

# Emergency Room Risk Stratification of Patients With Chest Pain Without ST Segment Elevation

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**Objectives.** To investigate the prognostic factors in patients who come to the emergency room with chest pain but without ST segment elevation.

**Patients and method.** 743 consecutive patients were evaluated by recording clinical history, electrocardiogram and troponin I determination, and early (< 24 h) exercise testing was done for the low-risk subgroup of patients (n = 203). All patients were followed during 3 months for major events (acute myocardial infarction or death).

**Results.** Major events occurred in 71 patients (9.6%). Multivariate analysis (C statistic = 0.79; 95% CI 0.73-0.84; p = 0.0001) identified the following predictors: age  $\geq$  72 years (OR = 1.7; 95% CI, 1.0-2.9; p = 0.05), insulin-dependent diabetes mellitus (OR = 2.9; 95% CI, 1.5-5.4; p = 0.001), previous ischemic heart disease (OR = 1.9; 95% CI, 1.1-3.2; p = 0.02), ST depression (OR = 2.1; 95% CI, 1.2-3.8; p = 0.01) and troponin I elevation (OR = 2.9; 95% CI, 1.5-5.3; p = 0.001). These five predictors were used to construct a risk score based on their odds ratios, which allowed event rate stratification by quartiles of the score: 0-2 points (1.6% events), 3-4 points (8.1% events), 5-7 points (11.9% events) and  $\geq$  8 points (26.2% events); p = 0.0001. No patient with negative findings in the early exercise testing had major events.

**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.

**Key words:** *Unstable angina. Electrocardiography. Troponin. Exercise.*

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## Estratificación del riesgo de pacientes con dolor torácico sin elevación del segmento ST en la puerta de urgencias

**Objetivos.** Investigar en la puerta de urgencias los factores pronósticos de pacientes que acuden por dolor torácico sin elevación del segmento ST.

**Pacientes y método.** Se evaluó a 743 pacientes consecutivos mediante la historia clínica, el electrocardiograma, la determinación de troponina I y la ergometría precoz (< 24 h) en el subgrupo de bajo riesgo (n = 203). Todos los pacientes fueron seguidos durante 3 meses, y se recogieron los eventos mayores (infarto agudo de miocardio o muerte).

**Resultados.** En 71 pacientes (9,6%) ocurrieron eventos mayores. En el análisis multivariable (estadístico C = 0,79; IC del 95%, 0,73-0,84; p = 0,0001) se identificaron los siguientes predictores: edad  $\geq$  72 años (OR = 1,7; IC del 95%, 1,0-2,9; p = 0,05), diabetes insulinodependiente (OR = 2,9; IC del 95%, 1,5-5,4; p = 0,001), cardiopatía isquémica previa (OR = 1,9; IC del 95%, 1,1-3,2; p = 0,02), descenso del segmento ST (OR = 2,1; IC del 95%, 1,2-3,8; p = 0,01) y elevación de la troponina I (OR = 2,9; IC del 95%, 1,5-5,3; p = 0,001). Se creó una puntuación de riesgo basada en las OR de estos 5 predictores que permitió la estratificación de la población por cuartiles de esta puntuación: 0-2 puntos, 1,6% eventos; 3-4 puntos, 8,1% eventos; 5-7 puntos, 11,9% eventos;  $\geq$  8 puntos, 26,2% eventos; p = 0,0001. Ningún paciente con ergometría precoz negativa presentó eventos.

**Conclusiones.** En los pacientes con dolor torácico, el conjunto de los datos clínicos, electrocardiográficos y bioquímicos disponibles en la puerta de urgencias permite establecer una rápida estratificación pronóstica. La ergometría precoz es útil para la estratificación final en los pacientes de bajo riesgo.

**Palabras clave:** *Angina inestable. Electrocardiografía. Troponina. Ejercicio.*

## ABBREVIATIONS

ECG: electrocardiogram.  
 CK-MB: creatine kinase, MB fraction.  
 ROC: receiver operator characteristic.  
 OR: *odds ratio*.  
 CI: confidence interval.

