International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-08-53*

TIMI Risk Stratification and Clinical Outcomes in Patients Presenting with Chest Pain: A Prospective Emergency Department Study.

Dr. Manisha Reddy[1*], Dr. Kalyan Ram[2], Dr. Rafiudeen[3].

[1]DNB IIIrd Year Resident, Department of Emergency Medicine, KIMS-Saveera Hospital, Anantapuramu, Andhra Pradesh, India.
[2]HOD, Department of Emergency Medicine, KIMS-Saveera Hospital, Anantapuramu, Andhra Pradesh, India.
[3]DNB IIIrd Year Resident, Department of Emergency Medicine, KIMS-Saveera Hospital, Anantapuramu, Andhra Pradesh, India.

Correspondence:
Dr. Manisha Reddy.
DNB IIIrd Year Resident, Department of Emergency Medicine, KIMS-Saveera Hospital, Anantapuramu, Andhra Pradesh, India.

Received: 12-07-2026
Revised: 26-07-2026
Accepted: 06-08-2026
Published: 10-08-2026

Abstract

Background: Acute coronary syndrome causes substantial morbidity and mortality in patients with chest pain. Bedside assessment identifies patients requiring intensive monitoring or early invasive management. ***Objectives:*** To evaluate the association of Thrombolysis in Myocardial Infarction (TIMI) risk categories with major adverse cardiac events and urgent revascularization in emergency patients with suspected acute coronary syndrome and to assess associations of age and sex with outcomes. ***Methods:*** This hospital-based study included 150 consecutive adults presenting with chest pain or discomfort of less than 24 hours' duration at a tertiary emergency department. Clinical history, risk factors, examination findings, electrocardiography, troponin status, and laboratory variables were recorded. TIMI scores were categorized as low, intermediate, or high risk. Major adverse cardiac events and urgent revascularization were documented. Associations were examined using the chi-square test. Diagnostic indices at a threshold above 4 were recalculated from the reported contingency table. ***Results:*** Men constituted 64.0% of the cohort, and 34.7% were 51-60 years old. Low-, intermediate-, and high-risk categories comprised 25.3%, 44.7%, and 30.0% of patients. Major adverse cardiac events occurred in 28.0%, increasing from 7.9% in the low-risk group to 51.1% in the high-risk group. Urgent revascularization was required in 24.7%, with rates of 5.3%, 20.9%, and 46.7% across the three categories. A score above 4 provided 54.8% sensitivity, 79.6% specificity, 51.1% positive predictive value, and 81.9% negative predictive value. Adverse events were associated with age but not sex. ***Conclusion:*** Increasing TIMI risk category was strongly associated with adverse cardiac events and urgent revascularization. The score can support emergency prioritization but should not be used as a stand-alone rule-out tool.

Keywords: Acute coronary syndrome; chest pain; emergency department; major adverse cardiac events; risk stratification; TIMI risk score; urgent revascularization.

INTRODUCTION

Chest pain is among the most frequent and clinically demanding presentations in emergency medicine. Its causes range from self-limited musculoskeletal or gastrointestinal disorders to acute coronary syndrome (ACS), pulmonary embolism, and aortic disease. Because early symptoms and initial examination findings overlap substantially, clinicians must identify myocardial ischemia without exposing large numbers of low-risk patients to avoidable admission and invasive testing. A systematic assessment combining symptom characteristics, cardiovascular risk factors, electrocardiography, and cardiac biomarkers remains central to estimating the probability of ACS.1

The Thrombolysis in Myocardial Infarction (TIMI) risk score was developed in patients with unstable angina or non-ST-segment elevation myocardial infarction to predict short-term death, myocardial infarction, or urgent revascularization.2 It assigns one point for each of seven readily available variables: age of at least 65 years, three or more coronary risk factors, known coronary stenosis of at least 50%, aspirin use during the preceding week, recurrent angina within 24 hours, ST-segment deviation, and elevated cardiac biomarkers. Its simplicity permits rapid calculation at the bedside, without specialized software or delayed investigations.

