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The prognostic values of the admission electrocardiography, myocardial injury markers and physical examination in patients with acute myocardial infarction

心電圖、心肌損傷標記物和體檢在急性心肌梗死病人的預後價值

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Introduction: Acute coronary syndromes (ACS) are leading life threatening causes of chest pain, which is one of the most common complaints in the emergency department (ED). The aim of the study was to demonstrate the usefulness of physical examination, ECG and cardiac markers to predict short term outcome of ACS patients. ***Methods:*** A total of 1728 patients with chest pain were evaluated between 1st January 2003 and 31st December 2003 in the ED and 236 of the patients matched our study criteria. ***Results:*** In the study group 184 patients were (78%) male and the mean age was 59.8±12.2 (range=4-92) years old. Age, Killip score, cardiac marker values, the time interval between the beginning of the chest pain and ED entry and the ECG changes were the studied variables. With the logistic regression analysis, Killip score and any rhythm other than normal sinus rhythm on the first ECG were found to be the only independent variables to predict early mortality (p=0.036 and p=0.033). ***Conclusion:*** Simple measures in the ED such as ECG and serum markers of myocardial injury along with the thorough physical evaluation of the physician may predict early negative outcome. (Hong Kong j.emerg.med. 2011;18:294-299)

簡介：急性冠狀動脈綜合徵「ACS」是急症室「ED」最常見導致危及生命的胸疼痛原因。這項研究的目的證明身體檢查，心電圖和心肌標誌物來預測ACS的患者短期結果是有用的。**方法：**在2003年1月1日至2003年12月31日期間有1728例胸部痛疼病患被評估，其中236例符合我們的研究標準。**結果：**研究組184例患者（78%）男性，平均年齡為59.8±12.2（範圍4-92）歲。年齡，Killip分級評分，心臟標誌值，開始胸痛和ED項和心電圖變化的時間間隔。採用回邏輯歸分析，Killip評分和除了開始是正常竇性心律的其他任何心律是唯一用來預測早期死亡率（p=0.036和p=0.033）的獨立變量。**結論：**簡單的措施，如在急診室心電圖和心肌損傷的血清標誌物和詳細的身體評估，醫生可以早期預測的負面結果。

Keywords: Coronary angiography, hospital emergency service, outcome, risk assessment

關鍵詞：冠狀動脈造影術、醫院急診服務、結果、風險評估

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Introduction

Chest pain is one of the most common complaints in the emergency department (ED). Acute coronary syndrome (ACS) is one of the leading life threatening causes of chest pain[1] ACS should be vigilantly diagnosed and proper treatment should be initiated in the ED. Therefore, the emergency physician has to be well trained and informed about focused physical examination, history findings and diagnostic tools such as electrocardiography (ECG) and cardiac markers.

The aim of the study was to demonstrate the usefulness of these early measures to predict short term outcome of ACS patients.

Material and methods

This retrospective study is performed in a university hospital ED, with an annual volume of 40000 adult patients. The study group was formed by patients who ended up with a final diagnosis of acute myocardial infarction (AMI), either with or without ST segment elevation.

The specific diagnosis for the patient groups were identified with ICD-10 (International Classification of Diseases-10) coding system and the codes were searched by local software (MEDIACIL®) of the hospital, within the patient database. The data was collected by chart review; the demographical data, time interval between the beginning of the chest pain and ED entry in minutes; co-existing diseases which may affect the prognosis, such as diabetes mellitus (DM), hypertension (HT) and coronary artery disease (CAD); and the Killip scores at the ED were recorded.

The first ECG in the ED was validated for the study and evaluated by an emergency medicine specialist who was blinded to the clinical data of the patients. The number of the ECG leads with ST segment elevations (2-4 leads and >5 leads) and the ECG rhythms were recorded. The effects of variables on survival were evaluated.

The laboratory values were attained by local computer based follow up program. Coronary angiography (CAG) schemes, final diagnosis at discharge from cardiology department and final decisions on definitive therapy and follow up were also recorded from patient charts. The survival data for the first three months were attained either by chart review or thru a phone call to the patients or their relatives. Mortality was defined as non traumatic cardiovascular death.

