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Original Article

Development of the Acute Coronary Syndrome Predictive Scale

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Abstract

Introduction: The use of a predictive scale for acute coronary syndrome (ACS) can play an essential role in screening high-risk individuals. This study aimed to develop the ACS predictive scale (ACS-PS) and investigate its construct validity, reliability, sensitivity and specificity.

Methods: This was a retrospective methodological study with the aim of developing a predictive scale for ACS in Iran in 2019. In this study, the content validity (content validity index [CVI] and content validity ratio [CVR]), construct validity, sensitivity, specificity, cutoff point and internal consistency of the 13-item scale for predicting ACS (in Persian) were investigated. Participants included patients with a definite diagnosis of ACS (n = 150) and a healthy group without ACS (n = 143).

Results: The score range of the 13-item scale was 0-130, and with a cutoff point of 11.5, both the sensitivity and specificity of the scale were 0.75. Cronbach's alpha coefficient was 0.80.

Conclusion: The present study introduced a sensitive and specific scale for predicting ACS. The ACS-PS is a partially short-form scale and requires less time to complete.

Introduction

Cardiovascular diseases are the leading cause of death globally, with an estimated 17.9 million deaths per year.[1] Acute coronary syndrome (ACS) is the most crucial heart disease and includes myocardial infarction with or without ST-segment elevation and unstable angina.[2] Because of the high mortality rate due to this syndrome, early detection and timely treatment and diagnostic measures can play essential roles in reducing mortality and irreversible complications.[3,4] In this regard, some studies have shown that some prodromal cardiac symptoms occur before ACS incidence and can indicate its occurrence. Prodromal symptoms are warnings of imminent ACS that 49%-95% of people at risk experience from a few days to two years before a heart attack.[4-9]

Due to these symptoms, several researchers have designed tools to identify the prodromal symptoms of ACS before the onset of clinical signs and play an essential role in preventing progression of it.

Review of the Literature

The "McSweeney Acute and Prodromal Myocardial Infarction Symptom Survey" (MAPMISS) is a tool that examines 30 prodromal symptoms of myocardial infarction in women. However, because this tool is designed only for women and is not used for men and because the time required to use it in bed is long (one hour), its practical and comprehensive use is limited.[10] Another tool used to predict ACS is the prodromal symptoms-screening scale (PS-SS), which was introduced by O'Keefe-McCarthy and Guo.[6] Although the PS-SS has eliminated the problems of the MAPMISS and is the first tool that, in addition to assessing the symptoms of cardiac progression in women, has also evaluated these symptoms in men, a study by Elyaszadeh et al in Iran showed that this tool cannot be an accurate measure of ACS prediction.[11]

Three reasons may explain the low predictability of ACS screening tools: the diverse prevalence of ACS prodromal symptoms;[11,12] the sharing of ACS prodromal symptoms with symptoms of other diseases;[11,13] and the presence of nonspecific prodromal symptoms, as according to the MAPMISS tool, only 4 out of 30 signs were identified as specific prodromal symptoms.[4,11,13] Consequently, using the appropriate combination of specific prodromal symptoms with high prevalence can play an essential role in screening people at risk of ACS, and as a result, taking timely action and reducing ACS mortality.

This study aimed to (*a*) develop the ACS-PS by using specific prodromal symptoms with high prevalence and (*b*) investigate the construct validity, reliability, sensitivity and specificity of the ACS-PS.

Materials and Methods

Design

This study is a methodological study aimed at developing

the ACS-PS. This study was performed in the Emam Khomeini hospital in Ardabil, Iran.

Inclusion/Exclusion Criteria

A total of 300 participants entered the study over 6 months (May to August 2019) via convenience sampling. The patients were divided into 2 groups: (1) 150 people diagnosed with ACS (patient group) and (2) 150 people without ACS referred to the clinic who were diagnosed with a healthy heart condition after the necessary examinations were performed by a cardiologist (healthy group).

The inclusion criteria for both groups were as follows: (1) provided informed consent to participate in the study, (2) were able to communicate verbally, and (3) had a normal cognitive status (according to history and clinical records). The cardiologist confirmed the definitive diagnosis of ACS in the patient group and its absence in the healthy group. In the healthy group, in addition to the cardiologist confirming the absence of ACS by using physical examination and accurate diagnostic methods (echocardiography, exercise testing, and electrocardiography), according to the researchers, the lack of ACS in the healthy group was also reported at least 3 months after completing the questionnaire. Considering that 7 people in the healthy group were excluded from the study due to ACS occurring within 3 months after sampling, a total of 143 people in the healthy group were examined.

