Limitations of additive EuroSCORE for measuring risk stratified mortality in combined coronary and valve surgery


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Received 14 November 2003; received in revised form 12 January 2004; accepted 9 February 2004; Available online 19 March 2004

Abstract

Objective: To study the use of the additive and logistic European System for Cardiac Operative Risk Evaluation (EuroSCORE) to predict mortality following adult combined coronary artery bypass grafting (CABG) and valve surgery. Methods: Data were collected prospectively, from all four centres providing adult cardiac surgery in the north west of England, on 1769 consecutive patients undergoing combined CABG and valve surgery between April 1997 and March 2002. Observed in-hospital mortality was compared to predicted mortality as determined by both additive and logistic EuroSCORE. Results: Observed mortality for simultaneous CABG and valve surgery was 8.7%, compared to 6.7% (additive) and 9.4% (logistic). Sixty-five percent of patients were classified as high-risk (additive EuroSCORE $\geq 5$); the observed mortality was 11.5%, compared to 8.1% (additive) and 12.8% (logistic). Discrimination was similar in both systems as measured by the C statistic (additive 0.73, logistic 0.73). Conclusions: The logistic EuroSCORE is more accurate at predicting mortality in simultaneous CABG and valve surgery, as the additive EuroSCORE significantly under-predicts in this high-risk group.

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Keywords: EuroSCORE; Risk stratification; Simultaneous coronary artery bypass grafting; Valve surgery

1. Introduction

Since Victor Parsonnet and colleagues published their risk stratification scoring system in 1989, several other scoring systems have been proposed [1–5]. Over the last 15 years, the relevance of risk stratification to the practice of cardiac surgeons worldwide has increased. The reason for this is essentially 2-fold. The results of individual surgeons as well as institutions are under greater public scrutiny. Also, as results of cardiac surgery have improved and with cardiologists becoming more aggressive with cardiac interventions, the patients being referred for surgical intervention have a greater risk profile than ever before. Hence, risk stratified outcomes are a more valid and appropriate method of evaluating the performance of individual surgeons as well as cardiac surgical centres.

The European System for Cardiac Operative Risk Evaluation (EuroSCORE) was constructed from data analysis of 19,030 patients from 128 centres across the whole of Europe [6]. This data was then validated on a subset of patients from the original study [7]. Over the last 4 years, this additive EuroSCORE has been widely used and validated across different centres in Europe and across the world making it a primary tool for risk stratification in cardiac surgery [8–13].

While the accuracy of the additive EuroSCORE is well established for coronary artery bypass grafting (CABG) and isolated valve procedures, its predictive ability in combined CABG and valve procedures has not been evaluated. The additive EuroSCORE has recently been shown to be inadequate for risk stratification in high-risk EuroSCORE patients (EuroSCORE $> 5$), with the logistic EuroSCORE proving far more effective [14]. We have also recently shown that the additive EuroSCORE is a weak predictor in high-risk cases [13]. This study looks at the accuracy of both the additive and logistic EuroSCORE as a
risk stratification tool in patients undergoing combined procedures.

2. Methods

2.1. Patient population and data

The North West Quality Improvement Programme in Cardiac Interventions is a regional consortium involving all four centres (Blackpool Victoria Hospital, Blackpool; The Cardiothoracic Centre, Liverpool; Manchester Royal Infirmary, Manchester; Wythenshawe Hospital, Manchester) performing adult cardiac surgery and percutaneous coronary interventions in the North-west of England. The aim of the group is to continuously improve the quality of care for patients receiving cardiac interventions using a regionally based systems approach.

Data were prospectively collected on a total of 1769 consecutive patients undergoing simultaneous CABG and valve surgery between 1st April 1997 and 31st March 2002 in the North-west of England. Data collection methods and definitions have been described in detail previously and are available from the quality improvement programmes website [15]. Observed mortality was defined as death within the same hospital admission regardless of cause. All patients transferred from the base hospital to another hospital were followed-up to confirm their status at discharge.

