BRIEF REPORT

In-Hospital Prognosis in Non-ST-Segment Elevation Acute Coronary Syndrome Derived Using a New Risk Score Based on Electrocardiographic Parameters Obtained at Admission

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Several electrocardiographic variables are of prognostic value in non-ST-segment elevation acute coronary syndrome (NSTEACS). From observations in 427 patients, we developed a new risk score (the ECG-RS) based on admission ECG findings that can be used to determine the likelihood of death or recurrent ischemia during hospitalization, which occurred in 36% of patients. Logistic regression analysis, which considered seven electrocardiographic variables and variables from the Thrombolysis in Myocardial Infarction (TIMI) risk score, identified the following significant predictors: corrected QT interval (QTc) ≥450 ms (odds ratio 4.2, *P*<.001), ST-segment depression >0.5 mm (odds ratio 2.7, *P*<.001), and left atrial enlargement (odds ratio 1.8, *P*=.005). After taking the odds ratios into consideration, we awarded 3 points for a QTc ≥450 ms, 2 points for ST-segment depression >0.5 mm, and 1 point for left atrial enlargement. When patients were divided into three groups on the basis of their ECG-RSs (i.e. ≤1, 2–3 and ≥4), the risk of death or recurrent ischemia was significantly different between the groups, at 11%, 27% and 58%, respectively (*P*<.001). In conclusion, the new ECG-RS provides a simple, rapid and accurate means of determining prognosis in patients with NSTEACS.

Key words: *Acute coronary syndrome. Electrocardiogram. Prognosis.*

Pronóstico hospitalario del síndrome coronario agudo sin elevación del segmento ST determinado por una nueva escala de riesgo integrada por variables electrocardiográficas obtenidas al ingreso

Diferentes variables electrocardiográficas tienen capacidad predictiva en el síndrome coronario agudo sin elevación del ST (SCASEST). Tras analizar a 427 pacientes, construimos una escala de riesgo (ER) basada en el ECG al ingreso (ER-ECG) para definir la probabilidad de muerte o isquemia recurrente (M-IsqR) durante la hospitalización, que fue del 36%. En un análisis de regresión logística que incluyó siete variables electrocardiográficas y las de la ER TIMI, alcanzaron la significación estadística: QTc ≥ 450 ms (*odds ratio* [OR] = 4,2; p < 0,001); descenso del ST > 0,5 (OR = 2,7; p < 0,001) y crecimiento auricular izquierdo (OR = 1,8; p = 0,005). En función de la OR, se otorgó 3 puntos a QTc ≥ 450 ms, 2 a descenso del ST > 0,5 mm y 1 a crecimiento auricular izquierdo. Agrupando a los pacientes según la ER-ECG en: ≤ 1, 2-3, ≥ 4, ésta discriminó adecuadamente la probabilidad de M-IsqR: el 11 frente al 27 frente al 58% (p < 0,001). Por lo tanto, esta ER-ECG permite estratificar el pronóstico del SCASEST de una forma simple, rápida y precisa.

Palabras clave: *Síndrome coronario agudo. Electrocardiograma. Pronóstico.*

IINTRODUCTION

Patients attended for non-ST segment elevation acute coronary syndrome (NSTEACS) constitute a wide-ranging clinical population. If prognostic stratification of these patients were rapid (ideally on admission) and simple, efficacy and efficiency would improve because we could easily identify higher-risk patients who might benefit from more costly, more aggressive medical and interventional therapies. To this extent, several risk scores (RS) for NSTEACS have been described.[1,2] However, most of these are limited in that some of the variables on which they are based are not obtained immediately "at the patient's bedside" because they are either analytical or data-based variables that are not always obvious from the patient's clinical record.

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In contrast, the electrocardiogram (ECG), given its universal availability, low cost and simplicity, is an essential tool in the diagnosis and prognostic stratification of NSTEACS. In this clinical context, ECG variables like ST-segment depression,[3] QRS complex length[4]or corrected QT interval (QTc) have been investigated.[5-7]

The objective of the present study is to describe prospectively, in a non-selected population of patients in sinus rhythm attended for NSTEACS, a new RS that is based exclusively on ECG variables obtained on admission.

METHODS

Study Population

We included all patients with a definitive diagnosis of NSTEACS (typical chest pain, dynamic ST-segment changes and/or myocardial damage marker elevation) with the last episode of chest pain in the previous 24 h. We considered myocardial damage markers were elevated when the maximum serum value surpassed our laboratory's upper limit for normal (troponin I, ≥0.1 μg/L; MB fraction of creatine kinase [CK-MB] mass, ≥5 μg/L). We excluded patients with atrial fibrillation, receiving group Ia or III antiarrhythmic drugs, or with hypopotassemia, as these impede or interfere with QTc interval measurement. Diagnosis and treatment were conducted in line with European Cardiology Society Clinical Practice Guidelines.

