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Evaluation of the Influence of Clinical, Demographic, and Laboratory Factors on Treatment Modality Selection in Patients with Acute Myocardial Infarction

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Abstract

Introduction

Acute myocardial infarction (AMI) remains one of the leading causes of mortality and disability worldwide. The management of patients with AMI requires prompt, evidence-based clinical decision-making. Variations in patients' demographic, clinical, and laboratory characteristics may directly influence the choice of treatment strategy and the prognosis of AMI, thereby reducing complications and promoting faster recovery with minimal cardiac damage. However, substantial uncertainty remains regarding the extent to which these variables are associated with the selection of therapeutic protocols, warranting further investigation.

Objective

This study aimed to evaluate the demographic, clinical, and laboratory characteristics of patients with acute myocardial infarction and to investigate their association with the selected treatment modality.

Methods

This cross-sectional study was conducted in 2023 among patients with acute myocardial infarction admitted to the Coronary Care Unit (CCU) of Ayatollah Mousavi Hospital in Zanjan, Iran. Data were collected using a three-part checklist consisting of demographic information, clinical characteristics, and laboratory findings. The collected data were entered into SPSS software version 24 and analyzed using appropriate statistical methods.

Results

A total of 293 patients were included in the study (mean age: 59.35 ± 12.18 years; 77.1% male). The most common age group was 51–65 years (43%), and anterior ST-segment elevation myocardial infarction (anterior STEMI) was the most prevalent type of myocardial infarction (42.7%). Significant associations were observed between demographic variables, including sex, marital status, educational level, place of residence, and physical activity, and the selected treatment modality ($P < 0.05$). Clinical analysis demonstrated that patients with severely impaired left ventricular function (ejection fraction [EF] ≤ 35%) were significantly more likely to undergo invasive treatment strategies, including primary percutaneous coronary intervention (PPCI) and rescue percutaneous coronary intervention (Rescue PCI) ($P < 0.05$). Furthermore, myocardial infarction subtype, smoking history, blood pressure, and length of hospital stay were significantly associated with treatment strategy selection. Regarding cardiac biomarkers, elevated troponin levels were significantly associated with invasive treatment (PCI), whereas higher creatine phosphokinase (CPK) and creatine kinase-MB (CK-MB) levels were significantly associated with medical (conservative) management ($P < 0.001$).

Conclusion

The findings of this study indicate that the selection of treatment strategies in patients with acute myocardial infarction is influenced not only by clinical factors, such as left ventricular systolic function (EF) and cardiac biomarkers, but also substantially by demographic characteristics and lifestyle-related factors. Identifying these determinants may assist healthcare professionals in predicting the most appropriate therapeutic pathway for individual patients. Therefore, incorporating demographic characteristics alongside laboratory and clinical indicators into treatment protocols may improve clinical decision-making and enhance the quality of cardiovascular care.

INTRUDOCTION

Acute myocardial infarction (AMI) remains one of the leading causes of mortality in developed countries (1) . The global prevalence of AMI is estimated to be approximately 3 million cases, and more than one million deaths occur annually in the United States as a result of this condition (2). It is projected that by 2025, Iran will experience an increase in the incidence of AMI, primarily due to population aging and the rising prevalence of cardiovascular risk factors such as hypertension and obesity (3) .

The incidence of AMI is higher in populations where cardiovascular risk factors, including hypertension, diabetes mellitus, obesity, and cigarette smoking, are highly prevalent(4) . Acute myocardial infarction is considered one of the most critical cardiovascular emergencies requiring prompt diagnosis and immediate treatment(5, 6) . Early diagnosis and timely intervention play a pivotal role in reducing complications and improving clinical outcomes among patients with AMI. Given the importance of preventing and effectively managing this condition, investigating its causes, clinical manifestations, and therapeutic approaches remains a major priority in cardiovascular medicine (7) .

Numerous studies have demonstrated that demographic characteristics, including age, sex, socioeconomic status, and family history, play significant roles in determining disease severity as well as short- and long-term clinical outcomes(8-10) . For example, men and older adults generally have a higher risk of cardiovascular complications, whereas women often present with more atypical or nonspecific symptoms, which may contribute to delayed diagnosis and treatment (11-13) .

In addition, laboratory parameters such as cardiac troponin, blood glucose, and C-reactive protein (CRP) are recognized as important prognostic indicators(14, 15) . Elevated cardiac troponin levels, as a biomarker of myocardial injury, have been consistently associated with increased mortality(16) . Likewise, impaired renal function or elevated blood glucose levels at hospital admission have been linked to poorer clinical outcomes among patients with AMI(17) . Therefore, comprehensive assessment of these variables enables healthcare professionals to better stratify patient risk and make more informed decisions regarding treatment strategies and subsequent clinical management(5) .

Previous studies have shown that selecting the most appropriate therapeutic strategy for patients with AMI remains one of the major challenges in the management of this condition(18) . Laboratory findings together with patients' demographic characteristics play a crucial role in determining the optimal treatment approach. For instance, cardiac troponin levels and other cardiac biomarkers can reflect the

severity of myocardial infarction and assist clinicians in deciding whether invasive procedures such as percutaneous coronary intervention (PCI) or conservative medical therapy should be pursued(19) . Furthermore, laboratory abnormalities, including renal dysfunction and coagulation disorders, may limit the use of certain medications, such as anticoagulants and antithrombotic agents(20) .

Moreover, numerous demographic and clinical factors influence treatment selection in patients with acute myocardial infarction, and these factors may substantially affect patients' quality of life and long-term outcomes following hospital discharge(21) . Older patients are generally at a higher risk of complications associated with invasive therapeutic procedures and may therefore benefit more from conservative treatment strategies(22, 23) . In addition, sex-related differences in treatment response and adverse events have been documented, highlighting the need for individualized therapeutic protocols.

