SURGERY

Does the EuroSCORE Identify Patients at Minimum Risk of Mortality From Heart Surgery?

Miguel Álvarez,[a] Manuel Colmenero,[b] Pilar Martín,[a] Isabel Prades,[a] Eduardo Moreno,[a] Mercedes González-Molina,[a] Teodoro Moreno,[c] and José Azpitarte[a]

[a]Servicio de Cardiología, Hospital Universitario Virgen de las Nieves, Granada.
[b]Servicio de Cuidados Críticos y Urgencias, Hospital Universitario Virgen de las Nieves, Granada.
[c]Servicio de Cirugía Cardiovascular, Hospital Universitario Virgen de las Nieves, Granada, Spain.

Introduction and objectives. Risk of hospital death is one of the key factors considered by the clinical cardiologist when weighting indications for surgery. Risk estimation scales establish distinct levels of risk in quantitative terms. The aim of the present study was to investigate whether a low EuroSCORE value corresponds to low mortality in our setting.

Patients and methods. During 1999-2000 we prospectively calculated the EuroSCORE for all patients who underwent isolated coronary (CS) or valvular (VS) surgery. We then analyzed intrahospital mortality of patients with a low EuroSCORE. The validation group consisted of patients who underwent surgery in 2001 and obtained a low EuroSCORE.

Results. During 1999-2000 we identified 116 patients (16.2% of all patients treated with isolated CS or CV) with a low EuroSCORE (50 ± 8.6 years; 65% male). Fifty-seven of these patients underwent isolated CS, and 59 of them isolated VS. Intrahospital mortality was zero. In 2001 we identified 59 (16.1%) such patients (49 ± 8.7 years; 68% male), of whom 35 underwent isolated CS and 24 underwent isolated VS. Intrahospital mortality during this period was again zero.

Conclusions. A low EuroSCORE identifies a population of patients with minimum risk of mortality after isolated coronary or valve surgery. The score may be useful as a sentinel indicator in analyses of the complex issue of quality of cardiac surgery.

Key words: *Surgery. Mortality. Prognosis.*

Full English text available at: www.revespcardiol.org

¿Se puede identificar mediante el EuroSCORE a los pacientes con mortalidad mínima en cirugía cardíaca?

Introducción y objetivos. El nivel de riesgo de muerte hospitalaria ha sido uno de los factores clave que el cardiólogo clínico ha sopesado a la hora de establecer una indicación quirúrgica. Las escalas de estimación de riesgo evalúan cuantitativamente el riesgo, estableciendo niveles muy diferentes. El objetivo de nuestro estudio es investigar si, en nuestro medio, un valor mínimo del EuroSCORE se corresponde, en efecto, con una mínima mortalidad.

Pacientes y métodos. Durante 1999 y 2000 cuantificamos prospectivamente el EuroSCORE de todos los pacientes con cirugía de revascularización coronaria y valvular aisladas. Analizamos la mortalidad intrahospitalaria en aquellos con un valor mínimo del EuroSCORE. Los pacientes intervenidos en el año 2001 que obtuvieron un valor mínimo del EuroSCORE constituyeron el grupo de validación.

Resultados. Durante 1999-2000 identificamos a 116 (16,2% del total de la cirugía de revascularización coronaria y cirugía valvular aisladas) pacientes (50 ± 8,6 años; un 65%, varones) con un valor mínimo del Euro-SCORE. Se realizó cirugía coronaria en 57 pacientes y cirugía valvular en 59. La mortalidad intrahospitalaria fue nula. En el año 2001 identificamos a 59 (16,1% del total) pacientes (un 68%, varones; 49 ± 8,7 años). De ellos, 35 fueron sometidos a cirugía coronaria y 24 a cirugía valvular. La mortalidad en este período también fue nula.

Conclusiones. Un valor mínimo del EuroSCORE identifica a una población de pacientes cuyo riesgo de fallecimiento, tras una cirugía coronaria o valvular aisladas, es mínimo. Este valor podría ser utilizado como indicador centinela en el complejo tema de la calidad en la cirugía cardíaca.

