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Article

IL-6 and HMGB1 Levels for Predicting Major Adverse Vascular Events after Percutaneous Coronary Intervention in Patients with Acute Coronary Syndrome

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Abstract

Objective: This study aims to investigate the value of interleukin 6 (IL-6) and high-mobility group box 1 (HMGB1) in predicting major adverse cardiovascular events (MACE) after percutaneous coronary intervention (PCI) in patients with acute coronary syndrome (ACS). **Methods**: Patients with ACS who were treated in our hospital from October 2022 to October 2023 were divided into MACE and no-MACE groups according to the occurrence of MACE after PCI. The baseline data and IL-6 and HMGB1 levels in the two groups were observed, and the influencing factors of MACE in patients with ACS after PCI were evaluated with a logistic regression test. The receiver operator characteristic curve (ROC) values of IL-6 and HMGB1 in the prediction of MACE after PCI in patients with ACS were calculated. **Results**: No significant differences in age, sex, body mass index (BMI), and other general data were found between the groups. Compared with the patients in the no-MACE group, the patients in the MACE group had a history of smoking ($p = 0.011$), hypertension ($p < 0.001$), diabetes ($p < 0.001$), more coronary lesions ($p = 0.013$), longer coronary lesions ($p = 0.006$), higher preoperative Gensini score ($p < 0.001$), and lower left ventricular ejection fractions (LVEF) ($p < 0.001$). The levels of IL-6 and HMGB1 in the MACE group were significantly higher than those in the no-MACE group. Coronary lesion length, Gensini score, LVEF, IL-6, and HMGB1 had good predictive value for MACE after PCI. The area under the curve (AUC) scores were 0.683, 0.941, 0.816, 0.878, and 0.737. The sensitivity was 53.13%, 81.25%, 84.37%, 78.12%, and 53.13%, and the specificity was 87.50%, 93.18%, 63.64%, 86.36%, and 86.36%, respectively. Analysis of IL-6 and HMGB1 levels showed that the AUC was 0.922, the sensitivity was 90.62%, the specificity was 82.95%, and the 95% confidence interval (CI) was (0.858–0.963; $p < 0.05$). **Conclusion**: IL-6 and HMGB1 have good predictive value for MACE after PCI for patients with ACS and can be used as clinical evaluation indexes.

Keywords

acute coronary syndrome; major adverse cardiovascular events; interleukin 6; high-mobility group box 1

Introduction

Acute coronary syndrome (ACS) is caused by the rupture or invasion of the coronary atherosclerotic plaque and characterized by the complete or incomplete occlusion of coronary arteries. It ultimately leads to thrombosis or myocardial ischemia and is a common clinical syndrome with high incidence and mortality rates, imposing considerable burden on global medical care [1,2]. Percutaneous coronary intervention (PCI) is the main treatment method for the disease, not only quickly and effectively opening the coronary arteries of coronary stenosis or occlusion but also reducing the area of the infarction, alleviating clinical symptoms and saving patients' lives [3,4]. However, some patients experience major adverse vascular events (MACE) after surgery; MACE mainly refer to heart-related death, myocardial ischemia or infarction recurrence, recurrent blood transport reconstruction, new or aggravated heart failure, and stroke. The mechanism that compounds a vascular disease may involve lipid metabolic disorders, atherosclerosis, and endothelial damage, which adversely affect patients' prognoses and quality of life [5,6]. Therefore, predicting MACE and intervention at the early stage of the disease are essential.

Interleukin 6 (IL-6) plays a critical role in the production of inflammatory cytokines in the onset of atherosclerosis [7]; and oxidative stress and vascular damage determine the indicator level. IL-6 may be a predictor of MACE, but its value as a predicting factor has not been clarified [8]. High-mobility group box 1 (HMGB1) is an advanced inflammatory factor and may play an important role in the regulation of inflammatory response. HMGB1 levels are significantly high in the sera of patients with acute myocar-

dial infarction and ACS [9,10]. However, research on the predictive value of IL-6 and HMGB1 is rare, and no study has examined them simultaneously.

Therefore, this study aims to assess the clinical data of patients with ACS, follow up a MACE event, discuss the predictive value of IL-6 and HMGB1 for patients' postoperative MACE, and ultimately provide a theoretical basis for the evaluation of the clinical prognosis of ACS.

