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A Study of the Causes of In-Hospital Mortality in Patients with Acute Myocardial Infarction Complicated by Gastrointestinal Haemorrhage

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Abstract: *Objective:* To analyze the risk factors for death during hospitalization in patients with acute myocardial infarction (AMI) complicated by gastrointestinal bleeding (GIB). *Methods:* 260 patients with AMI complicated by GIB who were admitted to the cardiology department of a hospital from January 2022 to December 2023 were retrospectively analyzed. 27 patients who died during hospitalization were designated as the control group and the 233 patients who survived as the observation group. Baseline data and clinical indexes of patients in the two groups were compared, and multifactorial logistic regression was applied to analyze the risk factors for death during hospitalization in patients with AMI complicated by GIB. *Results:* Univariate analysis showed that the control group had higher proportions of patients with Killip classification III to IV on admission, new arrhythmias, and mechanical complications, as well as higher heart rates, white blood cell counts, urea nitrogen, and creatinine levels. The proportion of patients who received transfusion therapy during hospitalization was also higher in the control group. Conversely, the control group had lower systolic and left ventricular ejection fraction rates compared to the observation group, with statistically significant differences ($P < 0.05$). Multifactorial logistic regression analysis revealed that new-onset arrhythmia (OR = 2.724, 95% CI 1.289–5.759), heart rate > 100 beats/min (OR = 3.824, 95% CI 1.472–9.927), left ventricular ejection fraction < 50% (OR = 1.884, 95% CI 0.893–3.968), BUN level (OR = 1.029, 95% CI 1.007–1.052), and blood transfusion (OR = 3.774, 95% CI 1.124–6.345) were independently associated with an increased risk of death during hospitalization in patients with AMI complicated by GIB. *Conclusions:* New arrhythmia, heart rate > 100 beats/min, left ventricular ejection fraction < 50%, elevated BUN levels, and blood transfusion are risk factors for death during hospitalization in patients with AMI complicated by GIB.

Keywords: Acute myocardial infarction; Gastrointestinal haemorrhage; Death; Risk factors; Anticoagulation; Preventive strategies

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1. Introduction

Acute myocardial infarction (AMI) is a serious cardiovascular emergency usually caused by the acute occlusion of coronary arteries, leading to ischemia, injury, or necrosis of myocardial tissue. It has become one

of the leading causes of adult mortality worldwide, posing a significant challenge to public health [1]. Despite advancements in medical technology that have improved AMI treatment, its related complications remain an urgent clinical problem, particularly the occurrence of gastrointestinal bleeding (GIB), which significantly increases the risk of death [2].

GIB is a common complication of AMI and is caused by various factors, including physiological stress after myocardial infarction, the use of anticoagulants and antiplatelet drugs, and the patient's pre-existing gastrointestinal disorders. These factors collectively elevate the risk of GIB, making it a major cause of death in adults. After AMI, changes in the coagulation and fibrinolytic systems, along with the implementation of anticoagulation therapy, increase the patient's tendency to bleed from the digestive tract, thereby complicating clinical treatment and management [3].

In clinical practice, patients with AMI complicated by GIB have a high mortality rate. Previous studies have shown that factors such as the patient's age, past medical history, cardiac functional status, clinical presentation at the onset of bleeding, and the strategy of acute-phase treatment are all associated with high mortality in this patient group. To fully understand the independent risk factors for mortality in AMI patients with GIB during hospitalization, this study collected and analyzed the clinical data of relevant patients through a retrospective approach. Further in-depth research was conducted using univariate analysis and multifactorial logistic regression analysis to provide a more accurate risk assessment tool and optimize therapeutic protocols. This study aims to facilitate more effective preventive and therapeutic measures in clinical practice, ultimately reducing the risk of death and improving the overall prognosis of patients.

2. Materials and methods

2.1. General information

A retrospective analysis was conducted on 260 patients with gastrointestinal bleeding (GIB) complicated by acute myocardial infarction (AMI) who were admitted to the cardiology department of a hospital from January 2022 to December 2023. Among these patients, 27 who died during hospitalization were designated as the control group, and 233 who survived were designated as the observation group. The baseline data (gender, age, history of smoking, history of alcohol consumption) and clinical indicators of the patients in the two groups were recorded. The clinical indicators included:

(1) Past medical history: history of cerebrovascular disease, hypertension, diabetes mellitus, post-coronary stenting, post-coronary bypass surgery, history of AMI, history of GIB.

