







Clinical characteristics of in-hospital cardiopulmonary resuscitations recorded in medical records: a cross-sectional study

Características clínicas de reanimações cardiopulmonares intra-hospitalares registradas em prontuário: estudo transversal

Características clínicas de las reanimaciones cardiopulmonares intrahospitalarias registradas en las historias clínicas: estudio transversal

Jakeliny Serafini Terra¹ ; Daniele Delacanal Lazzari¹ ; Francine Carpes Ramos¹ ; Alex Becker¹ ;
Eliane Regina Pereira do Nascimento¹ ; Nicásio Urinque Mendes¹ 

¹Universidade Federal de Santa Catarina. Florianópolis, SC, Brazil

ABSTRACT

Objective: identify the clinical characteristics of cardiopulmonary arrests and cardiopulmonary resuscitations in the in-hospital environment. **Method:** this is a quantitative, prospective and observational study based on information from the medical records of patients who underwent resuscitation maneuvers due to cardiopulmonary arrest between January and December 2021. An instrument based on the variables of the Utstein registration protocol was used. **Results:** thirty-seven cardiopulmonary arrests were recorded in 12 months. The majority occurred in a respiratory intensive care unit, with hypoxia being the most prevalent clinical cause. Sixty-five percent of the patients were intubated and 57% had pulseless electrical activity. The duration of resuscitation ranged from less than five to more than 20 min. As for the immediate outcome, 57% survived. **Conclusion:** among the records analyzed, the highest occurrence of cardiopulmonary arrests was in respiratory intensive care units, and they were related to Covid-19. Moreover, incomplete records and a lack of standardization in cardiopulmonary resuscitation procedures were found. **Descriptors:** Nursing; Emergencies; Heart Arrest; Medical Records.

RESUMO

Objetivo: identificar características clínicas das paradas cardiopulmonares e reanimações cardiopulmonares ocorridas em ambiente intra-hospitalar. **Método:** estudo quantitativo, prospectivo e observacional, a partir de informações de prontuários de pacientes submetidos a manobras de reanimação devido à parada cardiopulmonar entre janeiro e dezembro de 2021. Utilizou-se um instrumento baseado nas variáveis do modelo de registro *Utstein*. **Resultados:** em 12 meses foram registradas 37 paradas cardiopulmonares. A maioria ocorreu na unidade de terapia intensiva respiratória, com causa clínica mais prevalente hipóxia. 65% dos pacientes foram intubados no atendimento e 57% apresentaram ritmo atividade elétrica sem pulso. A duração da reanimação variou entre menos de cinco a mais de 20 minutos. Como desfecho imediato, 57% sobreviveram. **Conclusão:** dentre os registros analisados, a maior ocorrência de paradas cardiopulmonares foi na unidade de terapia intensiva respiratória, relacionada à Covid-19. Foram encontrados registros incompletos e ausência de padronização nas condutas. **Descritores:** Enfermagem; Emergências; Parada Cardíaca; Registros Médicos.

RESUMEN

Objetivo: Identificar las características clínicas de paros cardiopulmonares y reanimaciones cardiopulmonares que ocurren en un ambiente hospitalario. **Método:** estudio cuantitativo, prospectivo y observacional, realizado a partir de información presente en historias clínicas de pacientes sometidos a maniobras de reanimación por paro cardiorrespiratorio entre enero y diciembre de 2021. Se utilizó un instrumento basado en las variables del modelo de registro *Utstein*. **Resultados:** en 12 meses se registraron 37 paros cardiopulmonares. La mayoría ocurrió en la unidad de cuidados intensivos respiratorios, la causa clínica más prevalente fue la hipoxia. El 65% de los pacientes fue intubado durante la atención y el 57% presentaba un ritmo de actividad eléctrica sin pulso. La duración de la reanimación varió entre menos de cinco y más de 20 minutos. Como resultado inmediato, el 57% sobrevivió. **Conclusión:** entre los registros analizados, la mayor cantidad de paros cardiopulmonares se dio en la unidad de cuidados intensivos respiratorios, relacionada con Covid-19. Se encontraron registros incompletos y falta de estandarización en el procedimiento. **Descriptor:** Enfermería; Urgencias Médicas; Paro Cardíaco; Registros Médicos.