Palabras clave: *Cirugía. Mortalidad. Pronóstico.*

INTRODUCTION

Risk of operative mortality is one of the factors considered by the clinical cardiologist when weighing the indication for surgery of a specific patient. Traditionally, the magnitude of this risk has been estimated in an intuitive, and therefore imprecise,

---

ABBREVIATIONS

CABG: coronary artery bypass graft.
VS: valve replacement or repair surgery.
AMI: acute myocardial infarction.
HT: hypertension.

---

manner. In recent years, the application of multivariate analysis in large surgical series has made it possible to obtain independent mortality predictors and use them to create scales for preoperative estimation of the risk of heart surgery.[1-3]

The use of these scales provides the surgeon with greater latitude when deciding whether surgery is indicated, as it allows the risk related to the natural history of the disorder to be weighed against the risk of surgery.

Furthermore, risk assessment scales are becoming basic instruments for measuring the quality of surgical activity. The scales can be used to estimate any deviation between actual and theoretical or expected mortality, based on the risk of the population studied. The degree and type of deviation can then be used to compare surgery in various countries[4] or departments, or within the same department over different periods.[2] Comparison is even possible between different members of the same department.[5]

The EuroSCORE is one of the scales most widely used in Europe.[6,7] It is calculated by adding the points assigned to several variables. A minimum value indicates the absence of risk variables, and therefore should correspond to minimum mortality.

The purposes of our study were: *a)* to determine the prevalence of patients at minimum risk among the population undergoing surgery in a general hospital such as ours, and *b)* to investigate the actual mortality rate in this population in order to determine whether minimum preoperative risk does indeed correspond to minimum mortality.

PATIENTS AND METHODS

Patients

A total of 1288 cardiac surgical procedures were performed in our hospital between 1 January 1999 and 31 December 2001 in patients ≥18 years of age. We only analyzed patients undergoing isolated on- or off-pump coronary artery bypass grafting (CABG) or valve replacement or repair surgery (VS), which accounted for 83.8% of all heart operations performed at our hospital.

During the study period (1999-2000), 836 operations were performed (39.1% CABG; 46.3% VS). The study group included of all patients with a minimum EuroSCORE.

A total of 452 operations were performed in 2001; 147 (32.5%) were CABG and 219 (55.6%) were VS. The validation group included surgical patients with a minimum EuroSCORE.

Risk scoring system and mortality

The EuroSCORE (Appendix 1) was prospectively calculated at the time of admission when the patient had been referred for surgical treatment by his or her cardiologist in the usual manner; i.e., without applying any of the risk scales.

The minimum score indicates that there are no risk variables, except those pertaining to gender and the type of surgery (Appendix 1). Therefore, patients at minimum risk were defined as men undergoing CABG (EuroSCORE 0), women undergoing CABG (EuroSCORE 1), men undergoing VS (EuroSCORE 2) and women undergoing VS (EuroSCORE 3).

In all patients, we analyzed the total in-hospital mortality, defined as death occurring before hospital discharge.

Statistical analysis

The data are expressed as the mean±standard deviation (SD). The discrete variables are expressed as a percentage. Qualitative variables were analyzed by the χ^2 test and the Fisher exact test. For the analysis of quantitative variables, we used the Student's *t*-test. Significance was set at a $P<.05$.

RESULTS

Study period (1999-2000)

A total of 714 isolated CABG and VS were performed during this period; 55% (n=180) of the CABG were done off-pump. During this period we identified 116 patients (16.2%) with a minimum EuroSCORE. The patients' baseline characteristics are shown in Table 1. CABG was performed in 57 patients (17.4% of all CABG) and one valvular surgery was performed in 59 (15.2% of all VS); 70% (n=40) of the CABG were performed off-pump.

By definition (minimum EuroSCORE), the patients did not present any of the EuroSCORE risk factors. However, an occasional risk factor was observed in other risk assessment scales (modified Parsonnet).

