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Submission date: 21-Feb-2026 04:08PM (UTC+0700)
Submission ID: 2884607483
File name: Ihsan_Angga-Scoping_In_Contagion_-_Copy.docx (225.9K)
Word count: 6260
Character count: 36422

DEVELOPMENT OF A SCORING SYSTEM FOR PREDICTING ACUTE CORONARY SYNDROME EVENTS: A SCOPING REVIEW

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Track Record Article

Accepted:

Published:

Abstract

The score predictor tool helps healthcare practitioners make diagnoses based on findings from physical or supplementary examinations, thereby facilitating prompt and accurate care. This scoping review aims to analyze and consolidate the scientific literature on scoring methods for acute coronary syndrome events, which can be utilized to evaluate or predict the incidence or prognosis of acute coronary syndrome. This review employs a scoping review utilizing electronic databases, including PubMed, Scopus, and Emerald, with the search terms: 'Acute Coronary Syndrome,' 'Scoring System OR Score Predictor,' and 'in Hospital.' Of the 1.961 articles identified, 18 articles were selected. A charting method was used to systematically extract and organize key data from each study, including author, year, country, study design, population, type of scoring system, variables used, and clinical outcomes assessed. The results were summarized descriptively and presented in tabular and narrative form to identify patterns and gaps in the literature. The scoring system for patients with ACS is highly beneficial for healthcare workers in assessing and determining the necessary actions, enabling them to make informed decisions quickly, including discharging patients who do not require hospitalization. Age, SBP, cardiac biomarkers, and ECG are indicators that are consistently used in every scoring system reviewed. Conclusion: The use of a scoring system enables quick and accurate decision-making, including the potential for discharging patients who do not require treatment. In the future, the scoring system in the pre-hospital phase needs to be developed to facilitate faster identification of the risk of ACS.

Keyword: acute coronary syndrome, scoring system, predictor

INTRODUCTION

Acute Coronary Syndrome (ACS) encompasses various clinical manifestations, including cardiac arrest, electrical instability, hemodynamic disturbances resulting in cardiogenic shock, intense chest pain from ongoing ischemia, or mechanical complications such as severe mitral regurgitation due to a sudden reduction in myocardial blood flow. The principal classifications of ACS comprise ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina pectoris (UAP) (Lewis et al., 2020; Singh et al., 2024).

Coronary heart disease (CHD) remains a major global health concern. According to WHO (2021), cardiovascular diseases (CVDs) caused 17.9 million deaths in 2019, with acute

myocardial infarction accounting for 85% of these deaths. Coronary artery disease (CAD) contributes to 2.2% of the global disease burden and 32.7% of all cardiovascular disorders. (WHO, 2021). In the United States, CAD affected approximately 15.5 million individuals between 2009 and 2012, with a prevalence of 7.6% in men and 5% in women. Globally, CVD-related mortality rose to 19.05 million in 2020, an 18.71% increase since 2010, despite a 12.19% decline in age-adjusted mortality rates. The age-adjusted mortality rate decreased to 239.80 deaths per 100,000 population(Tsao et al., 2023). The prevalence of CVD increased by 29.01% between 2010 and 2020, reaching 607.64 million cases worldwide. In the Asia-Pacific region, acute coronary syndrome (ACS) is the leading cause of cardiovascular mortality. ACS contributes to more than 50% of the global CVD burden (Nabovati et al., 2023). These trends underscore the urgent need for targeted interventions to mitigate the escalating impact of cardiovascular disorders worldwide.

Individuals with suspected ACS constitute 10% of emergency room visits; however, fewer than 15% experience acute myocardial infarction (AMI) (Khand et al., 2023). Due to statistical data indicating a significant frequency of cardiovascular diseases globally, the prompt prevention of these conditions appears crucial. Essential steps in disease control and prevention begin with gathering accurate and adequate information about the patient, how the disease progresses, how treatment is administered, and where it develops. The success of treatment and management in patients with ACS depends on the time from the onset of symptoms to the first medical contact. The principle of management in ACS is to prevent delays between the onset of symptoms and treatment within 60 minutes (Khaled et al., 2022). The scoring system plays a crucial role as a solution in the prevention and management of cardiovascular diseases, especially in patients with ACS. With the high global prevalence of cardiovascular diseases, collecting accurate and adequate information about patients becomes an essential step in disease control and prevention. Scoring systems can help accelerate diagnosis, optimize decision-making, and enable timely interventions.

