Progressively increasing operative risk among patients referred for Coronary Artery Bypass Surgery

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SUMMARY

Objective: Advances in surgical, anaesthetic and percutaneous interventional techniques may have led to higher risk patients being referred for coronary artery bypass graft surgery (CABG). The purpose of this study was to compare the predicted mortality risk (EuroSCORE) of a contemporary cohort of patients referred for isolated elective CABG (2002) with that of a cohort referred five years previously (1997) and to examine temporal trends in patient demographics.

Methods: Records (n=2873) of weekly cardiac surgical referral meetings were examined and the age, sex, type of operation and surgical decision for every patient referred from 1997 to 2002 inclusive were recorded. Furthermore samples of patients referred in 1997 (n=111) and in 2002 (n=110) were chosen, and a complete EuroSCORE was calculated for each patient and compared between groups.

Results: In both 1997 and 2002 the median EuroSCORE among patients not accepted for surgery was significantly higher than those accepted (1997: 3 vs 2, p<0.001. 2002: 5 vs.2, p<0.001). The median EuroSCORE of patients referred in 2002 was significantly higher than those referred in 1997 (3 vs. 2; p< 0.001). There was a progressive increase in median patient age throughout the study period and this accounted for the observed temporal increase in EuroSCORE.

Conclusions: Predicted mortality risk among patients referred for coronary artery bypass surgery is increasing, mainly due to patient age at referral.

INTRODUCTION

Recent advances in surgical and anaesthetic techniques have been associated with reduced mortality rates from cardiac surgery.¹ Improved surgical outcomes, along with major advances in percutaneous coronary intervention² and changes in the demographics of patients undergoing cardiac catheterisation³ are likely to have resulted in higher risk patients being referred for cardiac surgery compared with previously.⁴

There are several risk-predicting methods for patients undergoing cardiac surgery.⁵, ⁶ The EuroSCORE index⁷, ⁸ gives a practical and numerical prediction of early mortality risk following coronary artery bypass graft surgery (CABG). Its reliability has been demonstrated in clinical practice⁹, ¹⁰ and it is used commonly in the pre-operative assessment process.

The aims of this study were to audit the clinical and demographic profile of patients referred for isolated CABG at our institution, to detect any changes in calculated operative risk (EuroSCORE) over time and to identify factors contributing to any change observed.

METHODS

All patients referred for isolated CABG at Belfast City Hospital were identified from the records of a weekly combined cardiology-cardiac surgery meeting at which all referrals for non-emergency cardiac surgery are made. In all, 2873 patients referred between the beginning of 1997 and the end of 2002 were identified and their age, sex, type of surgery and decision regarding acceptance were collected. Patients referred for valvular surgery were excluded, as were those for whom no decision regarding acceptance was made at the time of discussion.

To study changes in risk profile in detail, a sample of patients was chosen from each of 1997 (n=111) and 2002 (n=110). These were the first patients referred in a calendar year for which complete medical records were available and the EuroSCORE was calculated based on identification of relevant patient and cardiac-related factors.⁵, ⁶ There were no operation-related factors as all patients were scheduled to undergo elective isolated CABG.

Statistical analysis

Variables are presented as median and interquartile range. Between-group analysis used the Mann-Whitney rank sum test. A P value of <0.05 was considered statistically significant.

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RESULTS

Activity figures showed a progressive increase in the number of diagnostic coronary angiograms performed annually and a gradual decrease in the percentage referred for elective CABG (Fig 1).

Changes in patient demographics over time

The median age of patients referred for CABG rose progressively between 1997 and 2002 (Table I). Although not reaching statistical significance, the following trends were observed: patients turned down for CABG tended to be older than those accepted in each individual year and patients referred between 2000 and 2002 were more likely to be turned down for CABG.

Changes in EuroSCORE over time

The calculated EuroSCORE of the patients sampled from 2002 was significantly higher than those sampled from 1997 (Table II). In both 1997 and 2002 the EuroSCORE among patients turned down for surgery was significantly higher than in patients accepted. In 2002 the median EuroSCORE of all patients referred was similar to that of patients being turned down for surgery in 1997.

Further analysis of the observed rise in EuroSCORE between 1997 and 2002 revealed that patient age was the dominant component with almost 100 extra EuroSCORE points being awarded for age in 2002 (Table III). In both 1997 and 2002, the largest age group of patients referred for elective CABG was in the 60-69 year bracket (Fig 2). The second largest group in 1997 was 50-59 years while it was 70-79 years in 2002. In 1997 no patient in the age group 80-89 was referred compared with 4% in 2002. The percentage of females referred for CABG remained similar over time (Table I).

DISCUSSION

Results from this audit indicate a progressive, temporal increase in the risk status of patients referred for CABG as assessed by the EuroSCORE. This increased risk is predominantly a reflection of older patient age. The observations may reflect changes in the population undergoing diagnostic cardiac catheterisation, changes in cardiology practice or advances in cardiac surgical and anaesthetic practice.