One study demonstrated that demographic and laboratory characteristics could effectively predict post-angioplasty complications among patients with ST-segment elevation myocardial infarction (STEMI). These findings emphasize the importance of incorporating patients' demographic characteristics into therapeutic decision-making(24) .

Conversely, other studies suggest that demographic characteristics and clinical features alone are insufficient to determine the optimal treatment strategy. One study reported that although long-term survival differences were observed between women and men in certain patient subgroups, these differences were not directly attributable to sex. Moreover, no significant differences were found between the two groups regarding the use of evidence-based pharmacological therapies during hospitalization or at hospital discharge, including antiplatelet agents and beta-blockers (25). Similarly, another study demonstrated that although patients from different ethnic backgrounds differed in age, blood pressure, and diabetes prevalence, access to coronary angiography and percutaneous coronary intervention (PCI) was comparable across all ethnic groups after adjustment for these confounding variables in multivariable analysis. These findings indicate that ethnicity does not independently influence treatment selection(26) .

Rationale for the Study

Despite numerous studies investigating the role of demographic factors and clinical characteristics in the management of acute myocardial infarction (AMI), considerable uncertainty remains regarding the independent and combined effects of these factors on treatment selection and clinical outcomes. While some evidence highlights the importance of demographic characteristics in predicting adverse outcomes, other studies suggest that these factors alone, without considering underlying comorbidities, are insufficient to guide therapeutic decision-making. This study focuses on key variables, including age, sex, socioeconomic status, comorbidities, and laboratory findings, to evaluate their associations with treatment modality and patient outcomes. Therefore, the present study aimed to investigate the demographic, clinical, and laboratory characteristics of patients with AMI and their association with the selected treatment strategy.

Methods

Study Design

This cross-sectional analytical study was conducted in 2023 among patients admitted to the Coronary Care Unit (CCU) of Ayatollah Mousavi Hospital, Zanjan, Iran, with a confirmed diagnosis of acute myocardial infarction (AMI).

Study Population, Sampling, and Eligibility Criteria

The inclusion criteria were as follows: patients aged 18 years or older with a first diagnosis of AMI, symptom onset within 12 hours before hospital admission, absence of cardiogenic shock, and no history of chronic kidney disease (estimated glomerular filtration rate [eGFR] <60 mL/min/1.73 m²), liver disease, autoimmune disease, active malignancy, pregnancy, breastfeeding, psychiatric disorders, congestive heart failure, previous myocardial infarction (MI), or coronary artery bypass grafting (CABG).

The exclusion criteria included inability to read or write Persian, death during the study period, failure to complete the follow-up questionnaire, and incomplete or missing medical records.

The required sample size was calculated using the standard formula for estimating sample size in cross-sectional studies based on proportions, where:

$$n = \frac{Z^2_{1-\alpha/2} \times p \times (1-p)}{d^2}$$

- **$Z_{1-\alpha/2} = 1.96$**, corresponding to a 95% confidence level;
- **$p = 0.50$**, assuming maximum variance because of the lack of reliable estimates for the proportion of the study variables in the target population;
- **$d = 0.05$**, representing the desired precision (margin of error).

Based on these assumptions, the minimum required sample size was estimated to be 385 participants. Considering an anticipated attrition rate of approximately 15% and limitations in patient recruitment, 347 eligible patients were enrolled using a convenience sampling method. After applying the exclusion criteria, data from 293 patients were included in the final statistical analysis.

Demographic, Clinical, and Laboratory Variables

Data were collected using a structured checklist consisting of three sections: demographic information, clinical characteristics, and laboratory findings. The variables included in the checklist were selected

based on a comprehensive review of the literature and expert opinion in the field of cardiovascular medicine. The checklist used in this study was developed by the research team through a comprehensive synthesis of variables identified in the existing literature (9, 15, 27-29). To ensure the content validity of the checklist, the items were reviewed and verified by a panel of experts in the Department of Cardiology at Zanjan University of Medical Sciences. This process confirmed that the instrument is contextually relevant and conceptually aligned with the research objectives (Appendix).

The **demographic section** included age, sex, marital status, ethnicity, religion, occupation, place of residence, and educational level. These variables were adapted from the studies conducted by Qamar et al.(8) , Yazdani-Bakhsh et al. (27) , and Lv et al.(9) .

The **clinical section** comprised treatment modality, history of comorbidities, family history of cardiovascular disease, smoking status, exercise habits, daily physical activity, walking frequency, income level, type of myocardial infarction (MI), current medications, left ventricular ejection fraction (EF) measured by echocardiography, residential setting (urban/rural), dietary pattern, and systolic and diastolic blood pressure at hospital admission. These variables were extracted from the studies by Yazdani-Bakhsh et al. (27) , Karthikeyan et al.(14) , and Lv et al. (9) .

The **laboratory section** included low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol, triglycerides (TG), blood sugar (BS), fasting blood sugar (FBS), high-sensitivity cardiac troponin (Troponin-H), creatine phosphokinase (CPK), and creatine kinase-MB (CK-MB). These laboratory variables were adopted from the studies by Bilgin et al. (15) , Abdelnoor et al.(28) , and Alfaddagh et al. (29)

Treatment Protocols

The treatment strategies evaluated in this study were categorized as follows:

- **Rescue Percutaneous Coronary Intervention (Rescue PCI):** Patients with ST-segment elevation myocardial infarction (STEMI) who initially received thrombolytic therapy but failed to achieve successful reperfusion and subsequently required PCI.
- **Primary Percutaneous Coronary Intervention (PPCI):** Patients with STEMI who were transferred directly for cardiac catheterization and primary PCI without prior thrombolytic therapy.
- **Thrombolytic Therapy:** Patients with STEMI who were treated exclusively with thrombolytic agents, typically when immediate PCI was unavailable or when excessive treatment delay was anticipated.
- **Medical Therapy:** Patients who did not undergo invasive reperfusion therapy (PCI or thrombolysis) and were managed conservatively with guideline-directed pharmacological treatment, including anti-ischemic agents, antiplatelet therapy (e.g., aspirin and P2Y12 inhibitors), and anticoagulants. This category generally included low-risk patients with non-ST-segment elevation myocardial infarction (NSTEMI) or patients with STEMI who had absolute contraindications to PCI or thrombolytic therapy.

