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EARLY RISK STRATIFICATION IN ACUTE CORONARY SYNDROME: CLINICAL INDICATORS AND APPROACHES TO PREVENTING ADVERSE OUTCOMES

Tashmatova G.A.
Department of Phthisiatry and Pulmonology, Microbiology, Virology, and Immunology
Assistant Andijan State Medical Institute
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Abstract:

Background: Acute coronary syndrome (ACS) is a major cause of cardiovascular morbidity and mortality. Despite advances in coronary revascularization and pharmacological treatment, patients remain at risk of serious complications, including acute heart failure, malignant arrhythmias, cardiogenic shock, and death. Early identification of high-risk patients is therefore essential for optimizing clinical management.

Objective: To review the major clinical, electrocardiographic, laboratory, and echocardiographic indicators associated with adverse outcomes in patients with acute coronary syndrome and to describe their role in early risk stratification.

Materials and Methods: A narrative review approach was used to organize evidence concerning clinical assessment, cardiovascular biomarkers, electrocardiographic abnormalities, left ventricular function, and validated prognostic scoring systems. Particular attention was given to contemporary recommendations for the management of ACS.

Results and Discussion: Advanced age, hypotension, tachycardia, delayed presentation, signs of heart failure, elevated cardiac troponin concentrations, and reduced left ventricular ejection fraction are important indicators of an unfavorable prognosis. Electrocardiographic changes and the extent of coronary artery disease provide additional information regarding myocardial injury and the likelihood of complications. The GRACE risk score is a validated tool for estimating mortality risk, while echocardiography helps identify ventricular dysfunction and mechanical complications. Combining these parameters provides a more comprehensive assessment than relying on a single clinical or laboratory marker.

Conclusion: Early, integrated risk stratification is an essential component of ACS management. Systematic assessment of clinical status, ECG findings, cardiac biomarkers, renal function, and ventricular performance can support timely therapeutic decisions and individualized follow-up. Prospective studies are needed to evaluate how integrated risk assessment strategies affect clinical outcomes in different patient populations.

Keywords: acute coronary syndrome, risk stratification, mortality, myocardial infarction, cardiac troponin, left ventricular ejection fraction, GRACE score, cardiovascular complications.

Introduction

Acute coronary syndrome represents a spectrum of clinical conditions associated with acute myocardial ischemia, including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina. These conditions require

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prompt diagnosis and appropriate treatment because delays in reperfusion and the development of hemodynamic instability may significantly worsen the clinical course.

Although advances in percutaneous coronary intervention (PCI), antithrombotic therapy, and secondary prevention have improved the management of ACS, substantial differences in outcomes remain between individual patients. Some recover following successful revascularization, whereas others develop heart failure, recurrent ischemia, ventricular arrhythmias, or cardiogenic shock[3].

Risk assessment is therefore not limited to confirming the diagnosis. It also involves estimating the probability of early complications and identifying patients who require intensive monitoring or urgent intervention. The 2023 European Society of Cardiology guidelines and the 2025 American College of Cardiology/American Heart Association guideline emphasize the importance of structured clinical evaluation and validated prognostic tools in ACS management [1,2].

Advanced age is associated with a higher risk of adverse cardiovascular outcomes. Older patients are more likely to have multiple comorbidities, impaired renal function, previous cardiovascular events, and reduced physiological reserve. Diabetes mellitus, hypertension, chronic kidney disease, and a history of heart failure may further complicate treatment and recovery.

However, age should not be considered an isolated determinant of therapeutic decisions. Clinical status, frailty, renal function, bleeding risk, functional capacity, and patient preferences should also be taken into account.

Blood pressure and heart rate are among the most accessible indicators of early clinical deterioration. Hypotension may indicate impaired cardiac output, extensive myocardial injury, or cardiogenic shock. Persistent tachycardia can reflect sympathetic activation, ongoing ischemia, pain, or reduced ventricular function[4].

The coexistence of hypotension, tachycardia, pulmonary congestion, and altered peripheral perfusion should raise concern about a high-risk clinical course. Such findings require immediate assessment and appropriate escalation of care.

The interval between symptom onset and effective reperfusion is an important determinant of myocardial injury, particularly in STEMI. Prolonged ischemia increases the risk of irreversible cardiomyocyte damage and may contribute to ventricular dysfunction and subsequent heart failure.

Public education, early emergency medical services activation, rapid ECG acquisition, and direct transfer to a PCI-capable center can help reduce avoidable treatment delays.

A 12-lead electrocardiogram is a fundamental diagnostic tool in suspected ACS. ST-segment elevation may indicate acute coronary occlusion requiring immediate reperfusion, while ST-segment depression and dynamic T-wave changes may indicate myocardial ischemia in patients without persistent ST-segment elevation[5].