## INTRODUCTION

Emergency room triage of patients with chest pain is an ongoing challenge. To optimize the use of health care resources, unnecessary hospitalization of patients without coronary disease and patients with a favorable prognosis should be avoided.<sup>1</sup> In addition, accurate risk stratification is required to reduce the incidence of inappropriate hospital discharges. From 2% to 4% of patients with acute myocardial infarction seen in emergency departments are discharged home.<sup>2,3</sup>

The main objective of chest pain units is to improve diagnostic efficacy in patients with this clinical symptom.<sup>4</sup> Early protocols were based on clinical history and ECG results.<sup>5</sup> In recent years, troponin measurement<sup>6-11</sup> and early exercise testing<sup>4,12-17</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 focuses on patients who came to the emergency room for chest pain, but had no evidence of ST segment elevation on the electrocardiogram (ECG). The patients were evaluated according to the chest pain unit 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

### Study group

The study population included consecutive patients who came to the Emergency Department of the Hospital Clínico Universitario de Valencia (Valencia, Spain) for chest pain from 15 January 2001 to 30 September 2002. The criterion for inclusion was a clinical diagnosis of chest pain of possible coronary origin by the cardiologist on duty. All patients with ST segment elevation or left bundle branch block on the initial ECG were excluded. Patients who came to the

emergency room more than once during the study period were enrolled only at their first admission. A total of 743 emergency room patients were included in the study. All patients were assessed according to the usual protocol<sup>15</sup> in the hospital chest pain unit, which included clinical history, ECG, serial troponin I concentrations and early exercise testing.

### Clinical history

The clinical pain characteristics were examined using the scoring system of Geleijnse.<sup>15,18</sup> In addition, the following risk factors were recorded: age, sex, hypertension, diabetes, smoking, hypercholesterolemia, and history of ischemic heart disease or coronary surgery.

### Electrocardiography

The following findings from the emergency ECG were assessed: *a*) ST segment depression, defined as a  $\geq 1$  mm ST segment downslope 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).

### Troponin I

Troponin I concentrations were determined (Immulite<sup>®</sup>, Los Angeles, CA, USA) upon arrival at the emergency room, at 6 hours (in patients who came within the first 2 hours after onset of pain), at 8 hours and at 12 hours after the onset of pain. Troponin I elevation was defined as a concentration of  $\geq 1$  ng/mL (normal upper limit recommended by our laboratory).

### Early exercise testing

After assessment of the clinical history, ECG and troponin I results, 540 patients (73%) were hospitalized immediately with a confirmed or strongly suspected diagnosis of acute coronary syndrome, whereas 203 patients (27%) were selected for early exercise stress testing (within the first 24 h). The patients in the latter group had no electrocardiographic evidence of ischemic disease or troponin I 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 downsloping decrease >0.5 mm and <1 mm, with no chest pain).

The 119 patients with negative exercise tests were discharged, whereas the 42 with positive tests were hospitalized. For patients with inconclusive exercise testing, the final decision was at the discretion of the attending cardiologist; thus, 7 patients with inconclusive results were discharged and 25 were hospitalized.

### Management of hospitalized patients

Hospitalized patients were treated with aspirin, low-molecular-weight heparin and beta-blockers, except when these drugs were contraindicated. The subgroup of patients who had nonspecific clinical symptoms, inconclusive ECG and normal troponin concentration, and who were unable to undergo exercise testing, received aspirin alone until further examinations could confirm the diagnosis. In patients with increased troponin I, concentrations were repeated at 18 hours and every 24 hours until peak values were reached. According to current guidelines, myocardial infarction is defined by troponin I elevation. The MB fraction of creatine kinase (CK-MB) mass is used to define reinfarction. For this purpose, CK-MB mass (Immulite®, Los Angeles, CA, USA) was routinely measured in all patients with elevated troponin I at the time of admission, using an upper normal limit of 5 ng/mL.

Cardiac catheterization was performed in 282 patients during their hospital stay. The decision to use this procedure was made by the attending cardiologist on the basis of the following criteria: *a*) recurrent angina (new episode of chest pain without elevated markers of heart damage after hospitalization) in 74 patients; *b*) myocardial infarction (new episode of chest pain with elevated markers) in 15 patients; *c*) abnormal early or pre-discharge exercise testing in 136 patients, and *d*) systematic invasive management in 57 patients. Percutaneous revascularization was performed in 86 patients and surgical revascularization in 56. In the group of 67 patients hospitalized after early exercise testing, cardiac catheterization was done in 52 (78%); 23 (34%) of these patients underwent revascularization (15 by angioplasty and 8 by surgery).

### Follow-up

All 743 patients were followed up on an outpatient basis at 1 and 3 months after hospitalization. The

following events were noted: *a*) myocardial infarction, in the case of a new episode of chest pain with a rise in markers of heart damage; *b*) cardiac death, and *c*) a major event defined by infarction or cardiac death.

