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*Original Article*

# Huangqi Guizhi Wuwu decoction improves hemorheology and inhibits inflammatory response after PCI for acute myocardial infarction

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**Abstract:** Objective: To determine the impact of Huangqi Guizhi decoction of five ingredients on hemorheology and inflammatory factors in patients with acute myocardial infarction (AMI) after percutaneous coronary intervention (PCI). Methods: A total of 111 cases of AMI treated in Tongchuan Hospital of Traditional Chinese Medicine from February 2019 to February 2022 were analyzed retrospectively. Among them, 47 patients who received routine treatment were assigned to the control group, while those who received Huangqi Guizhi decoction of five ingredients in addition to the treatment of the control group were assigned to the study group. The clinical efficacy in the two groups was evaluated after therapy. The two groups were compared as to changes in serum inflammatory factors [tumor necrosis factor-α (TNF-α), high-sensitivity C-reactive protein (hs-CRP), and interleukin-6 (IL-6)] before and after therapy. The two groups were also compared as to differences in fibrinogen, plasma viscosity, whole blood low-shear viscosity (WBLSV), and whole blood high-shear viscosity (WBHSV) before and after therapy. Left ventricular end-diastolic dimension (LVEDD), left ventricular end-systolic diameter (LVESD), and left ventricular ejection fraction (LVEF) in the two groups were evaluated. In addition, the two groups were compared as to incidence of major adverse cardiovascular events (MACE) in 6 months. Logistic regression analysis was conducted to analyze the risk factors for MACE. Results: The study group showed a significantly higher treatment efficacy than the control group ($P < 0.05$). After therapy, the study group had significantly lower levels of TNF-α, hs-CRP, IL-6, fibrinogen, plasma viscosity, WBLSV, and WBHSV than the control group (all $P < 0.05$), and showed lower LVEDD and LVESD levels and a higher LVEF level than the control group. According to logistic regression analysis, age, history of diabetes mellitus (TM), New York Heart Association (NYHA) classification, hsCPR, and LVEF were independent risk factors for MACE (all $P < 0.05$). Conclusion: Huangqi Guizhi decoction of five ingredients contributes to higher efficacy in AMI and has the effects of inhibiting the inflammation and hemorheology of patients. In addition, age, history of TM, NYHA classification, hsCPR, and LVEF were independent risk factors for MACE.

**Keywords:** Huangqi Guizhi decoction of five ingredients, acute myocardial infarction, percutaneous coronary intervention, hemorheology, inflammatory factors

## Introduction

With the aging of society, the incidence of coronary heart disease is increasing year by year, and acute myocardial infarction (AMI) is also increasingly troubling the young population, in which it has become the primary cause of death [1]. AMI is myocardial necrosis triggered by acute/persistent coronary ischemia and hypoxia, and is a cardiac emergency. It is clinically manifested by severe and persistent pain after chest pain, and its diagnosis and evaluation are based on the comprehensive evaluation of clinical symptoms, electrocardiogram, myocardial enzymes, and coronary angiography [2, 3]. According to one statistical survey [4], at

least 330 million people suffer from cardiovascular diseases in China, including more than 10 million people with coronary heart disease. Therefore, the burden of cardiovascular disease in China is still heavy, and their prevention and treatment cannot be relaxed.

Percutaneous coronary intervention (PCI) is the recommended alternative for the treatment of AMI [5]. It can relieve the risk from coronary artery obstruction, so that myocardial cells are perfused in time and the survival rate of patients with AMI can be greatly increased [6]. However, the postoperative ischemia-reperfusion injury affects the prognosis and recovery of cardiac function, with clinical symptoms such as chest pain and a tendency to develop inflammatory reaction after operation, which hinders the patients' physical recovery [7, 8]. According to a growing body of studies [9], PCI can improve the long-term prognosis of patients with AMI, but the risk of major adverse cardiovascular events (MACE) is still high. MACE after PCI mainly include recurrent myocardial infarction, revascularization, in-stent restenosis, and heart failure [10]. According to one statistic by Copeland-Halperin et al. [11], the incidence of MACE in 12,445 patients with AMI was higher than 17% at one year after PCI.

At the current stage, the prevention and therapy of reperfusion injury by traditional Chinese medicine (TCM) is a novel research field [12]. TCM has the unique advantages of overall regulation, multi-targets, multi-links, and few toxic and side effects. Early intervention by invigorating Qi and activating blood circulation, eliminating phlegm and toxic substances, warming the meridian, and dredging arthralgia will further lower the risk of ischemic reperfusion injury [13]. Huangqi Guizhi decoction of five ingredients is composed of astragalus flavone, codonopsis pilosula, cinnamomum cassia, radix paeoniae alba, Chinese angelica root, rhizoma chuanxiong, salvia miltiorrhiza, rhizomacorydalis, fried atractylodes macrocephala koidz, snakegourd root, coptidis rhizoma, ginger, Chinese-date, and pseudo-ginseng, which has the effects of nourishing blood, invigorating Qi, activating Yang, and tonifying Qi and warming the meridian [14]. This study was designed to analyze the influence of Huangqi Guizhi decoction of five ingredients on the disease condition, inflammation, and hemorheology indexes of patients with AMI, and analyzing the risk factors of MACE, with the purpose of providing a reference for clinical treatment.

## Materials and methods

### *Clinical data*

Clinical data of 111 cases of AMI treated in Tongchuan Hospital of Traditional Chinese Medicine from February 2019 to February 2022 were analyzed retrospectively. Among them, 47 patients who received routine treatment were assigned to the control group, while the rest who additionally received Huangqi Guizhi decoction of five ingredients in addition to treatment of the control group, were assigned to the study group. This study was carried out with approval from the Medical Ethics Committee of Tongchuan Hospital of Traditional Chinese Medicine.