Instrument and Data Collection

The demographic information questionnaire and ACS-PS were used to collect data in Persian. The demographic questionnaire included information about the participants' age, sex, and comorbidities. ACS-PS questions were asked from the patient group as "Which of the following symptoms did you experience before being hospitalized due to chest pain or heart attack?" and from the healthy group as "Which of the following symptoms did you experience during the last 3 months?" The questions were read by the researcher to the participants and subsequently answered.

Forty-two specific ACS predictor items mentioned in Heidarzadeh et al were entered into the study,[13] followed by item reduction and item clarification in two phases: content validity and statistical methods.

A content validity test, including the content validity index (CVI) and the content validity ratio (CVR), was used in the first step to select the best items. For this purpose, 42 items were given to ten professors and experts in heart disease. The panel of experts included three nurses with more than 10 years of experience in the coronary care unit (CCU), one experienced nurse working in the emergency department, one cardiologist, and five nursing faculty members with enough experience in the field of heart disease. To review the CVI, participants were asked to comment on the simplicity, clarity, and relevance of each item using the Bausell and Waltz method, with scores ranging from 1 to 4 so that more scores indicate greater simplicity, clarity, and relevance. Then, to obtain the CVI for each item, the percentage of those who gave a score of 3 or 4 for each of the options for relevance, clarity, and simplicity was calculated.[14] To determine the CVR, experts were asked to provide their opinions for each item based on a 3-point Likert scale for each item, as "it is necessary," "useful, but not necessary," and "it is not necessary".[15] According to the Lawshe table, CVRs greater than 0.62 were accepted, and CVIs of 0.78 and above were accepted.[14,16] Six items were discarded during this stage due to low CVR and CVI, and 36 items remained as proprietary symptoms in the tool and were examined as primary ACS-PS items.

In the second step, using logistic regression, the odds ratios with 95% confidence intervals (CIs) were calculated to investigate the relationship between the presence or absence of each of the 36 symptoms and the occurrence of ACS. This stage showed that the score and frequency of all items (except heart racing) in the patient group were greater than those in the healthy group. Odds ratios (ORs) were subsequently calculated to determine the best items for the ACS-PS. Therefore, those with ORs less than three, which included 23 items, were removed, and the psychometric properties of the 13-item scale were subsequently examined. For scoring the 13-item scale, the method of O'Keefe McCarthy was used[12] so that each item, in terms of occurrence (no and yes, scores 0 and 1, respectively), intensity (mild, moderate and severe, scores 1 to 3) and frequency (daily, several times a week, once a week, 2-3 times a month, once a month and less than once a month, scores 6 to 1), was examined. The overall score of each item is calculated from the sum of the three parts of occurrence, severity and frequency, and the score range of each item is from 0 to 10. The overall scale score of the scale is calculated by summing all the item sums and ranges from 0 to 130.

In the psychometric phase, the methods of determining construct validity, sensitivity, specificity, the cutoff point of the scale, and internal consistency were used to examine the scale. Construct validity was determined using the "contrasted groups approach".[17] For this purpose, the mean overall score of the ACS-PS was compared between the healthy and patient groups using the Mann–Whitney U test.

Statistical Analyses

Data analysis was performed using descriptive and inferential statistics. The descriptive statistics used statistical indicators such as frequency, percentage, mean, and standard deviation. In inferential statistics, independent t-test and chi-square tests were used to compare the groups. A logistic regression model was used to calculate ORs with 95% CIs to examine the

relationship between the presence or absence of any prodromal symptoms in the patient group (its lack in the healthy group). The absence of symptoms in the healthy group was considered a dependent variable and was calculated for each variable separately. Since none of the items had a normal distribution ($P < 0.05$ according to the Kolmogorov–Smirnov test), the nonparametric Mann-Whitney U test was used to compare the scores of the items in the two groups. It was assumed that if the score of the items in the patient group was higher than their score in the healthy group, the construct validity of the scale would be confirmed. ROC curve was used to determine the sensitivity, specificity, and cutoff point. Cronbach's alpha coefficient for each dimension was calculated for each model to determine the internal consistency. All the above analyses were performed using SPSS software version 13.

