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External validation of the SCARE score in identifying acute coronary syndromes during medical regulation of chest pain

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Abstract

Background Medical regulation of chest pain is challenging due to the multitude of potential diagnoses. The key challenge is to avoid misdiagnosing acute coronary syndrome while preventing over-triage. The SCARE score (based on age, sex, smoking, typical coronary pain, inaugural pain, sweats, and dispatcher's conviction) classifies patients as low, intermediate, or high risk of acute coronary syndrome. This study aimed to determine the diagnostic performance of the SCARE score among patients calling with chest pain.

Methods This single-center prospective study was conducted at the Charleville-Mézières Emergency Medical Communication Centre. Data collection included standardized questionnaires and call tape reviews. The SCARE score was compared with final diagnoses from medical records.

Results From October 2 to November 16, 2023, 194 patients were included, with 32 (16%) diagnosed with acute coronary syndrome. Of these, 24 patients (75%) were managed by a prehospital medical team. The AUROC for the SCARE score was 0.80 [95% CI 0.73—0.87]. At a low-risk threshold (26), sensitivity was 100% [95% CI 89—100] and specificity was 45% [95% CI 37—53]. At a high-risk threshold (36), sensitivity was 72% [95% CI 53—86] and specificity was 70% [95% CI 63—77].

Conclusion The SCARE score exhibited excellent sensitivity and overall acceptable performance in predicting acute coronary syndrome in patients calling with non-traumatic chest pain.

Trial registration ID-RCB 2023-A01672-43.

Keywords Acute coronary syndrome, Chest pain, Risk factors, Triage, Emergency medical services, Emergency medical dispatch

Background

Chest pain is a common reason for seeking medical care. The EPIDOULTHO study recorded 1,339 requests for care for this symptom on a single day in France in January 2013, including 537 calls to Emergency Medical Communication Centres (EMCCs) [1].

The potential severity of chest pain is primarily related to its coronary origin. In 2020, 99,800 patients in France were treated for acute coronary syndrome (ACS) [2]. ACS is the leading cause of death worldwide [3] and the second leading cause of death in France [4]. Post-ACS, the one-month mortality rate is 5.9%, with more than half of these deaths occurring within one hour of symptom onset [5, 6].

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Prompt management, particularly the time to perform the initial electrocardiogram and primary angioplasty, is correlated with prognosis [7, 8]. Patients with ACS are at risk of complications during transport, including rhythm disorders, cardiogenic shock, and cardiac arrest. The French healthcare system includes Mobile Intensive Care Units (MICUs) with medical teams equipped with electrocardiographs and defibrillators, trained in resuscitation, enabling appropriate management and close monitoring of these patients, in line with ESC 2023 recommendations [9].

Medical dispatch aims to provide the most appropriate response to each patient; for chest pain, this involves distinguishing clinical presentations compatible with ACS to initiate the appropriate means to avoid under-triage [10]. Concurrently, dispatch physicians must also limit over-triage. In the French DOLORES registry, 51.9% of patients calling with non-traumatic chest pain were cared for by a MICU [11].

Decision-making in medical dispatch is complex, particularly for novice dispatchers, and there are few decision aids for non-traumatic chest pain [12]. In 2017, Guerineau et al. developed the SCARE score to estimate the probability of ACS during calls for chest pain (Table 1) [13]. This score still lacks external validation.

This observational study aimed to provide an external validation of the diagnostic performance of the SCARE score.

Methods

French emergency medical system

The French healthcare system comprises 105 Emergency Medical Communication Centre (EMCCs, Service d'aide médicale urgente) that receive calls from patients in need of care. An auxiliary medical triage staff member (Assistant de Régulation Médicale) collects patient data and prioritizes calls. An emergency physician then gathers clinical data and makes the appropriate decision for each patient, such as sending a MICU (equivalent to Advanced Life Support) with an emergency physician, an ambulance with paramedics (equivalent to Basic Life Support), advising the patient to go to the nearest emergency department, consulting a general practitioner, or advising the patient by telephone.

