Cardiac Services

Adult Cardiac Surgery

Audit Report 2007 – 08

Photo by Paul Highnam

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Foreword

This is the twelfth annual report from the cardiac surgical unit at the Bristol Royal Infirmary. The database now contains detailed, prospectively collected data on nearly 16,000 patients who have undergone cardiac surgery under our care. During this time we have set a number of objectives to satisfy:

1) Comprehensive data collection with direct uploading to the Central Cardiac Audit Database with surgeon specific data available both locally and from the Care Quality Commission website.
2) A research database for the conduct of clinical research and service improvement in association with the Academic Departments of Cardiac Surgery and Anaesthesia.
3) A resource for the conduct of local clinical audit projects to inform and direct our practice.
4) An administrative tool to produce operation notes and discharge summaries.

This document describes a successful year where our activity at 1471 procedures has been very close to our target of 1500 procedures within the available clinical facilities. The activity for the last three years has been between 1,400-1,500 operations, suggesting that this is the ceiling within the current facilities. Indeed, even to achieve this has required a certain amount of out of hours working to cope with the demand for urgent patients.

We have continued to struggle to meet waiting list targets and reduce waiting times for urgent in-hospital patients, which remain higher than is acceptable. There remains concern among clinicians that the pressure to achieve waiting time targets for elective patients where clinical priority may be low sometimes compromises the care of more urgent patients in the hospital where no such waiting time targets apply. The main operational problem we struggle with is the large variations in the rate of referral of urgent in-hospital patients and our need to maintain short waiting times with a relatively fixed level of cardiac surgical activity. Our inability to regularly meet short waiting times for urgent in hospital patients has meant that a significant number of urgent in patients have been referred to London centres.

Despite the increasing role of percutaneous coronary intervention (PCI) in acute coronary care, demand for cardiac surgery in our part of the region remains high. This is almost certainly due to the overall increase in the provision of cardiological services, coupled with the ageing population and our ability to achieve good clinical results in elderly patients. The idea that coronary artery surgery would become rapidly obsolete with the development of PCI appears to have been over-optimistic: both approaches are complementary – rather than competing – therapies; with increasing understanding of the patient groups best served by either intervention.

The year 2009 represents a landmark in the development of cardiac services in Bristol with the opening of the new Bristol Heart Institute in May. This gives us a marvellous opportunity to develop a top-class cardiovascular care facility which we hope will allow further integration of the clinical service with the very active programme of scientific research within the research arm of the Bristol Heart Institute. Few other heart centres in the UK will have opportunities like this and we must grasp the chance firmly.

On a national level, the Healthcare Commission produced its fourth year of surgeon-specific data for cardiac surgery, with most surgeons in the UK participating in this initiative. Given that surgeon-specific data is now well-established in the public domain it is hard not to note the decided cooling of interest of the media. In keeping with the perceived need for perpetual reorganisation, the Healthcare Commission has been dissolved and replaced by a new organisation, the Care Quality Commission (www.cqc.org.uk), the new independent regulator of healthcare in England. One of the stated aims of this new organisation is to publish a whole range of outcomes data for hospitals for a range of diagnoses and procedures to allow the public access to more information with which to make a choice. The challenge for cardiac surgery is to continue the good record it has and to develop other measures which can be used to judge quality of care rather than just in-patient mortality as the only index of quality.

On a local level, the main issue has been the resources available for data collection and audit. The demand for data at a national level has spiralled with eight national datasets in the adult cardiac domain, which is far greater than in other clinical areas. This has meant that all our resources in terms of personnel and time have been diverted to the completion of national audits. We have welcomed Trudy Gale as an audit facilitator and she has already made a significant difference to our ability to support local audit projects, which had fallen by the wayside. What must be clear is that for any major clinical department the collection of accurate clinical data is of paramount importance. This is true whatever use data are put to - whether this is audit, research, service evaluation or service improvement. It has to be recognised that such endeavours require appropriate funding and staffing, and that the value of the information far outweighs the cost of data collection.

Thanks again go to Dr Alan Cohen for his ongoing and major contribution to the overall project. We acknowledge the contribution of David Finch to this project over many years. I am extremely grateful to the Clinical Trials Unit in the Academic Department of Cardiac Surgery for their help with data analysis, in particular Katie Pike. Jane Sims and Chris Gummer continue to work hard to sustain our high levels of data completeness.

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April 2009

CONTENTS

1. INTRODUCTION 7

2. DATA COLLECTION AND REPORTING 8

3. OVERALL SURGICAL ACTIVITY 9

4. DEMOGRAPHIC AND GEOGRAPHICAL CHARACTERISTICS 12

5. ORGANISATION, OPERATIVE PRIORITY AND WAITING TIMES 15

6. RISK STRATIFICATION 19

7. SURGERY OF ISCHAEMIC HEART DISEASE 25

8. SURGERY OF VALVULAR HEART DISEASE 32

9. OTHER PROCEDURES 38

a) Adult Congenital Heart Disease 38

b) Aortic Disease 40

10. POSTOPERATIVE RECOVERY 39

11. POST-OPERATIVE MORBIDITY 42

12. ASSESSMENT OF SURGICAL PERFORMANCE 50

13. DEVELOPMENT OF QUALITY OF CARE INDICATORS 56

14. KEY CONCLUSIONS 60

List of Appendices

Appendix 1	Mortality rates for commonly performed procedures
Appendix 2	Distribution of procedure types between surgical firms
Appendix 3	euroSCORE risk stratified outcomes
Appendix 4	Individualised Surgical Record
Appendix 5	Surgeon-specific results for adult cardiac surgery
Appendix 6	PATS steering group membership

1. Introduction

We are already at the end of our thirteenth year of data collection. This has been a long journey with many changes along the way. In the 2005-6 report I outlined the evolution of presentation of cardiac surgical data, starting with the UK Cardiac Surgical Register in 1977 and followed by the National Adult Cardiac Surgery Database (NACSD) in 1994, until this was absorbed into the Central Cardiac Audit Database (CCAD) in 2004.

In the current situation we directly upload our data to CCAD via the internet. We receive regular feedback on data quality, and it is this data which is used for the surgeon-specific data presented on the Care Quality Commission website. Indeed, cardiac surgery outcomes remain some of the only surgeon-specific data published in the UK:

http://heartsurgery.cqc/index.aspx

In addition to this we continue to present and publish surgeon- and anaesthetist-specific data on an annual basis on a local level. Given the particular history of the cardiac surgical service in Bristol we tend to present more detailed information than is presented elsewhere because we feel the need to stay at the forefront in this area.

Despite this rapid evolution in data collection and presentation, our core objective remains the same: to collect comprehensive and complete data with respect to pre-operative characteristics, operative treatment and post-operative outcome (both early and late) for all patients under our care. All other objectives, and all other benefits of this project stem from this one fundamental principle.

2. Data Collection and Reporting

The data presented and analysed in this document are for every adult cardiac surgical procedure undertaken in the Bristol Royal Infirmary cardiac surgical unit between 1st April 2007 and 31st March 2008. In addition, we have used the whole database of 14,863 procedures to observe trends in practice between 1st April 1996 and 31st March 2008.

We continue to collect data prospectively using the Patient Analysis and Tracking System (PATS – as licensed by Dendrite Clinical Systems Ltd.). Data are recorded on a proforma which follows the patient on their journey from admission to discharge, and thus is very much a multi-disciplinary effort. Core data items are gathered according to the guidelines of the Society for Cardiothoracic Surgery of Great Britain and Ireland (SCTS), and these are supplemented by a number of additional variables agreed by the PATS steering group (appendix 6) as being pertinent to a particular area of interest or concern.

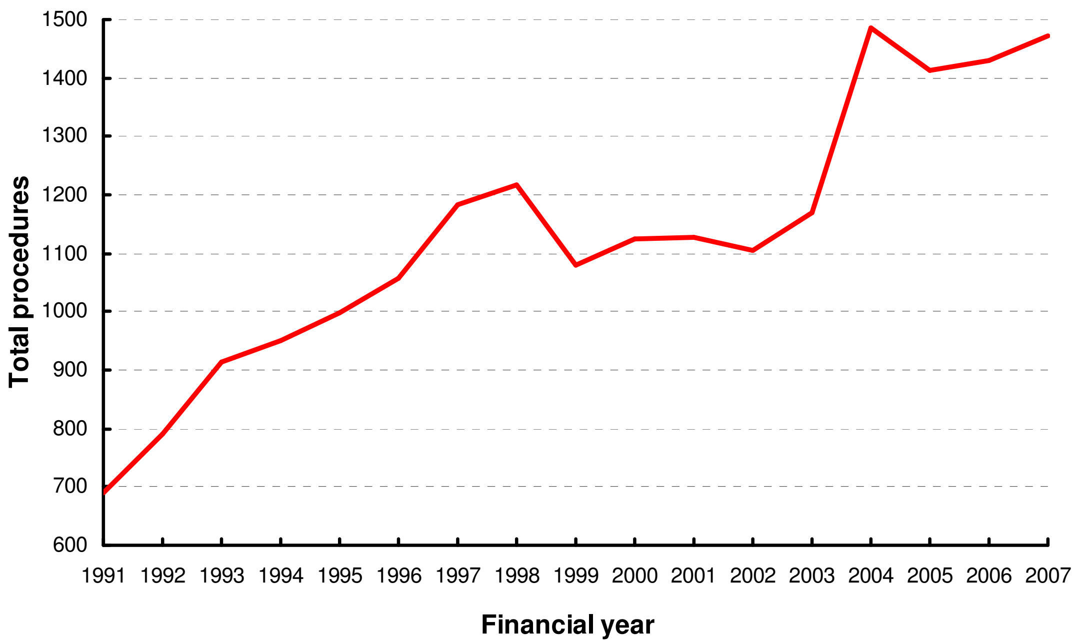
The debate over online versus paper methods of data collection continues and our philosophy is to move towards direct data input. At the time of writing we have invested in a new web-based 'front-end' for the PATS system that is far more user-friendly, and there is an increasing proportion of data input directly although it is our intention for the moment to continue to collect the data on paper.

Our unit supplies data on a regular basis via a secure internet link directly to the CCAD, from which the Care Quality Commission and Strategic Health Authorities may review our performance. Though the mechanics of this are largely automated and straightforward, data are not sent out of the unit until they are thoroughly checked and validated. This is a substantial ongoing task. To date our unit has submitted over 15,000 data records to CCAD for cardiac surgery procedures dating back to 1996, and has thus contributed significantly to the overall knowledge-base. The value of a robust national database is considerable; the key value arguably being the ability to track the life status of every patient in the longer-term. Our linkage to CCAD thus now means we are able to accurately ascertain mortality data beyond discharge – something which hitherto had relied upon contacting general hospitals, GPs, care-homes and relatives – and we fully expect to see five- and ten-year survival analyses appearing in future editions of this report. These will be most interesting indeed, for the real benefits for most patients do not accrue in our theatres and wards, but in their everyday life post discharge.

3. Overall Surgical Activity

Between April 1st 2007 and March 31st 2008 a total of 1,471 adult cardiac surgical operations were performed in the cardiac surgical unit at Bristol Royal Infirmary. This was very similar level of activity to the 1,430 cases performed last year but still leaves us some way short of the target of 1,500 procedures which the current phase of development was expected to achieve (Figure 1).

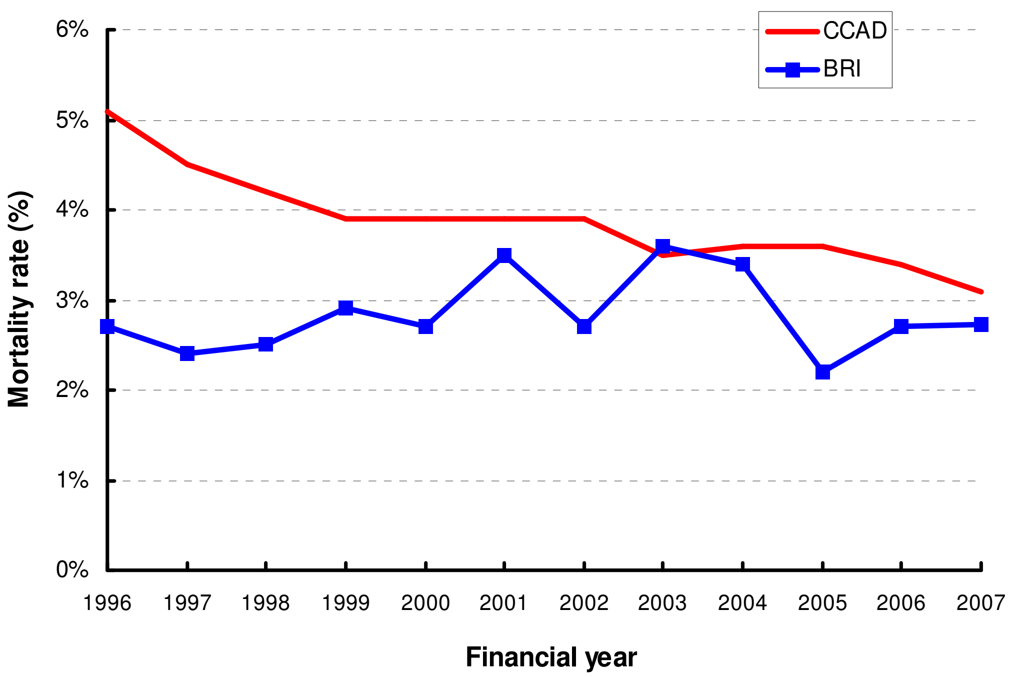
Figure 1: Surgical activity 1st April 1991 – 31st March 2008



The step up in activity from 2003-4, which has been maintained, suggests that we have reached a further ceiling within the current facility although we now look forward to utilising the reconfigured and expanded facilities within the new Bristol Heart Institute. Nevertheless, this is a high level of activity which(reasonably) allows us to consider ourselves a major cardiac centre. It should be noted that, even with this level of activity, we still find ourselves struggling to meet both elective and urgent waiting time targets - suggesting that there is further scope for modest expansion and our target is to achieve an additional 200 cases within the new centre.

Mortality (defined as death during the primary admission to the base hospital ie the BHI) for the period under study was 2.7% (40 deaths in 1,471 procedures) which is virtually the same as that achieved last year (CCAD 3.1% 2007-8). These outcomes bear comparison with other similar institutions both nationally and internationally. Figure 2 shows our annual mortality rate in comparison to the UK as a whole, and in general we have managed to achieve an overall mortality rate lower than the national average in all but one of the last 12years.

Figure 2: Mortality rate comparison for all cause in-hospital deaths
1st April 1996 – 31st March 2008



The overall distribution of the type of cardiac surgery undertaken during 2007-8 is provided in Table 1. The steady decline in the proportion of our workload which is coronary artery bypass grafting (CABG) has continued and this has reached 58% in the current year.

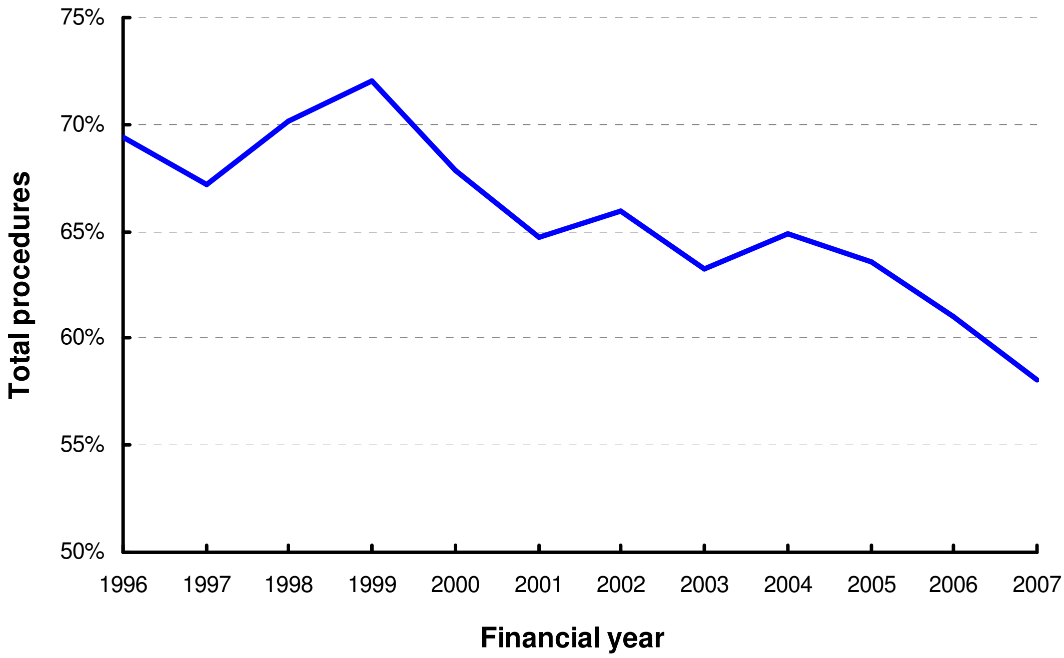
Table 1: Activity and mortality by procedure type
1st April 2007 – 31st March 2008

Procedure	Number	%	Deaths	Rate (%)
Isolated primary CABG	854	58.1	11	1.3%
Other IHD	39	2.7	2	5.1%
Valve	288	19.6	7	2.4%
Valve + CABG	165	11.2	10	6.1%
Thoracic Aorta	62	4.2	7	11.3%
Adult Congenital	43	2.9	1	2.3%
Other	20	1.4	2	10.0%
ALL TYPES	1,471		40	2.7%

Figure 3 clearly shows this decline with a 10% fall over less than 10 years from a high of 72% in 1999-2000. This is a trend observed nationally and internationally(CCAD 07-08, Primary CABG 56.9%). Fortunately (for the service), this decline has been matched by an increase in other areas of our activity: for the first time since 1996 we have undertaken more than 450 valve procedures, and this now makes up more than 30% of our overall activity.

Valve surgery increased to a total of 453 procedures, the highest we have ever recorded and a 13% increase over 2006-7. Of all the procedures undertaken for valvular heart disease, 36% involved concomitant CABG, which is a reflection of the ageing surgical population. Operations on the thoracic aorta were stable at the level of 60-70 procedures per year maintaining the increase observed in the previous year. There were also 43 procedures for adult congenital heart disease, one of our targeted areas, a 50% increase on the previous year's activity.

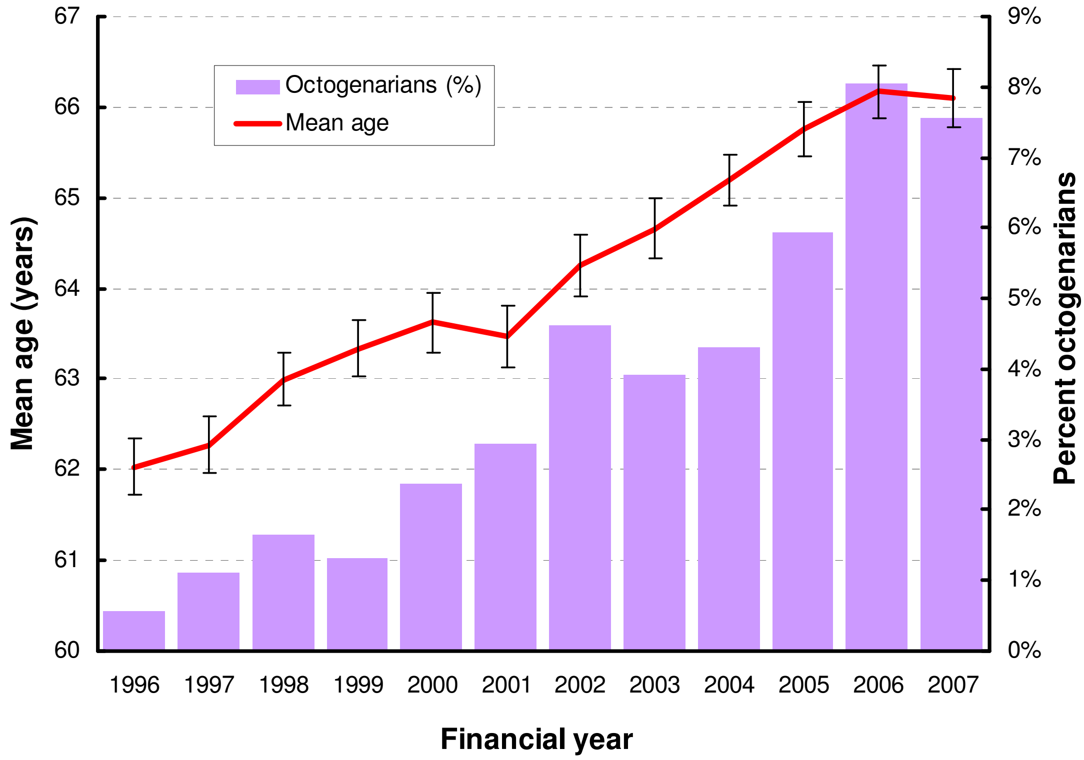
Figure 3: Trend in isolated primary CABG activity
1st April 1996 – 31st March 2008 (n=9,703)



4. Demographic and Geographical Characteristics

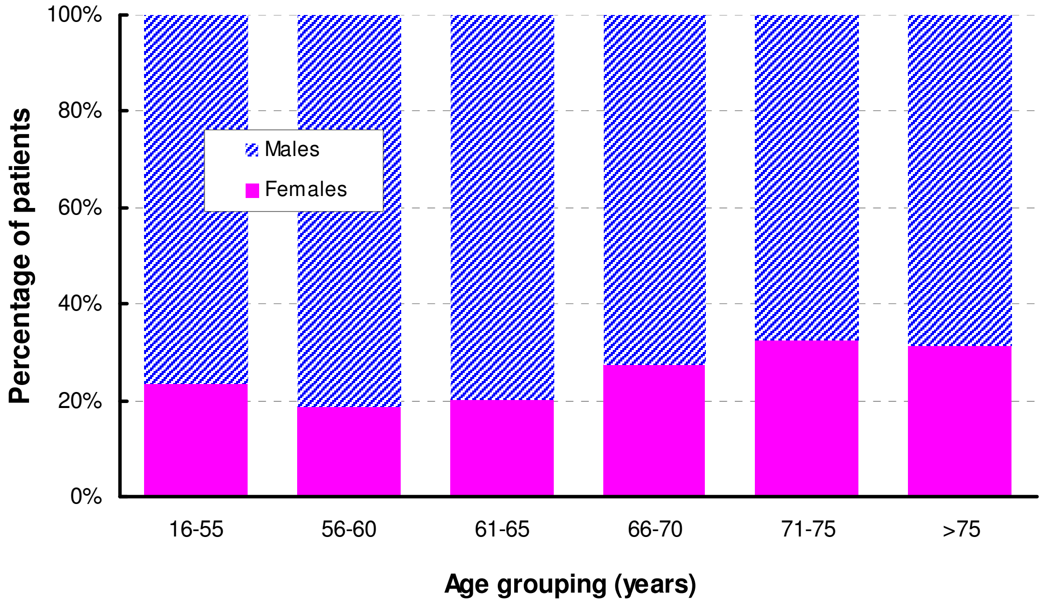
The most consistent characteristic of the population undergoing cardiac surgery has been increasing age. In our unit the mean age at operation during 2007-8 was 66.1years (range 19 - 88 years)(CCAD 07-08 mean 66.1yrs). If we examine Figure 4 we see that the mean age has increased by one year every two years of study. In particular there continues to be an increase in the proportion of patients over 80 undergoing surgery. Although there was a small decrease in the current year of study this figure remains around 8% of our total patient population. These changes mirror many similar areas of healthcare in western societies and it is at least reassuring that, despite the demanding techniques required to achieve good results in this age group, we are increasingly able to justify operations in elderly patients based on the acceptable mortality and functional benefit that accrues from successful surgery.