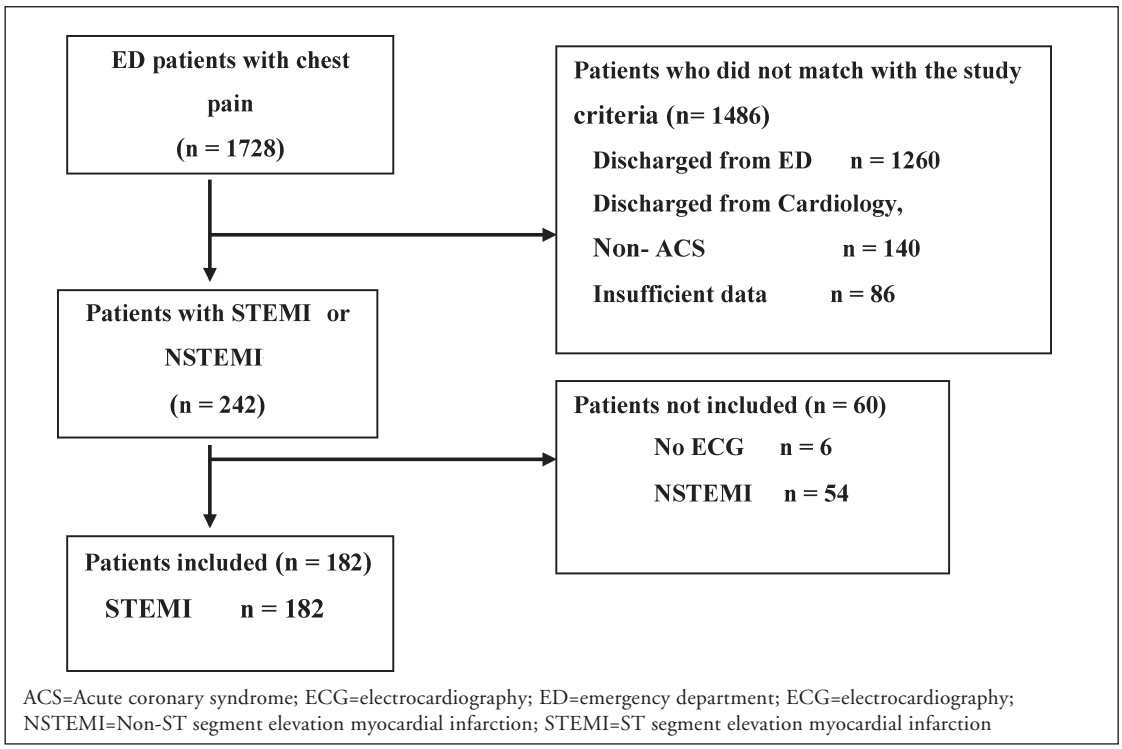
Comparisons were made with the Pearson chi-square analysis of variables and logistic regression analysis was performed for dependent variables. The goodness of fit of the logistic regression model was performed by Hosmer Lemeshow test. A p value ≤ 0.05 was considered significant. All statistical analyses were performed by SPSS 10.0 (SPSS Inc., Chicago, Illinois).

Results

A total of 1728 patients with chest pain were evaluated between 1 January 2003 and 31 December 2003 in the ED. Totally 1486 of these patients did not match the study criteria: 1260 were discharged from ED with diagnoses other than ACS, 140 discharged from cardiology department with diagnoses other than ACS and 86 patients had insufficient data on their charts (Figure 1). Of the 242 patients who were identified as ACS by controlled chart data, 6 patients with no ECGs in their records were excluded from the study.

Of these 236 patients 184 (78%) were male. The mean age was 59.8±12.2 (34-92), and females were older than males (Table 1). Thirty patients (12.7%) were found to be dead within the first three months following their incident. Mortalities were recorded (in patient charts) or told (by relatives) to be of cardiac arrest and none were defined to be of other causes.

Of 236 patients, 186 (77.1%) had ST segment elevation myocardial infarction (STEMI), while 54 (22.9%) had non-ST segment elevation myocardial infraction (NSTEMI). The most common type of STEMI was anterior MI in 92 patients (39.5%). CAG



ACS=Acute coronary syndrome; ECG=electrocardiography; ED=emergency department; ECG=electrocardiography; NSTEMI=Non-ST segment elevation myocardial infarction; STEMI=ST segment elevation myocardial infarction

Figure 1. Patient flowchart.

was performed for 152 patients, 129 with STEMI and 23 with NSTEMI. Left anterior descending artery (LAD) was the responsible vessel in 77 patients (59.7%), followed by right coronary artery (RCA) in 42 patients (32.6%) and the circumflex coronary artery (Cx) in 10 patients (7.7%). The relationship between the type of the MI and the responsible vessel is shown in Table 2.