Electrocardiographic Analysis

We analyzed the first ECG performed following patient arrival at our center. We analyzed the following variables: heart rate ≥85 beats/min, left atrial enlargement (LAE),[8] defined by a ≥1 m negative terminal deflection in V1 of the P wave, 2 or more pathologic Q waves in concordant leads, QRS complex length ≥100 ms,[4] left ventricular enlargement (Sokolov index >35 mm), Bazett's QTc interval ≥450 ms,[5] >0.5 mmST-segment depression,[3] and presence of two or more concordant leads with ≥2 mm negative T wave.

Objective

To construct an RS based exclusively on electrocardiographic variables (ECG-RS) with predictive power for the outcome of death or recurrent ischemia (D-RIsch) during hospitalization. We defined recurrent ischemia as the reappearance of anginal chest pain together with any of the following: ST-segment elevation in at least two concordant leads, >0.5 mm ST-segment depression and ≥20% increase in serum troponin I concentration.

Statistical Analysis

Statistical analysis was with SPSS 11.5 for Windows (SPSS Inc., Chicago, Illinois, USA). Continuous variables with a normal distribution are described as mean and SD; categorical variables are expressed as absolute number and percentage. Comparison of categorical variables was with χ^2. Multivariate analysis was with logistic regression. We considered $P<.05$ statistically significant.

RESULTS

From January 2002 to December 2004, 523 consecutive patients were attended for NSTEACS in our center. We excluded patients with atrial fibrillation (n=69), receiving group Ia or III antiarrhythmic drugs (n=16), or with hypopotassemia on admission (n=11). Demographic characteristics of the remaining 427 patients are in Table 1.

Incidence of D-RIsch was 155 patients (36%), of whom 25 (5.9%) died. Recurrent ischemia took the form of recurrent angina in 88 patients (59%) and reinfarction in 60 (41%).

Electrocardiographic Variables With Independent Prognostic Value

We conducted logistic regression analysis for D-RIsch during hospitalization. This included the ECG variables under study, those in the TIMI RS,[1] gender and Killip class. As Table 2 indicates, only three ECG variables showed independent prognostic power: >0.5 mm ST-segment depression, ≥450 ms

TABLE 1. **Characteristics of the Study Population**

Variable	Value
Age, mean (SD), y	70 (10)
Men	289 (68)
Diabetes mellitus	117 (27)
High blood pressure	260 (61)
History of infarction	139 (32)
Heart rate on admission, mean (SD), beats/min	87 (22)
ST-segment depression >0.5 m	172 (40)
Elevated myocardial damage markers	307 (72)
Killip class >1	73 (17)
Coronary angiography during hospitalization	241 (56)
Coronary revascularization during hospitalization	149 (35)
TIMI RS score	3 [2]
Follow-up, d	5 [3]

RS indicates risk score.
The figures express n (%), mean (SD) or median [interquartile range].

TABLE 2. **Multivariate Analysis (Logistic Regression) of Predictors of Death or Recurrent Ischemia During Hospitalization**

	D-RIsch, %[a]	Adjusted OR (95% CI)	*P*
Age ≥65 years	38/31	1.2 (0.7-2)	.5
Men	38/33	0.7 (0.4-1.2)	.1
History of coronary artery disease	60/32[b]	3 (1.4-6.4)	.004
≥2 anginas in previous 24 h	42/34	1.6 (0.9-2.6)	.07
Elevated markers	41/24[b]	1.01 (0.5-1.8)	0.9
≥3 cardiovascular risk factors	44/35	1.06 (0.5-2)	.8
Aspirin treatment in previous week	41/32	0.8 (0.5-1.3)	.3
Killip class >1	76/28[b]	4.1 (2-8.2)	<.001
Heart rate ≥90 beats/min	38/34	1.4 (0.8-1.4)	.2
LAE	50/28[b]	1.8 (1.2-3)	.01
≥2 Q waves	38/36	0.5 (0.3-1.7)	.7
ST-segment depression >0.5 mm	54/24[b]	2.5 (1.3-3.5)	<.001
QRS length ≥100 ms	50/30[b]	0.9 (0.5-1.6)	.8
Left ventricular enlargement (Sokolov)	40/34	1.2 (0.6-3.3)	.8
≥2 negative T waves	33/38	0.9 (0.6-1.5)	.8
QTc ≥450 ms	49/16[b]	3.8 (2.5-6.5)	<.001

CI indicates confidence interval; QTc, corrected QT interval; D-RIsch, death or recurrent ischemia; LAE, left atrial enlargement; OR, odds ratio.
[a]Frequency of death or recurrent ischemia: variable present/variable absent.
[b]*P*<.05 in univariate analysis.