INTRODUCTION

Cardiopulmonary resuscitation (CPR) consists of an organized sequence of maneuvers performed to reverse cardiopulmonary arrest (CA), artificially maintaining blood flow to the brain and vital organs until spontaneous circulation returns (SCR). Quality CPR reduces mortality rates and prevents neurological sequelae after CPR¹. The incidence of in-hospital CPR is 1.6 per 1,000 admissions and 52% of the time it occurs in an intensive care unit (ICU). In Brazil, there is little data in the literature on the incidence of CA, but it is estimated that there are around 200,000 CAs per year, half of which occur in hospital settings and the other half in out-of-hospital settings^{2,3}.

Corresponding author: Francine Carpes Ramos. E-mail: franrammos@gmail.com
Editor in chief: Cristiane Helena Gallasch; Associate Editor: Flavia Giron Camerini

A study carried out in 583 hospitals showed the direct influence of the early start of CPR as a factor that directly influences patient survival, and also showed a significant frequency of in-hospital CA where CPR was not started immediately. Other determining factors for patient survival identified in the aforementioned study were associated with the need for immediate defibrillation when a shockable rhythm was identified, and the immediate administration of epinephrine in non-shockable rhythms, which revealed a greater decline in survival for patients with non-shockable rhythms compared to shockable rhythms⁴.

Despite the relevance of continuous training, even experienced healthcare professionals can perform poor quality CPR. For this reason, there are a range of characteristics that must be assessed when performing CPR, which significantly affect its quality and the patient survival, which includes team management, patient management, medical devices (cardiac monitors, electroshock devices, etc.), infrastructure, and performing CPR based on recent guidelines recommended by the American Heart Association (AHA)⁵.

The factors involved in the success of a CPR include committed and competent professionals to early identification of CPR, calling the emergency medical service, performing high-quality CPR followed by defibrillation, when necessary, as well as assessing factors related to the patient (age, comorbidities, initial rhythm of CPR, location of the event), and the hospital infrastructure (presence of emergency teams, materials and post-CPR care facilities)⁶.

The low level of knowledge about the profile, prognosis and evolution of patients undergoing CPR in a hospital environment in Brazil is noteworthy, since this characterization is a way of specifying survival rates and the results of the treatment provided, and this data is important for assessing the quality of care provided and identifying related factors³.

The importance of epidemiologically characterizing patients undergoing CA, as well as their causes and clinical evolution, makes it possible to identify this population's needs and determining factors in the health-disease process, thus providing conditions for planning, proposing and implementing specific prevention measures⁷. It is also possible to promote training and updates for the team involved in care, with a view to systematized treatment⁷. Records impact the flow, nature and quality of communication between teams, as well as hospital statistics, which are extremely important for healthcare and a significant indicator of the quality of patient care⁸.

This raises the question: what are the clinical characteristics of cardiopulmonary arrests and resuscitations in an in-hospital environment, as recorded in medical records?

The aim of this study was to identify the clinical characteristics of cardiopulmonary arrests and resuscitations in an in-hospital environment.

METHOD

This is a cross-sectional, quantitative and prospective study. Data reporting follows the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology statement (STROBE)⁹. It was developed in a public hospital in southern Brazil, which treats clinical and surgical patients in a wide range of specialties. The hospital has two clinical and two surgical wards, two Intensive Care Units, Hemodynamics, Endoscopy, Dialysis Treatment Unit, Outpatient Clinics, Urgent and Emergency Care Unit and Surgical Center. The institution has no statistics on CPR, which is a recurring demand for training by the team at the Permanent Education Center.