The rhythm at the first ECG was found to be significantly related with death. While the death rate for the patients with normal sinus rhythm (NSR) was 6.8%, it was 29% for the patients with any rhythm other than NSR including sinus tachycardia, atrial fibrillation, supraventricular tachycardias (p=0.000).

The mortality was found clearly higher in STEMI group (14.8%) than NSTEMI group (5.6%) while it was not statistically significant (p=0.065) (Table 3). Patients with anterior MI and inferior MI constituted 14.5% and 17.1% of mortality, respectively.

There was no statistically significant relationship between the number of the leads with elevated ST

Table 1. Patients demographics

	Number	%	Mean age±SD
Male	184	78	57.9±12.1
Female	52	22	66.5±9.5
Total	236	100	59.8±12.2

SD=standard deviation

Table 2. Coronary artery lesions in STEMI patients

	LAD	RCA	Cx	CAG Ø	Total
Anterior	73	–	–	22	95
Inferior	2	37	5	20	64
Inferolateral	2	1	–	2	5
Inferoposterior	–	4	1	5	10
Posterior	–	–	2	–	2
Lateral	–	–	2	2	4
High lateral	–	–	–	1	1
Posterolateral	–	–	–	1	1
Total	77	42	10	53	182

CAG Ø=coronary angiography not performed; Cx=circumflex coronary artery; LAD=Left anterior descending coronary artery; RCA=right coronary artery; STEMI=ST segment elevation myocardial infarction

Table 3. ECG changes and mortality rates

	Type of MI (%)		Reciprocal changes (%)		Total ST segment elevation (%)		
	STEMI	NSTEMI	Yes	No	≤4 mm	5-9 mm	≥10 mm
Death	14.8%	5.6%	19.4%	13.3%	15.2	6.3	18.5
Survive	85.2%	94.4	80.6%	86.7%	84.8	93.7	81.5
Total	100%	100%	100%	100%	100%	100%	100%

MI=myocardial infarction; NSTEMI=Non-ST segment elevation myocardial infarction; STEMI=ST segment elevation myocardial infarction

segments and early mortality. On the other hand, troponin-I levels were found to be higher in patients with 5 or more elevated ST segments compared to 4 or less ST segments (median values 6.42 versus 3.42 respectively, p=0.06). There was also no correlation between the existence of both reciprocal changes and total ST segment elevation in millimeters in ECG and mortality of patients (p>0.05) (Table 3).

The time interval between the onset of the chest pain and ED entry was less than 1 hour for 21.3% of the patients, between 1 to 3 hours for 30.2% patients, 3 to 6 hours for 23.3% patients and over 6 hours for 25.2% of the patients. The mortality rates of the patients admitted within the first 3 hours onset of chest pain was lower than those admitted with longer onset time but the difference was not statistically significant [9.2% and 17.4% respectively (p=0.097)]. Our results also did not show a statistically significant relationship between the onset time interval and age, gender and the type of the MI (STEMI or NSTEMI) (p>0.05).

Patients with a Killip score of I had a mortality rate of 4.9%. The mortality rate for patients with a Killip score of IV was 100% (Table 4).

The higher levels of myocardial markers (Myoglobin, CK-MB and Troponin) at the ED entry were associated with higher mortality rates (p=0.000, p=0.009 and p=0.001, respectively).

The patient age was also a statistically significant predictor of early mortality. The mean age of the patients who were dead within the first three months was 66.7±12.9, compared to 57.9±11.2 for the survivors (p=0.001) (Table 4).

With the logistic Regression analysis performed for age, Killip score, cardiac marker values, the time interval between the onset of the chest pain and ED entry and the ECG changes, only the Killip score and any rhythm other than normal sinus rhythm on the first ECG were found to be the significant independent variables to predict early mortality (p=0.036 and p=0.033, respectively) (Table 5). The significance of the goodness of fit test was 0.85.