Figure 4: Trends in age on admission for surgery
1st April 1996 – 31st March 2008 (n=14,820)



With regard to gender differences in our patient population, there is an overall 3.8:1 ratio of males to females (figure 5). These reflect, we believe, the well-known gender differences in the prevalence of coronary artery disease rather than any difference in treatment or access to treatment. As expected, the proportion of women is greater in the older age group as the protective effect of oestrogens against coronary disease begins to lessen.

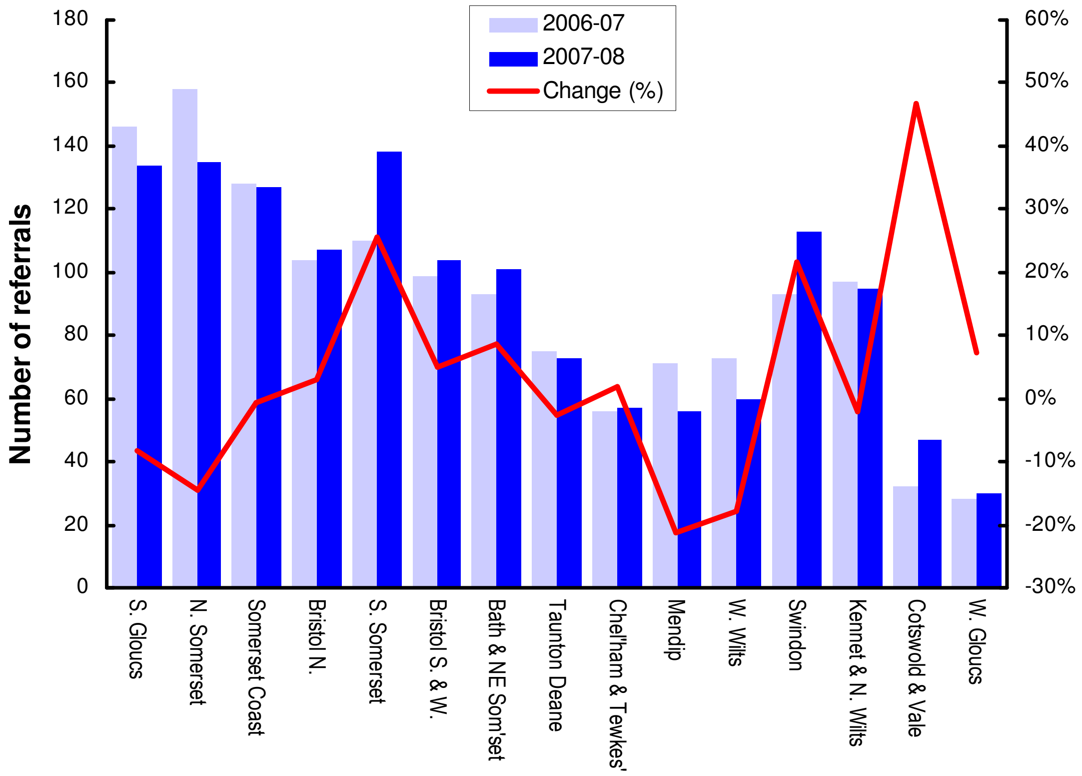
Figure 5: The relation between age and gender
1st April 2007 – 31st March 2008 (n=1,471)



The geographical origins of the majority of our patients have not changed significantly over the last year with the patients coming from Bath, Cheltenham and Gloucester, Swindon, Taunton, Weston-Super-Mare and Yeovil, as well as our Bristol patients (Figure 6). The most notable percentage swing between 2005-6 and 2006-7 was an increase in cases coming from Gloucestershire and the Cotswolds.

We have to compete successfully for patients with other cardiac surgical providers and we can only do so if we provide a top-level service. With the advent of initiatives like *Patient Choice* we have to provide care which is perceived to be a high standard by patients and their relatives as well as the referring cardiological centres.

Figure 6: Referral patterns by Primary Care Trust
1st April 2006 – 31st March 2007 (n=2,740)

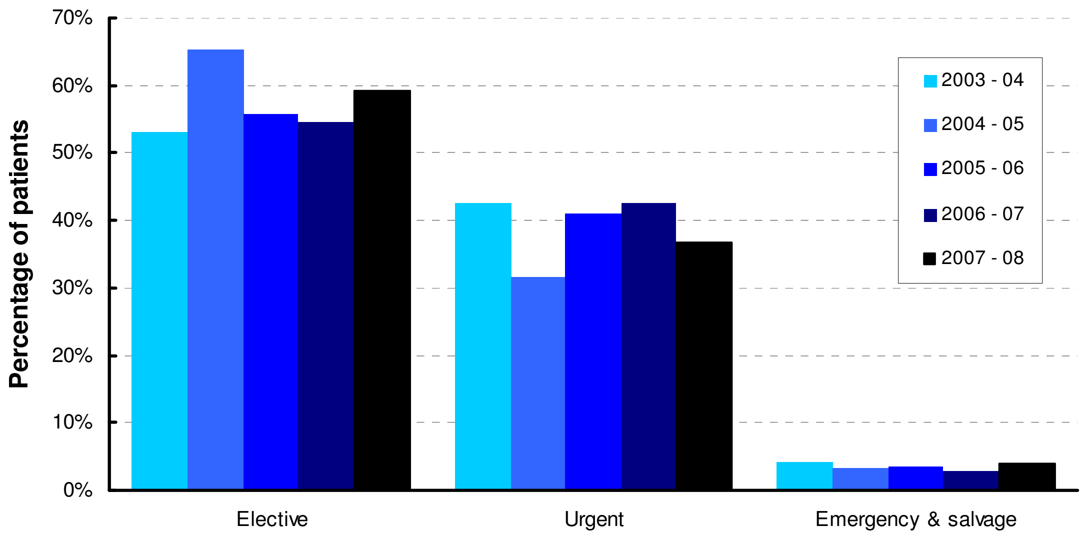


5. Organisation, Operative Priority and Waiting Times

Over the last few years the targets for treatment of patients with heart disease have progressively decreased to a level where we now treat elective patients within a 18 week referral to treatment time. This represents a revolution in the efficiency of the treatment of patients with heart disease. Nevertheless, even within these shorter timescales, judgements will still need to be made with respect to urgency of treatment. There will continue to be competing pressures to achieve elective waiting time targets yet achieve clinically appropriate treatment for urgent patients.

The designations of operative priority according to the Society of Cardiothoracic Surgeons (SCTS) have been standardised for many years and these have been discussed in detail in previous reports. There are four categories: elective, urgent, emergency and salvage. The vast majority of our patients are either classed as 'elective' – meaning they are a routine admission from home – or 'urgent', when their cardiac condition is deemed threatening enough that they remain in hospital awaiting surgery. In 2007-8 the pattern of operative priority showed a certain amount of change with a fall in the proportion of urgent in hospital patients to 37% (Figure 7). This is almost certainly due to the impact of underprovision of services resulting in some of our network partner hospitals choosing to send increasing numbers of urgent patients to London providers. Across the UK as a whole in 2007-8 about 30.7% of the patients were non-elective(CCAD).

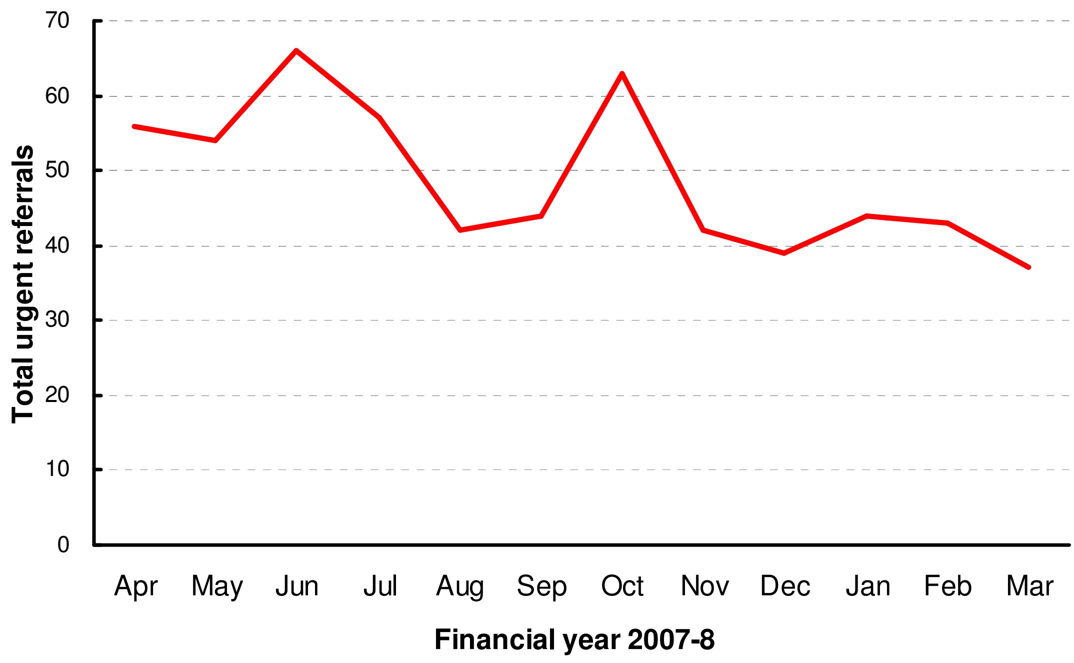
Figure 7: Caseload priority by financial year
1st April 2003 – 31st March 2008



Currently within the Avon, Gloucester and Wiltshire Cardiac Network our aim is to treat urgent in-patients within 10 days of admission which is usually 5-7 days from referral. However, when a substantial proportion of the service is based around an urgent patient caseload then the fluctuation in referral numbers can cause problems. These are understandable if we examine Figure 8 where we see the frequency of referral of urgent patients by month during the financial year 2007-8. The monthly rate of referral varies from less than 37 to 66: a very large variance. In practical terms, this means in order to effectively manage the service we have to have the capacity not only to cope with the elective waiting list targets but also to deal effectively with varying numbers of urgent patients within a very short timescale. To do so requires either excess capacity to cope with peak demands for the service or considerable flexibility in routine cardiac surgical activity to deal with these peaks. Unfortunately, cardiac surgical activity cannot be turned on and off like a tap, and therefore it follows that some excess capacity is required to deal with both elective targets and urgent patients. Without excess capacity urgent patients must sit in hospital beds for prolonged periods around the region. This is wasteful and exposes them to additional risks.

This kind of 'real world' observation demonstrates the Achilles heel of calculations of cardiac surgical activity based on a target population: they fail to take into account the natural variation in the level of referral of both urgent and elective patients if strict waiting times are to be observed.

Figure 8: Monthly referral patterns for urgent in-hospital transfers
1st April 2007 – 31st March 2008 (n=587)



In 2007-8 our basic model of activity was operating on two patients per day in three theatres, which is six cases per day, and a total of 32 cases per week(we have an additional theatre available one day per week). Thus working a 50-week year we can theoretically attain a maximum activity of 1,500 cases provided there are no cases lost. However, at present we are losing cases at 5% - 15% per month and it doesn't take much of a mathematician to realise we are going to struggle to realise our projected activity within the theatre base currently available. Cardiac surgery is a complex activity needing a whole series of components fully in place for it to safely go ahead. Sometimes case cancellation is unavoidable - for instance a complicated case or unforeseen problems with surgery in a patient which over-runs the theatre booking to occupy the whole day. However, as may be seen in Table 2, a significant proportion of reasons for cancellation of cases *are* avoidable, and we must continue to focus our attention on this area to minimise the idle time for resources as valuable as an operating theatre and the associated highly trained staff.

Table 2: Reasons for cancellation
1st April 2005 – 31st March 2008

	05-06	06-07	07-08
No ITU beds	31	60	20
No Perfusionist	2	6	11
Case overran/long first case	21	44	38
No ITU staff	14	4	29
Patient unfit	10	5	12
No theatre staff/emergency overnight	49	29	49
Unable to admit(No wd bed/Norovirus/A&E alert)	11	0	22
Emergency in catheter laboratory	2	3	7
No surgeon	6	8	10
Miscellaneous	19	5	7
TOTAL	165	164	205
Available Operating Slots	1519	1542	1577
% Cancellation Rate	10.8	10.6	13

If we examine the current year of study in comparison to the preceding year there has been an increase in the number of cases lost, resulting in a disappointing 13% of possible operating slots. In keeping with previous years, we saw a significant number of potential operating slots lost because of prolonged cases or unforeseen problems as well as no ICU beds from time to time. However, 07-08 saw us lose a significant number of operating slots because of shortages of ICU staff(14%) and inability to admit patients because of lack of ward beds, Norovirus or an A&E bed alert (10.7%). In addition, we continue to struggle with theatre staffing with problems particularly arising if there was an emergency overnight. In each of these areas we may argue that each cause of lost cardiac surgery is not a major cause in itself but the problem is that the sum total adds up to a lot of potential cardiac surgery slots being wasted and this is then reflected in increased waiting times for patients. It does seem disappointing that despite a lot of effort there remain significant areas where it should be possible to improve this situation and further concentrated effort is required.

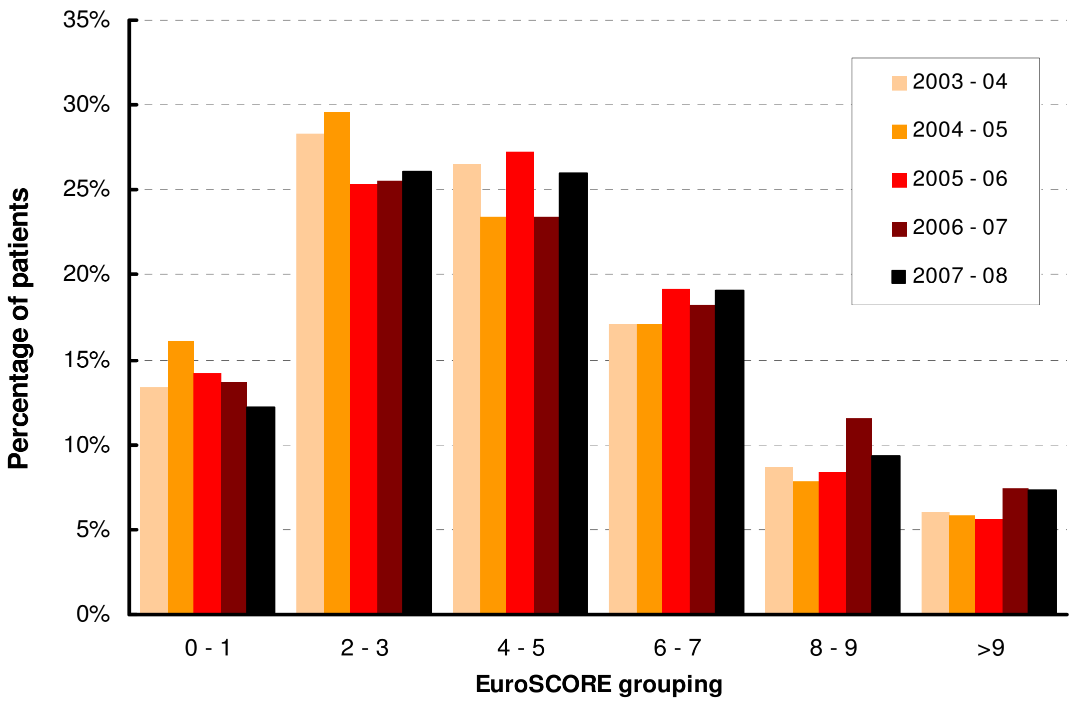
Risk Stratification

In assessing the operative risk for an individual patient, or to allow comparison of outcomes for different patients treated by different surgeons in different centres, it is vital that there is some objective measure of case severity. The profession has tended towards use of additive systems which accord points for elements of risk, like increased age or poor left ventricular function, with a higher total score denoting a higher operative risk.

Like many units around the UK we have been using the euroSCORE system, which was derived from a large dataset collected in the early 1990s[1]. Its application in large numbers of patients world-wide has proven successful, and it has been widely used in comparisons of surgical practice. The euroSCORE was initially developed so that the calculated value broadly approximated to the predicted operative mortality, in percentage terms. However, the nature of such systems is that they become outdated as clinical practice advances, and recent analyses of outcomes indicates that the most complex form of euroSCORE - the logistic euroSCORE - overestimates contemporary operative risk by a factor of about two and therefore requires recalibration[2,3]. It is also a tool which has been shown not to work well in specialised circumstances like complex adult congenital problems and thoracic aortic surgery. Nevertheless, we find the euroSCORE extremely helpful in informing our practice, and until it is superseded by an updated standard we will continue to use it in its present form.

Figure 9 shows the change in the euroSCORE profile over the last five years. There has been little change in this profile in the last year with the mean remaining at 4.8(CCAD 07-08 Mean euroSCORE 3.8). We have observed the euroSCORE profile for the last eight years and we have seen the overall mean score increase by 1.0 over this time: a modest increase. When significant numbers of urgent numbers of patients from our overall population are referred elsewhere it is difficult to make clear judgements on how our population is changing.

Figure 9: euroSCORE distribution by financial year
1st April 2003 – 31st March 2008 (n=6,953)



Given the increasing focus (or seeming preoccupation) with cardiac surgical results we must consider whether there is any evidence of risk-averse behaviour. This is a complex area and one which our colleagues in the North-West have examined this in detail. They conclude that, because the risk profile in their area has been maintained or worsened, there is no evidence of risk-averse behaviour[(4)]. In our practice at Bristol we can see that patients in the higher-risk groups continue to increase as a proportion of the caseload, and therefore it is reasonable to conclude that there is similarly no evidence of systematic risk-averse behaviour. However, without any record of numbers of patients who may be advised against surgery it is hard to make hard scientific observations in this area. We simply do not know how the risk profile might have looked in the absence of public disclosure of surgeon-specific results.

In fact, if we look at some of the ways in which our patient profile is changing (Figures 10 - 12) we can observe some trends. There does appear, in recent years, and certainly since 2002, to be a trend towards a lower proportion of patients with severe left ventricular(LV) dysfunction which regression analysis revealed to be highly statistically significant ($p<0.001$). Currently in Bristol about 3.9% of our patients have severe LV dysfunction compared to the 6.4% in the UK as a whole(CCAD 07-08). What we don't know is whether this represents a change in approach to treatment, a change in referral practices for surgery or a change in the willingness of surgeons to undertake CABG in patients with severe LV dysfunction. There is an obvious trend in the timing of surgery in relation to myocardial infarction(MI), with an increase in the proportion undergoing surgery within 30 days. This almost certainly reflects the increasingly acute nature of cardiovascular care and the recognition that CABG can, in most cases, be undertaken after seven days of a myocardial infarct without any additional risk of mortality.

Lastly, the increasing role of PCI in treating people with coronary artery disease is reflected in the increasing proportion of our patients - now around 8% - who have undergone a PCI. We should not necessarily think this represents cases of failed PCI because increasingly the two therapies are complementary with PCI often now being used as a primary therapy in acute MI to minimise myocardial damage, and with surgery being employed beyond the acute phase for definitive treatment of multivessel disease. These complex treatment patterns are not always obvious from such data.