The sample was intentional and consisted of all the medical records of patients who suffered CA, regardless of the outcome, during the year 2021. The exclusion criteria were patients under the age of 18 and those in palliative care. The aim was to evaluate the way in which care was provided and the event itself, even if indirectly, via the medical records.

Data was collected between January and December 2021 by analyzing the medical records of adult patients who were victims of in-hospital CPR and who underwent CPR maneuvers in any of the above-mentioned units. Every day, the main researcher contacted the units, carrying out an active search for the last 24 h. The physical medical records were then evaluated in their entirety at the administrative department responsible for billing in the event of the patient's death or at the inpatient unit where the event took place (the units were not yet using electronic medical records, which were being tested at the institution). For this evaluation, an instrument was developed based on the variables used in Utstein's record protocol.

Utstein consists of a recording protocol containing essential elements to be collected when attending a CA¹⁰. The variables collected for the patients include gender, age, diagnosis/reason for admission, previous comorbidities, and date of admission. The variables related to CPR included immediate cause, initial rhythm, interventions carried out, medication used, date of CPR, location of the event, and duration of resuscitation maneuvers (in min). Finally, variables relating to the outcome were considered, i.e. death or return of spontaneous circulation (RCE).

The data was organized and tabulated in Excel for Windows spreadsheets, version 2016® and analyzed using descriptive statistics, so that categorical variables were described using absolute frequencies and proportions and continuous variables using measures of central tendency and dispersion: median, mean, standard deviation and variance.

The research protocol for this study was approved by the Research Ethics Committee and the consent of the patients' relatives was obtained by means of a Free and Informed Consent Form (FICF). After locating the cases of patients who had suffered CA, the lead researcher contacted a family member for authorization and to sign the FICF. There were no refusals from any of the relatives contacted by telephone (in the event of death) or in person during visiting hours.

RESULTS

During the 12-month period between January and December 2021, 37 CAs were recorded, and in 100% of cases, the patients underwent CPR maneuvers (Table 1).

Table 1: Characteristics related to cardiac arrest and cardiopulmonary resuscitation events, initial rhythm detected, drugs administered, causes, and interventions at the time of the event. Florianópolis, SC, Brazil, 2022.

Variables	n (%)
Initial rhythm detected	
Pulseless electrical activity	21 (57)
Asystole	4 (11)
Ventricular tachycardia	1 (3)
Ventricular fibrillation	1(3)
No record	10 (27)
Medications administered	
Adrenaline	37 (100)
Bicarbonate	4 (11)
Amiodarone	1 (3)
Atropine	1 (3)
Causes	
Hypoxia	24 (65)
Hypovolemia	1 (3)
Acute coronary syndrome	1 (3)
Pulmonary thromboembolism	4 (11)
Hyperkalemia	2 (6)
Hypotension	2 (6)
No record	3 (8)
Interventions at the time of the event	
Endotracheal intubation	24 (65)
Previous endotracheal intubation	7 (19)
Previous tracheostomy	1 (3)
Shock	5 (14)
No record	1 (3)
Outcome	
Return of spontaneous circulation	21 (57)
Death	16 (43)

It should be noted that 100% of the records were made by physicians and no records were found, even on nursing evolution sheets or intensive control sheets (which include vital signs, for example), by nursing technicians or nurses about the events, even in the ICUs. With regard to the variables relating to the patients, the average age was 51 years, ranging from 21 to 71 years, and the majority (58%) were male. Among the main previous comorbidities, 36% of the patients had systemic arterial hypertension, 28% were obese and 25% had diabetes mellitus. Only one patient was a smoker, eight were former smokers and one was a former alcoholic. In the distribution of data regarding diagnosis/reason for admission, 42% of patients were identified as having Covid-19, followed by vascular causes (14%) and neoplasms (14%).

