Available online at www.sciencedirect.com
SCIENCE DIRECT
ELSEVIER
JNMU
Journal of Nanjing Medical University, 2007, 21(6):363–366
www.elsevier.com/locate/jnmu
Research Paper

The early risk stratification of the patients with acute chest pain

Chunping Tang, Yanrong Liu ,Qin Shen, Zhijian Yang, Jun Huang, Ming Gui*
Chest Pain Emergency Department, the First Affiliated Hospital of Nanjing Medical University, Nanjing 210029, Jiangsu Province, China
Received 20 September 2007

Abstract

Objective: This investigation was designed to stratify patients with acute chest pain based on their symptoms, electrocardiogram (ECG), cardiac injury markers and the number of accompanying traditional risk factors(smoking, obesity, hyperlipemia, hypertension, diabetes), and to assess the effect of the above factors to obtain a risk stratification for patients with chest pain. **Methods:** We identified 139 patients with acute chest pain, including 45 myocardiac infarction patients, 65 unstable angina patients and 29 chest pain patients without identified acute coronary syndrome(ACS) admitted to our Coronary Heart Center during December 2004 to February 2005. All patients accepted coronary angiography. All data was collected using questionnaires. Based on reported symptom, electrocardiogram (ECG), cardiac injury markers and the number of the accompanying traditional risk factors, we stratified all patients into four groups: Group 1, patients with acute chest pain, ECG changes and abnormal cardiac injury biomarkers. Group 2, patients with acute chest pain and ECG changes(without abnormal cardiac injury biomarkers). Group 3, patients with acute chest pain, normal ECG, normal cardiac injury biomarkers and >2 traditional risk factors. Group 4, patients with acute chest pain, normal ECG and normal cardiac injury biomarkers, but only $\leqslant 2$ traditional risk factors. From this data we examined the difference of ACS incidence in the four groups. **Results:**After stratification the ACS incidence of the grouped patients in turn was 100%, 84%, 69.6% and 53.3%. The combination of early phase ECG and cardiac injury markers identified 70.9% patients with ACS(the specificity being 90.7%). The mortality of group 3 was higher compared with group 4(69.6% vs 53.3%), however the P value was more than 0.05 and didn't show significant statistical difference. The correlation analysis found the number of the traditional risk factors had a significant positive correlation ($r = 0.202$, $P = 0.044$) with the number of stenosis being more than 50% of the artery diameter. Multiple linear regression showed the hypertension had a significant correlation with the number of the diseased regions($P = 0.014$). **Conclusions:**The risk stratification based on the symptom, ECG, cardiac injury markers and accompanying traditional risk factors is both important and available in practice. It is unsuitable for patients with a normal ECG and cardiac injury markers to differentiate ACS from non-cardiac chest pain relying only on the number of the accompanying traditional risk factors. However we found the number of the risk factors can indicate the disease severity.

Key words: acute chest pain; risk stratification; ECG; cardiac injury markers

INTRODUCTION

Chest pain, as the presentation of many diseases, is one of the most common complaints in the emergency department(ED). The task of evaluation and diagnosing of the patients with chest pain is usually challenging every ED physician[1]. In the United States, every year approximately 8 million patients present to the emergency department with chest pain, 5 million of whom are diagnosed with suspected acute coronary syndrome(ACS) and admitted, but only about half of these admitted patients are finnally diagnosed with ACS. Among the patients who are excluded the possibility of ACS and discharged from the emergency department, about 40 000(1.3%) patients will ultimately have an acute myocardial infarction[2]. Because of atypical presentations and nonspecific electrocardiogram(ECG) findings, about 5% of the AMI patients are inadvertently discharged home[3-4]. Large numbers of unneces-

This study was supported by the Province Natural Science Foundation of the Department of Education of Jiangsu(01 KJB320003), Innovation Fund of Nanjing Medical University(CX 2003001)
*Correspondence author
E-mail address: minggui99@ 163.com

sary admissions result in considerable cost and inefficient resource utilization, while missed AMI is a leading cause of malpractice. Although there have been many risk stratification protocols for patients with chest pain[5-8], it is controversial which is the most efficient. In practice, the Goldman's protocol[9] and the TIMI risk score[10] are widely used. The former stratifies patients with chest pain based on the ECG and risk factors, admits the high risk patients and advocates that low-/moderate risk patients take an exercise stress test which decides the patients admitted or discharged. It has been shown that this protocol not only avoids the missed diagnosis of the high risk patients but also decreases hospitalization expense. Further analysis shows its diagnosis sensitivity to AMI is similar to that of the inpatient in coronary care unit(88% vs 87%), and the specificity is slightly higher(74% vs 71%). To date, domestic research about the early risk stratification of the patients with chest pain is scant. Our study aims to stratify the patients with acute chest pain on the basis of the symptom, ECG, cardiac injury markers and accompanying traditional risk factors including smoking, obesity, lipoprotein disorder, hypertension, diabetes, and evaluate the effect of these basic information in the early risk stratification of the patients with acute chest pain.

