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Original Article

Acute coronary syndrome in a hospital in southern Brazil: peak of hospitalizations on Mondays and severe cases on weekends and at night

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Abstract: Introduction: Ischemic heart disease is the leading cause of death in Brazil and worldwide. The term acute coronary syndrome (ACS) generically represents the acute myocardial ischemic events. These events are clinically divided into three types: acute myocardial infarction (AMI) with ST-segment elevation, AMI without ST-segment elevation, and unstable angina. Although cardiovascular ischemic events occur acutely, studies describe cyclic patterns of ACS, mainly on circadian and weekly variation. Objective: The aim of this study was to analyze the circadian and weekly variation of hospitalizations for ACS in a hospital in southern Brazil in 2019. Methods: Observational, cross-sectional type study. The population was the patients hospitalized at the Nossa Senhora da Conceição Hospital (NSCH) in Tubarão (SC, Brazil) with the international classification of diseases (ICD) code referring to ACS in the year 2019, corresponding to 579 patients. Results: After applying the exclusion criteria, 512 patients hospitalized for ACS were analyzed, 55.1% were male with a median (p25-p75) age of 62.0 (56.0-69.0) years. The main ICDs of hospitalization were: I20.0 (76.2%), I21.9 (16.6%), I21.3 (3.1%) and the most prevalent comorbidities were high blood pressure (82.6%), diabetes (30.1%) and previous AMI (23.6%). The median (p25-p75) time of admission was 14 h (10-18) h and length of stay was 5 (3-9) days. Death occurred in 18 hospitalizations (3.5%) of cases. Conclusion: We conclude that in the present study there was a peak of hospitalizations for ACS on Mondays, proportionally reducing throughout the week and with a significant decrease on the weekend.

Keywords: Acute coronary syndrome, myocardial infarction, angina unstable, hospitalization, circadian rhythm

Introduction

According to data from the World Health Organization (WHO), ischemic heart disease is the leading cause of death worldwide, and it is estimated that over 7 million people die annually due to ischemic syndromes [1]. In Brazil, acute coronary heart disease is also the leading cause of death, accounting for 31% of deaths within the group of cardiovascular diseases and represents a large share of hospitalizations in the public health system [2]. Data from the unified health system (UHS) show that in the year 2019, 288,671 hospitalizations for acute coronary syndrome were recorded in the country [3].

The term acute coronary syndrome (ACS) generically represents the acute myocardial ischemic events, situations in which the patient presents clinical and/or laboratory evidence of myocardial necrosis, with the instability of an atherosclerotic plaque as the main cause. The clinical manifestation, in most cases, is ischemic chest pain described as angina pectoris. When acute myocardial infarction occurs, there is an elevation of biomarkers of myocardial necrosis such as creatine kinase MB isoenzyme (CK-MB) and troponins, especially troponin T and I. These events present in two clinical forms according to electrocardiographic patterns: with ST-segment elevation (STEMI), also called acute myocardial infarction with supra-ST-segment elevation (STEMI), and the non-ST-segment elevation (non-ST-segment elevation myocardial infarction (STEMI) form), which is subdivided into unstable angina (UA) and acute myocardial infarction without supra-ST-segment elevation (STEMI) [4].

Although cardiovascular ischemic events occur acutely, affecting their victims suddenly, some

studies describe cyclic patterns of ACS. Among them, seasonal, weekly, and circadian aspects can be highlighted [5-8]. Several possible triggers have been studied, from hormonal fluctuations [5], climatic factors and the adrenergic activation, such as in stressful situations [6]. However, most studies are related to the circadian and weekly variation of cardiovascular events [7, 8].

A few cardiac functions, related to the pathogenesis of ischemic heart disease, are influenced by the circadian rhythm, mainly by the diurnal variation in autonomic nervous system activity. In the early morning, there is an increase in systolic blood pressure and heart rate, which results in an increased demand for oxygen by the heart. On the other hand, in the early hours of the day, the vascular tone of the coronary artery tends to increase, and coronary blood flow decreases. This mismatch between oxygen demand and supply in the morning is related to the onset of ACS symptoms [9].