Materials and Methods

General Information

This study is a case-control study, in which 120 patients diagnosed with ACS and admitted to three provincial hospitals from October 2022 to October 2023 were enrolled: 32 in the MACE group and 88 in the no-MACE group. The cases comprise 73 cases of unstable angina pectoris (UAP), 22 cases of ST-segment elevation myocardial infarction, and 25 cases of ST-segment elevation myocardial infarction. This study was approved by the ethics committees of the hospitals ((2023) -014), and consent was obtained from the patients or family members. Uniform training was provided to all data collectors to standardize data collection procedures and minimize bias.

Increase in Standards and Exclusion Standards

Inclusion criteria: ① the diagnostic criteria of the European Heart Diseases [11] and the American Cardiac Society [12]; ② age >40 years; ③ coronary angiography confirms that at least 1 coronary artery stenosis, stenosis >75%, confidence interval (CI) treatment requirement; ④ complete clinical data; ⑤ high compliance and being available for follow-ups.

Exclusion criteria: ① heart functional function; ② infectious and hematological diseases; ③ malignant tumors; ④ inability to use the bracket; ⑤ impaired liver and renal function; ⑥ congenital heart disease, valve disease, and other structures. Referring to other abnormalities or lesions of the heart or vasculature other than the coronary artery, heart valves, or congenital heart disease.

Method

Information about population statistics and laboratory data were obtained from the patients' medical records, including age, gender, body mass index (BMI), smoking history, history of coronary heart disease, hypertension history, history of diabetes, cerebral vascular medical history, family, cholesterol level, pathological history of coronary artery, and number of stents. Coronary angiography results were as follows: the length of coronary lesions, Gensini score before surgery. Ultrasonic cardiac diagram results (US GE VIVID E9 cardiopathic ultrasound diagnostic (General Electric Company, Boston, Massachusetts); three-dimensional matrix probe frequency 1.5–3.5 mHz). The late diastolic left-hearted indoor diameter, and the end-stage indoor diameter (LVESD) of the contraction scores (LVEF) were measured. Early morning admission data were collected, and empty vein blood was collected and tested. Serum scientific parameters included triglyceride (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), fasting blood glucose (FBG), and glycated hemoglobin (HBA1C), white blood cell (WBC) count, IL-6, and HMGB1 were analyzed by standard laboratory methods.

Treatment Method

All patients were examined before surgery and treated with PCI. Patients with right-sided arterial indications underwent percutaneous coronary intervention (PCI). Postoperatively, they were administered 75 mg of clopidogrel hydrochloride (Sanofi Winthrop Industrie; Hangzhou, Zhejiang, China; 75 mg; catalog number: HJ20171237) and 100 mg of aspirin (Bayer HealthCare Manufacturing S.r.l., Leverkusen, Germany; 100 mg; catalog number: HJ20160685) daily. The medication dosage was maintained at this level on a daily basis.

Before the PCI, multibody application was administered to clear the coronary lesions, and patients whose main branches of the coronary arteries had stenosis of >75% received interventional therapy. The drug was eluted.

Follow-up

All patients were followed up through telephone calls. According to the patient's conditions and the incidence of MACE at different time points, the follow-up time was 1 year or follow-up was conducted until a MACE. MACE were defined as cardiovascular death, recurrence myocardial ischemia or infarction, recurrent blood transport reconstruction, new or aggravated heart failure, stroke, or peripheral vascular disease.

Evaluation Indicator

The age, gender, BMI, smoking history, history of coronary heart disease, history of hypertension, history of diabetic disease, coronary pathogenesis, stent number, balloon expansion, thrombolysis in myocardial infarction (TIMI) blood flow score, coronary vein length, surgery, Gensini score, LVEDD, LVESD, LVEF, TG, TC, LDL-C, HDL-C, FBG, HBA1C, IL-6, and HMGB1 were determined. The influencing factors of PCI after the ACS PCI were identified, and the predictive value for MACE after PCI was determined.

