ELSEVIER

European Journal of Cardio-thoracic Surgery 15 (1999) 816–823

EUROPEAN JOURNAL OF CARDIO-THORACIC SURGERY

Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19030 patients ☆

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Received 22 September 1998; received in revised form 8 March 1999; accepted 11 March 1999

Abstract

Objective: To assess risk factors for mortality in cardiac surgical adult patients as part of a study to develop a European System for Cardiac Operative Risk Evaluation (EuroSCORE). **Methods**: From September to November 1995, information on risk factors and mortality was collected for 19030 consecutive adult patients undergoing cardiac surgery under cardiopulmonary bypass in 128 surgical centres in eight European states. Data were collected for 68 preoperative and 29 operative risk factors proven or believed to influence hospital mortality. The relationship between risk factors and outcome was assessed by univariate and logistic regression analysis. **Results**: Mean age (± standard deviation) was 62.5 ± 10.7 (range 17–94 years) and 28% were female. Mean body mass index was 26.3 ± 3.9. The incidence of common risk factors was as follows: hypertension 43.6%, diabetes 16.7%, extracardiac arteriopathy 2.9%, chronic renal failure 3.5%, chronic pulmonary disease 3.9%, previous cardiac surgery 7.3% and impaired left ventricular function 31.4%. Isolated coronary surgery accounted for 63.6% of all procedures, and 29.8% of patients had valve operations. Overall hospital mortality was 4.8%. Coronary surgery mortality was 3.4% In the absence of any identifiable risk factors, mortality was 0.4% for coronary surgery, 1% for mitral valve surgery, 1.1% for aortic valve surgery and 0% for atrial septal defect repair. The following risk factors were associated with increased mortality: age ($P = 0.001$), female gender ($P = 0.001$), serum creatinine ($P = 0.001$), extracardiac arteriopathy ($P = 0.001$), chronic airway disease ($P = 0.006$), severe neurological dysfunction ($P = 0.001$), previous cardiac surgery ($P = 0.001$), recent myocardial infarction ($P = 0.001$), left ventricular ejection fraction ($P = 0.001$), chronic congestive cardiac failure ($P = 0.001$), pulmonary hypertension ($P = 0.001$), active endocarditis ($P = 0.001$), unstable angina ($P = 0.001$), procedure urgency ($P = 0.001$), critical preoperative condition ($P = 0.001$) ventricular septal rupture ($P = 0.002$), non-coronary surgery ($P = 0.001$), thoracic aortic surgery ($P = 0.001$). **Conclusion**: A number of risk factors contribute to cardiac surgical mortality in Europe. This information can be used to develop a risk stratification system for the prediction of hospital mortality and the assessment of quality of care.

Keywords: Risk factors; EuroSCORE database

1. Introduction

As a result of continually improving surgical strategy and the technology which supports it, cardiac surgery is now possible in an increasingly high-risk population [1]. Crude mortality rates have often been used as an indicator of quality of care, but their value is limited without knowledge of the risk profile of the patients. Little is known about the current risk profile of the European cardiac surgical patients. Some European states have access to procedural cardiac surgical mortality rates but these are usually not related to preoperative risk factors. We embarked on this study with a view to establish the risk profile of adult cardiac surgical patients and determine the procedural mortality in these patients. The large multinational database of this project will then serve to develop the European System for Cardiac Operative Risk Evaluation (EuroSCORE).

2. Methods

2.1. Project setup

A multinational project steering group was set up to include a number of European cardiac surgeons and epide-

☆ Presented at the 12th Annual Meeting of the European Association for Cardio-thoracic Surgery, Brussels, Belgium, September 20–23, 1998.