Table 1 SCARE score calculation

SCARE score criteria	Number of points
Male sex	10
Age between 43 and 57 years	13
Age above 58 years	15
Smoking (active or weaned)	8
Typical coronary pain	6
Inaugural pain (first episode of pain of this type)	5
Sweating	7
Conviction by the dispatching physician of the coronary origin of the pain	11

Study design and setting

This single-center prospective study was conducted at the Charleville-Mézières EMCC. Data collection included standardized questionnaires and call tape reviews.

Population

All patients who called the EMCC for chest pain were included. Exclusion criteria included minors (< 18 years), patients under guardianship, traumatic-related pain, patients in vital distress, language barriers or impossible interrogation, patients refusing care, regulation by another EMCC, patients objecting to data collection, or those with a diagnosis already made at the time of the call.

The required sample size was 178, with an alpha risk of 0.05, a beta risk of 0.2, a primary endpoint prevalence of 16% [1], an estimated AUROC of 0.82 [13], and an assumption of an AUROC greater than 0.7. Adding 10% for excluded patients resulted in an expected sample size of 198.

Data collection

A first questionnaire was filled out by the medical dispatcher immediately after each chest pain case was regulated, containing information needed to calculate the SCARE score. A second standardized, anonymous, computerized questionnaire was completed retrospectively by replaying the dispatch tapes, including elements of telephone medical semiology and whether these data had been sought by the dispatching physician (supplementary file 1). Medical records were consulted by the investigator to establish the diagnosis. Hospital discharge diagnoses made by the cardiologist were used for hospitalized patients. For patients discharged from emergency departments, the emergency doctor's diagnosis (carried out with the expert advice of a cardiologist if necessary) was recorded. General practitioners who saw patients referred by the EMCC were contacted for their diagnosis. The investigator was not involved in the medical dispatch of the included patients.

Outcomes and objectives

The primary outcome was the occurrence of ACS diagnosed by the emergency physician and confirmed by the cardiologist during hospitalization in cardiology,

according to the European Society of Cardiology 2023 diagnostic criteria [9].

The primary objective was to calculate the diagnostic performance of the SCARE score among patients calling EMCC for chest pain, reflected by AUROC. The secondary objectives were to study the association between the SCARE score and the resources used to manage these patients.

Statistical analysis

Data were transcribed using SPHINX® software. Descriptive and univariate analyses were performed on R Studio®. Data are expressed as numbers and percentages for binary qualitative data and ordinal quantitative data. Continuous quantitative data are expressed as mean with standard deviation. Sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, negative likelihood ratio, Youden index, and their 95% confidence intervals were calculated, followed by plotting the ROC curve and calculating its AUROC. The risk thresholds selected in the original study were used to calculate the diagnostic performance of the SCARE score. The significance threshold for univariate analyses was defined as $p < 0.05$, using the chi-square test (or Fisher's exact test if the theoretical numbers were not reached). For each anamnesis item, patients for whom data had not been collected were excluded.

Ethical statement

An information letter was sent to each patient included in the study. Patients had the opportunity to fill out an opposition form, resulting in exclusion from the study. EMCC dispatchers received a letter informing them of the study and its objectives and signed individual, free, and informed consent forms to listen to their dispatch tapes. This study, registered as ID-RCB 2023-A01672-43, was approved by the Comité de Protection des Personnes Est III on September 22, 2023. It complied with the CNIL's MR003 methodology, registered under number 2230644 v0.

