

# Emergency Room Risk Stratification of Patients with Chest Pain without ST Segment Elevation

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## Abstract

**Background:** Emergency room triage of patients with chest pain is an ongoing challenge. Over the years a number of modalities have been evolved for rapid diagnosis and better risk stratification of patients. **Aim:** to investigate the prognostic factors in patients who came to the Emergency Department with chest pain suspected of acute coronary syndrome without ST segment elevation. **Patients and Methods:** one-hundred and three consecutive patients (from Suez Canal university Hospital and Al Monira General Hospital) were evaluated by recording clinical history, electrocardiogram and troponin determination. Early (< 24 h) exercise testing was done for the low-risk subgroup of patients (n= 28). All patients were followed up for 3 months for major events (acute myocardial infarction or death). **Results:** Major events occurred in 14 patients (9.6%). Multivariate analysis identified the following predictors: age  $\geq 65$  years (OR = 1.7; p = 0.05), diabetes mellitus (OR = 2.9; p = 0.001), previous ischemic heart disease (OR = 2.5; p = 0.004), ST depression (OR = 2.1; p = 0.048) and troponin elevation (OR = 2.6; p = 0.003). These five predictors were used to construct a risk score based on their odds ratios, which allowed event risk stratification 0-3 points low risk 48% of the studied patients, 4-7 points intermediate risk 31% of the studied patients, 8 points or more high risk 21% of studied patients. **Conclusions:** In patients with chest pain, the combination of clinical, electrocardiographic and biochemical data available on admission to the emergency service allows rapid prognostic stratification. Early exercise testing is advisable for the final stratification of low risk patients.

**Keywords:** Triage, Acute coronary syndrome, ER

## Introduction

Emergency room triage of patients with chest pain is an ongoing challenge. Over the years a number of modalities have been evolved for rapid diagnosis and better risk stratification of patients, still the evaluation of acute

chest pain should begin with a clinical history taking that focuses on character of chest pain, the time of onset and duration of symptoms, examination that emphasizes vital signs and cardiovascular status<sup>(1)</sup>. In addition, accurate risk stratification is required to reduce the incidence of inappropriate hospital

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discharges. From 2% to 4% of patients with acute myocardial infarction seen in emergency departments are discharged home<sup>(2,3)</sup>. Early protocols were based on clinical history and ECG results<sup>(4)</sup>. In recent years troponin measurement<sup>(5)</sup>, and early exercise testing<sup>(6)</sup> have been added. Nevertheless, few studies have evaluated the combination of all these factors for classifying patients with chest pain into levels of probability of myocardial infarction. The present study focused on patients who came to the emergency room for chest pain, but had no evidence of ST segment elevation on the electrocardiogram (ECG). Patients were evaluated according to a protocol, which included clinical history, ECG, serial troponin determinations and early exercise testing. The aim of the study was to investigate the combined use of these data in an integrated approach to risk stratification in these patients.

## Patients and Method

*Design:* This is an observational, cross section study

*Study population:* The study population included 103 consecutive patients who came to the Emergency Department of the Suez Canal university Hospital and Al Monira General Hospital. *Inclusion criteria:* The criterion for inclusion was a clinical diagnosis of chest pain of possible coronary origin, all ages & both genders. *Exclusion criteria:* i) Left bundle branch block on initial ECG. ii) Patients who came to the emergency room more than once during ST-segment elevation on initial ECG. iii) Chest pain due to non coronary origin.

*Methods:* All patients were assessed

according to the protocol which included clinical history, ECG, serial troponin concentrations and early exercise testing.

*1-Clinical history:* The chest pain characteristics (site; quality; reference; course and duration) were examined. The following risk factors were recorded: age, hypertension, diabetes, smoking, hypercholesterolemia, and history of ischemic heart disease or coronary surgery.

*2-Electrocardiography:* The following findings from the emergency ECG were assessed a) ST segment depression, defined as a  $\geq 1$  mm ST segment downsloping occurring 80 ms after the J point; b) T wave inversion, defined as a  $\geq 1$  mm inversion of the T wave peak, and c) non-assessable ECG, in which ST segment or T wave alterations might be explained by other causes (e.g., pacemaker or left ventricular overload)<sup>(1)</sup>.

*3-Troponin:* Troponin concentrations were determined upon arrival at the emergency room, at 6 hours (in patients who came within the first 2 hrs after onset of pain), at 8 hours and at 12 hours after the onset of pain. Troponin elevation was defined as a concentration of  $\geq 1$  ng/mL (normal upper limit recommended by our laboratory).

