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ACUTE CORONARY SYNDROME: EARLY DIAGNOSIS AND THERAPEUTIC MANAGEMENT IN EMERGENCY DEPARTMENT

SÍNDROME CORONARIANA AGUDA: DIAGNÓSTICO PRECOCE E MANEJO TERAPÊUTICO NA EMERGÊNCIA

SÍNDROME CORONARIO AGUDO: DIAGNÓSTICO PRECOZ Y MANEJO TERAPÉUTICO EN URGENCIAS

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ABSTRACT

Cardiovascular diseases remain the leading cause of global morbidity and mortality, and acute coronary syndrome (ACS) represents a major challenge in urgent and emergency care services. This narrative review synthesizes evidence published between 2021 and 2025 on the early diagnosis and management of ACS in emergency settings. Contemporary diagnosis is based on the integration of clinical assessment, a 12-lead electrocardiogram, and high-sensitivity cardiac biomarkers, especially troponin. The adoption of accelerated diagnostic algorithms (0/1 h and 0/2 h) has increased the efficiency and safety of clinical workflows, allowing reliable exclusion of acute myocardial infarction in low-risk patients when applied in conjunction with clinical judgment. Risk stratification is improved through validated scores, particularly the HEART score for short-term mortality prediction and the T-MACS score for identifying patients at higher risk of major adverse cardiovascular events. In ACS without persistent ST-segment elevation, the timing of coronary angiography is determined by the ischemic risk profile, with immediate invasive strategy recommended for very high-risk patients and early invasive approach for high-risk individuals. Initial therapeutic management includes antiplatelet therapy and anticoagulation, balancing ischemic benefit and bleeding risk. Challenges persist due to the heterogeneity of clinical presentations and disparities in care, especially among women and older adults. Overall, recent advances support a care model increasingly guided by risk stratification, standardized protocols, and technological integration.

Keywords: Acute Coronary Syndrome. Early Diagnosis. Emergency Medicine. Myocardial Infarction. Therapeutics.

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RESUMO

As doenças cardiovasculares permanecem como a principal causa de morbimortalidade global, e a síndrome coronariana aguda (SCA) constitui um desafio central nos serviços de urgência e emergência. Esta revisão narrativa sintetiza evidências publicadas entre 2021 e 2025 sobre o diagnóstico precoce e o manejo da SCA no contexto emergencial. O diagnóstico contemporâneo baseia-se na integração entre avaliação clínica, eletrocardiograma de 12 derivações e biomarcadores cardíacos de alta sensibilidade, especialmente a troponina. A adoção de algoritmos diagnósticos acelerados (0/1 h e 0/2 h) aumentou a eficiência e a segurança do fluxo assistencial, permitindo a exclusão confiável de infarto agudo do miocárdio em pacientes de baixo risco, quando aplicada em consonância com o julgamento clínico. A estratificação de risco é aprimorada pelo uso de escores validados, destacando-se o HEART na predição de mortalidade em curto prazo e o T-MACS na identificação de pacientes com maior risco de eventos adversos cardiovasculares maiores. Na SCA sem supradesnivelamento persistente do segmento ST, o momento da cineangiocoronariografia é determinado pelo perfil de risco isquêmico, recomendando-se estratégia invasiva imediata para pacientes de muito alto risco e abordagem precoce para aqueles de alto risco. O manejo terapêutico inicial inclui antiagregação plaquetária e anticoagulação, equilibrando benefício isquêmico e risco hemorrágico. Persistem desafios relacionados à heterogeneidade das apresentações clínicas e às disparidades assistenciais, especialmente em mulheres e idosos. Em conjunto, os avanços recentes apontam para um modelo de cuidado progressivamente orientado pela estratificação de risco, protocolos padronizados e integração tecnológica.

Palavras-chave: Síndrome Coronariana Aguda. Diagnóstico Precoce. Medicina de Emergência. Infarto do Miocárdio. Terapêutica.

RESUMEN

Las enfermedades cardiovasculares continúan siendo la principal causa de morbimortalidad a nivel mundial, y el síndrome coronario agudo (SCA) constituye un desafío central en los servicios de urgencias y emergencias. Esta revisión narrativa sintetiza evidencias publicadas entre 2021 y 2025 sobre el diagnóstico precoz y el manejo del SCA en el contexto asistencial de emergencia. El diagnóstico contemporáneo se basa en la integración de la evaluación clínica, el electrocardiograma de 12 derivaciones y biomarcadores cardíacos de alta sensibilidad, especialmente la troponina. La adopción de algoritmos diagnósticos acelerados (0/1 h y 0/2 h) ha incrementado la eficiencia y la seguridad del flujo asistencial, permitiendo la exclusión fiable del infarto agudo de miocardio en pacientes de bajo riesgo cuando se aplica en concordancia con el juicio clínico. La estratificación del riesgo se optimiza mediante el uso de escalas validadas, destacándose el puntaje HEART en la predicción de mortalidad a corto plazo y el T-MACS en la identificación de pacientes con mayor riesgo de eventos cardiovasculares adversos mayores. En el SCA sin elevación persistente del segmento ST, el momento de la coronariografía se determina según el perfil de riesgo isquémico, recomendándose una estrategia invasiva inmediata en pacientes de muy alto riesgo y una estrategia precoz en aquellos de alto riesgo. El manejo terapéutico inicial incluye antiagregación plaquetaria y anticoagulación, equilibrando el beneficio isquémico y el riesgo hemorrágico. Persisten desafíos relacionados con la heterogeneidad de las presentaciones clínicas y las desigualdades asistenciales, especialmente en mujeres y adultos mayores. En conjunto, los avances recientes apuntan hacia un modelo de atención progresivamente orientado por la estratificación del riesgo, protocolos estandarizados e integración tecnológica.