Results

From October 2 to November 16, 2023, 258 calls were classified as "Chest pain." Of these, 206 questionnaires were completed by dispatching physicians. After excluding patients meeting the exclusion criteria, 194 questionnaires were analyzed (Fig. 1). This population comprised 108 (56%) women, with a mean age of 56.5 years (σ 19.1). ACS was diagnosed in 32 patients (16%), including 15 STEMI (8%), 12 NSTEMI (6%), and 5 unstable angina (3%). Forty percent ($n=78$) of patients were managed by a MICU. The most common diagnoses were pain of psychogenic origin (18%, $n=34$) and parietal pain (17%, $n=33$). Other cardiovascular causes (stable angina, cardiac decompensation, dysrhythmias, myopericarditis, hypertensive crises, aortic dissection, and pulmonary embolism) accounted for 22% of diagnoses ($n=43$), while pulmonary causes (pleuro-pneumopathy, chronic obstructive pulmonary disease exacerbation, and pneumothorax) were diagnosed in 7% of patients ($n=14$). The semiological characteristics of patients and the percentages of each telephone interview data collected are shown in Table 2.

The SCARE score associated with the diagnosis of ACS ($p<0.001$). It had a sensitivity of 100% [95% CI 89%—100%] and a specificity of 45% [37%—53%] for a threshold > 25, defined as a low-risk (< 5%) threshold in the study by Guerineau et al. [13]. For a threshold > 35 (high-risk threshold in the original study [13]), sensitivity was 72% [53%—86%], specificity 70% [63%—77%]. The Youden index identified an optimal threshold > 25, with an index calculated at 0.45. The ROC curve for the SCARE score is shown in Fig. 2, with an AUROC of 0.80 [95% CI 0.73—0.87]. ACS percentages were 0% [95% CI 0–5%] for SCARE scores 0–25, 18% [9–31%] for scores 26–35, and 32% [22–44%] for scores 36–62. Diagnostic performances of the SCARE score for different thresholds are presented in Table 3.

Table 4 shows the distribution of dispatch choices made by the attending physician for patients with chest pain, according to the SCARE score. There was an association between the SCARE score and the dispatch decision ($p<0.001$). If all high-risk score patients (> 35) had MICU involvement, three ACS (two STEMI, one NSTEMI) would have been appropriately managed, reducing delays to revascularization and risk of complications, at the cost of 17 additional MICU commitments.

Discussion

This study demonstrates the SCARE score's good accuracy in predicting ACS during telephone regulation of non-traumatic chest pain in the Ardennes population, France, in autumn 2023. The study population included a higher proportion of women than large-scale chest pain regulation studies [1, 11, 13], closer to the general population proportion. The average age is equivalent to other studies, with higher smoking rates and lower myocardial infarction and dyslipidemia history. The MICU involvement percentage (40%) is slightly lower than the national EpiDoulTho study (45.1%) [1], favoring non-medicalized ambulances. The ACS proportion (16%) matches EpiDoulTho and exceeds Guerineau's study (13.4%) [13]. This study found a higher psychogenic pain proportion (18%) than other studies (11% in EpiDoulTho, 14.3% for Guerineau et al.). While common chest pain characteristics are often collected, many elements are rarely sought,