Thus, 11.4% of patients had diabetes mellitus, 32% a history of hypertension, 9.7% congestive heart failure and 1.1% (2 patients) had creatinine values of 1.5-2 mg/dL. A total of 14 patients (12%) had suffered an acute myocardial infarction (AMI) at least 90 days earlier (not one of the risk criteria defined in the

table 1. **Patient characteristics. Comparison between the two study groups**

	1999-2000 n (%)	2001 n (%)	P	Total n (%)
Isolated CABG and VS	714	366		1080
N (minimum EuroSCORE)	116 (16.2)	59 (16.1)	.95	175 (16.2)
Age	50±8.6	49±8.7	.33	50±8.6
Sex			.68	
Men	75 (65)	40 (68)		115 (66)
Women	41 (35)	19 (32)		60 (34)
Other risk factors				
History of AMI	14 (12)	7 (11.8)	.96	21 (12)
Diabetes	12 (10.3)	8 (13.6)	.57	20 (11.4)
Hypertension	41 (35)	15 (25)	.18	56 (32)
Creatinine >1.5 µmol/L	2 (1.7)	0 (0)	.43	2 (1.1)
CHF	9 (7.7)	8 (13.5)	.21	17 (9.7)
Coronary disease (n=81)				
1-2 vessels	22 (38.6)	10 (41.6)	.8	32 (39.5)
3 vessels	26 (45.6)	11 (45.9)	.9	37 (45.7)
LCA	9 (15.8)	3 (12.5)	.49	12 (14.8)
Parsonnet score	4.5±4	4.9±4.1	.55	4.6±4
Euroscore	1.4±1.3	1.5±1.2	.60	1.4±1.3
Type of surgery			.28	
CABG	57 (49)	24 (40.7)		81 (46.3)
VS	59 (51)	35 (59.3)		94 (53.7)
Coronary surgery				
Off-pump CABG	40 (70)	15 (62.5)	.67	55 (68)
No. of grafts	3.1±1.3	2.8±1.2	.45	3±1.2
No. of arterial grafts	2±1.1	2.2±1.2	.41	2±1.1
Valvular surgery				
Mitral	21 (36.8)	16 (45.7)	.33	37 (39.3)
Aortic	27 (45.7)	15 (42.8)	.78	42 (44.7)
Mitral-aortic	11 (18.6)	5 (14.3)	.58	16 (17)

CABG indicates coronary artery bypass grafting; off-pump CABG, off-pump coronary artery bypass grafting; VS, valvular surgery; HT, hypertension; AMI, acute myocardial infarction; CHF, congestive heart failure; LCA, left coronary artery.

EuroSCORE); 5 of these were anterior and 9 were inferior.

Validation period (2001)

A total of 366 isolated CABG and VS were performed during this period: 57% (n=84) of the CABG were off-pump. Among these, 59 patients (16.1%) had a minimum EuroSCORE. CABG was performed in 24 (16.3% of all CABG), and an isolated VS procedure was performed in 35 (16% of all VS) (Table 1); off-pump CABG accounted for 62.5% (n=15).

Diabetes mellitus was present in 13.5% of patients, 25% had a history of hypertension, and 13.5% had a history of congestive heart failure. No patient had creatinine values in the range of 1.5-2 mg/dL. Seven patients (11.8%) had a history of AMI, five were inferior and two in another location.

Total group

CABG was performed in 81 patients (46.3%) and VS in 94 (53.7%). A total of 71 patients (40.6%) had a EuroSCORE of 0; 10 patients (5.7%) had 1; 45 patients (25.7%) had 2 and 49 (28%) had 3.

There were 34 patients with the minimum Parsonnet score: 27 patients with CABG (25 men with 0 and 2 women with 1) and 7 patients with VS (5 men and 1 woman with aortic VS and 1 woman with mitral VS).

We found no statistically significant differences in either the study group (1999-2000) or the validation group (2001) in terms of the type of surgical procedure, age, gender, associated diseases, EuroSCORE or Parsonnet score (Table 1).

Mortality

No patient in the study group or validation group died during the assessment period.

DISCUSSION

In our setting, 16% of patients who underwent cardiac surgery (isolated coronary artery bypass and valvular surgery) had no risk variables except those related to gender or type of surgical procedure. This minimum-risk population of 175 patients collected over 3 years of activity presented no in-hospital mortality.