Figure 10: Left Ventricular Ejection Fraction on admission
Isolated primary CABG 1st April 1996 – 31st March 2008 (n=9,788)

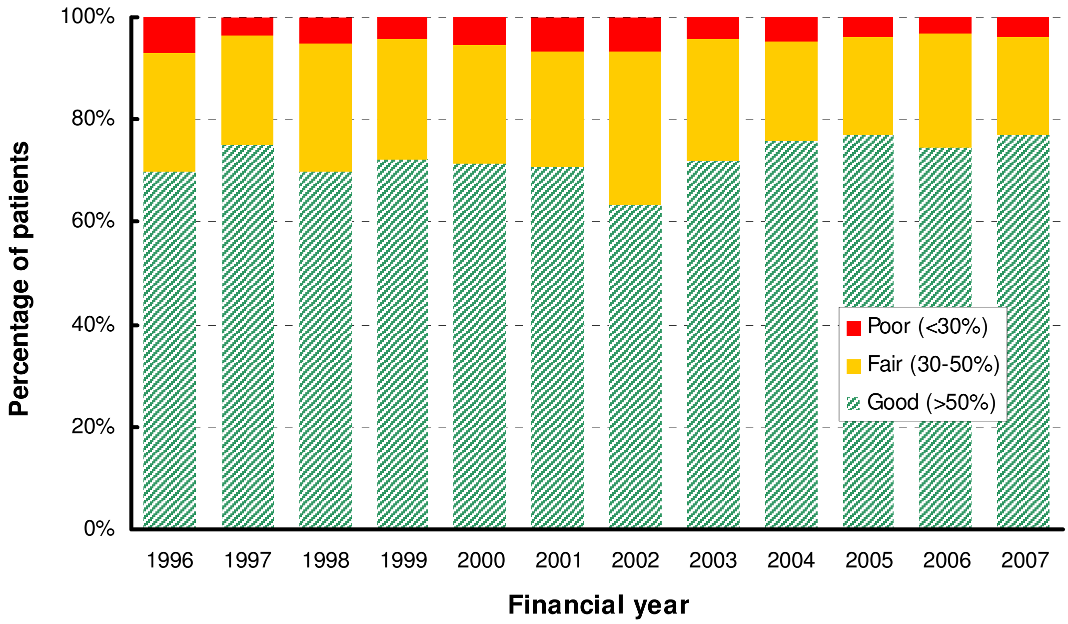


Figure 11: Recent Myocardial Infarction
Isolated primary CABG 1st April 1996 – 31st March 2008 (n=9,800)

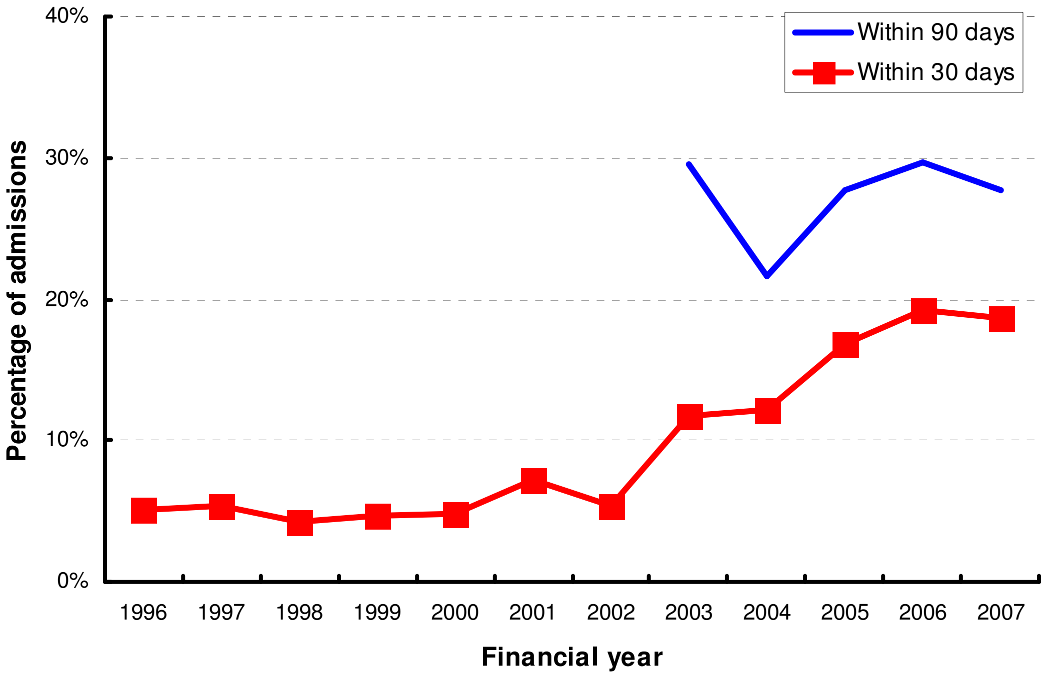
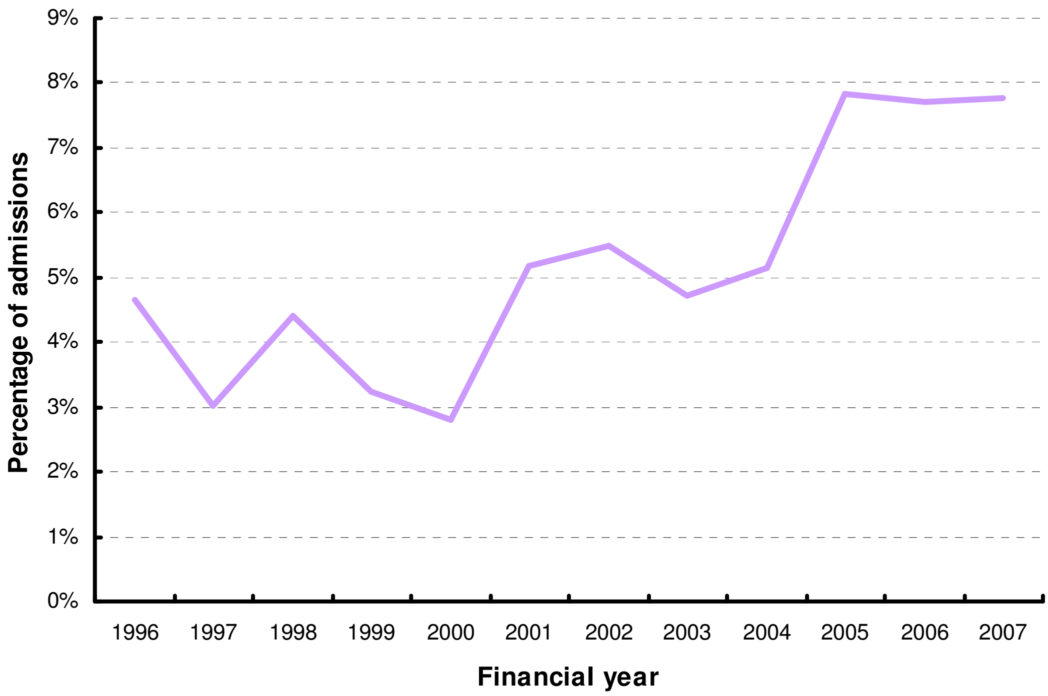


Figure 12: Previous Percutaneous Coronary Intervention
Isolated primary CABG 1st April 1996 – 31st March 2008 (n=9,883)



When we analyse the risk profile of patients under the care of individual surgical firms we found statistically significant differences with respect to all procedures ($p<0.03$; Kruskal-Wallis) but not for isolated primary CABG ($p=0.44$; Kruskal-Wallis). Figures 13 and 14 show the mean risk profiles for individual firms and we can see that there is considerable variation across the spectrum of risk scores for all procedures but a much closer grouping for CABG patients. The cause of such variation is complex. Some surgeons may have a stated expertise in treating patients at high operative risk and it may be right that they are encouraged to do so. The focus on outcomes for cardiac centres and individuals has become sufficiently intense that it is hard to believe that this does not influence patient selection. The notion that risk-adjusted data will protect surgeons from unfair public scrutiny is scientifically sound but scientific rigour cannot be assumed to be applied to everyday surgical practice.

Figure 13: euroSCORE by surgeon firm with standard errors of mean
All procedures 1st April 2007 – 31st March 2008 (n=1,471)

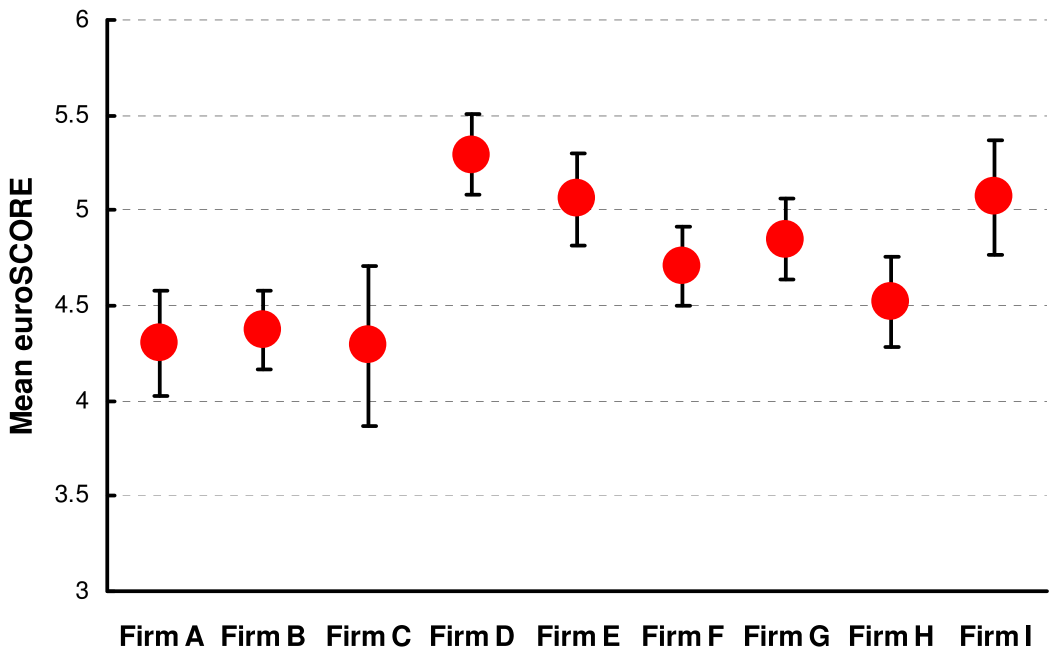
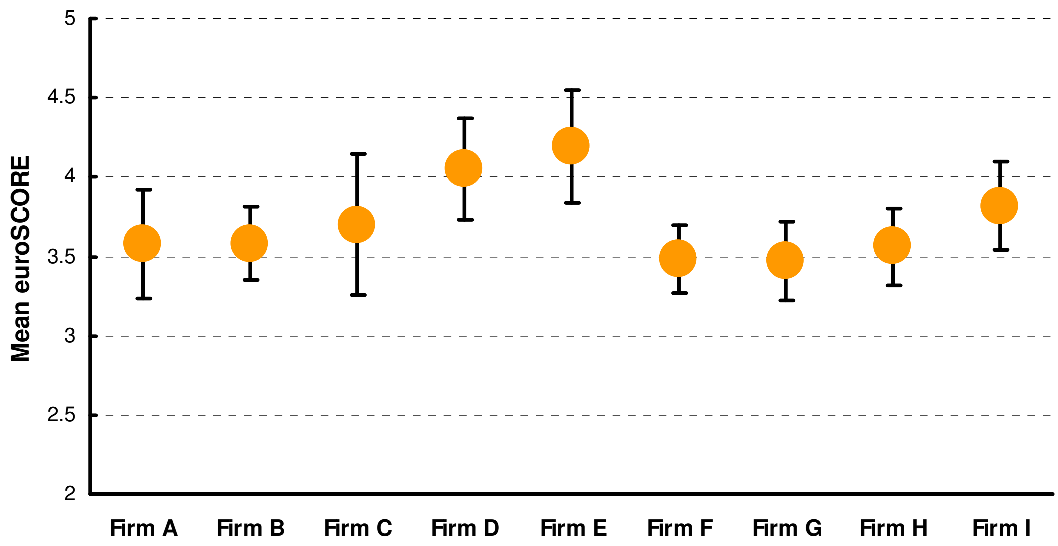


Figure 14: euroSCORE by surgeon firm with standard errors of mean
Isolated primary CABG 1st April 2007 – 31st March 2008 (n=854)



6. Surgery of Ischaemic Heart Disease

The surgery of ischaemic heart disease remains the major component of our workload comprising some 61% of our workload (893/1471 procedures). In the year under scrutiny a total of 854 isolated primary CABG (ipCABG) operations were undertaken with a total of 11 deaths (1.3%; 1.4% CCAD 2007-8). This represented a small fall in overall activity from the previous year with a mortality just less than the national average of 1.4%. The proportion of our work constituted by ipCABG continues to fall year by year and is now down below 60%(CCAD 07-08 56.9%). If we add our activity this year to the previous 10 years we have undertaken a total of 9,703 ipCABG operations with an overall institutional mortality of 1.3%. These are excellent results which will stand comparison with any national or international standard (figure 15).

Figure 15: Isolated primary CABG mortality rate trend
1st April 1996 – 31st March 2008 (n=9,703)

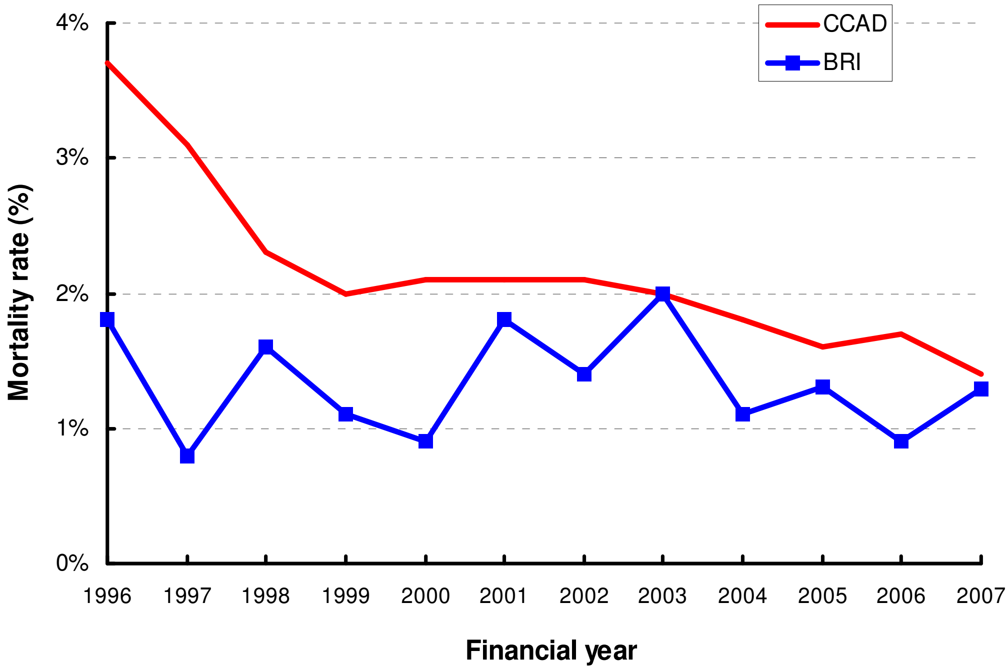
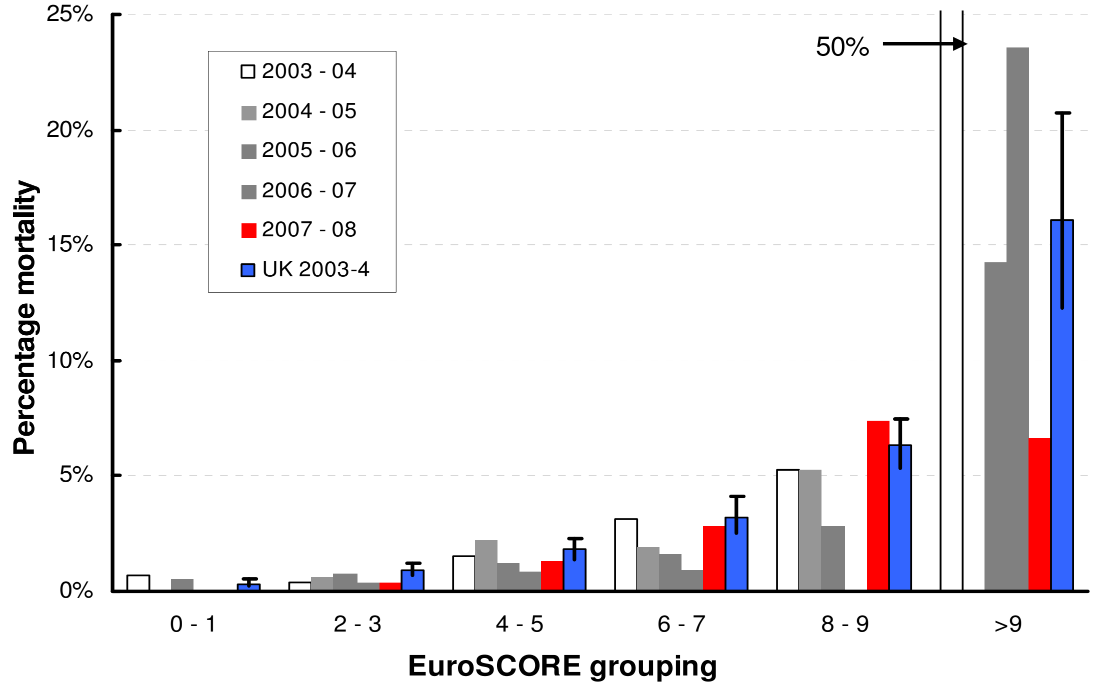


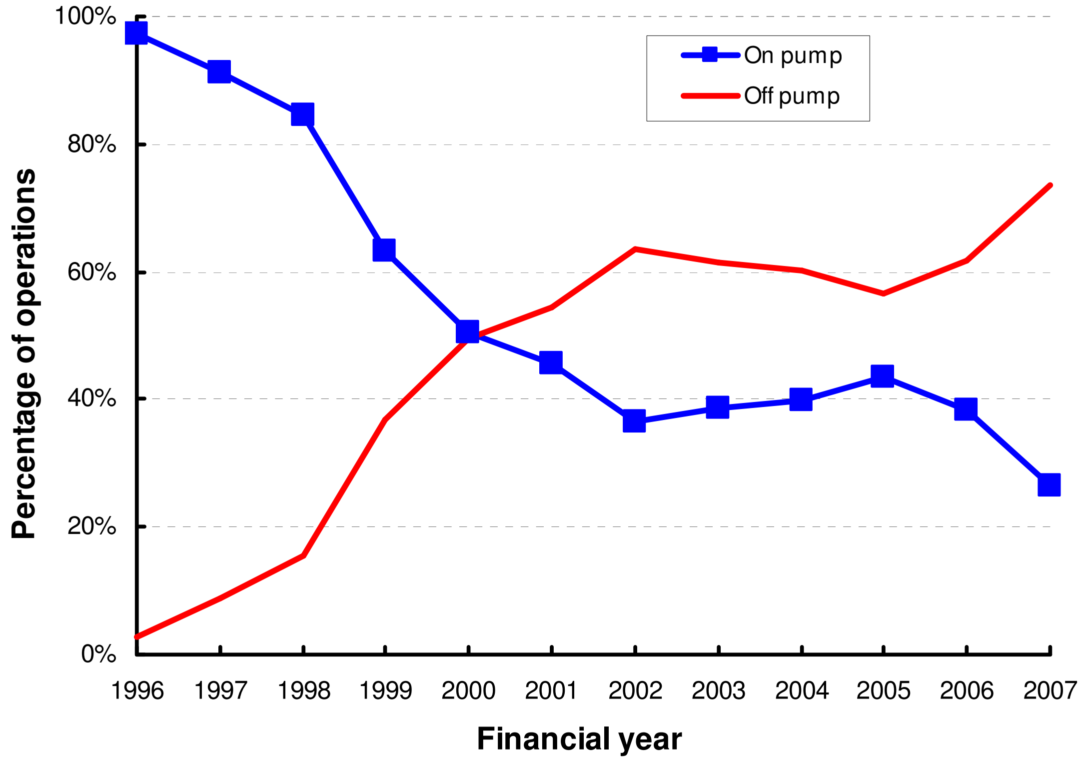
Figure 16 shows our mortality rates for ipCABG for the last five years stratified for EuroSCORE, and compared to UK outcomes for the financial year 2003-4. In the current year of study, in all but one group, our mortality rate was lower than the UK figure available for comparison. In the highest risk group the numbers are very small with large errors around the mean.

Figure 16: Mortality rates by euroSCORE group
Isolated primary CABG (n=4,330)



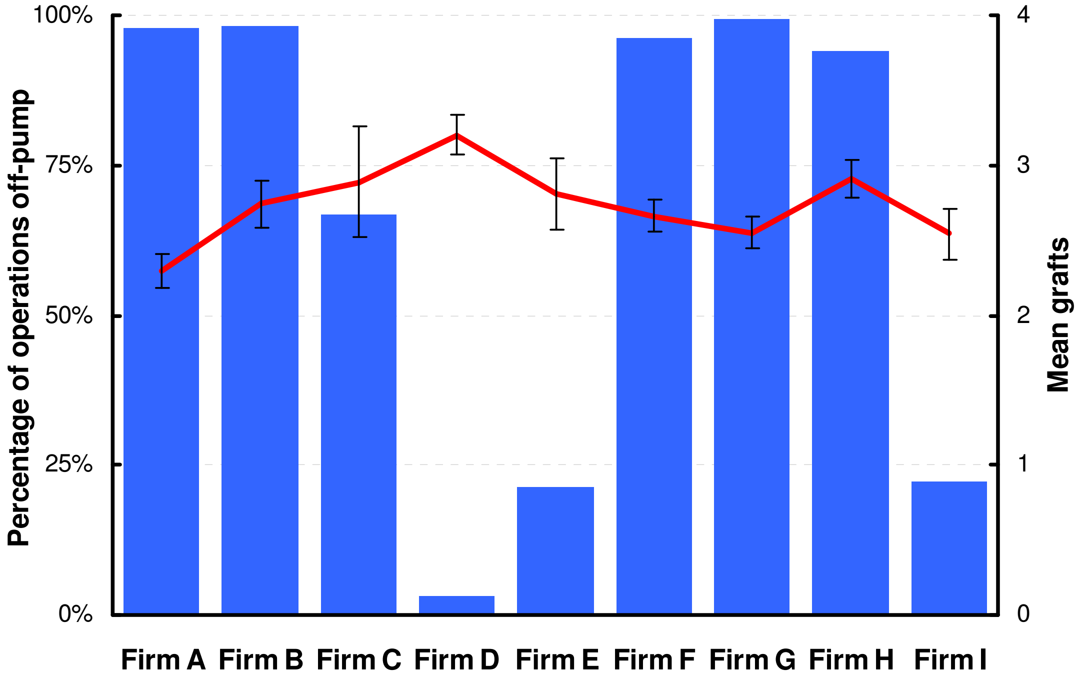
The proportion of off-pump CABG cases has increased over the last twelve months to around 75% of all CABG work (Figure 17) most likely due to the appointment of another consultant surgeon Mr George Asimakopoulos who predominantly favours off-pump techniques. Bristol continues to be one of the leading centres in the UK with a very high percentage of cases undertaken without cardiopulmonary bypass. In the UK the figure is around 20% (CCAD 2007-8), but this is steadily rising as more surgeons and more centres adopt the technique. In our centre, with non risk-adjusted data, the mortality rates for on and off pump CABG surgery were 0.9% and 2.2% respectively. If we compare deaths over a period of seven years when there has been substantial use of the technique the figures become 1.5% and 1.2% respectively. This difference is not statistically significant ($p<0.21$). In prospective randomised studies, there have been few differences in major outcomes although large observational series from registries like New York State have shown a lower early mortality for off-pump surgery, but a higher late intervention rate despite adjustment for differences in the population[5] .

