.9%), followed by PEA (19.3%), VF (9.6%), and VTP (5.1%). Heart failure defined by PEA and asystole was shown to be common in both ICU and ward populations in an observational study, with 80% of the ICU population experiencing a non-shockable initial rhythm and 83% of patients in the ward due to asystole/PEA. When it comes to the frequency of non-shockable rhythms compared to that of shockable rhythms in intrahospital cardiorespiratory arrest, there is significant consistency across studies.[12,14]

As a result of our research, we discovered that the length of time spent in the hospital had no statistically significant link with the percentage of the sample ($p = 0.068$). As previously stated, advanced age and female gender had a statistically significant association with survival ($p < 0.05$).

Many studies have identified variables associated with favorable neurological survival after a hospital cardiac arrest, including younger age, initial rhythm of VF cardiac arrest or SVT with a defibrillation time of 2 minutes, basal neurological state without disability, location of cardiorespiratory arrest in a monitored unit, shorter response time and duration of resuscitation, and the lack of need for resuscitation after a cardiac arrest in the community.

Approximately 2% of patients in the ICU need CPR, and their survival is comparable to that of those patients in a general hospital who receive CPR. This suggests that the additional monitoring and, potentially, faster detection of cardiorespiratory arrest and the initiation of CPR in the ICU are offset by the severity of the underlying disease.

When it came to invasive mechanical ventilation, the use of medications that are part of the CPR protocol (epinephrine and amiodarone) was commonly administrated, with rates of 93.3% (126) and 83% (112) in the current study, respectively. However, neither the use of invasive mechanical ventilation nor the administration of vasoactive medications was shown to be statistically significant in association with the survival rate ($p > 0.05$).

There are several prognostic factors that are associated with poorer survival rates: advanced age, unwitnessed arrest, comorbid conditions, such as sepsis or cancer, renal failure, black ethnicity, sedentary lifestyle, prolonged duration of CPR, and higher total dose of adrenaline during resuscitation.[2,13,15–21]

The length of CPR and the time it takes for patients to regain spontaneous circulation were shown to be significantly inversely related.

For 40.7% ($n = 55$) of the patients in our study, the length of CPR was shorter than or equal to 20 minutes (10 cycles), according to the Utstein model. Similarly, a multicenter study of 64,339 patients found a relationship between the length of CPR and length of survival. Additionally, other studies have shown that shorter periods of CPR were linked with better chances of immediate survival.[5,14] This is consistent with previous findings.

It is essential to note that the majority of the studies reviewed and the data gathered in the current study did not assess the quality of CPR or the presence or absence of a fast response team, which is a limitation of this study. The interval between identification of cardiopulmonary arrest and initiation of resuscitation procedures, as well as other variables, is associated with a poorer long-term prognosis in cardiopulmonary arrest patients. Interventions, such as cardiac compression and defibrillation, have been shown to decrease the fatality rate when they are performed as soon as feasible and according to high-quality standards of care.

Conclusion

Even though the resuscitation maneuver started, time was extremely brief and that defibrillation was delivered as quickly as feasible, there was a significant frequency of cardiac arrest and a poor survival rate after CPR was done in this study. This was aggravated by advanced age, various comorbidities, and the prevalence of heart disease in females, all of which contributed to the rise in mortality.

There was no difference in the incidence of cardiorespiratory arrests based on the predominant sex, and there was also no difference in the mean age of the patients studied. Patients with shockable stop rhythms had a higher rate of spontaneous circulation resumption. The most common arrhythmias, however, were asystole and PEA, which are unshockable rhythms. The length of resuscitation maneuvers had an impact on prognosis as well, with longer mean durations being associated with a greater incidence of ROSC than those with shorter mean durations. While the data collected were not sufficient to make definitive conclusions, knowledge of the profile, prognosis, and outcomes of patients who underwent CPR, as well as the use of the Utstein-based registry for cardiorespiratory arrest data, would allow for the implementation of a high-quality care approach for cardiorespiratory arrest and an improvement in the survival of those who present with this condition.