The EuroSCORE as a risk predictor for CABG mortality

The EuroSCORE was derived from analysis of 19,030 patients undergoing CABG across Europe. It is calculated by additive point scoring based on preoperative patient, cardiac and operation-related factors. Subsequently it has been validated as an accurate predictor of mortality in Europe and North America. Based on the EuroSCORE, patients are designated as low risk (EuroSCORE 0-2, average predicted mortality 0.8%), medium risk (EuroSCORE 3-5, predicted mortality 3%) and high risk (EuroSCORE >6, predicted mortality 11.2%).

When applied to the population in the present study, the average patient referred for elective CABG in 2002 was of medium risk status (median EuroSCORE 3, Table II) compared with low risk status in 1997 (median EuroSCORE 2). The median EuroSCORE of patients accepted for CABG did not change between 1997 and 2002 although the distributions of EuroSCORE values point to a higher risk cohort in 2002. Patients turned down for CABG had substantially higher risk scores compared with those accepted and this disparity increased markedly with time. The data suggest that high-risk patients were more likely to undergo diagnostic cardiac catheterisation and to be referred for elective CABG in 2002 compared with 1997.

Reasons underlying the increase in EuroSCORE over time

The progressive increase in EuroSCORE in the present study is largely due to rising patient age. While populations in the industrialised world are aging, this has not occurred rapidly enough to account for the rise in EuroSCORE we observed. Changes in the epidemiology and treatment of cardiovascular disease may have resulted in patients presenting for the first time later in life. This may be due to advances in primary prevention, secondary prevention or both. Advances in medical therapy and in percutaneous coronary intervention may delay or prevent patients’ referral for surgery. Patients’ and clinicians’ expectations of standard care may also have changed from a conservative to a more invasive view, resulting in increased angiography rates in elderly patients.

As a result, increasingly only those patients who have a survival benefit from surgery or those for whom PCI is technically not feasible are being referred for elective CABG. Furthermore the wider availability of PCI compared with CABG may have resulted in some patients undergoing percutaneous treatment who might otherwise have been referred for CABG.

While elderly patients (>70 years) have a higher mortality rate after cardiac surgery than their younger counterparts, in selected elderly populations, CABG can achieve excellent improvements in quality of life without excessive mortality, even in those over 80 years. Therefore it is recommended that CABG not be denied on the basis of age alone, especially if elective procedures prevent the subsequent need for emergency surgery with higher associated mortality.
## Table 1

**Demographic profile of patients referred for coronary artery bypass surgery between 1997 and 2002**

| Year | All patients referred | Accepted | Rejected | No decision made |
|------|-----------------------|----------|----------|------------------|
| 1997 | 420                   | 298 (70.9) | 39 (9.3) | 83 (19.8) |
|      | Median age (IQR)      | 62 (55-67) | 61 (55-67) | 63 (57-69) | 62 (55-67) |
|      | Number (%)/female     | 74 (17.6) | 49 (16.4) | 11 (28.2) | 14 (16.9) |
| 1998 | 507                   | 368 (72.6) | 46 (9.1) | 93 (18.3) |
|      | Median age (IQR)      | 62 (55-68) | 62 (55-68) | 63 (57-70) | 61 (55-67) |
|      | Number (%)/female     | 97 (19.1) | 62 (16.8) | 8 (17.4) | 27 (29.0) |
| 1999 | 541                   | 374 (69.1) | 59 (10.9) | 108 (20.0) |
|      | Median age (IQR)      | 62 (55-69) | 61 (55-68) | 63 (55-69) | 63.5 (54-69) |
|      | Number (%)/female     | 112 (20.7) | 76 (20.3) | 10 (16.9) | 26 (24.1) |
| 2000 | 468                   | 313 (66.9) | 106 (22.6) | 49 (10.5) |
|      | Median age (IQR)      | 63 (56-69)* | 62 (55-68) | 65 (59-72) | 63 (54-69) |
|      | Number (%)/female     | 93 (19.9) | 50 (15.9) | 31 (29.2) | 12 (24.5) |
| 2001 | 500                   | 323 (64.6) | 101 (20.2) | 76 (15.2) |
|      | Median age (IQR)      | 63 (57-70) † | 63 (57-69) † | 65 (57-71) | 63 (57-69) |
|      | Number (%)/female     | 108 (21.6) | 55 (17.0) | 31 (30.7) | 22 (28.9) |
| 2002 | 437                   | 286 (65.5) | 82 (18.7) | 69 (17.8) |
|      | Median age (IQR)      | 65 (58-71) † | 64 (58-71) † | 66 (59-73)* | 68 (59-73) † |
|      | Number (%)/female     | 89 (20.4) | 55 (19.2) | 21 (25.6) | 13 (18.8) |