### Statistical analysis

The independent variables included in the analysis of predictors of events were clinical history, chest pain score, cardiac risk factors, ECG findings (ST segment depression, T wave inversion and non-assessable ECG), and troponin I elevation. Categorical values were compared with the  $\chi^2$  test and expressed as percentages. The continuous variables *chest pain score* and *age* were transformed into categorical variables and receiver operator characteristic (ROC) curves were used to define the best cut-off point for predicting events. Multivariate analysis was performed by binary logistic regression, including the variables that showed a significance level of less than 0.1 in the univariate analysis. The odds ratio (OR), 95% confidence interval (95% CI) and C statistic of the model were also calculated. A *P* value of less than .05 was considered significant.

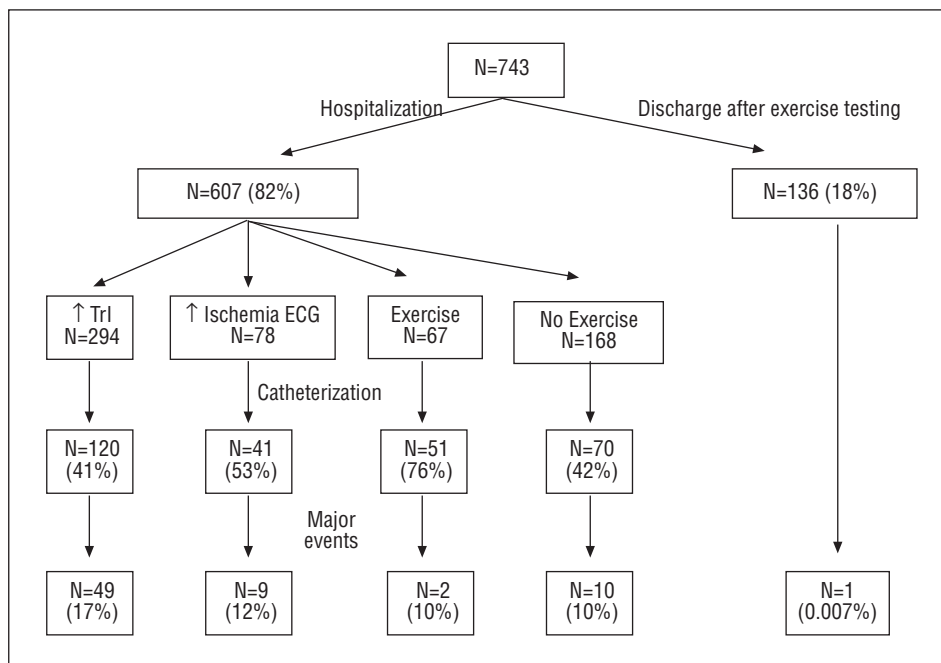
A risk scoring system was created with the five variables associated with major events in the multivariate model: age 72 years or older, insulin-dependent diabetes mellitus, history of ischemic heart disease, ST segment depression and elevated troponin I. One point was assigned to each variable for each 0.5 step or fraction of the OR value above 1 (e.g., OR 1.01-1.5=1 point; 1.51-2.0=2 points, etc.).<sup>19</sup>

The risk score was calculated for each patient by summing the points for all five variables. The study

TABLE 1. Characteristics of the study population (n=743)

Clinical history	
Pain score, points	10.6±8
Age, years	66±12
Men	449 (67%)
Smokers	162 (22%)
Hypertension	464 (62%)
Hypercholesterolemia	355 (48%)
Diabetes	201 (27%)
IDDM	77 (10%)
History of ischemic heart disease	305 (41%)
Prior coronary surgery	40 (5%)
ECG	
ST depression	284 (24%)
T wave inversion	73 (10%)
ECG non-assessable	36 (5%)
Biochemical markers	
Troponin I elevation	294 (40%)

IDDM indicates insulin-dependent diabetes mellitus



**Fig. 1** Flow chart showing the evolution of patients from admission to the emergency room until three months later. A total of 136 patients were discharged after early exercise testing, whereas 607 were hospitalized. The reasons for hospitalization were divided into four groups: a) troponin elevation; b) ECG suggestive of ischemia (ST depression or T wave inversion) with normal troponin; c) positive or inconclusive early exercise testing, and d) none of the previous categories, but exercise testing excluded because of symptoms highly suggestive of acute coronary syndrome or inability to perform the test. The chart shows catheterizations performed and the number of major events occurring over three months in each subgroup. ↑TrI: troponin I elevation.

population was divided into quartiles based on this score, and the frequency of major events between quartiles was calculated by analysis of variance and the Scheffe test.