Many risk scoring instruments for patients with ACS are currently used, one of which is the TIMI score (Thrombolysis in Myocardial Infarction). This score was developed and validated in a cohort of hospitalized patients with non-ST-elevation myocardial infarction (NSTEMI) to determine the likelihood of experiencing a Major Adverse Cardiac Event (MACE) within 14 days. MACE is a composite outcome that includes mortality, myocardial infarction (MI), and

revascularization, which involves percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG). The American Heart Association (AHA) and the American College of Cardiology (ACC) support the TIMI score for the initial assessment of patients presenting with chest pain; however, its application for identifying low-risk chest pain patients does not yield consistent results (Antman et al., 2000; Hess, Agarwal, et al., 2010; Pollack Jr et al., 2006; Scirica et al., 2002). To overcome these limitations, the HEART score, which consists of History, Electrocardiogram (ECG), Age, Risk factors, and Troponin, was developed as a simpler and more practical tool for risk stratification in patients with chest pain. This scoring system has demonstrated superior predictive performance in identifying low-risk patients suitable for early discharge, and several validation studies have shown its higher accuracy in predicting short-term major adverse cardiac events (MACE) compared to the TIMI score (Six et al., 2013b).

Scoring systems enable clinicians to categorize patients into high-, moderate-, or low-risk groups, thereby optimizing clinical decision-making and improving outcomes. However, despite the widespread use of various scoring models, differences remain in their intended purpose, predictive parameters, and validation settings. Existing literature reveals fragmented evidence regarding the diagnostic and prognostic performance of these scoring systems in diverse populations and clinical contexts. Therefore, a comprehensive synthesis is needed to map, compare, and classify existing ACS scoring systems based on their clinical objectives.

Given this gap, a scoping review approach is considered appropriate to systematically explore, chart, and synthesize the breadth of available evidence on ACS scoring systems. This approach is particularly useful for identifying research trends, methodological variations, and evidence gaps across studies (Arksey & O'Malley, 2005). Accordingly, this review aims to analyze and synthesize the existing scientific literature on scoring methods applied in ACS to evaluate or predict its incidence and prognosis, and to provide a comprehensive overview of the classifications and clinical relevance of these scoring systems.

METHOD

Design

The design employs a scoping review technique that consolidates summaries, explanations, and interpretations of current quantitative and qualitative studies related to the review issue. A scoping review differs significantly from a systematic review. by tackling broader questions and exploring pertinent literature, rather than focusing just on a specific research problem (Moher et al., 2015). This review requires the identification of all pertinent literature, irrespective of the research approach. This review necessitates the identification of all relevant literature, regardless of the study's methodology.

According to the researcher's understanding of the literature, a scoping review enables researchers to establish search keywords and conduct research, particularly in the data retrieval phase. The researcher did not enforce stringent constraints on search keywords, the identification of pertinent studies, or the selection of preliminary studies for this research. The study identification process is iterative, necessitating researchers to interact reflectively with each stage and, if needed, revisit them. This strategy enables the review to extract diverse facts and present it in a coherent, transparent, and methodical manner. The key aspect of this technique is to provide an exhaustive analysis of a broad problem (Arksey & O'Malley, 2005; Moher et al., 2015; Pham et al., 2014).

Search Methods

The process of performing a scoping review has five stages: formulating the research question, identifying pertinent studies, selecting studies, mapping data, and collecting, summarizing, and reporting the findings (Arksey & O'Malley, 2005).

This study exclusively examines quantitative or qualitative research papers published since the inception of the ACS scoring system. The papers must be written in English, be full-length texts, and discuss how the scoring system was designed, developed, and evaluated. On the other hand, the exclusion criteria for this study include articles that report general information about scoring systems or are not specific to the occurrence of ACS.

Stage 1: Identifying Research Question

In a scoping review, defining the objectives and articulating the key research question(s) is essential. The main question must be sufficiently broad to include the variety found in the

literature on the selected topic. A thorough primary question suffices for a scoping examination. The incorporation of subsidiary or exploratory inquiries is acceptable and can yield more profound insights into specific facets of literature. These supplementary inquiries should investigate diverse facets or subtopics related to the primary theme. The study provides five research questions. (PCC)

1) How is the development process of the ACS scoring system?
2) Is there an existing scoring system to assess ACS incidents?
3) How can we implement the ACS incident scoring system?
4) What are the results of the scoring system correction in ACS?
5) What are the results of the scoring system measurement in assessing ACS?

Regarding the study topic, the researcher delineates the population, concept, and setting. This study employs the keywords and Boolean operators "acute coronary syndrome" AND "scoring system" OR "score predictor" AND "in hospital" for the literature search.

Stage 2: Identifying Relevant Studies

Before finding interesting journal articles, the writers initially establish keywords related to the study topic. The MeSH search terms were subsequently utilized in conjunction: 'Acute Coronary Syndrome,' 'Scoring System,' and 'in Hospital.' Electronic databases, such as PubMed, Emerald, and ScienceDirect, were utilized to identify journal articles that fulfilled the inclusion criteria. We also conducted a manual search of specific publications and identified articles or reviews through scan readings.