Figure 17: Trend in cardiopulmonary bypass use
Isolated primary CABG April 1st 1996-March 31st 2008 (n=9,703)



The proportion of patients who undergo CABG without cardiopulmonary bypass is related to preference (or expertise) of the individual surgical teams rather than specific patient characteristics. In Figure 18 we see that some surgeons undertake CABG surgery almost exclusively without CPB, while others undertake almost all operations with CPB. In our unit six surgeons predominantly undertake off-pump surgery, and this seems likely to increase as techniques become more refined and late adopters gradually learn the technique. It may ultimately be hard to agree whether or not there is a major difference in certain 'endpoints', but it seems likely that the technique will be adopted by the majority of cardiac surgeons in any case.

Figure 18: Cardiopulmonary bypass use (blue column) and mean graft rate (red line) by surgical firm for isolated primary CABG
1st April 2007 – 31st March 2008 (n=854)



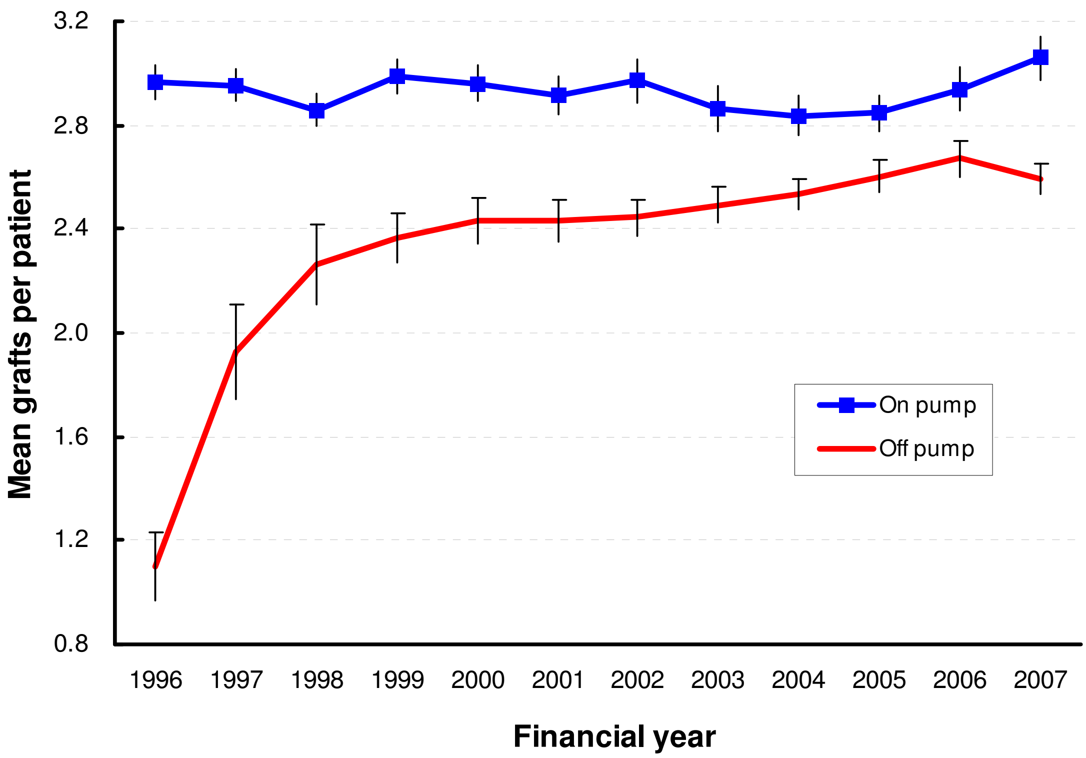
The mean number of grafts per patient in isolated primary CABG was 2.72, which shows a small fall from last year. This is interesting as for the previous few years a steady increase has been observed which has been attributed to the evolution of off-pump surgery.

Table 3: Trends in graft rate for isolated primary CABG
1st April 1996 – 31st March 2008(n=9703)

Financial Year	Mean grafts per patient	Number of procedures
1996 - 97	2.92	733
1997 - 98	2.87	794
1998 - 99	2.77	853
1999 - 00	2.76	777
2000 - 01	2.70	763
2001 - 02	2.65	728
2002 - 03	2.64	727
2003 - 04	2.64	740
2004 - 05	2.66	963
2005 - 06	2.71	899
2006 - 07	2.77	872
2007- 08	2.72	854

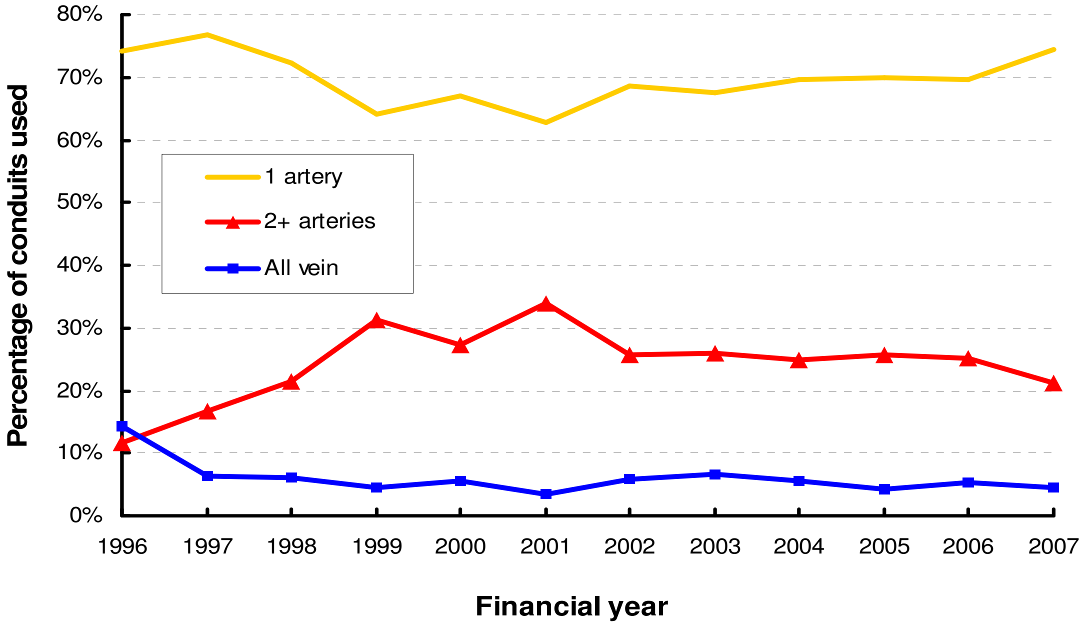
Figure 19 shows that the reduction in the mean number of grafts has been within the off-pump group as the mean has increased for the on-pump group. This change follows a number of years where there was increasing convergence of the curves as the number of grafts by both techniques approached each other. In the last year the mean number of grafts in the on and off-pump groups were 2.59 and 3.06 respectively which is still statistically significantly different (Mann-Witney $p<0.001$).

Figure 19: Mean graft rate by cardiopulmonary bypass use
With 95% confidence intervals for mean
Isolated primary CABG: 1st April 1996 – 31st March 2008 (n=9,703)



The percentage of patients receiving at least one arterial graft (predominantly the left internal mammary artery to the left anterior descending coronary artery) remains high at 95.6%. This statistic is also often viewed as a further marker of good performance and we will return to this later in the document. The number of patients receiving two or more arterial grafts has declined somewhat to around 21% (fig 20). As a group, we accept the principle that arterial grafts and particularly internal mammary artery grafts have a better late patency than saphenous vein grafts, and this has been shown to translate both into improved late survival and a reduction in late cardiac events and recurrent angina. These factors should continue to stimulate their use where possible. The increasing age of the patients, the high percentage of urgent in-hospital patients coupled with the increased technical complexity of using multiple arterial grafts may be factors that dissuade surgeons from using them more liberally. In 2007 – 08 the majority of our multiple arterial graft patients received a radial artery graft (165/180, 92%), with only 11%(20/180) receiving a second internal mammary artery graft.

Figure 20: Use of arterial grafts in isolated primary CABG
1st April 1996 – 31st March 2008 (n=9,703)



In our practice the proportion of patients undergoing re-operative CABG remains low at 1.6% (14 procedures). There were no deaths in this group. To gain more of a perspective with respect to outcomes in this group it may be better to look at our total experience over the last eleven years of 270 procedures with 10 deaths (3.7%;CCAD 5.3% 2007-8). This kind of figure is very typical of many major centres where the risk of redo CABG is generally observed as two to three times higher than the risk of primary CABG. While PCI approaches may be preferred on occasion, redo CABG can clearly be undertaken at low risk, and should be considered in any patient with recurrent ischaemia after CABG in the past.

There were 25 other procedures for ischaemic heart disease with two deaths. These tend to be a higher risk group of patients undergoing concomitant procedures like left ventricular aneurysm resection, left ventricular remodelling procedures and closure of ventricular septal defects after myocardial infarction.

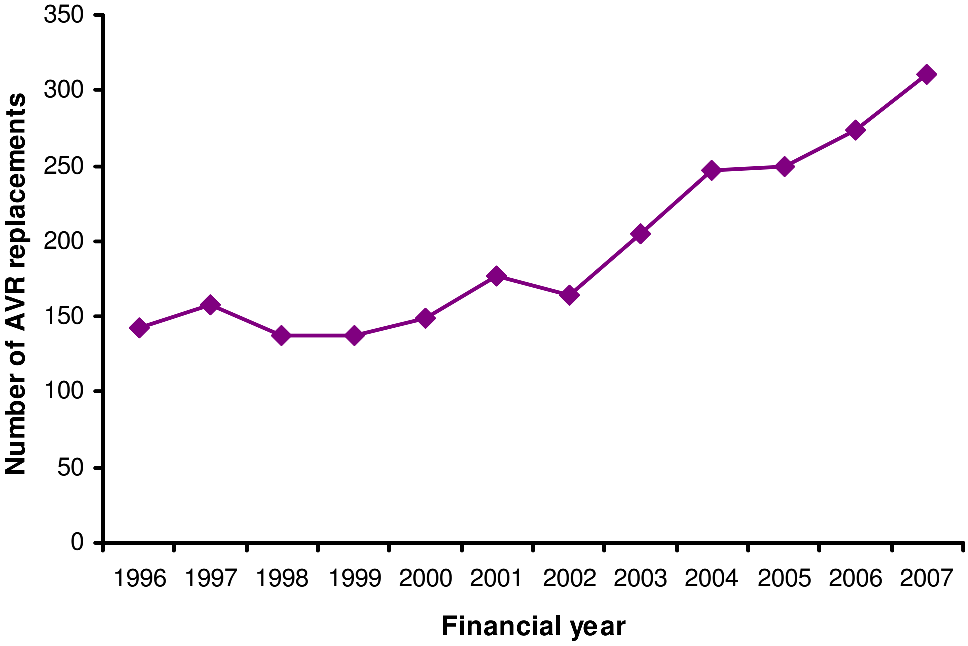
7. Surgery of Valvular Heart Disease

In 2007-8 a total of 453 procedures were undertaken for valvular heart disease, which represents 31% of the overall workload. This is a 13% increase from the 402 procedures undertaken in the previous year. Of these patients, 160 (35.3%) underwent concomitant CABG in association with their valve surgery. Within this group of 453 patients 17 (3.8%) did not survive their primary hospital stay - which compares to the most recently available figure for the UK as a whole of 5.5% (NACSD 2003) – and is also an improvement on our own previous year's achievement of 5.2%.

Aortic valve replacement (AVR) is the commonest procedure undertaken for valvular heart disease. A total of 311 procedures on the aortic valve were undertaken with 9 deaths (2.9%). This was an increase in activity of 14% over the 273 procedures undertaken in 2006-7. There were 168 primary isolated AVR with two deaths (1.2%), which is below the national figure of 1.7% (CCAD 2007-8). Over the last 11 years we have undertaken 1,413 primary isolated AVR with 42 deaths, giving a mortality of 3.0%. The year 2007-8 represents our best results ever for aortic valve replacement and is the first year in some time that we have bettered the national outcomes data. In the period 17 patients underwent redo AVR with no deaths, which suggests that we can undertake at least a first re-operation with little increase in mortality in comparison to a first operation.

A total of 124 patients underwent primary aortic valve replacement in association with CABG with 7 deaths (5.6%). This rate is a little higher than we have managed to achieve in recent years, but again, if we examine our performance in the larger cohort, we have undertaken 894 procedures since 1996 with 39 deaths (4.4%), which compares favourably with the UK figure of 4.3% (CCAD 2007-8)

Fig 21. Trends in Aortic Valve Replacement Bristol Royal Infirmary
1st April 1996- 31st March 2008 (n=2,350)

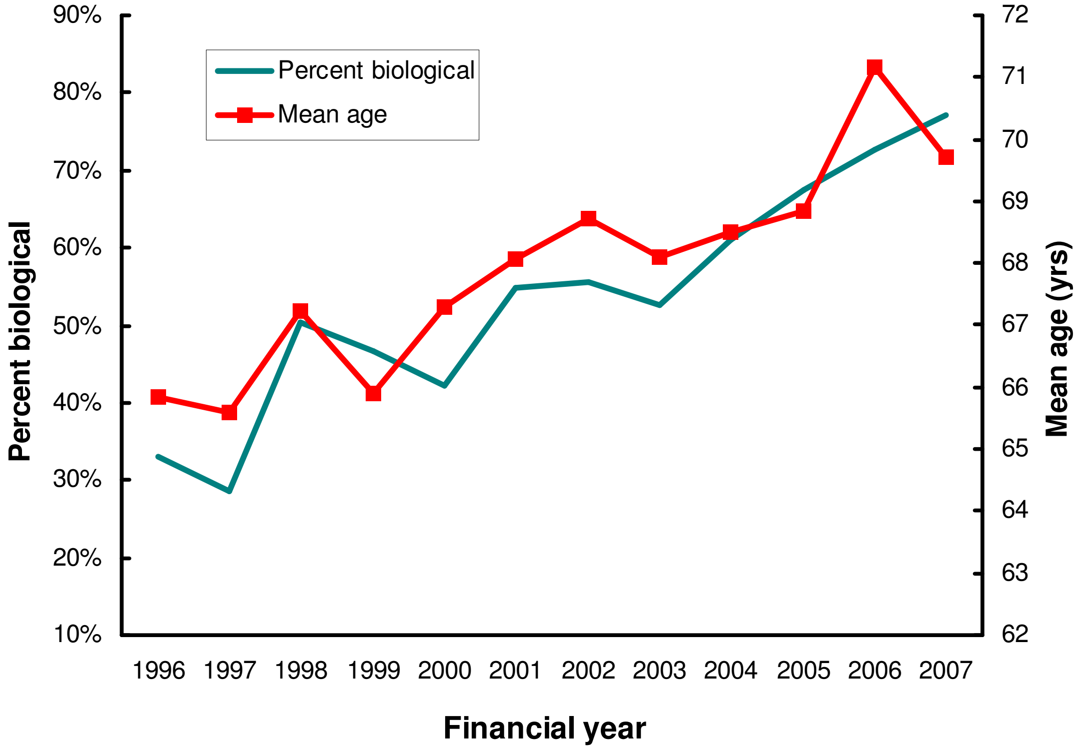


There has been a major and consistent increase in the number of aortic valve procedures undertaken in our institution from around 150 between 1996-2000 to more than 300 in 2007-8. This represents a doubling of the frequency of this operation in less than 10 years. It seems likely that as patients get older the frequency of aortic valve disease increases and is more a reflection of the changing surgical population and it applicability to older patients than any actual change in surgical technique. This is a trend which is mirrored in the UK as a whole with an doubling of activity from 1964 aortic valve replacements in 2001-2 up to 3968 procedures in 2007-8.

As was stated earlier, there continues to be a marked predominance of biological prostheses, which is a reflection of our aging population. The age of patients undergoing aortic valve replacement is around 70 and although in the current year of study there was a small fall in the mean age to just under 70 the overall trend is one of increasing age. There is a continuing trend towards the implantation of biological substitutes and at 77% this is the highest proportion we have yet recorded (Figure 21).

In our centre in the last 18 months a multidisciplinary team including cardiologists, surgeons and anaesthetists has embarked on a programme of percutaneous aortic valve replacement. The patients selected have predominantly been elderly patients at the higher end of the surgical risk spectrum. The mentorship programme has been successfully completed with 25 procedures undertaken with good results. It remains to be seen what impact this will have on the applicability of surgical valve replacement.

Figure 22: Trend in biological prosthesis use for aortic valve replacement
1st April 1996 – 31st March 2008 (n=2,350)



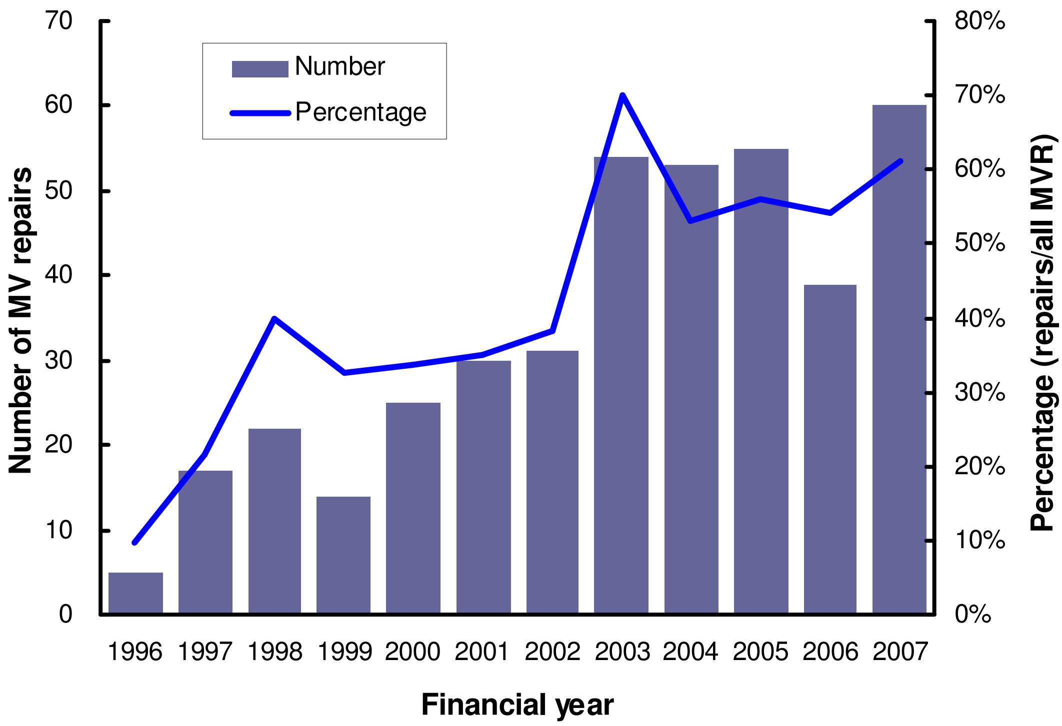
In recent years the profile of mitral valve disease has changed. The aetiology is now predominantly ischaemic or degenerative rather than rheumatic. In degenerative cases mitral valve repair is preferred because of better long-term survival and preservation of left ventricular function as well as potential freedom from anticoagulation. Increasingly, it is becoming clear that even asymptomatic patients with severe mitral regurgitation - particularly if there is any evidence of left ventricular dysfunction - stand to benefit from early valve repair. There are clear guidelines for referral for surgical intervention, but in some instances the benefit clearly depends on the potential for effective repair.

Successful valve repair depends on three key ingredients. Firstly, effort has to be invested in preoperative imaging to precisely define the nature of the mitral valve abnormality. Secondly, a range of surgical techniques need to be acquired, particularly in the use of artificial PTFE chordae to treat prolapse of the anterior mitral leaflet. Lastly, the very best results are likely to be achieved by limiting activity to surgeons performing at least 25 procedures per year.

Guidelines for running an effective valve repair service have been defined and we intend to move towards this model.

During 2007-8 a total of 111 procedures were performed for mitral valve disease. Of these 36 procedures involved concomitant CABG (32%). This was a major increase (35%) over the 82 procedures performed in the previous year. In this year there were 64 primary mitral valve procedures with or without ablation of atrial fibrillation (AF) with one death (1.6%). This compares favourably when benchmarked against the UK performance with a mortality of 2.6% for isolated primary mitral valve procedures. Over a total of 12 years we have achieved an institutional mortality of 4.4% which is close to the current UK average of 2.5%. Over this period, with the increasing trend towards valve repair, mortality has dropped and our own current performance outperforms average UK performance. In the re-operative group there were 13 procedures with one death.

Figure 23: Trend in isolated primary mitral valve repair
1st April 1996 – 31st March 2008(n=915)



Valve replacement was undertaken in 39 patients, and of these 26 underwent mechanical valve replacement (67%). In 34 procedures for mitral valve repair/replacement with concomitant CABG (with or without AF ablation) there were three deaths (8.8%). This takes the outcome for our patients over the 11 year period of study to 22 deaths in 293 patients or 7.5%, which is again close to the UK average of 7.7% (CCAD 2007-8)

In the 98 patients who underwent primary mitral valve procedures (+/- CABG,+/-ablation) there were 60 who underwent valve repair (61%). This is the largest number of mitral valve repairs yet undertaken in the Bristol unit in a single year and this is set to increase further. There were four procedures involving concomitant mitral and tricuspid surgery in all of whom tricuspid valve repair was possible. Figure 23 shows the trend in mitral valve repair at the BRI, with a trend towards increasing volumes of mitral valve surgery with an increasing proportion of patients undergoing reparative procedures..