As for the rhythm of the cardiac arrest, 57% of the 37 events had pulseless electrical activity (PEA) as the initial rhythm and 11% had asystole. In ten events (27%) there was no record of the initial rhythm. Ventricular tachycardia and ventricular fibrillation rhythms were detected in one event, and both received defibrillation. Among the drugs used, adrenaline was administered in all events. At the time of the CA, seven patients were already intubated, and one was tracheostomized and on mechanical ventilation. 24 patients (65%) were intubated during the event. Regarding the causes of CA, the most frequent was hypoxemia (65%), followed by pulmonary thromboembolism (11%). The duration of CPR in min ranged from less than five min (28%) to more than 20 min (25%), with a median of 8.5 min and a range of 2 to 50 min.

Regarding the outcome of patients who underwent CPR, 21 (57%) patients had a CPR and 16 (43%) died. This variable was assessed in the immediate aftermath of CPR; there was no assessment 24 h after the event. Figure 1 illustrates the locations where the CPRs occurred.

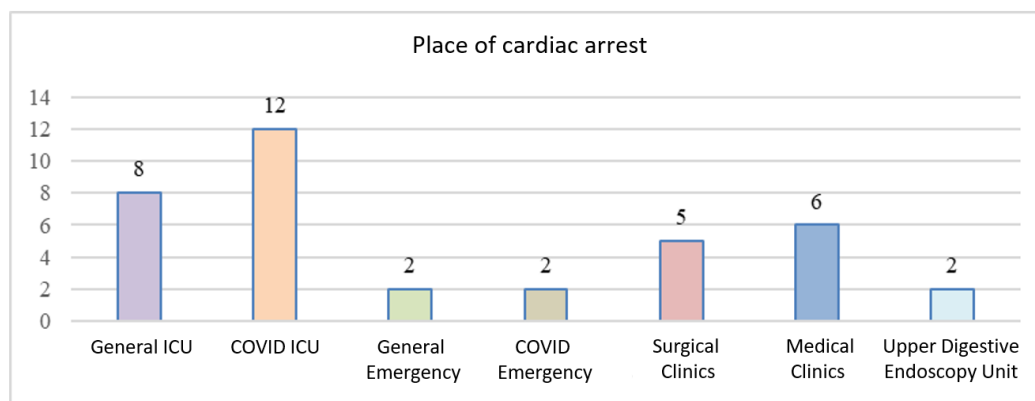


Figure 1: Places of cardiac arrest. Florianópolis, SC, Brazil, 2022
ICU: Intensive Care Unit

Among the 16 patients who died, seven medical records had no record of the initial rhythm; 100% of them were intubated and given adrenaline.

The results of the descriptive statistical analyses are shown in Table 2.

Table 2: Distribution of data by mean, median and standard deviation, related to diagnosis/reason for admission, previous comorbidities, location of the event, immediate cause, initial rhythm, interventions at the time of the event and medications used. Florianópolis, SC, Brazil, 2022.

Variables	Mean	Median	SD*
Diagnosis/reason for admission			
Vascular Causes	1.86	2	0.35
Covid-19	1.57	2	0.50
Acute Respiratory Pulmonary Failure	1.92	2	0.28
Chronic Renal Failure	1.97	2	0.16
Heart Failure	1.97	2	0.16
Pneumonia	1.97	2	0.16
Neoplasms	1.86	2	0.35
Urinary sepsis	1.97	2	0.16
Liver Transplant	1.97	2	0.16
Subacute aortic valve endocarditis	1.97	2	0.16
Upper Digestive Bleeding	1.97	2	0.16
Major burn	1.97	2	0.16
Viral meningoencephalitis	1.97	2	0.16
No record	1.95	2	0.23
Immediate cause			
Hypoxia	1.35	1	0.48
Hypovolemia	1.97	2	0.16
Acute Coronary Syndrome	1.97	2	0.16
Thrombus Pulmonary Embolism	1.89	2	0.31
Hyperkalemia	1.95	2	0.23
Hypotension	1.95	2	0.23
No record	1.92	2	0.28
Initial rhythm			
Pulseless Electrical Activity	1.43	1	0.50
Asystole	1.78	2	0.42
Ventricular Tachycardia	1.86	2	0.35
Ventricular Fibrillation	1.97	2	0.16
No record	1.73	2	0.45
Interventions at the time of the event			
Shock	1.86	2	0.35
Endotracheal intubation	1.24	1	0.43
Previous endotracheal intubation	1.81	2	0.40
Tracheostomy	1.97	2	0.16
No record	1.97	2	0.16
Medications used			
Adrenaline	1	1	0
Bicarbonate	1.89	2	0.31
Amiodarone	1.97	2	0.16
Atropine	1.97	2	0.16