QTc, and LAE. These variables constituted the ECG-RS and, as a function of the odds ratio (OR), ≥ 450 ms QTc scored 3 points, >0.5 mm ST scored 2, and presence of LAE scored 1.

Prognostic Value of the Risk Score Based Exclusively on Electrocardiographic Variables

Incidence of D-RIsch showed a linear increase with respect to ECG-RS score. (Figure 1). The validity of our model was endorsed by using the Hosmer-Lemeshow test (c statistic =2.9; *P*=.3). The area beneath the ROC curve was 0.75 (0.70-0.78), which enabled us to judge that the ECG-RS discriminates adequately between patients at different levels of risk. The area beneath the ROC curve for in-hospital death was 0.78 (0.71-0.84).

After classifying patients in three groups according to their ECG-RS scores (≤1, 2-3, ≥4), we found stratification for risk of death (0% vs 2.8% vs 11.4%; *P*<.001) and risk of D-RIsch (11% vs 27% vs 58%; *P*<.001) was satisfactory. This level of prognostic capability was demonstrated both in unstable angina and non-Q wave infarction (Figure 2). The indices of statistical validity for D-RIsch of the ECG-RS cutoff points are described in Table 3.

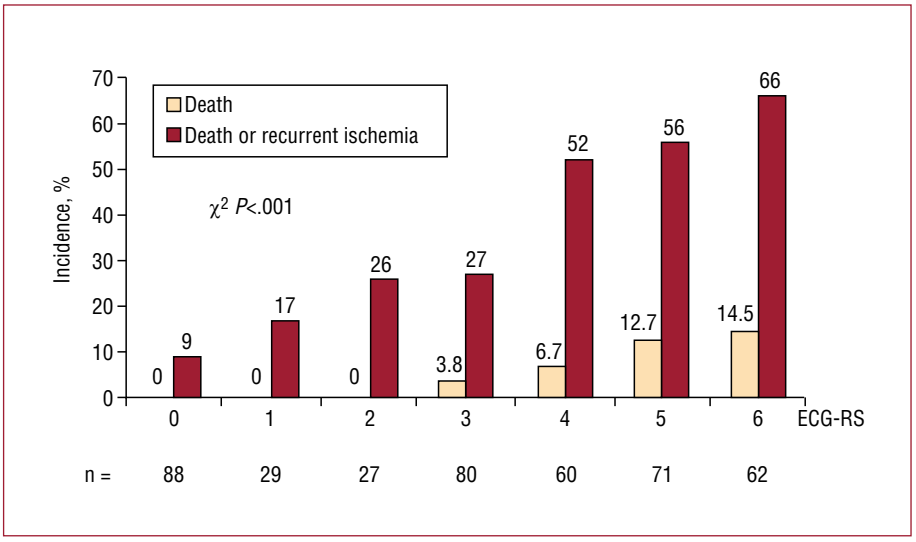

Figure 1. Incidence of death and death or recurrent ischemia according to the ECG-RS.

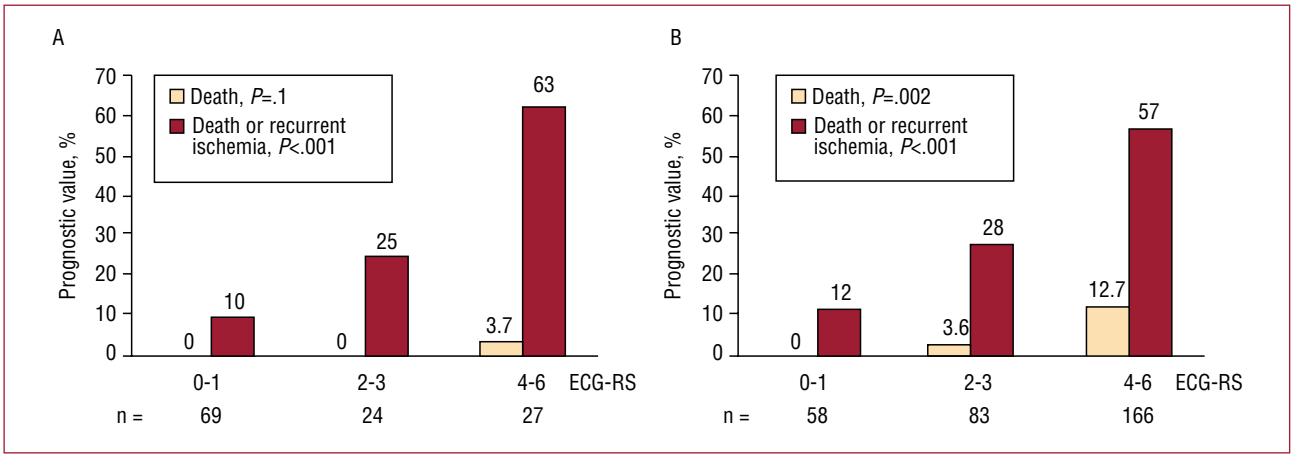

Figure 2. Prognostic value of the electrocardiographic variable-based risk score in unstable angina (A) and non-Q wave myocardial infarction (B) ECG-RS.