It is believed that the construction of the clinical–epidemiological profile has yielded information that will be of critical importance in the prevention of new cardiorespiratory arrest events, as well as indirectly in the improvement of public health because once the information is in the possession of healthcare providers, it will be possible to develop preventive health measures or improve performance. That is because patient prognosis may be improved by the early identification of triggering factors, careful planning of the intervention for each clinical situation, and a strong focus on follow-up treatment once spontaneous circulation has been restored.

Limitations

It was undertaken because of several issues, including incorrectly completed medical records, investigation of only one hospital center, failure to evaluate the quality of CPR provided, and a lack of information on the time that passed between the discovery of cardiorespiratory arrest and the start of CPR maneuvers.

Orcid

Antônio da Silva Menezes Jr ● https://orcid.org/0000-0003-1751-5206
Angélica L Braga ● https://orcid.org/0000-0001-5805-507X
Viviane de Souza Cruvinel ● https://orcid.org/0000-0002-5098-4517

References

1. Miana LA, Moraes MM, Moraes BM, Ponte PG, Venturelli E Jr, Mallosto RU, et al. Cardiopulmonary resuscitation in an average brazilian intensive care unit: should we perform less or better? Braz J Cardiovasc Surg 2017;32(3):177–183. DOI: 10.21470/1678-9741-2017-0036.
2. Ocen D, Kalungi S, Ejoku J, Luggya T, Wabule A, Tumukunde J, et al. Prevalence, outcomes and factors associated with adult in hospital cardiac arrests in a low-income country tertiary hospital: a prospective observational study. BMC Emerg Med 2015;15(1):1–6. DOI: 10.1186/s12873-015-0047-0.
3. Bernoche C, Timerman S, Polastri TF, Palma Dallan LA, Araujo S, Lage SG, et al. Update of the cardiopulmonary resuscitation and emergency care guideline of the Brazilian Society of Cardiology. Arq Bras Cardiol 2019;113(3):449–663. DOI: 10.5935/abc.20190203.
4. Gonzalez MM, Timerman S, Gianotto-Oliveira R, Polastri TF, Canesin MF, Schimidt A, et al. [First guidelines of the Brazilian Society of Cardiology on Cardiopulmonary Resuscitation and Cardiovascular Emergency Care]. Arq Bras Cardiol 2013;101(2 Supl 3):1–221. DOI: 10.5935/abc.2013S006.
5. Silva RM, Silva BA, Silva FJ, Amaral CF. Cardiopulmonary resuscitation of adults with in-hospital cardiac arrest using the Utstein style. Rev Bras Ter Intensiva 2016;28(4):427–435. DOI: 10.5935/0103-507X.20160076.
6. Idris AH, Bierens JJLM, Perkins GD, Wenzel V, Nadkarni V, Morley P, et al. 2015 revised utstein-style recommended guidelines for uniform reporting of data from drowning-related resuscitation. Circ Cardiovasc Qual Outcomes 2017;10(7):1–16. DOI: 10.1161/HCQ.0000000000000024.
7. Bougouin W, Aissaoui N, Combes A, Deye N, Lamhaut L, Jost D, et al. Post-cardiac arrest shock treated with veno-arterial extracorporeal membrane oxygenation: an observational study and propensity-score analysis. Resuscitation 2017;110:126–132. DOI: 10.1016/j.resuscitation.2016.11.005.
8. Hunter BR, O'Donnell DP, Kline, JA. Receiving hospital characteristics associated with survival in patients transported by emergency medical services after out-of-hospital cardiac arrest. Acad Emerg Med 2016;23(8):905–909. DOI: 10.1111/acem.12978.