### *Inclusion and exclusion criteria*

Inclusion criteria: patients who met the diagnostic criteria of "Guidelines for Diagnosis and Treatment of Acute ST-segment Elevation Myocardial Infarction" [15]; patients who received PCI; patients who suffered from AMI for the first time; and patients with detailed clinical data.

Exclusion criteria: patients with severe liver or kidney failure, severe blood system diseases, autoimmune diseases, malignant tumors or psychosis; patients comorbid with serious cardiac mechanical complications; patients with febrile diseases, chronic inflammations, trauma, or clear evidence of clinical infection.

### *Therapeutic regimen*

All patients were treated with PCI. After operation, basic interventions such as health-related education, exercise, and diet were advocated and conducted. Patients were informed of knowledge about myocardial infarction in time and were required to avoid irritating and spicy foods.

The control group was given the following therapy: aspirin (Hunan Xinhui Pharmaceutical Co., Ltd., State Food and Drug Administration (SFDA) approval number: H43021756, 50 mg), once a day, oral, 300 mg each time; clopidogrel (Lepu Pharmaceuticals, Inc., SFDA approval number: H20123116, 75 mg), once a day, oral, 75 mg each time; isosorbide mononitrate

(Lunan Pharmaceutical Group, SFDA approval number: H20052095, 20 mg), three times a day, oral, 20 mg each time; and low molecular heparin (Shenzhen SCIPROGEN Bio-Pharmaceutical Co., Ltd., SFDA approval number: H20060190, 1 mL), twice a day, intramuscular injection, 50 mg each time. The patients were treated for 1 consecutive month.

The study group was additionally treated with Huangqi Guizhi decoction of five ingredients in addition to treatment to the control group. Huangqi Guizhi decoction of five ingredients (1 dose) is composed of 30 g astragalus flavone, 15 g rhizomacorydalis, 15 g Chinese angelica root, 15 g rhizoma chuanxiong, 15 g radix paeoniae alba, 15 g salvia miltiorrhiza, 12 g fried atractylodes macrocephala koidz, 12 g cinnamomum cassia, 9 g mongolian snakegourd fruit, 9 g ginseng, 9 g coptidis Rhizoma, 6 g Chinese-date, 6 g pseudo-ginseng, and 6 g ginger. The above herbs were soaked in 600 mL water for 4 hours, boiled with strong heat, and then decocted to 300 mL with gentle heat. The decoction was orally taken, twice a day in the morning and evening, 1 dose a day, for 4 weeks.

*Detection of hemorheologic indexes*

Fasting peripheral venous blood (5 mL) was extracted from each patient, followed by quantification of fibrinogen, plasma viscosity, whole blood low-shear viscosity (WBLSV), and whole blood high-shear viscosity (WBHSV) by one automatic rheometer (Chongqing Saihang Technology, model SH210A) before and after therapy.

*Detection of inflammatory factors*

Fasting peripheral venous blood (5 mL) was extracted from each patient, followed by centrifugation and quantification of serum tumor necrosis factor-α (TNF-α, CSB-E09315h), high-sensitivity C-reactive protein (hs-CRP, CSB-E08617h), and interleukin-6 (IL-6, CSB-E046-38h) through enzyme-linked immunosorbent assay (ELISA). All kits were obtained from Huamei Biology, Wuhan, China.

*Outcome measures*

*Primary outcome measures:* (1) The clinical efficacy was evaluated in two groups of patients. Markedly effective: The clinical symptoms such as palpitation and chest pain were obviously alleviated, and the curative effect index of patients was ≥ 95%; Effective: The clinical symptoms such as palpitation and chest pain were relieved, and the curative effect index was about 70%-95%. Ineffective: No improvement in clinical symptoms or they were even aggravated, and the curative effect index was lower than 70%. Overall response rate = (the number of markedly effective cases + that of effective cases)/total number of cases * 100%. (2) The fibrinogen, plasma viscosity, WBLSV, and WBHSV of the patients were evaluated before and after therapy. (3) The levels of TNF-α, hs-CRP, and IL-6 were evaluated before and after therapy.

*Secondary outcome measures:* (1) The cardiac function was compared between the two groups before and after therapy, including left ventricular end-diastolic dimension (LVEDD), left ventricular end-systolic diameter (LVESD), and left ventricular ejection fraction (LVEF). (2) The incidence of MACE in the two groups was counted, and the independent risk factors impacting MACE were analyzed by logistic regression.

*Statistical analyses*

In this study, SPSS20.0 software was used for statistical analyses, and GraphPad 7 for data visualization. The measured data were expressed by (mean ± SD), and their inter-group comparison and intra-group comparison were conducted by the independent-sample t test and paired t test, respectively. Counted data were described by n (%), and compared using the chi-square test. Logistic regression analysis was performed to analyze the independent risk factors impacting patients' MACE. Receiver operating characteristic (ROC) curves were drawn to analyze the value of independent risk factors in predicting the clinical efficacy. $P < 0.05$ was considered significant.

## Results

*Comparison of baseline data*

According to inter-group comparison of baseline data, the study and control groups were not greatly different in clinical data (all $P > 0.05$, **Table 1**).