Subsequent studies extended TIMI assessment from selected trial populations to patients with undifferentiated chest pain in emergency departments.3 Prospective validation demonstrated a graded increase in adverse outcomes with rising scores, although very low scores did not uniformly exclude events.4 Modified applications also supported its role in separating patients who require urgent evaluation from those suitable for less intensive pathways.5 A meta-analysis confirmed high sensitivity but comparatively modest specificity in emergency chest-pain populations, indicating that TIMI is useful for risk classification but should not replace clinical judgment.6

Modern accelerated diagnostic pathways combine clinical scores with serial or high-sensitivity troponin testing. The ADAPT strategy showed that a low TIMI score with negative troponins can support early rule-out in carefully selected patients.7 The HEART score and HEART Pathway subsequently achieved broader adoption for low-risk discharge decisions.8,9 Comparative studies have often reported stronger discrimination by HEART, while TIMI remains practical for recognizing intermediate- and high-risk patients.10,11 High-sensitivity troponin concentrations further improve early prognostic assessment,12,14 and current chest-pain guidelines recommend structured clinical decision pathways integrating validated scores, electrocardiography, biomarkers, and selective imaging.13 Evidence from Indian emergency departments remains less extensive, particularly regarding the relationship between TIMI categories and actual urgent revascularization. Accordingly, this study aimed to evaluate the effectiveness of the TIMI risk score in predicting major adverse cardiac events among adults presenting with chest pain suggestive of ACS. The primary objective was to determine its utility in guiding treatment decisions, particularly urgent percutaneous coronary intervention or coronary artery bypass grafting. The secondary objective was to examine whether age and sex were associated with adverse cardiac outcomes in the study cohort.

MATERIALS AND METHODS

Study design and setting

A hospital-based prospective observational study was conducted over one year in the Department of Emergency Medicine, KIMS Saveera Hospital, Anantapuram, Andhra Pradesh, India. The study evaluated the prognostic performance of a bedside risk score in adults presenting with symptoms suggestive of ACS.

Participants and sampling

Patients were enrolled consecutively after initial emergency assessment. Eligible participants were older than 18 years and presented primarily with chest pain or discomfort of less than 24 hours' duration, with clinical features supporting possible ACS, including ischemic electrocardiographic changes or established cardiovascular risk factors. Patients with traumatic chest pain were excluded. A total of 150 eligible patients were included in the final analysis.

Sample size

The protocol used a diagnostic-accuracy approach. Anticipated TIMI sensitivity and specificity were 97% and 25%, respectively, based on previous emergency-department evidence.6 The calculated requirements were 63 participants for sensitivity and 88 for specificity. The larger estimate was selected, and the final target was increased to 150 to strengthen precision and accommodate attrition.

Data collection

A pretested structured proforma captured age, sex, presenting symptoms, medical history, smoking and alcohol exposure, family history of coronary artery disease, examination findings, electrocardiography, troponin status, and selected laboratory measurements. Clinical care followed the treating team's judgment and institutional practice.

TIMI risk assessment

The TIMI score was calculated at presentation using the original seven-item model.2 One point was assigned for age at least 65 years, three or more coronary artery disease risk factors, known coronary stenosis of at least 50%, aspirin use within seven days, at least two anginal episodes during the preceding 24 hours, ST-segment deviation of at least 0.5 mm, and positive cardiac biomarkers. Scores ranged from 0 to 7 and were categorized as low risk (0-2), intermediate risk (3-4), or high risk (5-7). This classification is consistent with established emergency-department validation studies.3,4

Outcome measures

The principal prognostic outcome was a major adverse cardiac event during the study period, as documented in the study record. The management outcome was urgent revascularization, defined as urgent percutaneous coronary intervention or coronary artery bypass grafting. Associations of age and sex with major adverse cardiac events were examined. The source dataset did not provide a component-level breakdown or fixed post-discharge time window for the composite outcome.