Palabras clave: Síndrome Coronario Agudo. Diagnóstico Precoz. Medicina de Urgencias. Infarto de Miocardio. Tratamiento.

1 INTRODUCTION

Cardiovascular diseases remain the leading cause of global morbidity and mortality, with acute coronary syndrome (ACS) diagnosed in more than seven million individuals annually worldwide (Bhatt, Lopes e Harrington, 2022). ACS comprises a broad clinical spectrum, including ST-segment elevation myocardial infarction (STEMI), non–ST-segment elevation myocardial infarction (NSTEMI), and unstable angina—conditions that may coexist or evolve during initial evaluation (Rao *et al*, 2025). Although sharing an atherothrombotic substrate, these entities exhibit marked heterogeneity in presentation, risk, and prognosis, requiring individualized diagnostic and therapeutic strategies (Kraler *et al*, 2025).

Patient prognosis is highly dependent on the timeliness of care, as delays in diagnosis or treatment are associated with larger infarct size, heart failure, and increased mortality (de Barros e Silva *et al*, 2025). Current guidelines therefore recommend acquisition and interpretation of a 12-lead electrocardiogram (ECG) within 10 minutes of first medical contact as a cornerstone of early risk stratification (Byrne *et al*, 2023). Concurrently, high-sensitivity cardiac troponin (hs-cTn) assays have become central to detecting myocardial injury, enabling earlier and more accurate identification of acute myocardial infarction than conventional biomarkers (Rao *et al*, 2025).

Accelerated diagnostic algorithms, particularly the 0/1-hour and 0/2-hour protocols, have improved diagnostic accuracy and safety in emergency departments, supporting rapid rule-in or rule-out decisions (Engström, Mokhtari e Ekelund, 2024). Validated risk scores, notably the HEART score, further enhance short-term prognostic assessment, demonstrating high discriminatory performance for 30-day mortality (Aktemur *et al*, 2025). Integration of biomarker-based algorithms with structured risk stratification allows safe exclusion of infarction in low-risk patients and reduces unnecessary hospital admissions (Gulati *et al*, 2021).

Despite advances in reperfusion and antithrombotic therapies (Lima Filho *et al*, 2024), important challenges persist, especially variability in clinical presentation and sex- and age-related disparities (Zou *et al*, 2021). Women more frequently present with non-obstructive mechanisms and atypical symptoms, contributing to diagnostic delay and undertreatment (Kraler *et al*, 2025). Emerging precision medicine approaches and artificial intelligence–based tools hold promise for improving individualized ACS management (Kraler *et al*, 2025). Accordingly, this review synthesizes contemporary evidence on early diagnosis and therapeutic management of ACS in emergency care.

2 METHODS

This descriptive narrative review aimed to synthesize contemporary evidence on early diagnosis and therapeutic management of ACS in emergency care settings. A literature search was conducted in PubMed/MEDLINE using Medical Subject Headings (MeSH) combined with Boolean operators (AND/OR). Search terms included “Acute Coronary Syndrome,” “Myocardial Infarction,” “Emergency Medical Services,” and “Therapeutic Management.”

Eligible publications comprised original studies, systematic reviews, meta-analyses, and clinical guidelines from recognized scientific societies, including the Brazilian Society of Cardiology (BSC), the American College of Cardiology/American Heart Association (ACC/AHA), and the European Society of Cardiology (ESC). Only full-text articles published between 2021 and 2025 in English or Portuguese were included. Studies unrelated to emergency care, case reports, animal studies, pediatric populations, and publications focused exclusively on rehabilitation or outpatient follow-up were excluded.

Study selection involved title and abstract screening followed by full-text review. Extracted data were analyzed descriptively to provide an integrated synthesis of evidence on high-sensitivity cardiac biomarkers, accelerated diagnostic algorithms, and contemporary reperfusion and antithrombotic strategies in ACS.

3 RESULTS AND DISCUSSION

3.1 EARLY DIAGNOSIS IN THE EMERGENCY SETTING

Early diagnosis of ACS is fundamentally based on the rapid identification of patients with acute myocardial ischemia and immediate risk stratification. The primary objective is to minimize delays to reperfusion while simultaneously avoiding unnecessary hospital admissions and diagnostic testing in low-risk patients (Byrne *et al*, 2023). Contemporary guidelines recommend that the initial assessment integrates focused clinical history, physical examination, ECG, and cardiac biomarkers, prioritizing standardized diagnostic pathways to accelerate clinical decision-making and improve safety (Gulati *et al*, 2021; Byrne *et al*, 2023).

