ORIGINAL ARTICLE

Risk Stratification in Chest Pain: Impact on the Diagnosis of Acute Coronary Syndrome

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Abstract

Background: The implementation of institutional protocols in the emergency department (ED) for risk stratification in patients with chest pain has been recommended.

Objective: To assess the sensitivity, specificity and predictive value of an institutional risk stratification protocol for chest pain suggestive of acute coronary syndrome (ACS).

Method: Cross-sectional study conducted based on the computerized records of patients treated with the use of a chest pain protocol adapted from the Manchester protocol. The level of risk was stratified by applying five colors representing the respective levels. Each color represents a level of severity and a maximum waiting time for receiving medical care. Red and orange were considered to be high priority, while patients with yellow, green or blue indications were considered to represent a low priority. To compare the type of diagnosis and the classification of priority for receiving care, the Pearson's chi-square test was used, considering a significance level of $p< 0.05$ for all tests.

Results: The records of 1,074 patients admitted to the cardiology ED were analyzed. Men (54%), with a mean age of 60 ± 15 years, with complaints of chest pain (44%) of moderate intensity (80%) were predominant the study. Of these patients, 19% were classified as high priority, while 81% were considered to represent a low priority. ACS was confirmed in 23% of the patients, with 34% of them being classified as high priority and 66% as low priority. The sensitivity of the risk stratification protocol for chest pain was 33.7% and the specificity was 86.0%, with a positive and negative predictive value of 41.7% and 81.3%, respectively.

Conclusion: The Institutional risk stratification protocol for chest pain suggestive of ACS presented satisfactory specificity and a low degree of sensitivity. Int J Cardiovasc Sci. 2020; [online].ahead print, PP.0-0

Keywords: Chest Pain; Acute Coronary Syndrome; Risk Factors; Risk Assessment; Sensitivity and Specifity; Emergency Medical Services.

Introduction

Chest pain is mentioned as one of the main complaints reported by patients admitted to the Emergency Department (ED). The demand for providing care to patients with cardiac chest pain is related to the significant impact that heart diseases have on the world population, as they are considered to be the leading cause of death in Brazil and worldwide.[1]

In order to meet this demand, a triage scale was created, in these departments, based on the guidelines established by the National Humanization Policy (*PNH - Política Nacional de Humanização*) and QualiSUS. These determinations include the implementation of a patient classification screening and/or triage service in the ED,[2] pursuant to the law published by the Ministry of Health under Ordinance GM/MS No. 2048/2002.[3]

In general, applying scales/protocols that stratify the risk across five levels has been recommended, as this offers improved creditability, validity and reliability in the assessment of the patient's clinical status.[4,5] Institutional protocols can be developed using the

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expertise of the healthcare practitioners of the institution. Besides, there is a recommendation from the Ministry of Health indicating that flowcharts should be structured based on those found in the literature and adapted to the service profile and its context in terms of the respective healthcare network.[6]

When receiving patients with chest pain in the ED, the health care professional responsible for patient screening should be aware of the referenced clinical signs and symptoms. An appropriate clinical examination and early diagnosis assist in the classification of the respective risk for patients with acute coronary syndrome (ACS), making healthcare faster.[7] Although chest pain is indicative of priority, aspects such as intense patient flow, delays in performing the supplemental exams and delays in obtaining a definitive diagnosis directly influence the promptness and accuracy of the care provided.

Based on this context, this study aimed to assess the sensitivity, specificity and predictive value of an institutional risk stratification protocol for chest pain suggestive of ACS.

Methods

Study Design and Population

This is a cross-sectional study conducted with patients consecutively treated for complaints of chest pain in a cardiology ED in southern Brazil, from October to December 2017. Patients admitted to the ED with a confirmed diagnosis of ST-Segment Elevation Acute Myocardial Infarction (STEMI), referred from other institutions or by ambulance transport, were excluded.

Scenario

The study was conducted based on the computerized records completed by the healthcare team at the time of admission. The ED provides public and/or private care to an average of 1,800 patients/month. Whereby, 18-20% of these patients have complaints involving chest pain. The respective Hemodynamics Laboratory is available 24 hours a day for myocardial reperfusion cases.

