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Analysis of patients presenting with chest pain in the emergency department using laboratory parameters and scoring in the prediction of acute coronary syndrome hospitalization

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Abstract

This study aimed to identify predictive factors that assist in the accurate triage of patients presenting with chest pain, supporting effective hospitalization decisions, clinical judgment, and optimized use of emergency department (ED) resources. A retrospective analysis was performed on 200 adult patients presenting with chest pain to the ED at Gaziantep City Hospital between December 2023 and January 2025. Patients were grouped into discharged (n=120) and hospitalized (n=80) categories. Demographic data, symptoms, laboratory results, electrocardiogram (ECG) findings, and clinical risk scores (History, ECG, Age, Risk Factors, Troponin (HEART) and Thrombolysis in Myocardial Infarction (TIMI)) were collected and analyzed. Independent predictors of hospitalization were identified using multivariable logistic regression. Hospitalized patients were generally older (median age 72 vs. 58, p<0.001) and more likely to have hypertension (75% vs. 41.7%, p<0.001), diabetes (50% vs. 25%, p<0.001), and hyperlipidemia (62.5% vs. 33.3%, p<0.001). Dyspnea and diaphoresis were significantly more prevalent among hospitalized individuals. Median troponin levels were also higher (0.025 ng/L vs. 0.010 ng/L, p<0.001). The HEART score demonstrated higher predictive value (AUC 0.79, 95% CI 0.72–0.86) than the TIMI score (AUC 0.68, 95% CI 0.61–0.75, p=0.012). Among those admitted, 56.3% had a confirmed diagnosis of acute coronary syndrome, compared to 12.5% of those discharged. Advanced age, cardiovascular comorbidities, dyspnea, diaphoresis, ischemic ECG findings, and elevated troponin independently predicted hospitalization. The HEART score proved to be more effective than TIMI in stratifying risk, supporting its clinical utility in improving ED triage and patient care.

Keywords: Chest pain, emergency medicine, hospitalization, risk assessment, risk stratification

Introduction

Chest pain continues to be among the most common complaints encountered in emergency departments globally, representing a substantial burden on healthcare systems. It is a symptom that can result from a wide range of underlying causes, spanning from benign musculoskeletal disorders to serious cardiovascular emergencies such as acute coronary syndrome (ACS). Despite being common, chest pain poses a multifaceted diagnostic challenge, especially when the signs are ambiguous or outside the norm. This complexity not only challenges clinicians but also places a substantial burden on emergency departments (EDs), which must balance the need for rapid, accurate diagnosis with the efficient allocation of limited resources [1].

Chest pain presents with diverse clinical features, and studies indicate that approximately 5.1% of patients who arrive at the ED with this symptom are eventually diagnosed with ACS [2]. This gap highlights the critical need for accurate risk stratification tools to distinguish patients needing urgent admission from those suitable for safe discharge. Misdiagnosis or delayed diagnosis of ACS can have severe consequences, including increased morbidity and mortality, while unnecessary hospitalizations contribute to healthcare costs and ED overcrowding [3].

Chest pain can arise from many causes, from life-threatening ACS to benign musculoskeletal issues. When symptoms are atypical, distinguishing these causes is difficult. In older individuals, ACS may present with atypical symptoms like

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fatigue or shortness of breath instead of typical chest pain, complicating the identification of high-risk cases [4]. Moreover, this demographic faces an elevated risk of complications such as functional deterioration and cognitive decline, which emphasizes the need to balance comprehensive assessment with the possible risks associated with hospitalization [5].

To address these challenges, several risk assessment tools have been developed, including the Thrombolysis in Myocardial Infarction (TIMI) and History, Electrocardiogram, Age, Risk Factors, and Troponin (HEART) scores. The goal of the tools is to give clinicians a stepwise method for assessing patients with chest pain so that clinicians can determine which patients are low risk and can be discharged and which patients are high risk and need further treatment [6]. Nevertheless, ongoing research continues to explore how well these scoring systems predict hospitalization outcomes, particularly across diverse populations and different clinical environments. This study aims to identify clinical, demographic, and laboratory factors associated with hospitalization among ED patients presenting with chest pain and to compare the predictive accuracy of the TIMI and HEART scoring systems. Identifying these factors could improve ED triage and resource use.