3.1.1 Initial clinical assessment and variability of presentations

Beyond symptom characterization, clinical assessment should be understood as a tool for estimating pre-test probability rather than establishing a definitive diagnosis. Typical anginal features increase diagnostic likelihood, whereas atypical presentations substantially reduce the discriminatory value of history alone, particularly in women, older adults, and patients with diabetes or chronic kidney disease (Byrne *et al*, 2023; Kraler *et al*, 2025). In this

context, pre-test probability directly influences the interpretation of ECG findings and hs-cTn results, reinforcing that neither biomarker elevation nor normal values should be interpreted in isolation. Structured integration of clinical probability with objective testing remains essential to avoid both false reassurance and unnecessary escalation of care (Gulati *et al*, 2021; Byrne *et al*, 2023).

Clinical history remains essential for estimating the pre-test probability of ACS, encompassing characterization of chest pain and anginal equivalents such as dyspnea, diaphoresis, fatigue, or syncope (Gulati *et al*, 2021). However, substantial heterogeneity in clinical presentations—particularly among older adults, women, and patients with multiple comorbidities—significantly limits the diagnostic accuracy of isolated clinical assessment (Byrne *et al*, 2023; Kraler *et al*, 2025). As a result, integration with electrocardiography and hs-cTn testing is indispensable to reduce the risk of misdiagnosis and inappropriate clinical management (Gulati *et al*, 2021; Byrne *et al*, 2023).

3.1.2 Central role of electrocardiography in triage

The ECG remains the most decisive initial diagnostic test in the evaluation of patients with suspected ACS, playing a central role in the detection of acute myocardial ischemia and in guiding time-sensitive therapeutic decisions. Immediate ECG interpretation enables prompt differentiation between ST-segment elevation myocardial infarction (STEMI) and non–ST-segment elevation ACS (NSTE-ACS) (Bergmark *et al*, 2022; Byrne *et al*, 2023; Rao *et al*, 2025).

Contemporary guidelines recommend that a 12-lead ECG be obtained and interpreted within 10 minutes of first medical contact, representing a key quality-of-care indicator in ACS management (Byrne *et al*, 2023). Whenever feasible, early diagnosis in the prehospital setting is encouraged, as it facilitates rapid activation of cardiac catheterization laboratories and optimization of care pathways for immediate reperfusion (de Barros e Silva *et al*, 2025; Rao *et al*, 2025). This approach is critical for reducing total ischemic time and mortality, as evidence consistently shows that each 30-minute delay to reperfusion is associated with an approximately 7.5% relative increase in the risk of death (de Barros e Silva *et al*, 2025; Rao *et al*, 2025).

In patients with NSTE-ACS, serial ECG acquisition is mandatory when symptoms persist or when clinical suspicion remains high, reflecting the dynamic nature of ischemic electrocardiographic changes (Gulati *et al*, 2021; Byrne *et al*, 2023). In this context, prehospital telecardiology has demonstrated significant reductions in door-to-balloon time and in-hospital mortality by enabling earlier diagnosis and timely activation of specialized care

teams (Bergmark *et al*, 2022; Byrne *et al*, 2023; de Barros e Silva *et al*, 2025; Rao *et al*, 2025).

Recently, machine learning (ML) has enhanced the detection of occlusion myocardial infarction beyond conventional STEMI criteria, particularly in patients with subtle findings. By identifying high-risk patterns not captured by ST-elevation alone, these models support improved risk stratification and timely reperfusion, reinforcing the role of ECG analysis in emergency care (Al-Zaiti *et al*, 2023).

3.1.3 High-sensitivity troponin and accelerated diagnostic algorithms

The introduction of hs-cTn assays has established them as the preferred standard for detecting myocardial injury and underpinning rule-in or rule-out strategies for AMI (Sandoval *et al*, 2022; Byrne *et al*, 2023; Rao *et al*, 2025). Diagnostic algorithms based on hs-cTn—specifically the 0/1-hour and 0/2-hour protocols—substantially enhance emergency department efficiency by allowing rapid classification of patients into rule-out, observation, or rule-in categories (Byrne *et al*, 2023).

Importantly, hs-cTn reflects a continuum of myocardial injury rather than a binary diagnostic marker for ACS. Contemporary definitions emphasize the distinction between acute myocardial injury and AMI, the latter requiring evidence of ischemia in addition to troponin elevation (Byrne *et al*, 2023; Rao *et al*, 2025). Both absolute troponin concentrations and dynamic changes over time (delta values) contribute to risk stratification, with greater deltas conferring higher likelihood of ischemic injury. Failure to incorporate clinical context and troponin kinetics may lead to misclassification, particularly in patients with chronic troponin elevation or structural heart disease (Sandoval *et al*, 2022; Ashburn *et al*, 2023).