Logistics of the Service Protocol

The chest pain protocol used in the Institution's ED (Figure 1) is developed based on the Manchester protocol[8] and on the recommendations of the Welcome with Risk Classification of the National Humanization Program of the SUS (Brazilian Unified Health System).[2] This protocol has been in force since June 2013.

During the triage screening process, a nurse performs the triage oriented towards the main complaint, in which the patient is asked about signs and symptoms, onset, personal history, medications used and allergies. Airway patency, the presence of ventilation and pulse, as well as the identification of conditions that imply imminent risk of death are also assessed. Patients who present with the complaint of chest pain are referred for an electrocardiogram (ECG). Afterwards, the medical team assesses the patient and the indicated therapy is implemented.

The risk stratification is represented by five color-coded levels. Each color represents a severity level and a maximum waiting time for receiving medical care (Figure 2). In this study, red (immediate) and orange (very urgent) were considered to be high priority, while patients with yellow (urgent), green (standard) or blue (non-urgent) indications were considered to represent a low priority. Based on the recommendations of the American Heart Association,[9] this protocol was defined as being positive when the patient was classified as a high priority.

Confirmation of the diagnosis of ACS was performed according to the International Classification of Diseases (ICD) recorded at the end of the consultation. The medical diagnoses were divided into two groups: ACS (STEMI, NSTEMI and Unstable Angina); and Other Diagnoses (Unspecified Chest Pain, Arrhythmias, Systemic Arterial Hypertension, Aortic Dissection, among others). In addition to the ACS diagnosis and flowchart data, clinical and demographic data were collected.

Data Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 22.0, considering a significance level of $p < 0.05$ for all tests. Continuous variables were expressed as mean and standard deviation. Categorical variables were described as absolute numbers (n) and percentages (%).To compare the type of diagnosis and the classification of priority for receiving care, the Pearson's chi-square test was used. To verify the normality of the data the Kolmogorov-Smirnov test was used.

For sample calculation, the sensitivity, specificity, positive predictive value (PPV) and negative predictive