Material and Methods

Study Design and Setting

This retrospective cohort study was carried out at Gaziantep City Hospital, located in Turkey. The hospital fulfills the healthcare needs of the people belonging to both rural as well as urban areas. The emergency department at the hospital ranks among the most active in the region, handling a high volume of patient visits annually. From December 2023 to January 2025, the study included 200 adult patients aged 18 years and older who presented to the emergency department with chest pain as their chief complaint. This timeframe was chosen to allow an assessment of patients' outcomes under ordinary healthcare services while minimizing the mitigation effects of the Coronavirus disease (COVID) pandemic that affected healthcare usage in earlier years.

Study Population

The study population comprised 200 individuals admitted to the ED with a preliminary diagnosis of chest pain. To reduce selection bias, only those referred by primary care providers or outpatient clinics were included in the analysis. Patients who presented directly to the ED without a referral were excluded, as their clinical profiles and reasons for seeking emergency care may differ significantly. This strategy helped establish a more uniform cohort, concentrating on individuals with a greater probability of having cardiac-related chest pain. To preserve the generalizability of the results, no further exclusion criteria were implemented.

Data Collection

We reviewed hospital electronic medical records (EMRs) to collect data on demographics, medical history, presenting symptoms, electrocardiogram (ECG) findings, and lab results, including troponin and inflammatory markers. We also recorded risk scores (TIMI, HEART). Information on age, sex, marital status, and residency type (home versus nursing home) was captured. Clinical features incorporated chronic diseases (hypertension, diabetes, hyperlipidemia), symptoms at presentation (chest pain, dyspnea, diaphoresis), and ECG observations. Laboratory evaluations included cardiac biomarkers like troponin, inflammatory indicators such as C-reactive protein, and hematologic parameters including the neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios.

Each patient's risk was assessed using the TIMI and HEART scoring systems, derived from clinical records. These scores were applied to categorize patients by their risk of adverse cardiac events and to assess how accurately they predicted the need for hospitalization.

Physician Groups and Decision-Making Protocols

The ED at Gaziantep City Hospital is staffed by a mix of senior emergency medicine specialists and internal medicine physicians undergoing fellowship training. Senior physicians, who have completed at least five years of post-graduate training in emergency medicine, are responsible for final decisions regarding patient admission or discharge. To ensure consistency in clinical decisions, all physicians adhered to standardized chest pain evaluation protocols, which incorporate established risk assessment tools and guidelines issued by the European Society of Cardiology (ESC) and the American Heart Association (AHA).

ECG and Diagnostic Classification

ECG results were classified into four categories: (1) normal with no ischemic changes, (2) presence of ischemic changes, (3) non-specific abnormalities, and (4) arrhythmias occurring without ischemic findings. Significant dysrhythmias, such as supraventricular tachycardia (SVT), were noted, while rare conditions like ventricular tachycardia (VT) were excluded due to their low prevalence in the study population. Final diagnoses at discharge or admission were classified into seven categories: ACS, respiratory causes, abdominal causes, trauma, arrhythmias, non-specific chest pain, and other causes. Each patient's final diagnosis was determined by the attending physician based on all available clinical, laboratory, and imaging data at the time of discharge or hospitalization.

Statistical Analysis

Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean±standard deviation or median with interquartile range, depending on their distribution. Distribution normality was evaluated using histograms and Q-Q plots. Group comparisons were conducted using either the Chi-square or Fisher's exact test for categorical variables, and the independent samples t-test or Mann–Whitney U test for continuous variables.

To identify factors independently associated with hospitalization, multivariate logistic regression analysis

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was used. Variables with a p-value below 0.05 in univariate analysis were entered into the model, and a backward stepwise selection method was applied. Receiver operating characteristic (ROC) curve analysis was used to evaluate the predictive performance of the TIMI and HEART scores, with comparisons of area under the curve (AUC) values made using the DeLong test.

Ethical Considerations

The study was approved by the Gaziantep Islam Science and Technology University Ethic Committee (Approval number: 496.41.16, Date of approval: 22/11/2023). Informed consent was not required, as the study was retrospective and based solely on anonymized data retrieved from electronic health records.

Results

A total of 200 patients presenting to the ED with chest pain as their chief complaint were included in the study. Among them, 120 patients (60%) were discharged following the initial assessment, whereas 80 patients (40%) were admitted for further care. Hospitalized patients were significantly older, with a median age of 72 years (mean±SD: 70.1±9.8) compared to 58 years (mean±SD: 57.6±11.2) in the discharged group (p<0.001). Chronic conditions such as hypertension, diabetes, hyperlipidemia, and ischemic heart disease were significantly more common among hospitalized patients, indicating a strong association between cardiovascular risk factors and the likelihood of admission (Table 1).

