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ORIGINAL

The impact of the COVID-19 pandemic on the management of acute coronary syndrome: a retrospective cohort study*

O efeito da pandemia por COVID-19 no atendimento da síndrome coronariana aguda: coorte retrospectiva

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ABSTRACT

Objective: To assess the impact of the COVID-19 pandemic on response times and clinical outcomes of acute coronary syndrome admissions. **Method:** Retrospective cohort study. Data were analyzed using SPSS version 20.0 with parametric and non-parametric tests for group comparisons. Generalized linear modeling was used for multivariate analysis. **Results:** 434 patients were included in the pre-pandemic period and 430 during the pandemic. Delta-t was higher during the pandemic period (p=0.003). There were no differences in response times and mortality. Admission during the pandemic period (RR 1.56; 95% CI: 1.30-1.87) and a previous diagnosis of ischemic heart disease (RR 1.82; 95% CI: 1.50-2.20) were associated with increased delta-t. **Conclusions:** There was no difference in the number of patients presenting to the emergency department with acute coronary syndrome during the periods analyzed. Despite longer Delta-t during the pandemic, no worse clinical outcomes were observed.

Descriptors: Acute Coronary Syndrome; COVID-19; Emergency Service, Hospital.

RESUMO

Objetivo: avaliar a contribuição da pandemia por COVID-19 sobre os tempos de atendimento e desfechos clínicos de admissões relacionadas à Síndrome Coronariana Aguda. **Método:** Coorte retrospectiva. Os dados foram analisados pelo SPSS, versão 20.0, empregados em testes paramétricos e não paramétricos para comparar os grupos. Aplicado o Modelo linear generalizado para análise multivariada. **Resultados:** Incluídos 434 pacientes no período pré-pandemia e 430 durante a pandemia. Delta-t foi maior no período durante a pandemia (p=0,003). Não encontramos diferença nos tempos de atendimento e mortalidade. Admissão no período da pandemia (RR1,56; IC95%:1,30-1,87) e ter diagnóstico de cardiopatia isquêmica prévio (RR1,82; IC95%:1,50-2,20) foram associados ao aumento do Delta-t. **Conclusão:** Não houve diferença no número de pacientes que acessou a emergência por Síndrome Coronariana Aguda nos períodos analisados. Apesar do Delta-t ter sido maior durante a pandemia, não foram observados piores desfechos clínicos.

Descritores: Síndrome Coronariana Aguda; COVID-19; Serviço Hospitalar de Emergência.

INTRODUCTION

The COVID-19 pandemic posed a significant challenge to healthcare systems worldwide and negatively impacted the standard of care for patients requiring urgent interventions[1]. The maintenance of emergency services, including hospital infrastructure, capacity, and

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the conditions of care provided by healthcare teams during the pandemic, was affected[2,3]. The recommendation by public health authorities that hospital care should be sought only in severe cases, coupled with the public's fear of virus exposure, may have affected the diagnosis, treatment, and prognosis of several other clinical conditions[1-3].

In acute coronary syndrome (ACS), timely percutaneous coronary intervention (PCI), appropriate emergency response times, and a door-to-balloon time of less than 90 minutes[4-7] reduce mortality. Early treatment of ACS results in fewer ventricular arrhythmias, less myocardial damage, lower reinfarction rates, and better preservation of ventricular function[8].

During the pandemic, there have been reports of increased time to medical care for ACS and increased complication and mortality rates [9-18]. The time to perform PCI was affected because of the need to modify care pathways to implement necessary biosafety measures against the coronavirus[1].

In southern Brazil, a public university hospital, already a reference for the care of ACS patients, became a reference for treating severe COVID-19 patients. Despite being responsible for treating approximately 50% of all severe cases in the state, the impact of COVID-19 on ACS patient care in this setting has not been described in the literature. In addition, data on the reorganization of emergency services and the description of response times during the pandemic are scarce.

Therefore, the present study aims to evaluate the impact of the COVID-19 pandemic on response times and clinical outcomes of acute coronary syndrome admissions to an emergency department.