**Table 1.** Baseline data

| Factor | Control group (n = 47) | Study group (n = 64) | $\chi^2$ value | *P* value |
|---|---|---|---|---|
| Age | | | 0.289 | 0.590 |
| ≥ 65 years old | 27 | 40 | | |
| < 65 years old | 20 | 24 | | |
| Gender | | | 0.190 | 0.663 |
| Male | 23 | 34 | | |
| Female | 24 | 30 | | |
| History of hypertension | | | 0.645 | 0.421 |
| Yes | 17 | 28 | | |
| No | 30 | 36 | | |
| History of diabetes mellitus | | | 0.064 | 0.799 |
| Yes | 12 | 15 | | |
| No | 35 | 49 | | |
| Hyperlipidemia | | | 0.167 | 0.682 |
| Yes | 13 | 20 | | |
| No | 34 | 44 | | |
| NYHA classification | | | 0.673 | 0.411 |
| ≤ Class II | 22 | 35 | | |
| > Class II | 25 | 29 | | |
| Killip classification | | | 0.519 | 0.471 |
| ≤ Class II | 30 | 45 | | |
| > Class II | 17 | 19 | | |

Note: NYHA: The New York Heart Association.

*Clinical efficacy*

Comparison of clinical efficacy between the two groups revealed a significantly higher overall response rate in the study group than in the control group (P < 0.05, **Table 2**).

*Changes in hemorheologic indexes*

Before therapy, the two groups were similar in the levels of fibrinogen, plasma viscosity, WBLSV, and WBHSV (all P > 0.05), while after therapy, all these levels decreased in both groups (all P < 0.05). Additionally, after therapy, the study group showed lower levels of fibrinogen, plasma viscosity, WBLSV, and WBHSV than the control group (all P < 0.05, **Figure 1**).

*Changes in inflammatory factors*

Before therapy, the levels of TNF-α, hs-CPR, and IL-6 levels were not greatly different between the two groups (all P > 0.05), while after therapy, the levels of these in both groups decreased (all P < 0.05), with lower levels of TNF-α, hs-CPR, and IL-6 in the study group than in the control group (all P < 0.05, **Figure 2**).

*Changes of cardiac function*

The two groups were similar in the levels of LVEDD, LVESD, and LVEF before therapy (all P > 0.05), while after therapy, both groups showed decreased LVEDD and LVESD levels and greatly increased LVEF (all P < 0.05). In addition, the study group showed lower LVEDD and LVESD levels and a higher LVEF level than the control group after therapy (all P < 0.05, **Figure 3**).

*Incidence of MACE*

The incidence of MACE in patients within 6 months was assessed. The control group showed a significantly higher incidence of MACE than the study group (P < 0.05, **Table 3**).

*Logistic regression analysis of risk factors for MACE*

Based on the occurrence of MACE, the patients were grouped into a MACE group and non-MACE group. By univariate analysis, age, history of diabetes mellitus (TM), NYHA classification, Killip classification, hs-CPR, LVEF, and therapeutic regimen were statistically different between the two groups (all P < 0.05, **Table 4**). Those factors with statistical significance by univariate analyses were assigned (**Table 5**). According to logistic regression analysis, age, history of TM, NYHA classification, hsCPR and LVEF were independent risk factors for MACE (all P < 0.05, **Table 6**). In addition, the ROC curve-based analysis showed that the area under the combined detection curve for various indicators was 0.939, so their combination can be used as a predictive index of MACE in patients (**Figure 4**).

## Discussion

Acute myocardial infarction (AMI) belongs to the category of "chest obstruction" in tradition-

**Table 2.** Efficacy analysis

| Group | Markedly effective | Effective | Ineffective | Overall response rate |
|---|---|---|---|---|
| Control group (n = 47) | 21 (44.68%) | 14 (29.79%) | 12 (25.53%) | 35 (74.47%) |
| Study group (n = 64) | 39 (60.93%) | 20 (31.26%) | 5 (7.81%) | 59 (92.19%) |
| $\chi^2$ value | | | | 6.560 |
| *P* value | | | | 0.010 |