In this context, emerging evidence suggests that ML models leveraging cardiac troponin concentrations as continuous variables may further improve diagnostic accuracy beyond conventional threshold-based algorithms. Such approaches may enhance individualized risk assessment and support more nuanced clinical decision-making in the early evaluation of suspected AMI (Doudesis *et al*, 2023).

Direct comparative studies indicate that while both algorithms demonstrate excellent safety profiles, the 0/2-hour protocol may classify a larger proportion of patients as rule-out compared with the 0/1-hour approach (Engström, Mokhtari e Ekelund, 2024).

Nevertheless, caution is warranted when applying troponin-only algorithms in isolation, particularly in subgroups with known coronary artery disease, in whom the negative predictive value for 30-day adverse events may fall below accepted safety thresholds, making integration with clinical risk scores essential (Ashburn *et al*, 2023). Moreover, persistent sex-

related disparities have been observed, as evidence indicates that low troponin concentrations in women often fail to trigger proportional intensification of clinical management, a phenomenon associated with a significantly increased risk of death or myocardial infarction at 12 months (Lambrakis *et al*, 2023).

3.1.4 Risk stratification and integrated clinical decision-making

Early diagnosis and safe triage in the emergency setting rely on the integration of clinical history, ECG findings, biomarker assessment, and validated risk scores (Byrne *et al*, 2023; de Barros e Silva *et al*, 2025). Although international guidelines recommend the GRACE score as the standard tool for prognostic estimation and determination of angiography urgency, alternative models such as HEART and T-MACS offer superior diagnostic performance and stronger support for early discharge decisions in emergency care (Gulati *et al*, 2021; Aktemur *et al*, 2025; de Barros e Silva *et al*, 2025).

The HEART score has emerged as one of the most reliable predictors of 30-day mortality, demonstrating an area under the receiver operating characteristic curve (AUC) of 0.929 and a reported sensitivity of 100% for this outcome (Aktemur *et al*, 2025). Conversely, the T-MACS score, which incorporates variables such as vital signs and physical examination findings, shows superior performance in identifying patients at high risk for major adverse cardiac events, with particular sensitivity for global ischemic outcomes (Akman *et al*, 2023; Aktemur *et al*, 2025). In resource-limited settings or in prehospital care where hs-cTn testing is unavailable, the HE-MACS score represents an effective alternative for safe risk exclusion in highly selected subgroups (Todd, Duff e Carlton, 2022; Aktemur *et al*, 2025). Comparative performance of these models, as demonstrated in prospective analytical data from 2025, is summarized in Table 1 (Aktemur *et al*, 2025).

Table 1

Performance of the HEART, T-MACS, and HE-MACS risk scores for prediction of 30-day mortality (adapted from Aktemur et al)

Risk score	AUC (Mortality)	Sensitivity (%)	Specificity (%)	Cut-off (original scale)	Interpretative summary
HEART	0.929	100.0	81.0	6.5	Highest discriminative performance; useful for prognostic stratification and support of safe early discharge.

T-MACS	0.875	85.7	83.9	32.5	Balanced sensitivity and specificity; useful for identifying patients at higher risk.
HE-MACS	0.729	71.4	80.7	40.9	Lower performance in this study; applicability depends on clinical context.

Abbreviations: AUC, area under the receiver operating characteristic (ROC) curve; HEART, History, ECG, Age, Risk factors, Troponin; T-MACS, Troponin-only Manchester Acute Coronary Syndrome; HE-MACS, History and ECG-only Manchester Acute Coronary Syndrome.
Notes: For the HEART score, cut-off values are expressed as absolute scores, whereas T-MACS and HE-MACS are expressed as estimated probabilities (%).