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1010-7940/99/$ - see front matter
PII: S1010-7940(99)00106-2

Table 1
National patient and centre distribution[a]

Country	Number of centres	Number of patients
Germany	23	4799
France	41	4701
UK	15	3593
Italy	20	2846
Spain	25	2444
Finland	6	1275
Sweden	1	245
Switzerland	1	111
Total	132	20014

[a] Data collection was organized separately for England (11 centres, 2774 patients) and Scotland (four centres, 819 patients).

miologists with an interest in the field of cardiac surgical risk (Euroscore study group: Appendix A). The findings of preliminary studies by members of the group [2,3], and the features of predominantly North American risk models, their refinements and their application [4–14] were considered and analysed. Consequently, 68 preoperative and 29 operative risk factors were selected and defined on the basis of credibility, objectivity, reliability and prevalence. These risk factors and definitions are detailed in Appendices B–H.

2.2. Data collection

A simple data collection form was then designed so that information on these risk factors could be entered easily on one side of A4 size paper. Comprehensive information on data collection requirements and definitions of variables was provided to all participating institutions and summarized on detachable sections on every data collection form. Mortality was defined as death within 30 days of operation or within the same hospital admission (Appendix I). To preserve confidentiality, patient and centre identification was coded. Members of the steering committee acted as national organizers to supervise and coordinate centre recruitment and data collection in participating countries. Recruitment was on a voluntary basis. Data collection was carried out over three months (September–December 1995). All adult patients who underwent cardiac surgery under cardiopulmonary bypass during this period were included in the study.

Table 2
Critical preoperative conditions. These are defined in detail in Appendix E.

Condition	Number of patients	Percentage
Ventricular tachycardia/ fibrillation	216	1.1
IABP	188	1.0
Inotropic support	446	2.3
Cardiac massage	94	0.5
Tracheal intubation	202	1.0
Anuria	144	0.8

2.3. Data entry

Data were gathered and entered onto a computer database at the biostatistical research centre of the University of Bordeaux, France. In order to ensure the highest possible quality of data entry, all data were entered twice independently by two operators and any discrepancies checked and corrected. The database was subjected to 16 out-of-range error checking operations and a further 16 separate operations were used to identify errors of logic. Incomplete forms were identified by the absence of information in any of 10 mandatory fields. Erroneous and incomplete data collection forms thus identified were returned to the participating centres for correction and completion. At the end of this procedure, centres whose data did not reach the preset target of $> 99\%$ for accuracy and completeness of mandatory fields were removed from the study.

2.4. Analysis

The statistical model was multiple logistic regression. The variables entered in the model were selected using bivariate tests, chi square tests for categorical covariates and unpaired *t*-tests or Wilcoxon rank sum tests for continuous covariates. All variables significant at the $P < 0.2$ level were entered into the model provided they were present in at least 2% of the sample. Non-significant variables were eliminated from the model one at a time, beginning with the variable having the highest *P*-value. Stability of the model was checked every time a variable was eliminated. In the case of continuous variables where the relationship with outcome was not linear, such as serum creatinine, we determined cut-off points using the fractional polynomials method. When all statistically non-significant variables had been eliminated from the model, goodness-of-fit testing was used to assess how well the model was calibrated and the area under the receiver operating characteristic (ROC) curve was used to assess how well the model could discriminate between patients who lived and patients who died.

3. Results

In all, 132 centres from 8 European countries participated in the project, giving a total of 20014 patients. National patient and centre distribution is detailed in Table 1. Following the error checking and quality control procedures described above, four centres were eliminated from the study, leaving 19030 patients for analysis.

3.1. Patient characteristics

The mean age of the patients was 62.5 with a standard deviation of 10.7. Age range was 17–94 years, 10% of patients were aged 75 or over and 28% were female. Mean body mass index was 26.3 ± 3.9 with a range of 12

Table 3
Rare preoperative conditions. These are defined in detail in Appendix F.