*4-Early exercise testing:* After clinical, ECG and troponin assessment, 75 patients (73%) were hospitalized immediately with a confirmed or strongly suspected diagnosis of acute coronary syndrome, whereas 28 patients (27%) were selected for early exercise stress testing (within the first 24 h). The patients in the latter group had no electrocardiograph ECG evidence of ischemic disease or troponin elevation during the first 12 hours after onset of

pain and were physically able to undergo exercise testing. Symptom limited treadmill testing was performed using a standard Bruce protocol. The test was interpreted as positive when typical chest pain occurred or diagnostic ST segment depressions were found (horizontal or downsloping ST segment decrease  $\geq 1$  mm or ST segment increase). The test was considered negative when the patient reached submaximal heart rate with no chest pain or ST segment changes. The results were considered inconclusive when the test was negative but heart rate was not submaximal, or

when ST segment changes were non-diagnostic (horizontal or down sloping decrease  $>0.5$ mm and  $<1$ mm, with no chest pain)<sup>(1)</sup>.

#### Statistical analysis

The independent variables included the analysis of predictors i.e. clinical history, cardiac risk factors, ECG findings, and troponin elevation. A scoring system was done according to P value and OR of each risk factor associated with major event. One point was assigned to each variable for each 0.5 step or fraction of an OR  $<1$  (e.g., OR 1.01-1.5=1 point; 1.51-2.0=2 points, etc.).

**Table 1:** Risk factors of major event

Risk Factor	Patients' number	P value	OR	Scoring points
Age $\geq 65$ yrs	15	0.05	1.7	2
Diabetes mellitus	35	0.001	2.9	4
History of IHD	42	0.004	2.5	3
Depressed ST segment	25	0.048	2.1	3
Elevated troponin I	37	0.003	2.6	4

IHD= ischemic heart disease; OR= Odds ratio

## Results

After studying 103 patients with chest pain and without ST-segment elevation and follow up at one and three month for occurrence of major event that include myocardial infarction (STEMI or NSTEMI) and cardiac death that may follow cardiogenic shock or fatal arrhythmia (e.g. ventricular tachycardia, fibrillation) and observation the risk factors of MI or death. we found that the independent variables included in the analysis of predictors of events were: i) Clinical history, ii) Cardiac risk factors 65% of studied patients were

HTN, 32% smoking and 34% DM (table 2), all the Presence of risk factors of the studied population in details in figure 1 iii) ECG findings (ST segment depression in 24.3% of patients and T-wave inversion in 15.5% of patients (Table 3) , iv) Troponin elevation in 36%of studied patients (Table 4). According to the risk score, the studied patients stratified into three categories; 0-3 points= (Low risk) represented 48% of the studied patients, 4-7 points= (intermediate risk) represented 31% of the studied patients, and  $\geq 8$  points= (high risk) represented 21%of studied patients (Figure 2).Major event per-

centage was seen in 35% (8/22 patients) of high risk patients (Figure 3), 15% (5/32 patients) of intermediate risk patients (Figure 4), and 2% (1/49 patients) of low risk patients (Table 5). Major event occurrence during follow up in relation to hypertension 65% of studied patients (Table 6) while Major event occurrence during follow up in relation to DM 34.7% (Table 7) and Major event occurrence during the follow up in relation to troponin elevation at first visit to ED were 37.9% (Table 8).

**Discussion**

The results of this study indicate that certain data recorded at emergency room admission are related with a higher probability of cardiac events