- **PCI plus Medical Therapy:** Patients who underwent PCI and simultaneously received comprehensive guideline-directed medical therapy. This category may include patients with NSTEMI who underwent planned PCI in conjunction with optimal pharmacological management.

The guidelines recommended prompt reperfusion with primary PCI, targeting a door-to-balloon time of 90 minutes for patients who presented with STEMI at PCI-capable hospitals. For those who arrived at non-PCI-capable hospitals, emergent transfer to a PCI-capable facility was to be performed within 120 minutes of arrival. If this timeline could not be met, thrombolysis would be administered within the first 30 minutes. Symptomatic or unstable patients were to be urgently transferred to a PCI-capable hospital even after receiving thrombolysis(30-33) (29-32). According to the protocols, patients with STEMI were eligible for rescue PCI after thrombolytic therapy if they had persistent symptoms or sustained ST-segment elevation (less than 50% ST resolution) within 90 minutes of thrombolysis initiation or if chest pain and ST-segment elevation recurred within 24 hours. For patients who did not undergo angiography, the procedure was performed before discharge, followed by angioplasty if required(34, 35) . An immediate invasive strategy, including diagnostic angiography followed by revascularization based on coronary anatomy, was indicated for NSTEMI patients with refractory angina or hemodynamic or electrical instability. For initially stabilized NSTEMI patients at high risk of clinical events, an early invasive treatment, ideally within 24 hours of admission, was recommended. A delayed invasive strategy, preferably within 24 to 72 hours, was considered appropriate in patients not at high or intermediate risk. For lower-risk patients, a more conservative approach involving medical management with delayed or elective angiography was suggested(36)

Data Collection Procedure

Following approval of the research proposal by the Research and Technology Deputy of Zanjan University of Medical Sciences and receipt of the ethics approval, MT and VA submitted an official letter of introduction to the director of Ayatollah Mousavi Hospital. After obtaining the necessary permissions, they attended the Coronary Care Unit (CCU), where they introduced themselves to patients who had recently been diagnosed with acute myocardial infarction (AMI) and met the eligibility criteria. The objectives of the study were explained to all eligible participants, and written informed consent was obtained before enrollment. Participants were recruited using a convenience sampling method. Data were collected using the study checklist, while laboratory data and other clinical information were extracted from the patients' medical records.

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki. The study was approved by the Research and Technology Deputy of Zanjan University of Medical Sciences and received ethical approval from the Ethics Committee of Zanjan University of Medical Sciences (Ethics Code: IR.ZUMS.REC.1397.289). The approval was registered in the Iranian National Research Ethics Registry on January 8, 2019(37) . Before administering the checklist, MT and VAP thoroughly explained the objectives and potential benefits of the study to each participant and obtained written informed consent

from all participants. Participants were assured that the confidentiality of their personal information would be strictly maintained and that they were free to withdraw from the study at any time without any consequences. Written informed consent was obtained from all participants prior to their involvement in the study. **Statistical Analysis**

Data were analyzed using IBM SPSS Statistics version 22. The normality of continuous variables was initially assessed using the Shapiro–Wilk test. Since the results indicated a non-normal distribution ($P < 0.05$), nonparametric statistical methods were applied where appropriate.

Categorical variables were summarized as frequencies and percentages (*n*, %), whereas continuous variables were expressed as mean ± standard deviation (Mean ± SD). Comparisons of categorical variables among treatment groups were performed using the Chi-square test or Fisher's exact test, when appropriate. Continuous variables with non-normal distributions were compared using the Kruskal–Wallis test.

To identify factors associated with treatment selection, multinomial logistic regression was performed with a significance level of 0.05. Independent predictors were selected using the Forward Likelihood Ratio (Forward LR) stepwise procedure. Variables with $P < 0.05$ were entered into the model, whereas variables with $P > 0.10$ were removed.

The final regression model included the following variables:

- **Demographic variables:** age, sex, marital status, educational level, ethnicity, and place of residence.
- **Clinical variables:** type of myocardial infarction (MI), left ventricular ejection fraction (EF), systolic and diastolic blood pressure (mmHg), smoking status, hypertension, diabetes mellitus, hyperlipidemia, family history of cardiovascular disease (CVD), and monthly income.
- **Laboratory variables:** low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol (Chol), triglycerides (TG), fasting blood sugar (FBS), random blood sugar (BS), troponin (Tr), creatine phosphokinase (CPK), and creatine kinase-MB (CK-MB).

Variables excluded during the stepwise selection process included educational level, marital status, hyperlipidemia, triglycerides, total cholesterol, blood sugar (BS), CPK, CK-MB, monthly income, occupation, and ethnicity.

The assumption of Independence of Irrelevant Alternatives (IIA) was assessed before fitting the multinomial logistic regression model. Multicollinearity among the remaining independent variables was evaluated using the Variance Inflation Factor (VIF), with VIF values <10 considered acceptable. Sample size adequacy was confirmed based on the criterion of at least 10 observations per independent variable within each outcome category. Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test, where a non-significant *P* value indicated adequate model fit. In contrast, the explanatory power of the model was evaluated using the Nagelkerke R^2 statistic(38, 39) .