9. Christenson J, Andrusiek D, Everson-Stewart S, Kudenchuk P, Hostler D, Powell J, et al. Chest compression fraction determines survival in patients with out-of-hospital ventricular fibrillation. Circulation 2009;120(13):1241–1247. DOI: 10.1161/CIRCULATIONAHA.109.852202.
10. Khatib J, Schwartz N, Bisharat N. Twenty-year trends of survival after in-hospital cardiac arrest. Isr Med Assoc J 2017;19(12):756–760. PMID: 29235738.
11. Chen LM, Nallamothu BK, Spertus JA, Li Y, Chan PS; American Heart Association's Get With the Guidelines-Resuscitation (formerly the National Registry of Cardiopulmonary Resuscitation) Investigators; Association between a hospital's rate of arrest cardiac incidence and cardiac arrest survival. JAMA Intern Med 2013;173(13):1186–1195. DOI: 10.1001/jamainternmed.2013.1026.
12. Truhlář A, Deakin CD, Soar J, Khalifa GE, Alfonzo A, Bierens JJ, et al. European resuscitation council guidelines for resuscitation 2015: Section 4: cardiac arrest in special circumstances. Resuscitation 2015;95:148–201. DOI: 10.1016/j.resuscitation.2015.07.017.
13. Witten L, Gardner R, Holmberg MJ, Wiberg S, Moskowitz A, Mehta S, et al. Reasons for death in patients successfully resuscitated from out-of-hospital and in-hospital cardiac arrest. Resuscitation 2019;136:93–99. DOI: 10.1016/j.resuscitation.2019.01.031.
14. Lacerda FH, Checoli PG, Silva CMDD, Brandão CE, Forte DN, Besen BAMP. Mechanical ventilation withdrawal as a palliative procedure in a Brazilian intensive care unit. Rev Bras Ter Intensiva 2020;32(4):528–534. DOI: 10.5935/0103-507X.20200090.
15. Bougouin W, Lamhaut L, Marijon E, Jost D, Dumas F, Deye N, et al. Characteristics and prognosis of sudden cardiac death in Greater Paris: population-based approach from the Paris Sudden Death Expertise Center (Paris-SDEC). Intensive Care Med 2014;40(6):846–854. DOI: 10.1007/s00134-014-3252-5.
16. Oddo M, Bracard S, Cariou A, Chanques G, Citerio G, Clerckx B, et al. Update in neurocritical care: a summary of the 2018 Paris international conference of the French Society of Intensive Care. Ann Intensive Care 2019;9(1):47. DOI: 10.1186/s13613-019-0523-x.
17. Cour M, Turc J, Madelaine T, Argaud L. Risk factors for progression toward brain death after out-of-hospital cardiac arrest. Ann Intensive Care 2019;9(1):45. DOI: 10.1186/s13613-019-0520-0.
18. Fennessy G, Hilton A, Radford S, Bellomo R, Jones D. The epidemiology of in-hospital cardiac arrests in Australia and New Zealand. Intern Med J 2016;46(10):1172–1181. DOI: 10.1111/imj.13039.
19. Geri G, Grimaldi D, Seguin T, Lamhaut L, Marin N, Chiche JD, et al. Hemodynamic efficiency of hemodialysis treatment with high cut-off membrane during the early period of post-resuscitation shock: The HYPERDIA trial. Resuscitation 2019;140:170–177. DOI: 10.1016/j.resuscitation.2019.03.045.

20. Martins GS, Menezes Jr AS, Coimbra FPL, Cordeiro Silva AMT, Fernandes JF, Laranjeira TDA, et al. Epidemiological analysis of sudden cardiac death in Brazil-2014 to 2019. Int J Dev Res 2021;11(05):46952–46955. DOI: 10.37118/ijdr.21898.05.2021.

21. Janiczek JA, Winger DG, Coppler P, Sabedra AR, Murray H, Pinsky MR, et al. Hemodynamic resuscitation characteristics associated with improved survival and shock resolution after cardiac arrest. Shock 2016;45(6):613–619. DOI: 10.1097/SHK.0000000000000554.