METHOD

This is a retrospective cohort study conducted at the Emergency Department of a University Hospital in Southern Brazil, which serves as a reference for patients with ACS and has been designated as a COVID-19 treatment center since the beginning of the pandemic in 2020. Eligible participants were adults (aged >18 years) of both sexes who presented with chest pain and were diagnosed with ICD-10 code I21 (acute myocardial infarction) and its subcategories at any time during hospitalization between January 1, 2019, and August 20, 2021. For this study, the ongoing healthcare process due to COVID-19 was considered the primary exposure factor. Thus, patients treated between January 1, 2019, and March 17, 2020, constituted the unexposed group, while patients treated between March 18, 2020 (the date of the first recorded case in the hospital in question) and August 20, 2021, comprised the exposed group.

The data were derived from the institution's database and provided by the Information Technology Department based on criteria provided by the researchers. The dataset was delivered to the researchers in electronic spreadsheet format and sorted according to the variables they requested in the database query request (electronic database query report). In addition, the medical records of all patients were reviewed for records related to the time elapsed in the patient care process, which are routinely recorded by healthcare teams during patient care.

Descriptive analysis of continuous variables was preceded by an assessment of distributions using the Shapiro-Wilk test. Categorical variables were compared using chi-squared tests, and continuous variables were analyzed using the Mann-Whitney test. A generalized linear model (GLM) with gamma distribution was used to analyze the variables contributing to the increase in delta-t time since the delta-t variable has a positively skewed distribution. The study was ethically and methodologically approved (CAAE: 30797320.8.0000.5327).

RESULTS

From January 2019 to August 2021, 2,212 patients presented to the emergency department with complaints of chest pain and were assigned ICD-10 code I21 (Acute Myocardial Infarction and subchapters). Of these, 864 were diagnosed with ACS during that hospitalization and met eligibility criteria, with 434 in the pre-pandemic group and 430 in the pandemic group (Figure 1).

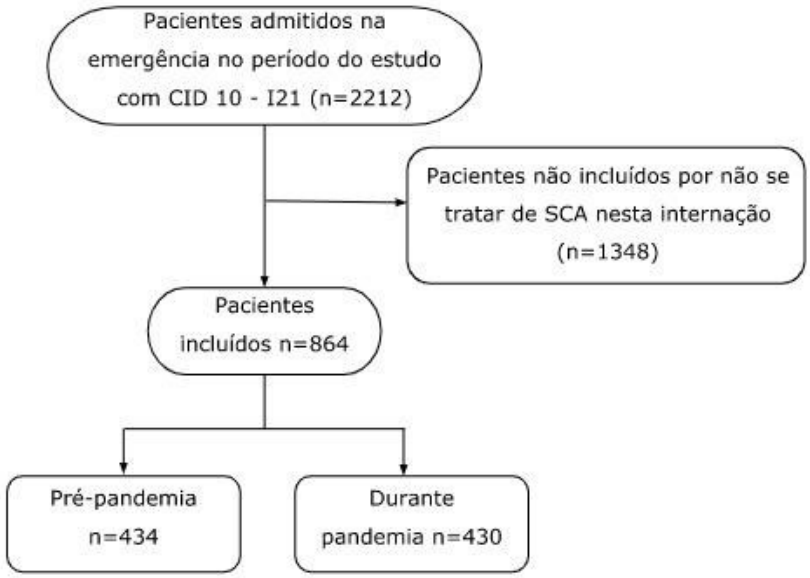

Figure 1 - Flowchart of the selection of patients for the study according to the eligibility criteria. Porto Alegre, RS, Brazil, 2022

The group of patients treated in the pre-pandemic period was similar to the group treated during the pandemic concerning age, sex, race, place of origin, pre-existing conditions, alcohol consumption, and smoking ($p > 0.05$ for all comparisons). However, they differed in risk stratification ($p < 0.001$) and type of ACS ($p = 0.023$). Regarding risk classification, many patients were not immediately classified during the pandemic. In contrast, more patients were classified as urgent and urgent during the pre-pandemic period. Regarding the type of ACS, ST-segment elevation myocardial infarction (STEMI) was more common in the pre-pandemic period. In contrast, non-ST-segment elevation ACS (NSTEMI) was more common during the pandemic (Table 1).