The distribution and extent of ECG abnormalities can provide information about the territory of myocardium at risk. Continuous ECG monitoring is particularly important in high-risk patients because ventricular tachycardia, ventricular fibrillation, and advanced conduction disturbances may occur during the acute phase.

Nevertheless, ECG findings must be interpreted alongside symptoms, serial cardiac biomarkers, and other clinical information.

High-sensitivity cardiac troponin I or T is central to the diagnosis of myocardial injury. Serial measurements help identify changes in troponin concentrations and support differentiation between acute and chronic myocardial injury[6].

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Elevated troponin concentrations also provide prognostic information. However, troponin elevation is not specific to type 1 myocardial infarction and may occur in other conditions, including myocarditis, severe heart failure, and critical illness. Results must therefore be interpreted in the appropriate clinical context.

Additional laboratory investigations include serum creatinine, estimated glomerular filtration rate, complete blood count, glucose, and selected inflammatory or neurohormonal biomarkers. These measurements may help identify comorbidities and refine the assessment of complications.

Echocardiography is an important component of the evaluation of patients with ACS. It provides information about left and right ventricular function, regional wall-motion abnormalities, valvular function, and potential mechanical complications.

Left ventricular ejection fraction (LVEF) is a particularly important prognostic parameter. A reduced LVEF may indicate extensive myocardial damage and is associated with an increased risk of heart failure and adverse cardiovascular events[7].

Echocardiography may also help identify complications such as acute mitral regurgitation, ventricular septal rupture, and left ventricular thrombus. In patients with inadequate echocardiographic images or unresolved diagnostic questions, additional imaging may be considered.

Assessment of ventricular function before hospital discharge is recommended in patients with ACS. In selected patients with substantially reduced LVEF, reassessment after recovery and optimized treatment may be necessary to guide further management [1].

Validated scoring systems can complement clinical judgment and improve consistency in risk assessment.

The Global Registry of Acute Coronary Events (GRACE) score incorporates variables such as age, heart rate, systolic blood pressure, renal function, cardiac biomarkers, ECG changes, and clinical evidence of heart failure or cardiac arrest. It is used to estimate the risk of adverse outcomes in patients with ACS[8].

The Thrombolysis in Myocardial Infarction (TIMI) score is another established tool used in selected ACS populations. Its variables and intended outcomes differ according to the specific version and patient group.

These scoring systems should be used as aids to clinical decision-making rather than as substitutes for clinical assessment. A risk score alone does not determine the diagnosis, replace emergency treatment criteria, or account for every individual clinical circumstance [1,2].

The prevention of complications begins with rapid recognition of high-risk clinical features and timely implementation of evidence-based treatment[9].

Key elements include:

1. Early diagnosis and appropriate classification of ACS.
2. Prompt reperfusion for eligible patients with STEMI.
3. Timely invasive evaluation in patients with high-risk or very-high-risk non-ST-segment elevation ACS.
4. Continuous ECG and hemodynamic monitoring when clinically indicated.
5. Assessment of ventricular function and early recognition of heart failure.
6. Individualized antithrombotic and pharmacological treatment, with attention to ischemic, bleeding, and renal risks.

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7. Secondary prevention, including lipid-lowering therapy, smoking cessation, cardiovascular rehabilitation, and appropriate management of hypertension and diabetes.

The intensity and timing of intervention should be determined by the patient's presentation, clinical stability, contraindications, and applicable guideline recommendationsx[2].

Discussion

The prognosis of patients with ACS depends on several interacting factors, including the extent of myocardial injury, the duration of ischemia, baseline cardiovascular health, the presence of comorbidities, and the effectiveness of treatment.

No single parameter provides a complete assessment of risk. For example, troponin concentrations indicate myocardial injury but do not independently describe ventricular performance. Echocardiography identifies structural and functional abnormalities but does not replace clinical assessment of hemodynamic stability. Similarly, prognostic scores provide standardized estimates but cannot fully capture all patient-specific factors.

An integrated approach combining clinical examination, ECG, serial biomarkers, renal function, echocardiography, and validated risk scores is therefore preferable. Such an approach can support the identification of patients who need closer observation, more rapid invasive evaluation, or additional assessment before discharge.

Further research should evaluate the performance of integrated risk models in different healthcare settings and determine whether their implementation improves patient-centered outcomes. Particular attention should be given to external validation, calibration, clinical feasibility, and the potential benefits of incorporating additional biomarkers or automated decision-support systems.

Conclusion

Early risk stratification is a central component of modern ACS management. Advanced age, hemodynamic instability, delayed presentation, ECG abnormalities, elevated cardiac troponin concentrations, renal dysfunction, and reduced LVEF provide complementary information about the risk of adverse outcomes.

The combined use of clinical assessment, laboratory investigations, echocardiography, and validated prognostic scores can support more timely and individualized treatment decisions. Consistent application of evidence-based recommendations, appropriate monitoring, and structured secondary prevention may contribute to improved care following ACS.

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