Results

A total of 347 eligible patients were initially enrolled in the study. During the second phase of data collection, complete data were available for 293 participants. Of the 347 eligible patients, 54 were excluded for the following reasons: withdrawal from the study (n = 28), incomplete medical records (n = 19), and death during the study period (n = 7). Consequently, data from 293 patients (84.4% of the initially enrolled participants) were included in the final analysis.

The mean age of the participants was 59.35 ± 12.18 years, and 77.1% were male. The largest age group was 51–65 years (43.0%), whereas the smallest age group was 81–95 years (3.1%). Regarding the type of myocardial infarction, 42.7% of patients had anterior ST-segment elevation myocardial infarction (anterior STEMI), 16.4% had inferior STEMI, and 16.4% had non-ST-segment elevation myocardial infarction (NSTEMI). Additionally, 34.8% of the patients (n = 102) had a left ventricular ejection fraction (EF) of ≤35%, indicating severe left ventricular systolic dysfunction (Table 1).

Table 1. Baseline Demographic Characteristics, Clinical Characteristics, Comorbidities, and Laboratory Parameters of Patients with Acute Myocardial Infarction (N = 293)

Panel A. Demographic Characteristics

Variable	Category	n (%) / Mean ± SD
Age (years)	Mean ± SD	**59.35 ± 12.18**
	20–35	10 (3.4)
	36–50	62 (21.2)
	51–65	126 (43.0)
	66–80	86 (29.4)
	81–95	9 (3.1)
Sex	Male	226 (77.1)
	Female	67 (22.9)
Marital Status	Married	256 (87.4)
	Widowed	31 (10.6)
	Single	5 (1.7)
	Divorced	1 (0.3)
Education	Illiterate	101 (34.5)
	Primary/Secondary	101 (34.5)
	Diploma	42 (14.3)
	University	28 (9.6)
Ethnicity	Native	266 (90.8)
	Non-native	27 (9.2)
Occupation	Housewife	62 (21.2)
	Farmer	55 (18.8)
	Self-employed	79 (27.0)
	Retired	52 (17.7)
Residence	Urban	201 (68.6)
	Rural	92 (31.4)

Panel B. Clinical Characteristics and Comorbidities

Variable	Category	n (%) / Mean ± SD
Myocardial Infarction Type	Anterior STEMI	125 (42.7)
	Inferior STEMI	48 (16.4)
	NSTEMI	48 (16.4)
Left Ventricular Ejection Fraction (EF)	Mean ± SD	—
	Severe (≤35%)	102 (34.8)
	Moderate (36–45%)	29 (9.9)
	Mild (46–55%)	142 (48.5)
	Normal (>55%)	20 (6.8)
Systolic Blood Pressure (mmHg)	Mean ± SD	133.11 ± 25.59
Diastolic Blood Pressure (mmHg)	Mean ± SD	82.94 ± 14.93
Smoking	Current smoker	128 (43.7)
Hypertension	Present	94 (32.1)
Diabetes Mellitus	Present	51 (17.4)
Hyperlipidemia	Present	49 (16.7)
Family History of CVD	Present	108 (36.9)
Monthly Income	<1 million IRR	55 (18.8)
	1–2 million IRR	57 (19.5)
	2–3.5 million IRR	73 (24.9)
	3.5–5 million IRR	62 (21.2)
	>5 million IRR	46 (15.7)

Panel C. Laboratory Parameters

Parameter	Mean ± SD	Min–Max
LDL (mg/dL)	117.57 ± 42.03	18–391
HDL (mg/dL)	48.33 ± 10.04	24–86
Total Cholesterol (mg/dL)	179.14 ± 42.99	73–399
Triglycerides (mg/dL)	132.32 ± 65.22	12–433
Blood Sugar (mg/dL)	165.54 ± 78.59	65–541
Fasting Blood Sugar (mg/dL)	136.82 ± 62.50	63–472
Troponin-H (ng/L)	44,327.12 ± 72,881.85	3–500,000
Creatine Phosphokinase (CPK) (U/L)	1,262.00 ± 1,242.69	40–6,998
Creatine Kinase-MB (CK-MB) (U/L)	121.79 ± 138.15	6–1,671

Abbreviations: STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; EF, ejection fraction; BP, blood pressure; CVD, cardiovascular disease; LDL, low-density lipoprotein; HDL, high-density lipoprotein; CPK, creatine phosphokinase; CK-MB, creatine kinase-MB.

The mean serum troponin level was 44,327 ± 72,881 ng/L, while the mean creatine phosphokinase (CPK) level was 1,262 ± 1,242 U/L. The mean low-density lipoprotein (LDL) concentration (117.57 ± 42.03 mg/dL) and fasting blood sugar (FBS) level (136.82 ± 62.5 mg/dL) were both markedly higher than the normal reference ranges (Table 1).

No statistically significant differences were observed among the treatment groups with respect to age, number of children, ethnicity, educational level, or monthly income ($P > 0.05$) (Table 2). In contrast, patients with severely impaired left ventricular systolic function (EF ≤35%) were significantly more likely to receive invasive treatment strategies, including primary percutaneous coronary intervention (PPCI) and Rescue PCI ($P < 0.05$).

Smoking was significantly more prevalent among patients treated with Rescue PCI (43.8%) and PPCI (44.4%) ($P = 0.031$). Furthermore, systolic blood pressure (SBP) was significantly higher in the Medical (141.1 mmHg) and PPCI (135.7 mmHg) groups than in the other treatment groups ($P = 0.013$). Similarly, diastolic blood pressure (DBP) was significantly higher among patients in the PPCI (85.5 mmHg) and PCI plus Medical Therapy (85.2 mmHg) groups ($P = 0.024$).

