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Predictors and in-hospital prognosis of recurrent acute myocardial infarction

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Abstract

Objective To investigate the contributing factors and in-hospital prognosis of patients with or without recurrent acute myocardial infarction (AMI). **Methods** A total of 1686 consecutive AMI patients admitted to Peking University People's Hospital from January 2010 to December 2015 were recruited. Their clinical characteristics were retrospectively compared between patients with or without a recurrent AMI. Then multivariable logistic regression was used to estimate the predictors of recurrent myocardial infarction. **Results** Recurrent AMI patients were older (69.3 ± 11.5 *vs*. 64.7 ± 12.8 years, $P < 0.001$) and had a higher prevalence of diabetes mellitus (DM) (52.2% *vs*. 35.0%, $P < 0.001$) compared with incident AMI patients, they also had worse heart function at admission, more severe coronary disease and lower reperfusion therapy. Age (OR = 1.03, 95% CI: 1.02–1.05; $P < 0.001$), DM (OR = 1.86, 95% CI: 1.37–2.52; $P < 0.001$) and reperfusion therapy (OR = 0.74; 95% CI: 0.52–0.89; $P < 0.001$) were independent risk factors for recurrent AMI. Recurrent AMI patients had a higher in-hospital death rate (12.1% *vs*. 7.8%, $P = 0.039$) than incident AMI patients. **Conclusions** Recurrent AMI patients presented with more severe coronary artery conditions. Age, DM and reperfusion therapy were independent risk factors for recurrent AMI, and recurrent AMI was related with a high risk of in-hospital death.

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1 Introduction

Patients who present with an acute myocardial infarction (AMI) continue to represent a major health concern. Numerous publications have reported on the improved survival rates of patients admitted with AMI.[1,2] However, only few reports have targeted recurrent AMI, which is a higher risk subgroup of those with AMI. Despite the best efforts at secondary prevention, the rate of recurrent AMI remains high, they represent 14% to 41.6% of patients hospitalized for AMI.[3–5] It is reported that patients with a recurrent AMI have worse outcomes.[5–7] However, the clinical predictors of recurrent MI and the contributing factors of patients with a recurrent AMI are not well explored. The objective of this study is to compare the differences in the presenting characteristics, in-hospital prognosis of patients with or without a recurrent AMI.

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2 Methods

2.1 Study population

From January 2010 to December 2015, all patients > 18 years of age with an admission for AMI to the intensive coronary care unit of Peking University People's Hospital were enrolled in the present study.

The diagnosis of AMI was made in the presence of two of the following three characteristics: (1) chest pain or equivalent symptoms; (2) dynamic ECG changes consistent with AMI; and (3) a typical serial rise (to at least three times the upper normal value) and fall in serum biochemical markers of cardiac necrosis such as creatine kinase-MB or troponin I. Recurrent AMI was identified as AMI occurred after 28 days following an incident MI according to the ESC/ACCF/AHA/WHF Task Force for the third universal definition of MI.[8]

Exclusion criteria were as follows: (1) AMI associated with percutaneous coronary intervention (PCI); (2) AMI associated with coronary artery bypass grafting (CABG); (3) AMI associated with stent thrombosis; and (4) re-infarction occurred 28 days within an incident MI.

Finally, a total of 1686 patients were recruited in the analysis. All patients were divided into two groups, 1479

patients had an incident AMI, and the left 207 patients had a recurrent AMI who had excluded from the first AMI group. We retrospectively compared clinical characteristics, coronary risk factors, angiographic findings and in-hospital mortality between incident and recurrent AMI patients.

2.2 Data collection

The demographic and clinical characteristics of AMI patients included age, gender, medical history, left ventricular function on admission, lipid profiles, serum creatinine, and hemoglobin. The angiographic and procedural characteristics included number of diseased vessels and the use of intra-aortic balloon pump. In addition, medical therapies during the hospitalization were also collected.

2.3 Statistical analysis

Statistical analysis was performed using SPSS for Windows 18.0 (SPSS, Chicago, IL). Continuous variables are expressed as mean ± SD, categorical variables are given as frequencies (%). Univariate comparisons between the two groups were performed using Pearson's chi-square test for categorical variables, and a Student *t* test for continuous variables. Multivariable logistic regression modeling was performed to derive the independent predictors of recurrent AMI. *P* values were estimated in a 2-tailed fashion. Difference was considered to be statistically significant at $P < 0.05$.