Stage 3: Selection of Studies

The search found 1.961 articles. The subsequent phase of article filtering employs Rayyan AI assistance. The initial phase involves identifying article duplication, which is assessed by the first author (IA) based on established research inclusion criteria. (a) Quantitative or qualitative research publications; (b) published after the first formulation of the scoring system for assessing SKA occurrences; (c) authored in English; (d) complete text; (e) containing information regarding the design, development, and evaluation of the scoring system. We identified 20 articles, performed a comprehensive full-text evaluation, and sought pertinent outcome measures. Both authors (IA and AK) independently reviewed the complete texts of the chosen studies, which were identified according to the inclusion criteria. After a

comprehensive screening and assessment aligned with the review criteria, we identified 18 articles that were deemed appropriate for inclusion in the final dataset. The selection of pertinent articles is determined by research objectives rather than the outcomes of the critical assessment procedure; however, minimum quality norms are incorporated. The researchers conducted a comprehensive systematic assessment of existing studies to ascertain the extent of literature available on their area of investigation (Arksey & O'Malley, 2005). The methodology employed for selecting the papers included is illustrated in Figure 1.

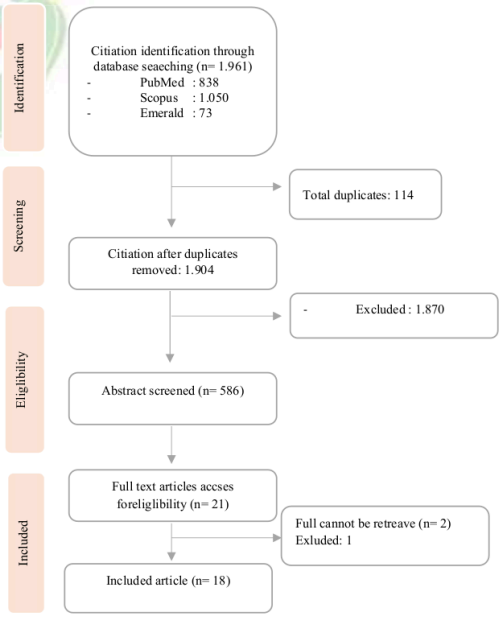

FIGURE 1
PRISMA and the phases of Arksey & O'Malley's framework

Stage 4: Mapping Data

Both writers systematically read each of the 18 selected full-text papers multiple times to extract relevant information and ensure that no critical details were overlooked. This review dataset was constructed based on the formulated questions. The dataset is routinely refined by assessing the consistency of the extracted data with the review questions and research objectives. The retrieved dataset is further classified into authors, study aims, research strategy, generated scoring systems, measured variables, and outcomes, as illustrated in Table 1. Design: The authors examined this dataset.

Stage 5: Collecting, synthesizing, and presenting the findings

Data can be organized and summarized thematically by detecting, analyzing, and elucidating patterns within the dataset to address the research topic (Arskey & O'Malley, 2005).

RESULTS

In this scoping review, a total of 18 articles were analyzed. The studies included in this review span across twenty-one countries, with the highest number of studies originating from the United States (n = 4), followed by the United Kingdom (n = 3), China (n = 3), Italy (n = 2), Canada (n = 2), Sweden (n = 2), Australia (n = 2), Turkey (n = 1), and South Korea (n = 1). In addition, several of the included studies were multi-country investigations, conducted through international collaborations that involved data collection and analysis across multiple healthcare systems. These multi-country studies provide broader comparative perspectives and enhance the external validity of the findings. Nearly all of the articles focused on the development and evaluation of ACS event scoring systems. After reviewing the literature, four main themes were identified in this review: scoring system development, existing scoring systems, scoring techniques, and measurement outcomes.

Development of the ACS scoring system

The individual risk assessment is crucial for the effective management of ACS, as it aims to identify patients at high risk who are most likely to benefit from invasive interventions. This process simultaneously reduces the potential harm associated with unnecessary treatments for low-risk patients and supports prognostic counseling. In alignment with these objectives, clinical practice guidelines underscore the importance of initiating risk assessment immediately upon patient admission. Consequently, healthcare practitioners prioritize not only therapeutic

strategies but also the creation of standardized scoring systems to enhance the evaluation and diagnosis of ACS in individuals presenting with chest pain in the Emergency Department (ED). Predominantly, studies employ cohort designs, combining prospective and retrospective methodologies, to systematically identify and analyze risk factors predictive of ACS occurrences. The research framework encompassed the following phases:

Phase I: Problem identification

Doctors in the ED often face challenges in diagnosing patients with chest pain who do not show clear abnormalities on the ECG. There is an urgent need for a tool that can quickly and accurately identify high-risk patients for serious heart disease in order to guide therapy and treatment decisions.

Phase II: Data collection

The study utilized data collected from individuals admitted to the emergency department with complaints of chest discomfort. The dataset comprised comprehensive clinical evaluations, including medical histories, electrocardiogram (ECG) results, cardiac biomarker analyses, and additional relevant parameters associated with cardiovascular risk stratification. Rigorous inclusion criteria were subsequently formulated to standardize the selection of eligible participants for the investigation. Following this, a systematic approach was employed to develop a predictive scoring model, designed to integrate the collected variables into a structured framework for clinical assessment.

Phase III: Development of Scoring Model

At this stage, the researchers compile data based on various criteria tailored to the conditions of the hospital where they work. Next, determine the score for each assessed variable.