Table 1. Demographic and clinical characteristics of the study population (N=200)

Variable	Total (N=200)	Discharged (N=120)	Hospitalized (N=80)	p-value
Age (years), median (IQR)	65 (52–73)	58 (45–68)	72 (65–78)	<0.001
Gender, n (%)				
Male	110 (55)	70 (58.3)	40 (50)	0.210
Female	90 (45)	50 (41.7)	40 (50)	
Marital status, n (%)				
Married	140 (70)	85 (70.8)	55 (68.8)	0.750
Single	30 (15)	20 (16.7)	10 (12.5)	
Widowed/divorced	30 (15)	15 (12.5)	15 (18.8)	
Primary residence, n (%)				
Home	160 (80)	100 (83.3)	60 (75)	0.130
Nursing home	40 (20)	20 (16.7)	20 (25)	
Chronic conditions, n (%)				
Hypertension	110 (55)	50 (41.7)	60 (75)	<0.001
Diabetes	70 (35)	30 (25)	40 (50)	0.001
Hyperlipidemia	90 (45)	40 (33.3)	50 (62.5)	<0.001
Ischemic heart disease	60 (30)	20 (16.7)	40 (50)	<0.001

IQR: interquartile range

Clinical symptoms also differed significantly between the two groups. Dyspnea, diaphoresis, and fatigue were all more frequently reported in hospitalized patients. Notably, ischemic ECG changes were observed in nearly one-third of the hospitalized group, compared to a much lower proportion in discharged patients. These findings underscore the role of both symptom burden and ECG abnormalities in clinical decision-making (Table 2).

Table 2. Clinical symptoms and ECG findings (N=200)

Variable	Total (N=200)	Discharged (N=120)	Hospitalized (N=80)	p-value
Presenting symptoms, n (%)				
Chest pain	180 (90)	110 (91.7)	70 (87.5)	0.320
Dyspnea	70 (35)	30 (25)	40 (50)	<0.001
Diaphoresis	30 (15)	10 (8.3)	20 (25)	0.002
Fatigue	50 (25)	20 (16.7)	30 (37.5)	0.001
ECG findings, n (%)				
No ischemic changes	140 (70)	100 (83.3)	40 (50)	<0.001
Ischemic changes	30 (15)	5 (4.2)	25 (31.3)	<0.001
Non-specific changes	20 (10)	10 (8.3)	10 (12.5)	0.340
Dysrhythmias	10 (5)	5 (4.2)	5 (6.3)	0.520

ECG: electrocardiogram

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Laboratory findings further supported this distinction. Hospitalized patients had higher median troponin and C-reactive protein (CRP) levels, as well as elevated inflammatory markers such as neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR). Lower hemoglobin levels and reduced estimated glomerular filtration rate (eGFR) were also observed in this group, suggesting greater systemic stress and possible renal impairment (Table 3).

Table 3. Laboratory findings (N=200)

Variable	Total (N=200)	Discharged (N=120)	Hospitalized (N=80)	p-value
Troponin (ng/L), median (IQR)	0.015 (0.010–0.030)	0.010 (0.010–0.015)	0.025 (0.015–0.050)	<0.001
CRP (mg/L), median (IQR)	5.0 (2.0–12.0)	3.5 (1.5–8.0)	8.0 (4.0–20.0)	<0.001
Hemoglobin (g/dL), median (IQR)	13.5 (12.0–14.5)	14.0 (12.5–15.0)	12.5 (11.0–13.5)	<0.001
eGFR (mL/min/1.73 m²), median (IQR)	80 (60–95)	85 (70–100)	70 (50–85)	0.001
NLR, median (IQR)	3.0 (2.0–5.0)	2.5 (1.8–4.0)	4.0 (3.0–6.0)	<0.001
PLR, median (IQR)	150 (120–200)	140 (110–180)	180 (140–220)	0.002

CRP: C-reactive protein, eGFR: estimated glomerular filtration rate, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio, IQR: interquartile range

Risk stratification scores were effective in distinguishing between discharged and hospitalized patients. A larger proportion of hospitalized patients had elevated TIMI (≥4) and HEART (4–6) scores. Receiver operating characteristic (ROC) curve analysis demonstrated that the HEART score had superior predictive accuracy for hospitalization, with an AUC of 0.79 (95% CI 0.72–0.86), compared to the TIMI score with an AUC of 0.68 (95% CI 0.61–0.75). This difference was statistically significant (p=0.012) (Table 4).