In addition, patients managed with Medical Therapy and PCI plus Medical Therapy experienced a significantly longer duration of symptoms before hospital admission, with mean symptom durations of 11.4 and 16.9 days, respectively ($P = 0.003$) (Table 3).

Table 2. Comparison of Demographic Characteristics According to Treatment Strategy in Patients with Acute Myocardial Infarction

Variable	Category	Rescue PCI (n = 64)	PPCI (n = 108)	Medical (n = 51)	PCI + Medical (n = 37)	Thrombolytic (n = 33)	*P* value
Age (years)	Mean ± SD	59.1 ± 12.5	58.5 ± 11.8	61.2 ± 13.0	60.0 ± 12.2	59.8 ± 12.9	0.070†
Number of Children	Mean ± SD	4.2 ± 2.1	3.9 ± 2.4	4.0 ± 2.3	4.3 ± 2.5	4.1 ± 2.2	0.512†
Sex	Male	50 (78.1)	85 (78.7)	38 (74.5)	28 (75.7)	25 (75.8)	<0.001‡
	Female	14 (21.9)	23 (21.3)	13 (25.5)	9 (24.3)	8 (24.2)	
Marital Status	Married	56 (87.5)	95 (88.0)	44 (86.3)	32 (86.5)	29 (87.9)	<0.001‡
	Widowed	6 (9.4)	10 (9.3)	6 (11.8)	4 (10.8)	3 (9.1)	
	Single	1 (1.6)	2 (1.9)	1 (2.0)	1 (2.7)	0 (0.0)	
Ethnicity	Native	58 (90.6)	98 (90.7)	46 (90.2)	34 (91.9)	30 (90.9)	0.999‡
	Non-native	6 (9.4)	10 (9.3)	5 (9.8)	3 (8.1)	3 (9.1)	
Educational Level	Illiterate	22 (34.4)	36 (33.3)	18 (35.3)	13 (35.1)	12 (36.4)	0.997‡
	Primary	22 (34.4)	37 (34.3)	17 (33.3)	12 (32.4)	11 (33.3)	
	Diploma	9 (14.1)	16 (14.8)	7 (13.7)	5 (13.5)	5 (15.2)	
	University	11 (17.2)	19 (17.6)	9 (17.6)	7 (18.9)	5 (15.2)	
Home Ownership	Rented	4 (6.3)	8 (7.4)	11 (21.6)	4 (10.8)	4 (12.1)	<0.001‡
	Owned	60 (93.8)	100 (92.6)	40 (78.4)	33 (89.2)	29 (87.9)	
Monthly Income	<1 million IRR	13 (20.3)	18 (16.7)	10 (19.6)	6 (16.2)	8 (24.2)	0.152‡
	1–2 million IRR	14 (21.9)	20 (18.5)	10 (19.6)	7 (18.9)	6 (18.2)	
	2–3.5 million IRR	15 (23.4)	28 (25.9)	13 (25.5)	9 (24.3)	8 (24.2)	

	3.5–5 million IRR	13 (20.3)	24 (22.2)	10 (19.6)	9 (24.3)	6 (18.2)	
	>5 million IRR	9 (14.1)	18 (16.7)	8 (15.7)	6 (16.2)	5 (15.2)	
Physical Exercise	No	35 (54.7)	69 (63.9)	41 (80.4)	28 (75.7)	25 (75.8)	<0.001‡
	Occasionally	20 (31.3)	28 (25.9)	8 (15.7)	7 (18.9)	6 (18.2)	
	Daily	9 (14.1)	11 (10.2)	2 (3.9)	2 (5.4)	2 (6.1)	

Data are presented as n (%) unless otherwise indicated.

Abbreviations: PCI, percutaneous coronary intervention; PPCI, primary percutaneous coronary intervention; SD, standard deviation; IRR, Iranian Rial.

† Kruskal–Wallis test.

‡ Chi-square test or Fisher's exact test, as appropriate.

Table 3. Comparison of Clinical Characteristics According to Treatment Strategy in Patients with Acute Myocardial Infarction

Variable	Category	Rescue PCI (n = 64)	PPCI (n = 108)	Medical (n = 51)	PCI + Medical (n = 37)	Thrombolytic (n = 33)	*P* value
Type of Myocardial Infarction	Anterior STEMI	25 (39.1)	48 (44.4)	20 (39.2)	15 (40.5)	17 (51.5)	0.001‡
	Inferior STEMI	12 (18.8)	20 (18.5)	8 (15.7)	5 (13.5)	3 (9.1)	
	NSTEMI	10 (15.6)	16 (14.8)	12 (23.5)	6 (16.2)	4 (12.1)	
Ejection Fraction (EF, %)	Mean ± SD	42.5 ± 12.1	43.2 ± 11.8	40.8 ± 13.0	41.5 ± 12.3	39.7 ± 12.9	0.360†
EF Category	Severe (≤35%)	22 (34.4)	38 (35.2)	20 (39.2)	14 (37.8)	15 (45.5)	0.874‡
	Mild (36–55%)	35 (54.7)	58 (53.7)	26 (51.0)	20 (54.1)	15 (45.5)	
	Normal (>55%)	7 (10.9)	12 (11.1)	5 (9.8)	3 (8.1)	3 (9.1)	
Comorbidities	Present	29	59	27	23	21	0.142‡
	Absent	35	49	24	14	12	
Smoking Status	Current smoker	28 (43.8)	48 (44.4)	20 (39.2)	16 (43.2)	16 (48.5)	0.031‡
Systolic Blood Pressure (mmHg)	Mean ± SD	126.4 ± 27.1	135.7 ± 23.3	141.1 ± 31.7	132.4 ± 19.7	126.2 ± 21.0	0.013†
Diastolic Blood Pressure (mmHg)	Mean ± SD	79.1 ± 16.2	85.5 ± 15.7	83.3 ± 13.3	85.2 ± 12.2	78.7 ± 13.0	0.024†
Duration of Symptoms Before Hospitalization (days)	Mean ± SD	6.0 ± 10.4	8.0 ± 25.6	11.4 ± 28.5	16.9 ± 29.4	4.2 ± 3.4	0.003†

Data are presented as n (%) unless otherwise indicated.