Phase IV: Pilot testing and model validation

After the scoring model was developed, the researchers conducted initial trials on a subset of the population to determine its accuracy and practical utility. Calculating the sensitivity, specificity, positive predictive value, and negative predictive value of the score in predicting ACS events. Next, conduct testing on different cohorts or patient populations to confirm that the results are consistent and applicable to a broader population.

The exists scoring system to assess the ACS Event

This review identified eleven clinical scoring systems utilized to assess and predict the occurrence of ACS. The commonly referenced systems include the Global Registry of Acute Coronary Events (GRACE), the HEART score (History, Electrocardiogram, Age, Risk Factors, Troponin), the Thrombolysis in Myocardial Infarction (TIMI) risk index, the Canada Acute Coronary Syndrome (CACS) score, SAFER, the Chest Pain Score, the BETTER risk stratification tool (Biomarkers and Computed Tomography Score), the ACEF model (Age, Creatinine, Ejection Fraction), the Portuguese Registry on Acute Coronary Syndromes (Pro-ACS), the Novel score, the Manchester Acute Coronary Syndrome (MACS) criteria and the Chest Pain Screening Scale for Triage Nurses (CSS-TN). These frameworks are designed to enhance risk stratification and clinical decision-making in ACS evaluation.

Table 1 Data Extraction

No	Authors/ Country	Design	Sample Size	Phase	Name of Scoring System	Item Evaluated	Findings
1	Akyuz et al., 2016 (Turkey)	Prospective Cohort	396 consecutive patients diagnosed with ACS: NSTEMI	Validation	GRACE (version 2.0)	GRACE score 2.0 for the mortality of NSTE-ACS patients	The findings indicate that the GRACE 2.0 score shows limited accuracy for in-hospital outcomes (AUC 0.53–0.58) but demonstrates better performance for predicting 1-year mortality (AUC 0.51–0.75). Higher risk categories were associated with greater mortality, and patients without angiography had the highest 1-year mortality, while those undergoing PCI or CABG had lower rates. Overall, GRACE 2.0 is effective for 1-year mortality prediction in NSTE-ACS patients, but less reliable for short-term outcomes.
2	Pieper et al., 2009 14 (Argentina, Australia, Austria, Belgium, Brazil, Canada, France, Germany, Italy, New Zealand, Poland, Spain, the United Kingdom, and the United States)	Retrospective Cohort	48.023 Patients with ACS	Modified	GRACE	**1. Killip Class** **2. Systolic Blood** **3. Heart Rate** **4. Age** **5. Creatinin** **6. Baseline risk factors**	The measurement results are divided into 3 (three) categories: 1. Low (Score 0-108) 2. Moderate (Score 109-140) 3. High (Score >140)
3	Six et al., 2013 (australia, china (including Hong Kong), india, indonesia, new Zealand,	Retrospective Cohort Study	2.906 patients presenting with chest discomfort at the emergency departments of 14 hospitals.	Modified	HEART	**1. History** **2. ECG** **3. Age** **4. Risk factors** **5. Troponin**	The criteria for the Heart score for risk classification were as follows: Scores ranging from 0 to 3 points imply minimal risk, 4 to 6 points denote moderate risk, and 7 to 10 points signify high risk for MACE.

No	Authors/ Country	Design	Sample Size	Phase	Name of Scoring System	Item Evaluated	Findings
	Singapore, South Korea, taiwan, and thailand)						
4	Melki & Jernberg, 2013 Sweden	Retrospective observational study	A total of 410 consecutive patients presented to the emergency department with chest discomfort and no ST-segment abnormalities.	Modified	HEART	**1. History** **2. ECG** **3. Age** **4. Risk factors** **5. Troponin**	1. Low risk: 0–3 2. Intermediate: 4–6 3. High: 7–10
5	Georgiopoulos et al., 2023 Greece	Retrospectively designed longitudinal cohort study	A total of 9803 patients ACS from March to June 2023.	Modified	GRACE Risk Score Modification	**1. Killip Class:** **2. Systolic Blood Pressure:** **3. Heart Rate:** **4. Age:** **5. Creatinin:** **6. Baseline risk factor**	1. Low (Score 0-108) 2. Moderate (Score 109-140 3. High (Score >140) Mortality Predicting: 1. In-hospital mortality 2. 30 Day mortality 3. 1-Year mortality
6	Pollack et al., 2006 USA	Prospective observational cohort study	A total of 3,929 adult patients exhibiting chest pain syndrome requiring assessment via ECG	Development	TIMI	1. Age 2. CAD Risk Factors 3. History of CAD 4. Administration of acetylsalicylic acid (ASA) within the preceding seven days. 5. Angina 6. ECG 7. Cardiac Biomarkers	A total of 7 (seven) items are assessed in this scoring system, where a "Yes" answer is given a score of 1 and a "No" answer is given a score of 0. This scoring system will provide information regarding the patient's condition, which is divided into 3 (three) categories: 1. 0 – 2: Low Risk 2. 3 – 4: Moderate risk 3. ≥5: high risk
7	Jaffery et al., 2007	Retrospective Cohort	947 consecutive patients assessed in	Modified	Modified TIMI	1. Age 2. CAD History. 3. Troponin	1. 0 – 1: Low Risk 2. 2: Moderate 3. ≥3: High Risk