The hospital mortality of any surgical procedure is an extremely important factor for the clinical cardiologist and is the first obstacle to be overcome in order to achieve the benefits of surgery. Although the indications for coronary artery bypass and valvular surgery are presently well-defined in the clinical guidelines issued by various medical societies,[8,9] there are some situations in which the indication should be individualized. If the cardiologist considers that the mortality associated with a procedure is high in relation to the mortality of the disorder, there will be some hesitation in deciding the indication for surgery, unless the objective is to improve the patient's quality of life, something that is not always accomplished.[10]

As a result, scoring systems to predict the risk of operative mortality have been under development for more than a decade. One of their main uses is to provide a quality control mechanism to compare expected mortality with observed mortality.[7,8] The clinical practice guidelines for coronary artery bypass grafting of the Sociedad Española de Cardiología (Spanish Society of Cardiology) suggest that each medical-surgical team become familiar with one of these risk scoring systems and adapt it to their particular situation when making decisions concerning their patients.[8]

The EuroSCORE is one of the risk scoring systems that is gradually increasing in use, as it is less complex than other systems and originated within Europe (with

the participation of several Spanish hospitals). The EuroSCORE system is also now starting to be evaluated in the U.S. Nevertheless, its diagnostic accuracy has not been definitively ascertained. The area under the curve values (obtained by ROC analysis) were below 0.80 in the original article,[6] although other authors have found higher values.[3] At our hospital, the EuroSCORE is the risk scoring system with the highest diagnostic accuracy for both isolated coronary[11] and valvular[12] surgery, a finding that has been reported by other authors.[13,14]

In order to evaluate the quality of cardiac surgery, we decided to analyze the mortality of minimum-risk patients. Verifying low hospital mortality in this population is only an initial step in the analysis of quality. However, we may logically assume that services which do not achieve this level are unlikely to adequately handle medium- and/or high-risk patients. In this group of very low risk patients, a good outcome appears to be independent of the experience of the surgical teams.[15] Therefore, if our hypothesis is met, the findings could be extrapolated to other hospitals.

The EuroSCORE description contains three risk groups, based on the score obtained:[8] low-risk patients (value ≤2) with a predicted mortality below 1%, patients at moderate risk (mortality around 3%) and a high-risk group (predicted mortality of 10%-11%).

We decided to evaluate patients with a minimum EuroSCORE, since the group of patients with a score ≤2 was not sufficiently homogeneous. It is composed of men undergoing valve surgery with no other risk factors (2 points), women undergoing CABG with no other risk factor (1 point) or with any risk factor adding one point (2 points), and men undergoing CABG with 1 or 2 risk factors of 1 point or with one 2-point risk factor. Additionally, the use of the ≤2 criteria would not allow us to assess mortality in women who underwent valve surgery but had no other risk factors (3 points).

When calculating the minimum EuroSCORE, we included women with no other additional risk factor undergoing both CABG and valvular surgery. This was done because it is believed that even though operative mortality is higher (particularly in CABG surgery,[16] not as much in valvular surgery[17]) this mortality may be influenced by other risk factors that are absent or less frequent in men.[18]

Why minimum mortality? The predicted mortality range in the Euroscore low-risk group was 1.27%-1.29% and the observed mortality was 0.8%.[6] Mortality in patients with no risk factors was analyzed by the authors of the EuroSCORE, resulting in 0.4% in CABG surgery and 1% in valvular surgery. This article does not state whether or not women (risk factor of 1) were included in this patient group.[7] We should not forget that mean values below 1% might signify that some hospitals obtained minimum mortality in low-risk patients. Other authors have reported minimum mortality in patients with a low-risk EuroSCORE.[14,19,20]

Therefore, what measure of quality control could be better than minimum mortality?