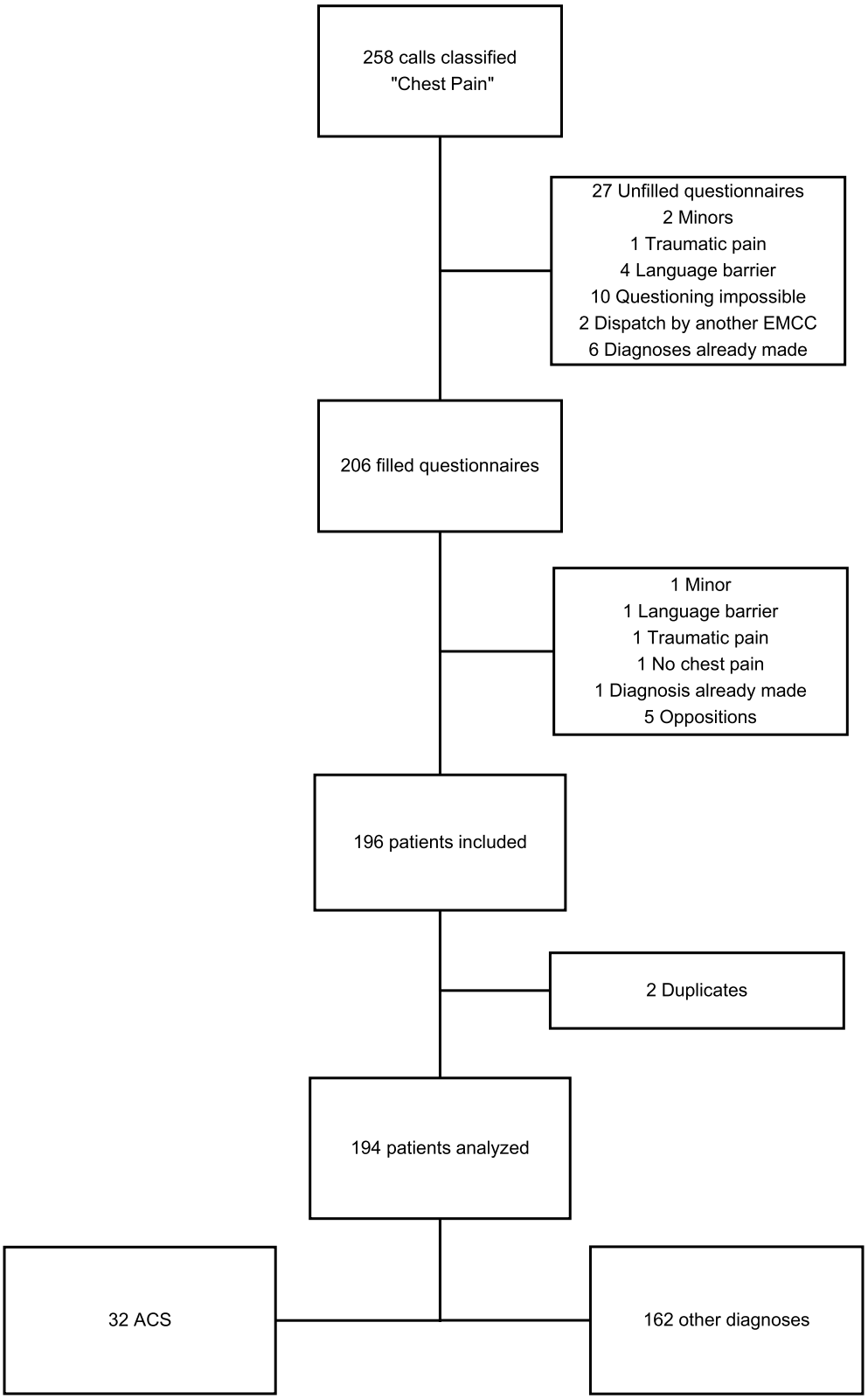

Fig. 1 Flow chart. ACS: Acute Coronary Syndrome; EMCC: Emergency Medical Communication Centre