Statistical Method

SPSS 22.0 software package (IBM Corp., Armonk, NY, USA) was used for analysis. Because it provides powerful data processing and statistical analysis functions, it suits our research needs. The data were presented as [n (%)]. When the sample volume was ≥40 and theoretical frequency T was ≥5, the two groups were compared with χ^2 test. Because it applies to large samples andtheoretical frequency T was ≥5. When the sample volume was ≥40 and $1 \leq T < 5$, the correction formula was tested by chi-square. To minimize the bias in the standard error estimates due to small theoretical frequencies. When the sample quantity was <40 or the frequency T of <1, the Fisher accurate probability method was used. As it applies in the case of small samples or rare events. Continuous variables were used in the Shapiro–Wilk test to determine whether it is in line with the normal distribution, and measurement data with normal distribution were presented as mean ± standard deviation ($\bar{x} \pm s$). According to M (P25, P75), the groups were tested with Mann–Whitney U test, and the influencing factor for patients with ACS after PCI was identified with logistic regression (subject work characteristics curve). Receiver operator characteristic curve (ROC) analysis was performed, and the indicators showed statistical significance for MACE's after PCI for patients with ACS.

Results

Baseline Information

This study included in 135 patients, the follow-up time was 5.56 ± 2.25 months, and the outlier rate was 10%. Finally, 120 patients were included and grouped. No significant difference in general information, such as age, gender, and BMI, was found between the groups ($p > 0.05$). There were statistically significant differences between the two groups in history of smoking ($p = 0.011$), history of hypertension ($p < 0.001$), history of diabetes ($p < 0.001$), coronary lesions ($p = 0.013$), coronary pathogenic length ($p = 0.006$), Gensini score before surgery ($p < 0.001$), LVEF ($p < 0.001$) (Table 1).

Observe the Level of Two Groups of Patients IL-6 and HMGB1

Compared with the no-MACE group (7.20 ± 2.10) and (63.82 ± 8.20), the MACE group IL-6 (10.80 ± 2.30), HMGB1 level (71.35 ± 9.30) is high ($p < 0.05$, Table 2).

Binary Logistics Regression Analysis

History of smoking, history of hypertension, history of diabetes, coronary lesions, coronary lesion length, preoperative Gensini score, LVEF, IL-6, and HMGB1 are related factors affecting patients after PCI Table 3.

ROC Analysis and IL-6, HMGB1 Joint Analysis

The length of coronary pathogens, Gensini scores, LVEF, IL-6, HMGB1 have a good predictive value for patients after PCI. AUC is divided into different: 0.683, 0.941, 0.816, 0.878, and 0.737, respectively: 53.13%, 81.25%, 84.37%, 78.12%, and 53.13%, and the specific degree is 87.50%, 93.18%, 63.64%, 86.36%, and 86.36% ($p < 0.05$), Table 4, Fig. 1; IL-6, HMGB1 joint analysis The AUC is 0.922, the sensitivity is 90.62%, the specificity is 82.95%, and 95% CI is (0.858–0.963) $p < 0.05$, Fig. 2.

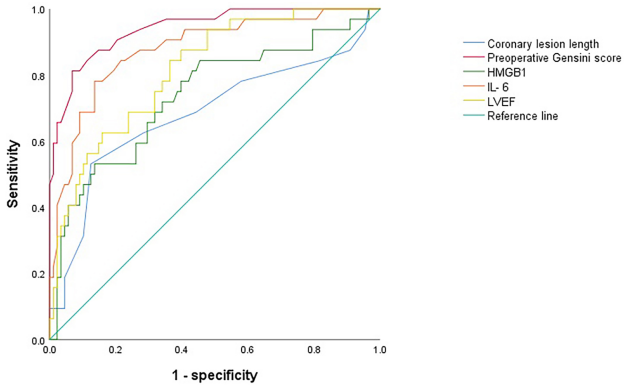

Fig. 1. Receiver operator characteristic (ROC) curve analysis. IL-6, interleukin 6; HMGB1, high-mobility group box 1; LVEF, left ventricular ejection fractions.