Note: *SD = Standard deviation

Regarding the variables, the results found were a mean of 1.57, median 2 and standard deviation 0.50 of cases with a reason for hospitalization with a diagnosis of Covid-19.

DISCUSSION

Regarding the places where the CPR occurred, it is possible to evaluate different effects in relation to clinical outcomes and the influence on patient survival, as it is thought that CPR will start more quickly for events that occur in a hospital environment. One study³ reports that CPR in an in-hospital environment has better outcomes in intensive care units compared to wards, due to the fact that the patient is monitored, so the event is identified earlier, and advanced life support is provided immediately. In this study, 20 of the 37 events occurred in intensive care units. In-hospital cardiac arrest is a relatively common event and is associated with a high mortality rate¹¹.

The initial rhythm detected has an important influence on the management of care and patient survival. The most frequent presenting rhythms (81%) identified in the With the Guidelines-Resuscitation records are non-

shockable (asystole or PEA), a figure that is in line with the findings of this study, in which the main initial rhythm detected was PEA¹². Regarding the location of the event, a study¹³ shows that approximately half of cardiac arrests occur in wards, with a smaller proportion in intensive care units and operating rooms. This differs from this study, in which more than half of the events occurred in intensive care units, highlighting the fact that most of them took place in units specializing in Covid-19.

The main causes of CA described in the literature are related to cardiac factors, such as myocardial infarction, arrhythmia or heart failure, with a prevalence of approximately 50% to 60%. The second most common cause is respiratory failure^{13,14}. In this study, hypoxia, as the immediate cause of CA, was present in more than half of the patients, a finding similar to that described in the literature^{13,14}.

The main reason for admission revealed in this research was related to Covid-19 (42%), with the Respiratory ICU as the unit with the highest rate of events. It is noteworthy that patients with Covid-19 can present various complications, the most serious of which are related to a sustained inflammatory response, acute respiratory distress syndrome, cardiovascular involvement and secondary infections. The main potential causes of Covid-19-related CA include hypoxia secondary to acute respiratory distress syndrome, cardiovascular problems, as well as contributing factors such as sepsis, pulmonary thromboembolism and dehydration or hypotension. It should also be noted that the initial rhythms are usually non-shockable, corresponding to asystole or PEA^{15,16}.

Regarding the care given to CPR patients, most of the medical records indicated cardiac compression, shock in shockable rhythms and intubation as immediate action. With regard to the drugs administered at the time of CPR, all patients received adrenaline. According to the latest AHA recommendations, the first drug to be used in CPR should be a vasopressor, such as adrenaline, at a dose of 1mg every three minutes, regardless of the initial rhythm detected in CPR. Moreover, the use of atropine during CPR is not indicated, as it has been shown to cause poor survival in patients associated with its use¹⁷. In this study, all the patients received adrenaline and four received bicarbonate.

Although the 2020 American Heart Association (AHA) guidelines recommend that sodium bicarbonate be avoided during routine CPR, one study¹⁸ examined the effects of bicarbonate injection during prolonged CPR (> 15 min) in a pre-hospital setting, concluding that its use during prolonged CPR did not improve the likelihood of sustained on-site CPR and survival until discharge. In cases requiring prolonged CPR, high-quality maneuvers and determining the cause of arrest should be emphasized over buffer therapy.