Statistical analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 24. Continuous variables were summarized as mean and standard deviation; categorical variables were expressed as frequencies and percentages. The chi-square test assessed associations between TIMI categories and outcomes and between demographic groups and major adverse cardiac events. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy at a TIMI threshold above 4 were recalculated from the 2 x 2 contingency table. Patient-level receiver operating characteristic output was unavailable; therefore, area under the curve was not analysed. Statistical significance was set at $p<0.05$.

Ethical considerations

Institutional Ethics Committee approval was obtained before enrolment. Written informed consent was secured from each participant or an authorized attendant after explanation of the study procedures, benefits, and risks. Participant information was handled confidentially.

RESULTS

All 150 enrolled patients were included in the analysis. The mean age was 58.6 ± 17.4 years, and the largest age group was 51–60 years (34.7%), followed by 41–50 years (22.7%). Men constituted 64.0% of the cohort. Smoking (41.3%) and hypertension (38.0%) were the most frequently documented cardiovascular risk factors. The baseline demographic and risk-factor profile is summarized in Table 1.

Table 1. Baseline demographic and cardiovascular risk-factor characteristics

Characteristic	Number	Percentage
Age 18–30 years	3	2.0
Age 31–40 years	27	18.0
Age 41–50 years	34	22.7
Age 51–60 years	52	34.7
Age 61–70 years	28	18.7
Age >70 years	6	4.0
Male sex	96	64.0
Female sex	54	36.0
Diabetes mellitus	34	22.7
Hypertension	57	38.0
Coexisting diabetes and hypertension	24	16.0
Dyslipidaemia	26	17.3
Smoking	62	41.3
Alcohol use	37	24.7
Family history of coronary artery disease	42	28.0

Risk factors were not mutually exclusive. Values are presented as n and %.

Chest pain or discomfort was present in every participant because it formed the principal eligibility criterion. Radiating pain was reported by approximately half of the cohort. The mean heart rate was 91.6 ± 16.4 beats/min, mean peripheral oxygen saturation was 95.1 ± 3.2%, and mean HbA1c was 7.4 ± 1.6%. Ischaemic electrocardiographic abnormalities were recorded in 123 patients (82.0%), while troponin was positive in 96 patients (64.0%). The presenting clinical, laboratory, electrocardiographic, and biomarker findings are shown in Table 2.

Table 2. Presenting clinical, laboratory, electrocardiographic, and biomarker profile

Domain	Characteristic	Value
Symptoms	Chest pain or discomfort	150 (100.0%)
	Radiating pain	76 (50.7%)
	Sudden sweating	46 (30.7%)
	Shortness of breath	38 (25.3%)
	Dizziness	34 (22.7%)
	Gastrointestinal symptoms	29 (19.3%)
	Palpitations	26 (17.3%)
	Unusual fatigue	16 (10.7%)
Clinical/laboratory parameters	Heart rate, beats/min	91.6 ± 16.4
	Systolic blood pressure, mmHg	132.8 ± 24.7
	Diastolic blood pressure, mmHg	84.3 ± 14.6
	Respiratory rate, breaths/min	20.8 ± 4.6
	Peripheral oxygen saturation, %	95.1 ± 3.2
	HbA1c, %	7.4 ± 1.6
Electrocardiography	ST-segment elevation	55 (36.7%)
	ST-segment depression	40 (26.7%)
	T-wave inversion	28 (18.7%)
	Normal or non-specific ECG	27 (18.0%)
Troponin status	Positive	96 (64.0%)
	Negative	54 (36.0%)

Categorical variables are presented as n (%); continuous variables are presented as mean ± standard deviation. Symptoms were not mutually exclusive. ECG, electrocardiogram; HbA1c, glycated haemoglobin. Intermediate-risk patients formed the largest TIMI category (44.7%), followed by high-risk (30.0%) and low-risk (25.3%) groups. Major adverse cardiac events (MACE) occurred in 42 patients (28.0%), and 37 patients (24.7%) underwent urgent percutaneous coronary intervention or coronary artery bypass grafting. The TIMI distribution and overall study outcomes are presented in Table 3.