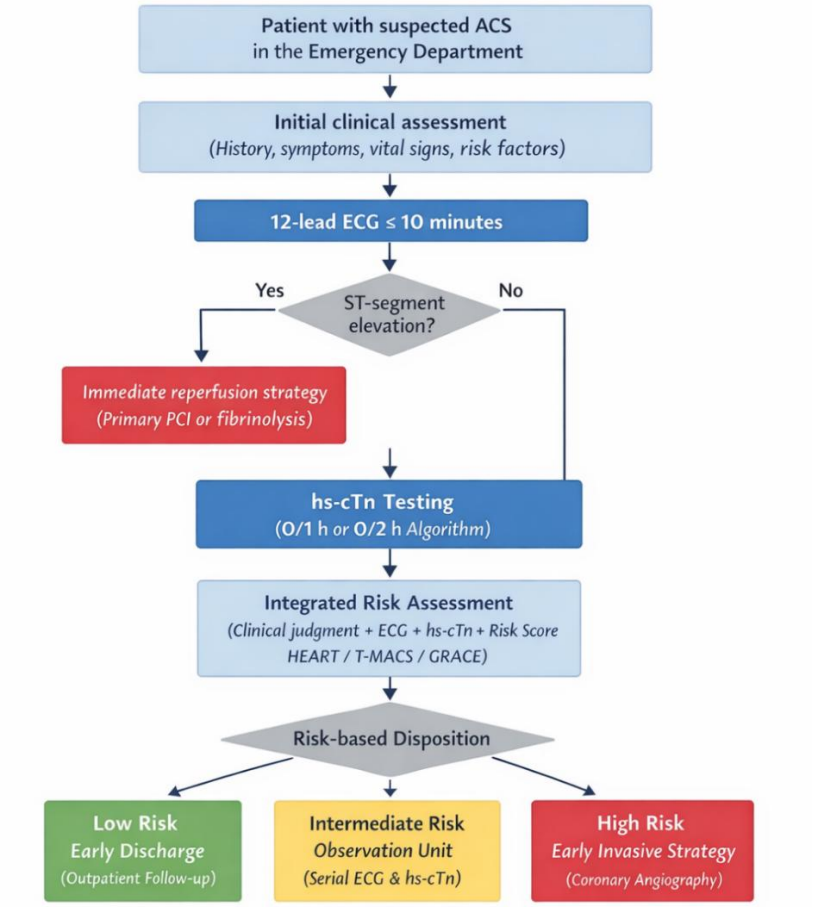
The differential performance of HEART, T-MACS, and HE-MACS reflects fundamental distinctions between diagnostic and prognostic modeling. HEART demonstrates superior performance for short-term mortality prediction, supporting its role in prognostic stratification and early discharge decisions, whereas T-MACS shows greater sensitivity for identifying patients at risk of major adverse cardiac events, favoring its use in early diagnostic triage (Akman *et al*, 2023; Aktemur *et al*, 2025). These complementary characteristics underscore that no single score is universally optimal; instead, score selection should be tailored to the clinical objective—diagnostic exclusion, prognostic estimation, or prioritization of invasive evaluation—within an integrated decision-making framework (Gulati *et al*, 2021; Aktemur *et al*, 2025; de Barros e Silva *et al*, 2025).

The application of these risk scores, when integrated with accelerated hs-cTn algorithms (0/1-hour or 0/2-hour), enables dynamic and individualized risk stratification (Sandoval *et al*, 2022; Byrne *et al*, 2023; Engström, Mokhtari e Ekelund, 2024; de Barros e Silva *et al*, 2025). This integrated model should guide decisions regarding the need for intensive monitoring and prioritization of coronary angiography, optimizing patient flow by reducing unnecessary admissions in low-risk cases while preventing therapeutic delays in patients with instability or high ischemic risk (Sandoval *et al*, 2022; Byrne *et al*, 2023; Rao *et al*, 2025). However, exclusive reliance on troponin-based algorithms requires caution in patients with prior coronary artery disease, in whom integration with clinical risk scores is mandatory to maintain diagnostic safety (Ashburn *et al*, 2023; Byrne *et al*, 2023; de Barros e Silva *et al*, 2025; Kraler *et al*, 2025).

A practical synthesis of this integrated diagnostic and risk stratification approach, applicable to routine emergency department workflows, is summarized in Figure 1.

Figure 1

Practical emergency department pathway for early diagnosis and risk stratification of ACS



ACS, acute coronary syndrome; ECG, electrocardiogram; hs-cTn, high-sensitivity cardiac troponin; PCI, percutaneous coronary intervention; HEART, History, ECG, Age, Risk factors, Troponin; T-MACS, Troponin-only Manchester Acute Coronary Syndrome; GRACE, Global Registry of Acute Coronary Events.
Source: Developed by the authors**.**

3.1.5 Limitations of biomarkers and differential diagnosis

It is imperative to recognize that troponin elevation reflects myocardial injury but is not synonymous with ACS. Conditions such as tachyarrhythmias, heart failure, myocarditis, pulmonary embolism, sepsis, and chronic kidney disease may also result in elevated troponin levels (Gulati *et al*, 2021; Bhatt, Lopes e Harrington, 2022; Byrne *et al*, 2023; de Barros e Silva *et al*, 2025). Interpretation must therefore account for the clinical context, dynamic patterns of rise and fall, and adjunctive imaging findings to avoid both underdiagnosis of ACS and inappropriate treatment of non-ischemic etiologies (Gulati *et al*, 2021; Bhatt, Lopes e Harrington, 2022; Sandoval *et al*, 2022; Byrne *et al*, 2023; de Barros e Silva *et al*, 2025). In cases of diagnostic uncertainty among intermediate-risk patients, stress cardiovascular magnetic resonance (CMR) imaging has emerged as a feasible strategy to determine the underlying etiology of myocardial injury (Cavalier *et al*, 2025).

3.2 THERAPEUTIC MANAGEMENT IN THE EMERGENCY SETTING

Management of ACS must be initiated immediately to limit myocardial injury, prevent recurrent ischemic events, and reduce mortality (Bhatt, Lopes e Harrington, 2022; Byrne *et al*, 2023; de Barros e Silva *et al*, 2025). The initial strategy is determined by the clinical presentation, ECG findings, and structured risk stratification, enabling early separation of patients who require immediate invasive management from those suitable for an initial conservative approach (Byrne *et al*, 2023; Lima Filho *et al*, 2024; Rao *et al*, 2025).