MATERIALS AND METHODS

Subjects

This study included 139 patients with acute chest pain who were admitted to our coronary heart disease center from December 2004 to February 2005. The patients who met any of the following were excluded: ① Post definitive acute myocardiac infarction (AMI), but no records of ECG and cardiac injury biomarkers. ②Suspected ACS, but no angiography.

Diagnosis

The final diagnosis was established on the basis of ACC/AHA guidelines for ACS[11-12]. The diagnosis criterias included:① typical angina symptom. ② ST segment depression $\geqslant 0.1$ mV in any continuous adjacent leads. ③ ST segment elevation $\geqslant 0.2$ mV in the manitruncus leads or $\geqslant 0.1$ mV in the limbs leads. ④abnormal cardiac injury biomarkers including CTnT/I and CKMB. ⑤pathological Q wave. ⑥angiography demonstrates stenosis $\geqslant 50\%$.

Method

We completed the ECG and serum collection for detection of cardiac injury biomarkers as soon as the patient was admitted. Before breakfast blood was collected to detect the serum lipoprotein. All patients received a questionnaire for their base information including their case history, symptom feature, ECG, accompanying diseases and traditional risk factors. Then angiography was planned.

The patients were divided into four groups as the following: Group 1, patients with acute chest pain, ECG change and abnormal cardiac injury biomarkers. Group 2, patients with acute chest pain and ECG change without abnormal cardiac injury biomarkers. Group 3, patients with acute chest pain, normal ECG, normal cardiac injury biomarkers and >2 traditional risk factors. Group 4, patients with acute chest pain, normal ECG and normal cardiac injury biomarkers, but only $\leqslant 2$ traditional risk factors.

Statistical analysis

SPSS 12.0 was applied to analyze data. The data was expressed as mean $\pm$ *s*. We analyzed the morbility of ACS with Chi-Square test and the base information with *t* test. The correlation between the parameters was calculated with the Pearson method. $P < 0.05$ was considered to be statistically significant.

RESULTS

Common information of the patients

The results table shows 45 myocardiac-infarction patients, 65 unstable angina patients and 29 noncardiac chest pain patients(***Tab 1***). The patients with AMI were older than these with noncardiac chest pain(63.7 vs 59.4 years old), but had no difference statistically. The patients with UA were significantly older than those with noncardiac chest pain(65.1 vs 59.4 years old, $P < 0.05$). The prevalence of AMI, UA in men and women was similar to that of noncardiac pain chest.

Tab 1 **Base information of the patients with chest pain**

	N	Age(years)	Sex(male/female)
AMI	45	$63.7 \pm 11.3^{\triangle}$	$35/10^{\triangle}$
UA	65	$65.1 \pm 8.7^{*}$	$49/16^{\triangle}$
Non-cardiac	29	59.4 ± 12.8	22/7

Patients with AMI or UA compared to patients with non-cardiac chest pain, $^{*}P < 0.05$, $^{\triangle}P > 0.05$.

Risk stratification

After risk stratification according to the design, the diagnosis is shown in ***Tab 2***. In group 1, there were no patitents with noncardiac chest pain. Among the 53 patients with normal ECG and cardiac injury markers, 32 patients were diagnosed as having cardiac chest pain (including 1 patient with AMI). The results demonstrated

Tab 2 **Patients construction in every subgroup**

Group	*n*	UA	AMI	Non-cardiac
1	36	3	33	–
2	50	31	11	8
3	23	15	1	7
4	30	16	–	14

that the morbidity of ACS in every subgroup had a decrease trend that was 100%, 84%, 69.6%, 53.3% respectively. The mortality of group 3 was higher compared with group 4(69.6% vs 53.3%), but the *P* value was more than 0.05 and therefore didn't show significant statistical difference(***Tab 3***).

Tab 3 **The morbidity of ALS in every subgroup**

Group	*n*	ACS	Non-cardiac	Morbidity(%)
1	36	36	0	100.0
2	50	42	8	84.0
3	23	16	7	69.6 △
4	30	16	14	53.3

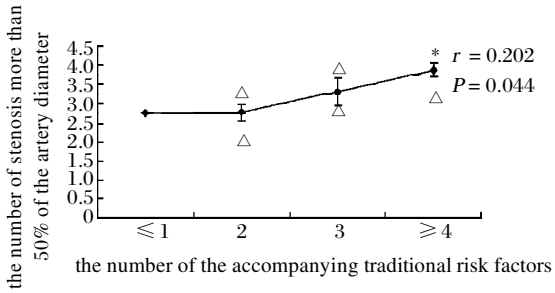
Group 3 was compared with group 4, △ $P > 0.05$.