3 Results

3.1 Baseline characteristics

As shown in Table 1, recurrent AMI patients were older and had a higher incidence of diabetes mellitus (DM), higher level of blood creatinine, higher prevalence of non-ST-elevation myocardial infarction (NSTEMI) and higher prevalence of Killip 3/4 at admission compared with incident AMI patients. In addition, recurrent AMI patients had lower prevalence of current smoking, more favorable diastolic blood pressures and lipid profiles during their recurrent presentation.

Of all patients, coronary angiography (CAG) was performed in 1179 patients. Reperfusion therapy in recurrent AMI patients was lower than incident patients. Table 2 showed the number of diseased vessels of the two groups, recurrent AMI patients had higher prevalence of three diseased vessels (59.5% *vs*. 44.2%; $P = 0.002$).

3.2 Predictors of recurrent AMI

Variables which were significant differences in univariate analyses were included in further multivariate logistic regression analysis. Multivariate logistic regression analysis showed that age, DM and reperfusion therapy were significant independent risk factors for recurrent AMI (Table 3).

Table 1. Baseline characteristics of study population.

	Recurrent AMI (*n* = 207)	First AMI (*n* = 1479)	*P* value
Male	154 (74.4%)	1081 (73.1%)	0.5691
Age, yrs	69.3 ± 11.5	64.7 ± 12.8	< 0.001
Hypertension	133 (64.3%)	870 (58.8%)	0.136
DM	108 (52.2%)	517 (35.0%)	< 0.001
Current and former smoking	117 (56.5%)	8132 (54.9%)	0.661
Current smoking	52 (25.1%)	637 (43.1%)	< 0.001
Hypercholesterolemia	58 (28.0%)	449 (30.4%)	0.492
CHD family history	17 (8.2%)	132 (8.9%)	0.735
Blood pressure			
SBP, mmHg	125.9 ± 21.8	125.4 ± 21.3	0.749
DBP, mmHg	74.4 ± 12.2	76.5 ± 12.8	0.023
Lipid profiles			
TC, mmol/L	4.13 ± 1.10	4.39 ± 1.11	0.001
LDL-C, mmol/L	2.50 ± 0.82	2.78 ± 0.90	< 0.001
FPG, mmol/L	7.3 ± 3.2	6.9 ± 3.1	0.161
Creatinine, μmol/L	128.0 ± 104.4	101.3 ± 64.8	< 0.001
HbA1c	7.5% ± 1.4%	7.5% ± 1.5%	0.692
Presentation diagnosis			
STEMI	82 (39.6%)	952 (64.4%)	< 0.001
NSTEMI	125 (60.4%)	527 (35.6%)	< 0.001
Killip 3/4 at admission	42 (20.3%)	158 (10.7%)	< 0.001
Reperfusion therapy	94 (45.4%)	995 (67.3%)	< 0.001
Thrombolysis	3 (1.4%)	63 (4.3%)	0.051
PCI	59 (28.5%)	754 (51.0%)	< 0.001
CABG	32 (15.5%)	178 (12.0%)	0.162
IABP	7 (3.4%)	54 (3.1%)	0.883
Aspirin	201 (98.5%)	1738 (99.4%)	0.922
Clopidogrel	201 (98.5%)	1730 (99.0%)	0.899
Statins	196 (94.7%)	1684 (96.3%)	0.853
β-blocks	186 (89.9%)	1593 (91.3%)	0.745

Data are presented as mean ± SD or *n* (%). AMI: acute myocardial infarction; CABG: coronary artery bypass grafting; CHD: coronary heart disease; DBP: diastolic blood pressure; DM: diabetes mellitus; IABP: intra-aortic balloon pump; FPG: fasting plasma glucose; LDL-C: low-density lipoprotein cholesterol; NSTEMI: Non-ST- elevation myocardial infarction; PCI: percutaneous coronary intervention; SBP: systolic blood pressure; STEMI: ST-segment elevation myocardial infarction; TC: total cholesterol.

Table 2. Number of diseased vessels in study population.

	Recurrent AMI (*n* = 116)	First AMI (*n* = 1063)	*P* value
0	0	10 (0.9%)	0.296
1	6 (5.2%)	207 (19.3%)	< 0.001
2	23 (19.8%)	284 (26.5%)	0.119
3	69 (59.5%)	474 (44.2%)	0.002
LMT	18 (15.5%)	115 (10.7%)	0.120

Data are presented as *n* (%). AMI: acute myocardial infarction; LMT: left main trunk.