Radiofrequency ablation of atrial fibrillation (AF) at the time of mitral valve repair is considered a valuable adjunct in avoiding the need for long term anticoagulation with warfarin and its potential complications. In the year of study 24 patients underwent AF ablation in association with other valve surgery, the most common of which was mitral valve repair (17 patients).

Joint aortic and mitral valve procedures were undertaken in 14 patients with two deaths (14.0%). Of these, 13 were isolated primary procedures with two deaths. These are small numbers to draw conclusions from. Over the last 11 years we have undertaken 114 procedures with only six deaths (5.3%), which is an excellent institutional record.

8. Other Procedures

a) Adult Congenital Heart Disease

The Royal Bristol Hospital for Children together with Bristol Royal Infirmary provide a comprehensive clinical service for children and adults suffering from congenital heart disease. This service covers a much wider geographical area than the adult service, extending into Devon and Cornwall and South Wales. Those patients over the age of 18 are treated in the BRI. Patients with congenital heart disease live longer and as a consequence this service will expand. The service currently includes interventional cardiology and electrophysiology and pacing treatments as well as surgical correction of heart defects.

In terms of the presentation of these procedures within this report it should be noted that they are always somewhat underrepresented because congenital heart disease patients who undergo valvular heart surgery are classified along with acquired heart disease patients in Chapter 8.

In the current period there were 43 procedures with one death. This means that over the last seven years 197 procedures have been performed with just four deaths (2%). This is a group with a wide range of complexity - from the 12 patients who underwent closure of an atrial septal defect to the largest group of 18 patients undergoing surgery to the pulmonary valve or right ventricular outflow tract. We have shown now over a number of years that we can consistently offer a high quality surgical service for this group of patients and in the current 12 months we are already seeing further expansion of this service.

b) Surgery of the Thoracic Aorta

This year saw us maintain our increased activity in this area with 62 aortic reconstructions. There were seven deaths in this relatively high risk group with an overall mortality of 11.3% (Table 4). Over the last 12 years as a group we have now undertaken 524 thoracic aortic reconstructions with 67 deaths - an overall mortality of 12.8% - which is just below the last published UK figure of 13.7% (NACSD 2003). Within this group the most challenging patients are those with acute dissection of which there were 19 patients this year with three deaths.

In addition, a full range of aortic reconstructions including aortic arch replacement and resection of thoracoabdominal aneurysms were performed. However, the ongoing development of endovascular stenting with the advent of hybrid approaches has reduced the number of descending thoracic aortic operations and thoracoabdominal reconstructions to a very low level.

We have continued to develop our multidisciplinary team for endovascular stent grafting for thoracic aortic disease and this is now standing at around 50 procedures undertaken in total. The application of this technique includes traumatic aortic rupture (where it has really supplanted the role of conventional surgery), aneurysmal disease limited to the descending aorta, and type B (descending) aortic dissection where the indications are still evolving.

Table 4: Aortic surgery, 1st April 2000 – 31st March 2008

	2000	2001	2002	2003	2004	2005	2006	2007
Aortic procedures	45	37	41	43	46	34	67	62
Total procedures	1,124	1,127	1,105	1,170	1,485	1,414	1,430	1,471
Percentage	4.0%	3.3%	3.7%	3.7%	3.1%	2.4%	4.7%	4.2%
Deaths	7	3	3	9	7	4	5	7
Mortality rate	15.6%	8.1%	7.3%	20.9%	15.2%	11.8%	7.5%	11.3%

9. Postoperative Recovery

The main indices of postoperative recovery used in the unit are:

- duration of postoperative mechanical ventilation;
- intensive care unit length of stay;

- hospital length of stay

This information is presented in Figures 23 – 25 which cannot be viewed without bearing in mind the changing profile of our patient population: we are operating on more elderly and less fit patients as may be witnessed in Figures 4, 9, 11 and 12 (presented earlier in this report). Despite this, it can be seen that the overall trend is a tendency towards a quicker recovery with decreased times to extubation and also decreased time to hospital discharge.

Figure 24: Duration of mechanical ventilation
With standard errors for the mean
1st April 2000 – 31st March 2008 (n=9,967)

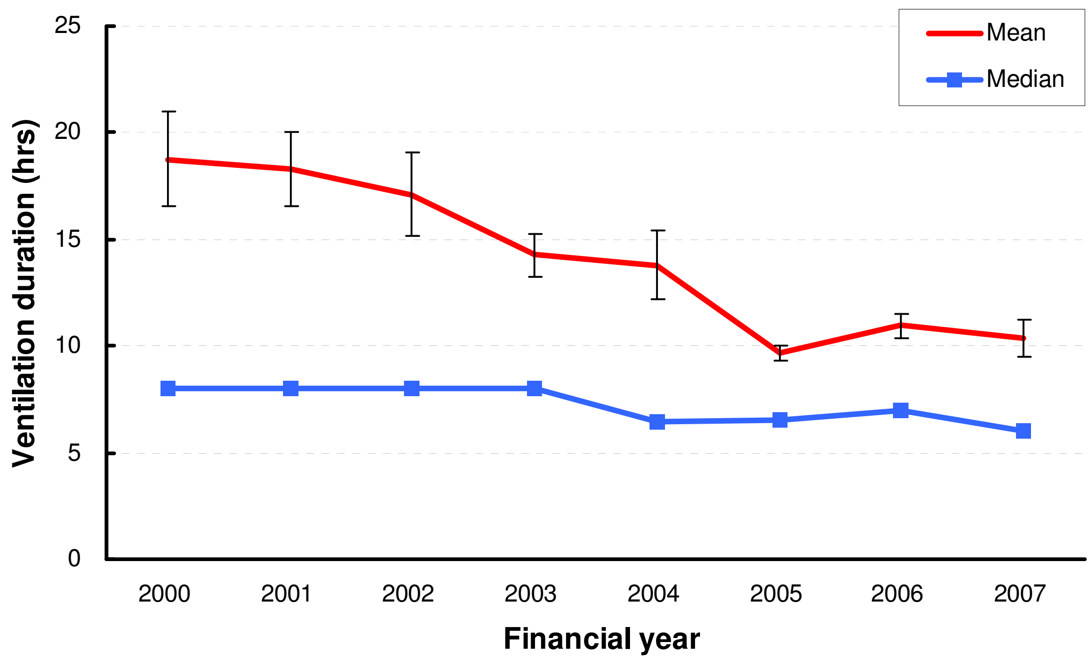


Figure 25: Cardiac Intensive Care Unit (CICU) length of stay
With standard errors for the mean
1st April 2000 – 31st March 2008 (n=9,967)

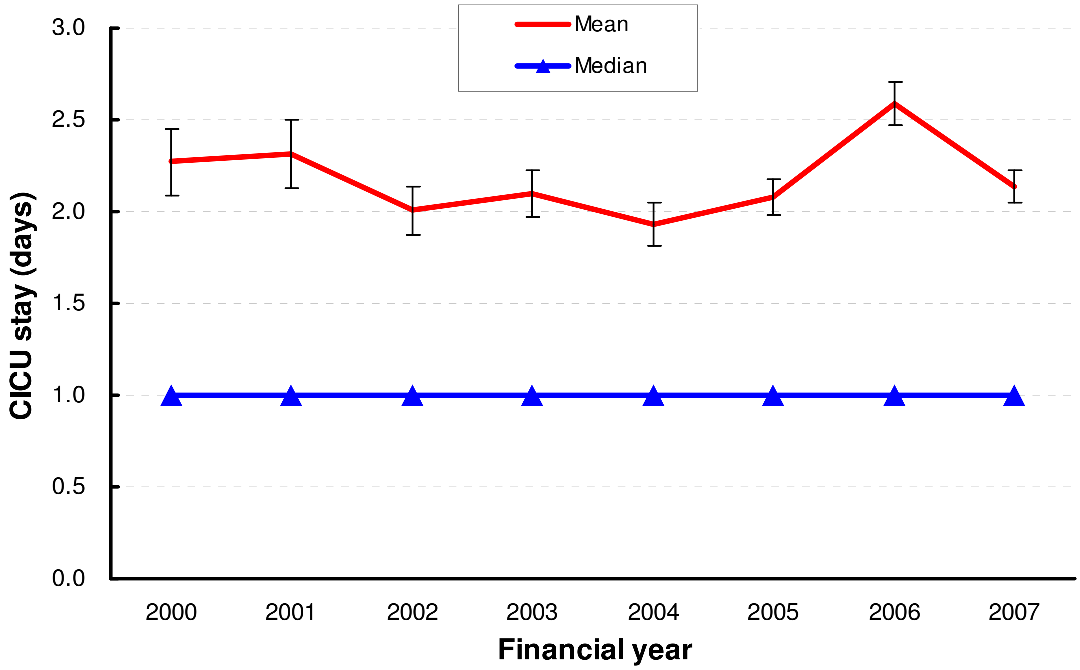
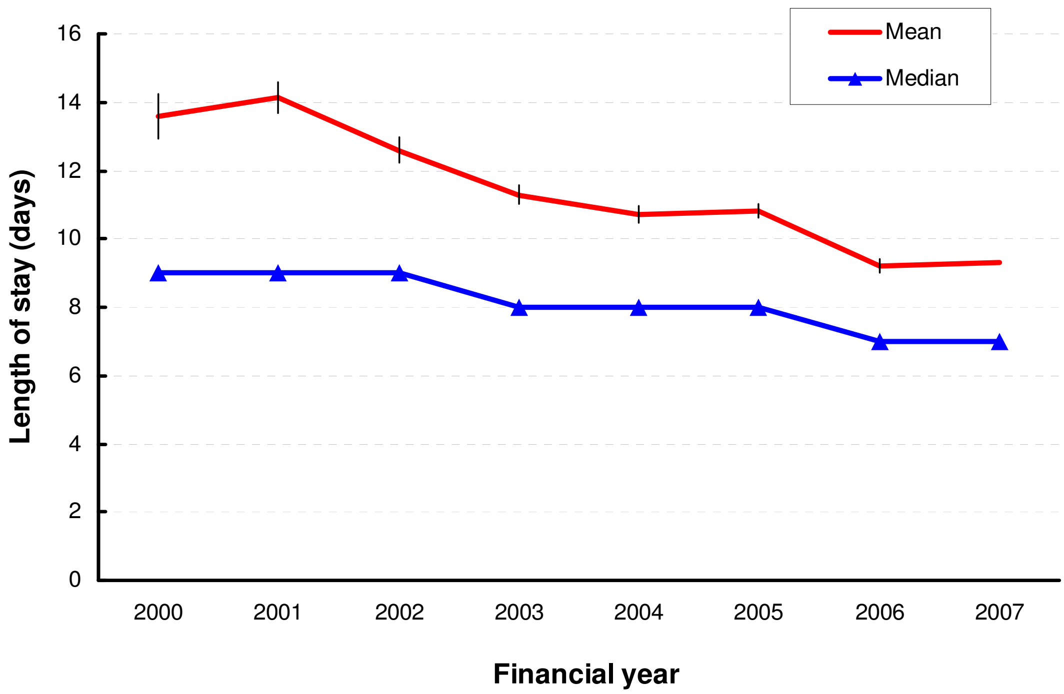


Figure 26: Post-operative length of stay
With standard errors for the mean
1st April 2000 – 31st March 2008 (n=9,967)



Regarding the duration of stay on the cardiac surgical intensive care unit (CICU), the median remains at one day and the mean which had risen last year because of a cohort of long stay patients is back down again this year. We have been able to reduce postoperative hospital stay from a mean of around 14 days in 2000 to just over 9 in the current year of study with the corresponding median figures reducing from 9 days to 7days. In any case, taken as a whole the figures are consistent with a high quality of care and, as such, are gratifying. We hope to be able to continue this trend of decreasing hospital stay within the new Bristol Heart Institute so that we can optimally use the new facilities.

10. <u>Postoperative Morbidity</u>

The collection of data for postoperative morbidity continues to represent one of the biggest challenges to our audit programme. There are several reasons for this:

1. The practical issues of clinical staff entering data while working on a busy intensive care (or ward environment), where clinical care tasks obviously carry greater priority. This differs to data entry in theatre which can usually be carried out at moments of convenience during quieter parts of the procedure or, in the case of entry of surgical data, after completion on the operation. In the CICU, for example, such quiet moments do not always arise since there is often pressure to move the patient to a different part of the unit to create space for a new patient.;

2. The person entering the data will not have looked after the patient throughout the postoperative period and may therefore be less familiar with all aspects of the patient's postoperative course. For example, when entering data for a patient who has been in CICU for over three weeks, it may be possible to be unaware of a successfully treated episode of sepsis earlier in their course. Once again, this situation contrasts with the short period in the operating theatre where the same

clinicians (surgeon and anaesthetist) are usually with the patient throughout the procedure;

3. The assessment of some postoperative complications (such as myocardial infarction or sepsis) may not always be straightforward.

In order to address these issues, we have moved to a system whereby all data for postoperative complications is entered by the medical team. We believe that this has improved the quality of our data collection, although there are still instances where certain data fields are not filled in - we currently do not have the resources within the audit team to individually 'chase' such discrepancies. Consequently, these issues should be borne in mind when interpreting the data for postoperative complications.

The following areas of postoperative morbidity are presented in Figures 27 – 33:

- Reoperation for 'early' postoperative bleeding;
- Renal deterioration (rise in creatinine to greater than 200 µmol/L; requirement for haemofiltration);
- Requirement for intra-aortic balloon pump support;
- New neurological deficits (either temporary or permanent);
- Septic complications (septicaemia or requirement for sternal reconstruction);
- Gastrointestinal complications (GI bleed, pancreatitis, need for laparotomy);
- Respiratory complications (pneumonia; need for tracheostomy)

In general, the data presented shows little change in the incidence of most postoperative complications over the past two to three years. One area where there does appear to be a continuing change is the persistent fall in the proportion of patients requiring resternotomy for bleeding or cardiac tamponade. This was necessary in approximately two per cent of cases during the year in question, which represents a fall to 50% of the levels five years ago. Such an improvement is likely to be multi-factorial reflecting improved surgical technique, the use of pharmacological agents like aprotinin and tranexamic acid and the use of thromboelastography perioperatively to manage coagulation defects appropriately.

Figure 27: Trend in resternotomy for bleeding/tamponade – all cases
With standard error bars for binomial proportions
1st April 2000 – 31st March 2007 (n=10,308)

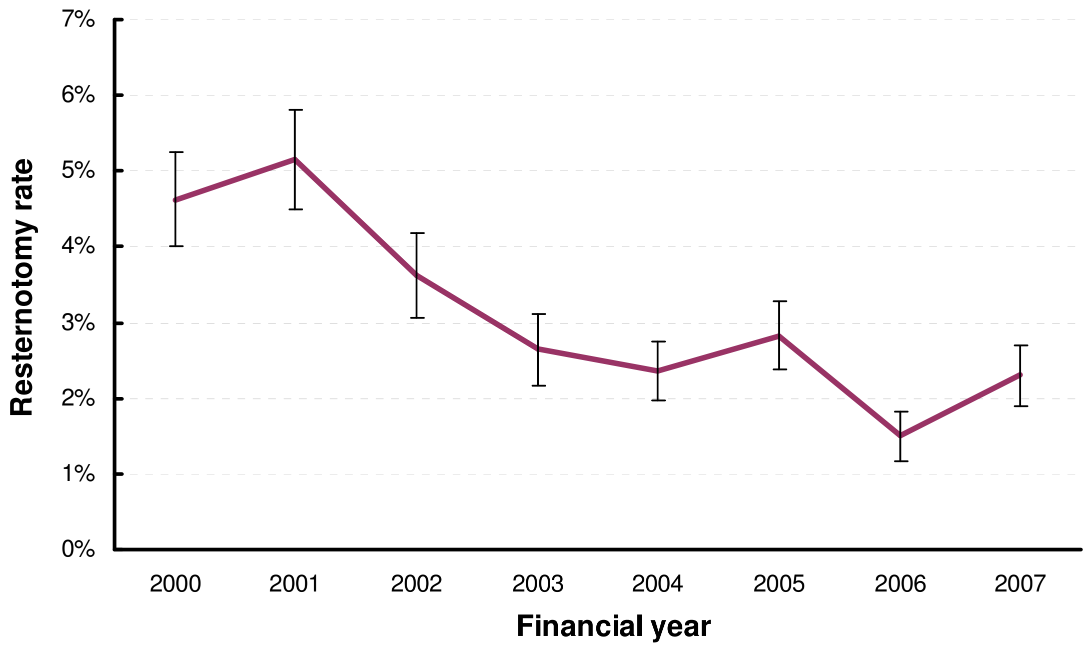


Figure 28: Trend in post-operative renal morbidity
1st April 2000 – 31st March 2008 (n=10,000)

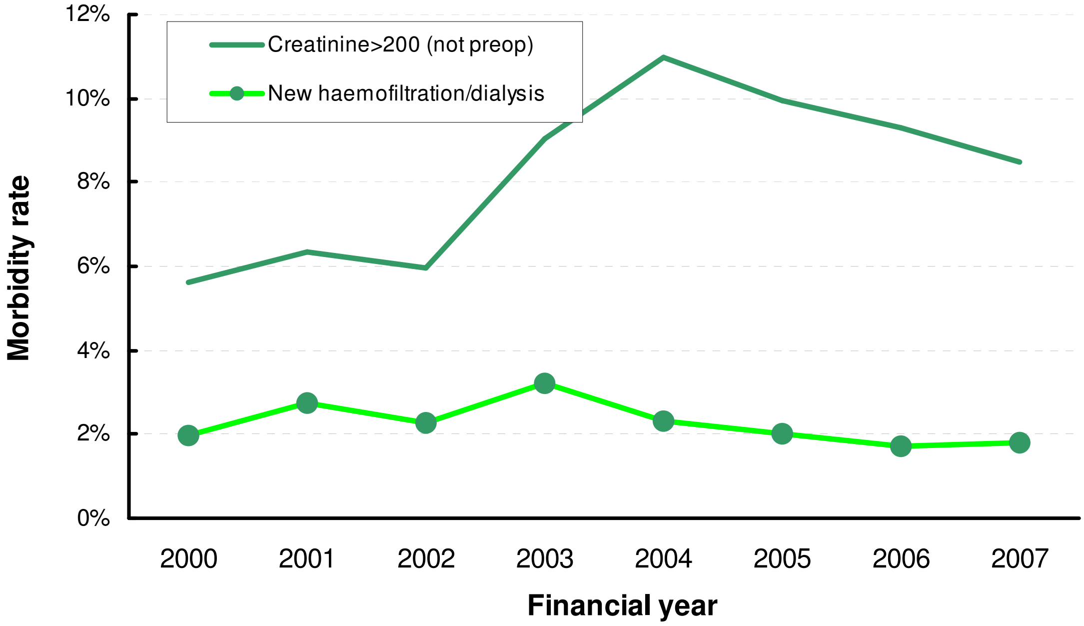


Figure 29: Trend in post-operative IABP support
with standard error bars for binomial proportions
1st April 2000 – 31st March 2008 (n=10,163)

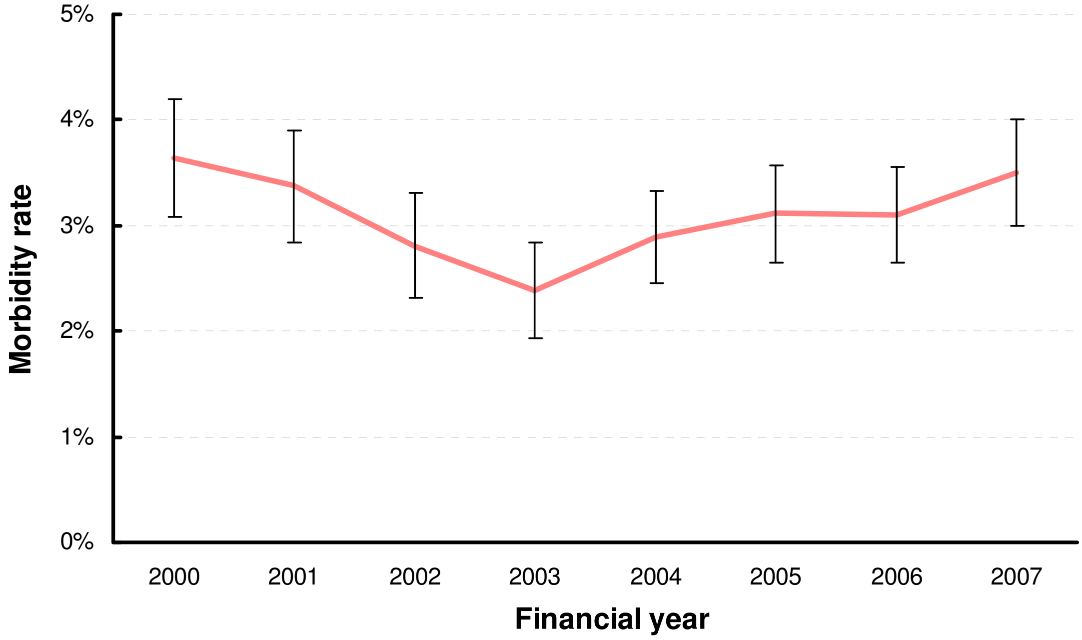


Figure 30: Trend in post-operative neurological morbidity
1st April 2000 – 31st March 2008 (n=10,163)