Regarding CPR time, a multicenter study¹⁹ evaluated 348,996 patients and of these, 233,551 (66.9%) achieved return of spontaneous circulation with a median interval of 7 min (interquartile range 3-13 min) between the start of chest compressions and the first return of spontaneous circulation, while 115,445 (33.1%) patients did not achieve return of spontaneous circulation with a median interval of 20 min (14-30 min) between the start of chest compressions and the end of resuscitation. In this study, CPR varied between 5-50 min, considering that most of the events occurred in patients in intensive care units, which have professionals, materials and equipment at their disposal, as well as being monitored.

The 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care with recommendations for treatment, education and team implementation was unable to make recommendations on when to terminate cardiopulmonary resuscitation in the event of in-hospital cardiac arrest²⁰.

Advanced life support during cardiac arrest requires airway management, with endotracheal intubation traditionally considered the preferred approach to ensure adequate ventilation and oxygenation. Some evidence suggests alternative approaches in out-of-hospital and in-hospital cardiac arrests, such as bag-valve-mask ventilation or supraglottic airways, which can be equally or even more effective. In terms of airway management in recorded cardiac arrests, seven of the patients already had endotracheal intubation at the time of the event and one was tracheostomized, while another 24 were intubated at the time of the event, reflecting the majority opting for an approach to establish an advanced airway^{10,21}.

Chest compressions, ventilation and early defibrillation, when applicable, are the cornerstones of cardiac arrest treatment. Early initiation of CPR is associated with better outcomes for both out-of-hospital and in-hospital cardiac arrests. The quality of chest compressions and CPR in general has been associated with better outcomes in patients with cardiac arrest⁵. In this study, all patients underwent chest compression and ventilation, and of these, five (9%) patients who had a shockable rhythm were defibrillated.

Relying on a record of CA/CPR care, it is possible to guide new training, as well as direct investments in adequate physical and material resources for units dedicated to the treatment of critically ill patients and contribute to improving assistance²². At the hospital where this study was carried out, no recording method was used, so many variables relating to the event were not found and there was no standardized recording report. The scarcity of data caused by the absence of standardized records makes it difficult to collect data on treatment, which could provide information to help improve and evaluate the team's performance, as well as studies on survival and prognosis in CPR.

This study showed that all CA events were subjected to CPR maneuvers. The highest occurrence was in the Respiratory ICU, the main diagnosis/reason for admission of the victims was related to Covid-19 and hypoxemia as the immediate cause in most patients. Pulseless electrical activity was identified as the initial rhythm in most events, and more than half of the patients were intubated during CA. Adrenaline was used in all events, and more than half of the patients survived.

Study limitations

Limitations of this study include the fact that patients were not assessed in the long term after CA, nor were they assessed on their neurological evolution. The records were not always complete, and the study was carried out in a single public hospital and therefore does not reflect the disparities that may exist between hospitals and regions.

CONCLUSION

In-hospital cardiac arrest continues to be a neglected condition compared to cardiac arrest that occurs outside of hospital. This highlights the importance of standardizing records of cardiac arrests as a way of providing information for analyzing the events, seeking to identify strengths and weaknesses in care, as well as to draw up strategies for qualified assistance.