(2) Characteristics of the patients at the time of hospital admission: STEMI (ST-segment elevation myocardial infarction), Killip's cardiac function classification, new-onset arrhythmia, left ventricular ejection fraction, mechanical complications, heart rate, and systolic blood pressure.

(3) Laboratory indicators: white blood cells, albumin, hemoglobin, platelets, blood urea nitrogen (BUN), creatinine.

(4) Treatment during hospitalization: blood transfusion, reperfusion therapy, etc.

Definitions are listed below:

(1) Diagnosis of AMI: The diagnosis of AMI is confirmed based on the literature [4], the fourth global harmonized definition of myocardial infarction (139), which includes insufficient blood supply to the myocardial region as a result of an acute complete or partial obstruction of a coronary artery, and consequent cardiomyocyte injury or necrosis. Other criteria include typical chest pain lasting more than 30 minutes, an electrocardiogram showing new ST-segment elevation or new left bundle-branch block,

and significantly elevated cardiac biomarkers (e.g., cardiac troponin) with at least one exceeding the upper 99th percentile of the normal reference value.

(2) Definition of GIB: GIB is defined by clinical manifestations of vomiting blood, black stools, or bloody stools, with confirmation that the bleeding originated from within the gastrointestinal tract. Hemodynamic instability, such as a drop in hemoglobin and blood pressure, is shown by medical supportive tests.

(3) New-onset arrhythmia: This is defined as the absence of a previous history of arrhythmia, with the patient developing palpitations and syncope after AMI. An electrocardiogram (ECG) shows heart rate abnormalities, new-onset tachycardia, ventricular fibrillation, atrial fibrillation, and second-degree type II or higher atrioventricular block.

(4) Mechanical complications: These involve physical damage to cardiac structures after AMI, such as septal perforation, papillary muscle dysfunction, or rupture of the ventricular free wall, and echocardiographic abnormalities of cardiac structures.

(5) Reperfusion therapy: Treatments to restore blood supply to the heart by pharmacological or mechanical means during hospitalization include percutaneous coronary intervention (PCI) and thrombolysis.

2.2. Inclusion and exclusion criteria

Inclusion criteria:

(1) Age >18 years.

(2) Patients diagnosed with AMI complicated by GIB based on clinical symptoms, electrocardiogram, imaging, and laboratory analysis.

(3) Admission within 24 hours of symptom onset, with at least two renal function tests, including serum creatinine (SCr) and urea nitrogen (BUN), performed during hospitalization.

(4) Patients and their families signed an informed consent form to voluntarily participate in this study.

Exclusion criteria:

(1) Patients with incomplete medical records who were unable to provide complete information on diagnosis, treatment, and outcomes.

(2) Patients with a previous history of severe gastrointestinal diseases.

(3) Patients with concomitant malignant tumors or other systemic bleeding disorders (e.g., hemophilia).

2.3. Statistical methods

Data were analyzed and processed using SPSS 25.0 statistical software. Categorical data were expressed as [*n* (%)], and comparisons between groups were made using the chi-squared (χ^2) test. Continuous data were subjected to a normality test; data that followed a normal distribution were expressed as mean ± standard deviation (SD), and comparisons between groups were made using an independent samples *t*-test. Indicators with a one-way comparison of $P < 0.05$ were included in a multivariable logistic regression model to identify independent risk factors for death during hospitalization in patients with AMI complicated by GIB, with $P < 0.05$ indicating statistically significant differences.

3. Results

3.1. Univariate analysis of risk factors for in-hospital mortality in patients with AMI complicating GIB

There was no statistically significant difference between the two groups in terms of general information,

past medical history, laboratory indexes such as albumin (g/L), hemoglobin (g/L), platelets ($\times 10^9$/L), and the proportion of patients who received reperfusion therapy during their hospital stay ($P > 0.05$). However, the proportion of patients in the observation group with high Killip classification upon admission, new arrhythmias, and mechanical complications, as well as elevated heart rate, white blood cell count, BUN, and creatinine levels, were higher than those of the control group. Conversely, systolic blood pressure and left ventricular ejection fraction (LVEF) were lower in the observation group compared to the control group. The proportion of patients receiving transfusion therapy during hospitalization was also higher in the observation group than in the control group, with these differences being statistically significant ($P < 0.05$). See **Table 1**.