*p<0.05 versus 1997, †p<0.001 versus 1997. IQR = interquartile range

## Table II

**EuroSCORE values in 1997 and 2002 cohorts. P value column compares accepted with rejected groups**

|         | All referred | Accepted | Rejected | P     |
|---------|--------------|----------|----------|-------|
| 1997    |              |          |          |       |
| Number (%) | 111           | 80 (72.1) | 31 (27.9) |       |
| EuroSCORE | 2 (1-3)       | 2 (0-3)  | 3 (2.25-4) | <0.001|
| 2002    |              |          |          |       |
| Number (%) | 110           | 81 (73.6) | 29 (26.4) |       |
| EuroSCORE | 3 (2-5)*      | 2 (1-4) † | 5 (4-8)* | <0.001|

Median (interquartile range). *p<0.001 vs. 1997, †p<0.05 vs. 1997.
Table III

Components of the EuroSCORE calculation (reference 5) and analysis of the total number of EuroSCORE points awarded for each of these components in samples of patients referred for isolated CABG in 1997 (n=111 patients) and 2002 (n=110 patients)

| Definition                                                                 | Score | 1997 cohort | 2002 cohort |
|---------------------------------------------------------------------------|-------|-------------|-------------|
| **Patient-related factors**                                              |       |             |             |
| Age Per 5 years or part thereof over 60 years                             | 1     | 118 (44.5%) | 214 (57.2%) |
| Gender Female                                                             | 1     | 23 (8.7%)   | 14 (3.7%)   |
| Chronic pulmonary disease Long term use of bronchodilators or steroids    | 1     | 9 (3.4%)    | 9 (2.4%)    |
| Extra cardiac arteriopathy See belowa                                    | 2     | 14 (3.4%)   | 9 (2.4%)    |
| Neurological dysfunction Disease severely affecting ambulation or day-to-day functioning | 2     |             |             |
| Previous cardiac surgery Previous surgery requiring opening of the pericardium | 3     | 9 (3.4%)    | 3 (1%)      |
| Serum creatinine ≥200µmol/L pre-operatively                              | 2     | 2 (1%)      | 0           |
| Active endocarditis Under antibiotic treatment for endocarditis at time of surgery | 3     |             |             |
| Critical pre-operative state See belowb                                  | 3     |             |             |
| **Cardiac-related factors**                                              |       |             |             |
| Unstable angina Requiring iv nitrates until arrival in the operating room | 2     |             |             |
| LV dysfunction Moderate (EF 30-50%) Poor <30%                             | 1 or 3| 58 (21.9%)  | 56 (15%)    |
| Recent myocardial infarct <90 days                                       | 2     | 32 (12.1%)  | 42 (11.2%)  |
| Pulmonary hypertension Systolic PA pressure >60mmHg                       | 2     |             |             |
| **Operation-related factors**                                            |       |             |             |
| Emergency Carried out on referral before the beginning of the next working day | 2     |             |             |
| Other than isolated CABG Major cardiac operation other than or in addition to CABG | 2     |             |             |
| Surgery on the thoracic aorta Ascending, arch or descending aorta         | 3     |             |             |
| Post infarct septal rupture                                               | 4     |             |             |

a Any of: claudication, carotid occlusion or >50% stenosis, previous or planned surgery on the abdominal aorta, limb arteries or carotids

b Ventilation before arrival in the operating room, pre-operative inotropic support, intra-aortic balloon counterpulsation (IABP) or preoperative acute renal failure (anuria or oliguria <10ml/hr). Several patient- and operation-related factors did not apply to this study of elective CABG.
Among the patients we sampled in 1997 and 2002, no risk-predicting factor other than patient age changed over time (Table III). Specifically there was no increase in the numbers of patients being referred with severe LV dysfunction, renal impairment, chronic lung disease or other co-morbidity. The present study focused on patients referred for isolated CABG (approximately 80% of all referrals), and therefore excluded those being referred for valve surgery and emergency surgery, among whom different patterns of co-morbidity may have been observed.

Implications for health care funding

The increase in EuroSCORE we observed has implications for those involved in health care funding. Although the EuroSCORE is designed to predict mortality rather than morbidity, our observations anticipate an increase in the number of patients who might expect a complicated post-operative course and a prolonged intensive care stay.

CONCLUSION

The risk status of patients referred for CABG in 2002 was substantially higher than in 1997, due entirely to differences in patient age. Reasons for this trend are likely to be multifactorial, including changes in preventive medicine and invasive cardiology practice. It is likely that such trends will continue, with implications for cardiologists, cardiac surgeons, intensive care providers and health care purchasers.

The authors have no conflict of interest.

REFERENCES

1. Goodney PP, Siewers AE, Stukel TA, Lucas FL, Wennberg DE, Birkmeyer JD. Is surgery getting safer? National trends in operative mortality. J Am Coll Surg 2002; 195(2): 219-27.