3.2.1 Initial pharmacotherapy and supportive measures

Antiplatelet therapy is a cornerstone of ACS management. Acetylsalicylic acid (ASA) should be administered to all patients without contraindications, using a loading dose of 162–325 mg, preferably chewed, followed by a maintenance dose of 75–100 mg daily (Bhatt, Lopes e Harrington, 2022; Rao *et al*, 2025). Dual antiplatelet therapy (DAPT) requires the addition of a P2Y12 receptor inhibitor, with prasugrel or ticagrelor preferred over clopidogrel due to greater potency, faster onset of action, and superior reduction of ischemic events and stent thrombosis (Byrne *et al*, 2023; Rao *et al*, 2025).

Parenteral anticoagulation should be initiated promptly at the time of ACS diagnosis (Byrne *et al*, 2023; Rao *et al*, 2025). Unfractionated heparin (UFH) remains the standard for patients undergoing percutaneous coronary intervention (PCI), while enoxaparin or fondaparinux are appropriate alternatives during conservative management or delayed invasive strategies; however, fondaparinux should not be used as the sole anticoagulant during PCI because of the risk of catheter thrombosis (Byrne *et al*, 2023; Rao *et al*, 2025).

Supportive measures include cautious use of nitrates for ischemic symptom relief, avoiding administration in patients with hypotension or recent phosphodiesterase-5 inhibitor use, and limiting oxygen therapy to those with hypoxemia (SaO_2 < 90%), as routine hyperoxia provides no benefit and may increase myocardial injury (Byrne *et al*, 2023; Rao *et al*, 2025). Oral beta-blockers and high-intensity statins should be initiated early, preferably within the first 24 hours, in hemodynamically stable patients without signs of acute heart failure or shock (Bergmark *et al*, 2022; Byrne *et al*, 2023; Rao *et al*, 2025).

3.2.2 Reperfusion strategies in STEMI

STEMI requires immediate restoration of coronary blood flow to limit myocardial damage, prevent complications, and reduce mortality (Bhatt, Lopes e Harrington, 2022; Byrne *et al*, 2023; Rao *et al*, 2025). Primary PCI is the preferred reperfusion strategy when it can be performed within 120 minutes of ECG diagnosis (Bhatt, Lopes e Harrington, 2022;

Byrne *et al*, 2023; Rao *et al*, 2025). When this timeframe is not achievable, fibrinolysis should be initiated ideally within 10 minutes after diagnosis, using fibrin-specific agents (tenecteplase, alteplase, or reteplase) (Byrne *et al*, 2023; Rao *et al*, 2025).

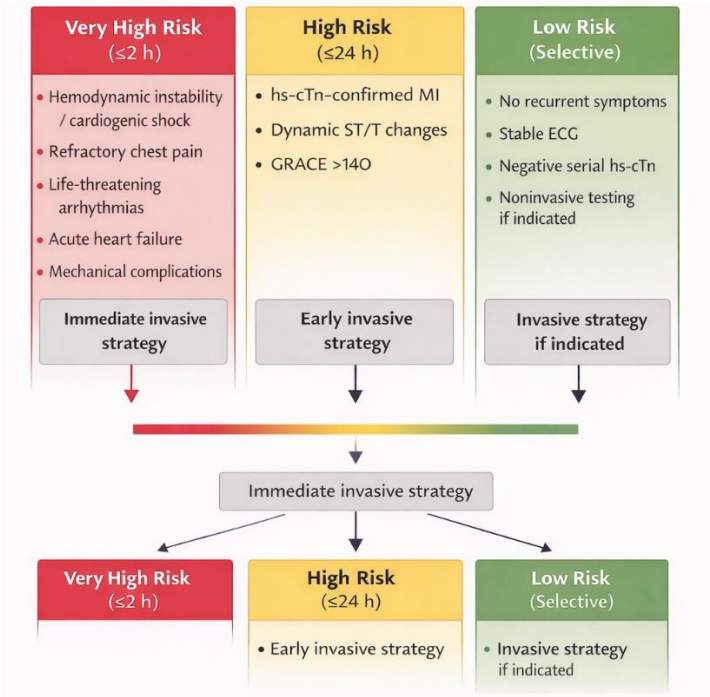
A pharmaco-invasive strategy—defined as transfer for angiography and PCI within 2–24 hours after successful fibrinolysis—reduces recurrent ischemic events without a proportional increase in major bleeding, supporting its role when timely primary PCI is not feasible (Byrne *et al*, 2023; Bergmark *et al*, 2022; Rao *et al*, 2025). Rescue PCI remains indicated immediately in cases of failed reperfusion, clinically or electrocardiographically defined by <50% ST-segment resolution 60–90 minutes after the bolus (Byrne *et al*, 2023; Rao *et al*, 2025).