Table 3. TIMI risk categories and overall study outcomes

Variable	Number	Percentage
Low risk, TIMI score 0–2	38	25.3
Intermediate risk, TIMI score 3–4	67	44.7
High risk, TIMI score 5–7	45	30.0
MACE present	42	28.0
No MACE	108	72.0
Urgent PCI/CABG	37	24.7
No urgent revascularization	113	75.3

CABG, coronary artery bypass grafting; MACE, major adverse cardiac events; PCI, percutaneous coronary intervention; TIMI, Thrombolysis in Myocardial Infarction.

A significant stepwise association was observed between TIMI category and MACE ($p<0.0001$). Event rates increased from 7.9% in the low-risk group to 23.9% in the intermediate-risk group and 51.1% in the high-risk group. The need for urgent revascularization followed a similar gradient, rising from 5.3% to 20.9% and 46.7%, respectively ($p<0.0001$). Using a TIMI score above 4 as the positive threshold, the recalculated sensitivity was 54.8%, specificity was 79.6%, and overall accuracy was 72.7% (Table 4).

Table 4. Association of TIMI risk category with MACE and urgent revascularization, with diagnostic indices

Analysis/category	Outcome present or value	Outcome absent	Total	p-value
A. Major adverse cardiac events				
Low risk (0–2)	3 (7.9%)	35 (92.1%)	38	
Intermediate risk (3–4)	16 (23.9%)	51 (76.1%)	67	
High risk (5–7)	23 (51.1%)	22 (48.9%)	45	
Total	42 (28.0%)	108 (72.0%)	150	<0.0001
B. Urgent revascularization				
Low risk (0–2)	2 (5.3%)	36 (94.7%)	38	
Intermediate risk (3–4)	14 (20.9%)	53 (79.1%)	67	
High risk (5–7)	21 (46.7%)	24 (53.3%)	45	
Total	37 (24.7%)	113 (75.3%)	150	<0.0001
C. TIMI score >4 for predicting MACE				
Sensitivity	54.8%	—	—	—
Specificity	79.6%	—	—	—
Positive predictive value	51.1%	—	—	—
Negative predictive value	81.9%	—	—	—
Overall accuracy	72.7%	—	—	—

For panels A and B, percentages within TIMI categories are row percentages; p-values are from the chi-square test. Diagnostic indices were recalculated from 23 true-positive, 22 false-positive, 86 true-negative, and 19 false-negative results. The area under the receiver operating characteristic curve was not reported because patient-level ROC output was unavailable. CABG, coronary artery bypass grafting; MACE, major adverse cardiac events; PCI, percutaneous coronary intervention.

Age group was significantly associated with MACE ($p<0.0001$). Event proportions remained below 20% through 51–60 years, then increased sharply to 78.6% among patients aged 61–70 years and 83.3% among those older than 70 years. MACE occurred in 27.1% of men and 29.6% of women; the difference was not statistically significant ($p=0.369$). Age- and sex-stratified outcomes are shown in Table 5.

Table 5. Association of age group and sex with major adverse cardiac events

Factor/category	MACE present	No MACE	Total	p-value
Age group				
18–30 years	0 (0.0%)	3 (100.0%)	3	
31–40 years	1 (3.7%)	26 (96.3%)	27	
41–50 years	4 (11.8%)	30 (88.2%)	34	
51–60 years	10 (19.3%)	42 (80.7%)	52	
61–70 years	22 (78.6%)	6 (21.4%)	28	
>70 years	5 (83.3%)	1 (16.7%)	6	
Total	42 (28.0%)	108 (72.0%)	150	<0.0001
Sex				
Male	26 (27.1%)	70 (72.9%)	96	
Female	16 (29.6%)	38 (70.4%)	54	
Total	42 (28.0%)	108 (72.0%)	150	0.369

Percentages within age and sex categories are row percentages. p-values are from the chi-square test. MACE, major adverse cardiac events.