2.2. Statistical analysis

Both the additive and full logistic EuroSCORE were derived for each patient to assess predicted mortality compared to observed mortality. For the additive EuroSCORE, the relevant weights of any present risk factor were added together to provide a predicted percent mortality (Table 1). The logistic EuroSCORE was calculated using the formula available from www.euroscore.org (Table 1). The C statistic (equivalent to the area under the receiver operating characteristic curve) was calculated to assess the performance of the two systems in predicting observed mortality for simultaneous CABG and valve surgery [16]. Cumulative summation (cusum) curves were plotted, with the number of patients along the x-axis and cumulative mortality along the y-axis, with 95% confidence intervals (CI). Performances deviating significantly can be seen by predicted mortality lying either consistently above (better than expected performance) or below (worse than expected performance) the 95% CIs of observed mortality. All statistical analysis was performed retrospectively with SAS for Windows Version 8.2.

3. Results

Of the 1769 patients, there were 154 operative deaths, which equates to 8.7% (95% CI 7.5–10.1). Logistic EuroSCORE prediction for the simultaneous CABG and valve procedures was a mortality of 9.4% (95% CI 8.9–9.9) and did not differ significantly from actual mortality. Additive EuroSCORE predicted a significantly lower mortality of 6.7% (95% CI 6.6–6.8). When analysed by risk bands, it can be clearly seen that this difference is entirely due to under-prediction in high-risk patients; defined as EuroSCORE > 5 (Table 2). The numbers

<table>
<thead>
<tr>
<th>Risk band</th>
<th>Observed mortality (%)</th>
<th>Additive EuroSCORE (mean)</th>
<th>Logistic EuroSCORE (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (0–3) (n = 60; 3.4%)</td>
<td>0 (0–7.5)</td>
<td>2 (2–2)</td>
<td>1.5 (1.5–1.5)</td>
</tr>
<tr>
<td>Medium (3–5) (n = 555; 31.4%)</td>
<td>3.8 (2.4–5.8)</td>
<td>4.3 (4.2–4.3)</td>
<td>3.1 (3–3.2)</td>
</tr>
<tr>
<td>High (&gt;5) (n = 1154; 65.2%)</td>
<td>11.5 (9.8–13.5)</td>
<td>8.1 (8–8.3)</td>
<td>12.8 (12.1–13.4)</td>
</tr>
<tr>
<td>All patients (n = 1769)</td>
<td>8.7 (7.5–10.1)</td>
<td>6.7 (6.6–6.8)</td>
<td>9.4 (8.9–9.9)</td>
</tr>
</tbody>
</table>

EuroSCORE, European system for cardiac operative risk evaluation.
of patients in each risk band were as follows: 60 (3.4%) low-risk, 555 (31.4%) medium-risk, and 1154 (65.2%) high-risk.

The risk stratified cusum curve for simultaneous CABG and valve surgery is shown in Fig. 1, which shows that according to the standard additive EuroSCORE the region is performing significantly worse than expected. However, use of the logistic EuroSCORE indicates performance at an acceptable level.

The C statistic for additive and logistic EuroSCORE were both 0.73 indicating both perform at an acceptable level in discriminating between patients who have died and those who did not.

4. Discussion

Of the 20,855 patients undergoing CABG, valve surgery and combined procedures across the four centres in the North-west of England over a 5-year period between April 1997 and March 2002, 1,769 underwent combined procedures. We have shown that in the patients undergoing combined procedures, the additive EuroSCORE underpredicted the risk significantly compared to the observed mortality (6.7 vs. 8.7%). However, the logistic EuroSCORE proved to be more accurate in this sub-group of patients predicting a mean mortality of 9.4%.

Broadly, there are two possible explanations for this discrepancy. First, as a group, the cardiac surgeons in the North-west of England are under-performing in this particular subset of patients. However, this is unlikely as the overall results of all the surgeons in isolated CABG and isolated valve surgery are both within acceptable limits. Also, the results in this group of patients have been acceptable when using a locally developed and validated modification of the Parsonnet score [15]. Hence, a widespread multi-centre, multi-surgeon problem is unlikely to be the reason for this discrepancy.