Table 2 Univariate analysis based on ACS diagnosis

	All patients			ACS		Non ACS		*p*-value
	% of data collection	n (or mean)	% (or SD)	n (or mean)	% (or SD)	n (or mean)	% (or SD)	
		194		32	16	162	84	
Call duration		6	2	7	3	5	2	**0.014**
Age		57	19	68	16	54	19	**< 0.001**
Cardiovascular risk factors								
• Age > 50 in men, > 60 in women		96	49	27	84	69	43	**< 0.001**
• Male sex		86	44	19	59	67	41	
• Smoking	82	72	37	14	44	58	36	
• Prior ischemic heart disease	76	28	14	10	31	18	11	**< 0.01**
• Diabetes	71	28	14	10	31	18	11	**0.011**
• High blood pressure	68	55	28	14	44	41	25	**0.012**
• Dyslipidemia	43	17	9	4	12	13	8	
• Coronary heredity	14	12	6	1	3	11	7	
• BMI > 25 or sedentary lifestyle	16	14	7	2	6	12	7	
• Drug use	3	2	1	0	0	2	1	
Presence of more than 2 risk factors		124	64	30	94	94	58	**< 0.001**
Pain duration	94							
Pain characteristics								
• Inaugural	98	119	61	22	69	97	60	
• Identical to a previous ACS	86	11	6	5	16	6	4	**0.021**
• Sudden onset	62	84	43	16	50	68	42	
• At rest	64	99	51	25	78	74	46	
• On exertion	64	35	18	8	25	27	17	
• Continuous	65	73	38	21	66	52	32	
• Widespread	48	67	35	17	53	50	31	**0.0497**
Typology	88							
• Tightness		113	58	26	81	87	54	**< 0.01**
• Heaviness		15	8	5	16	10	6	
• Burning		19	10	2	6	17	10	
• Tingling		28	14	0	0	28	17	**< 0.01**
• Discomfort		10	5	1	3	9	6	
• Other description		17	9	2	6	15	9	
Location	93							
• Medio-thoracic/retrosternal		100	52	19	59	81	50	
• Left thoracic		76	39	15	47	61	38	
• Right thoracic		10	5	0	0	10	6	
• Epigastric		17	9	1	3	16	10	
• Isolated irradiation		8	4	0	0	8	5	
Presence of irradiation	95	120	62	25	78	95	59	**0.021**
• Left upper limb		60	31	18	56	42	26	**< 0.001**
• Right upper limb		11	6	5	16	6	4	**0.018**
• Shoulders		17	9	2	6	15	9	
• Neck		23	12	4	12	19	12	
• Jaw		12	6	3	9	9	6	
• Back		47	24	7	22	40	25	
• Stomach		14	7	1	3	13	8	
Associated symptoms								
• Dyspnea	78	107	55	20	62	87	54	
• Malaise	28	34	18	7	22	27	17	

Table 2 (continued)

	All patients			ACS		Non ACS		*p*-value
	% of data collection	n (or mean)	% (or SD)	n (or mean)	% (or SD)	n (or mean)	% (or SD)	
		194		32	16	162	84	
• Disturbed consciousness	70	16	8	3	9	13	8	
• Pain intensity	44	47	24	16	50	31	19	**< 0.01**
• Sweating	96	65	34	15	47	50	31	
• Paleness	48	48	25	13	41	35	22	**0.023**
• Palpitations	19	30	15	2	6	28	17	
• Agitation	65	18	9	1	3	17	10	
• Near-death sensation	9	10	5	3	9	7	4	
• Nausea/vomiting	20	30	15	8	25	22	14	
Non-coronary symptoms								
• Mechanical trigger	16	16	8	1	3	15	9	
• Postural variability/reproducibility	29	33	17	2	6	31	19	
• Respiratory variability	22	28	14	2	6	26	16	
• Anxiety	26	29	15	0	0	29	18	**< 0.01**
• Hyperthermia	14	16	8	0	0	16	10	
• Cough	14	20	10	1	3	19	12	
• Pyrosis	3	5	3	1	3	4	3	
• Postprandial pain	6	4	2	0	0	4	3	
SCARE score		30	14	42	10	28	13	**< 0.001**
• 0 to 25		73	38	0	0	73	45	
• 26 to 35		50	26	9	28	41	25	
• 36 to 62		71	37	23	72	48	30	
Conviction of the dispatching physician		65	34	22	69	43	27	**< 0.001**
Dispatch decision								**< 0.01**
• MICU		74	38	22	69	52	32	
• Ambulance		89	46	9	28	80	49	
• Emergency department		23	12	1	3	22	14	
• Family physician		6	3	0	0	6	4	
• Medical advice		2	1	0	0	2	1	

ACS Acute Coronary Syndrome, *SD* standard deviation, *BMI* Body Mass Index

such as symptoms pointing to differential diagnoses and more concerning elements like malaise, palpitations, nausea, or family coronary history. The French Regulation Aid Guide [14] encourages seeking severity criteria and reassuring elements, but these are rarely explored by EMCC regulating physicians.