2. de Feyter PJ, Serruys PW, Unger F, Beyar R, de Valk V, Milo S, et al. Bypass surgery versus stenting for the treatment of multivessel disease in patients with unstable angina compared with stable angina. Circulation 2002; 105(20): 2367-72.

3. Ulrich MR, Brock DM, Ziskind AA. Analysis of trends in coronary artery bypass grafting and percutaneous coronary intervention rates in Washington State from 1987 to 2001. Am J Cardiol 2003; 92(7): 836-9.

4. Pera M, Mestres CA, Pomar JL. [Cardiac surgery in patients over 70. Its incidence and trends in Spain]. Rev Esp Cardiol 1994; 47: 678-81.

5. Asimakopoulos G, Al Ruzzeh S, Amberger G, Omar RZ, Punjabi P, Amrani M, et al. An evaluation of existing risk stratification models as a tool for comparison of surgical performances for coronary artery bypass grafting between institutions. Eur J Cardiothorac Surg 2003; 23(6): 935-41.

6. Kurki TS, Jarvinen O, Kataja MJ, Laurikka J, Tarkka M. Performance of three preoperative risk indices; CABLEAL, EuroSCORE and Cleveland models in a prospective coronary bypass database. Eur J Cardiothorac Surg 2002; 21(3): 406-10.

7. Roques F, Nashef SA, Michel P, Gauducheau E, de Vincentis 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(6): 816-22.

8. Nashef SA, Roques F, Michel P, Gauducheau E, Lemeshow S, Salamon R. European system for cardiac operative risk evaluation (EuroSCORE). Eur J Cardiothorac Surg 1999; 16(1): 9-13.

9. Roques F, Nashef SA, Michel P, Pinna Pintor P, David M, Baudet E, The EuroSCORE Study Group. Does EuroSCORE work in individual European countries? Eur J Cardiothorac Surg 2000; 18(1): 27-30.

10. Nashef SA, Roques F, Hammill BG, Peterson ED, Michel P, Grover FL, et al. EuroSCORE Project Group. Validation of European System for Cardiac Operative Risk Evaluation (EuroSCORE) in North American cardiac surgery. Eur J Cardiothorac Surg 2002; 21(1): 101-5.

11. Uemura K, Pia Z. Trends in cardiovascular disease mortality in industrialized countries since 1950. World Health Stat Q 1988; 41(3-4): 155-78.

12. Tunstall-Pedoe H, Vanuzzo D, Hobbs M, Mannonen M, Cepaitis Z, Kuulasmaa K, et al. Estimation of contribution of changes in coronary care to improving survival, event rates, and coronary heart disease mortality across the WHO MONICA Project populations. Lancet 2000; 355(9205): 688-700.

13. Yusuf S, Zucker D, Peduzzi P, Fisher LD, Takaro T, Kennedy JW, et al. Effect of coronary artery bypass graft surgery on survival: overview of 10-year results from randomised trials by the Coronary Artery Bypass Graft Surgery Trialists Collaboration. Lancet 1994; 344(8922): 563-70.

14. Comparison of coronary bypass surgery with angioplasty in patients with multivessel disease. The Bypass Angioplasty Revascularization Investigation (BARI) Investigators. N Engl J Med 1996; 335(4): 217-25.

15. van den Brand MJ, Rensing BI, Morel MA, Foley DP, de Valk V, Breeman E, et al. The effect of completeness of revascularization on event-free survival at one year in the ARTS trial. J Am Coll Surg 2002; 49(3): 559-64.

16. Zacek P, Dominik J, Harrer J, Lansky V, Mand’ak J, Kunes P, et al. Morbidity and mortality in patients 70 years of age and over undergoing isolated coronary artery bypass surgery. Acta Medica (Hradec Kralove) 2001; 44(3): 109-14.

17. Chaitman BR, Fisher LD, Bourassa MG, Davis K, Rogers WJ, Maynard C, et al. Effect of coronary bypass surgery on survival patterns in subsets of patients with left main coronary artery disease. Report of the Collaborative Study in Coronary Artery Surgery (CASS). Am J Cardiol 1981; 48: 765-77.

18. Parry AJ, Giannopoulous N, Ormerod O, Pillai R, Westaby S. An audit of cardiac surgery in patients aged over 70 years. Q J Med 1994; 87(2): 89-96.

19. Dalrymple-Hay MJ, Alzetani A, Aboel-Nazar S, Haw M, Livesey S, Monjo J. Cardiac surgery in the elderly. Eur J Cardiothorac Surg 1999; 15(1): 61-6.

20. Vermeulen T, Rodrigus I, Stockman B, et al. Cardiac surgery in octogenarians. Acta Cardiol 2001; 56(6): 367-73.