No	Authors/ Country	Design	Sample Size	Phase	Name of Scoring System	Item Evaluated	Findings
	USA		the emergency department			4. ECG.	
8	Hess, Perry, et al., 2010 United Kingdom	Prospective cohort study	1017 individuals presenting with chest pain and potential	Validation	Validation TIMI	1. Age 2. Multiple CAD Risk Factors 3. Pre-existing CAD 4. Recent Aspirin Use 5. High-Frequency Angina 6. Ischemic ECG Findings 7. Biomarker Elevation	The revised scoring system emphasizes two key variables: ischaemic ECG changes (ST-segment deviation ≥0.05 mV) and elevated cardiac biomarkers, by increasing their weighting from 1 to 5 points each. This modification expands the total score range from 0–7 to 0–10, thereby enhancing the prognostic value of acute ischaemic and biochemical indicators and improving the accuracy of clinical risk stratification.
9	Huynh et al., 2013 Canada	Retrospective Cohort	3670 patients with ACS	Development	C-ACS	1. Age 2. Killip Class 3. SBP 4. Heart rates	1. 0 – 1: Low Risk 2. 2: Moderate 3. ≥3: High Risk
10	Faxén et al., 2017 Sweden	Derivation cohort	Patient 242.303: Cardiac Arrest Outside Hospital: 240.226 In-hospital cardiac arrest: 2.077	Development	SAFER Score	1. SBP 2. Age 3. Heart Rate 4. ECG 5. Killip Class	The scoring system categorizes risk into low (0–2), intermediate (3–4), high (5–6), and very high (≥7) groups. Higher scores show a significant correlation with increased cardiac arrest risk, demonstrating a progressive rise in adverse outcomes and confirming the system's effectiveness in stratifying ACS patients.
11	Conti et al., 2010 Italy	Prospective Cohort Study	2233 patients with Chest Pain.	Development	Chest Pain Score	1. Location 2. Radiation 3. Character 4. Associated symptoms	The scoring system prioritizes pain-related parameters across four domains. Pain location in the substernal or precordial area receives the highest score (+3), while less specific sites score +1. Pain radiation to the arms, shoulders, back, neck, or jaw adds +1. Pain characteristics described as crushing or pressing are rated +3, whereas atypical sensations score +1. Associated symptoms such as dyspnea, nausea, or diaphoresis contribute +2, and a history of prior chest pain adds +3, reflecting its strong predictive value.

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No	Authors/ Country	Design	Sample Size	Phase	Name of Scoring System	Item Evaluated	Findings
12	Xia et al., 2015 Jiangsu, China	Prospective Cohort Study	The study group consisted of 201 patients with confirmed UA.	Development	Better Score	1. MPO (Myeloperoxidase) 2. Hs-TnT (High-Sensitivity Troponin T) 3. Hs-CRP (High-Sensitivity C-Reactive Protein) 4. Stenosis 5. Plaque 6. EFV (Ectopic Fat Volume)	BETTER risk score = (MPO X 0.1)+ (Hs-TnT X 50)+ (Hs-CRP X 0.4) + stenosis X 9) + (plaque X 13)+ (EFV X 0.2)
13	Ståhli et al., 2018 Swiss	Prospective Cohort Study	A total of 1901 patients prospectively enrolled in the Swiss ACS Cohort were included in the analysis	Development	ACEF Score	1. Age 2. Creatinine 3. Ejection Fraction	ACEF SCORE= (Age / Ejecetion Fraction) + 1
14	Timóteo et al., 2017 Portuguese	Retrospective Cohort Study	8586 patients registry in the Portuguese Multicenter nationwide	Development	PRO ACS	1. Age 2. Systolic Blood Pressure 3. Killip class 4. ST Segment Elevation	The model showed good discriminatory ability, with AUC values of 0.796 in the development cohort and 0.785 in the internal validation cohort (p = 0.333), confirming internal consistency. External validation yielded an AUC of 0.815, indicating excellent predictive performance. Overall, the score is simple, reliable, and valid for predicting in-hospital mortality in patients with acute coronary syndrome.
15	Crim et al., 2016 US	Retrospective Cohort Study	285 patients with known coronary artery disease presenting to the ED with chest pain	Development	Novel Score	1. Prior Revascularization 2. History of Chronic Kidney Disease 3. Onset of chest discomfort at rest 4. Dynamic ECG changes in the ED	1. A history of prior revascularization was associated with a positive score of +1. 2. Documented chronic kidney disease demonstrated an inverse relationship, scoring -1. 3. The presence of chest discomfort onset during rest was assigned a score of +1.