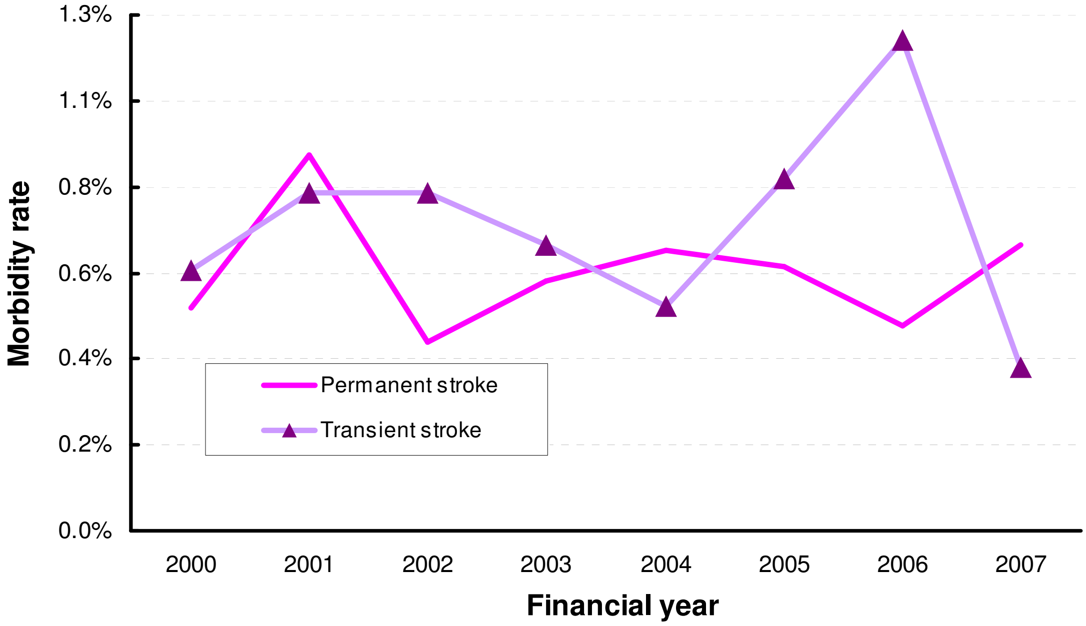


Figure 31: Trend in major infective complications
1st April 2000 – 31st March 2008

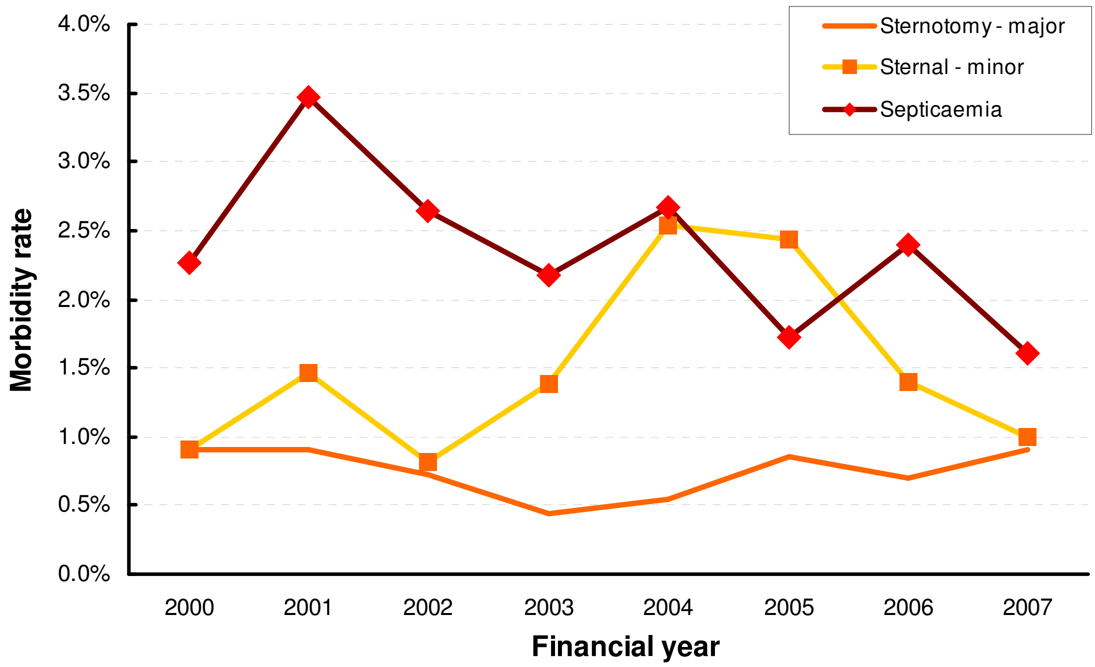


Figure 32: Trend in Gastrointestinal complications
With standard error bars for binomial proportions
1st April 2000 – 31st March 2008 (n=9,895)

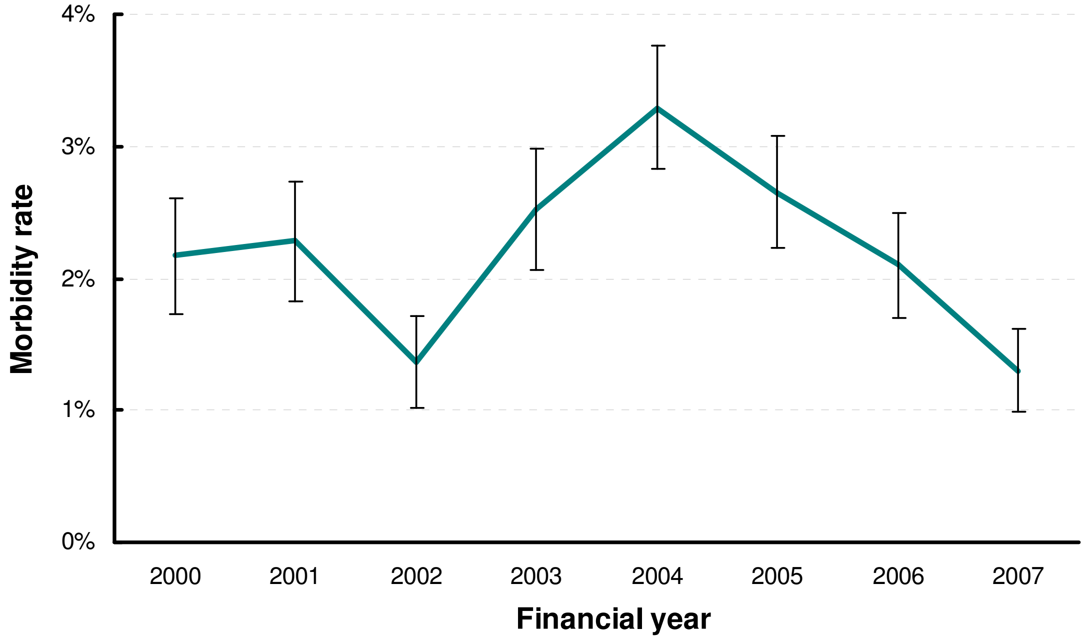
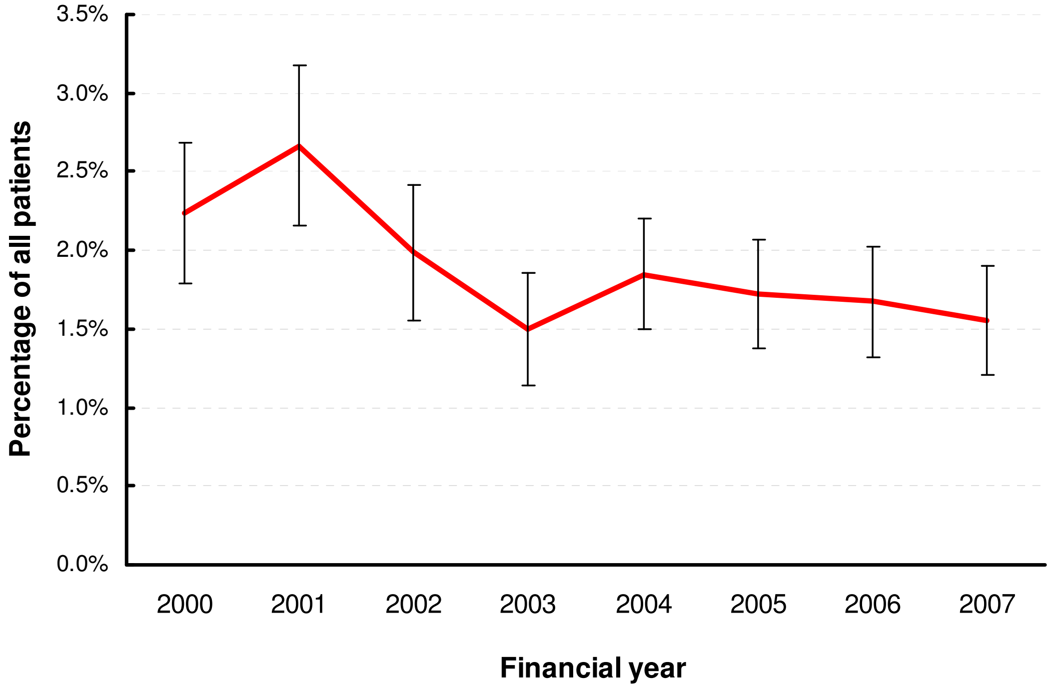


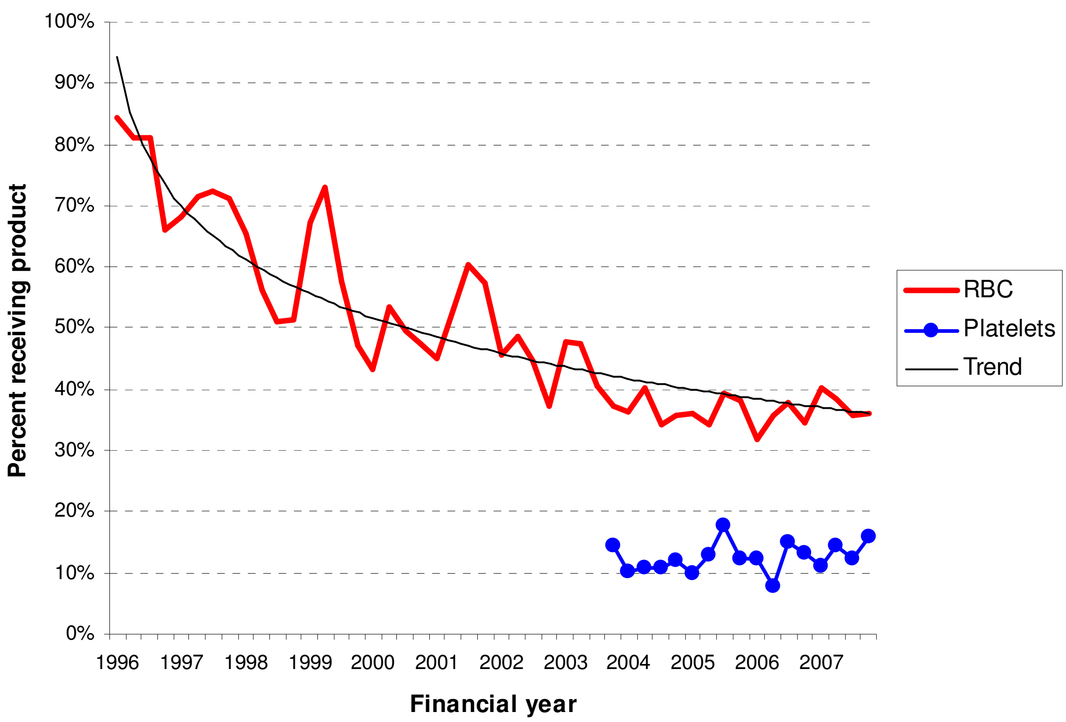
Figure 33: Trend in tracheostomy rate
with standard error bars for binomial proportions
1st April 2000 – 31st March 2008 (n=9,734)



There is a drive in the UK to compare and benchmark different units with respect to both mortality and morbidity. There is some contemporary information available for morbidity with respect to major morbidity and with respect to these we represent the UK figures for 2007-8 in parentheses after our own local figures: Mortality 2.7%(3.1%), Reoperation for Bleeding/Tamponade 2.3% (3.8%), Neurological deficit/stroke 1.1%(1.6%). All of these figures can act as encouragement to us to continue to develop our practice.

Figure 33 show trends in our transfusion practice. The huge drop in red cell usage over the past ten years has been commented on in previous reports and is consistent with the increased importance placed on blood conservation within modern surgical practice. This trend has levelled off in recent years – currently between 32% and 40% of our patients are given red cells and 8% to 18% are given platelets. Again, this has to be set against the decreased fitness of our current patients.

Figure 34: Trend in blood product use – all cases
1st April 1996 – 31st March 2008 (n=14,866)

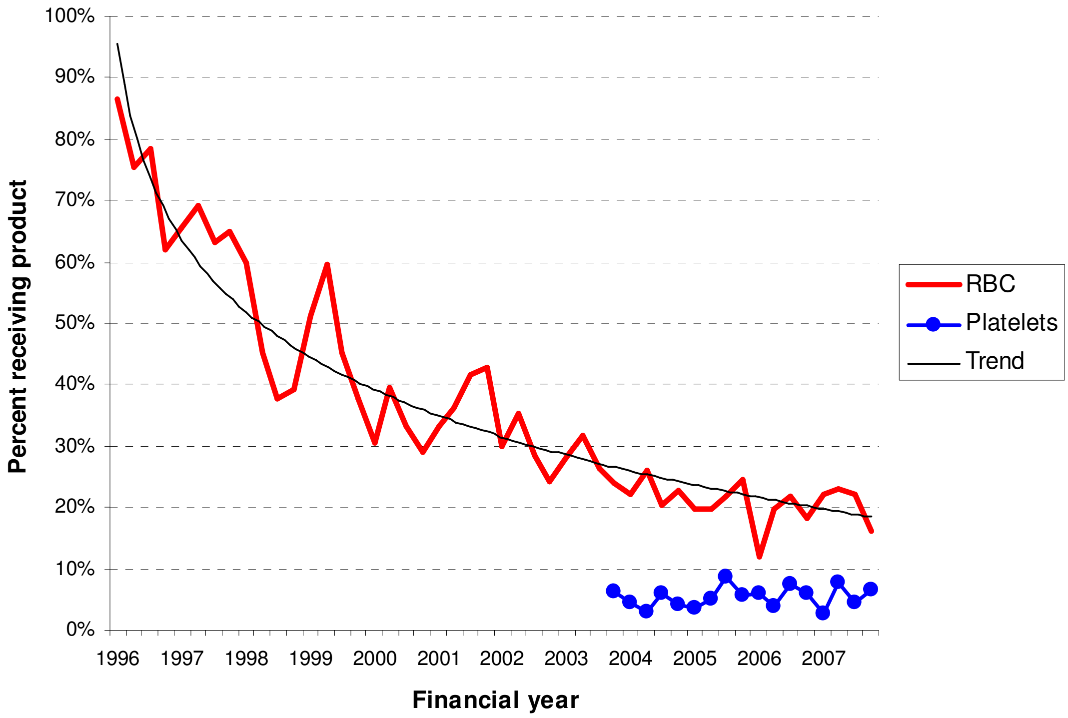


In order to minimise the confounding effect of the change in patient age and fitness, we also examine transfusion figures in a subset of our patients deemed ‘low risk for transfusion’:

- *isolated primary CABG cases undergoing elective or urgent surgery;*
- *patients under 75 years of age and over 55 kg in weight;*
- *patients who were not returned to theatre for reoperation because of bleeding;*
- *patients who did not require an intra-aortic balloon pump, pre or post-operatively*

The transfusion rates in this group are shown in figure 34. The transfusion rates are generally lower (12% – 25% for red cells; 3% – 9% for platelets) and show little change over the past few years, despite the vast increase in patients receiving antiplatelet drugs, particularly clopidogrel. All in all, these figures suggest good transfusion practice, although we believe that there is still room for further improvement.

Figure 35: Trend in blood product use – cohort group
1st April 1996 – 31st March 2008 (n=7,900)



11. Assessment of Surgical Performance

At Bristol we have now completed 12 years of prospective monitoring of performance. Back in the late 1990's we simply submitted our individual mortality data for isolated primary CABG to the UK Cardiac Surgical Register. Data were neither risk-adjusted nor validated. Since then data requirements and presentation have gone through a series of changes. The current status is that for the fourth year we are presenting surgeon-specific outcomes for ipCABG, ipAVR and for all procedures (Appendix 5). We now upload all of our data directly to the Central Cardiac Audit Database (CCAD), and some surgeon-specific data that is extracted from this is presented on the Care Quality Commission website:

www.cqc.org.uk

There continues to be controversy in the cardiothoracic surgical community as to whether this approach is beneficial or not; indeed not all centres contribute to this initiative or present their own surgeon-specific data.

There are a number of ways in we can undertake monitoring of our performance. We can compare the crude mortality for ipCABG operations and all procedures against the UK average for 2007-8 (Figures 35 & 36), or we can produce a 'funnel plot' (Figure 37) which is perhaps a more accessible means of comparing rates between firms. A funnel plot is actually two plots: the first is an X-Y plot of surgeon mortality rate against the number of procedures they undertook (blue dots); the second is an X-Y plot of 95% (thin lines) and 99% (thick lines) confidence intervals for the national mortality rate for ipCABG (1.56%, CCAD 2005/8) against the number of procedures. As sample sizes increases, statistical error decreases, and this law can be observed by the 'funneling down' of the confidence intervals with an increasing number of operations. If an individual point lies within the inner 95% confidence envelope then an individual surgeon's performance is not statistically different from the national rate at this level. Figure 38 shows the crude mortalities for all nine surgical firms in the unit for ipCABG procedures during the period 1st April 2007 to 31st March 2008. As can be seen, the performance of seven of our firms falls within the inner 95% confidence envelope, whilst the performance of two firms falls clearly below the lower 95% confidence limit of the national rate, which is indeed exemplary.

However, we have already identified differences in the risk profile of the caseloads of the individual consultant surgeons (Figures 13 & 14). While comparisons of outcomes for CABG operations may be made relatively straightforward by utilising nationally published mortality rates, comparisons of surgeons with grossly different caseloads for other operations is difficult at the national level. In our own unit, we can see from appendix 2 that the distribution of procedure types is quite different between consultant firms, and it remains difficult - even locally - to fully adjust for such differences in caseload. In general, the use of raw mortality statistics is to be avoided.

Figure 36: Mortality rates for all procedures by surgeon firm
with 95% confidence intervals for Poisson rates
1st April 2007 – 31st March 2008 (n=1,471)

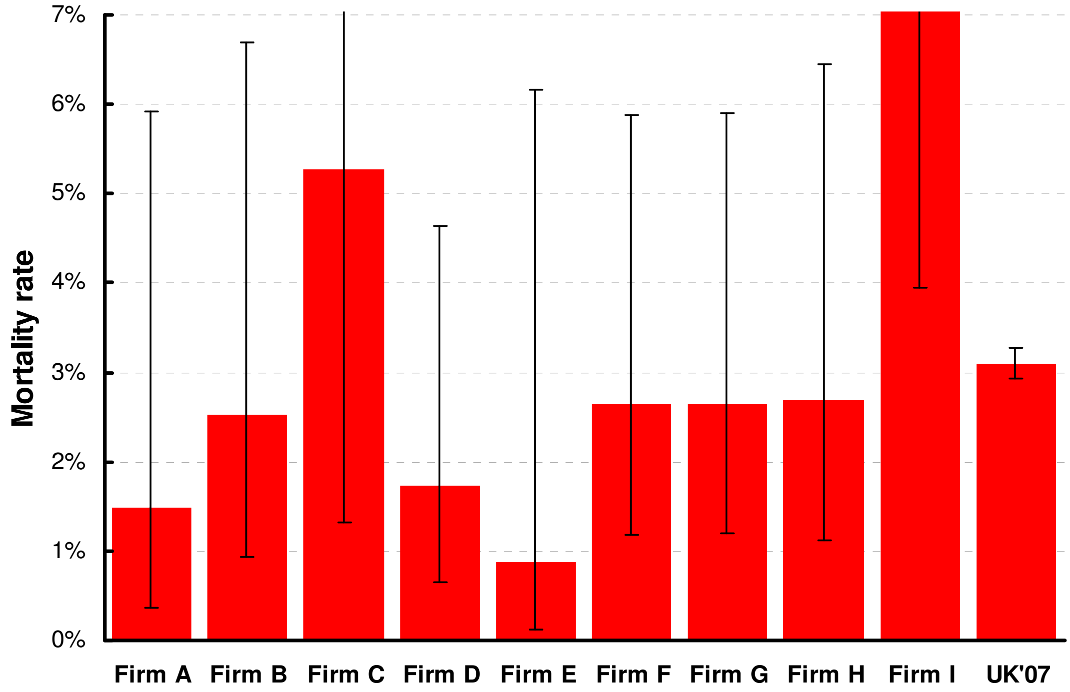


Figure 37: Mortality rates for ipCABG by surgeon firm
with 95% confidence intervals for Poisson rates
1st April 2007 – 31st March 2008 (n=854)