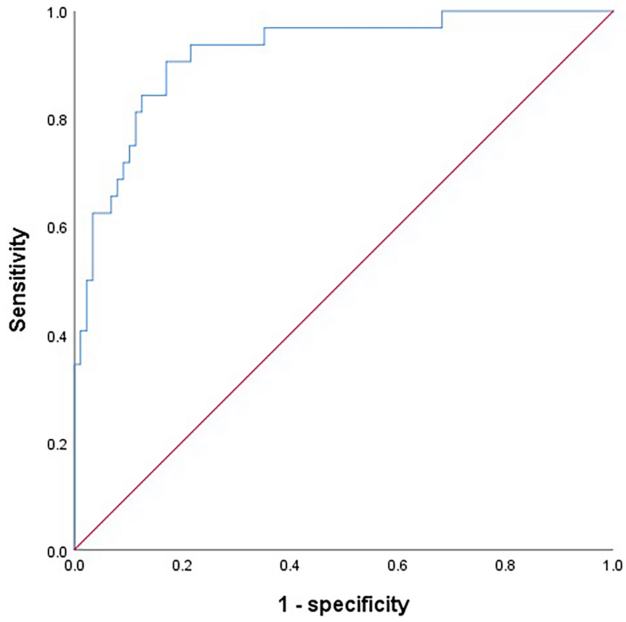

Fig. 2. Joint ROC curve analysis.

Table 1. Two sets of baseline information comparison ($\bar{x} \pm s$).

Project	MACE group (n = 32)	No MACE group (n = 88)	t/χ^2/Z	*p*
Age (year)	64.16 ± 9.26	62.82 ± 8.86	0.723	0.471
Gender [n (%)]			0.753	0.385
Male	21 (65.63)	50 (56.82)		
Female	11 (34.38)	38 (43.18)		
BMI (kg/m^2)	25.80 ± 3.77	26.72 ± 4.02	−1.129	0.261
History of smoking [n (%)]			6.501	0.011
Yes	24 (75.00)	43 (48.86)		
No	8 (25.00)	45 (51.14)		
History of coronary heart diseases [n (%)]			0.381	0.537
Yes	23 (71.87)	58 (65.91)		
No	9 (28.13)	30 (34.09)		
Hypertension [n (%)]			12.893	<0.001
Yes	26 (81.25)	39 (44.32)		
No	6 (18.75)	49 (55.68)		
History of diabetes [n (%)]			13.169	<0.001
Yes	22 (68.75)	28 (31.82)		
No	10 (31.25)	60 (68.18)		
Cerebrovascular history [n (%)]			0.154	0.695
Yes	14 (43.75)	35 (39.77)		
No	18 (56.25)	53 (60.23)		
Family hypercholesterolia [n (%)]			0.092	0.762
Yes	10 (31.25)	25 (28.41)		
No	22 (68.75)	63 (71.59)		
Coronary lesions [n (%)]			6.158	0.013
1	5 (15.63)	35 (39.77)		
≥2	27 (84.37)	53 (60.23)		
Number of brackets [n (%)]			0.610	0.737
1	19 (59.37)	57 (64.77)		
2	11 (34.38)	28 (31.82)		
≥3	2 (6.25)	3 (3.41)		
Balloon expansion [n (%)]			0.125	0.723
Yes	4 (12.50)	9 (10.23)		
No	28 (87.50)	79 (89.77)		
TIMI Blood flow score [n (%)]			0.441	0.932
Level 0	1 (3.12)	4 (4.55)		
Level 1	4 (12.50)	8 (9.09)		
Level 2	15 (46.88)	44 (50.00)		
Level 3	12 (37.50)	32 (36.36)		
Coronary lesion length (mm)	16.06 ± 3.26	14.25 ± 2.42	2.870	0.006
Gensini score before surgery (score)	95.63 ± 13.06	71.40 ± 9.26	9.648	<0.001
LVEDD (cm)	4.00 (4.00, 4.00)	4.00 (4.00, 4.00)	−1.114	0.265
LVESD (cm)	5.50 (4.25, 7.00)	6.00 (5.00, 7.00)	−0.134	0.894
LVEF (%)	43.46 ± 7.10	53.22 ± 8.00	−6.081	<0.001
TG (mmol/L)	1.48 ± 0.22	1.52 ± 0.52	−0.594	0.554
TC (mmol/L)	3.98 ± 0.52	4.10 ± 0.46	−1.202	0.232
LDL-C (mmol/L)	1.59 ± 0.52	1.82 ± 0.65	−1.835	0.069
HDL-C (mmol/L)	3.62 ± 0.66	3.52 ± 0.61	0.767	0.445
FBG (mmol/L)	7.50 ± 2.12	7.68 ± 2.28	−0.395	0.693
HbA1c (%)	7.50 ± 1.40	7.80 ± 1.40	−1.039	0.301
WBC (×10^9/L)	8.00 (7.00, 9.00)	8.00 (6.00, 9.00)	−0.938	0.348