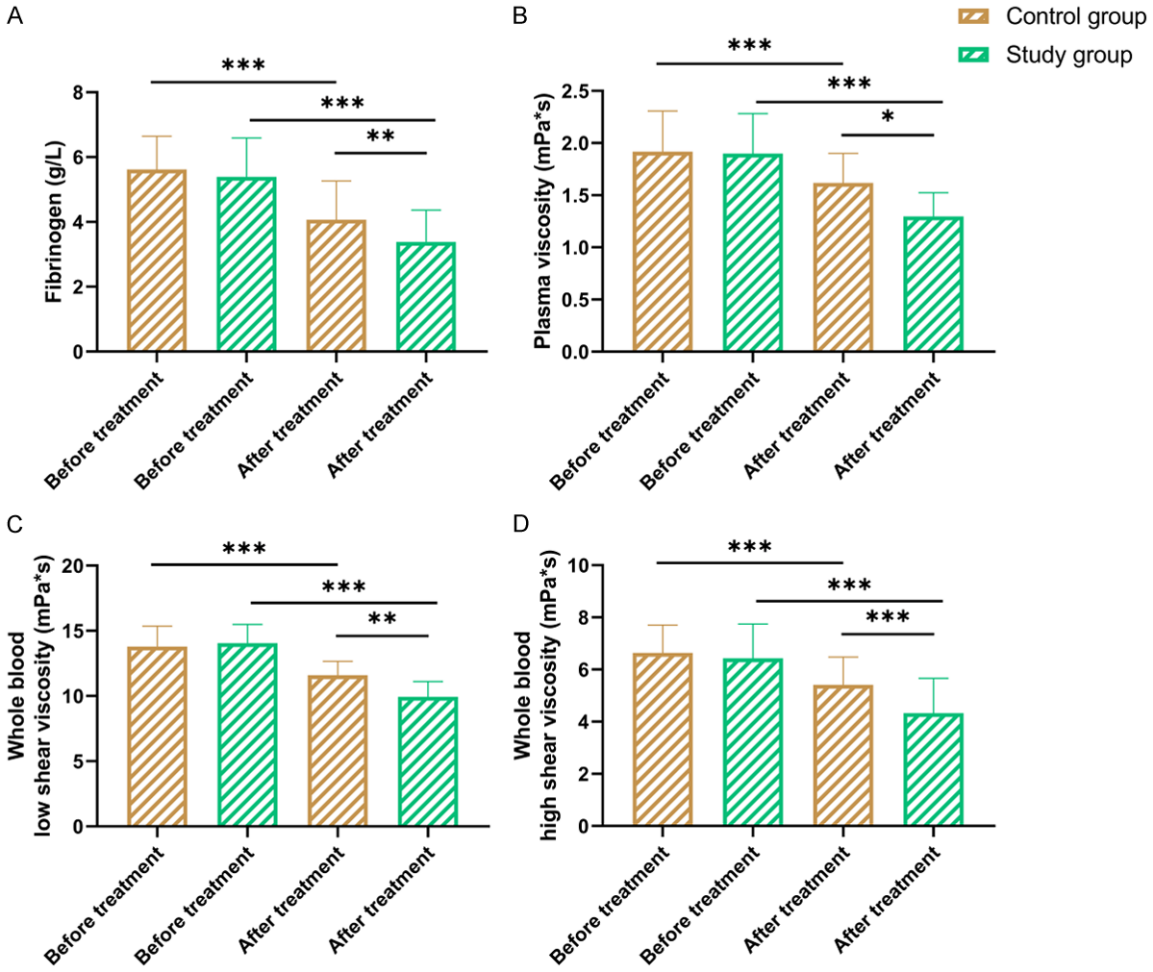


**Figure 1.** Changes in hemorheological index in patients before and after therapy. A. Comparison of the changes in fibrinogen between the two groups before and after therapy. B. Comparison of the changes in plasma viscosity between the two groups before and after therapy. C. Comparison of the changes in whole blood low-shear viscosity between the two groups before and after therapy. D. Comparison of changes in whole blood high-shear viscosity between the two groups before and after therapy. Notes: $^{**}P < 0.01$, $^{***}P < 0.001$.

al Chiese medicine (TCM). The patients suffer from blockage of veins due to poor circulation of Qi and blood and sudden pain in the heart after a long illness [16]. In TCM, it is believed that for patients with AMI, PCI surgery itself causes a series of vascular injuries due to endothelial injury, inflammatory reaction, and myocardial infarction disease due to infarcted vascular injury, necrosis and microcirculatory lesions, resulting in cardiovascular and collateral damage [17]. Therefore, in TCM therapy of patients with AMI after PCI, priority is to replenishing Qi, warming Yang, removing blood stasis, and dredging arthralgia [18]. Huangqi Guizhi decoction of five ingredients (Astragalus flavone, cinnamomum cassia, radix paeoniae

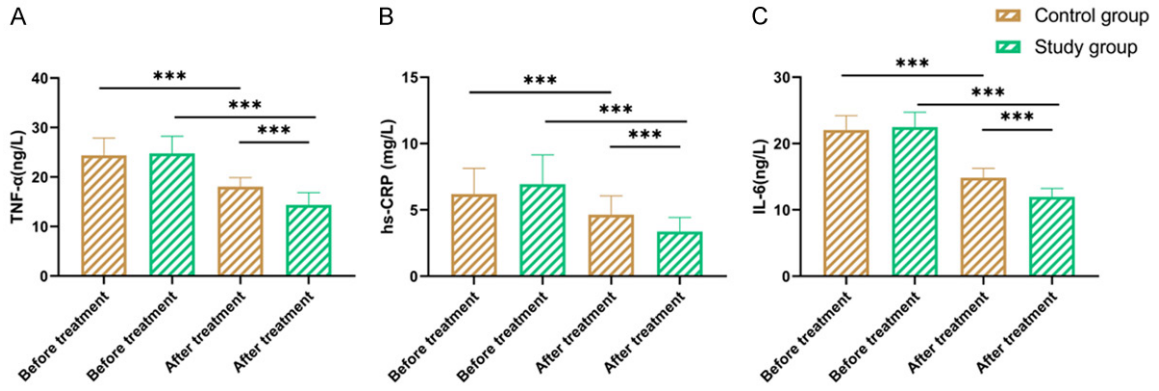


**Figure 2.** Changes in inflammatory indexes in patients before and after therapy. A. Comparison of the changes in TNF-α in patients before and after therapy. B. Comparison of the changes in hs-CPR in patients before and after therapy. C. Comparison of the changes in IL-6 in patients before and after therapy. Notes: **P < 0.01, ***P < 0.001. TNF-α: Tumor necrosis factor-α; hs-CRP: High sensitivity C-reactive protein; IL-6: interleukin-6.