**Table 2:** Risk factors occurrence from the history of the studied patients

	Positive		Negative	
	N	%	N	%
HTN	67	65	36	35
Smoking	33	32	70	68
DM	35	34	68	66

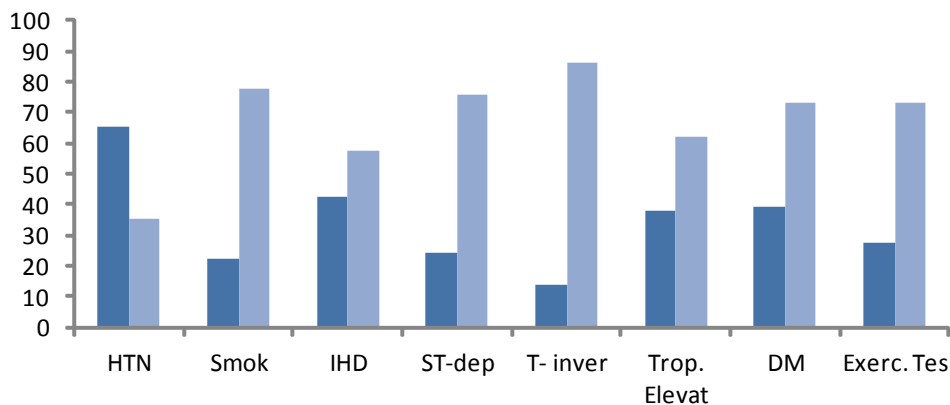
during the next three months in patients with chest pain and no ST segment elevation: age 65 years or older, diabetes mellitus, history of ischemic heart disease, ST segment depression and increased troponin values. A score created with these parameters was useful for risk stratification of emergency room patients. Early exercise testing was found to be advisable for final stratification of low risk patients.

**Table 3:** Risk factors occurrence based on ECG of the studied patients

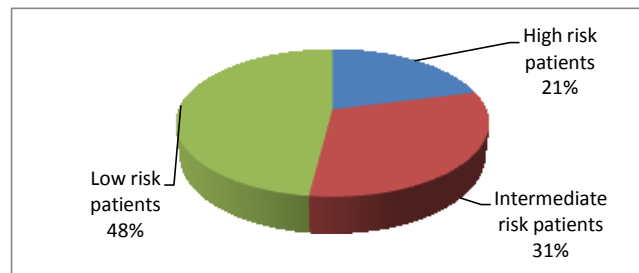
	Positive		Negative	
	N	%	N	%
ST-depression	25	24.3	78	75.7
T wave-inversion	16	15.5	87	84.5

**Table 4:** Risk factors occurrence based on Cardiac markers in the studied patients

	Positive		Negative	
	N	%	N	%
Trop. Elevation	37	36	66	64



**Figure 1:** Presence of risk factors of the studied population



**Figure 2:** Patients risk stratification according to the risk score

**Table 5:** Major event occurrence in each category

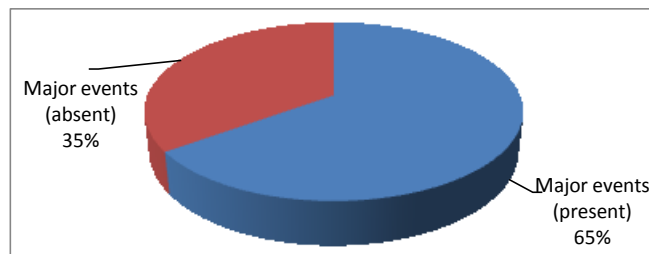
Item	Patients No. (%)	Major event during the follow up		
		Event	Patients No.	Patients (%)
High risk patients	22 (21%)	Death	3	35%
		MI	5	
Intermediate risk patients	32 (31%)	death	2	15%
		MI	3	
Low risk patients	49 (48%)	MI	1	2%

A risk score was calculated and assigned to each of the five variables related to major events according to their OR values. Thus, two points were assigned to age 65 years or older (OR=1.7), 3 points to history of ischemic heart disease (OR=2.5), 3 points to depressed ST segment (OR=2.1), and 4 points to troponin elevation (OR=2.6) and diabetes mellitus (OR=2.9). According to the risk score, the studied patients were stratified into three categories. Low risk (0-3 points) represented 48% of the studied patients. Intermediate risk (4-7 points) represented 31% of the studied patients. And high risk ( $\geq 8$  points) represented 21% of studied patients. Major event percentage of high risk patients was 35% (8 patients from 22), Major event percentage of intermediate risk patients was 15% (5 patients from 32) and Major event percentage of high risk patients