Note: MACE, major adverse vascular events; BMI, body mass index; TIMI, thrombolysis in myocardial infarction; LVEDD, left ventricular end diastolic diameter; LVESD, left ventricular end systolic diameter; LVEF, left ventricular ejection fractions; TG, triglyceride; TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FBG, fasting blood glucose; HbA1c, glycosylated hemoglobin, type A1c; WBC, white blood cell.

Table 2. Two groups of patients IL-6 and HMGB1 level comparison ($\bar{x} \pm s$).

Group	N	IL-6 (pg/mL)	HMGB1 (pg/mL)
MACE group	32	10.80 ± 2.30	71.35 ± 9.30
No MACE group	88	7.20 ± 2.10	63.82 ± 8.20
t		8.105	4.288
p		<0.001	<0.001

IL-6, interleukin 6; HMGB1, high-mobility group box 1.

Discussion

Along with the continuous progress in society and rapid developments in economy, the incidence of ACS is increasing. Therefore, patients are treated with PCI to improve coronary veins and improve blood flow, but this treatment may cause MACE, such as coronary re-narrowing, affecting patients' prognoses [13,14]. Therefore, this study mainly focuses on this effect. Given that IL-6 and HMGB1 are key inflammatory factors [15], their levels were detected in the patients with ACS, and their predictive value for MACE after surgery was evaluated. IL-6 and HMGB1 jointly promote atherosclerosis and increase the risk of major adverse cardiovascular events (MACE) through a variety of biological mechanisms. They activate inflammatory cytokines, aggravate inflammatory reaction and promote the development of atherosclerosis. These two molecules also damage the function of endothelial cells, leading to endothelial damage and dysfunction, which is a key process in the early stage of atherosclerosis. In addition, IL-6 and HMGB1 activate the coagulation system, where IL-6 promotes platelet activation and coagulation factor expression, while HMGB1 affects the coagulation process through its receptors, which may lead to blood hypercoagulability and thrombosis [16]. HMGB1, as a damage associated molecular pattern (DAMP), may promote autoimmune response, cause chronic inflammation and tissue damage, and exacerbate the progression of cardiovascular disease [17]. These interactive mechanisms provide a theoretical basis for the development of therapeutic strategies targeting IL-6 and HMGB1, helping to control inflammation, improve vascular health, reduce the risk of thrombosis, and potentially regulate autoimmune responses, providing new directions for the prevention and treatment of cardiovascular diseases.