No	Authors/ Country	Design	Sample Size	Phase	Name of Scoring System	Item Evaluated	Findings
						5. Elevated troponin in the ED 6. Associated illness at presentation to the ED	4. Dynamic electrocardiographic changes observed during emergency department evaluation contributed +1 point. 5. Elevated serum troponin levels detected in the emergency department setting demonstrated the strongest predictive value with a score of +3. 6. The presence of concurrent acute comorbid conditions at emergency department presentation showed an inverse association, scoring -2 points.
16	Ma et al., 2016 China	Retrospective cohort study	A total of 1,300 patients admitted to the emergency department with suspected NSTE-ACS were enrolled	Development	Modified Heart	1. History 2. ECG 3. Age 4. Risk Factors 5. Hs-cTnl	The study developed a five-parameter scoring model for assessing acute coronary syndrome risk, incorporating clinical history, ECG findings, age, risk factors, and high-sensitivity cardiac troponin I (hs-cTnI) levels. Each variable was scored from 0 to 2 based on its predictive value. Higher total scores reflecting suspicious clinical presentation, significant ST-segment depression, older age, multiple risk factors, and elevated hs-cTnI were associated with greater ACS probability and adverse outcomes.
17	Body et al., 2014 Manchaster, UK	Two sequential prospective observational cohort studies	790 participant	Development	MACS	1. High sensitivity troponin T 2. ECG Ischemia 3. Sweating Observed 4. Vomiting 5. Systolic blood pressure <100mmHg 6. Worsening angina 7. Pain radiating to right arm or shoulder	The following dichotomous variables were evaluated (presence coded as 1, absence as 0): 1. Elevated high-sensitivity troponin T levels 2. Electrocardiographic evidence of myocardial ischemia 3. Sweating 4. Vomiting 5. Systolic blood pressure below 100 mmHg threshold 6. Progression of angina symptoms 7. Chest pain with radiation to the right upper extremity or shoulder region
18	Jang & Choe, 2024 South Korea	Empirical Quantitative Study:	3.131 patient	Development	Chest Pain Screening Scale for	1. Sex 2. Age	1. Eight significant predictors were proven effective in detecting ACS among patients presenting with chest pain.

No	Authors/ Country	Design	Sample Size	Phase	Name of Scoring System	Item Evaluated	Findings
		Retrospective cohort			Triage Nurses (CSS-TN)	3. Typical ACS symptoms 4. NRS 5. Pain Duration 6. Prior CAD 7. Hypertension 8. Hyperlipidemia	2. Accuracy of the CSS-TN (Chest Pain Screening Scale for Triage Nurses): Sensitivity: 86.6% Specificity: 73.1% AUC (ROC): 0.870 — comparable to mHEART (0.883) and TIMI (0.851). 3. A score of ≥6 indicates a high probability of ACS (71.2% among patients with confirmed ACS). 4. The CSS-TN can be used independently by triage nurses without requiring additional diagnostic tools such as ECG or cardiac enzymes, making it time- and resource-efficient. 5. This scale supports early detection and prioritization of high-risk patients in the emergency department (ED).

Technique for implementing the ACS event scoring system

The scoring technique for assessing ACS varies; the GRACE score includes factors such as Killip Class, systolic blood pressure, heart rate, age, creatinine levels, and baseline features (Akyuz et al., 2016; Georgiopoulos et al., 2023; Pieper et al., 2009). The HEART score consists of five evaluative elements: History, ECG, Age, Risk Factors, and creatinine levels (Ma et al., 2016; Melki & Jernberg, 2013; Six et al., 2013a). The TIMI scoring assesses the following criteria: age, coronary artery disease risk factors, established coronary artery disease, aspirin usage, severe angina, electrocardiogram findings, and positive cardiac biomarkers (Jaffery et al., 2007; Pollack et al., 2006). The elements evaluated in the CACS score include Age, Killip class, SBP, and Heart Rate (Huynh et al., 2013).

SAFER scoring system, the items assessed are SBP, Age, Heart Rate, ST abnormal, and Killip class. Chest pain score: the items evaluated are location, radiation, character, and associated symptoms (Conti et al., 2010). Next, the BETTER score items evaluated are the levels of myeloperoxidase, Hs-TnT (High Sensitivity Troponin T), Hs-CRP (High-Sensitivity C-Reactive Protein), stenosis, plaque, and EFV (Ectopic Fat Volume) (Xia et al., 2015). ACEF Score, several items that are assessed are Age, Creatinine, and Ejection Fraction. Next, in the Pro-ACS, several items are assessed, namely Age, SBP, Killip Class, and ST Segment Elevation (Timóteo et al., 2017). The subsequent scoring model is the Novel Score, which considers several clinical variables, including previous revascularization procedures, a history of chronic kidney disease, the onset of chest pain at rest, dynamic electrocardiographic changes observed in the emergency department, elevated troponin levels detected in the emergency setting, as well as comorbid conditions identified at the time of presentation to the emergency department (Crim et al., 2016). Next, the MACS scoring system evaluates high sensitivity troponin T, ECG, observed sweating, vomiting, SBP, worsening angina, and pain radiating to the right arm or shoulder (Body et al., 2014).