Condition	Number of patients	Percentage
Immunosuppression	80	0.4
Blood product refusal	46	0.2
Neurological disorder	266	1.4
Neoplasm	106	0.6
AIDS	4	0.02

to 68. and 5% of patients can be classified as morbidly obese with a body mass index of 33 or over. Systolic arterial blood pressure exceeded 140 in 25% of patients and diastolic pressure exceeded 90 in 10%. A history of hypertension was elicited from 44% of patients. Diabetes was present in 17% distributed as follows: 4% on insulin, 8.5% on oral therapy and the rest on diet control.

3.2. Vascular disease

Evidence of extracardiac arteriopathy as defined in Appendix C was present in 11% of patients: 2.9% had already undergone vascular surgery and in 1.3% such surgery was planned for the future. Intermittent claudication affected 5.8% of patients. Carotid disease was present in 4.4% and was bilateral in one third. Abdominal aortic disease was present in 1.3%. There was some overlap between the above categories because of the presence of generalized arteriopathy in some patients.

3.3. Renal and respiratory function

Mean serum creatinine was 103 μmol/l with 5% of patients exceeding 150 μmol/l. A diagnosis of chronic renal insufficiency was established in 3.5% but only 0.5% were on long-term dialysis treatment. Chronic pulmonary disease, defined by the long-term use of bronchodilators and steroids, affected 3.9% of patients.

3.4. General cardiac status

Previous cardiac surgery had been carried out in 7.2% of patients of whom 85% had one previous operation, 10% had two and 5% had three or more. Chronic cardiac insufficiency was present in 13.7% of patients, with 5.8% in NYHA class IV. Atrial fibrillation was present in 9%. Left ventricular (LV) function was normal in 61% of patients with an ejection fraction (EF) of 50% or more, moderate in 32% (EF 30–50%) and poor in 7% (EF $<$ 30%).

Table 4
Procedural mortality overall and in the absence of any risk factors (95% confidence intervals in brackets)

Procedure	Overall mortality	Baseline mortality
Isolated CABG	3.4% [3.03–3.69]	0.4% [0.09–0.92]
AVR	6% [5.27–6.78]	1.1% [0.36–2.56]
MVR	7% [5.94–8.01]	1% [0.21–2.92]
ASD	2.8% [0.57–4.99]	0% [0.00–3.97]

3.5. Cardiac status of coronary patients

In patients undergoing isolated coronary surgery, 15% had a myocardial infarction within the preceding 3 months with a mean interval of 35 days. Rest pain was present in 21% of patients and 12% were unstable to the extent of needing intravenous nitrate therapy. Emergency surgery for catheter laboratory complications accounted for 1% of all procedures. Two thirds of coronary patients had triple vessel disease, a quarter had double vessel disease and only 8% single vessel disease. Left main stem stenosis ($>$ 50%) was present in 22% of patients and very tight ($>$ 90%) in 5.3%.

3.6. Cardiac status of valve patients

In mitral valve surgery, the valve lesion was regurgitation in 58%, stenosis in 26% and both in 16%. Pulmonary artery systolic pressure exceeded 60 mmHg in 16.5% of mitral patients. In aortic valve surgery, the proportions were reversed with stenosis being the predominant lesion (55%) over regurgitation (27%) and mixed lesions (18%). In aortic stenosis the systolic gradient across the valve exceeded 120 mmHg in 8% of patients. Active endocarditis was present in 202 (3.6%) of all valve patients.

3.7. Other variables

Critical preoperative conditions affected 774 (4%) of patients and are summarized in Table 2. Rare conditions which may contribute to risk were identified in 737 patients (3.9%) and are detailed in Table 3.

3.8. Operations

Elective surgery accounted for 74% of procedures, with 21% and 5% being urgent or emergent as defined in Appendix G. Isolated coronary surgery was performed in 65% of patients and 29.4% had valve procedures. Two thirds of coronary patients had three or more distal anastomoses, 25% had two and only 9% had one. Aortic valve surgery accounted for 57% of valve procedures, mitral repair or replacement 29% and double valve procedures 14%. There were 489 (2.6%) operations on the thoracic aorta of which a third involved the aortic root and 18% the aortic arch. Atrial septal defect repair accounted for 236 procedures (1.2%) and there were 136 heart transplants.