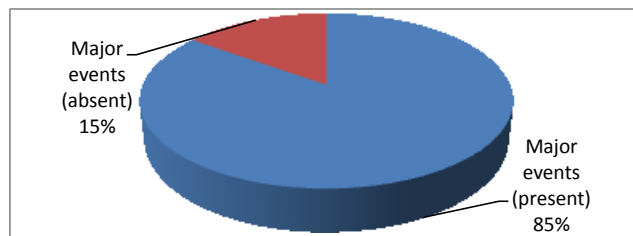
was 2% (1 patient from 49). Symptom assessment is essential in patients with chest pain. Among the coronary risk factors studied, diabetes mellitus, age 65 years or older and a history of ischemic heart disease were associated with the development of cardiac events. Diabetes was the most potent predictor, in keeping with extensive evidence indicating a poorer prognosis for acute coronary syndrome in patients with diabetes<sup>(7)</sup>. Approximately 50% of the patients with acute coronary syndrome and negative ST segment elevation showed no significant ECG alterations<sup>(8)</sup>. The finding most indicative of a poor prognosis was ST segment depression<sup>(9)</sup>. Depressed ST segment was found in 24% of our patients, and was associated with a higher probability of infarction and major events during follow-up. As reported in other study<sup>(10)</sup>, T wave Inversion had no prognostic value. Numerous studies

have demonstrated the prognostic usefulness of troponin elevation in patients with chest pain<sup>(11)</sup>. Likewise in our series, troponin was an independent predictor of any major cardiac event. Nevertheless, the importance of troponin as a prognostic factor should not overshadow the predictive value of data from the clinical history and ECG. Comprehensive assessment of all these factors seems advisable. A normal troponin value does not guar-

antee that a patient can be safely discharged from the emergency room<sup>(12)</sup>. In the present study, elevated troponin with no other factors indicating poor prognosis was given a score of four points on the risk scale and hence a classification of moderate risk; the presence of other factors would result in a classification of high or very high risk. Early exercise testing was the final step in the protocol for risk stratification.



**Figure 3:** Percentage of the occurrence of major event in high risk patients



**Figure 4:** Percentage of the occurrence of major event in intermediate risk patients

Several studies have demonstrated the prognostic value of exercise testing in low-risk patients with chest pain<sup>(13-14)</sup>. In the present series, none of the patients with negative exercise testing presented with events during follow-up, despite early discharge. Patients hospitalized after early exercise testing underwent numerous invasive

studies and revascularization procedures. Although we cannot know what the natural course of these patients would have been without exercise testing and subsequent hospitalization, it seems reasonable to assume that the prognosis would have been worse if they had been sent home from the emergency room.

**Table 6:** Major event occurrence during follow up in relation to hypertension

HTN	Major event			
	+Death	+MI	-ve	Total
Positive No. (%)	5 (100%)	9 (100%)	53 (59.6%)	67 (65%)
Negative No. (%)	0	0	36 (40.4%)	36 (35%)
Total No. (%)	5 (100%)	9 (100%)	89 (100%)	103 (100%)
X <sup>2</sup> (P-value)	8.706 (0.113)			

**Table 7:** Major event occurrence during follow up in relation to DM

DM	Major event			
	+Death	+MI	-ve	Total
Positive No. (%)	4 (80%)	7 (77.6%)	24 (23.6%)	35 (34.7%)
Negative No. (%)	1 (20%)	2 (33.3)	65 (76.4%)	68 (65.3%)
Total No. (%)	5 (100%)	9 (100%)	89 (100%)	103 (100%)
X <sup>2</sup> (P-value)	23.905 (0.001)			

**Table 8:** Major event occurrence during the follow up in relation to troponin elevation at first visit to ED

Troponin Elevation	Major event			
	+Death	+MI	-ve	Total
Positive No. (%)	4 (80%)	5 (55.6%)	28 (32.6%)	37 (37.9%)
Negative No. (%)	1 (20%)	4 (44.4%)	61 (67.4%)	66 (62.1%)
Total No. (%)	5 (100%)	9 (100%)	89 (100%)	103 (100%)
X <sup>2</sup> (P-value)	10.457 (0.005)			

## Conclusions

The results emphasize the value of an integrated approach that includes combined analysis of the clinical history, ECG, troponin levels and early exercise testing in emergency room patients with chest pain. Age 65 years or older, diabetes mellitus, a history of IHD, ST segment depression and troponin elevation were markers of a poor prognosis. The combinations of these findings, which are easy to obtain in the emergency room, allow effective risk stratification. Early exercise testing is advisable for final stratification of low-risk patients.

### Limitations of the study

The risk score system developed in this study is applicable to patients similar to the study population, it remains to be demonstrated whether this risk score provides appropriate stratification in a different population. T wave inversion was evaluated as a categorical value (present or absent), without distinguishing among types of inversion. Thus, we did not analyze deep negative T wave in the precordial leads (suggestive of a severe lesion in the anterior descending artery), which may have prognostic significance.

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