Risk Stratification Tools for Acute Chest Pain: Improving Diagnostic Accuracy in Emergency Care

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Introduction

Acute chest pain is one of the most common presenting complaints in emergency departments' worldwide, accounting for a substantial proportion of visits and hospital admissions. The differential diagnosis ranges from benign musculoskeletal pain to life-threatening conditions such as acute coronary syndromes, pulmonary embolism, and aortic dissection. Given the potential severity of underlying causes, clinicians must rapidly distinguish patients who require urgent intervention from those who can be safely discharged. However, chest pain presentations are often nonspecific, and unnecessary admissions strain healthcare resources, while missed diagnoses carry catastrophic consequences. In this context, risk stratification tools have emerged as essential instruments in improving diagnostic accuracy, guiding clinical decision-making, and optimizing resource allocation. These tools combine clinical assessment, biomarkers, and imaging findings into structured scoring systems, thereby standardizing evaluation and reducing reliance on subjective judgment [1].

Description

The development of risk stratification tools for acute chest pain has been driven by the need to balance safety with efficiency. Traditional approaches relied heavily on clinical acumen and electrocardiography findings, yet both methods have limitations. For instance, initial ECGs may be non-diagnostic in up to 50% of patients with ACS, while clinical presentation alone is often ambiguous, particularly in elderly patients, women, and those with comorbidities such as diabetes. Biomarkers like troponin have improved diagnostic sensitivity, but their interpretation requires context and serial testing. Risk scores, therefore, integrate multiple parameters to provide a probabilistic assessment of ACS or major adverse cardiac events. Tools such as the TIMI (Thrombolysis in Myocardial Infarction) score, GRACE (Global Registry of Acute Coronary Events) score, and HEART (History, ECG, Age, Risk factors, Troponin) score are widely used, each with unique strengths and limitations. These structured approaches not only enhance clinician confidence but also provide a common language for communication between emergency physicians, cardiologists, and intensivists [2].

Among available tools, the HEART score has gained prominence in emergency care due to its simplicity and predictive accuracy. Developed specifically for chest pain evaluation in the ED, the HEART score assesses five domains: patient history, ECG findings, age, cardiovascular risk factors, and troponin levels. Patients are stratified into low, intermediate, or high risk for MACE within 30 days. Multiple studies have validated its utility, showing that low-risk patients (score 0–3) can often be safely discharged with outpatient follow-up, reducing unnecessary admissions without compromising safety. In contrast, intermediate- and high-risk patients benefit from more aggressive investigation and monitoring. Compared to older tools such as TIMI, the HEART score is more tailored to the undifferentiated ED population and incorporates both objective and subjective clinical features, offering a balanced approach. Its integration into accelerated diagnostic pathways, often combined with high-sensitivity troponin assays, has further improved efficiency in ruling out ACS [3].

The GRACE score, in contrast, is more comprehensive and was initially developed for patients with confirmed ACS rather than undifferentiated chest pain. It incorporates variables such as age, blood pressure, heart rate, creatinine, and Killip class, providing prognostic information on mortality and recurrent ischemic events. While highly accurate for risk prediction in hospitalized ACS patients, its complexity and reliance on laboratory and hemodynamic parameters make it less practical for rapid ED triage. The TIMI score, though simpler, has similar limitations, as it was also designed for patients already diagnosed with unstable angina or non-ST elevation myocardial infarction. Nevertheless, these tools remain useful in stratifying admitted patients and guiding intensity of care, highlighting the importance of selecting the appropriate tool for the clinical context. In recent years, hybrid approaches that combine rapid biomarker testing with simplified risk scores have been adopted, offering a pragmatic solution to ED diagnostic challenges. Despite their proven benefits, the implementation of risk stratification tools is not without challenges. Variability in clinician training, workflow integration, and access to high-sensitivity assays can limit consistent application. Overreliance on scoring systems without adequate clinical judgment may lead to inappropriate decisions, particularly in atypical cases such as young patients with few risk factors or those presenting with non-cardiac chest pain [4,5].

Conclusion

Risk stratification tools for acute chest pain represent a pivotal advancement in emergency medicine, bridging the gap between rapid decision-making and diagnostic precision. By systematically integrating clinical, electrocardiographic, and biomarker data, these tools improve the identification of high-risk patients while minimizing unnecessary admissions among low-risk individuals. The HEART score has emerged as the most practical for ED use, though TIMI and GRACE remain valuable in specific contexts. The future of chest pain evaluation lies in combining validated scoring systems with emerging technologies such as high-sensitivity biomarkers and AI-based risk prediction. Successful implementation will require not only technological innovation but also clinician education, workflow integration, and consideration of local healthcare resources. Ultimately, the goal remains to provide safe, efficient, and individualized care for patients presenting with one of the most challenging and consequential symptoms in emergency medicine.

Acknowledgement

Conflict of Interest

References

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