Table 1. Univariate analysis of risk factors for in-hospital mortality in patients with AMI complicated by GIB

	Item	Control group (n = 27)	Observation group (n = 233)	t / χ^2	P
General information	Age (years)	65.85 ± 5.14	66.02 ± 5.06	0.1650	0.8691
	Sex (m/f)	15/12	134/99	0.0378	0.8458
	Smoking [n (%)]	10 (37.04)	81 (34.76)	0.0550	0.8148
	Alcohol consumption [n (%)]	4 (14.81)	39 (16.74)	0.0004	0.9840
Past medical history	History of cerebrovascular disease [n (%)]	6 (22.22)	45 (19.31)	0.1298	0.7189
	Hypertension [n (%)]	19 (70.37)	155 (66.52)	0.1617	0.6876
	Diabetes [n (%)]	12 (44.44)	92 (39.48)	0.2480	0.6182
	With coronary stent [n (%)]	6 (22.22)	39 (16.74)	0.3994	0.5274
	With coronary artery bypass graft [n (%)]	2 (7.41)	8 (3.43)	0.2381	0.6256
	History of AMI [n (%)]	5 (18.52)	31 (13.30)	0.2009	0.6540
	GIB history [n (%)]	1 (3.70)	8 (3.43)	0.2551	0.6135
Characteristics on admission	STEMI [n (%)]	18 (66.67)	166 (57.08)	0.2451	0.6205
	Killip Cardiac Function Classification (Class I–II / Class III–IV)	10/17	169/64	14.2132	0.0002
	New-onset arrhythmias [n (%)]	13 (48.15)	35 (15.02)	15.5069	0.0001
	Left ventricular ejection fraction (%)	55.1 ± 11.3	46.1 ± 13.4	3.3529	0.0009
	Mechanical complications [n (%)]	7 (25.93)	19 (8.15)	6.6310	0.0100
	Heart rate (beats/min)	87.6 ± 18.7	76.9 ± 15.2	3.3764	0.0008
	Systolic blood pressure (mmHg)	111.6 ± 20.2	120.8 ± 21.5	2.1174	0.0352
Laboratory indicators	Leukocytes ($\times 10^9$/L)	10.77 ± 3.27	9.49 ± 2.12	2.7828	0.0058
	Albumin (g/L)	36.39 ± 8.24	38.82 ± 7.67	1.5465	0.1232
	Haemoglobin (g/L)	121.32 ± 25.56	124.36 ± 26.09	0.5743	0.5663
	Platelets ($\times 10^9$/L)	225.12 ± 85.79	223.46 ± 74.37	0.1080	0.9141
	BUN (mmol/L)	9.02 ± 2.22	6.87 ± 1.33	7.3201	0.0000
	Creatinine (μmol/L)	114.09 ± 25.68	85.57 ± 14.65	8.7095	0.0000
Treatments during hospitalization	Blood transfusions [n (%)]	13 (48.15)	53 (22.75)	8.2425	0.0041
	Reperfusion therapy [n (%)]	10 (37.04)	114 (48.93)	1.3712	0.2416

3.2. Multifactorial logistic regression analysis of risk factors for in-hospital mortality in patients with AMI complicated by GIB

The variables considered for the logistic regression analysis included Killip classification ≥ 2, new-onset arrhythmia, mechanical complications, heart rate > 100 beats/min, systolic blood pressure < 100 mm Hg, LVEF < 50%, leukocyte count, and BUN levels. Clinically relevant factors such as sex, age, blood transfusion, and reperfusion therapy, which showed $P < 0.05$ in the univariate analysis, were also included in the logistic regression model. The regression analysis revealed that new-onset arrhythmia, heart rate > 100 beats/min, LVEF < 50%, elevated BUN levels, and blood transfusion were independent risk factors for death during hospitalization in patients with AMI complicated by GIB ($P < 0.05$). See **Table 2**.

Table 2. Multifactorial logistic regression analysis of in-hospital mortality in patients with AMI complicated by GIB

Factors	β	Wald χ^2	*P*	OR	95% CI
Age	0.029	1.900	0.168	1.029	0.989–1.070
Gender	0.325	0.580	0.446	1.384	0.608–3.145
Killip classification ≥ 2	0.845	3.000	0.083	2.328	0.905–5.983
New-onset arrhythmias	1.002	6.700	0.009	2.724	1.289–5.759
Mechanical complications	0.701	2.100	0.075	2.016	0.992–4.098
Heart rate > 100 beats/min	1.341	7.400	0.022	3.824	1.472–9.927
Systolic blood pressure < 100 mmHg	0.797	3.120	0.054	2.219	0.563–3.789
Left ventricular ejection fraction < 50%	0.633	2.350	0.045	1.884	0.893–3.968
Leukocyte count	-0.020	0.160	0.692	0.980	0.891–1.075
BUN levels	0.012	6.420	0.003	1.029	1.007–1.052
Blood transfusion	1.328	4.550	0.032	3.774	1.124–6.345
Reperfusion therapy	-0.422	0.590	0.575	0.784	0.337–1.833

4. Discussion

Acute myocardial infarction (AMI) is one of the leading causes of death and disability worldwide. In recent years, with the continuous progress of medical technology, the survival rate of AMI patients has improved, but the challenge of multiple complications remains a significant topic in clinical research. Gastrointestinal bleeding (GIB) is one of the common serious complications in AMI patients, mainly due to the complex pathophysiological mechanisms associated with both conditions [5].