Another explanation, which seems more likely, is the inaccuracy of additive EuroSCORE in patients undergoing combined procedures. A recent study by Michel et al. has shown that while the additive EuroSCORE continues to be a simple and accessible ‘gold standard’ of risk assessment, it is inaccurate in high-risk cases and significantly underpredicts the risk [14]. We have shown that the additive EuroSCORE significantly under-predicts the mortality risk in patients undergoing combined procedures and the main discrepancy occurs in those patients having a higher EuroSCORE (>5).

The imminent publication of surgeon-specific crude mortality data in the United Kingdom, strengthens the case for risk stratified surgeon-specific mortality. It is becoming quite clear that the additive EuroSCORE is not a very accurate tool for risk prediction in high-risk patients. As a region, we have recently suggested comparing CABG death rates in low-risk cases, due to concerns with the high-risk patients [13].

Appropriate risk assessment is vital in obtaining informed consent and risk stratification is essential for monitoring the quality of operations performed by surgeons and institutions. Hence, it is very important that the tools used for this should be as accurate as possible. While simplicity of any model is desirable, we feel that this should not be at the cost of accuracy. This is more relevant in modern day practice, where the results of both individual surgeons and institutions are under greater scrutiny by both the public and governing bodies. In addition, the widespread availability of information technology systems makes
the need for simplicity no longer paramount. The logistic EuroSCORE risk calculator is easily available at the website www.euroscore.org and can be easily programmed into appropriate software resident on desktops and hand-held computers.

We believe that in addition to the situations identified by Michel et al. [14], the use of the logistic EuroSCORE as a risk stratification tool should also be extended to the subset of patients undergoing combined CABG and valve surgery. In the United Kingdom, in the financial year ending 2001, a total of 2881 patients underwent combined procedures [17]. This represents approximately 8% of the patients undergoing cardiac surgery. Similarly in our study population, they represent approximately 8.5% of our exclusively adult cardiac practice. This subset of patients forms a significant group, in whom accurate risk stratification is desirable.

It is important to note that all scoring systems have two major limitations. Scoring systems use routinely available data, but high-risk patients carry a variability in risk not explained by these collected variables. Also, these scoring systems observe an interval of risk that is scientifically incorrect and is not the actual risk interval [18]. Certainly in this population several patients will die from the procedure in the interval outside the one studied.

In conclusion, while the additive EuroSCORE is a simple and easily applicable risk assessment tool, we have shown that it is inaccurate in patients undergoing combined valve and CABG procedures. In this subset of patients, the logistic EuroSCORE is a better and more accurate method of risk assessment. As our results are under constant scrutiny, we need robust risk stratification tools in place, even if they cannot be easily calculated by the patient’s bedside. We strongly recommend the routine usage of the logistic EuroSCORE for this subset of patients.

Acknowledgements

We would like to acknowledge the co-operation given to us by all the Consultant Cardiac Surgeons in the region.

Blackpool Victoria Hospital: Mr Au, Mr Bhatnagar, Mr Duncan, Mr Fagan, Mr Millner, Mr Nkere, Mr Sharpe, Mr Sogliani.

The Cardiothoracic Centre-Liverpool: Mr Chalmers, Mr Dihmis, Mr Drakeley, Mr Fabri, Ms Griffiths, Mr Mediratta, Mr Oo, Mr Page, Mr Pullan, Mr Rashid, Mr Weir.

Manchester Royal Infirmary: Mr Grotte, Mr Hasan, Mr Keenan, Mr Odom, Mr Pendergast.

Wythenshawe Hospital: Mr Bridgewater, Mr Campbell, Mr Carey, Mr Deiraniya, Mr Hooper, Mr Jones, Mr O’Keefe, Mr Lawson, Mr Rahman, Mr Waterworth, Mr Yonan.

We would also like to thank for their considerable efforts Stephen Bullough, Suzanne Chaisty, Janet Deane and Catherine Malpas, who maintain the quality and ensure completeness of data collected in our Cardiac Surgery Registry.

References