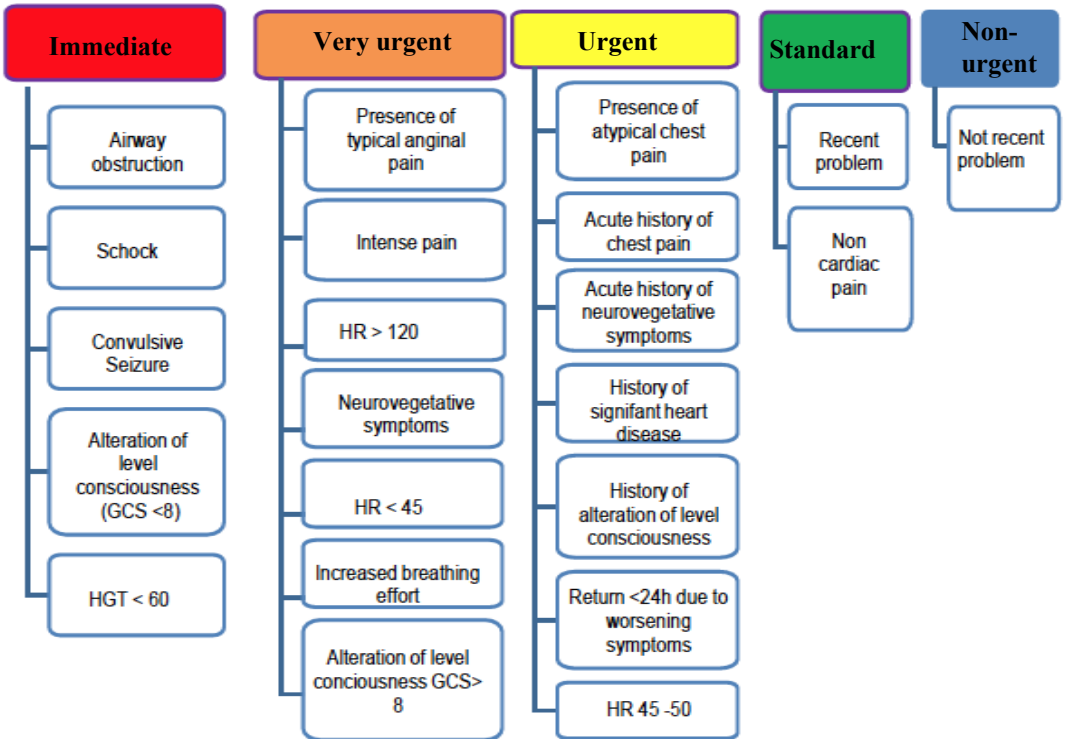

Figure 1 – The chest pain protocol chart used in the Institution's ED.
GCS: Glasgow Coma Scale; HGT: Hemoglobin Test; HR: Heart rate.

Priority	Color	Severity	Target Time to Treat (minutes)	Risk stratification (Priority)	ACS Diagnosis	Other diagnosis
I	Red	Immediate	0	High	True Positive ACS +	False positive ACS -
II	Orange	Very urgent	10			
III	Yellow	Urgent	60			
IV	Green	Standard	120	Low	False negative ACS +	True negative ACS
V	Blue	Non-urgent	360			

ACS: Acute Coronary Syndrome; STEMI: ST-Elevation Myocardial Infarction; NSTEMI: Non-ST-elevation myocardial infarction.

Figure 2. Priorities for receiving care of the Institutional Protocol for Chest Pain and classification of true positives and true negatives, false positives and false negatives, related to the diagnosis of ACS (STEMI AND NSTEMI) and the appropriate prioritization with the protocol for chest pain.

value (NPV) for chest pain suggestive of ACS were assessed in relation to the chest pain protocol. Based in the study conducted by Lunet,[10] for each estimate a confidence interval of 95% was considered, with an absolute error of 9% and sensitivity of 87%. Sample size calculation resulted in a total of 1,061 patients.

Ethical Aspects

The project was approved by the institution's Research Ethics Committee, under number CAAE80458917.1.000.5333, in accordance with Resolution 466/12 of the National Health Council (*Conselho Nacional de Saúde*).

Results

The computerized records of 1,074 patients screened in a cardiology ED were analyzed using the chest pain protocol. Men (54%), with a mean age of 60 ± 15 years, with complaints of acute chest pain (44%), of moderate intensity (80%) were predominant in the study. Among all patients treated, 19% were classified as being a high priority and 81% as low priority for receiving care (Table 1).

The diagnosis of ACS was confirmed in 23% of the patients, with 34% being classified as high priority for receiving care and 66% as low priority (Table 2).

Table 1 – Clinical and demographic characteristics of the study sample (n = 1,074).

Characteristics assessed	Total n (%) (n=1074)	High priority n (%) (n = 199)	Low Priority n (%) (n = 875)	p
Male Gender	582 (54.2)	112 (56.3)	470 (53.7)	0.512
Age (years)*				0.165
18-40	129 (12.0)	15 (7.5)	114 (13.0)	
41-60	411 (38.3)	76 (38.2)	335 (38.3)	
61-80	432 (40.2)	87 (43.7)	345 (39.4)	
81-97	102 (9.5)	21 (10.6)	81 (9.3)	
ED hours of service				0.065
8:01 AM to 2:00 PM	439 (40.9)	67 (33.7)	372 (42.5)	
2:01 PM: to 8:00 PM	355 (33.1)	76 (38.2)	279 (31.9)	
8:00 PM to 8:00 AM	280 (26.1)	56 (28.1)	224 (25.6)	
Pain scale				< 0.001
1-4 Light	23 (2.1)	1 (0.5)	22 (2.5)	
5-7 Moderate	857 (79.8)	7 (3.5)	850 (97.1)	
8-10 Intense	194 (18.1)	191 (96.0)	3 (0.3)	
Determining Factor				<0.001
History Acute of chest pain	477 (44.4)	0 (0)	477 (54.5)	
History of significant heart disease	322 (30.0)	4 (2.0)	318 (36.3)	
Intense pain	190 (17.7)	187 (94.0)	3 (0.3)	
Final diagnosis				<0.001
STEMI	54 (5.0)	37 (18.6)	17 (1.9)	
NSTEMI or UA	192 (17.9)	46 (23.1)	146 (16.7)	
Other	828 (77.1)	116 (58.3)	712 (81.4)	