TABLA 3. **Validity Indices for Cutoff Points Defined on the ECG-Based Risk Score Calculated on Admission for the Combined Event of Death or Recurrent Ischemia**

	Sensitivity, %	Specificity, %	PPV, %	NPV, %
All patients				
0-1	9	59	11	53
2-3	19	71	27	61
4-6	72	70	58	82
Non-Q wave AMI				
0-1	6	72	12	53
2-3	18	67	28	55
4-6	76	61	57	79
Unstable angina				
0-1	23	31	10	55
2-3	20	80	25	75
4-6	57	89	63	86

NPV indicates negative predictive value; PPV, positive predictive value.

Figure 3 shows the relation between ECG-RS and coronary anatomy, which was less favorable for ECG-RS ≥4. Coronary revascularization was associated with lower mortality in patients with ECG-RS ≥4: 3.5% versus 18% (non-adjusted *P*=.002), but not with ECG-RS <4: 0% versus 1.8% (non-adjusted *P*=.2).

DISCUSSION

Our data indicate that an RS derived from the ECG performed on admission facilitates the creation of a classification system that precisely predicts short-term risk of death and ischemic events in NSTEACS. This new ECG-RS includes only ECG variables that in previous studies have shown prognostic capability and that in our series maintain

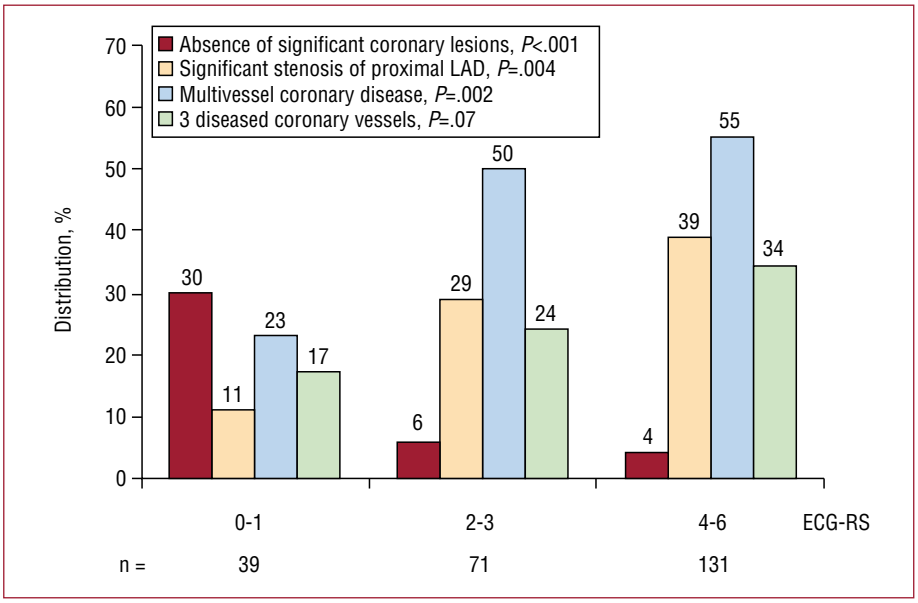

Figure 3. Relation between electrocardiographic variable-based risk score and coronary anatomy. ECG-RS indicates rish score based on electrocardiographyc variables obtained on admission; LAD, left anterior descending artery.

predictive power independently of the TIMI RS variables. We chose the TIMI RS as the benchmark in multivariate analysis because it is widely used and simple, and has a prognostic capability similar to other RSs.[9]

This new ECG-RS is obtained immediately, without the delay inherent in obtaining analytical results. It is simple to apply, based on quantifiable (and therefore objective) variables, and universally available. Hence, it could be used for the rapid risk stratification of suspected coronary origin chest pain and in decision-making on therapy, beyond simple ST-segment analysis.[10]

However, despite the fact that our data are a faithful reflection of daily clinical practice, given that the size of our study population is relatively small and that revascularization frequency was low (in our opinion, these are the principle limitations of this work), further research will be needed, based on broader-ranging cohorts, particularly in centers where invasive management is more frequent, to confirm our results and the practical implications derived from them.

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