3.9. Mortality

Overall cardiac surgical mortality for all procedures was 4.8%. Table 4 illustrates the overall procedural mortality as well as the baseline mortality for patients without any identifiable risk factors whether significant or not.

Table 5
Determinants of operative mortality for adult patients undergoing open heart surgery

Variable	Odds ratio	Standard error	*P* value
Age (continuous)	1.1	0.007	0.001
Female	1.4	0.128	0.001
Serum creatinine > 200	1.9	0.256	0.001
Extracardiac arteriopathy	1.9	0.376	0.001
Pulmonary disease	1.6	0.284	0.006
Neurological dysfunction	2.3	0.584	0.001
Previous cardiac surgery	2.6	0.324	0.001
Recent myocardial infarct	1.6	0.208	0.001
LVEF 30–50%	1.5	0.138	0.001
LVEF < 30%	2.5	0.340	0.001
Chronic congestive heart failure	1.5	0.179	0.001
Systolic pulmonary pressure > 60	2	0.423	0.001
Active endocarditis	2.5	0.678	0.001
Unstable angina	1.5	0.202	0.001
Urgent operation	1.6	0.173	0.001
Emergency operation	2.8	0.440	0.001
Critical preoperative state	2.2	0.319	0.001
Ventricular septal rupture	3.8	1.735	0.002
Non-coronary surgery	1.6	0.170	0.001
Thoracic aortic surgery	3.2	0.650	0.001

3.10. Risk factors analysis

Multivariate analysis identified a number of risk factors to be related to operative mortality. These are detailed in Table 5. The calibration of the model was satisfactory and the discrimination power was very good (area under ROC curve 0.79).

4. Discussion

The changing risk profile in cardiac surgical patients over the past decade means that crude procedural mortality figures are no longer sufficient either for informed consent by patients or for the assessment of the quality of care in institutions. It is sometimes argued that crude mortality may suffice for quality of care measurement as it also reflects the wisdom of careful patient selection. This is fallacious in cardiac surgery because of the risk paradox: it has been shown that it is particularly in high risk patients that the superiority of surgical over medical treatment is most pronounced [15]. It is also argued by some that operative mortality is not the only important outcome measure, that patients who survive cardiac operations may still have high morbidity and a poor long-term outcome [16,17]. Although this argument is undoubtedly true, its impact is much weakened by the fact that both postoperative morbidity and poor late results largely stem from failure to achieve a satisfactory cardiac outcome, itself the primary reason for operative mortality. In other words, low early mortality is likely to be associated with low morbidity and good long-term results. Therefore, relating mortality to risk remains the mainstay of any system that assesses the quality of cardiac surgical care.

There have been many studies of risk-factors in cardiac surgery [2–14]. Most were derived from the North American patient population and may not necessarily apply to European practice. This study was undertaken to produce a reliable and contemporary European risk profile for cardiac surgery. Entry to the study was voluntary. This necessarily means that centres which agreed to participate were self selected. We accept that this inevitably leads to a degree of bias, but the alternative approach of random selection followed by compulsion would have been associated with two larger problems. The first is that of non-compliance leading to incomplete data collection. The second and worse problem is possible scepticism or malevolence towards the project leading to unreliable data, wrong results and erroneous conclusions. We believe that the excellent compliance and high degree of data accuracy that we obtained justifies the voluntary enrolment approach. Accuracy and completeness were further enhanced by three features of the study design: considerable time and effort were invested in the preparation of a brief, user-friendly and unambiguous data collection sheet with detailed explanation at the point of use; data collection was 'short and sweet' in order to avoid loss of momentum and enthusiasm for the project over time; finally, patient and centre confidentiality were guaranteed.