As for the weekly variation, there is a peak incidence of coronary events on Mondays [10]. The reason is not well known yet, but studies relate it to the excessive consumption of alcoholic beverages on weekends. Alcohol seems to be able to cause cardiac arrhythmias in healthy people, a fact that is described by researchers as “Holiday Heart Syndrome” [11].

The fact that ACS has a higher incidence on Mondays and during the morning hours seems to be well established in the medical literature, but there are few studies correlating this data with intrinsic and extrinsic risk factors of patients, such as gender, age, and associated comorbidities.

Information on the circadian and weekly variation of ACS may be useful for planning the care of these patients, besides contributing to a better epidemiological understanding of acute cardiovascular ischemic events. Therefore, the present study has the proposal to analyze the circadian and weekly variation of hospitalizations for acute coronary syndrome, characterizing clinical and sociodemographic aspects of patients admitted to a tertiary care hospital in southern Brazil in the year 2019.

Methods

This is an observational, analytical cross-sectional study. The target population of this study was the patients hospitalized at Nossa Senhora da Conceição Hospital (NSCH) for ACS between January 1, 2019 and December 31, 2019, corresponding to 579 patients. There was no sample selection, it was contemplated the universe of subjects selected within the inclusion and exclusion criteria.

Inclusion criteria

To obtain the sample, the inclusion criteria were defined as patients hospitalized at the NSCH of Tubarão (SC, Brazil) between January 1, 2019 and December 31, 2019 with international classification of diseases (ICD) code corresponding to acute coronary syndromes: I20.0, I20.1, I21.0, I21.1, I21.2, I21.3, I21.4, I21.9, I22.0, I22.1, I22.8, I22.9, I23.0, I23.1, I23.2, I23.3, I23.4, I23.5, I23.6, I23.8, I24.0, I24.8, and I24.9.

Exclusion criteria

Patients whose medical record data had incomplete variables related to the research outcome, patients who were transferred to another hospital or who escaped before the case outcome, patients who were admitted electively for catheterization, and patients who did not confirm ACS after hospital admission were excluded from the present study.

Data collection

Data were obtained from the Philips Tasy electronic medical record of patients hospitalized at NSCH in the year 2019 and diagnosed with ACS. The indicators used to study the daily rhythm and the weekly rhythm of patients with ACS were the time of day of hospitalization: [morning (06-11:59 h), afternoon (12-17:59 h), and evening (18-05:59 h)], and the day of week of hospitalization: Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday.

Variables

The dependent variables were:

- Type of ACS: unstable angina (UA); non-ST-elevation myocardial infarction (NSTEMI) and ST-elevation myocardial infarction (STEMI).

- Outcome: hospital discharge or death.

The independent variables were:

- Socio-demographic data: gender and age.

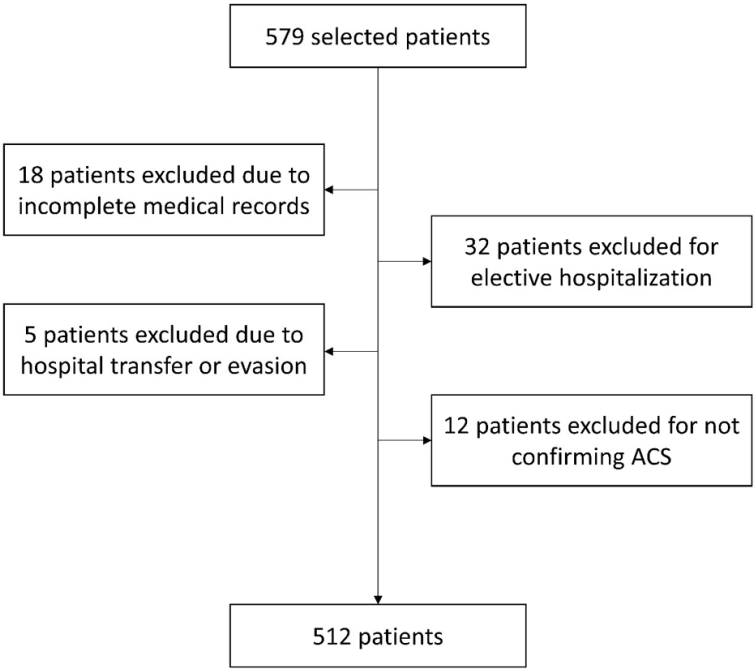

Figure 1. Flowchart of the research exclusion criteria. ACS: acute coronary syndrome.