On one hand, AMI patients often present with multiple risk factors such as advanced age, diabetes mellitus, and hypertension, which increase the risk of GIB. On the other hand, antiplatelet drugs and anticoagulants are often used in the clinical treatment of AMI, reducing cardiovascular events but increasing the risk of GIB. Additionally, the presence of cardiac insufficiency and hemodynamic instability in patients with AMI can damage the mucosa of the digestive tract, further exacerbating the risk of bleeding.

Studies have shown that the in-hospital mortality rate of patients with AMI complicated by GIB is significantly higher than that of patients with AMI alone. This is mainly due to the severity of GI bleeding itself, as well as the fact that GIB is often accompanied by various complications such as anemia, shock, and multiorgan failure, which further worsen the patient's condition [6]. Therefore, an in-depth study of the risk

factors for in-hospital mortality in patients with AMI complicated by GIB is of great significance for improving treatment outcomes and patient survival.

Currently, most studies on patients with AMI complicated by GIB focus on the analysis of individual factors. The lack of a systematic, multifactorial, and comprehensive analysis makes it difficult for clinicians to assess the risk of patient death comprehensively and accurately and to formulate an individualized treatment plan for managing this patient group [7]. To fill this gap, this study aims to systematically assess the risk factors for in-hospital mortality in patients with AMI complicated by GIB through multifactorial logistic regression analyses, providing a scientific basis and guidance for clinical practice.

In this study, logistic regression analysis revealed that new-onset arrhythmia, heart rate > 100 beats/min, left ventricular ejection fraction < 50%, BUN level, and blood transfusion were independent risk factors for death during hospitalization in patients with AMI complicated by GIB. The reasons for these findings are summarized as follows:

(1) New-onset arrhythmias: New-onset arrhythmias, especially atrial fibrillation and ventricular arrhythmias, lead to hemodynamic instability, increasing the burden on the patient's heart, and in severe cases, can lead to cardiac arrest, significantly raising the risk of patient death [8]. Therefore, arrhythmias need to be recognized and controlled promptly during treatment to improve prognosis.

(2) Tachycardia: Tachycardia increases myocardial oxygen consumption and reduces coronary blood supply, leading to increased myocardial ischemia. In the case of AMI complicated by GIB, the patient's overall condition is more complicated, and a heart rate of more than 100 beats/min further increases the risk of death. Therefore, controlling the heart rate in therapeutic management is an important measure to stabilize the patient's condition.

(3) Left ventricular ejection fraction (LVEF): An LVEF of < 50% indicates that the patient's left ventricular pumping function is weakened, resulting in a significant reduction in the heart's ability to cope with additional stresses (e.g., gastrointestinal bleeding), leading to an increased risk of worsening of the condition and death [9]. Therefore, assessing and improving the patient's cardiac function is an important part of treatment.

(4) BUN Level: The BUN level reflects the patient's renal function status, and an elevated BUN level suggests the presence of renal insufficiency or acute kidney injury. During the treatment of AMI complicated with GIB patients, renal insufficiency further complicates the condition and increases the difficulty of treatment and the risk of death. Therefore, real-time monitoring and protection of renal function are particularly important for prognostic management.

(5) Blood transfusion: Although blood transfusion is necessary for treating GI bleeding, the procedure can trigger complications such as transfusion reaction, infection, and immunosuppression, substantially increasing the risk of WAHI and death [10]. Therefore, it is necessary to strictly control transfusion indications and closely monitor the transfusion process to balance the risks and benefits of blood transfusion.

In conclusion, new-onset arrhythmia, heart rate > 100 beats/min, LVEF < 50%, elevated BUN levels, and blood transfusion are independent risk factors for death during hospitalization in patients with AMI complicated by GIB. Therefore, early identification and intervention for these high-risk factors and optimization of therapeutic regimens are needed in clinical practice to improve the survival and prognosis of patients.

Disclosure statement

The author declares no conflict of interest.

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