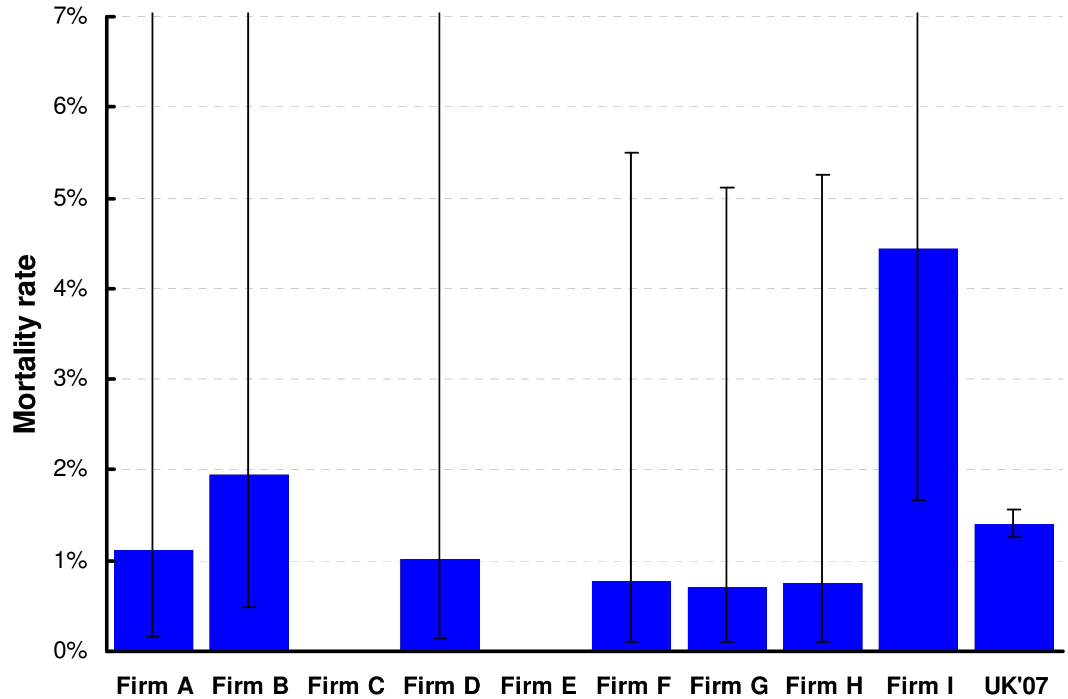
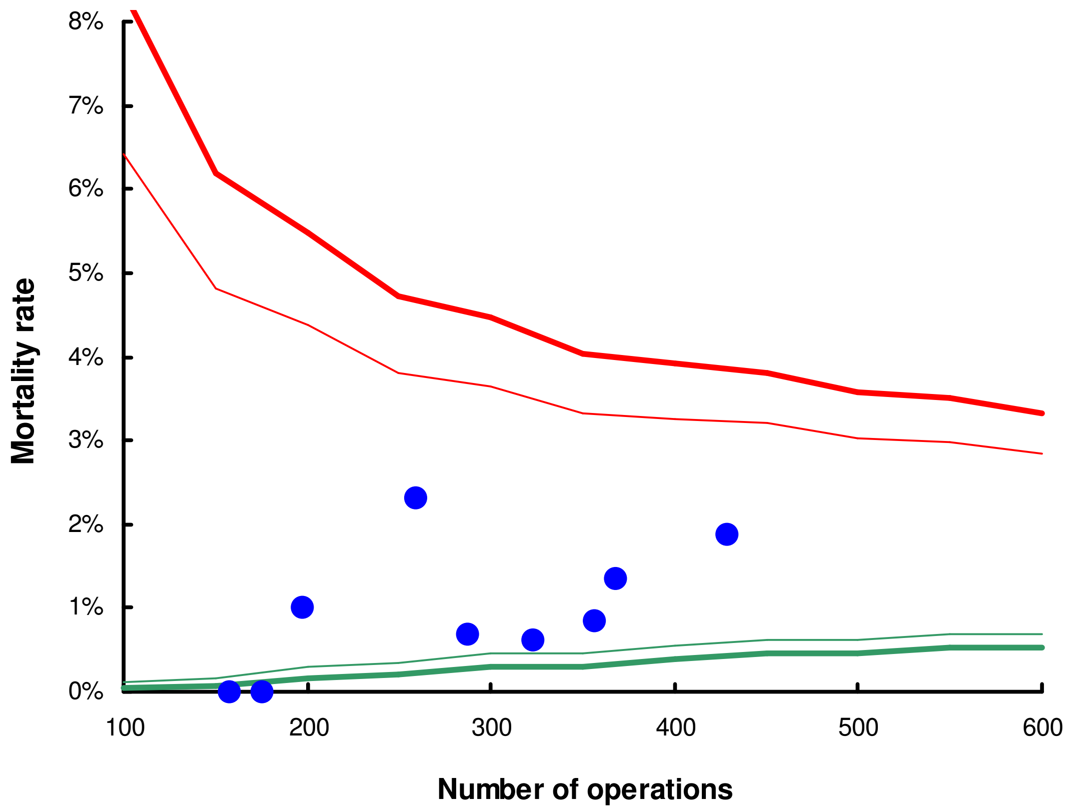


Figure 38: Funnel plot for isolated primary CABG
1st April 2005 – 31st March 2008 (n=2,629)



For ongoing monitoring of outcomes after CABG we have been using the Sequential Probability Ratio Test(SPiRiT)[6]. This test takes the form of a simple adaptation of a cumulative "observed-expected" plot, with horizontal thresholds which are risk-adjusted. Figure 38 shows the SPiRiT plot for the last four years to determine whether the mortality rate of any firm is approaching double the national rate using euroSCORE as the basis for risk-adjustment. No firm even remotely approaches such a level of underperformance. Figure 39 is a similar plot to test whether any firm has managed to perform at half the national mortality rate after adjusting for case-mix.

Figure 39: Sequential Probability Ratio Test (SPiRiT) plot for doubled mortality rate isolated primary CABG, 1st April 2005 – 31st March 2008 (n=2,629)

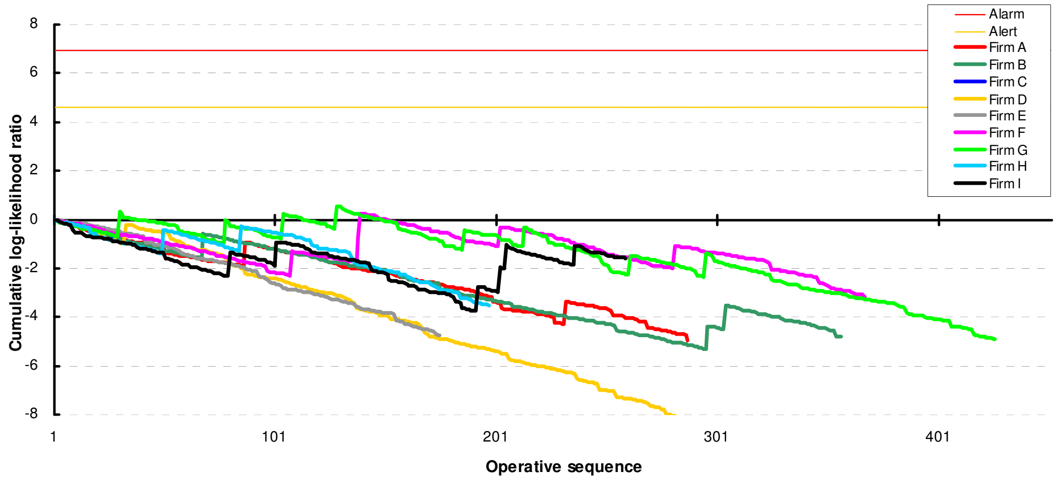
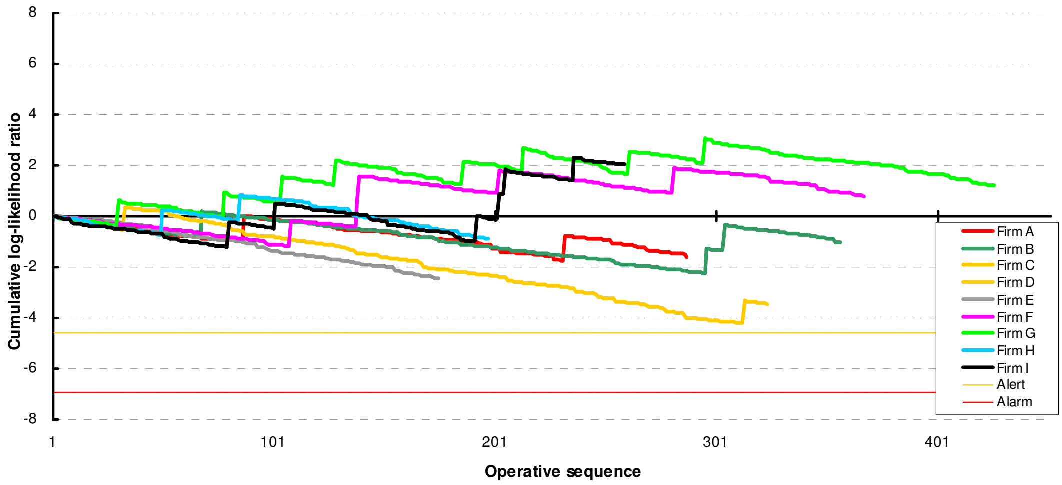


Figure 40: Sequential Probability Ratio Test (SPiRiT) plot for halved mortality rate isolated primary CABG, 1st April 2005 – 31st March 2008 (n=2,629)



After *The Guardian* newspaper forced publication of poorly-presented surgeon-specific data in 2005 (by exercising rights under the *Freedom of Information Act*), we resolved to independently and comprehensively present our data for isolated primary CABG, isolated primary AVR and all procedures in a user-friendly format. For this purpose mortality data are presented as observed against expected outcomes plots derived using euroSCORE as the reference point for expected outcome. Charts for individually named surgeons and the unit as a whole are presented in Appendix 5. Most of the outcomes are better than expected, and all are within the 95% confidence limits for statistical variation. What remains at issue is whether the presentation of surgeon-specific data is helpful to the doctor or the patient.

On the positive side, it has generally been observed that, where quality improvement programmes feedback information with respect to outcomes, then outcomes will improve [6]. It is also generally seen as positive that such information is available for patients to make an informed choice about where they go for surgery and who does it.

On the negative side, we see that quality improvement programmes with public disclosure appear to have a similar beneficial effect to those with no disclosure - bringing into doubt the benefit of the 'public aspect' of disclosure above that of performance monitoring[7]. Indeed, around 12% of patients have been found to consult surgeon-specific data prior to treatment [8]. There is also no evidence from North America of a shift of patients from high to low mortality centres[9], and even surgeons themselves have said in informal surveys that they would not base their own choice of surgeon on mortality data. A great concern is that disclosure of surgeon-specific data could actually work against public interest by encouraging risk-averse behaviour, with surgeons not taking on high-risk cases. Disclosure stimulates competitive behaviour between surgeons and centres, encourages 'gaming' in a number of firms, and has the potential to have a negative impact on teaching. We must also remember that the psychology of disclosure is such that it may affect the practice of some surgeons but not others, and will depend on individual circumstances.

By way of example of the efficacy of non-disclosure, we have used various performance data and associated techniques to develop individualised logbooks for all surgeons and cardiac anaesthetists within the unit (Appendix 4). These logs provide information with respect to outcomes and morbidity, comparing these with the unit's overall performance and national statistics. These have proven extremely useful for personal feedback and professional appraisal, and may serve as a model for other specialties to adopt when their data collection reaches an appropriate stage.

12. Development of Quality of Care Indicators

For some years risk-adjusted mortality has been used as the standard measure to evaluate institutional and individual performance for CABG surgery. This is despite the fact that this approach has an uncertain link to the overall quality of care. Quality of care has been defined as *"the degree to which health services for individuals increases the likelihood of desired health outcomes and are consistent with current professional knowledge"*. A number of authors have evaluated the potential for the use of a range of quality indicators for assessment of CABG surgery, and there is now a significant impetus to develop a quality of care framework by the SCTS.

The STS has published a detailed "manifesto" in relation to quality measurement in cardiac surgery[10-12] . This document describes both the conceptual framework and measure selection and subsequently the statistical considerations to be applied to generate composite measures of quality and provider ratings. Essentially the STS arrived at a composite of 11 markers of quality for CABG procedures and there is a detailed justification of these choices.

One of the most detailed initiatives of this kind is described at **www.qualitycabg.org** and published by Guru et al [10]. In this initiative the primary focus is directed towards institutional quality of care rather than individual surgeons. The factors examined include those relating to the structure of the service; for instance, staffing ratios or institutional volume - those relating to the process of the surgery; for instance, the usage of the left internal mammary artery to bypass the LAD coronary artery - and finally those relating to outcomes; for instance, hospital survival or freedom from reoperation for bleeding.

While this idea is a simple one there may be a number of factors which may hamper its successful implementation. These may include:

1. Accuracy of data collection for end points other than those absolutely clearly defined such as death;
2. Lack of certainty of the association with quality of care for a chosen variable;
3. Factors relating to the efficiency of delivery of the service which may be distorted by central/network directives - for instance, waiting times which cannot be breached.

Our proposal is to develop a scale of multiple indicators that reflect the care we provide, and which relate to process delivery and outcome. These factors will be presented as percentages and will be summated to generate an overall CABG Quality Score. This will inevitably be an evolving process to begin with, as we may select some dimensions which may need to be re-defined or discarded as we gain greater understanding. It may also be that, as a national view unfolds through SCTS, we will move toward a professionally-agreed approach.

The factors to be included at the outset will be:

1. % of patients where the LAD is grafted when the IMA is used;
2. % of patients leaving the base hospital alive after surgery;
3. % of patients leaving the base hospital without evidence of a stroke;
4. % of patients who do not require insertion of an IABP either intra or postoperatively;
5. % of patients who did not require reoperation for bleeding;
6. % of patients who did not require new haemofiltration/haemodialysis;
7. % of patients not transfused with blood /blood products;
8. % of patients free of major sternal wound complications;
9. % of patients spending 24 hours or less on the ICU;
10. % of patients discharged on the 5th postoperative day or sooner.

These 10 dimensions will give us a maximum potential institutional score of 1000 (percentage points), and the higher the score we can achieve, the better the quality of care - at least in theory. At this stage in the evolution of our quality score system there is no weighting of the individual dimensions – all are considered equally as important. We have omitted some potentially useful factors such as perioperative myocardial infarction because of concerns about accurate diagnosis. Other potentially useful markers - like freedom from late revascularisation – have been omitted because they obviously require a long interval before presentation. We have also omitted some markers considered by the STS to be of value like preoperative beta blockade because we do not collect the information. It is of course possible to argue the converse case for certain factors e.g. that a higher use of IABP may be a marker of a good, rather than a bad service; reflecting a service willing to take on a greater proportion of higher-risk patients. This argument is intrinsically circular and ultimately gets us nowhere: provided we index the overall quality score against our risk profile, useful information may be generated.

Figure 41: Trend in Bristol Royal Infirmary CABG Quality score and operative risk isolated primary CABG, 1st April 2002 – 31st March 2008 (n=5,092)

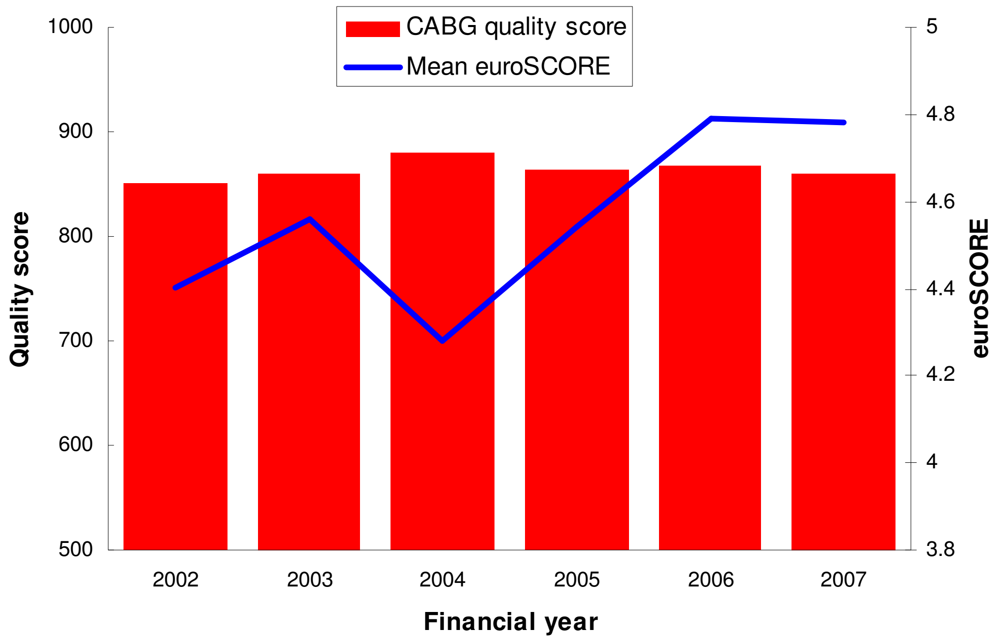
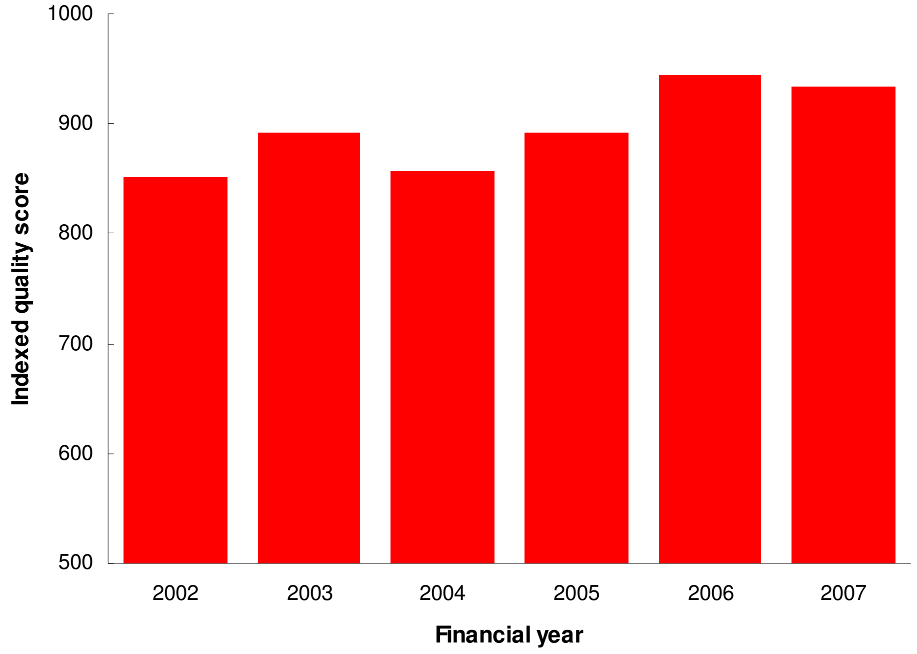


Figure 42: Indexed CABG Quality score (2002 as base year for risk) isolated primary CABG, 1st April 2002 – 31st March 2008 (n=5,092)



13. Key Conclusions

i) A twelfth year of comprehensive risk stratified outcomes data for the BRI adult cardiac surgical unit has been successfully completed. Whilst this has required substantial investment in terms of resources, the benefits of this at a number of levels have easily outweighed the investment.

ii) The overall mortality of 2.7% for all cases and 1.3% for primary CABG represent excellent outcomes and conform to contemporary UK(CCAD 1.4% CABG, 3.1% All Cases 07-08) and European standards.

iii) The proportion of primary CABG operations continues to decline and stands at around 58%. Around 40% of the patients are urgent in-hospital referrals and the significant variations in this workload makes service planning difficult. The cancelled operations rate of 5-15% of planned operating slots is subject to many influences but must be minimised to run the service efficiently and we continue to struggle with the problems which cause this

iv) The percentage of patients undergoing first time CABG without cardiopulmonary bypass has risen to more than 70% which is one of the highest rates in the UK.

v) The main change in the risk profile of the surgical population is increasing age. Fewer patients with severe LV dysfunction underwent coronary artery surgery, fewer had a history of recent myocardial infarction and more patients had had previous PCI

vi) The number of patients undergoing valvular heart surgery continues to increase and exceeded 450 procedures. This has mainly been because of a steep increase in the number of patients undergoing aortic valve replacement which has doubled in the last 10 years.

vii) Despite a static risk profile there is a steady but demonstrable reduction in mechanical ventilation time and hospital stay. Specific subsystem morbidity appears to be static or declining in most areas and notably appears to be better than UK average performance.

viii) After nine years of multidisciplinary effort there has been a marked reduction in the transfusion of blood and blood products such that now around 30-40% of patients will receive blood product transfusion around the time of cardiac surgery. In low risk CABG cases this is less than 20%

ix) For the period 2005-2008 the mortality rate for isolated primary CABG, isolated primary AVR and all procedures was significantly better than the predicted euroSCORE outcomes.

x) The individual performance of all surgeons specialising in adult cardiac surgery serving as permanent members of staff between 2005-2008, was within accepted ranges of predicted outcomes, as judged against the euroSCORE for ipCABG, ipAVR and all cases respectively..