The 120 enrolled patients with ACS comprised 32 patients that experienced MACE 1 year after surgery, accounting for 26.67%. This percentage was similar to the results of Groenland *et al*. [18]. The results of this study showed that the two groups were comparable in terms of age, gender, and BMI. Single-factor analysis results showed that patients in the MACE group had a history of smoking, hypertension, and diabetes and had a large number of coronary diseases. The length of coronary lesions, Gensini score before surgery, and LVEF were low, indicating that the above variables have a certain correlation with PCI after surgery. Cardiovascular diseases accounted for a large proportion of deaths worldwide [19], and smoking once every day may increase the risk of coronary disease and stroke. The energy consumption of the body increase insulin resistance over time, and smoking itself is the first step toward subhealth, which affects metabolic processes. Smoking affects blood pressure and quickly increases the blood pressure by activating the sympathetic nerve. Patients with a history of smoking stopped smoking for 10 years. The probability of formation increased the risk of MACE [20]. In addition, the patients had history of hypertension. The reason that patients were at increased risk of experiencing a MACE may be due to the vascular endothelial damage caused by persistent high pressure level. The formation of atherosclerotic plaques can lead to the disruption of vascular integrity and function, contributing to the increased risk of MACE in patients with a history of hypertension, and abnormal blood pressure causes embolism in the blood vessels, which constrict, and thus patients with a history of hypertension should be further examined [21]. Moreover, patients with a history of diabetes have high blood sugar levels due to insulin resistance, and thus the inflammatory response of these patients damages the endothelial function. Finally, membrane hyperplasia and arteriomycoccal stenosis have been observed [22,23]. In addition, stent implantation causes MACE by causing vascular injuries and excessive hyperplasia, which will eventually activate platelets and release various cytokines, such as inflammatory factors [24]. In addition, the length of coronary lesions are the main indicators of the degree of coronary pathogenesis in patients with coronary heart disease. The coronary stenosis state increases with the length of coronary path lesions, the higher the coronary stenosis rate [25]; therefore, the risk of MACE increases. Furthermore, a scoring method for the analysis of coronary pathogenesis was analyzed. The Gensini score is simpler and more scientific than other clinical scores and is more suitable for patients diagnosed with ACS and treated with PCI. The Gensini score not only faciliate the evaluation of a patient's condition but also can facilitate the evaluation of prognosis [26]. The risk of a MACE increases with the score. LVEF is an index that can reflect the physiological function of the heart. LVEF reduction is easily triggered by a MACE because the index is low. The myocardial muscle may suffer from ischemia, and the tolerance of PCI surgery is low; these conditions trigger a MACE [27,28]. These results are consistent with those of the present study, confirming the accuracy of the analysis of the factors of this study.

An inflammatory response is an important factor for mediating a disease. IL-6 is an important inflammatory indicator reflecting the formation of coronary plaques. HMGB1 is an important inflammatory medium, playing an important role in the progresssion of a vascular disease [29,30]. Compared with the no-MACE group (7.20 ± 2.10;

Table 3. Logistic regression analysis affects the relevant factors that affect the patient's postoperative MACE.

Model	β	SE	Wald	p	OR	95% CI
History of smoking	1.845	0.498	13.725	<0.001	6.328	2.384–16.795
Hypertension	1.485	0.639	5.404	0.020	4.417	1.262–15.455
History of diabetes	1.633	0.416	15.416	<0.001	5.121	2.266–11.573
Coronary lesions	2.221	0.854	6.767	0.009	9.221	1.729–49.172
Coronary lesion length	2.132	0.739	8.326	0.004	8.435	1.982–35.903
Gensini score before surgery	–0.277	0.069	16.125	<0.001	0.758	0.662–0.868
LVEF	–0.574	0.163	12.421	<0.001	0.563	0.409–0.775
IL-6	–0.981	0.258	14.453	<0.001	0.375	0.226–0.622
HMGB1	–0.098	0.039	6.264	0.012	0.907	0.840–0.979

Note: SE, standard error; OR, odds ratio; CI, confidence interval.

Table 4. Related variable ROC curve analysis results.

Variable	AUC	Best truncation value	Youden index	SE	95% CI	p	Sensitivity (%)	Specificity (%)
Coronary Lesion length	0.683	16	0.406	0.063	0.592–0.765	0.003	53.13	87.50
Gensini score Before surgery	0.941	83	0.744	0.023	0.883–0.976	<0.001	81.25	93.18
LVEF	0.816	49.86	0.480	0.042	0.735–0.881	<0.001	84.37	63.64
IL-6	0.878	9.4	0.645	0.037	0.806–0.931	<0.001	78.12	86.36
HMGB1	0.737	71.9	0.395	0.056	0.649–0.813	<0.001	53.13	86.36

Note: ROC, receiver operator characteristic curve; AUC, area under the curve.