DISCUSSION

This prospective study demonstrated a pronounced outcome gradient across TIMI risk categories. MACE occurred in 7.9% of low-risk, 23.9% of intermediate-risk, and 51.1% of high-risk patients. This pattern is consistent with the original TIMI derivation, in which increasing scores identified progressively greater short-term risk of death, myocardial infarction, or urgent revascularization.2 Prospective emergency-department studies have likewise shown that TIMI retains prognostic value beyond selected clinical-trial populations.3,4

At a threshold above 4, diagnostic indices recalculated from the reported contingency table were 54.8% sensitivity, 79.6% specificity, 51.1% positive predictive value, and 81.9% negative predictive value. These estimates indicate that the high-risk threshold identifies a subgroup with substantial event prevalence, but it misses almost half of all patients who experience MACE. The result reinforces evidence that score performance depends strongly on the chosen cut-off and clinical spectrum. Hess et al. reported high sensitivity but low specificity when lower TIMI thresholds were used to screen emergency chest-pain populations.6 Therefore, a score above 4 is more suitable for prioritizing higher-risk patients than for excluding ACS-related events.

The relationship with urgent revascularization adds practical relevance. Intervention rates increased from 5.3% in the low-risk category to 46.7% in the high-risk category. Because urgent revascularization formed part of the original TIMI composite, the score is clinically aligned with an invasive-management endpoint.2 In departments with constrained monitored beds or catheterization access, category-based assessment can assist prioritization. Nevertheless, it should complement electrocardiographic interpretation, serial troponin testing, hemodynamic assessment, and cardiology evaluation rather than dictate treatment independently.

Contemporary pathways clarify this complementary role. The ADAPT protocol combined a low TIMI score with serial negative troponins to identify selected patients for accelerated evaluation.7 HEART-based approaches classify a larger proportion of patients as suitable for early discharge,8,9 and head-to-head studies often report better overall discrimination by HEART.10,11 High-sensitivity troponin assays further strengthen early rule-out and prognostication,12,14 supporting guideline recommendations for integrated clinical decision pathways instead of reliance on a single score.13

Advancing age was strongly associated with MACE, particularly after 60 years, whereas event proportions were similar in men and women. These were unadjusted associations and should not be interpreted as independent effects. Overall, TIMI categorization was useful for clinically ordering overall risk and identifying patients likely to require urgent intervention, but the limited sensitivity at the selected threshold in this cohort argues strongly against its use as a stand-alone discharge or rule-out instrument.

LIMITATIONS

This single-centre study had a modest sample, limiting external validity. Consecutive enrolment of patients with ischemic electrocardiographic changes or cardiovascular risk factors produced a high-acuity cohort. The dataset lacked detailed MACE components, a defined follow-up interval, and patient-level receiver operating characteristic output. Multivariable adjustment and direct comparison with HEART or GRACE scores were not performed. These constraints reduce interpretation of long-term and adjusted risk.

CONCLUSION

Increasing TIMI risk category was strongly associated with major adverse cardiac events and urgent revascularization among adults presenting with chest pain suggestive of acute coronary syndrome. Event rates rose consistently from low- to high-risk groups, supporting the score's value for bedside prioritization and cardiology assessment. However, a threshold above 4 had limited sensitivity and did not identify all patients who developed adverse outcomes. Advanced age was associated with MACE, whereas sex was not. TIMI scoring should therefore be incorporated into structured emergency pathways alongside clinical evaluation, electrocardiography, serial troponin testing, hemodynamic assessment, and specialist judgment. It should guide escalation of care rather than function as a discharge or rule-out criterion.