Results

Sample Characteristics

Data from 150 patients with ACS and 143 people with healthy cardiac status were used to analyze the data. There was no statistically significant difference between the two groups regarding age, sex, and underlying diseases ($P > 0.05$). The patient and healthy groups' mean (SD) ages were 58.11 (13.20) and 57.89 (13.31) years, respectively, with an age range of 34 to 89 years in both the patient and healthy groups. The other individual social profiles of the participants are shown in Table 1.

Table 1. Demographic characteristics and medical history of the participants

Parameter	Patient group	Healthy group	*P* value
	No. (%)	No. (%)	
Mean age, year (SD)	57.89 (13.31)	58.11 (13.20)	0.88[a]
Education			
Illiterate	49 (32.7)	64 (44.8)	0.09[b]
Diploma and less	81 (54)	61(42.7)	
College graduate or postgraduate	20 (13.3)	18 (12.6)	
Marital status			
Single	2 (1.3)	0 (0)	0.01[b]
Married	132 (88)	138 (96.5)	
Divorced, widow or widower	16 (10.7)	5 (3.5)	
Gender			
Female	72 (48)	69 (48.3)	0.96[b]
Male	78 (52)	74 (51.7)	
Medical history			
Hypertension	51 (34)	51(35.7)	0.76[b]
Diabetes	37 (24.7)	33(23.1)	0.75[b]
Hyperlipidemia	30 (20)	28 (19.6)	0.92[b]
Thyroid condition	5 (3.3)	5 (3.5)	0.93[b]
COPD, asthma	8 (5.3)	5 (3.5)	0.44[b]

Note. Patient group = participants with ACS incidence; Healthy group = participants without ACS incidence. COPD, chronic obstructive pulmonary disease; SD, standard deviation.
[a] Using independent sample t-test, [b] Using chi-square tests.

Research Question Results

Table 2 shows the logistic regression results that compare the score and frequency of symptoms in the two groups of patients and healthy. According to the odds ratio (3 or more), 23 items were removed, and the 13-item model was determined.

The results showed that the mean overall score of the ACS-PS in the patient and healthy groups were 24.56 and 7.66, respectively. The construct validity of the scale was confirmed by the Mann-Whitney U test, which showed that the mean overall score of the ACS-PS was significantly higher in the patient group than in the healthy group. The scores and odds ratios of the final 13 items are shown in Table 2. Table 3 shows the internal consistency (using Cronbach's alpha), sensitivity, and specificity of the 13-item model.

Discussion

The present study developed a scale for predicting ACS (ACS-PS). For this purpose, 42 primary items were decreased to 13 items step by step. Six items were removed due to low CVI and CVR, and 23 items, such as heartburn, frequent indigestion, a sense of hopelessness, numbness or burning of fingers on both hands, general malaise, and numbness or burning of fingers on the left hand, were removed due to odds ratios of less than three. Although these items scored high in the patient group, they also scored high in the healthy group, so the ability of the scale to differentiate between healthy and patient groups could be reduced. It was assumed that removing these 23 symptoms would significantly reduce the number of items and the time required to complete the scale. Finally, the psychometric properties of the 13-item scale were examined for construct validity, sensitivity, specificity, cutoff point, and internal consistency.

Although the ACS-PS overall scores ranged from zero to 130, the mean overall score was not high even in the ACS-PS patient group. Due to the nature of prodromal cardiac symptoms, which are very diverse and can vary according to variables such as physical factors, sex, and underlying disease,[11,13,18,19] it is expected that the symptoms on the scale are not completely visible in all patients. The type of symptoms varies from patient to patient.

The Cronbach's alpha coefficient ($\alpha = 0.80$) indicates the desired internal consistency for the scale and indicates a relatively good correlation between scale items. On the other hand, the acceptable sensitivity and specificity of the ACS-PS indicate that the scale has sufficient power to predict ACS and differentiate low-risk individuals from high-risk individuals and has better sensitivity and specificity than do the existing tools. Additionally, the cutoff point of the ACS-PS for ACS prediction in the present study was 11.5, which is a good score considering that the score ranges from 0 to 130 for the ACS-PS. In previous studies, tool designers have not determined the sensitivity, specificity, or cutoff point for any of the

Table 2. Comparing the score of the patient and healthy groups and association of the prodromal symptom with the incidence of ACS