Table 4. Risk scores, hospitalization outcomes, and ROC analysis (N=200)

Variable	Total (N=200)	Discharged (N=120)	Hospitalized (N=80)	p-value
TIMI score, n (%)				
0	60 (30)	50 (41.7)	10 (12.5)	
1–3	110 (55)	60 (50)	50 (62.5)	<0.001
≥4	30 (15)	10 (8.3)	20 (25)	
HEART score, n (%)				
≤3	100 (50)	80 (66.7)	20 (25)	
4–6	80 (40)	30 (25)	50 (62.5)	<0.001
≥7	20 (10)	10 (8.3)	10 (12.5)	
ROC analysis				
HEART score AUC (95% CI)	0.79 (0.72–0.86)	--	--	0.012
TIMI score AUC (95% CI)	0.68 (0.61–0.75)	--	--	

TIMI and HEART scores are clinical tools used to assess the risk of adverse cardiac events; AUC: area under the receiver operating characteristic curve, CI: confidence interval, ROC: receiver operating characteristic, TIMI: thrombolysis in myocardial infarction, HEART: history, electrocardiogram, age, risk factors, troponin

Multivariate logistic regression identified several independent predictors of hospitalization, including age ≥65 years, hypertension, hyperlipidemia, ischemic ECG findings, diaphoresis, dyspnea, and elevated troponin levels. Among these, ischemic ECG changes had the highest odds ratio (OR 6.80), emphasizing their clinical importance. The final model was developed using backward elimination from 12 variables that were statistically significant in univariate analysis and demonstrated good model fit according to the Hosmer–Lemeshow test (χ^2=6.24, df=8, p=0.620) (Table 5).

Table 5. Multivariable logistic regression analysis for predictors of hospitalization

Variable	OR	95% CI	p-value
Age ≥65 years	2.50	1.30–4.80	0.006
Hypertension	2.10	1.10–4.00	0.024
Hyperlipidemia	3.20	1.70–6.00	<0.001
Ischemic ECG changes	6.80	2.50–18.50	<0.001
Diaphoresis	5.50	2.00–15.00	0.001
Dyspnea	3.00	1.50–6.00	0.002
Elevated troponin	4.20	1.90–9.30	<0.001

OR: odds ratio, CI: confidence interval, ECG: electrocardiogram

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Final diagnoses differed significantly between the two groups. Among hospitalized patients, the most frequent diagnosis was acute coronary syndrome (56.3%), followed by respiratory causes and non-specific chest pain. In contrast, discharged patients more frequently had non-specific chest pain, respiratory causes, and abdominal etiologies. This diagnostic distribution supports the role of early risk assessment and scoring tools in identifying patients who require hospitalization and further cardiac evaluation.

Discussion

The most clinically significant finding of our study was the superior predictive accuracy of the HEART score compared to the TIMI score in identifying patients requiring hospitalization. This result highlights the practical value of the HEART score as a more sensitive and effective triage tool in emergency settings. Given its simplicity and higher discriminatory power, especially in our cohort, the HEART score may serve as a preferable option for frontline clinicians aiming to stratify chest pain patients quickly and accurately.

Older age, hypertension, and hyperlipidemia were found to be significantly associated with hospitalization in our study. These findings align with previous research identifying age and cardiovascular comorbidities as major contributors to adverse outcomes in chest pain patients presenting to the emergency department [7,8]. The elevated hospitalization rate among hyperlipidemic patients further reinforces the role of long-term metabolic factors in shaping acute cardiovascular risk [9].

Symptoms such as diaphoresis and dyspnea were also notable predictors of admission. These clinical findings reflect acute physiologic stress and are consistent with prior evidence highlighting their relevance in risk stratification for acute coronary syndromes [7,10]. As also noted by Aldrich et al., such symptoms are widely recognized warning signs indicative of underlying ischemic pathology.

Electrocardiographic findings played a pivotal role in risk assessment. Our study confirmed that ischemic ECG alterations were strongly predictive of hospitalization, echoing prior literature that underscores ECG abnormalities as critical for identifying high-risk patients [10]. This finding supports the central role of ECG interpretation in emergency cardiac triage.

Furthermore, the HEART score demonstrated superior predictive accuracy for hospitalization compared to the TIMI score. This result highlights the HEART score's practical utility in clinical decision-making for ED physicians, aligning with previous studies that favor its use over older scoring systems [11,12].