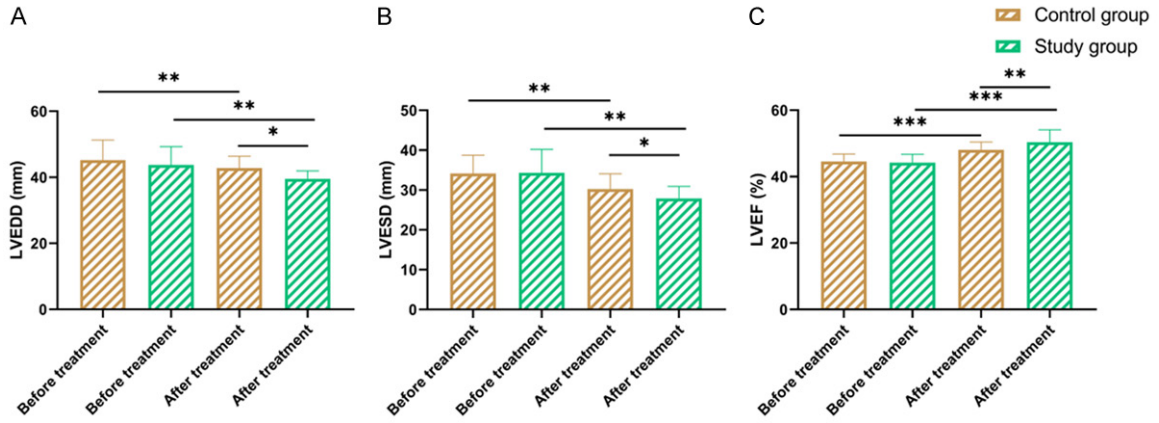


**Figure 3.** Changes in cardiac function of the patients before and after therapy. A. Comparison of the changes in LVEDD in patients before and after therapy. B. Comparison of the changes in LVESD in patients before and after therapy. C. Comparison of the changes in LVEF in patients before and after therapy. Notes: *P < 0.05, **P < 0.01, ***P < 0.001. LVEDD: Left ventricular end-diastolic dimension; LVESD: Left ventricular end-systolic diameter; LVEF: Left ventricular ejection fraction.

**Table 3.** Incidence of MACE

| Group | In-stent thrombosis | Severe arrhythmia | Recurrent myocardial infarction | Cardiogenic death | Malignant arrhythmia | Total incidence rate |
|---|---|---|---|---|---|---|
| Control group (n = 47) | 3 (6.38%) | 3 (6.38%) | 2 (4.25%) | 1 (2.13%) | 2 (4.25%) | 11 (23.39%) |
| Study group (n = 64) | 1 (1.56%) | 1 (1.56%) | 2 (3.12%) | 1 (1.56%) | 0 (0.00%) | 5 (7.80%) |
| $\chi^2$ value | | | | | | 5.340 |
| *P* value | | | | | | 0.021 |

alba, ginger, and Chinese-date) is an herbal formula recorded in *Golden Chamber Synopsis* [19]. According to prior research, Huangqi Guizhi decoction of five ingredients can be used for diabetic peripheral neuropathy [20] and rheumatoid arthritis [21]. In this study, according to analysis, the overall response rate in the study group treated by Huangqi Guizhi decoction was higher, with significantly lower fibrinogen, plasma viscosity, WBLSV, and WBHSV levels than the control group. This indicates that the treatment can reduce the blood

**Table 4.** Univariate analysis of risk factors for MACE

| Factor | MACE (n = 16) | Non-MACE (n = 95) | $\chi^2$ value | *P* value |
|---|---|---|---|---|
| Age | | | 8.710 | 0.003 |
| ≥ 65 years old | 15 | 52 | | |
| < 65 years old | 1 | 43 | | |
| Gender | | | 3.543 | 0.059 |
| Male | 4 | 43 | | |
| Female | 12 | 42 | | |
| History of hypertension | | | 0.079 | 0.777 |
| Yes | 7 | 38 | | |
| No | 9 | 57 | | |
| History of diabetes mellitus | | | 10.351 | 0.001 |
| Yes | 9 | 18 | | |
| No | 7 | 77 | | |
| Hyperlipidemia | | | 0.020 | 0.885 |
| Yes | 5 | 28 | | |
| No | 11 | 67 | | |
| NYHA classification | | | 7.954 | 0.004 |
| ≤ Class II | 3 | 54 | | |
| > Class II | 13 | 41 | | |
| Killip classification | | | 7.713 | 0.005 |
| ≤ Class II | 6 | 69 | | |
| > Class II | 10 | 26 | | |
| Fibrinogen (g/L) | 5.58±1.78 | 5.47±1.12 | 0.359 | 0.719 |
| Plasma viscosity (mPa*s) | 1.76±0.47 | 1.93±0.37 | 1.647 | 0.102 |
| Whole blood low-shear viscosity (mPa*s) | 14.09±1.44 | 13.92±1.51 | 0.414 | 0.679 |
| Whole blood high-shear viscosity (mPa*s) | 6.74±1.08 | 6.48±1.24 | 0.803 | 0.423 |
| TNF-α (ng/L) | 23.88±6.65 | 24.73±3.49 | 0.906 | 0.366 |
| hs-CPR (mg/L) | 8.08±2.22 | 6.38±2.01 | 3.073 | 0.002 |
| IL-6 (ng/L) | 21.70±2.20 | 22.40±2.20 | 1.174 | 0.242 |
| LVEDD (mm) | 43.69±11.75 | 44.50±5.87 | 0.518 | 0.605 |
| LVESD (mm) | 36.06±4.51 | 33.94±5.42 | 1.482 | 0.141 |
| LVEF (%) | 42.75±1.81 | 44.62±2.39 | 2.988 | 0.003 |

NYHA: The New York Heart Association; TNF-α: Tumor necrosis factor-α; hs-CRP: High sensitivity C-reactive protein; IL-6: interleukin-6; LVEF: Left ventricular ejection fraction; LVEDD: Left ventricular end-diastolic dimension; LVESD: Left ventricular end-systolic diameter; LVEF: Left ventricular ejection fraction; MACE: major adverse cardiovascular events.