Table 3. Multivariate analysis for predictors of recurrent AMI.

	OR	95% CI	*P* value
Gender	0.72	0.49–1.07	0.103
Age	1.03	1.02–1.05	< 0.001
Hypertension	1.06	0.77–1.45	0.740
DM	1.86	1.37–2.52	< 0.001
Smoking	1.38	0.98–1.96	0.068
LDL-c	0.79	0.57–1.10	0.161
Creatinine	1.42	0.81–2.49	0.222
Reperfusion therapy	0.74	0.52–0.89	0.017

AMI: acute myocardial infarction; CHD: coronary heart disease; DM: diabetes mellitus.

3.3 In-hospital outcomes between recurrent AMI and first AMI

Table 4 shows the in-hospital adverse events in the two groups. Recurrent AMI patients had a higher prevalence of in-hospital all-cause death (12.1% *vs*. 7.8%, $P = 0.039$) than incident AMI patients.

Table 4. In-hospital outcomes of study population.

	Recurrent AMI	First AMI	*P* value
All-cause death	25 (12.1%)	1176 (7.8%)	0.039
Cardiac death	20 (9.7%)	92 (6.2%)	0.063
Shock	13	59	
Vt/Vf	1	9	
Cardiac arrest	5	15	
Cardiac tamponade	0	2	
Rupture	1	7	
Noncardiac death	5 (2.4%)	24 (1.6%)	0.411

Data are presented as *n* (%) or *n*. AMI: acute myocardial infarction; Vf: ventricular fibrillation; Vt: ventricular tachycardia.

4 Discussion

The major findings of the present study were as follows: (1) recurrent AMI patients were older and had a higher prevalence of DM, more severe coronary lesions, lower reperfusion therapy compared with incident AMI patients; (2) age, DM and reperfusion therapy were independent risk factors for the recurrence of AMI; and (3) recurrent AMI had significantly higher in-hospital mortality than first AMI.

Our results were similar to Shiraishi's study,[6] who showed that the repeat-MI patients had a significantly higher in-hospital mortality rate than the first-MI patients (15.3% *vs*. 9.4%, $P = 0.005$). However, Motivala, *et al*.,[5] showed that in-hospital outcomes were not significantly different in the two groups, except for a higher incidence of cardiac arrest and cardiogenic shock among recurrent AMI patients. However, at six month post-discharge, the incidences of death (8.0% *vs*. 4.5%; $P < 0.0001$) were significantly higher in patients with a prior history of MI.

The rate of reperfusion therapy was very low in the present study, only 67.3% in the incident AMI patients and 45.4% in the recurrent AMI patients, which partly reflected the current situation of the management of AMI in China. The Clinical Pathways for Acute Coronary Syndromes in China (CPACS) study showed that only 30% of STEMI and 40% of NSTEMI or unstable angina pectoris received reperfusion therapy during hospitalization.[9] The rate of CAG was also very low, especially in recurrent AMI patients, which might bias the results of our study. The CPACS study showed that only 58.3% of acute coronary syndromes received CAG during hospitalization.[9]

One of the most important results of the present study was that DM was an independent risk factor for the recurrence of AMI. Patients with DM were 1.86 times more likely to suffer a new cardiovascular event than those without DM. This result corresponded with that of Vega, *et al*.,[10] and Levantesi, *et al*.,[11] who reported DM to be one of the most important risk factors for new cardiovascular events following an AMI. In addition, age was also an independent risk factor in the present study. Older patients were more likely to have a recurrence of AMI. This independent association was also observed in the MITRA-MIR Registry Study,[12] and PRIMVAC Registry Study.[13]

Patients with a recurrent AMI had lower prevalence of current smoking and lower level of serum total cholesterol and low-density lipoprotein cholesterol compared with incident AMI patients. This might be due to the improved health awareness and received secondary prevention after the first AMI. The prevalence of patients with three diseased vessels on CAG was higher in recurrent AMI than that in incident AMI. This may be due to the high prevalence of DM in patients with a recurrent AMI. Many studies had concluded that coronary artery disease in patients with DM seemed to be severe and diffuse. These patients had more frequent three diseased vessels and less common one diseased vessel on CAG than patients without DM.[14,15] Caracciolo, *et al*.,[16] reported that 87% of CHD patients with DM had two or three diseased vessels on CAG, which was much higher than those without DM.