- ICD10 (I20.0, I20.1, I21.0, I21.1, I21.2, I21.3, I21.4, I21.9, I22.0, I22.1, I22.8, I22.9, I23.0, I23.1, I23.2, I23.3, I23.4, I23.5, I23.6, I23.8, I24.0, I24.8, and I24.9).

- Comorbidities: previous acute myocardial infarction (AMI), high blood pressure (HBP) and diabetes.

- Time of day of hospitalization: [morning (06-11:59 h), afternoon (12-17:59 h), and evening (18-05:59 h)].

- Day of week of hospitalization: Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday.

- Length of stay.

- Therapeutic approach: coronary artery bypass graft (CABG), angioplasty, and clinical treatment.

Ethical statement

The present project was approved by the Research Ethics Committee of University of South of Santa Catarina (UNISUL, Tubarão, SC, Brazil) opinion 4.477.757 on 20/12/2020.

Data analysis

The data were stored in a database created with the help of Microsoft Excel software and were later exported to SPSS 20.0® software. The data were presented as absolute numbers and percentages, measures of central tendency and dispersion. Variables were compared in relation to the outcomes time and weekly day of hospitalization by the chi-square test, using the adjusted standardized residual when necessary. A confidence interval of 95% was considered, with a statistical significance level of 5%.

Results

Sample selection

According to the proposed methodology, 579 participants were initially selected. **Figure 1** shows the inclusion and exclusion of patients from the study.

Epidemiological profile of the sample

We analyzed 512 patients hospitalized for ACS in the year 2019 at the Nossa Senhora da Conceição Hospital, in Tubarão (SC, Brazil), and 55.1% were male with a median (p25-p75) age of 62.0 (56.0-69.0) years. The main ICDs of hospitalization were: I20.0 (76.2%), I21.9 (16.6%), I21.3 (3.1%) and the most prevalent comorbidities were HBP (82.6%), Diabetes (30.1%), superimposition of HBP and Diabetes (29.5%) and previous AMI (23.6%). The median (p25-p75) time of admission was 14 (10-18) h and length of stay was 5 (3-9) days. Death occurred in 18 hospitalizations (3.5%) of cases.

Comparison of circadian and weekly variation in hospitalizations with ACS

The days of the weeks and the time of day are shown in **Table 1**. Acute coronary syndromes were divided into three subgroups: Unstable Angina (UA); non-ST-elevation myocardial in-

Table 1. Circadian and weekly variation of hospitalizations for acute coronary syndrome

			UA	NSTEMI	STEMI	p
Days of the week	n	%	n (%)	n (%)	n (%)	
Sunday	24	4.7	12 (3.2)#	3 (6.1)	9 (10.6)*	<0.001
Monday	179	35	150 (39.7)*	13 (26.5)	16 (18.8)#	
Tuesday	110	21.5	88 (23.3)	6 (12.2)	16 (18.8)	
Wednesday	68	13.6	47 (12.4)	11 (22.4)*	10 (11.8)	
Thursday	62	12.1	42 (11.1)	6 (12.2)	14 (16.5)	
Friday	49	9.6	31 (8.2)	7 (14.3)	11 (12.9)	
Saturday	20	3.9	8 (2.1)#	3 (6.1)	9 (10.6)*	
Time of day						
Morning	177	34.6	156 (41.3)*	9 (18.4)#	12 (14.1)#	<0.001
Afternoon	180	35.2	136 (36)	16 (32.7)	28 (32.9)	
Night	155	30.3	86 (22.8)#	24 (49)*	45 (52.9)*	

*Adjusted standardized residual >1.96; #Adjusted standardized residual <-1.96; UA: unstable angina; NSTEMI: non-ST-elevation myocardial infarction; STEMI: ST-elevation myocardial infarction.

farction (NSTEMI) and ST-elevation myocardial infarction (STEMI). Statistical differences were found regarding circadian and weekly variation in hospitalizations.