**RESULTS**

**TABLE 2. Predictors of acute myocardial infarction during follow-up**

	Univariate	Multivariate		
	P	P	OR	95% CI
<b>Clinical history</b>				
Pain score ≥11	.07	.7		
Age, years ≥68	.05	.4		
Man	0.9			
Smoker	0.4			
Hypertension	0.6			
Diabetes	0.2			
IDDM	0.08	0.6		
Hypercholesterolemia	0.9			
History of ischemic heart disease	0.002	0.002	2.6	1.4-4.8
Prior coronary surgery	0.7			
<b>ECG</b>				
ST depression	0.0001	0.04	2.0	1.0-4.0
T-wave inversion	0.8			
ECG non-assessable	0.6			
<b>Biochemical markers</b>				
Troponin I elevation	0.001	0.03	2.2	1.1-4.3

IDDM indicates insulin-dependent diabetes mellitus; CI, confidence interval; NS, non-significant; OR, odds ratio; P, statistical significance.

**Characteristics of the population**

Table 1 summarizes the population characteristics. Troponin I levels were elevated in 294 patients (40%), leading to a diagnosis of myocardial infarction at the time of admission. During follow-up, 48 patients (6.5%) had a new myocardial infarction (infarction as

**TABLE 3. Predictors of cardiac death**

	Univariate	Multivariate		
	P	P	OR	95% CI
<b>Clinical history</b>				
Pain score ≥11	0.002	0.05	2.6	1.0-6.8
Age, years ≥72	0.0001	0.03	2.5	1.1-5.9
Man	0.8			
Smoker	0.8			
Hypertension arterial	0.08	0.4		
Diabetes	0.001	1		
IDDM	0.0001	0.0001	5.8	2.5-13.4
Hypercholesterolemia	0.4			
History of ischemic heart disease	0.6			
Prior coronary surgery	0.7			
<b>ECG</b>				
ST depression	0.0001	0.2		
T-wave inversion	1			
ECG non-assessable	0.4			
<b>Biochemical markers</b>				
Troponin I elevation	0.0001	0.0009	6.4	2.1-19.2

IDDM indicates insulin-dependent diabetes mellitus; CI, confidence interval; NS, non significant; OR, odds ratio; P, statistical significance

event), 28 (3.8%) had cardiac death, and 71 (9.6%) a major event. Six deaths were related to revascularization procedures (5 surgery and 1 angioplasty). Figure 1 shows the patients' course from emergency room admission to three months later.

### Predictors of myocardial infarction

Table 2 shows the predictors of myocardial infarction as an event during follow-up in the univariate and multivariate analyses. Factors indicating increased risk of infarction were a history of coronary disease (OR=2.6; 95% CI, 1.4-4.8;  $P=.002$ ), ST segment depression (OR=2.0; 95% CI, 1.0-4.0;  $P=.04$ ) and troponin I elevation (OR=2.2; 95% CI, 1.1-4.3;  $P=.03$ ). The C statistic of the model was 0.71 (95% CI, 0.63-0.79;  $P=.0001$ ).

### Predictors of death

The predictors of death derived from the univariate and multivariate analyses are shown in Table 3. Mortality was independently associated with age 72 years or older (OR=2.5; 95% CI, 1.1-5.9;  $P=.03$ ), insulin-dependent diabetes mellitus (OR=5.8; 95% CI, 2.5-13.4;  $P=.0001$ ), chest pain score  $\geq 11$  points (OR=2.6; 95% CI, 1.0-6.8;  $P=.05$ ) and troponin I elevation (OR=6.4; 95% CI, 2.1-19.2;  $P=.0009$ ). The C statistic of the model was 0.86 (95% CI, 0.79-0.93;  $P=.0001$ ).

### Predictors of major events

The independent predictors of major events (infarction or death) in the multivariate analysis (Table 4) included age 72 years or older (OR=1.7; 95% CI, 1.0-2.9;  $P=.05$ ), insulin-dependent diabetes mellitus (OR=2.9; 95% CI, 1.5-5.4;  $P=.001$ ), history of ischemic heart disease (OR=1.9; 95% CI, 1.1-3.2;  $P=.02$ ), ST segment depression (OR=2.1; 95% CI, 1.2-3.8;  $P=.01$ ) and troponin I elevation (OR=2.9; 95% CI, 1.5-5.3;  $P=.001$ ). The C statistic of the model was 0.79 (95% CI, 0.73-0.84;  $P=.0001$ ).