Our study also examined patients' primary living settings—either private residences or nursing facilities—but found no statistically significant difference in hospitalization rates between these groups (p=0.130, Table 1). This contrasts with the findings of Templeton et al. [10,13], who reported that specialized nursing facilities can lower hospital readmissions and mortality through structured post-acute care programs. Additionally, Templeton highlighted that such organized care models may alleviate ED congestion and enhance outcomes for elderly patients [13]. Even though our data may suggests no significantly different values, the role of care settings on chest pain management, especially in elderly patients with several comorbidities, warrants more attention.

In this analysis, our attention was directed primarily at clinical and laboratory predictors of hospitalization. However, Gorski et al. [13,14] claim that some operational aspects such as ED congestion and the activity of the physician on duty may have substantial relevance to the decision to admit the patient. Gorski's study showed that there was an increased rate of admissions with the increase in proportionality of ED census due to limited time for evaluation [14]. In addition, Aaronson and Yun [14,15] suggested cognitive fatigue during a busy shift is likely to influence clinical decisions that need to be made. It was remarked that the physicians might have higher admission thresholds during high-stress periods, which could be relevant to our findings on risk stratification [14,15]. Further research should look at how these operational dynamics may affect clinical decision making for patients with chest pain at our institution.

The superior predictive accuracy of the HEART score compared to the TIMI score in our study is consistent with previous research. The HEART score has been validated as an effective tool for quickly assessing chest pain risk in the ED, and studies have shown it to be more accurate than both TIMI and GRACE scores in predicting major adverse cardiac events (MACEs) [16,17]. This makes the HEART score particularly valuable for identifying low-risk patients who can be safely discharged, thereby reducing unnecessary hospitalizations and optimizing ED resources [16,17].

Moreover, non-cardiac chest pain (NCCP) represents a considerable share of ED chest pain presentations. Research indicates that NCCP is often linked to increased psychological distress and recurrent use of healthcare services [18]. The management of NCCP remains challenging, as these patients often require extensive diagnostic evaluations to rule out cardiac causes, which can strain ED resources [19]. Our findings emphasize the importance of distinguishing between cardiac and non-cardiac causes of chest pain to ensure appropriate resource allocation and patient care.

Research has also examined the role of physical activity and disability in individuals with NCCP, revealing that such patients frequently suffer from functional impairments and diminished quality of life [20]. These findings emphasize the importance of integrated care approaches that address both the physical and emotional dimensions of NCCP, especially in older adults with multiple health conditions [20]. Furthermore, the variability in coronary heart disease risk factors, as noted by Simonetto et al., highlights the necessity of tailored risk evaluation and management strategies in the emergency department setting [21].

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Limitations

This study included only patients who presented to the emergency department via referral from primary care or outpatient clinics, which may limit the generalizability of our findings to all chest pain patients, including those who self-present. While this approach was intended to create a more homogeneous population with higher pretest probability for ACS, it may exclude atypical or lower-risk presentations that also challenge ED triage decisions.

Additionally, as a retrospective, single-center analysis, the study is subject to potential information bias related to the completeness and accuracy of electronic medical records. Physician decision-making, though guided by standardized protocols, may vary depending on individual clinical judgment or ED workload, which could influence hospitalization decisions.

The study endpoint was in-hospital diagnosis of ACS rather than 30-day or long-term MACE outcomes. While this reflects real-time triage and hospitalization relevance, it does not assess delayed adverse events following discharge.

Finally, the HEART and TIMI scores were used to assess predictive value across both discharged and hospitalized patients, including those with confirmed ACS. While this reflects how these scores function in real-life decision-making, their original design was primarily focused on identifying low-risk patients for safe discharge.

Conclusion

Thus, our study confirms the necessity of applying clinical predictors and risk stratification tools like the HEART score in the management of chest pain patients in the ED. These symptoms, chronic conditions, and ECG changes as predictors of hospitalization can help clinicians in making informed choices and improving patient outcomes. Nonetheless, further research is needed to replicate these findings in larger, multicenter studies involving more diverse populations and to assess the long-term consequences of discharge and admission decisions.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
The study was approved by the Gaziantep Islam Science and Technology University Ethic Committee (Approval number: 496.41.16, Date of approval: 22/11/2023). Informed consent was waived due to the retrospective nature of the study, which relied on anonymized data extracted from electronic medical records.

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