Table 1 - Comparison between patient characteristics in the pre-pandemic (n=434) and pandemic (n=430) periods. Data are expressed as mean±standard deviation or median (P25 - P75), absolute numbers (relative numbers), according to the characteristics of the variables. Porto Alegre, RS, Brazil, 2022

Variables	Pre-pandemic (n=434)	Pandemic	P-value
Sex, male	260 (59,9)	269 (62,6)	0,466 [q]
Age, years	64,8 ± 12,1	63,8 ± 11,7	0,619[q]
Marital status			0,326[q]
Married	227 (52,3)	212 (49,3)	
Single	108 (24,9)	117 (27,2)	
Divorced	27 (6,2)	26 (6,0)	
Separated	16 (3,7)	18 (4,2)	
Widowed	54 (12,4)	48 (11,2)	
Other	2 (0,5)	9 (2,1)	
Origin			0,279[q]
Porto Alegre	220 (50,7)	195 (45,3)	
Metropolitan region	132 (30,4)	148 (34,4)	

Variables	Pre-pandemic (n=434)	Pandemic	P-value
Interior of the state of RS	82 (18,9)	87 (20,2)	
Previous illnesses			
	SAH	35 (54,7)	55 (48,2)
	DM	18 (28,1)	29 (25,4)
Cancer	16 (25)	19 (16,7)	0,252[q]
COPD	6 (9,4)	11 (9,6)	1,000[q]
	CRF	13 (20,3)	13 (11,4)
	CHF	6 (9,4)	8 (7)
	IHD	6 (9,4)	9 (7,9)
Alcoholism			0,075[q]
No	390 (81,9)	365 (84,9)	
Yes	10 (2,3)	18 (4,2)	
Former alcoholic	34 (7,8)	47 (10,9)	
Tobacco use			0,508[q]
No	189 (43,5)	173 (40,2)	
Yes	143 (32,9)	143 (33,3)	
Former smoker	102 (23,5)	114 (26,5)	
Skin color (self-reported)			0,181 [q]
White	390 (89,9)	382 (88,8)	
Black	32 (7,4)	42 (9,8)	
Brown	12 (2,8)	6 (1,4)	
Risk classification using the MTS			**<0,001** [q]
No Classification*	17 (3,9)	89 (20,7)	
Emergency*	28 (6,5)	15 (3,5)	
Very Urgent*	368 (84,8)	309 (71,9)	
Urgent	21 (4,8)	16 (3,7)	
Less Urgent	0 (0)	1 (0,1)	
Type of ACS			**0,023** [q]
STEMI*	280 (64,5)	240 (55,8)	
NSTEMI*	120 (27,6)	155 (36,0)	
UA	34 (7,8)	35 (8,1)	

*Adjusted residuals showed differences in proportions between the periods. Categorical variables are expressed as n (%). Numeric variables are described as median (P25-P75). Tests used: MW (Mann-Whitney), q (Bivariate chi-square). Systemic Arterial Hypertension (SAH), Diabetes Mellitus (DM), Chronic Obstructive Pulmonary Disease (COPD), Chronic Renal Insufficiency (CRI), Ischemic Heart Disease (IHD), Manchester Triage System (MTS), Acute Coronary Syndrome (ACS), ST-segment Elevation Myocardial Infarction (STEMI), Non-ST-segment Elevation Acute Coronary Syndrome (NSTEMI), Unstable Angina (UA).

The median time, expressed in hours, from the onset of patient symptoms to arrival in the emergency department (Delta-t) was longer during the pandemic (7 hours vs. 10 hours; p = 0.003). The same trend was observed regarding the time in minutes between the patient's arrival in the emergency department and the medical consultation (13 vs. 16; p = 0.014) and the time in hours until the second ECG was recorded in the electronic medical record (1 hour and 16 minutes vs. 2 hours and 4 minutes; p < 0.001), both of which were longer during the pandemic. However, the median total time of care in the emergency department was similar between the two periods (p = 0.799) (Table 2).