No.	Prodromal symptom	Items overall mean score (SD)		*P* value[a]	*P* value[b]	Odds ratio
		Patient group (n=150)	Healthy group (n=143)			
1	Pain/discomfort in left breast	1.35 (2.29)	0.16 (0.97)	<0.001	<0.001	13.965
2	Vomiting	0.73 (1.79)	0.04 (0.42)	<0.001	0.001	12.768
3	Numbness or burning of left arm	0.51 (1.50)	0.06 (0.53)	0.001	0.005	8.418
4	Pain/discomfort in both arms	1.83 (2.88)	0.3 (1.19)	<0.001	<0.001	7.007
5	Pain/discomfort centered in left part of chest	2.04 (2.66)	0.39 (1.27)	<0.001	0.001	6.854
6	Difficulty breathing at night	2.37 (3.23)	0.62 (1.87)	<0.001	<0.001	5.084
7	Pain/ discomfort in left arm or shoulder	2.33 (3.11)	0.66 (1.80)	<0.001	<0.001	4.502
8	Headache frequency change (Increased frequency of headaches)	1.21 (2.66)	0.28 (1.27)	<0.001	0.001	4.265
9	Pain/ discomfort in right arm or shoulder	1.34 (2.67)	0.29 (1.14)	<0.001	<0.001	4.199
10	Shortness of breath	2.23 (3.22)	0.74 (2.14)	<0.001	<0.001	4.089
11	Nausea	1.72 (2.50)	0.59 (1.62)	<0.001	<0.001	3.794
12	Pain/discomfort at top of shoulders	2.07 (3)	0.73 (1.90)	<0.001	<0.001	3.360
13	Unusual fatigue	4.83 (3.38)	2.80 (3.30)	<0.001	<0.001	3.174
14	Pain/discomfort centered in the superior part of chest	2.09 (2.73)	1.22 (2.14)	0.004	0.015	1.842
15	Pain/discomfort in chest	2.47 (2.7)	1.55 (2.32)	0.003	0.004	1.989
16	Pain/discomfort in back, between/ under shoulder blades	2.55 (3.14)	1.24 (2.39)	<0.001	<0.001	2.725
17	Pain/discomfort in jaw/teeth	0.69 (1.96)	0.32 (1.36)	0.021	0.020	2.747
18	Numbness or burning of fingers on both hands	1.88 (2.87)	1.61 (2.76)	0.347	0.208	1.382
19	Arms weak /heavy	2.12 (3.02)	1.30 (2.54)	0.013	0.011	1.951
20	Cough	2.58 (3.45)	1.70 (3.09)	0.014	0.007	2.001
21	Orthopnea	1.29 (2.67)	0.58 (1.84)	0.011	0.016	2.304
22	Diaphoresis	4.68 (3.56)	3.04 (3.59)	<0.001	<0.001	2.689
23	Heart racing	3.58	4.70	0.005	0.028	0.584
24	Sleep disturbance	4.16 (3.70)	2.84 (3.55)	0.002	0.002	2.084
25	Headache intensity change (Increased intensity of headaches)	2.02 (3.12)	0.82 (2.08)	<0.001	0.001	2.806
26	Heartburn	3.11 (3.32)	2.56 (3.17)	0.142	0.166	1.386
27	Frequent indigestion	2.23 (3.27)	1.70 (3.01)	0.155	0.126	1.486
28	Loss of appetite	2.51 (3.29)	1.12 (2.39)	<0.001	<0.001	2.786
29	A feeling of hopelessness	1.77 (3.13)	1.11 (2.43)	0.075	0.109	1.581
30	Depression	1.37 (2.85)	0.97 (2.28)	0.295	0.385	1.304
31	Stress	4.55 (3.59)	3.67 (3.59)	0.045	0.046	1.612
32	Apprehension	4.95 (3.41)	3.47 (3.49)	<0.001	0.001	2.310
33	Anxiety	4.03 (3.74)	3.73 (3.63)	0.550	0.542	1.154
34	Nervousness	5.81 (3.15)	4.79 (3.45)	0.017	0.008	2.066
35	General malaise	4.30 (3.58)	3.99 (3.66)	0.522	0.241	1.322
36	Numbness or burning of fingers left hand	1.96 (2.72)	1.55 (2.57)	0.174	0.110	1.500

Note. SD, standard deviation;
[a] Using Mann Whitney U test; [b] Using logistic regression
Items 1-13 are the final 13 prodromal symptoms of the study.