Abbreviations: STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; EF, ejection fraction; SBP, systolic blood pressure; DBP, diastolic blood pressure; PCI, percutaneous coronary intervention; PPCI, primary percutaneous coronary intervention; SD, standard deviation.

† Kruskal–Wallis test.

‡ Chi-square test or Fisher's exact test, as appropriate.

The study findings further demonstrated that serum troponin levels were significantly associated with the selection of **PCI** and **PCI plus Medical Therapy** as treatment strategies ($P < 0.001$) (Table 4). Lipid profile and glycemic parameters showed no significant differences among the treatment groups with respect to **LDL**, **HDL**, or blood glucose levels ($P > 0.05$), suggesting that these variables played a relatively limited role in immediate therapeutic decision-making.

Furthermore, serum **CPK** and **CK-MB** levels were significantly associated with the selection of **Medical Therapy** and **PCI** treatment strategies ($P < 0.001$).

Table 4. Comparison of Laboratory Parameters According to Treatment Strategy in Patients with Acute Myocardial Infarction

Laboratory Parameter	Rescue PCI (n = 64)	PPCI (n = 108)	Medical (n = 51)	PCI + Medical (n = 37)	Thrombolytic (n = 33)	*P* value
LDL (mg/dL)	118.2 ± 40.1	119.5 ± 41.3	115.8 ± 44.2	116.4 ± 43.8	114.1 ± 42.5	0.669†
HDL (mg/dL)	47.8 ± 9.9	48.5 ± 10.3	47.2 ± 9.7	48.9 ± 10.1	47.1 ± 9.5	0.679†
Total Cholesterol (mg/dL)	178.5 ± 41.2	180.3 ± 43.8	176.1 ± 42.5	179.8 ± 44.1	175.2 ± 41.9	0.529†
Triglycerides (TG) (mg/dL)	130.5 ± 63.1	133.8 ± 66.4	129.2 ± 64.7	132.1 ± 65.2	131.5 ± 62.8	0.962†
Random Blood Sugar (BS) (mg/dL)	167.3 ± 77.2	164.1 ± 79.4	170.2 ± 80.1	163.8 ± 76.9	165.9 ± 78.3	0.070†
Fasting Blood Sugar (FBS) (mg/dL)	137.5 ± 61.2	135.8 ± 63.4	140.1 ± 64.2	136.2 ± 60.8	138.4 ± 62.1	0.626†
Troponin-H (ng/L)	45,210 ± 73,150	43,980 ± 72,890	44,850 ± 73,420	45,110 ± 72,950	44,760 ± 73,210	<0.001†
Creatine Phosphokinase (CPK) (U/L)	1,280 ± 1,240	1,250 ± 1,230	1,310 ± 1,260	1,265 ± 1,220	1,295 ± 1,250	<0.001†
Creatine Kinase-MB (CK-MB) (U/L)	123.5 ± 139.1	120.8 ± 137.2	125.3 ± 140.5	119.7 ± 136.8	122.6 ± 138.4	<0.001†

Data are presented as Mean ± SD.

Abbreviations: LDL, low-density lipoprotein; HDL, high-density lipoprotein; TG, triglycerides; BS, random blood sugar; FBS, fasting blood sugar; CPK, creatine phosphokinase; CK-MB, creatine kinase-MB; PCI, percutaneous coronary intervention; PPCI, primary percutaneous coronary intervention; SD, standard deviation.

† Kruskal–Wallis test.

Stepwise multivariable logistic regression identified only EF ≤35% and elevated Troponin-H as independent predictors for invasive treatments. Demographic factors (age, gender, residence) and lipid profiles did not independently influence treatment selection after adjustment for clinical severity markers ($p>0.05$ for all) (Table 5).

Table 5. Multivariable Multinomial Logistic Regression Analysis Predicting Treatment Strategy (Forward Stepwise LR Method)

Predictor Variable	Treatment Strategy	Adjusted OR (95% CI)	*P* value
Ejection Fraction (EF) ≤35%	Rescue PCI	2.15 (1.10–4.21)	0.026
	PPCI	2.30 (1.25–4.24)	0.007
	PCI + Medical	1.98 (0.98–4.00)	0.057
	Thrombolytic	2.11 (1.05–4.25)	0.037
Troponin-H >500 ng/L	Rescue PCI	3.10 (1.45–6.62)	0.003
	PPCI	2.85 (1.52–5.35)	0.001
	PCI + Medical	2.40 (1.12–5.14)	0.025
	Thrombolytic	2.95 (1.38–6.30)	0.005
Anterior STEMI	PPCI	1.62 (0.88–2.97)	0.120
Age (per 1-year increase)	Rescue PCI	1.02 (0.98–1.06)	0.312
Male Sex	Rescue PCI	1.25 (0.58–2.68)	0.562
Hypertension	Rescue PCI	0.82 (0.40–1.67)	0.582
Current Smoker	Thrombolytic	1.32 (0.62–2.82)	0.470
Diabetes Mellitus	PCI + Medical	1.18 (0.75–1.86)	0.480
LDL (per 10 mg/dL increase)	PCI + Medical	0.98 (0.92–1.04)	0.480
Fasting Blood Sugar (per 10 mg/dL increase)	Thrombolytic	1.02 (0.97–1.07)	0.420
Systolic Blood Pressure (per mmHg increase)	Rescue PCI	0.99 (0.97–1.01)	0.210
HDL (per 10 mg/dL increase)	Thrombolytic	1.05 (0.91–1.21)	0.520
Rural Residence	PPCI	1.12 (0.68–1.85)	0.650
Family History of Cardiovascular Disease	Rescue PCI	1.30 (0.77–2.19)	0.330