Overall, the present study reflected that age, DM and reperfusion therapy were important independent risk factors for another cardiovascular event following an AMI, and recurrent AMI patient had a poor in-hospital prognosis. There are several limitations in our study. First, this was a retrospective observational analysis, ideally, a prospective study should be designed to analysis the predictors for the

recurrent AMI; second, this study lacked data on type and management of the previous MI which could influence the prognosis; third, we did not compare the long-time outcomes between patients with or without a recurrent AMI.

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References

1 Yeh RW, Sidney S, Chandra M, *et al*. Population trends in the incidence and outcomes of acute myocardial infarction. *N Engl J Med* 2010; 362: 2155–2165.
2 Roe MT, Parsons LS, Pollack CV Jr., *et al*. National Registry of Myocardial Infarction Investigators. Quality of care by classification of myocardial infarction. *Arch Intern Med* 2005; 165: 1630–1636.
3 Wagner S, Burczyk U, Schiele R, *et al*. The 60 minutes myocardial infarction project: characteristics on admission and clinical outcome in patients with reinfarction compared to patients with a first infarction. *Eur Heart J* 1998; 19: 879–884.
4 Natali A, Vichi S, Landi P, *et al*. Mortality from coronary heart disease in subjects with type 2 diabetes and in non-diabetic subjects with and without prior myocardial infarction. *N Engl J Med* 1998; 339: 229–234.
5 Motivala AA, Tamhane U, Ramanath VS, *et al*. A prior myocardial infarction: how does it affect management and outcomes in recurrent acute coronary syndromes? *Clin Cardiol* 2008; 31: 590-596.
6 Shiraishi J, Kohno Y, Sawada T, *et al*. Predictors of in-hospital outcome after primary percutaneous coronary intervention for recurrent myocardial infarction. *Circ J* 2008; 72: 1225–1229.
7 Shotan A, Blondheim DS, Gottlieb S, *et al*. Comparison of outcome of recurrent versus first ST-segment elevation myocardial infarction (from National Israel Surveys 1998 to 2006). *Am J Cardiol* 2011; 107: 1730–1737.
8 Thygesen K, Alpert JS, Jaffe AS, *et al*. Third Universal Definition of Myocardial Infarction. *Circulation* 2012; 126: 2020–2035.
9 Gao R, Patel A, Gao W, *et al*. Prospective observational study of acute coronary syndromes in China: practice patterns and outcomes. *Heart* 2008; 94: 554–560.
10 Vega G, Martínez S, Jiménez PA, *et al*. Effect of cardiovascular risk factors on long-term morbidity and mortality following acute myocardial infarction. *Rev Esp Cardiol* 2007; 60: 703–713.
11 Levantesi G, Macchia A, Marfisi R, *et al*. Metabolic syndrome and risk of cardiovascular events after myocardial infarction. *J Am Coll Cardiol* 2005; 46: 277–283.
12 Dönges K, Schiele R, Gitt A, *et al*. Incidence, determinants, and clinical course of re-infarction in-hospital after index acute myocardial infarction [results from the pooled data of the Maximal Individual Therapy in Acute Myocardial Infarction [MITRA], and the Myocardial Infarction Registry (MIR)]. *Am J Cardiol* 2001; 87: 1039–1044.
13 Ahumada M, Cabadés A, Valencia J, *et al*. Reinfarction as a complication of acute myocardial infarction. PRIMVAC registry data. *Rev Esp Cardiol* 2005; 58: 13–19.
14 Melidonis A, Dimopoulos V, Lempidakis E, *et al*. Angiographic study of coronary artery disease in diabetic patients in comparison with nondiabetic patients. *Angiology* 2002; 50: 997–1006.
15 Silva JA, Escobar A, Collins TJ, *et al*. Unstable angina: a comparison of angioscopic findings between diabetic and nondiabetic patients. *Circulation* 1995; 92: 1731–1736.
16 Caracciolo EA, Chaitman BR, Forman SA, *et al*. Diabetic with coronary disease have a prevalence of asymptomatic ischemia monitoring similar to that of nondiabetic patients. *Circulation* 1996; 93: 2091–2098.