Angiography

Every involved patient accepted angiography. According to the number of the accompanying traditional risk factors, we divided all ACS patients into four subgroups. The result demonstrated that the number of stenosis more than 50% of the artery diameter was 2.75 ± 0.97、2.76 ± 1.66、3.30 ± 2.34、3.89 ± 1.49 respectively(***Tab 4***) and had a significant positive correlation($r = 0.202$, $P = 0.044$) with the number of the traditional risk factors(***Fig 1***). Multiple linear regression showed the hypertension had a significant correlation with the number of the diseased regions($P = 0.014$).

Tab 4 **Correlation between the traditional risk factors and the stenosis regions**

The number of the accompanying traditional risk factors	The number of stenosis more than 50% of the artery diameter	*P* value
⩽1	2.75 ± 0.97	–
2	2.76 ± 1.66	0.985
3	3.30 ± 2.34	0.256
⩾4	3.89 ± 1.49	0.027



Compared with the number of stenosis more than 50% of the artery diameter in the patients accompanied with ⩽1 traditional risk factor, * $P < 0.05$, △ $P > 0.05$.

Fig 1 Correlation between the traditional risk factors and the stenosis regions

DISCCUSION

Chest pain often posses a huge challenge to physicians owing to the wide spectrum of presentation of acute coronary syndromes(ACS). With this in mind chest pain centers(CPC) have been established to facilitate the rapid triage of these patients and allow identified ACS patients get the safe, accurate, cost-effective treatment[13-14]. The tools used to stratify such patients include mainly ECG and cardiac injury biomarkers. ECG is rapid, available and cheap, so it has been one of the main tools which are used in assessment and risk stratification of patients with suspected ACS. It is recommended that a 18-lead ECG should been obtained within 10 minutes after arrival[11-12]. Specific ECG changes relating to ACS include ST segment elevation(⩾0.2 mV in the anterior lead, ⩾0.1 mV in the limbs lead) or depression(⩾0.1mV in any continuous adjacent lead)[11-12,15-16]. In addition the pathological Q wave exits permanently after myocardial infarction. Our research shows that about 70.9% of patients who are diagnosed with ACS have above-mentioned ECG changes. About 97.8% of AMI patients have abnormal ECG findings, but only 52.3% in patients with UA. The ECG has a limited contribution to the diagnosis of UA.

The cardiac injury markers play an important role in the diagnosis of AMI. Currently the most widely used markers include myoglobin, cardiac troponin T/I(CTnT/I) and CKMB. The latter two markers have a higher specificity in identifying myocardial necrosis[17-18]. Despite their common use, these markers have many limitations, especially as they play a less important role in the diagnosis of patients with ischemia and not injury[19]. This research shows that only 4.6% of patients with certain UA have slight abnormal markers. Bindining markers to ECG changes, however the sensitivity for ACS isn't raised.

According to the design we divided all patients into four groups based on the ECG, cardiac injury markers and accompanying traditional risk factors. Compared with Goldman's protocol this design emphasizes the impact of the traditional risk factors in the risk stratification. The results demonstrated that the morbidity of ACS in every subgroup had a decreased trend and was 100%, 84%, 69.6%, 53.3% respectively. It is obvious that this plan is efficient in the risk stratification of patients with acute chest pain. Traditional risk factors have less contribution to the diagnosis of ACS than ECG and cardiac injury markers. In patients with symptoms of possible ACS, some of the traditional risk factors for coronary artery disease are only weakly predictive of the likelihood of ACS and far less important than symptoms, ECG findings, and cardiac injury markers[2], and therefore can't be used alone as the diagnosis criteria[11-12]. We had a similar result, when patients in group 3 were compared with those in group 4, the former mortality is higher(69.6% vs 53.3%), however

the P value was more than 0.05 and therefore didn't show significant statistical difference. With this in mind we don't recommended only relying on the number of accompanying traditional risk factors among patients with normal ECG and cardiac injury markers for the clinical diagnosis of ACS. In addition, the accumulating burden of accompanying traditional risk factors of coronary artery disease plays an important role in the progression of coronary atherosclerosis[20]. In our subgroups, according to the number of the accompanying traditional risk factors, the final angiography demonstrated that the number of stenosis more than 50% of the artery diameter was 2.75 ± 0.97、2.76 ± 1.66、3.30 ± 2.34、3.89 ± 1.49 respectively and had a significant positive correlation($r = 0.202$, $P = 0.044$) with the number of the accompanying traditional risk factors. Multiple linear regression shows the hypertension has a significant correlation with the number of the diseased regions($P = 0.014$).

In summary, our study has shown that risk stratification based on symptom, ECG, cardiac injury markers and accompanying traditional risk factors is important and available in practice. But we find that it is very difficult to diagnose the patients with acute chest pain without abnormal ECG and cardiac injury markers. To such patients, observation for a 9-12 h duration is necessary[5,21].