Comparison of outcome with ACS, day and period of hospitalization

Among the 18 deaths reported in the study, 15 occurred in the group admitted for AMI and only 3 in the group with unstable angina. Thus, a mortality of 12.29% was observed in the group of patients with Infarction. As for the day of the week and period of hospital admission in which more deaths occurred, there was statistical significance only in the day period, and most deaths from acute myocardial infarction occurred in admissions during the night period, as shown in **Table 2**.

Discussion

The main findings of this study show a peak of hospitalizations for ACS on Mondays; however, the most severe cases occurred on weekends and at night.

The sample of this study consisted mostly of patients aged between 56 and 69 years, with an average of 62 years, mostly men. The mean age found was similar in the studies consulted, such as that of López Messa et al. [12] in which the mean age was 69.9 years and of LaBounty et al. [13] who obtained a mean age of 64 years. Corroborating with these data, large ecological studies point to age over 60 years as a risk factor for acute coronary syndromes [14, 15].

In all consulted studies there was a predominance of males, which, like age, is a non-modifiable cardiovascular risk factor. Men have a higher risk of developing cardiovascular diseases than women at any age, and this risk worsens with aging [16, 17].

The comorbidities analyzed in our study were previous AMI, hypertension, and diabetes. HBP is the most prevalent cardiovascular risk factor worldwide for thromboembolic phenomena. Together with diabetes, they are considered the most important cardiovascular risk factors, and when they are associated in the same patient, they potentiate the damage at vascular level, affecting mainly the renal, cerebral, and cardiac systems [18].

A large percentage of the population presents HBP and diabetes simultaneously. In this study, a prevalence of 82.6% of patients with hypertension was found, and of these, 29.5% are also diabetics. In the study by Macedo & Ferreira [19], a prevalence of 20.41% of hypertensive patients with diabetes was found. These results are similar with the data from the Framingham Heart Study [20], which pioneered the subject, aiming to identify the epidemiology and risk factors for cardiovascular diseases, and with the INTERHEART study [21], an international, standardized, case-control study designed as an initial step to assess the importance of risk factors for heart disease worldwide.

Increased sympathetic activity in the morning causes variations in hemodynamic responses, including blood pressure, heart rate, blood flow, fibrinogen concentration, and coagulation factors. All these factors contribute to platelet aggregation [22]. Although several studies have reported a higher prevalence of AMI in the morning, between 6:00 a.m. and 12:00 p.m.

Table 2. Outcome according to type of acute coronary syndrome, day and period of hospitalization

	Discharge	Death	p
Type ACS	n (%)	n (%)	
UA	376 (76.1)*	2 (11.1)#	<0.001
NSTEMI	48 (9.7)	1 (5.6)	
STEMI	70 (14.2)#	15 (83.3)*	
Weekdays			
Sunday	21 (4.3)#	3 (16.7)*	0.016
Monday	176 (35.6)	3 (16.7)	
Tuesday	106 (21.5)	4 (22.2)	
Wednesday	66 (13.4)	2 (11.1)	
Thursday	60 (12.1)	2 (11.1)	
Friday	48 (9.7)	1 (5.5)	
Saturday	17 (3.4)#	3 (16.7)*	
Time of day			
Morning	177 (35.8)*	0 (0)#	0.004
Afternoon	172 (34.8)	8 (44.4)	
Night	145 (29.4)#	10 (55.6)*	

*Adjusted standardized residual >1.96; #Adjusted standardized residual <-1.96; ACS: acute coronary syndrome; UA: unstable angina; NSTEMI: non-ST-elevation myocardial infarction; STEMI: ST-elevation myocardial infarction.

[23, 24], this study showed only higher rates of hospitalization for unstable angina in the morning and AMI in the evening period. The review by Virag & Lust [22], which points out the circadian influences on myocardial infarction, corroborates with this finding, indicating that the most severe cases of AMI and sudden death may occur at night. The possible explanation for this result would be due to ethnicity or post-labor issues.