Table 2 - Comparison between groups before (n=434) and during (n=430) the pandemic in terms of time taken for each stage of the care process for ACS patients in an emergency department. Porto Alegre, RS, Brazil, 2022

Variables	Pre-pandemic (n=434)	During-pandemic (n=430)	P-value
Delta-t hours	7 (4 – 24)	10 (4 – 48)	0,003[MW]
Arrival - welcome and 1st ECG (min:sec)	4:50 (2:05-10:24)	5:36 (1:06-13:24)	0,174 [MW]
Reception - medical consultation (min:sec)	6:57 (2:57-15:40)	7:27 (3:00-17:10)	0,414 [MW]
Arrival - medical consultation (min:sec)	13:39 (7:05-24:52)	16:24 (7:29-27:53)	0,014 [MW]
Arrival until 2nd ECG recorded in the electronic medical record (h:min)	1:16 (0:37-4:03)	2:04 (0:48-5:52)	<0,001 [MW]
Door-to-balloon time (n=642) (h:min)	1:12 (0:40-6:49) (n=327)	1:32 (0:53-9:41) (n=319)	0,097 [MW]
Total emergency care time (days)	6 (4,75 – 10)	6,5 (5 – 10)	0,799 [MW]

*Adjusted residuals indicate a difference in proportions between periods. Numerical variables are described as medians (P25-P75). MW (Mann-Whitney) was used. Electrocardiogram (ECG)

The mean delta-t was significantly greater in the during-pandemic group compared with the pre-pandemic group (model 1, unadjusted). The time difference was maintained when the mean delta-t was adjusted for confounders (clinical and sociodemographic characteristics). In the models tested, the mean difference ranged from approximately 7 to 11 hours and was consistently greater during the pandemic (Table 3).

Table 3 – Comparison between Delta-t means in the pre-pandemic (n=434) and pandemic (n=430) groups, Porto Alegre, RS, Brazil, 2022

Models	Pre-COVID	During COVID	P-value[¥]
Model 1	20,491	28,886	<0,001
Model 2	19,936	30,878	<0,001
Model 3	18,683	29,598	0,000
Model 4	13,061	20,462	0,002

Generalized linear model with gamma distribution for the outcome delta-t hours

Model 1: Group variable (pre-pandemic or during pandemic)

Model 2: Model 1 + SAH+ IHD+ CHF + CA

Model 3: Model 1 + Model 2 + DM + dyslipidemia + alcoholism + smoking + CKD

Model 4: Model 1 + Model 2 + Model 3 + education + race + marital status + place of origin

Indeed, when modeling was conducted by including all clinical and sociodemographic variables, the only factors that independently contributed to the increase in the mean Delta-t were receiving emergency care during the pandemic period (RR 1.56; 95% CI: 1.30-1.87) and having a previous diagnosis of ischemic heart disease (RR 1.82; 95% CI: 1.50-2.20) (Table 4).

Table 4 - Model 1 for identifying variables associated with increased Delta-t time. Porto Alegre, RS, Brazil, 2022

Variables	Crude RR (95% CI)	Adjusted RR (95% CI)
Período COVID	1,41 (1,17-1,70)	1,56 (1,30-1,87)
IHD	1,70 (1,40-2,05)	1,82 (1,50-2,20)

RR: relative risk; 95%CI: confidence interval; IHD: ischemic heart disease.

Regarding the clinical course, more patients were admitted to the intensive care unit (ICU) during the pandemic (15.8% vs. 10.8%; p = 0.004). Although the proportion of patients on mechanical ventilation (MV) was similar between groups, the median number of days on MV was longer during the pandemic (2.2 vs. 4.1; p = 0.031). There were no differences between the periods (p > 0.05 for all comparisons) in the mode of discharge from the emergency department, use of other life-support devices, interventions, or in-hospital mortality (Table 3). Approximately 10% of patients died during hospitalization, with a similar proportion in both periods (p = 0.854), as shown in Table 5.