63.82 $\pm$ 8.20), the MACE group had higher levels of IL-6 (10.80 $\pm$ 2.30) and HMGB1 (71.35 $\pm$ 9.30). This high IL-6 and HMGB1 levels promote MACE and are common inflammation factors, producing early inflammatory signals that can reflect vascular inflammation and vascular damage and predict cardiovascular disease and prognosis. The risk of IL-6, MACE, cardiovascular death, and heart failure are reflected by increase in IL-6 level (up to 22%) [31]. An increase in HMGB1 level causes the heart function to deteriorate and promote thrombosis in a patient's stent. The reason is that HMGB1 is a nongroup protein in eukaryotic cells. It can bind to cell membrane receptors and promote the release of inflammatory factors, thereby enhancing inflammatory response. Components participating in an inflammatory response are related to the formation and stability of atherosclerotic plaques [10]. For variables based on the above research and the results of this study, the logarization analysis of the variables with the statistical significance of single factors was analyzed. The results showed that history of smoking, history of hypertension, history of diabetes, number of coronary lesions, length of coronary lesions, preoperative Gensini score, LVEF, IL-6, and HMGB1 are related factors affecting patients after PCI. In addition, the ROC results showed that the length of coronary lesions, Gensini score before surgery, the predictive value of the LVEF, IL-6, and HMGB1 improved, indicating that the above variables can be widely used as clinical evaluation indicators. However, IL-6 and HMGB1 have not been explored simultaneously. The joint ROC of this study showed that the value of the two joint predictions was higher than that of each predictor. In the future treatment, regular monitoring of inflammatory markers for the early diagnosis of atherosclerosis is helpful to implement timely treatment measures and prevent the occurrence of MACE.

C-reactive protein (CRP) and tumor necrosis factor α (TNF-α) are typical markers of inflammatory response. Their elevated levels in patients with acute coronary syndrome may indicate the activity of the inflammatory process, which is associated with the instability of atherosclerotic plaques and thus may potentially increase the risk of MACE after PCI. IL-6 and HMGB1 are also key mediators in the inflammatory process. CRP and TNF-α may interact with IL-6 and HMGB1 to jointly promote inflammatory responses and exacerbate vascular damage and thrombosis, thus affecting the development of MACE. These conjectures need to be verified by clinical studies and experimental data. Future studies should consider the interaction between these biomarkers, and we can better understand the role of these biomarkers in cardiovascular disease and develop more effective prevention and treatment strategies.

This study has some limitations: ① This study was performed on a small group, the sample volume was small, and the follow-up time was short. This may have limited our finding of certain subtle but important effects, and the results may not be fully generalizable to the wider population, as our sample may not be representative of the entire population. Sample volume and research time should be extended. ② The incorporated variables may be insufficient, and some aspects were not considered. We plan to consider more variables in future studies to assess the impact factors more comprehensively. ③ In the survey of related diseases and medical history, some patients may conceal real

information, which leads to a certain error in the data. For example through anonymous surveys or adding data validation steps. More indicators are needed. We also suggest that future studies should employ more rigorous data collection and validation procedures to reduce errors.

Comprehensive confounder analysis: ① Data completeness: We relied on participant self-reported data to assess medication adherence and lifestyle changes, which may be influenced by recall bias. ② Assessment of comorbid management: The quality assessment of comorbid management may be biased by the lack of a standardized assessment tool. ③ The veness of confounders: Although we considered multiple potential confounders, there may still be unidentified or inadequately controlled. To overcome these limitations, future studies could consider more objective approaches to assess medication adherence and lifestyle changes, such as the use of electronic monitoring devices or biomarkers. Furthermore, the development and application of standardized comorbidity management assessment tools that will help to improve the accuracy and comparability of study results.

Conclusion

The risk of MACE after surgery for ACS increases in patients with history of smoking, hypertension, diabetic disease, and coronary lesions, with presurgery. Gensini scores and IL-6 and HMGB1 levels increased. Patients with low LVEF were closely monitored. LVEF can predict patients' postoperative MACE and can thus be widely used as a clinical evaluation indicator.

Availability of Data and Materials

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

Author Contributions

WH and YL designed the study; all authors conducted the study. JL and JF collected and analyzed the data. JinL and LL participated in drafting the manuscript, and all authors contributed to critical revision of the manuscript for important intellectual content. All authors gave final approval of the version to be published. All authors participated fully in the work, take public responsibility for appropriate portions of the content, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or completeness of any part of the work are appropriately investigated and resolved.

Ethics Approval and Consent to Participate

Informed consent to participate in the study was obtained from all the participants. This study has been approved by the Medical Ethics Committee of Qinghai Provincial People's Hospital (Approval No.: (2023) -014).

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Conflict of Interest

The authors declare no conflict of interest.

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