3.2.3 Risk-guided invasive management in NSTE-ACS

In NSTE-ACS, clinical management and the timing of coronary angiography are guided by ischemic risk stratification, in accordance with contemporary ACC/AHA and ESC recommendations (Byrne *et al*, 2023; Rao *et al*, 2025). A stepwise decision model classifies patients into immediate (≤2 hours), early (≤24 hours), or selective invasive strategies based on integrated clinical criteria (hemodynamic instability, cardiogenic shock, or refractory chest pain), laboratory findings (hs-cTn elevation), and ECG features (dynamic ST-segment or T-wave changes), aiming to optimize time to intervention, reduce recurrent ischemic events, and rationalize invasive resource utilization (Figure 2) (Byrne *et al*, 2023; Lima Filho *et al*, 2024; Rao *et al*, 2025).

Figure 2

Risk-guided invasive strategy in NSTE-ACS



NSTE-ACS, non–ST-segment elevation acute coronary syndrome; hs-cTn, high-sensitivity cardiac troponin; ECG, electrocardiogram; GRACE, Global Registry of Acute Coronary Events.
Source: Developed by the authors.

For very high-risk NSTE-ACS, an immediate invasive strategy with coronary angiography within 2 hours of admission is recommended, particularly in the presence of hemodynamic instability, cardiogenic shock, refractory chest pain, life-threatening arrhythmias or cardiac arrest, mechanical complications of infarction, or acute heart failure secondary to ischemia (left panel of Figure 2) (Bergmark *et al*, 2022; Byrne *et al*, 2023; Lima Filho *et al*, 2024; Rao *et al*, 2025). In high-risk patients, an early invasive strategy with angiography within 24 hours is advised, including those with NSTEMI confirmed by hs-cTn-based algorithms, dynamic ECG changes, or a GRACE score >140 (central panel of Figure 2) (Bergmark *et al*, 2022; Byrne *et al*, 2023; Rao *et al*, 2025). In contrast, low-risk patients may be managed with a selective invasive approach, reserving angiography for cases with persistent ischemia after serial clinical assessment or noninvasive testing (right panel of Figure 2) (Byrne *et al*, 2023; Lima Filho *et al*, 2024; Rao *et al*, 2025).

Recent guidelines also discourage routine pretreatment with P2Y12 receptor inhibitors before coronary anatomy is defined when early angiography (<24 hours) is planned, owing to increased bleeding risk and the potential need for urgent coronary artery bypass grafting (Byrne *et al*, 2023; Ataş *et al*, 2025; Rao *et al*, 2025).

3.2.4 Technical considerations and revascularization therapy

Radial access is the preferred route for PCI and is consistently associated with lower mortality, major bleeding, and vascular complications compared with femoral access (Byrne *et al*, 2023; Lima Filho *et al*, 2024; Rao *et al*, 2025). With regard to revascularization extent, contemporary trials—including BIOVASC and FIRE—demonstrate that complete revascularization, addressing both culprit and significant non-culprit lesions, is superior to culprit-only PCI in hemodynamically stable patients, reducing cardiovascular death and reinfarction (Biscaglia *et al*, 2023; Diletti *et al*, 2023; Rao *et al*, 2025). These findings underpin current Class I recommendations in ACC/AHA and ESC guidelines for the management of multivessel disease in ACS (Byrne *et al*, 2023; Rao *et al*, 2025).

Intravascular imaging with intravascular ultrasound (IVUS) or optical coherence tomography (OCT) is recommended with Class I evidence to guide PCI in complex lesions or left main disease, optimizing stent deployment and reducing thrombosis and restenosis rates (Stone *et al*, 2024; Cesar *et al*, 2025; Rao *et al*, 2025). In contrast, routine manual aspiration thrombectomy is not recommended (Class III) and should be limited to selected cases with high thrombus burden, in accordance with international guideline recommendations (Byrne *et al*, 2023; Rao *et al*, 2025).

3.2.5 Complications and challenging subgroups

Cardiogenic shock in ACS requires immediate culprit-lesion revascularization, preferably with PCI, irrespective of symptom onset timing (Byrne *et al*, 2023; Rao *et al*, 2025). Microaxial ventricular assist devices (Impella CP) have shown reduced 180-day mortality in selected STEMI patients in the DanGer-SHOCK trial, although at the cost of increased bleeding, limb ischemia, and need for renal replacement therapy (Møller *et al*, 2024; Rao *et al*, 2025). By contrast, routine intra-aortic balloon pump (IABP) use does not reduce mortality and is not recommended (Class III), while venoarterial extracorporeal membrane oxygenation (VA-ECMO) should be restricted to selected cases in specialized centers, given the lack of consistent survival benefit in recent trials (Byrne *et al*, 2023; Thiele *et al*, 2023; Rao *et al*, 2025).