### Risk stratification

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 72 years or older (OR=1.7) and history of ischemic heart disease (OR=1.9), 3 points to depressed ST segment (OR=2.1), and 4 points to troponin I elevation (OR=2.9) and insulin-dependent diabetes mellitus (OR=2.9).

The study population was divided into quartiles according to the risk scores: 0 to 2 points, 3 to 5 points,

TABLE 4. Predictors of major events (acute myocardial infarction or cardiac death)

	Univariate <i>P</i>	Multivariate		
		<i>P</i>	OR	95% CI
<b>Clinical history</b>				
Pain scale $\geq 11$	.0001	.2		
Age $\geq 72$	.0001	.05	1.7	1.0-2.9
Male	1			
Smoker	1			
Hypertension 0.1	0.6			
Diabetes	.002	.9		
IDDM	.0001	.001	2.9	1.5-5.4
Hypercholesterolemia	0.3			
History of ischemic heart disease	.003	.02	1.9	1.1-3.2
Prior coronary surgery	0.6			
<b>ECG</b>				
ST depression	.0001	.01	2.1	1.2-3.8
T-wave inversion	0.8			
ECG non-assessable	0.7			
<b>Biochemical markers</b>				
Troponin I elevation	.0001	.001	2.9	1.5-5.3

IDDM indicates insulin-dependent diabetes mellitus; CI, confidence interval; NS, non-significant; OR, odds ratio; *P*, statistical significance.

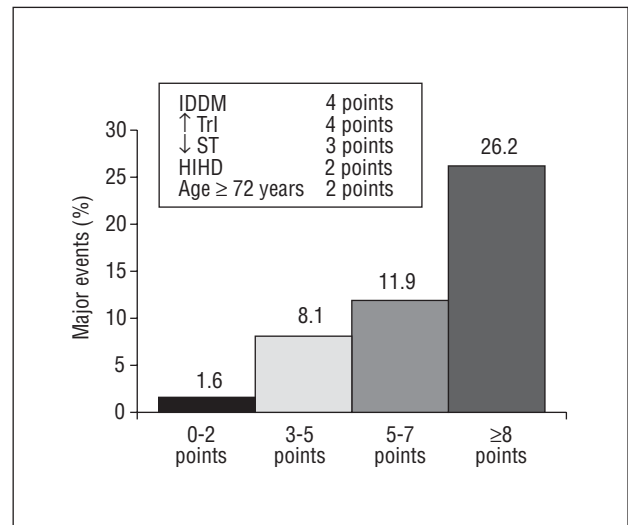


Fig. 2. Risk score according to the odds ratio (OR) of each of the 5 variables related with major events: 2 points for age 72 years or older (OR=1.7) and history of ischemic heart disease (OR=1.9), 3 points for ST segment depression (OR=2.1), and 4 points for troponin I elevation (OR=2.9) and insulin-dependent diabetes mellitus (OR=2.9). This scoring system was used to divide the population into quartiles: 0 to 2 points, 3 to 5 points, 5 to 7 points and  $\geq 8$  points. The frequency of major events was 1.6% in the first quartile (low-risk), 8.1% in the second quartile (moderate risk), 11.9% in the third quartile (high-risk) and 26.2% in the fourth quartile (very high risk). Differences were significant between the fourth quartile and each of the others ( $P=.0001$ ), and between the third and first quartiles ( $P=.005$ ); the difference between the second and first quartiles approached statistical significance ( $P=.1$ ). IDDM indicates insulin-dependent diabetes mellitus;  $\uparrow$ TrI: troponin I elevation;  $\downarrow$ ST, ST segment depression; HIHD, history of ischemic heart disease.

5 to 7 points and  $\geq 8$  points (Figure 2). The frequency of major events was 1.6% in the first quartile (low risk), 8.1% in the second quartile (moderate risk), 11.9% in the third quartile (high risk) and 26.2% in the fourth quartile (very high risk). Differences were significant between the fourth quartile and each of the other quartiles ( $P=.0001$ ), and between the third and first quartiles ( $P=.005$ ). The difference between the first and second quartiles was marginally significant ( $P=.1$ ).