**Table 5.** Assignment

| Index | Assignment |
|---|---|
| Age | ≥ 65 years old = 1, < 65 years old = 0 |
| History of diabetes mellitus | Yes = 1, No = 0 |
| NYHA classification | ≤ Class II = 0, > Class II = 1 |
| Killip classification | ≤ Class II = 0, > Class II = 1 |
| hs-CPR (mg/L) | Data belonging to continuous variables were their raw data |
| LVEF (%) | Data belonging to continuous variables were their raw data |
| Therapeutic regimen | Control group = 1, study group = 0 |
| MACE | Yes = 1, No = 0 |

NYHA: The New York Heart Association; hs-CRP: High sensitivity C-reactive protein; LVEF: Left ventricular ejection fraction; MACE: major adverse cardiovascular events.

**Table 6.** Multivariate logistic regression analysis of risk factors for MACE

| Index | β | SE | Wals | *P* value | OR value | 95% C.I. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower limit | Upper limit |
| Age | 3.238 | 1.256 | 6.649 | 0.010 | 25.479 | 2.174 | 298.553 |
| History of diabetes mellitus | 2.290 | 0.850 | 7.259 | 0.007 | 9.876 | 1.867 | 52.255 |
| NYHA classification | 1.902 | 0.875 | 4.726 | 0.030 | 6.699 | 1.206 | 37.213 |
| Killip classification | 0.812 | 0.796 | 1.039 | 0.308 | 2.252 | 0.473 | 10.722 |
| hs-CPR | 0.561 | 0.228 | 6.064 | 0.014 | 1.753 | 1.121 | 2.741 |
| LVEF | -0.554 | 0.210 | 6.944 | 0.008 | 0.575 | 0.381 | 0.868 |
| Therapeutic regimen | -0.008 | 0.827 | < 0.001 | 0.992 | 0.992 | 0.196 | 5.016 |

NYHA: The New York Heart Association; hs-CRP: High sensitivity C-reactive protein; LVEF: Left ventricular ejection fraction; MACE: major adverse cardiovascular events.

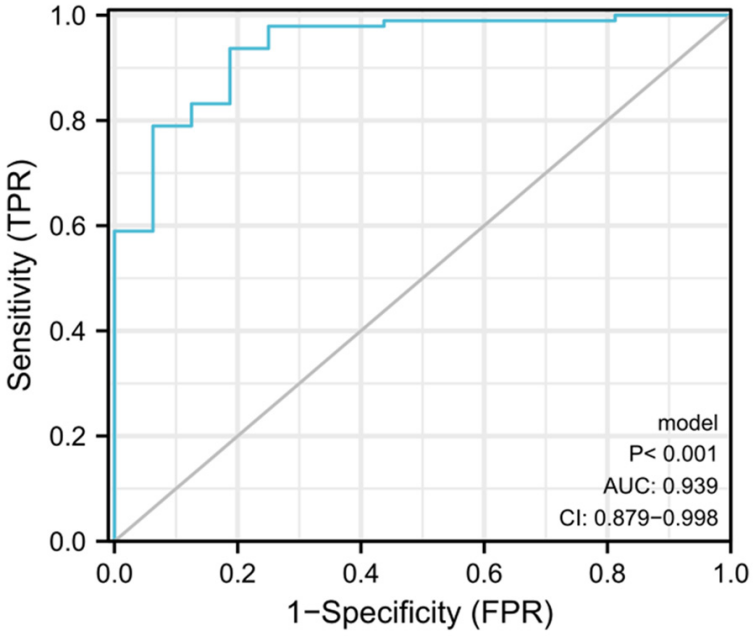


**Figure 4.** ROC curve of risk factors for predicting MACE in patients. MACE: Major adverse cardiovascular events.

viscosity of patients and prevent thrombosis. Moreover, the study group showed significantly lower levels of TNF-α, hs-CRP, IL-6, LVEDD, and LVESD than the control group, but had a higher LVEF level than the control group, implying that the decoction can strongly improve the cardiac function of patients with AMI, lower inflammatory factor levels, and improve the clinical effect. In modern pharmacologic studies, astragalus polysaccharides contained in Astragalus flavone can enhance myocardial contractility, scavenge oxygen free radicals, and improve the function of coronary endothelial cells [22]. Snakegourd root can promote the recovery of damaged myocardial cells and also strongly lower the metabolic rate of ischemia-reperfusion myocardium [23]. The saponins contained in cinnamomum cassia can effectively dilate coronary arteries, increase blood perfusion in diseased areas, and also effectively reduce the degree of reperfusion injury to ischemic areas [24]. In research by Lv et al. [25], Huangqi Guizhi decoction of five ingredients greatly lowered the levels of IL-6 and TNF-α in paclitaxel-related neurotoxicity rats. One study by Li et al. [26] has revealed that Huangqi Guizhi decoction of five ingredients can down-regulate serum TNF-α, IL-1β, and IL-6 in rats with oxaliplatin-induced chronic neuropathic pain. The studies suggest that Huangqi Guizhi decoction of five ingredients may alleviate the patient's condition and improve the therapeutic effect by regulating the inflammatory reaction of the patient.

With the extensive establishment of chest pain centers and the progress in interventional therapy, the mortality of patients with acute ST-segment elevation myocardial infarction has been greatly lowered [27]. MACE is a crucial factor for the high mortality of elderly patients with acute ST-segment elevation myocardial infarction during hospitalization. Thus, better identification of such patients by exploring related risk factors is helpful for targeted inter-