REFERENCES

1. Hooper GA, Butler AM, Guidry D, Kumar N, Brown K, Beninati W, et al. Relationship between resuscitation team members' self-efficacy and team competence during in-hospital cardiac arrest. *Crit Care Expl.* 2024 [cited 2024 Mar 10]; 6(1):pe1029, DOI: <http://dx.doi.org/10.1097/CCE.0000000000001029>.
2. Gonzalez MM, Timerman S, Oliveira RG, Polastri TF, Dallan LAP, Araújo S. I guideline for cardiopulmonary resuscitation and emergency cardiovascular care - Brazilian Society of Cardiology: executive summary. *Arq Bras Cardiol.* 2013 [cited 2021 Oct 10]; 100(2):105-13. DOI: <http://dx.doi.org/10.5935/abc.20130022>.
3. Baldi E, Savastano S. Utstein-style and the importance of the system, is it time for a new Utstein revision? *Resuscitation.* 2021 [cited 2024 Mar 10]; 165:196-7. DOI: <https://doi.org/10.1016/j.resuscitation.2021.05.035>.
4. Soar J, Berg KM. Early epinephrine administration for cardiac arrest. *JAMA Netw Open.* 2021 [cited 2024 Mar 10]; 4(8):e2120725. DOI: <http://dx.doi.org/10.1001/jamanetworkopen.2021.20725>.
5. Szabo D, Szabo, Magyar L, Szentgroti R, Batho JP, Szegezsky T, et al. Incidence rates of the different initial rhythms during out-of-hospital cardiopulmonary resuscitation and mortality of patients presenting ST elevation myocardial infarction. *Europ Heart J. Ac Cardiovasc Care.* 2023 [cited 2024 Mar 10]; 12(1):zuad036.103. DOI: <https://doi.org/10.1093/ehjacc/zuad036.103>.
6. Elon RD. Cardiac resuscitation procedures in US nursing facilities: time to reevaluate the standard of care? *J Am Med Dir Assoc.* 2023 [cited 2024 Mar 10]; 24(6):761-4. DOI: <https://doi.org/10.1016/j.jamda.2023.01.029>.
7. Canova JCM. Parada cardiorrespiratória e rescucitação cardiopulmonar: viências da equipe de enfermagem de um hospital escola [Dissertação de Mestrado]. Universidade de São Paulo. Ribeirão Preto, 2012. Available from: <https://www.teses.usp.br/teses/disponiveis/22/22132/tde-15012013-143946/en.php>.
8. Getzen E, Ungar L, Mowery D, Jiang X, Long Q. Mining for equitable health: assessing the impact of missing data in electronic health records. *J Biom Inform.* 2023 [cited 2024 Mar 10]; 139:104269. DOI: <https://doi.org/10.1016/j.jbi.2022.104269>.
9. Malta M, Cardoso LO, Bastos FI, Magnanini MMF, Silva CMFP. STROBE initiative: guidelines on reporting observational studies. *Rev Saude Publica.* 2010 [cited 2022 Mar 25]; 44(3):559-65. DOI: <http://dx.doi.org/10.1590/S0034-89102010000300021>.
10. Avansi PA, Meneghin P. Tradução e Adaptação para língua portuguesa do In-Hospital Utstein Style. *Rev Esc Enferm USP.* 2007 [cited 2021 Oct 10]; 42(3):504-11. Available from: <https://www.scielo.br/j/reeusp/a/sr5NmCkLZZqtzmmgq5jBp/?lang=pt&format=pdf>.
11. Andersen LW, Holmberg MJ, Berg KM, Donnino MW, Granfeldt A. In-hospital cardiac arrest: a review. *JAMA.* 2019 [cited 2021 Nov 20]; 321(12):1200-10. DOI: <http://dx.doi.org/10.1001/jama.2019.1696>.
12. Benjamin EJ, Virani SS, Callaway CW, Chamberlay AM, Chang AR, Cheng S, et al. Heart disease and stroke statistics—2018 update: a report from the American Heart Association. *Circulation.* 2018 [cited 2021 Nov 20]; 137(12):e67-e492. DOI: <https://doi.org/10.1161/CIR.0000000000000558>.
13. Andersen LW, Kurth T, Chase M, Berg KM, Cocchi MN, Callaway C, Donnino MW. Early administration of epinephrine (adrenaline) in patients with cardiac arrest with initial shockable rhythm in hospital: propensity score matched analysis. *BMJ.* 2016 [cited 2021 Nov 20]; 6;353:i1577. DOI: <https://doi.org/10.1136/bmj.i1577>.