Data expressed as absolute (n) and relative (%) frequencies. P-values for Pearson's Chi-square test. ED: Emergency Department; STEMI: ST-Segment Elevation Acute Myocardial Infarction; NSTEMI: Non-ST-elevation myocardial infarction; UA: Unstable Angina.

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Table 2 – Confirmed ACS and priority for receiving care (n = 1,074).

Priority	Diagnosis		Total of those classified for each priority level
	ACS n (%)	Other n (%)	
High	83 (33.7)	116 (14.0)	199
Low	163 (66.2)	712 (85.9)	875
Total classified for each diagnosis	246	828	1074

ACS: Acute Coronary Syndrome (STEMI, NSTEMI and Unstable Angina); High priority (red and orange); Low priority (yellow, green and blue).

The estimated sensitivity of the risk stratification protocol for chest pain was 33.7% (95% CI: 27.9-40.3) for identifying patients with ACS, and the specificity was 86.0% (95% CI: 83.3-88.2), with a positive and negative predictive value of 41.7% (95% CI: 34.8-48.9) and 81.3% (95% CI: 78.5-83.8), respectively (Table 3).

Discussion

This study found that the patients treated at this ED are predominantly male, aged between 40 and 60 years. These findings resemble previous studies with similar populations.[11] However, the comparison of the priority groups regarding these two variables did not reveal statistically significant differences, thus corroborating the results of another study.[12]

Data in the literature[13] indicate that the elderly and women often manifest dyspnea as the main complaint in the presence of a myocardial infarction, because the absence of chest pain is often evident or not sufficiently assessed. However, this population, which is most vulnerable to atypical manifestations of AMI, should be assessed individually.[14] A previous study on screening using the Manchester protocol showed that advanced age might be a factor associated with misclassifications regarding the prognosis of patients with AMI.[14]

Table 3 – Estimates for the institutional protocol in the risk stratification of patients with chest pain in relation to the medical diagnosis of ACS.

Tests	Values (%)	CI = 95%
Sensitivity	33.7	27.9-40.1
Specificity	85.9	83.3 - 88.2
PPV	41.7	34.8 - 48.9
NPV	81.3	78.5-83.8
Prevalence	22.9	20.4-25.5

PPV: positive predictive value; NPV: negative predictive value; CI: confidence interval.

Chest pain has a multifactorial etiology, including, but not limited to, thoracic, abdominal and psychosomatic pathologies. Although there are numerous diseases that cause chest pain, those originating from the cardiovascular system are of greatest concern due to the higher risk of mortality and the need for hospitalizations and investigations,[15] which may represent 5%-20% of all admissions to emergency rooms. Chest pain analysis, in this case series, was measured using the pain rule[8] at the time of screening and risk classification, with a "high priority" being indicated when patients said that they had severe pain. Accurate assessment of pain during reception is critical for the classification to be at the appropriate level of priority. In this sense, some key points such as the established culture, verbal demonstration and expressions of pain, behavioral changes and the type of injury or trauma should be considered.[16]

Most of the population was classified as representing a low priority for receiving care, based on the determining factors chosen, such as "acute history of chest pain", characterized by pain occurring in the last 24 hours, but not present at the time, and "history of significant heart disease." In addition to typical chest pain (pain, discomfort, burning or pressing sensation located in the precordial or retrosternal region that may radiate to the left shoulder or upper limb, right arm, neck or jaw), the patient may also have atypical complaints (malaise, indigestion, weakness or just sweating).