Recently, Jang and Choe (2024) developed the Chest Pain Screening Scale for Triage Nurses (CSS-TN), a novel diagnostic model specifically designed to aid nurses in independently identifying patients with a high probability of ACS during triage. The CSS-TN includes eight predictors: sex, age, typical ACS symptoms, pain intensity based on the Numeric Rating Scale

(NRS), pain duration, history of coronary artery disease (CAD), hypertension, and hyperlipidemia (Jang & Choe, 2025).

Measurement Outcomes of Scoring Systems in Patients with ACS

Various risk scoring systems have been developed to support early diagnosis, risk stratification, and prognosis assessment in patients with Acute Coronary Syndrome (ACS). These systems differ in their primary purposes, predictive variables, and clinical contexts of use. Broadly, ACS scoring systems can be categorized into three major groups: (1) diagnostic scores, (2) prognostic scores, and (3) cardiac arrest predictive scores.

The diagnostic scoring systems are primarily designed to identify patients with chest pain who are at high risk of ACS, particularly in emergency and pre-hospital settings. The HEART score is among the most widely adopted tools for assessing short-term MACE in patients presenting with chest pain (Ma et al., 2016; Melki & Jernberg, 2013; Six et al., 2013a). The TIMI score is also frequently utilized to stratify risk in patients with unstable angina or NSTEMI, incorporating age, cardiovascular risk factors, aspirin use, and electrocardiographic changes (Jaffery et al., 2007; Pollack et al., 2006). Other models such as the MACS score and the Novel score integrate clinical presentation, ECG findings, and high-sensitivity troponin levels to enhance diagnostic precision. Likewise, the Chest Pain Score evaluates symptom characteristics, including location, radiation, quality, and associated manifestations to distinguish ischemic from non-ischemic chest pain during triage (Body et al., 2014).

A recent advancement in this group is the CSS-TN, developed by Jang & Choe (2025) in South Korea. This instrument was specifically designed for use by triage nurses to identify ACS risk based on clinical and demographic predictors. The CSS-TN incorporates eight significant variables: sex, age, typical ACS symptoms, pain intensity (NRS), pain duration, history of coronary artery disease (CAD), hypertension, and hyperlipidemia.

The second category, prognostic scoring systems, focuses on estimating mortality and cardiovascular complications among patients with confirmed ACS. The GRACE score is one of the most comprehensive and globally validated models, incorporating parameters such as age, heart rate, systolic blood pressure, serum creatinine, Killip class, and ST-segment deviation (Akyuz et al., 2016; Georgiopoulos et al., 2023; Pieper et al., 2009). Other models,

including C-ACS and PRO-ACS, assess mortality risk using simplified clinical parameters such as age, blood pressure, and heart failure classification (Huynh et al., 2013; Timóteo et al., 2016). Additionally, the BETTER score employs a biomarker-based approach combining MPO, hs-TnT, hs-CRP, coronary stenosis, and ectopic fat volume to predict mortality risk, while the ACEF score serves as a reliable predictor of MACE and mortality in patients undergoing coronary intervention (Xia et al., 2015).

The third group, cardiac arrest predictive scores, identifies ACS patients at elevated risk of cardiac arrest or hemodynamic instability during the acute phase. The SAFER score exemplifies this category, using five variables: systolic blood pressure <100 mmHg, age ≥60 years, abnormal heart rate (<50 or ≥100 bpm), ST-T abnormalities, and Killip class >1 (Faxén et al., 2017).

Overall, diagnostic scores such as HEART, TIMI, and CSS-TN play an essential role in early detection and triage of chest pain patients; prognostic scores like GRACE, C-ACS, and ACEF contribute to mortality prediction and outcome evaluation; and predictive scores such as SAFER assist in identifying patients at imminent risk of cardiac arrest. Integration of these scoring systems provides a comprehensive framework for healthcare professional sparticularly triage nurses and emergency clinicians to enhance diagnostic accuracy, clinical decision-making efficiency, and patient safety in the management of ACS.

DISCUSSION

This review presents the scoring systems used to assess the incidence and prognosis in patients with ACS in the Hospital. Eleven scoring systems used in assessing the incidence and prognosis are included in this article. In this coverage review, the first step is to describe the development of the ACS event scoring system. Based on the information obtained from the article, it shows that the development of the scoring system has been carried out by various countries. Furthermore, developed countries contribute the most to the development of scoring systems in this review, such as the United States, the UK, China, Canada, and Portugal. The prevalence of coronary heart disease affects approximately 15.5 million people in the United States. The American Heart Association estimates that someone has a heart attack every 41 seconds. Heart disease is the leading cause of death in the United States. Chest pain is one of the main reasons for visits to the emergency room (Singh et al., 2023).