REFERENCES

1. Fanaroff AC, Rymer JA, Goldstein SA, Simel DL, Newby LK. Does this patient with chest pain have acute coronary syndrome? The Rational Clinical Examination systematic review. JAMA. 2015;314(18):1955-65. doi:10.1001/jama.2015.12735. PMID:26547467.
2. Antman EM, Cohen M, Bernink PJ, McCabe CH, Horacek T, Papuchis G, et al. The TIMI risk score for unstable angina/non-ST elevation MI: a method for prognostication and therapeutic decision making. JAMA. 2000;284(7):835-42. doi:10.1001/jama.284.7.835. PMID:10938172.
3. Pollack CV Jr, Sites FD, Shofer FS, Sease KL, Hollander JE. Application of the TIMI risk score for unstable angina and non-ST elevation acute coronary syndrome to an unselected emergency department chest pain population. Acad Emerg Med. 2006;13(1):13-8. PMID:16365321.
4. Chase M, Robey JL, Zogby KE, Sease KL, Shofer FS, Hollander JE. Prospective validation of the Thrombolysis in Myocardial Infarction risk score in the emergency department chest pain population. Ann Emerg Med. 2006;48(3):252-9. doi:10.1016/j.annemergmed.2006.01.032. PMID:16934646.
5. Jaffery Z, Hudson MP, Jacobsen G, Nowak R, McCord J. Modified thrombolysis in myocardial infarction (TIMI) risk score to risk stratify patients in the emergency department with possible acute coronary syndrome. J Thromb Thrombolysis. 2007;24(2):137-44. doi:10.1007/s11239-007-0013-3. PMID:17318424.
6. Hess EP, Agarwal D, Chandra S, Murad MH, Erwin PJ, Hollander JE, et al. Diagnostic accuracy of the TIMI risk score in patients with chest pain in the emergency department: a meta-analysis. CMAJ. 2010;182(10):1039-44. doi:10.1503/cmaj.092119. PMID:20530163.
7. Than M, Cullen L, Aldous S, Parsonage WA, Reid CM, Greenslade J, et al. 2-Hour accelerated diagnostic protocol to assess patients with chest pain symptoms using contemporary troponins as the only biomarker: the ADAPT trial. J Am Coll Cardiol. 2012;59(23):2091-8. doi:10.1016/j.jacc.2012.02.035. PMID:22578923.
8. Backus BE, Six AJ, Kelder JC, Bosschaert MA, Mast EG, Mosterd A, et al. A prospective validation of the HEART score for chest pain patients at the emergency department. Int J Cardiol. 2013;168(3):2153-8. doi:10.1016/j.ijcard.2013.01.255. PMID:23465250.
9. Mahler SA, Riley RF, Hiestand BC, Russell GB, Hoekstra JW, Lefebvre CW, et al. The HEART Pathway randomized trial: identifying emergency department patients with acute chest pain for early discharge. Circ Cardiovasc Qual Outcomes. 2015;8(2):195-203. doi:10.1161/CIRCOUTCOMES.114.001384. PMID:25737484.
10. Reaney PDW, Elliott HI, Noman A, Cooper JG. Risk stratifying chest pain patients in the emergency department using HEART, GRACE and TIMI scores, with a single contemporary troponin result, to predict major adverse cardiac events. Emerg Med J. 2018;35(7):420-7. doi:10.1136/emermed-2017-207172. PMID:29622596.
11. Poldervaart JM, Langedijk M, Backus BE, Dekker IM, Six AJ, Doevendans PA, et al. Comparison of the GRACE, HEART and TIMI score to predict major adverse cardiac events in chest pain patients at the emergency department. Int J Cardiol. 2017;227:656-61. doi:10.1016/j.ijcard.2016.10.080. PMID:27810290.
12. Chapman AR, Lee KK, McAllister DA, Cullen L, Greenslade JH, Parsonage W, et al. Association of high-sensitivity cardiac troponin I concentration with cardiac outcomes in patients with suspected acute coronary syndrome. JAMA. 2017;318(19):1913-24. doi:10.1001/jama.2017.17488. PMID:29127948.
13. Gulati M, Levy PD, Mukherjee D, Amsterdam E, Bhatt DL, Birtcher KK, et al. 2021 AHA/ACC/ASE/CHEST/SAEM/SCCT/SCMR guideline for the evaluation and diagnosis of chest pain. Circulation. 2021;144(22):e368-e454. doi:10.1161/CIR.0000000000001029. PMID:34709879.
14. Reichlin T, Hochholzer W, Bassetti S, Steuer S, Stelzig C, Hartwiger S, et al. Early diagnosis of myocardial infarction with sensitive cardiac troponin assays. N Engl J Med. 2009;361(9):858-67. doi:10.1056/NEJMoa0900428. PMID:19710484.