Table 5 - Comparison between pre-pandemic (n=434) and during-pandemic (n=430) groups regarding the mode of discharge from the emergency department, interventions performed, use of life support devices, ICU admission, ICU length of stay, hospitalization time, and in-hospital mortality. Porto Alegre, RS, Brazil, 2022

Variables	Pre-pandemic (n=434)	During-pandemic (n=430)	P-value
Discharge from the emergency department			0,879[q]
Discharge from the emergency department	48 (11,1)	50 (11,7)	
Death in the emergency department	3 (0,7)	4 (0,9)	
Internal transfer	383 (88,2)	373 (87,4)	0,753[q]
Percutaneous Coronary Intervention (PCI)	327(75,3)	319(74,2)	1,000[q]
Intra-Aortic Balloon Pump (IABP)	9(2,1)	8(1,0)	0,372[q]
Extracorporeal Membrane Oxygenation (ECMO)	1(0,2)	3(0,7)	0,968[q]
Mechanical Ventilation (MV)	64(14,7)	62(14,4)	**0,031**[MW]
Duration of MV (days)	2,2 (1,6-5,8)	4,1(2-8,3)	0,366[q]
Coronary Artery Bypass Grafting (CABG)	18(4,1)	12(2,8)	**0,004**[q]
Intensive Care Unit (ICU)	47(10,8)	68(15,8)	0,973[MW]
Duration of ICU stay (days)	4(3-7)	4(2-11)	0,127[MW]
Hospitalization days	5,9(4,4-9,5)	6,5(4,6-10,3)	0,854[q]
In-hospital mortality	**44(10,1)**	**41(9,5)**	

Categorical variables are expressed as n (%). Numeric variables are described as median (P25-P75). Mann-Whitney (MW) and bivariate chi-square (q) tests were used. Percutaneous Coronary Intervention (PCI), Intra-Aortic Balloon Pump (IABP), Extracorporeal Membrane Oxygenation (ECMO), Coronary Artery Bypass Grafting (CABG), Intensive Care Unit (ICU), Mechanical Ventilation (MV)

DISCUSSION

This article aimed to evaluate the impact of the COVID-19 pandemic on response times and clinical outcomes of admissions related to ACS in an emergency department. There was no difference in the number of ACS admissions during the studied periods and in the number of interventions performed in the hospital. During the pandemic, there was an increase in the time elapsed from the onset of the patient's symptoms to their arrival at the hospital, but not in the emergency department's response time or in-hospital mortality, either in the emergency department or during hospitalization.

The treatment of ACS in healthcare systems worldwide was affected by the COVID-19 pandemic[1-3]. Initially, early findings described a reduction in admissions, the performance of percutaneous coronary intervention (PCI), and an increase in ischemia time and door-to-balloon time[2,5,9-10,12,15].

Similarly to a study conducted in Canada[24], this study did not find a difference in the number of ACS admissions in the pre-pandemic and during-pandemic periods. These findings contrast with the international literature, as several authors[20-22,26,27] reported a significant reduction, especially in admissions for ST-segment elevation myocardial infarction (STEMI), highlighting a cohort study conducted in France that reported a 73% reduction in ACS admissions[28]. Data collected from 15 European centers showed a reduction in admissions for STEMI 0.78 (0.68-0.89), $p < 0.001$, non-ST-segment elevation ACS (NSTEMI) 0.56 (0.50-0.64), $p < 0.0001$, and unstable angina (UA) 0.79 (0.66-0.94), $p < 0.01$, after the onset of the pandemic. It was also observed that patients admitted for ACS during the pandemic were younger, indicating that in the pre-pandemic period, a greater number of patients aged ≥ 65 years were admitted for ACS ($p < 0.001$), which was not demonstrated in the present cohort.

In a hospital in northeastern Brazil, a 45% reduction in the daily number of emergency department visits for ACS was reported[29]; however, similar to our study, there was no difference in the number of primary PCIs performed.