Many risk factors have been associated with cardiac surgical mortality. Some are preoperative patient characteristics, others are related to the type and severity of the cardiac disease itself and a third group are related to the type and extent of the surgical procedure. Although the risk factors selected for evaluation were largely similar to those in other studies, it will be noted that, whenever possible, objective and simple definitions were provided. Previous studies have stumbled in fields which are either naturally complex, poorly defined or both such as unstable angina, extracardiac arteriopathy and pulmonary disease. We provided simplified definitions and clear subclassifications in order to avoid ambiguity and the loss of potentially valuable information.

This large database has for the first time provided a unique opportunity to assess the true risk of cardiac surgery in the absence of any identifiable risk factors. For the purposes of this analysis, baseline mortality figures were calculated in patients in whom no pre-operative risk factors could be identified (including risk factors which were not found to have a significant impact in this study, such as diabetes and hypertension). When all such patients are excluded, it was gratifying to note the extremely low current mortality for cardiac surgery in Europe: nil for atrial septal defect repair, 0.4% for CABG and barely over 1% for single valve repair or replacement. Many of these 'near-zero-risk' patients with coronary disease are currently offered interventional cardiology on the alleged basis of appreciable cardiac surgical mortality. These patients and their physi-

cians may be well advised to reconsider the option of coronary surgery in the light of these results.

Many of the risk factors identified as significant in the multivariate analysis, such as age, sex and left ventricular function have been identified elsewhere [2,4,13,18].The absence of diabetes, hypertension and smoking may surprise some clinicians but this too is supported by other studies [19–21]. Two relatively new risk factors figure prominently in our findings: extracardiac arteriopathy and severe neurological dysfunction. Many cardiac surgeons have learnt from experience that these are important determinants of outcome, and this is supported in recent work [2,22]. We believe that our ability convincingly to demonstrate their impact owes much to the simple and objective definitions provided at the data collection stage. The same applies to our definition of chronic airway disease, a condition judged to be too vague for inclusion by other workers [4].

The EuroSCORE database will be used to construct a risk stratification system for use in all European cardiac surgery. It is also a rich and highly accurate database, reflecting a snapshot of cardiac surgery in the 1990s, and will be subjected to further analysis in order to determine demographic, regional and procedural variations in European cardiac surgery.

Acknowledgements

The authors wish to thank St Jude Medical and Bard for their financial support to the EuroSCORE project. We are grateful to Mrs Helen Rodriquez for administering the data collection and to the European Club of Young Cardiac Surgeons for general support in the implementation of this venture. Finally, we wish to recognize the important efforts of the physicians and other health workers who cooperated and contributed to the data collection in every one of the 132 participating hospitals across Europe, without whom this project would not have been possible.

Appendix A. EuroSCORE study group

E Baudet, J Cortina, M David, A Faichney, F Gabrielle, E Gams, E Gauducheau, A Harjula, MT Jones, P Michel, SAM Nashef, P Pinna Pintor, F Roques, R Salamon, L Thulin, C de Vincentiis.

Appendix B. General patient information

Variable	Definition
Age	in years at last birthday
Sex	
Weight	in kilograms
Height	in centimetres
Haematocrit	last preoperative value
Serum creatinine	last preoperative value in μmol/l
Blood pressure(systolic and diastolic)	last preoperative value in mmHg

Appendix C. Preoperative general risk factors

Variable	Definition
History of hypertension	Patient thinks he or she has a diagnosis of hypertension
Diabetes	subdivided into diet-controlled, oral therapy or insulin
Intermittent claudication[a]	symptom present
Carotid disease(unilateral or bilateral)[a]	defined as occlusion or $>50\%$ stenosis
Previous surgery for vascular disease[a]	of the abdominal aorta, limb arteries or carotids
Future surgery disease[a]	already planned surgery of the abdominal aorta, for vascular limb arteries or carotids
Chronic renal failure	subdivided into with and without dialysis
Chronic pulmonary disease	defined by the long-term use of bronchodilators or steroids

[a] Extracardiac arteriopathy was defined as the presence of one or more of these four risks.