### Events in the group selected for early exercise testing

Among the 67 patients hospitalized after early exercise testing, there was one in-hospital death due to a retroperitoneal hematoma after coronary angioplasty. Immediately after early exercise testing, 136 patients (119 negative tests and 17 inconclusive) were discharged. None of the patients with negative exercise tests presented a major event during follow up, whereas one patient with an inconclusive test returned to the emergency room with a non-ST-segment elevation infarction.

## DISCUSSION

The results of this study indicate that certain data recorded at emergency room admission are related with a higher probability of cardiac events during the next three months in patients with chest pain and no ST segment elevation: age 72 years or older, insulin-dependent 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.

### Clinical history

Symptom assessment is essential in patients with chest pain. The Geleijnse score was used to evaluate chest pain characteristics in this study.<sup>15,18</sup> A pain score of  $\geq 11$  points was associated with mortality, although with borderline statistical significance. Among the coronary risk factors studied, insulin-dependent diabetes mellitus, age 72 years or older and a history of ischemic heart disease were associated with the development of cardiac events. Insulin-dependent diabetes was the most potent predictor, in keeping with extensive evidence indicating a poorer prognosis for acute coronary syndrome in patients with diabetes.<sup>20</sup>

### Electrocardiography

Approximately 50% of the patients with acute coronary syndrome and negative ST segment elevation showed no significant ECG alterations.<sup>21</sup> The finding most indicative of a poor prognosis was ST segment depression.<sup>7,21-24</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 studies,<sup>22-24</sup> T wave inversion had no prognostic value.

### Troponin

Numerous studies have demonstrated the prognostic usefulness of troponin elevation in patients with chest pain.<sup>6-11</sup> Likewise in our series, troponin I was an independent predictor of any major cardiac event. Nevertheless, the importance of troponin I 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 guarantee that a patient can be safely discharged from the emergency room.<sup>25</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.

### Combined assessment of clinical history, electrocardiography and troponins

A risk score was calculated according to five independent predictors of major events recorded as part of the emergency room assessment: age 72 years or older, insulin-dependent diabetes mellitus, history of ischemic heart disease, ST segment depression and elevated troponin I. Age was introduced as a dichotomous variable ( $\geq 72$  years according to the ROC curve) to simplify the model. As scores increased it was possible to stratify the population into progressively higher levels of risk with significant differences between strata. A score of  $\leq 2$  points identified the low-risk group (events in 1.6% of the patients at 3 months), 3 to 7 points identified moderate to high-risk patients (events in 8.1%-11.9%) and a score of  $\geq 8$  points indicated very high risk (events in 26.2%).

In the Thrombolysis in Myocardial Infarction (TIMI)<sup>26</sup> and the Proyecto de Estudio del Prognostico de la Angina (Angina Prognosis Study Project, PEPA)<sup>27</sup> multicenter studies, populations were also stratified according to risk scores. The TIMI study included patients with unstable angina or infarction and no ST elevation. The endpoint was a

composite variable: recurrent angina, infarction, or death at 14 days. The inclusion criterion for the PEPA study was chest pain of possible coronary origin and the endpoint was mortality at three months. The design of the present study more closely resembles the PEPA than the TIMI design. The inclusion criterion of the PEPA study was similar (chest pain of possible coronary origin), although the patients in the present study may have been a lower risk population since the pain did not have to be strongly suggestive of a coronary origin for inclusion. Other differences should also be mentioned: *a)* the present study was performed at a single center, thus, the clinical criteria of pain for inclusion were probably more homogeneous; *b)* the protocol at the chest pain unit included early exercise testing; *c)* transitory ST segment elevation was excluded; *d)* troponins were used as a marker of necrosis, and *e)* the endpoint was death or infarction at three months.

### Value of early exercise testing

Early exercise testing was the final step in the protocol for risk stratification. Several studies have demonstrated the prognostic value of exercise testing in low-risk patients with chest pain.<sup>12-17</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.

### CONCLUSIONS

The results of this study 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 72 years or older, insulin-dependent diabetes mellitus, a history of ischemic heart disease, ST segment depression and troponin elevation were markers of a poor prognosis. The combination 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

The risk score system developed in this study is applicable to patients similar to the study population,

that is, patients who have been examined according to a chest pain unit protocol that includes early exercise testing and a basically conservative approach to the indications for invasive studies. 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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