Several ACS risk scores have been created by emergency physicians to help them rule out ACS in patients presenting with chest pain. The Diamond-Forrester score was created to assess the pre-test probability of coronary pathology, based on age, sex and the typical nature of the pain. It performs well (AUC 0.82 [0.80—0.84]) and is simple and rapid to perform, but patients with ACS were excluded when it was designed [15]. The HEART score [16] (and its modified version the HEARTS3 [17] score) are used to stratify the risk of ACS but require an ECG and troponin assays, as do the HE-MACS score [18] and the HEAR score/CARE rule [19], which require an ECG; these scores are therefore not applicable in regulation, where only questioning the patient can guide the dispatching physician.

In 2019, Reuter et al. developed gender-specific predictive models for regulation using a large multicenter prospective cohort, but the female model failed in the validation cohort [20]. The EDACS was developed in 2014 by Than et al. to speed up the triage of chest pain in emergency departments, where it performs well [21–24]. It is based on anamnestic elements that could be collected in emergency call centres but its use there has not yet been tested. The SCARE score is the only score created for EMCCs. This study is the first to prove its external validity in a new population and by an independent team. The AUROC of 0.80 in this study matches the original study's AUROC of 0.81 [13], reinforcing the SCARE

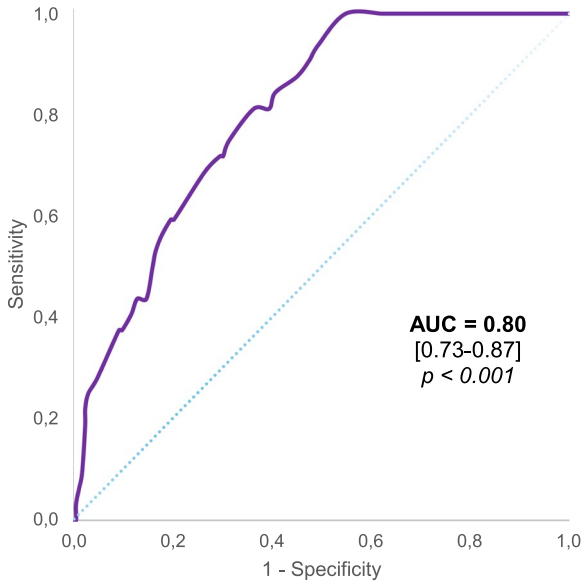

Fig. 2 ROC curve of the SCARE score. ROC: Receiver Operating Characteristic, AUC: Area Under the Curve

Table 3 Diagnostic performances of the SCARE score

	SCARE with threshold ≥ 26	SCARE with threshold ≥ 36
Sensitivity (%)	100 [95%CI 89–100]	72 [95%CI 53–86]
Specificity (%)	45 [95%CI 37–53]	70 [95%CI 63–77]
PPV (%)	26 [95%CI 19–35]	32 [95%CI 22–45]
NPV (%)	100 [95%CI 95–100]	93 [95%CI 87–97]
LR +	1.82 [95%CI 1.58–2.09]	2.43 [95%CI 1.76–3.35]
LR -	0	0.40 [95%CI 0.23–0.70]

% percentage, *PPV* Positive Predictive Value, *NPV* Negative Predictive Value, *LR* + Positive Likelihood Ratio, *LR*—Negative Likelihood Ratio, *95%CI* 95% Confidence Interval

score's external validity. Its excellent sensitivity and negative predictive values make it an asset for ruling out the diagnosis of ACS.