Thus, pathologies of the heart, aorta, lungs, mediastinum, ribcage, esophagus, stomach, gallbladder, pancreas and nervous system can produce symptoms with chest discomfort and are part of a broad differential diagnosis[17] This variability in the presentation of chest pain is a constant challenge for the healthcare team in ERs.

In the present study, the medical diagnoses of NSTEMI or unstable angina were most prominent, which may in part be attributed to the fact that patients who arrived at the hospital by ambulance with a confirmed diagnosis of STEMI were excluded. There is a tendency towards greater misclassification of patients with NSTEMI and unstable angina due to the less severe and atypical clinical presentations.[18] This hypothesis is corroborated by a previous study conducted in an ED with a similar population, where approximately 44% of those with ACS received a low priority classification based on the Manchester Triage Scale.[11] Furthermore, another important fact is that patients who arrive after being referred by an outpatient clinic have a reduced diagnostic accuracy in the triage screening compared to patients that arrive by ambulance.[19]

This study aimed at assessing the sensitivity, specificity and predictive value of an institutional risk stratification protocol for chest pain suggestive of ACS. Our findings showed a high specificity and low sensitivity in the classification of these patients in the ED. These results may reflect the demand of patients seeking for ED services, as well as the variability in the conditions under which chest pain may manifest.

The low sensitivity in terms of classifying individuals with a complaint suggestive of ACS may be associated with the difficulty faced by healthcare practitioners in performing this classification, considering the heterogeneity of the clinical presentation of chest pain. A study showed that, given the frequency of chest pain complaints in the ED, the variety of possible causes related to it, the potential severity of some of these and the higher prevalence of benign conditions may reduce the degree of suspicion of more serious causes by the less attentive emergency room worker, culminating in misclassifications, with the waiting time being longer than recommended.[20]

In a study conducted on the sensitivity of the Manchester protocol in ACS, the authors have found that data on atypical manifestations of ACS may decrease the sensitivity of the protocol in question. This may incorrectly indicate the selection of other flowcharts or determining factors, thus underestimating the classification of patients with chest pain.[14] Another European study evaluated the performance of the Manchester protocol in three hospitals, in which the sensitivity analyses were 47%, 72% and 87%. The specificity results presented values of 94%, 87% and 84%.[10] Whereby, similar to the present study, in the first institution, they attributed low sensitivity to the variability in the presentation of pain, while 20% of the patients with chest pain received an underestimated classification.

Alternative approaches that aim at reducing this negative impact of low sensitivity are necessary to improve the quality of care. For example, the systematic training of professionals working on protocols and clinical assessments; the incorporation of feasible and low-cost complementary exams; in addition to continuous evaluations of the results related to the new established strategies.[21]

The PPV observed in this study (41.7%; 95% CI: 34.8-48.9) was satisfactory compared to the study of Leite et al. (16%; CI 95%: 10-25)17, as this study also evaluated patients with any presentation of ACS.

This study has certain limitations: 1) the data were collected from medical records and the recorded information was not always complete; 2) the external applicability may be compromised, because it is a local study conducted at a single institution specialized in cardiology.

Conclusion

The specificity of the institutional risk stratification protocol for chest pain suggestive of ACS presented satisfactory values. However, the sensitivity found was low, which is possibly associated with an underestimated classification, being strongly linked to the heterogeneity of the clinical presentation of chest pain. The use of protocols in clinical practice is indicated because they contribute in providing indicators of the quality of the health care provided. These tools must be reviewed frequently and refined by management models.

Author Contributions

Conception and design of the research: Reis APP, Ruschel KB, Fagundes JE, Belli KC. Acquisition of data: Reis APP. Analysis and interpretation of the data: Fagundes JE, Ruschel KB, Belli KC. Writing of the manuscript: Reis APP, Fagundes JE. Critical revision of the manuscript for intellectual content: Ruschel KB, Saffi MAL, Moraes MAP.

Potential Conflict of Interest

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

Sources of Funding

There were no external funding sources for this study.

Study Association

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

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the *Instituto de Cardiologia do Estado do Rio Grande do Sul* under the protocol number CAAE80458917.1.000.5333. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013. Informed consent was obtained from all participants included in the study.

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