References

[1] Clark DS, Esherick J, Dachs R. Acute chest pain: when is it life-threatening? *Emergency Medicine* 2006; 38: 20-34.

[2] Kamineni R, Alpert JS. Acute coronary syndromes: initial evaluation and risk stratification. *Progress in Cardiovascular Disease* 2004; 46(5): 379-92.

[3] McCarthy BD, Beshansky JR, D'Agostino RB, Selker HP. Missed diagnoses of acute myocardial infarction in the emergency department: results from a multicenter study. *Ann Emerg Med* 1993; 22: 579-82.

[4] Schull MJ, Vermeulen MJ, Stukel TA. The risk of missed diagnosis of acute myocardial infarction associated with emergency department volume. *Ann Emerg Med* 2006; 48(6):647-55.

[5] Jesse RL, Kontos MC, Roberts CS. Diagnostic strategies for the evaluation of the patient presenting with chest pain. *Progress in Cardiovascular Disease* 2004; 46(5): 417-37.

[6] Arnold J, Goodacre S, Morris F. Structure, process and outcomes of chest pain units established in the ESCAPE trial. *Emergency Medicine Journal* 2007;24:462-6.

[7] Goldstein JA, Gallagher MJ, O'Neill WW, Ross MA, O'Neil BJ,Raff GL. A randomized controlled trial of multi-slice coronary com-puted tomography for evaluation of acute chest pain. *JACC* 2007;49:863-71.

[8] Yi-Mei Chng, Joshua M. Kosowsky.A Triage algorithm for the rapid clinical assessment and management of emergency department patients presenting with chest pain. *Critical Pathways in Cardiology* 2004;3: 154-7.

[9] Goldman L, Cook EF, Johnson PA, Brand DA, Rouan GW, Lee TH. Prediction of the need for intensive care in patients who come to emergency department with acute chest pain. *N Engl J Med* 1996; 334: 1498-504.

[10] Antman EM, Cohen M, Bernink PJ, McCabe CH, Horacek T, Papuchis G. The TIMI risk score for unstable angina/non-ST elevation MI: A method for prognostication and therapeutic decision making. *JAMA* 2000; 284(7): 835-42.

[11] Antman EM, Anbe DT, Armstrong PW, Green LA, Hand M, Hochman JS, et al. ACC/AHA guideline for the management of patients with ST-elevation Myocardial infarction-executive summary: a report of the American College of Cardiology/American Heart Association task force on practice guidelines. *Circulation* 2004;110:588-636.

[12] Braunwald E, Antman EM, Beasley JW, Califf RM, Cheitlin MD, Hochman JS. ACC/AHA 2002 guideline update for the management of patients with unstable angina and non-ST-segment elevation myocardial infarction-summary article: a report of the American College of Cardiology/American Heart Association task force on practice guidelines. *J Am Coll Cardiol* 2002;40(7):1366-74.

[13] Cross E, How S, Goodacre S. Development of acute chest pain services in the UK. *Emergency Medicine Journal* 2007; 24: 100-2.

[14] Price J. Trial finds that chest pain observation units reduce hospital admissions without increasing costs compared to usual care. *Evidence-Based Cardiovascular Medicine* 2004; 8: 183-4.

[15] Achar SA, Kundu S, Norcross WA. Diagnosis of acute coronary syndrome. *American Family Physician* 2005;72:119-26.

[16] Green M, Ohlsson M, Forberg JL, Björk J, Edenbrandt L, Ekelund U. Best leads in the standard electrocardiogram for the emergency detection of acute coronary syndrome. *J Electrocardiol* 2007; 40 (3):251-6.

[17] Kontos MC, Anderson FP, Schmidt KA, Ornato JP, Tatum JL, Jesse RL. Early diagnosis of acute myocardial infarction in patients without ST-segment elevation. *Am J Cardiol* 1999;83:155-8.

[18] Alpert JS, Thygesen K, Antman E, Bassand JP. Myocardial infarction redefined-a consensus document of the joint European Society of Cardiology/American College of Cardiology Committee for the redefinition of myocardial infarction. *J Am Coll Cardiol* 2000;36: 959-69.

[19] Nesby LK. Markers of cardiac ischemia, injury, and inflammation. *Progress in Cardiovascular Disease* 2004; 46(5): 404-16.

[20] Ehtisham A, Chimowitz MI, Furlan AJ, Lafranchise EF. Systemic risk factors associated with progression of atherosclerosis from the coronary to the carotid arteries. *J Stroke Cerebrovasc Dis* 2005;14 (4):182-5.

[21] Lewis WR, Amsterdam EA. Predictive instruments, critical care pathways, algorithms, and protocols in the rapid evaluation of chest pain. *Critical Pathways in Cardiology* 2005;4:30-6.