Patients with a SCARE score > 35 have a 32% ACS risk, warranting MICU involvement. In our cohort, this would have managed 2 STEMI and 1 NSTEMI more appropriately, reducing delays to revascularization and risk of complications, at the cost of 17 additional MICU commitments. Patients with a SCARE score 26–35 have an 18% ACS risk, requiring careful consideration for appropriate treatment. Collecting risk factors, severity symptoms, accompanying symptoms, and differential diagnosis symptoms would better guide the dispatch decision. Patients with a SCARE score ≤ 25 rarely have ACS, and without other reasons requiring initial medical attention (extreme tachycardia or respiratory distress), it seems appropriate to prefer an ambulance, reserving MICU for more complex cases. In our cohort, this strategy would have spared 4 MICU commitments. Out of 194 calls, 13 additional MICUs would have been sent, avoiding under-triage of 3 ACS cases. However, the dispatcher must adapt care to the patient, remaining the sole decision-maker.

Our study is not without limitations. This study is monocentric and observational but confirms the SCARE score's diagnostic performance in a new EMCC. The small sample size reaches the required number of subjects, but larger-scale studies will be needed to confirm these results. The large number of uncompleted "Chest pain" call questionnaires may indicate exclusion criteria not mentioned in the regulation file or non-suggestive ACS pain not motivating the dispatcher to fill in a questionnaire, creating a selection bias. The semiological data have significant missing variables not collected by dispatchers, but we did not want to disrupt their work by imposing additional questions. The data on smoking, sweating, and inaugural pain were constrained by the standardized questionnaire, leading to an information bias. The study lacks generalizability due to the French Emergency Medical System's particularities. The study's strengths include the participation of all dispatchers, the replaying of tapes for comprehensive data collection without disrupting dispatchers' work and validating the

Table 4 Decision of the dispatching physician according to the SCARE score

	SCARE 0–25 (*n* = 73)		SCARE 26–35 (*n* = 50)		SCARE 36–62 (*n* = 71)	
		Including ACS		*Including ACS*		*Including ACS*
MICU	8 (11%)		15 (30%)	4 (8%)	55 (77%)	20 (28%)
Ambulance	43 (59%)		26 (52%)	4 (8%)	16 (23%)	3 (4%)
Emergency department	15 (20%)		8 (16%)	1 (2%)		
Family physician	5 (7%)		1 (2%)			
Medical advice	2 (3%)					

Presented as number (percentage). *MICU* Mobile Intensive Care Unit, *ACS* Acute Coronary Syndrome

SCARE score in the Charleville-Mézières EMCC. This is the first research study within our EMCC, validating the SCARE score and providing data on professional practices. The score does not seem to increase regulation time, as its items are often already collected by the physician, but this remains to be confirmed in future studies. The results are consistent with previous studies.

Conclusion

The SCARE score has once again demonstrated its ability to classify patients as low, intermediate, or high risk of ACS in a different population and has the potential to increase the accuracy of call triage for patients presenting potentially cardiac-related complaints. It is available at https://scare.univ-reims.fr/. To confirm its place in the regulation of non-traumatic chest pain, a randomized interventional study comparing its use with standard practice is required.

Abbreviations

ACS	Acute Coronary Syndrome
EMCC	Emergency Medical Communication Centre
MICU	Mobile Intensive Care Unit
STEMI	ST Elevation Myocardial Infarction
NSTEMI	Non-ST Elevation Myocardial Infarction
AUROC	Area Under the Receiver Operating Characteristic Curve

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions

Study conception : AL, XF, MQ. Clinical data collection : AL, MQ. Database management : CD, AL. Statistical analysis : AL, CD. Manuscript drafting : AL. Manuscript revision : AL, XF, CD, MQ. All the authors approved the final version of the manuscript.

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Data availability

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

Declarations

Ethics approval and consent to participate

An information letter was sent to each patient included in the study. Patients had the opportunity to fill out an opposition form, resulting in exclusion from the study. EMCC dispatchers received a letter informing them of the study and its objectives and signed individual, free, and informed consent forms to listen to their dispatch tapes. This study was approved by the Comité de Protection des Personnes Est III on September 22, 2023.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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