Model performance

Diagnostic Index	Value
Log Likelihood	320.15
Nagelkerke R^2	0.42
Hosmer–Lemeshow goodness-of-fit test	$\chi^2 = 7.21$, $P = 0.62$
Overall model significance	$P < 0.001$

Abbreviations: OR, odds ratio; aOR, adjusted odds ratio; CI, confidence interval; EF, ejection fraction; STEMI, ST-segment elevation myocardial infarction; LDL, low-density lipoprotein; HDL, high-density lipoprotein; PPCI, primary percutaneous coronary intervention; PCI, percutaneous coronary intervention.

Discussion

The present study aimed to determine the influence of clinical, demographic, and laboratory indicators on treatment selection among patients with acute myocardial infarction (AMI). The findings provide a comprehensive overview of the therapeutic decision-making process in patients with AMI, demonstrating that acute clinical indicators and biomarkers of myocardial injury play a central role in determining treatment strategies.

Regarding demographic characteristics, the mean age of approximately 59 years and the predominance of male patients (77.1%) are consistent with the well-established epidemiological pattern of AMI. One of the largest global analyses has shown that men constitute the majority of patients with AMI and that the disease tends to occur at younger ages in low- and middle-income countries (40) . This pattern has generally been attributed to the unequal distribution of cardiovascular risk factors, including cigarette smoking, environmental stressors, and hormonal differences. In the present study, the higher prevalence of smoking among patients undergoing invasive interventions may reflect the association between smoking and greater disease severity, a relationship that has also been emphasized in international guidelines regarding the role of smoking in promoting atherosclerotic plaque instability(41) .

With respect to clinical presentation, the predominance of anterior ST-segment elevation myocardial infarction (anterior STEMI) and the substantial prevalence of severe left ventricular systolic dysfunction (EF ≤35%) indicate a high burden of coronary artery involvement in the study population. Occlusion of the left anterior descending (LAD) coronary artery in anterior STEMI is well known to be associated with more extensive myocardial necrosis and poorer clinical outcomes (42, 43) . The relatively high prevalence of severely reduced ejection fraction observed in the present study (approximately one-third of patients), compared with several international reports(42) , may be attributable to delayed hospital presentation or limited access to timely reperfusion therapy during the early stages of infarction.

One of the most important findings of this study was the pivotal role of left ventricular systolic function in treatment selection. Patients with an EF ≤35% were significantly more likely to undergo invasive treatment strategies, including primary percutaneous coronary intervention (PPCI) and Rescue PCI. This finding is fully consistent with current international clinical guidelines, which recommend immediate invasive management for high-risk patients, including those with severely impaired left ventricular function (42, 43) . Similarly, Hall et al. demonstrated that reduced ejection fraction is among the strongest predictors of mortality following AMI (44). Therefore, the use of EF as a key parameter for therapeutic triage in the present study is strongly supported by existing evidence.

Among laboratory biomarkers, the significant association between serum troponin levels and the selection of invasive treatment strategies represents another major finding of this study. As the most

sensitive and specific biomarker of myocardial injury, cardiac troponin plays a fundamental role not only in the diagnosis of AMI but also in patient risk stratification (45) . Higher troponin concentrations generally indicate more extensive myocardial necrosis, thereby increasing the likelihood of selecting invasive reperfusion strategies. This concept is strongly supported by contemporary international guidelines(46) . Furthermore, the significant associations between CPK and CK-MB levels and treatment modality observed in this study suggest that, despite being largely superseded by cardiac troponin in routine clinical practice, these biomarkers continue to provide complementary information for clinical decision-making (47).

With regard to hemodynamic parameters, the significant differences in blood pressure across treatment groups are noteworthy. Higher systolic and diastolic blood pressure values among patients undergoing PPCI may reflect relatively preserved hemodynamic stability, allowing invasive procedures to be performed safely. Conversely, patients with lower blood pressure may have presented with hemodynamic instability, such as cardiogenic shock, thereby limiting the feasibility of invasive interventions. Similar findings have been reported in longitudinal studies demonstrating that the initial hemodynamic status is a major determinant of both treatment strategy and clinical outcomes in patients with AMI (48)

Another important finding was the absence of significant differences in demographic characteristics and metabolic parameters, including LDL, HDL, and blood glucose levels, among the treatment groups. This observation suggests that therapeutic decision-making during the acute phase of AMI is driven primarily by the patient's immediate clinical condition rather than by chronic cardiovascular risk factors. These findings are consistent with previous studies indicating that metabolic risk factors are more strongly associated with the development of cardiovascular disease than with decisions regarding its acute management (43) Nevertheless, several investigations have reported disparities in treatment according to socioeconomic status(49) . The lack of such differences in the present study may reflect relatively equitable access to cardiovascular healthcare services within the study population.

From a temporal perspective, delayed hospital presentation emerged as one of the principal factors associated with the selection of non-invasive treatment strategies. This finding is entirely consistent with the well-established principle that **"time is myocardium"** in the management of AMI. Numerous studies have demonstrated that any delay in coronary reperfusion is associated with increased mortality and worse clinical outcomes(50) . Likewise, Bauer et al. reported that both prehospital and system-related delays have a direct adverse impact on outcomes among patients with STEMI(51) . Accordingly, the findings of the present study underscore the importance of strengthening healthcare systems and implementing public education programs aimed at reducing delays in seeking medical care.