vention in the early clinical stage, which not only further improves the survival rate of patients, but also saves medical resources [28]. In the current study, the risk factors of MACE after PCI were also analyzed. Age, history of TM, NYHA classification, hsCPR, and LVEF were independent risk factors for MACE. According to one study [29], due to physical function, complicated chronic diseases such as hypertension, hyperlipidemia, and diabetes, and complicated coronary artery lesions, older patients have higher difficulty in receiving PCI, and also face a higher risk of postoperative MACE. However, the increase in blood glucose level in diabetic patients can aggravate the severity of ischemia-reperfusion and myocardial infarction and can also aggravate the inflammatory state in the body. Moreover, the continuous increase in blood glucose can damage the vascular endothelium, and increase platelet aggregation, and the risk of adverse events [30]. LVEF is a direct reflection of cardiac pump function. One study has revealed that LVEF < 30% can greatly increase the risk of sudden cardiac death in patients with myocardial infarction [31]. However, the tolerance of myocardial hypoxia-ischemia in patients with NYHA > class II decreases with the decline of cardiac function, so the improvement of cardiac function by PCI is limited, and the risk of short-term cardiac insufficiency after operation increases [32]. Lastly, the above risk factors were fitted and the corresponding ROC curve of joint detection of the factors was drawn. Lim et al. [33] have found that the areas under the ROC curves of the risk factors for prediction of MACE and death were 0.79 and 0.98, respectively. In this study, the AUC of the joint curve for predicting MACE in patients was 0.939, which is a highly ideal prediction index.

This study has determined that Huangqi Guizhi decoction of five ingredients can strongly improve the treatment efficacy on AMI after PCI, and lower the hemorheology and inflammation levels of patients. However, it has some limitations. In such a retrospective study, we can collect only short-term MACE-associated data of patients. Secondly, this study is a single-center study, so we are unable to verify this risk model through external data. Therefore, we hope to carry out more clinical studies in the future to improve the research conclusions.

To sum up, Huangqi Guizhi decoction of five ingredients can contribute to higher efficacy on AMI and have the effect of inhibiting inflammation and hemorheology of patients. In addition, age, history of TM, NYHA classification, hsCPR, and LVEF are independent risk factors for MACE.

## Disclosure of conflict of interest

None.

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## References

[1] Dauerman HL and Ibanez B. The edge of time in acute myocardial infarction. J Am Coll Cardiol 2021; 77: 1871-1874.
[2] Thiele H and Zahn R. Acute myocardial infarction-actual issues. Herz 2020; 45: 507-508.
[3] Kapur NK, Thayer KL and Zweck E. Cardiogenic shock in the setting of acute myocardial infarction. Methodist Debakey Cardiovasc J 2020; 16: 16-21.
[4] Yang BY, Guo Y, Markevych I, Qian ZM, Bloom MS, Heinrich J, Dharmage SC, Rolling CA, Jordan SS, Komppula M, Leskinen A, Bowatte G, Li S, Chen G, Liu KK, Zeng XW, Hu LW and Dong GH. Association of long-term exposure to ambient air pollutants with risk factors for cardiovascular disease in China. JAMA Netw Open 2019; 2: e190318.
[5] Xiao M, Li Y and Guan X. Community-based physical rehabilitation after percutaneous coronary intervention for acute myocardial infarction. Tex Heart Inst J 2021; 48: e197103.
[6] Hoole SP and Bambrough P. Recent advances in percutaneous coronary intervention. Heart 2020; 106: 1380-1386.
[7] Rodrigo R, Prieto JC, Aguayo R, Ramos C, Puentes A, Gajardo A, Panieri E, Rojas-Sole C, Lillo-Moya J and Saso L. Joint cardioprotective effect of vitamin C and other antioxidants against reperfusion injury in patients with acute myocardial infarction undergoing percutaneous coronary intervention. Molecules 2021; 26: 5702.
[8] Heusch G and Gersh BJ. The pathophysiology of acute myocardial infarction and strategies of protection beyond reperfusion: a continual challenge. Eur Heart J 2017; 38: 774-784.