14. Legriel S, Bougouin W, Chocron R, Beganton F, Lamhaut L, Aissaoui N. Early in-hospital management of cardiac arrest from neurological cause: diagnostic pitfalls and treatment issues. *Resuscitation*. 2018 [cited 2021 Nov 20]; 132:147-55. DOI: <https://doi.org/10.1016/j.resuscitation.2018.08.004>.
15. Pina MA, Villén SR, Serrano JG, Rodríguez PM. Cardiopulmonary resuscitation during the Covid-19 pandemic in Spain. *Rev Esp Anestesiol Reanim (Engl Ed)*. 2021 [cited 2021 Nov 20]; 68(8):437-42. DOI: <https://doi.org/10.1016/j.redare.2021.09.001>.
16. Bengier JR, Kirby K., Black S, Brett SJ, Clout M, Lazaroo MJ, et al. Effect of a strategy of a supraglottic airway device vs tracheal intubation during out-of-hospital cardiac arrest on functional outcome. The AIRWAYS-2 Randomized Clinical Trial. *JAMA*. 2018 [cited 2021 Nov 20]; 320(8):779-91. DOI: <http://dx.doi.org/10.1001/jama.2018.11597>.
17. Joseph B, Sulmonte K, DeSanto-Madeya S, Koeniger-Donohue R, Cocchi, M. Improving accuracy in documenting cardiopulmonary arrest events. *Am J Nurs*. 2022 [cited 2024 Mar 10]; 122(4):40-5. DOI: <http://dx.doi.org/10.1097/01.NAJ.0000827332.60571.70>.
18. Huabbangyang T, Sangketchon C, Noimo G, Pinthong K, Saungun K, Bunta K, Saumok C. Using sodium bicarbonate during prolonged cardiopulmonary resuscitation in prehospital setting; a retrospective cross-sectional study. *Arch Acad Emerg Med*. 2023 [cited 2024 Mar 10]; 11(1):e41. DOI: <http://dx.doi.org/10.22037/aaem.v11i1.2002>.
19. Okubo M, Komukai S, Andersen LW, Berg RA, Kurz MC, Morrison LJ, et al. Duration of cardiopulmonary resuscitation and outcomes for adults with in-hospital cardiac arrest: retrospective cohort study. *BMJ*. 2024 [cited 2024 Mar 10]; 384:e076019 DOI: <http://dx.doi.org/10.1136/bmj-2023-076019>.
20. Greif R, Bhanji F, Bigham BL, Bray J, Breckwoldt J, Cheng A, et al. Education, implementation, and teams' collaborators. Education, Implementation, and Teams: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Circulation*. 2020 [cited 2024 Mar 10]; 142(suppl_1):S222-83. DOI: <http://dx.doi.org/10.1161/CIR.0000000000000896>.
21. Rohlin O, Taeri T, Netzereab S, Ullemark E, Djärv T. Duration of CPR and impact on 30-day survival after ROSC for in-hospital cardiac arrest: a Swedish cohort study. *Resuscitation*. 2018 [cited 2021 Nov 20]; 132:1-5. DOI: <https://doi.org/10.1016/j.resuscitation.2018.08.017>.
22. Starks MA, Dai D, Nichol G, Al-Khatib SM, Chan P, Bradley SM, Peterson ED. The association of duration of participation in get with the guidelines-resuscitation with quality of care for in-hospital cardiac arrest. *Am Heart J*. 2018 [cited 2021 Oct 11]; 204:156-62. DOI: <https://doi.org/10.1016/j.ahj.2018.04.018>.

Authors' contributions

Conceptualization, J.S.T. and D.D.L.; Methodology, J.S.T. and D.D.L.; Validation, J.S.T. and D.D.L.; Formal Analysis, J.S.T. and D.D.L.; Investigation, J.S.T. and D.D.L.; Resources, J.S.T. and D.D.L.; Data Curation, J.S.T. and D.D.L.; Manuscript Writing, J.S.T. and D.D.L.; Writing – Review and Editing, J.S.T., D.D.L., F.C.R., E.R.P.N. and N.U.M.; Visualization, J.S.T., D.D.L., F.C.R., E.R.P.N. and N.U.M.; Supervision, D.D.L.; Project Administration, D.D.L. All authors read and agreed with the published version of the manuscript.