Appendix D. Preoperative cardiac risk factors

Variable	Definition
Past cardiac operation (1, 2 or more)	any previous cardiac surgery requiring opening the pericardium, but excluding surgery during the current hospitalization
Chronic congestive heart failure	chronic or episodic peripheral oedema, pleural effusion or hepatomegaly
Chronic cardiac-related dyspnea at rest	NYHA class 4
Atrial fibrillation	
Ejection fraction	
Echocardiographic shortening fraction	
Left ventricular end-diastolic pressure	in mmHg
Left ventricular aneurysm	whether operated or not
Pacemaker	permanent pacemaker in place at the time of the operation

Appendix E. Critical preoperative situation

Variable	Definition
Ventricular tachycardia or fibrillation	preoperative history of ventricular tachycardia, fibrillation or aborted sudden death
Cardiac massage	preoperative
Intubated	critical preoperative situation needing intubation and ventilation before arrival in the operating room
Intra-aortic balloon pump (IABP)	arrival of patient in the operation room with IABP or cardiac assist device
Intravenous inotropic support	preoperative
Urine output < 10 ml/h	preoperative

Appendix F. Rare general conditions

Variable	Definition
Immunosuppression	long-term immunosuppressive therapy
Neurological dysfunction	neurological disease severely affecting ambulation or day-to-day functioning
Active neoplasm	malignant tumour present at operation
Active AIDS	excluding HIV positive alone
Patient refuses blood products	

Appendix G. Indication for surgery

Variable	Definition
Emergency	operation performed immediately on referral to surgeon or before the beginning of the next working day
Urgent	operation performed at or after the beginning of the next working day but the patient must absolutely be kept in hospital before surgery
Elective	all other operations
Recent myocardial infarction	<3 months before operation, number of days specified
Postinfarction angina	
Angina at rest	
Unstable angina	angina requiring intravenous nitrates until arrival in the operating room
Operation for catheter laboratory complication	unplanned emergency arrival of the patient in the operating room after a catheter laboratory procedure
Left main coronary stenosis	>50%, specify percentage
Number of diseased coronary vessels	of left anterior descending, circumflex and right coronary arteries, >50% stenosis or occlusion, maximum of 3
Mitral regurgitation	for mitral surgery
Mitral stenosis	for mitral surgery
Systolic pulmonary artery pressure>60	for mitral surgery
Aortic regurgitation	for aortic valve surgery
Aortic stenosis	for aortic valve surgery
Aortic gradient >120 mmHg	for aortic valve surgery
Acute active endocarditis	patient still under antibiotic treatment at time of surgery; specify number of weeks of intravenous treatment

Appendix H. Operative information

Variable	Definition
Number of distal coronary anastomoses	
Number of conduits	
Number of mammary arteries	
Number of saphenous conduits	
If no mammary artery used	specify if operative or preoperative decision
Mitral valve surgery	specify commissurotomy, repair, mechanical, bioprosthesis, homograft
Aortic valve surgery	specify commissurotomy, repair, mechanical, bioprosthesis, homograft
Tricuspid valve surgery	specify repair or replacement
Ascending aortic replacement	
Aortic root replacement	including valve replacement and reimplantation of the coronary ostia
Aortic arch replacement	any operation on the thoracic aorta needing deep hypothermic arrest or selective cerebral perfusion
Dissection	any aortic surgery for acute dissection
Heart transplant	
Heart–lung transplant	
Atrial septal defect closure	
Left ventricular aneurysmectomy	
Postinfarction ventricular septal rupture closure	
Pulmonary embolectomy	
Other procedure not fully described	describe in full

Appendix I. Outcome

Variable	Definition
Alive	alive and discharged from hospital <30 days from date operation
Dead	died within 30 days from operation or later than 30 days if still in hospital
Wait	patient still in hospital >30 days from operation: hold record and fill in as alive or dead when appropriate