[9] Zhao Y, Guo M and Shi G. Prediabetes predicts adverse cardiovascular outcomes after percutaneous coronary intervention: a meta-analysis. Biosci Rep 2020; 40: BSR20193130.
[10] Dehdar Karsidani S, Farhadian M, Mahjub H and Mozayanimonfared A. Intelligent prediction of major adverse cardiovascular events (MACCE) following percutaneous coronary intervention using ANFIS-PSO model. BMC Cardiovasc Disord 2022; 22: 389.
[11] Copeland-Halperin RS, Baber U, Aquino M, Rajamanickam A, Roy S, Hasan C, Barman N, Kovacic JC, Moreno P, Krishnan P, Sweeny JM, Mehran R, Dangas G, Kini AS and Sharma SK. Prevalence, correlates, and impact of coronary calcification on adverse events following PCI with newer-generation DES: findings from a large multiethnic registry. Catheter Cardiovasc Interv 2018; 91: 859-866.
[12] Han JY, Li Q, Ma ZZ and Fan JY. Effects and mechanisms of compound Chinese medicine and major ingredients on microcirculatory dysfunction and organ injury induced by ischemia/reperfusion. Pharmacol Ther 2017; 177: 146-173.
[13] Zheng Q and Bao YM. Regulatory effects of traditional Chinese medicine on autophagy in myocardial ischemia reperfusion injury. Zhongguo Zhong Yao Za Zhi 2017; 42: 2925-2929.
[14] Zheng HZ, Shen X, He YY, Yan XL, Wang SX, Yu AM and Wang LS. Pharmacokinetic analysis of Huangqi Guizhi Wuwu decoction on blood and brain tissue in rats with normal and cerebral ischemia-reperfusion injury by microdialysis with HPLC-MS/MS. Drug Des Devel Ther 2020; 14: 2877-2888.
[15] Collet JP, Thiele H, Barbato E, Barthelemy O, Bauersachs J, Bhatt DL, Dendale P, Dorobantu M, Edvardsen T, Folliguet T, Gale CP, Gilard M, Jobs A, Juni P, Lambrinou E, Lewis BS, Mehilli J, Meliga E, Merkely B, Mueller C, Roffi M, Rutten FH, Sibbing D and Siontis GCM; ESC Scientific Document Group. 2020 ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. Eur Heart J 2021; 42: 1289-1367.
[16] Wu GS, Li HK and Zhang WD. Metabolomics and its application in the treatment of coronary heart disease with traditional Chinese medicine. Chin J Nat Med 2019; 17: 321-330.
[17] Lu CY, Lu PC and Chen PC. Utilization trends in traditional Chinese medicine for acute myocardial infarction. J Ethnopharmacol 2019; 241: 112010.
[18] Lai XL, Liu HX, Hu X, Tian JF, Shang JJ, Li X, Zhou Q and Xing WL. Acute myocardial infarction in Chinese medicine hospitals in China from 2006 to 2013: an analysis of 2311 patients from hospital data. Chin J Integr Med 2021; 27: 323-329.
[19] Wang Y, Chen T, Yang C, Li Q, Ma M, Xu H, Shi Q, Wang Y, Wang Y and Liang Q. Huangqi Guizhi Wuwu decoction improves arthritis and pathological damage of heart and lung in TNF-Tg mice. Front Pharmacol 2022; 13: 871481.
[20] Zhang Y, Gong G, Zhang X, Zhou L, Xie H, Tian Y and Xie C. Huangqi Guizhi Wuwu decoction for diabetic peripheral neuropathy: protocol for a systematic review. Medicine (Baltimore) 2019; 98: e16696.
[21] Lu WW, Qiu YJ, Fan XF, Yu GY and Wu GL. Mechanism of Huangqi Guizhi Wuwu decoction in treatment of rheumatoid arthritis based on UPLC-LTQ-Orbitrap-MS, network pharmacology, and cell experiment. Zhongguo Zhong Yao Za Zhi 2021; 46: 6454-6464.
[22] Bao YR, Jiang WY, Yu JY, Chen JW and Zhang GX. Traditional Chinese medicine formulation Huangqi Jianzhong Tang improves cardiac function after myocardial infarction in rats. Evid Based Complement Alternat Med 2020; 2020: 3106076.
[23] Kim M, Kim JG and Kim KY. Trichosanthes kirilowii extract promotes wound healing through the phosphorylation of ERK1/2 in keratinocytes. Biomimetics (Basel) 2022; 7: 154.
[24] Lv X, Zhang Y and Zhang H. Neuroprotective effect of Trichosanthes kirilowii cassia twig on cerebral ischemia-reperfusion injury in rats. Pak J Pharm Sci 2018; 31: 1643-1647.
[25] Lv Z, Shen J, Gao X, Ruan Y, Ling J, Sun R, Dai J, Fan H, Cheng X and Cao P. Herbal formula Huangqi Guizhi Wuwu decoction attenuates paclitaxel-related neurotoxicity via inhibition of inflammation and oxidative stress. Chin Med 2021; 16: 76.
[26] Li M, Li Z, Ma X, Jin S, Cao Y, Wang X, Zhao J, Wang J, Wang X and Xu J. Huangqi Guizhi Wuwu decoction can prevent and treat oxaliplatin-induced neuropathic pain by TNFalpha/IL-1beta/IL-6/MAPK/NF-kB pathway. Aging (Albany NY) 2022; 14: 5013-5022.
[27] Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, Caforio ALP, Crea F, Goudevenos JA, Halvorsen S, Hindricks G, Kastrati A, Lenzen MJ, Prescott E, Roffi M, Valgimigli M, Varenhorst C, Vranckx P and Widimsky P; ESC Scientific Document Group. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: the task force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J 2018; 39: 119-177.
[28] Thiele H, Desch S and de Waha S. Acute myocardial infarction in patients with ST-segment

elevation myocardial infarction: ESC guidelines 2017. Herz 2017; 42: 728-738.
[29] Leiter LA, Bain SC, Hramiak I, Jodar E, Madsbad S, Gondolf T, Hansen T, Holst I and Lingvay I. Cardiovascular risk reduction with once-weekly semaglutide in subjects with type 2 diabetes: a post hoc analysis of gender, age, and baseline CV risk profile in the SUSTAIN 6 trial. Cardiovasc Diabetol 2019; 18: 73.
[30] Zelniker TA, Wiviott SD, Raz I, Im K, Goodrich EL, Furtado RHM, Bonaca MP, Mosenzon O, Kato ET, Cahn A, Bhatt DL, Leiter LA, McGuire DK, Wilding JPH and Sabatine MS. Comparison of the effects of glucagon-like peptide receptor agonists and sodium-glucose cotransporter 2 inhibitors for prevention of major adverse cardiovascular and renal outcomes in type 2 diabetes mellitus. Circulation 2019; 139: 2022-2031.
[31] Rini BI, Moslehi JJ, Bonaca M, Schmidinger M, Albiges L, Choueiri TK, Motzer RJ, Atkins MB, Haanen J, Mariani M, Wang J, Hariharan S and Larkin J. Prospective cardiovascular surveillance of immune checkpoint inhibitor-based combination therapy in patients with advanced renal cell cancer: data from the phase III JAVELIN renal 101 trial. J Clin Oncol 2022; 40: 1929-1938.
[32] Wang C, Li J, Zhang B and Li Y. Safety and efficacy of bone marrow-derived cells therapy on cardiomyopathy: a meta-analysis. Stem Cell Res Ther 2019; 10: 137.
[33] Lim TW, Karim TS, Fernando M, Haydar J, Lightowler R, Yip B, Sriamareswaran R, Tong DC and Layland J. Utility of Zwolle risk score in guiding low-risk STEMI discharge. Heart Lung Circ 2021; 30: 489-495.