Discussion

ACS is a major cause of sudden death, ED visits and hospital admittances. It also causes severe loss of work hours.[1,2] Emergency departments are the main entrance

Table 4. The mortality rates and patient characteristics

	Death	Survive	Total
Gender			
Male (%)	12.7	87.3	100
Female (%)	18.8	81.2	100
Mean age±SD	66.7±12.9	57.9±11.2	
Killip score (%)			
I	4.9	95.1	100
II	26.9	73.1	100
III	50	50	100
IV	100	0	100

SD=standard deviation

Table 5. Significant independent variables in the logistic regression analysis

Variables	P value	OR	95% CI
Killip score	0.04	0.40	0.17-0.98
ECG rhythm	0.04	0.23	0.05-0.94

OR=odds ratio; CI=confidence interval; ECG=electrocardiography

for ACS patients, and therefore they should provide the suitable care to decrease the mortality and morbidity rates of them. The Advanced Cardiac Life Support guidelines state that, the ECG should be taken and interpreted following the vital signs and IV line, all completed within first 10 minutes after the entry of patients with chest pain.[1]

ECG is a fast, easy to get, cheap, noninvasive and reliable tool for the diagnosis of AMI and predicting the early outcomes of ACS's. Schröder et al proposed that the difference between the ST segment heights before and after the thrombolytic therapy, provided a prognostic data on survival.[3] Kao et al notified ST segment and T wave changes in anterior leads showed worse outcome.[4] Our study could not show a statistically significant difference related to ST segment and T wave changes, but higher troponin-I levels were found to be seriously related with higher numbers of elevated ST segments. We believed that our relative small sample size might be underpowered to demonstrate the difference.

In the GISSI – 1 study both short and long term mortalities were found to increase with the number of the elevated ST segments.[5] However, our study showed contrary results with the literature. This might be due to the differences in patient populations, the retrospective design of the study and relatively shorter period of follow.

In a study by Parale et al[6] on 300 STEMI patients, reciprocal changes equal to or higher than the ST segment elevations were found to be related with worse left ventricular function. Although we could not define LV function in our patients because of the lack of the echocardiographic data, as a matter of the retrospective design of our study, we found no differences in 3 month death rates in STEMI patients with or without reciprocal changes.

The male to female ratio in our study was 3:1, which was higher compared to the literature with values about 2:1 or even equal. On the other hand the mean age of our study group was as low as 59, which could be related to the higher ratio of the males in our smaple. MacIntyre et al[7] found a mean age of 70 while Carrabba et al[8] found 70.4. The ages of our female patients were higher as expected.

With older age, myocardial performance gets worse, compensatory system breaks down and chronic effects of the co-existing diseases show up.[9] In our study, the 3 months mortality was higher in the elder patients. Coronado et al[10] showed that each decade raised mortality rates 1.8 times. Yu et al[11] inspected a group of ACS patients aged between 35-85 years, dividing into sub-groups of 10 years, and found that patients older than 75 had 2 times higher mortality rates compared to patients between 35 and 45 years old.

The connection of worse outcome and high values of myoglobin, CK-MB and troponin at the ED is well known. de Lemos et al[12] notified that high myoglobin levels were related with approximately 3 times raised mortality rates. Our results also suggested that, the patients with higher first cardiac enzyme values were more prone to early mortality. This might be a result of larger myocardial damage and also, other negative cumulative effects of the possibly extended pre-hospital period.

Neskovic et al[13] informed that, while Killip 1 patients had a perfect prognosis, Killip 2 and 3 patients formed the high risk group to benefit the most from revascularisation and Killip 4 patients, who are experiencing cardiogenic shock had very high mortality rates despite all treatment measures. In a study by Bahit et al[14] conducted on the GUSTO IIa database, STEMI patients with a Killip score over 1 were found to have higher mortality rates. Our study was concordant with the literature.

In the literature, we found no studies which correlate the time interval between the beginning of the chest pain and ED arrival, and the early mortality rates. Half of the mortalities due to AMI were known to occur at the pre-hospital setting.[15,16] In our study, although statistically insignificant, the mortality rates were 2 times higher in patients arriving later than 3 hours, compared to earlier arrivals. On the other hand the beginning time of the chest pain, does not necessarily point to the time of total coronary vessel occlusion.

The pain at the time may as well be unstable angina which then may be followed by coronary occlusion at any time in between.

Conclusion

Acute myocardial infarction is a highly mortal and fairly common disease. Our results suggest that simple measures in the ED such as ECG and serum markers of myocardial injury along with the thorough physical evaluation of the physician may predict early negative outcome. Although an initial ECG with NSR and normal LV function in the first evaluation may predict a better outcome, physicians must remember the importance of control ECGs and physical examination.

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