Table 3. Sensitivity, specificity, score range, and alpha coefficient of the 13-item model

Model	Score range	Sensitivity	Specificity	Cronbach's alpha coefficient
13-item	0-130	0.75	0.75	0.80

Note: The best sensitivity and specificity of the 13-item model determined in the cut of point of 11.5.

MAPMISS and PS-SS tools.[6,10] However, Elyaszadeh et al who studied the psychometric properties of the PS-SS in Iran, obtained a sensitivity, specificity, and cutoff point of 65.3, 52.7, and 18.5, respectively.[11]

Among the 13 items, pain/discomfort in the left breast, vomiting, numbness or burning of the left arm, and

pain/discomfort in both arms were the 4 top prodromal symptoms with high predicting power that can more likely indicate ACS. A comparison of the ACS-PS items with the items of two available tools (the MAPMISS and PS-SS) revealed that all 13 ACS-PS items were in at least one of the above two tools.[4] This matter indicates that the items used in the ACS-PS have been used and approved in other communities. On the other hand, this tool has advantages over the previous two tools. First, it has fewer items than the MAPMISS, which can be completed in a minimal amount of time to diagnose people at risk for ACS. Second, unlike in previous studies for determining ACS-PS psychometrics, construct validity was also calculated by comparing items in healthy and patient individuals. Third, its sensitivity and specificity were better than those of the PS-SS in the study by Elyaszadeh et al.[11]

In this study, the research was conducted in the community of patients with ACS in Ardabil. The ability to generalize the results to other populations is limited; therefore, studying its psychometric properties in different people is suggested. The sampling method was also convenience sampling, which tried to remove this limitation with the entry of all eligible patients. Given that the gold standard for diagnosing coronary artery disease is angiography, and in the present study, it was not possible to perform angiography in the healthy group to confirm complete rejection of heart disease; consequently, the diagnosis of heart disease by cardiologists using diagnostic tests such as cardiac stress test, echocardiography, and electrocardiography was limited. However, individuals were monitored for ACS for up to 3 months after sampling to minimize the effect of this restriction. Another limitation of this study was that it was retrospective. So that the tool items were asked to the patients focusing on the last three months. This limitation could reduce the accuracy of the answers over time.

Conclusion

The present study introduced a new 13-item scale for predicting the risk of ACS in individuals at high risk. This scale has a low volume of questions and less time to complete them and has better sensitivity and specificity than similar scales for screening at-risk individuals.

Acknowledgments

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Authors' Contribution

Conceptualization: Mehdi Heidarzadeh, Shahla Elyaszadeh.
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Investigation: Mehdi Heidarzadeh, Shahla Elyaszadeh.
Methodology: Mehdi Heidarzadeh, Shahla Elyaszadeh.
Project administration: Mehdi Heidarzadeh.

Research Highlights

What is the current knowledge?

- ACS, which includes myocardial infarction with or without ST-segment elevation and unstable angina, is the most crucial heart disease and has a high mortality rate.
- Prodromal symptoms are warning symptoms of imminent ACS.
- Using the appropriate combination of cardiac prodromal symptoms in screening scales can play an essential role in screening people at risk of ACS, and as a result, taking timely action and reducing ACS mortality.

What is new here?

- The ACS-PS is a partially short-form scale for predicting the risk of ACS in individuals at high risk and requires less time to complete.

Resources: Mehdi Heidarzadeh, Shahla Elyaszadeh, Sevda Gardashkhani.
Software: Mehdi Heidarzadeh, Shahla Elyaszadeh.
Supervision: Mehdi Heidarzadeh.
Validation: Mehdi Heidarzadeh, Shahla Elyaszadeh.
Visualization: Mehdi Heidarzadeh, Shahla Elyaszadeh.
Writing–original draft: Shahla Elyaszadeh, Mehdi Heidarzadeh.
Writing–review & editing: Shahla Elyaszadeh.

Competing Interests

The authors declare that there are no conflicts of interest.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Approval

This study is a research project approved by Ardabil University of Medical Sciences (IR.ARUMS.REC.1398.027). Before completing the questionnaire, participants were given brief information about the objectives and study methods and provided their consent orally. Patients were assured that the investigation would not interfere with the treatment and care process, the information contained in the questionnaires would be completely confidential, and the research results would be published in the form of group information.

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