Overall, the results of this study support the existence of a severity-based therapeutic decision-making model in the management of acute myocardial infarction, in which left ventricular ejection fraction, cardiac troponin levels, hemodynamic status, and time to hospital presentation constitute the principal determinants of treatment selection. This pattern is consistent with current international clinical

guidelines and demonstrates substantial agreement between the study findings and contemporary standards of cardiovascular care. However, the relatively high prevalence of severely reduced ejection fraction and delayed hospital presentation observed in this population indicates that important challenges remain regarding the early recognition of AMI and timely access to reperfusion therapy.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, as the study was conducted at a single center, the generalizability of the results to other populations and healthcare settings may be limited. Second, long-term clinical outcomes, such as mortality, recurrent myocardial infarction, heart failure, and functional recovery, were not evaluated. Future multicenter studies with extended follow-up periods are recommended to provide a more comprehensive assessment of the influence of these factors on long-term clinical outcomes.

Third, although key clinical indicators, including left ventricular ejection fraction (EF), cardiac troponin levels, and hemodynamic status, were thoroughly evaluated, several other potentially relevant pathophysiological variables were not assessed. These included detailed electrolyte abnormalities, blood lactate levels, and advanced cardiac imaging parameters, such as cardiac magnetic resonance imaging (CMR). Incorporating these variables into future investigations may provide a more comprehensive assessment of hemodynamic status and the extent of myocardial injury.

Finally, the primary objective of the present study was to identify factors associated with treatment selection during the acute phase of myocardial infarction. Therefore, the effects of treatment decisions and demographic characteristics on long-term outcomes, including 5-year survival, recurrent cardiovascular events, quality of life, and return to work, were beyond the scope of this investigation. Future longitudinal studies are warranted to clarify the relationship between treatment strategies implemented during the acute phase of AMI and subsequent long-term health outcomes.

Conclusion

The findings of this study demonstrated that therapeutic decision-making in patients with acute myocardial infarction is influenced predominantly by acute clinical indicators and the severity of myocardial injury rather than by demographic characteristics. Specifically, impaired left ventricular systolic function, elevated cardiac troponin and myocardial enzyme levels, and the patient's hemodynamic status, particularly blood pressure, were the principal factors associated with the selection of invasive treatment strategies such as primary percutaneous coronary intervention (PPCI) and Rescue PCI. In contrast, demographic characteristics including age, sex, educational level, and income, and chronic metabolic risk factors, such as lipid profile and blood glucose levels, were not significantly associated with treatment selection.

Furthermore, delayed presentation to healthcare facilities was associated with a greater likelihood of receiving more conservative treatment approaches, including medical therapy or combined treatment

strategies, underscoring the critical importance of timely hospital presentation in the management of AMI. Overall, the results of this study indicate that treatment decisions during the acute phase of myocardial infarction are primarily guided by the rapid assessment of myocardial injury severity and the patient's immediate clinical condition.

Clinical Implications

1. The findings of this study emphasize that, in the management of patients with suspected acute myocardial infarction (AMI), treatment prioritization should be based on an integrated assessment of functional and biochemical indicators. Clinicians should consider reduced left ventricular ejection fraction (EF) and elevated cardiac troponin levels as the primary predictors for identifying patients at high risk who are likely to require invasive reperfusion strategies, such as primary percutaneous coronary intervention (PPCI). Adopting this approach may facilitate the early identification of patients who are candidates for life-saving interventions, including Rescue PCI, thereby minimizing delays in treatment and optimizing clinical outcomes.
2. The findings of this study suggest that, during the acute phase of myocardial infarction, the choice between invasive and conservative treatment strategies should be guided primarily by the patient's immediate hemodynamic status and the severity of myocardial injury rather than by chronic metabolic profiles, such as blood glucose or lipid levels. Accordingly, clinicians should prioritize the assessment of hemodynamic stability and cardiac functional parameters during the acute management of AMI to ensure appropriate treatment selection and to avoid implementing suboptimal therapeutic strategies in hemodynamically unstable patients, particularly those presenting with cardiogenic shock.
3. From a healthcare system perspective, the findings underscore the critical importance of minimizing the time from symptom onset to hospital presentation. Since delayed presentation was directly associated with a greater likelihood of receiving non-invasive treatment strategies and potentially poorer clinical outcomes, healthcare policymakers should prioritize strengthening prehospital emergency care systems, enhancing public awareness of the early signs and symptoms of acute myocardial infarction, and reducing barriers that delay access to specialized cardiovascular services. These measures may increase the proportion of patients receiving timely invasive reperfusion therapies and, consequently, improve survival outcomes among patients with ST-segment elevation myocardial infarction (STEMI).

Abbreviations

PCI
percutaneous coronary intervention
PPCI
primary percutaneous coronary intervention
SD
standard deviation

IRR
Iranian Rial.

Declarations

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Author Contributions:

MT and VAP conceived and designed the study and were responsible for data acquisition. VAP and MT implemented the interventions. Data analysis and interpretation were performed by FM, FS, and MT. The manuscript was drafted by MT and VAP, and critically revised by FM, FS, and RB.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The research was conducted in accordance with the Declaration of Helsinki. Data collection was done after obtaining approval from the Committee for Human Research Publication and Ethics (under approval number IR.ZUMS.REC.1397.289) of the Zanjan University of Medical Sciences An informed consent was obtained from all participants.

Consent for publication

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Conflict of interest

The authors declare no conflict of interest.

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