What is the percentage of patients with a minimum EuroScore? At our hospital, the percentage of patients who fell in the EuroSCORE low-risk group (≤2) was 25%, lower than that reported by other authors. This is probably because our series included more valvular surgery than CABG and because the EuroSCORE is higher in valvular surgery (this surgery type is automatically assigned 2 points). The percentage of patients with a minimum EuroSCORE was 16%, since we only included patients who underwent isolated CABG or valvular surgery. We cannot compare our data with other Spanish series, since the last national registry for cardiac surgery dates back to 1999[21] and does not include risk scale data. The rest of the series that assess the EuroSCORE divide it into risk intervals, without defining a minimum value. Nevertheless, we could extrapolate that 15%-20% of patients from any cardiac surgery department might have a minimum EuroSCORE value, a number below the percentage of older patients (non-minimum EuroSCORE by definition), a level that is rising.[22]

Limitations

Since the cases were highly selected and collected over a three-year period, the number of patients (n=175) in our series is low. A multicenter study should be carried out to obtain a significantly higher number. The objective of our study was to assess the minimum EuroSCORE in our setting; nevertheless, it would be worthwhile to further evaluate these findings in a multicenter registry.

We did not analyze other types of cardiac surgery. Only one patient with combined valvular and CABG surgery had a minimum EuroSCORE value during the study period. Aortic surgery and the mechanical complications of AMI inherently imply a value above the minimum. Other diseases (pericardial processes, etc.) were infrequent. Surgery for congenital diseases in adults is infrequent and is known to involve low surgical risk. From 1999 to 2001, there was no mortality related to atrial septal defect surgery, the congenital condition most often treated surgically at our hospital (unpublished data).

Clinical implications

Use of the mortality rate in a minimum-risk population — such as the population we identified by using the EuroSCORE — can be a quick, first step in assessing the quality of a particular surgical team. If the mortality in this population differs substantially from the expected value, the surgical team should reflect at length on the outcome and define a strategy to improve it. If, in contrast, the mortality is along the lines of the

APPENDIX 1. **Risk assessment scale. EuroScore**

Factors	Score
Patient-related factors	
Age (per 5 years or part thereof above 60)	1
Female	1
Chronic pulmonary disease	1
Extracardiac arteriopathy	2
Neurological dysfunction disease	2
Previous cardiac surgery	3
Serum creatinine >200 µmol/L	2
Active endocarditis	3
Critical preoperative state	3
Cardiac-related factors	
Unstable angina with iv nitrates	2
LV ejection fraction 30%-50%	1
<30%	3
Recent myocardial infarct (less than 90 days)	2
Pulmonary artery systolic pressure > 60 mm Hg	2
Operation-related factors	
Emergency	2
Operation other than isolated CABG	2
Surgery on thoracic aorta	3
Postinfarct septal rupture	4

expected levels, the initial impression of the team would be favorable. In this case, additional analysis should still be performed to determine mortality in other risk groups.

Furthermore, the awareness that a very low-risk population in which mortality is minimum or zero does exist is clinically useful for avoiding unnecessary deferral of an operation in appropriate cases.