Patients with MINOCA (myocardial infarction with non-obstructive coronary arteries) or INOCA (ischemia with non-obstructive coronary arteries) require thorough diagnostic evaluation. In the absence of significant coronary obstruction (≤50%), cardiac magnetic resonance is essential to differentiate true infarction from alternative diagnoses such as myocarditis or Takotsubo syndrome (Reynolds *et al*, 2021; Byrne *et al*, 2023; Rao *et al*, 2025). MINOCA is more prevalent in women than in men (14.9% vs. 3.5%) (Bhatt, Lopes e

Harrington, 2022), and diagnostic inertia in women with borderline troponin elevations has been linked to worse long-term outcomes, including higher rates of death and reinfarction at 12 months (Zou *et al*, 2021; Lambrakis *et al*, 2023). These findings highlight the need for proactive and equitable clinical protocols (Byrne *et al*, 2023; Rao *et al*, 2025).

Finally, patients requiring chronic oral anticoagulation should transition early to dual therapy (oral anticoagulant plus a P2Y12 inhibitor, preferably clopidogrel), with aspirin discontinued after 1–4 weeks to reduce bleeding risk without compromising ischemic protection (Byrne *et al*, 2023; Rao *et al*, 2025).

3.3 SPECIAL CONSIDERATIONS AND MANAGEMENT OF SUBGROUPS IN THE EMERGENCY SETTING

Equity in ACS management remains a major challenge, as evidence consistently shows that women experience systematic delays in care, with symptom-to-balloon times up to twice those observed in men (Zou *et al*, 2021). Although chest pain is the most common presenting symptom in both sexes, women more frequently report associated manifestations such as nausea, dyspnea, fatigue, and atypical discomfort, contributing to diagnostic bias and under-treatment (Gulati *et al*, 2021; Rao *et al*, 2025). Moreover, traditional risk stratification tools, including the GRACE score, may underestimate ischemic risk in women, supporting the need for sex-specific recalibration of prognostic models (Wenzl *et al*, 2022). The higher prevalence of MINOCA and spontaneous coronary artery dissection in women further requires proactive diagnostic investigation using CMR and intravascular imaging to prevent therapeutic inertia and missed diagnoses (Reynolds *et al*, 2021; Byrne *et al*, 2023; Kraler *et al*, 2025). Evidence indicates that worse in-hospital outcomes among women are largely driven by modifiable disparities in care rather than biological differences, underscoring the need for equitable, bias-aware protocols (Zou *et al*, 2021; Bergmark *et al*, 2022).

Older adults (≥65 years) account for most ACS admissions and deaths (Bhatt, Lopes e Harrington, 2022) and often present with atypical symptoms, such as syncope, delirium, or unexplained functional decline, necessitating heightened clinical vigilance (Gulati *et al*, 2021; de Barros e Silva *et al*, 2025; Rao *et al*, 2025). While risk assessment should incorporate frailty and comorbidities, guidelines emphasize that age alone should not preclude invasive management, as appropriately selected older patients benefit from revascularization (Biscaglia *et al*, 2023; Byrne *et al*, 2023; Rao *et al*, 2025).

Chronic kidney disease, present in over 30% of ACS cases, complicates management due to increased ischemic and bleeding risk (Byrne *et al*, 2023; Rao *et al*, 2025). Interpretation of hs-cTn requires assessment of dynamic changes to distinguish chronic injury

from acute ischemia (Bhatt, Lopes e Harrington, 2022; Ashburn *et al*, 2023). Use of structured tools such as PRECISE-DAPT and ARC-HBR supports individualized antithrombotic strategies and safer tailoring of DAPT duration (Biscaglia *et al*, 2023; Byrne *et al*, 2023).

4 CONCLUSIONS

Acute coronary syndrome remains a major global cause of morbidity and mortality and continues to require rapid, accurate, and individualized management in the emergency care setting. This narrative review emphasizes that early diagnosis—based on the integrated use of clinical assessment, electrocardiography, high-sensitivity cardiac troponin assays, and validated risk stratification tools—is fundamental to optimize triage and minimize delays to definitive therapy.

Accelerated diagnostic algorithms, particularly the 0/1-hour and 0/2-hour hs-cTn pathways, have improved efficiency and safety in emergency departments when applied within structured clinical frameworks. In parallel, advances in pharmacological therapy, evidence-based reperfusion strategies for STEMI, and risk-guided invasive management in NSTE-ACS have contributed to meaningful reductions in ischemic complications and mortality. Nevertheless, safe implementation depends on careful integration of objective data with clinical judgment, especially in patients with atypical presentations, comorbidities, or increased bleeding risk.

This review also highlights the need for tailored approaches in vulnerable subgroups, including women, older adults, and patients with chronic kidney disease, in whom diagnostic uncertainty and therapeutic inertia are associated with poorer outcomes. Ensuring timely access to guideline-directed therapies and equitable care pathways remains a key priority.

In summary, contemporary ACS management in emergency care relies on structured, risk-based, and patient-centered strategies that balance diagnostic accuracy, therapeutic efficacy, and safety. Ongoing adherence to guidelines and judicious incorporation of emerging diagnostic and therapeutic tools are essential to further improve outcomes across the spectrum of ACS presentations.

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