A study conducted in China with patients suffering from STEMI found an increase in the time from symptom onset to seeking pre-hospital care (68 [56.5–90 min] vs. 60 [47–78 min]; $p = 0.023$), door-to-balloon time (76.5 [65.25–85 min] vs. 50 [40-60 min]; $p = 0.000$), and total ischemia time (185 [165.25-210.25 min] vs. 150 [131-174 min]; $p = 0.000$). Furthermore, mortality was significantly higher during the pandemic ($p = 0.000$) (30). In contrast, Little et al.[27] argued that the pandemic did not impact the total ischemia time until PCI in London[27]. In Japan, there was a significant increase in the incidence of late presentations ($p = 0.001$) in the emergency department, as well as a significant increase in mechanical complications during angioplasty ($p < 0.001$) and a significant reduction in the number of PCIs ($p = 0.009$)[31]. No difference in the number of deaths between the periods was observed, a finding that aligns with the results demonstrated in our study.

Regarding Delta-t, the time was longer during the pandemic ($p = 0.003$), consistent with cohort findings in Poland, Italy, China, Turkey, Japan, and Australia[20,23,25,32,33]. In other locations, the pandemic did not affect Delta-t, as found in studies in New York, France, Germany, and Switzerland[5,19,21,34,35]. The longer time to seek care after the onset of symptoms can be attributed to the health authorities' recommendation that hospital care be sought only in severe cases, combined with the fear of exposure to the coronavirus[21].

Having a previously diagnosed ischemic heart disease before the current hospitalization and receiving care during the COVID period was associated with an increase in the time to seek emergency care. However, this increased time did not result in worse immediate hospital clinical outcomes. In addition to the recommendations to seek healthcare only in severe cases, the literature reports that Black race, low income, and diabetes mellitus are predictors of delayed presentation to emergency services. However, having a history of prior heart disease is one of the factors that encourages patients to seek care more promptly[36]. This underscores the need for healthcare professionals to educate patients and their families to quickly identify typical and atypical signs and symptoms and treat such situations as suspected new ACS events.

In this study, the times at each stage of care after entering the emergency department were higher during the pandemic, although without statistical significance. The pandemic necessitated reallocating human resources and materials and reorganizing work processes. New teams were formed, consisting of newly hired professionals, many with little training. Medical teams were merged, with specialists from other medical disciplines, not just emergency and clinical specialists, being assigned to emergency

shifts due to the volume of simultaneous patients and increased overcrowding, as the studied institution was a reference for COVID-19 care in the state and the country. On the other hand, despite the increase in absolute numbers, we did not find a difference in the number of PCIs performed, the use of devices such as IABP, ECMO, and the number of deaths in our study. This can be attributed to the fact that the emergency department is a reference and has a well-established protocol for treating ACS patients. Furthermore, the physical areas and care teams during the pandemic were reorganized and optimized to maintain the quality of care for patients with other comorbidities who required urgent care, such as ACS.

This is a single-center study in which the variables evaluated were collected from electronic medical records, which means they depend on the records made by healthcare professionals. Emergency department records, especially in crowded facilities with critically ill patients, are sometimes incomplete, emphasizing brief and specific information about the patient's condition at arrival. This can make it difficult for researchers to retrieve data from medical records. In this study, unlike others previously published, we described the time from symptom onset to hospital arrival, the time from hospital arrival to initial assessment and first ECG performed by a nurse, the time from initial assessment to medical consultation, and the time from hospital arrival to medical consultation. In addition, we compared delta-t and door-to-balloon time, which have been previously described in studies from different countries[19-25].

This is the first study to compare all phases of emergency care before and during the pandemic, allowing us to identify the process phases that may have been affected during this significant global event. We can inform resource management strategies to improve care during future crises by documenting these changes.

This study provides insight into response times for ACS patients and compares groups during the pandemic, allowing us to observe how a critical event of this magnitude affected timely care. It underscores the importance of studies like this that can help inform healthcare management strategies to promote appropriate care even in critical situations.

CONCLUSION

The number of patients who accessed the emergency department for ACS during the analyzed periods was the same.

Small differences were identified in the other intra-hospital response times that make up the total time from the patient's arrival in the emergency department to the specific intervention for ACS. These differences did not impact immediate hospital clinical outcomes.

CONFLICT OF INTERESTS

The authors have declared that there is no conflict of interests.

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