From this data, it is clear that the United States has a very high percentage of ACS incidents, with a heart attack occurring every 41 seconds. In this case, to reduce the mortality rate caused by ACS events, researchers and healthcare professionals have developed methods that can quickly, accurately, and effectively assess the diagnosis, thereby providing the best interventions. In addressing this issue, the development of predictive tools is necessary to assist healthcare professionals in the field in assessing patient conditions, namely, scoring systems that evaluate several indicators based on the patient's clinical manifestations. Several scoring systems have been developed in the US, such as the GRACE and TIMI scores (Akyuz et al., 2016; Georgiopoulos et al., 2023; Jaffery et al., 2007; Pieper et al., 2009; Pollack et al., 2006).

Based on the reviewed articles from various developed scoring systems, there are several factors that almost always serve as indicators evaluated in the scoring systems, namely age, SBP, risk factors, heart rate, troponin, and ECG findings. Age ≥65 years is typically used as the cutoff, reflecting the strong influence of aging on cardiovascular risk. In our study, the majority of respondents (80.3%) were in the older age group, which further highlights the clinical relevance of age as a key determinant in risk stratification (Muliantino et al., 2024). Aging is associated with impaired coronary endothelial function and a reduced capacity to increase coronary blood flow, thereby predisposing older adults to MI and NSTEMI (Ferrucci & Fabbri, 2018).

Moreover, endothelial dysfunction, in conjunction with inflammation, is a significant catalyst of atherosclerosis, leading to a heightened incidence of both subclinical and manifest coronary artery disease with advancing age. Moreover, while chronic inflammation is not a natural aspect of normal aging, it frequently coexists with other age-related diseases and disorders, such as diabetes, arthritis, and frailty. The interplay of endothelial dysfunction and chronic inflammation fosters an environment conducive to the onset and advancement of coronary artery disease in older persons (Ferrucci & Fabbri, 2018).

SBP is an important indicator in assessing risk and predicting outcomes in patients with ACS. Blood pressure is one of the most accessible physiological indices that can be obtained within minutes after an AMI patient enters the emergency room, and it is even easier to obtain compared to other clinical data, such as troponin levels. Therefore, systolic blood pressure upon

admission can be used as a predictive factor for rapid clinical evaluation and studies of adverse cardiovascular outcomes (Pei et al., 2020). The Acute Coronary Syndrome Israel Survey (ACSIS) study on 7645 patients showed that low SBP (<110 mm Hg) is associated with an increased risk of death within 7 days and 1 year, as well as major adverse cardiovascular events (MACE) (Park et al., 2015). These findings suggest that SBP at admission has a significant impact on short-term outcomes in patients with AMI and may provide new guidance for clinical assessment and management (Pei et al., 2020).

In addition, risk factors such as hypertension, hypercholesterolemia, diabetes, family history of CAD, or current smoking are indicators that are almost always assessed to predict and evaluate the prognosis of patients with ACS. This is in line with the JSC 2018 guidelines on the management of ACS, which state that ACS is more likely to occur if there are at least 3 risk factors (age, smoking, dyslipidemia, diabetes mellitus, hypertension, family history, and kidney disorders), in addition to symptoms pointing towards ACS (Kimura et al., 2019).

The cardiac biomarker test commonly used to assess whether someone is experiencing ACS, in this case, is troponin T. Several studies have reported a number of clinically relevant findings related to significantly higher concentrations of hs-cTnT in patients with acute total occlusion (TO) and hs-cTnT being an independent predictor of acute TO. The cut-off value of 1006 ng/L hs-cTnT shows good accuracy for the diagnosis of acute TO (Baro et al., 2019). Furthermore, high-sensitivity cardiac troponin tests allow for earlier detection of myocardial injury (Khan et al., 2021).

12 Lead EKG examination, this examination remains the primary choice for evaluating patients with ACS during the first medical contact in detecting the presence and severity of coronary occlusion, thereby guiding timely therapeutic interventions and significantly improving patient outcomes (Bouzid et al., 2021).

This scoring system makes it easier for staff, especially nurses, to make accurate decisions in the ED without the need for invasive supporting examinations. In addition, this system can accelerate the diagnostic process, improve prognosis, and reduce the burden on the healthcare system. Thus, nurses can accurately diagnose and determine the necessary interventions for patients with ACS. On the other hand, for patients experiencing chest pain with a low-risk

score, they can go home without needing prolonged treatment, additional examinations, or excessive interventions (Sukamto, 2017).

CONCLUSIONS

This scoping analysis indicates the presence of various scoring systems intended to assess and predict the occurrence and outcome of acute coronary syndrome. Comprehensive scoring systems incorporate clinical risk evaluations that integrate demographic factors, symptoms, and supporting examination results. Despite progress in developing these tools, variability in methodology and clinical circumstances poses a challenge for consistent implementation. Further research is necessary to assess the validity and reliability of the existing scoring systems and to standardize the implementation of this instrument in clinical practice. Thus, the development of a more accurate and reliable scoring system is expected to assist healthcare providers in improving the management of patients with ACS.

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