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Appendix J. Conference discussion

Dr J. Bachet (*Suresnes, France*): I would like to congratulate Dr Roques for this very important work. He coordinated this study and I am sure that it was a very difficult task. This is of most importance because more and more non-medical people are dealing with this type of information and dealing incorrectly with it. A few weeks ago in France a popular so-called 'scientific' paper published a sort of hit parade of hospitals, and especially the cardiac centres, with a methodology which was outrageous. The classification was taking into account only the whole mortality without any group of diseases, without scores of patients, et cetera, et cetera; it was devastating for the public, the hospitals and moreover the patients. So I believe that this kind of study should be sponsored by the national societies and perhaps also by the European Association for Cardio-thoracic Surgery in order to spread it to most centres. I understand indeed that you had 131 centres in your study. I guess that this represents a very small proportion of the European centres. Maybe through the Association we could promote this kind of scoring into most centres in Europe.

Dr F. Grover (*Denver, CO*): I chair the STS National Database Committee and want to congratulate you on your risk modelling, your statistical analysis and your effort. As you know, in the United States we found out the hard way, about 10 years ago, just as the previous discusser mentioned, what happens when other people analyse our data and do not risk stratify the data so that you have a level playing field. You have a problem when governmental and other organizations publish non-risk stratified data. I firmly believe in the importance of any effort that we can all make as an international community to risk stratify, and the importance of taking the risk of the patient into account ahead of time. It is also interesting how close your odds ratios are for the various preoperative risk factors to ours the STS Database.

Dr R. Dion (*Brussels, Belgium*): How did you select the centres and are you planning to include more centres in your study? We would be very keen in Belgium to participate in such a study.

Dr Roques: We chose the centres on a voluntary basis. We announced, in most countries by mailing, that we intended to do this study and lots of centres answered us. But of course yesterday Sam Nashef invited everybody who wants to use this score to go on and use it and to share the study with us. And I do agree with Mr Bachet saying that now national societies or even the European Society should help us in this work.

Dr B. Bridgewater (*Manchester, UK*): Two points first and then a question. We have looked at the predictive ability of some of the North American models to predict mortality following coronary artery surgery in the UK, and we found that the makeup of the population that we operate on is very different in terms of its preoperative characteristics to the USA population, and the North American risk models are not good when you subject them to statistical analysis. The second thing is, even within a small geographically defined region within the UK such as the northwest of England there are very big differences in patient characteristics between the different centres. So my question is, have you started to look in a structured way at the differences in preoperative characteristics across the large geographical area which is Europe and how do you think that might influence the ability of the model to predict mortality accurately in the different areas?

Dr Roques: Well, first of all, we had to analyse whether or not there were

differences between North American results and European results. We have already worked on this subject in France four years ago and the study has been presented to you. Concerning regional particularity, of course we will not produce 10 or 12 or 100 scores all over Europe. We have to decide to use a score that will help every one of us to work, even if it does not take care of regional specificities. That is the reason why we have used an overall score concerning coronary surgery and valve surgery, because we know that in Europe some countries may still perform more valvular surgery than coronary surgery. That is the reason why we chose a global score.

Dr G. Rizzoli (*Padua, Italy*): The prevalence of the disease is changing quite rapidly. For instance, in Italy now, the mitral valve operation, which was more common among the valvular operations, has been superseded by the aortic valve, and the aortic is associated with coronary artery bypass. So I would like to know if you have special rules to take care of confounding from the prevalence of the different diseases when you prepare these studies?

Dr Roques: Well, we have tested every variable, we have tested 100 variables, and we decided to find a score, taking care of the major problems so as to create a global score. We considered any of the operative situations as valve surgery and coronary surgery, but we will not answer in detail to every specific problem. This is not the aim, this is not the purpose of our work. The purpose of the work is not to allow individual operative mortality assessment but rather to analyse quality of care for a centre, a country, in Europe.