As for the day of the week of admission, the results are in line with large studies in medical literature [25, 26]. AMI represents a clinical emergency, requiring medical care as soon as possible. Once the infarction is confirmed, the management is usually hospitalization, which will take place within a few hours after the onset of symptoms, in most cases, the same day of onset. Therefore, the weekly distribution of hospitalizations corresponds to the distribution of the occurrence of infarction cases [26].

On the other hand, in Unstable Angina, despite being an acute coronary syndrome, it does not present imminent risk of death, many times the patients are hospitalized without emergency status [27]. Therefore, it is important to distinguish acute coronary syndrome for better interpretation of the study.

Thus understood, the findings of the present study present great coincidence with those described in literature about the weekly distribution of infarction. The weekly variation of hospitalizations for ACS showed a peak pattern on Mondays (21.6%) and gradual reduction on the following days of the week: Tuesdays (16.4%), Wednesdays (15.6%), Thursdays (14.9%), Fridays (13.4%). There was a sharp drop at the weekend, with 8.9% on Saturday and 8.9% on Sunday. This uneven distribution throughout the week is statistically significant. In the study by Rocha et al. [14] a similar proportion was found, with 19.3% of hospitalizations occurring on Monday, and with a lower rate on weekends, 8.2% on Saturday and 8.6% on Sunday.

As an answer to this pattern of hospitalizations some hypotheses may be questioned. These results may reflect the cultural work pattern of our society, in which people do not work on Saturdays and Sundays, also reflecting in the hospital environment, with fewer attending physicians and trained professionals on weekends. On the other hand, on Mondays and Tuesdays, there is a preference to hospitalize patients to complete treatment and discharge them before the weekend [12]. Corroborating this hypothesis, the results of this study, as well as the work of Vieira Musse et al. [28] found a mean length of stay of 5 days for patients admitted with ACS, thus, admitting patients with ACS on Mondays is more likely to be discharged by Friday.

In addition, another hypothesis for the results is explained by alcohol intake on weekends. There is a large study on the subject Holiday Heart Syndrome [11]. On holidays and weekends, it is common for people to consume more alcoholic beverages, associated with the fact that alcohol is a trigger for arrhythmia episodes, it is suggestive that patients with coronary artery disease increase the chance of thromboembolic events in the days following ingestion [29].

As for the outcomes of hospitalizations, 18 patients died after hospital admission, which represents (3.5%) of the cases. Among these,

16 occurred in the group admitted for AMI and only 2 in the group with unstable angina. Thus, a mortality rate of 11.94% was observed in the group of patients with Infarction and 0.5% in the patients with unstable angina. According to Lima Silva et al. (2018), in an ecological study on mortality trend in patients with ACS undergoing emergency CABG procedures in Brazil, an average of 4.14 deaths were found for every 100 CABG or angioplasty procedures, similar to the present study. One of the explanations for a slightly higher percentage is that in the present study, patients undergoing clinical treatment were also considered; they did not undergo any surgical or hemodynamic intervention.

When comparing the outcomes with the days and times of hospitalization, after calculating the adjusted standardized residual, the results were similar to studies reporting higher mortality of patients on weekends, possibly due to the lower rate of invasive procedures performed on these days [30]. As for the time of hospitalization, a slightly higher mortality rate was reported for patients who were admitted at night, of the 18 deaths, 10 (55.5%) were hospitalizations during the night and early morning hours.

The shortcomings of this study are related to the retrospective characteristic, falling into biases as to the fidelity of the records in medical records of the study variables. In addition, the sample size was small compared to other retrospective studies on the subject, especially regarding the number of patients with Acute Myocardial Infarction [12, 13].

Conclusion

According to the results, it is concluded that in the present study there was a peak of hospitalizations for acute coronary syndrome on Mondays, reducing proportionally throughout the week and with a significant drop at the weekend. As for circadian variation, there was no statistical significance in the present study. A mortality rate of 3.5% was found among all patients with ACS and of 11.94% of infarcted patients, being higher in hospitalizations that occurred on the weekend and at night.

Emergency medical services can consider the weekday pattern of acute coronary syndromes to adapt emergency medical care according to the weekly incidence. In addition, further studies with larger samples and in other institutions are suggested to allow comparisons between regions and inferences for the general population.

Disclosure of conflict of interest

None.

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