REFERENCES

1. Parsonnet V, Dean D, Bernstein AD. A method of uniform stratification of risk for evaluating the results of surgery in adquired adult heart disease. Circulation 1989;79(Suppl 1):3-12.
2. Díaz de Tuesta I, Rufilanchas JJ, Cortina J, Renes E, Rodríguez E, Molina L, et al. Método de estimación predictivo de riesgo quirúrgico en patología cardíaca de adultos. Rev Esp Cardiol 1995;48:732-40.
3. Pons JMV, Granados A, Espinas JA, Borras JM, Martin I, Moreno V. Assessing open heart surgery mortality in Catalonia (Spain) through a predictive risk model. Eur J Cardiothorac Surg 1997; 11:415-23.
4. Roques F, Nashef SAM, Michel P, Pinna Pintor P, David M, Baudet E, et al. Does EuroSCORE work in individual European countries? Eur J Cardiothorac Surg 2000;18:27-30.
5. Nashef SAM, Carey F, Charman S. The relationship between predicted and actual cardiac surgical mortality: impact of risk grouping and individual surgeons. Eur J Cardiothorac Surg 2001;19: 817-20.
6. Nashef SAM, Roques F, Michel P, Gauducheau E, Lemeshow S, Salamon R, et al. European system for cardiac operative risk evaluation (EuroSCORE). Eur J Cardiothorac Surg 1999;16:9-13.
7. Roques F, Nashef SAM, Michel P, Gauducheau E, de Vincentiis C, Baudet E, et al. Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19030 patients. Eur J Cardiothorac Surg 1999;15:816-23.
8. Alonso JJ, Azpitarte J, Bardají A, Cabadés A, Fernández A, Palencia M, et al. Guías de práctica clínica de la Sociedad Española de Cardiología en cirugía coronaria. Rev Esp Cardiol 2000;53: 241-66.
9. Azpitarte J, Alonso AM, Gallego F, González JM, Paré C, Tello A. Guías de práctica clínica de la Sociedad Española de Cardiología en valvulopatías. Rev Esp Cardiol 2000;53:1209-78.
10. Permanyer C, Brotons C, Ribera A, Alonso J, Cascant P, Moral I. Resultados después de cirugía coronaria: determinantes de calidad de vida relacionada con la salud postoperatoria. Rev Esp Cardiol 2001;54:607-16.
11. Álvarez M, Martín P, Prades I, Calleja M, Lara J, Colmenero M, et al. Evaluación de nuestra tasa de mortalidad en cirugía coronaria mediante análisis ROC [abstract]. Rev Esp Cardiol 2000;53 (Supl 2):42.
12. Prades I, Martín P, Álvarez M, Moreno E, García R, Colmenero M, et al. Validación de los escores de riesgo prequirúrgico en 393 pacientes sometidos a cirugía valvular [abstract]. Rev Esp Cardiol 2001;54(Supl 2):132.
13. Geissler HJ, Hölzl P, Marohl S, Kuhn-Régnier F, Mehlhron U, Südkamp M, et al. Risk stratification in heart surgery: comparison of six score system. Eur J Cardiothorac Surg 2000;17:400-6.
14. Kawachi Y, Nakashima A, Toshima Y, Arinaga K, Kawano H. Risk stratification analysis of operative mortality in heart and thoracic aorta surgery: comparison between Parsonnet and Euro-SCORE additive model. Eur J Cardiothorac Surg 2001;20:961-6.
15. Nallamothu BK, Saint S, Ramsey SD, Hofer TP, Vijan S, Eagle KA. The role of hospital volume in coronary artery bypass grafting: Is more always better? J Am Coll Cardiol 2001;38:1923-30.
16. Hammar N, Sandberg E, Larsen FF, Ivert T. Comparison of early and late mortality in man and women after isolated coronary artery bypass graft surgery in Stockholm, Sweden, 1980 to 1989. J Am Coll Cardiol 1997;29:659-64.
17. Vallejo JL, González JM, Bastida E, Albertos J, González de Diego F, Riesgo MJ, et al. Influencia del sexo en la técnica y resultado de la cirugía valvular. Rev Esp Cardiol 1994;47(Supl 3):68-75.
18. González M. Revascularización miocárdica en el sexo femenino: ¿mayor riesgo quirúrgico o sesgo de referencia? Rev Esp Cardiol 1998;51(Supl 3):30-3.
19. Sergeant P, de Worm E, Meyns B. Single centre domain validation of the EuroSCORE on a consecutive sample of primary and repeat CABG. Eur J Cardiothorac Surg 2001;20:1176-82.
20. López LF, Cortina JM, Pérez E, Mencía MP, Forteza A, Maroto LC, et al. Estimación del riesgo quirúrgico en cirugía cardíaca mediante EuroSCORE [abstract]. Rev Esp Cardiol 2002;55(Supl 2):124.
21. Igual A, Saura A. Cirugía cardiovascular en España en el año 1999. Registro de intervenciones de la Sociedad Española de Cirugía Cardiovascular. Cir Cardiovasc 2001;8:87-96.
22. Rodríguez R, Torrents A, García P, Ribera A, Permanyer G, Moradi M, et al. Cirugía cardíaca en el anciano. Rev Esp Cardiol 2002;55:1159-68.