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Appendix 1

Mortality rates for commonly performed procedures 1st April 1996 – 31st March 2008 (n=13,870)

**95 percent confidence interval for mortality rate*

	Number	Deaths	Mortality Rate	Lower bound	Upper bound	CCAD 2007-08
Isolated CABG	9,703	122	1.3%	1.1%	1.5%	1.4%
Redo CABG	270	10	3.7%	2.0%	6.9%	5.3%
Aortic valve procedure	1,413	42	3.0%	2.2%	4.0%	1.7%
AV + CABG	894	39	4.4%	3.2%	6.0%	4.3%
Mitral Valve procedure	659	29	4.4%	3.1%	6.3%	2.6%
MV + CABG	293	22	7.5%	4.9%	11.4%	7.7%
AV + MV Procedure	114	6	5.3%	2.4%	11.7%	N/A
Aortic	524	67	12.8%	10.1%	16.2%	N/A

Appendix 2

Distribution of procedure types between surgical firms 1st April 2007– 31st March 2008

	CABG	**Valve**	**Valve + CABG**	**Aortic**	**Congenital**	**Other**	**Total**
Angelini, G D	91	29	12	2	0	1	135
Ascione, R	108	26	19	2	0	4	159
Asimakopoulos, G	27	6	5	0	0	0	38
Bryan, A J	107	59	40	23	0	1	230
Caputo, M	42	31	9	7	26	0	115
Ciulli, F	133	53	28	5	0	8	227
Hutter, J A	146	42	24	10	0	4	226
Murphy, G	142	21	15	8	0	0	186
Parry, A	0	2	0	0	17	0	19
Yeatman, M	97	19	13	5	0	2	136
Total	893	288	165	62	43	20	1,471

Appendix 3

euroSCORE risk-stratified outcomes 1st April 2007 – 31st March 2008 (n=1,471)

	0 - 1			2 - 3			4 - 5		
	No.	Deaths	%age	No.	Deaths	%age	No.	Deaths	%age
CABG	175	0	0.0%	282	1	0.4%	240	3	1.3%
Valve	2	0	0.0%	63	0	0.0%	74	2	2.7%
Valve+CABG	0	0	0.0%	14	0	0.0%	39	1	2.6%
Aortic	1	0	0.0%	1	0	0.0%	11	0	0.0%
Other	0	0	0.0%	4	1	25.0%	3	0	0.0%
Congenital	0	0	0.0%	17	0	0.0%	12	0	0.0%
Total	178	0	0.0%	381	2	0.5%	379	6	1.6%
	6 - 7			**8 - 9**			**10+**		
	No.	Deaths	%age	No.	Deaths	%age	No.	Deaths	%age
CABG	120	3	2.5%	37	4	10.8%	33	2	6.1%
Valve	83	1	1.2%	39	3	7.7%	27	1	3.7%
Valve+CABG	53	2	3.8%	40	5	12.5%	18	2	11.1%
Aortic	11	1	9.1%	13	0	0.0%	22	6	27.3%
Other	4	0	0.0%	3	0	0.0%	5	1	0.0%
Congenital	7	0	0.0%	4	0	0.0%	2	1	0.0%
Total	278	7	2.5%	136	12	8.8%	107	13	12.1%

Appendix 4

Individualised Surgical Record

United Bristol Healthcare NHS
NHS Trust

Mr I Cutwell

Journal for the period:	**1st April 2005 - 31st March 2006**
Data source:	PATS database
Compiled by:	D J Finch, Senior Clinical Audit Facilitator x0530

		Mean EuroScore	Number as supervisor	Teaching rate
Mr I Cutwell's procedures	207	5.2	43	21%
UNIT total procedures	1414	4.5		
Percentage of unit workload	14.6%			

Operative Priority	Count	IC %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST Rate
				Mortality Rate Analysis					
Elective	113	54.6%	55.8%	2	113	1.8%	8	674	1.2%
Urgent	81	39.1%	41.2%	2	81	2.5%	13	497	2.6%
Emergency	13	6.3%	2.7%	1	13	7.7%	2	32	6.3%
Salvage	0	0.0%	0.3%	0	0	0.0%	3	4	75.0%
Total	207			5	207	2.4%	26	1207	2.2%

Cardiac Procedures	Count	IC %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST Rate
				Mortality Rate Analysis					
CABG only	121	58.5%	65.7%	1	121	0.8%	11	793	1.4%
CABG + Valve	28	13.5%	9.4%	1	28	3.6%	7	114	6.1%
CABG + Valve + Other	2	1.0%	0.6%	1	2	50.0%	0	7	0.0%
CABG + Other	2	1.0%	1.7%	0	2	0.0%	0	20	0.0%
Valve	39	18.8%	15.6%	1	39	2.6%	4	188	2.1%
Valve + Other	7	3.4%	3.2%	0	7	0.0%	1	39	2.6%
Other (inc congenital)	8	3.9%	3.8%	1	8	12.5%	3	46	6.5%
Total	207			5	207	2.4%	26	1207	2.2%

Use of Bypass (isolated primary CABG)	Count	IC %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST Rate
				Mortality Rate Analysis					
OFF pump	1	0.9%	64.7%	0	1	0.0%	7	507	1.4%
ON pump	114	99.1%	35.3%	1	114	0.9%	4	277	1.4%
Total	115			1	115	0.9%	11	784	1.4%

All grafts (isolated primary CABG)	Count	IC %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST Rate
				Mortality Rate Analysis					
1	6	5.2%	4.8%	0	6	0.0%	1	38	2.6%
2	9	7.8%	33.7%	0	9	0.0%	6	264	2.3%
3	70	60.9%	52.8%	0	70	0.0%	3	414	0.7%
4	30	26.1%	8.5%	1	30	3.3%	1	67	1.5%
5	0	0.0%	0.1%	0	0	0.0%	0	1	0.0%
Total	115			1	115	0.9%	11	784	1.4%

Arterial grafts (isolated primary CABG)	Count	IC %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST Rate
				Mortality Rate Analysis					
One or more arterial grafts	108	93.9%	95.9%	1	108	0.9%	9	752	1.2%
Two or more arterial grafts	21	18.3%	26.8%	0	21	0.0%	1	210	0.5%

isolated primary valve replace/repair	Count	IC %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST Rate
				Mortality Rate Analysis					
Single	33	97.1%	93.3%	1	33	3.0%	2	153	1.3%
Double	1	2.9%	6.1%	0	1	0.0%	0	10	0.0%
Triple	0	0.0%	0.6%	0	0	0.0%	0	1	0.0%
Total	34			1	34	2.9%	2	164	1.2%

Complication Rates	**IC**	**REST**
Pulmonary	15.9%	13.4%
Neurological	6.0%	3.5%
Infective	36.8%	36.5%
Renal	10.0%	10.4%
GI	2.5%	2.6%
Reoperation for bleeding	3.4%	2.7%

Blood product use	**IC**	**REST**
%age of patients receiving any product	67.3%	55.4%

	IC	**REST**
Median time to extubation (hours)	7.0	7.0

		IC	**REST**
ICU stays > 24 hours	Count	1	11
	Total	205	1205
	Rate	0.5%	0.9%

SCTS marker operation: ipCABG mortality

	IC	**REST**	**UK2003**
Total operations performed	115	784	25277
Total deaths	1	11	495
Mortality rate	0.9%	1.4%	2.0%
Mean EuroScore	5.2	4.4	3

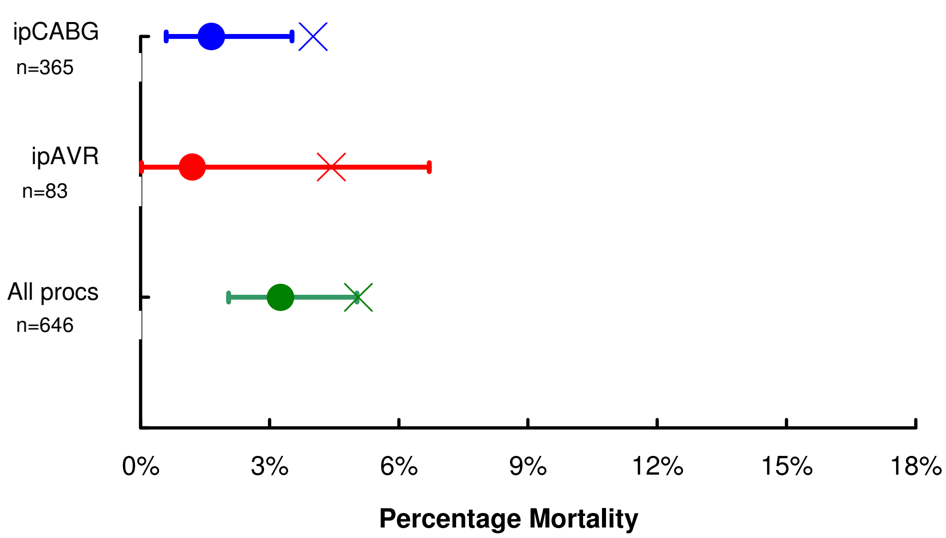
SCTS marker operation: ipCABG Mortality by EuroSCORE Group

	IC				**REST**				**UK2003**
EuroSCORE Group	Total	%age	Deaths	Rate	Total	%age	Deaths	Rate	Rate
0-1	22	19.1%	0	0.0%	178	22.7%	1	0.6%	0.3%
2-3	31	27.0%	0	0.0%	232	29.6%	2	0.9%	0.9%
4-5	31	27.0%	0	0.0%	222	28.3%	3	1.4%	1.8%
6-7	19	16.5%	0	0.0%	108	13.8%	2	1.9%	3.2%
8-9	7	6.1%	0	0.0%	28	3.6%	1	3.6%	6.3%
>9	5	4.3%	1	20.0%	16	2.0%	2	12.5%	16.1%
TOTAL	115		1	0.9%	784		11	1.4%	1.6%

DEATHS DURING PRIMARY ADMISSION

First name	**Last name**	**MRN**	**DOB**	**Opdate**	**Procedure**	**EuroSCORE**

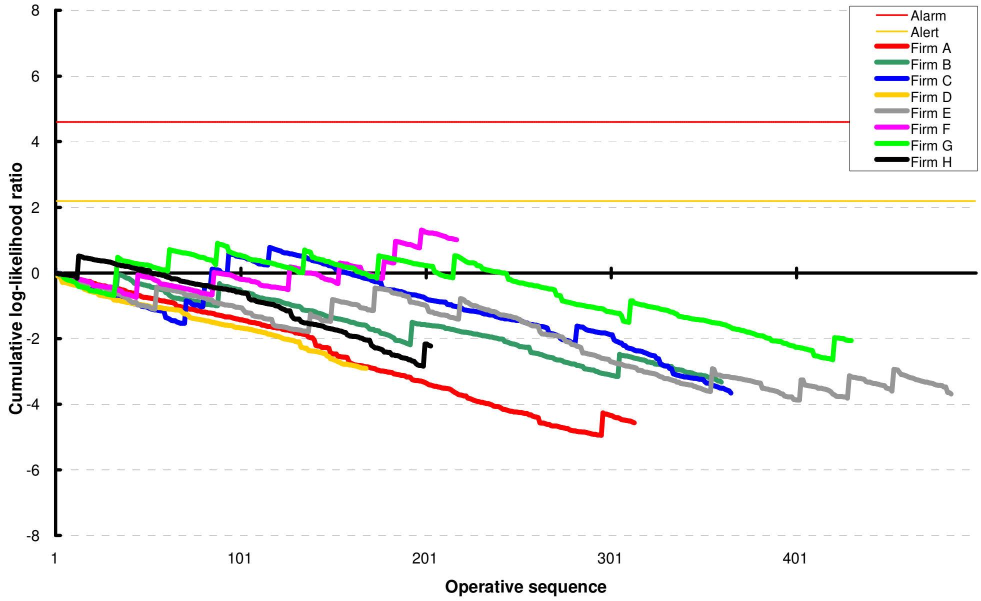
Mr I Cutwell Consultant cardiac surgeon



Sequential Probability Ratio Test (SPRT) Plot: Doubled mortality

Isolated primary CABG: 1st April 2003 - 31st March 2006

Using NACSD 2003 mortality rates for EuroSCORE

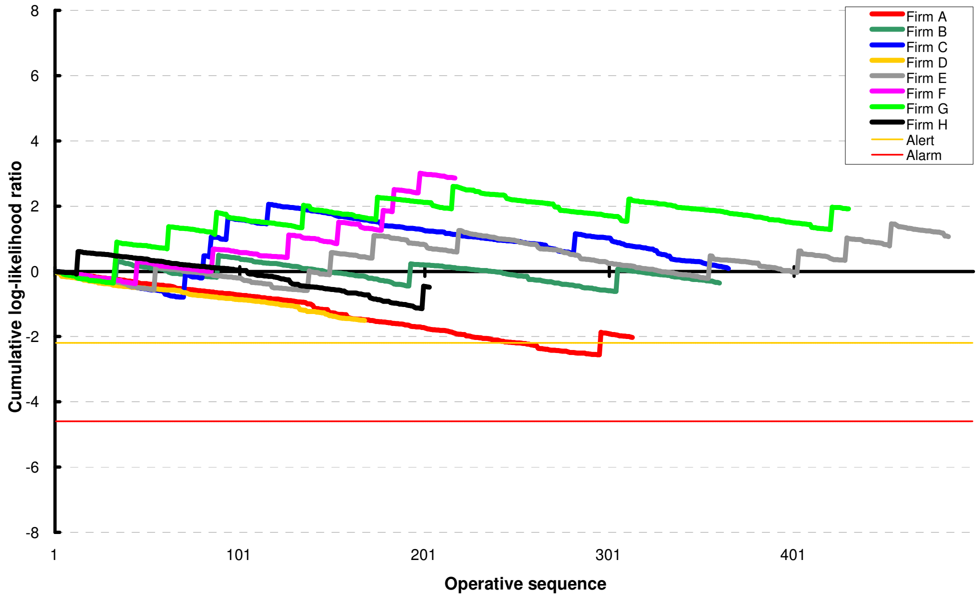


Mr I Cutwell is firm C

Sequential Probability Ratio Test (SPRT) Plot: Halved mortality

Isolated primary CABG: 1st April 2003 - 31st March 2006

Using NACSD 2003 mortality rates for EuroSCORE



Mr I Cutwell is firm C

Appendix 5

Surgeon-specific results for adult cardiac surgery
1st April 2005 – 31st March 2008

Explanatory notes

a). The performance standard we have set at the BRI is that mortality rate for both individual surgeons and the unit as a whole shall not be statistically worse than that predicted by additive euroSCORE in a three-year period for each of the following groups:

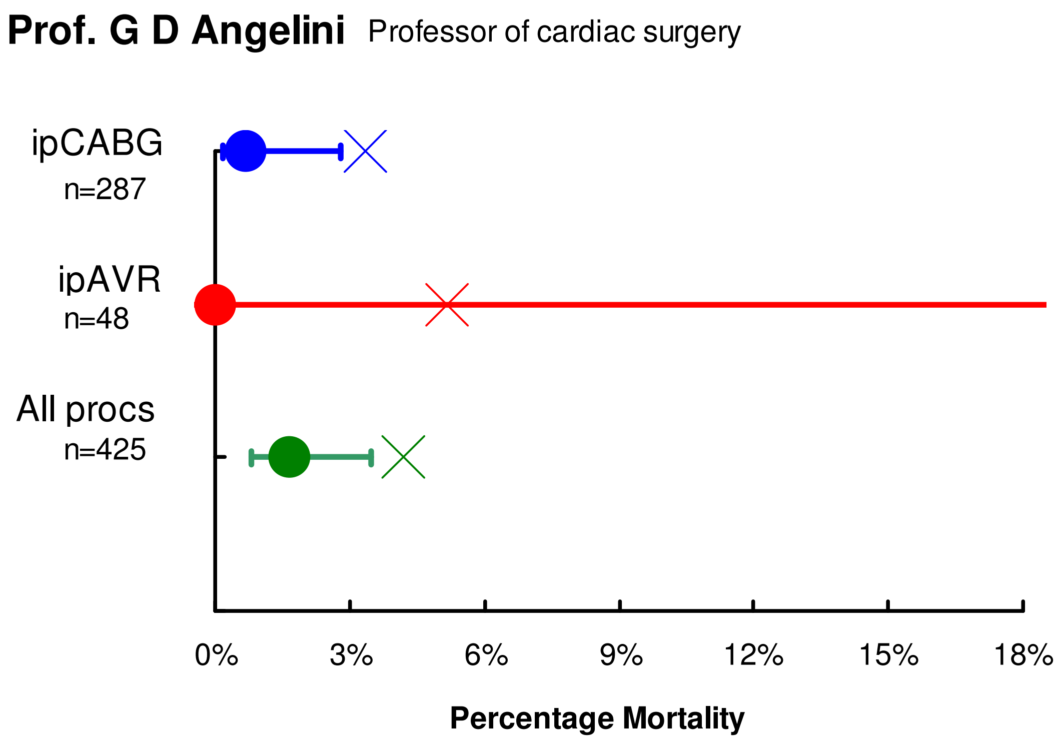
- *isolated primary CABG*
- *isolated primary AVR*
- *All procedures*

b). In the charts that follow the large 'dots' are the actual (observed) mortality rates over the three-year period for each procedure category. The horizontal bars around these show the 95 percent confidence interval associated with the observed rate. The figures expressed as 'n=' indicate the total number of procedures performed over the three-year period.

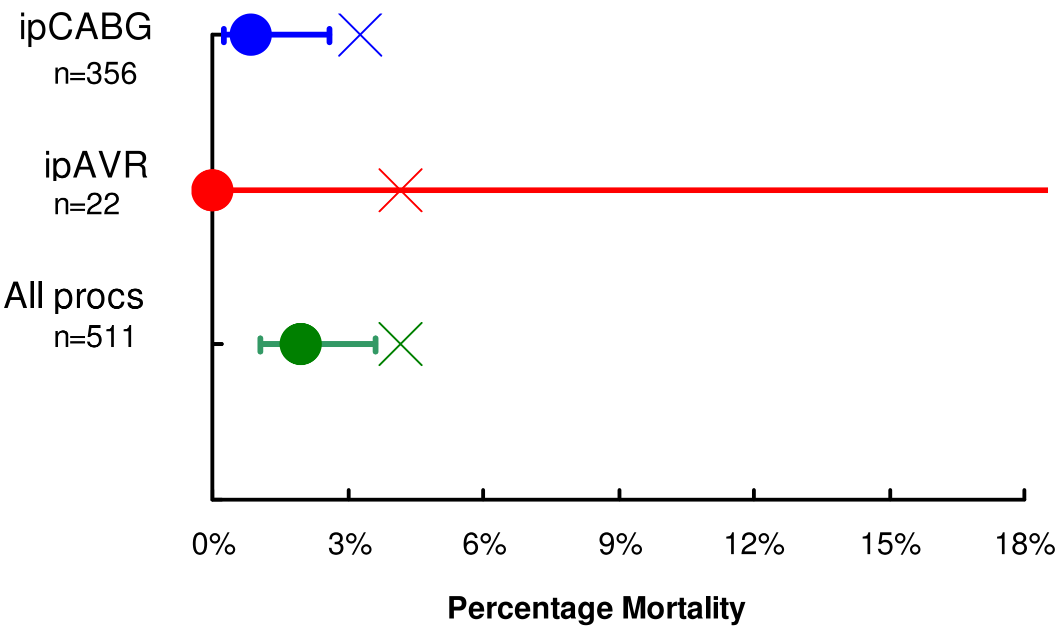
c). The predicted mortality rate is shown on the charts as a large 'X'. This is an estimate derived from application of the euroSCORE to each patient. Each score point represents a one percent change of death, and the accumulative score across all patients in the operative group for the period is calculated to arrive at the number of expected deaths amongst them.

d). With surgeon performance statistically significantly better than predicted, the 'X' would be to the right of the dot and clear of the dot's right-hand 95% confidence interval bar. With surgeon performance statistically significantly worse than predicted, the ‘X’ would be to the left of the dot and clear of the dot’s left-hand 95% confidence interval bar. If the ‘X’ intersects the bars at any point – even at the extremes – performance cannot be said to be better or worse than that predicted by euroSCORE.

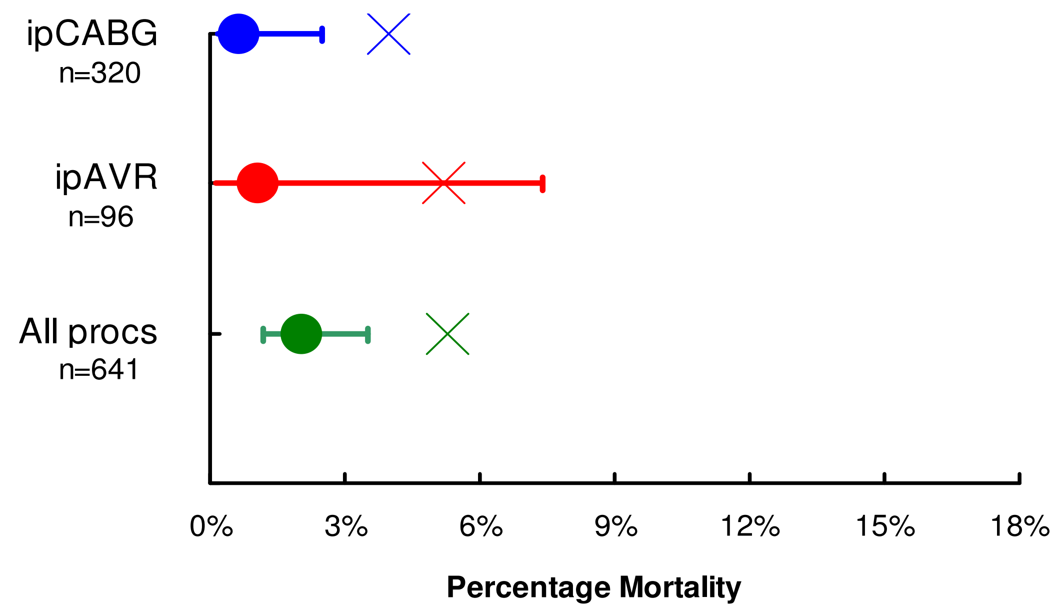
e). Only individualised charts for permanent members of staff specialising in adult cardiac surgery who have served for the majority of the time period have been provided.

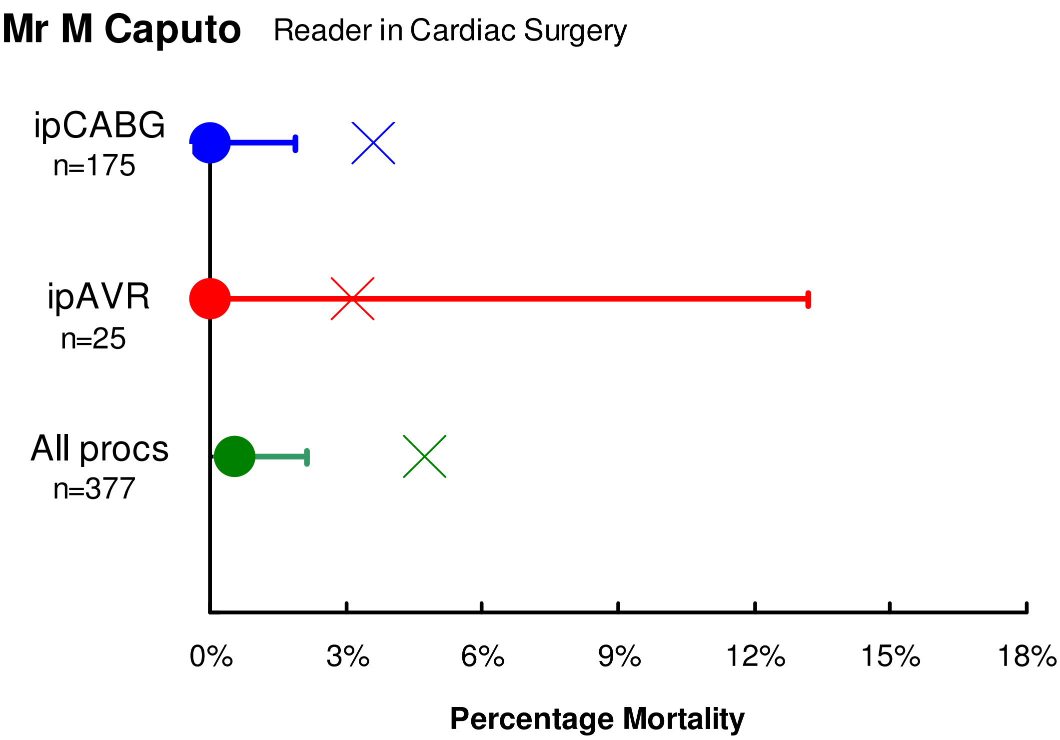


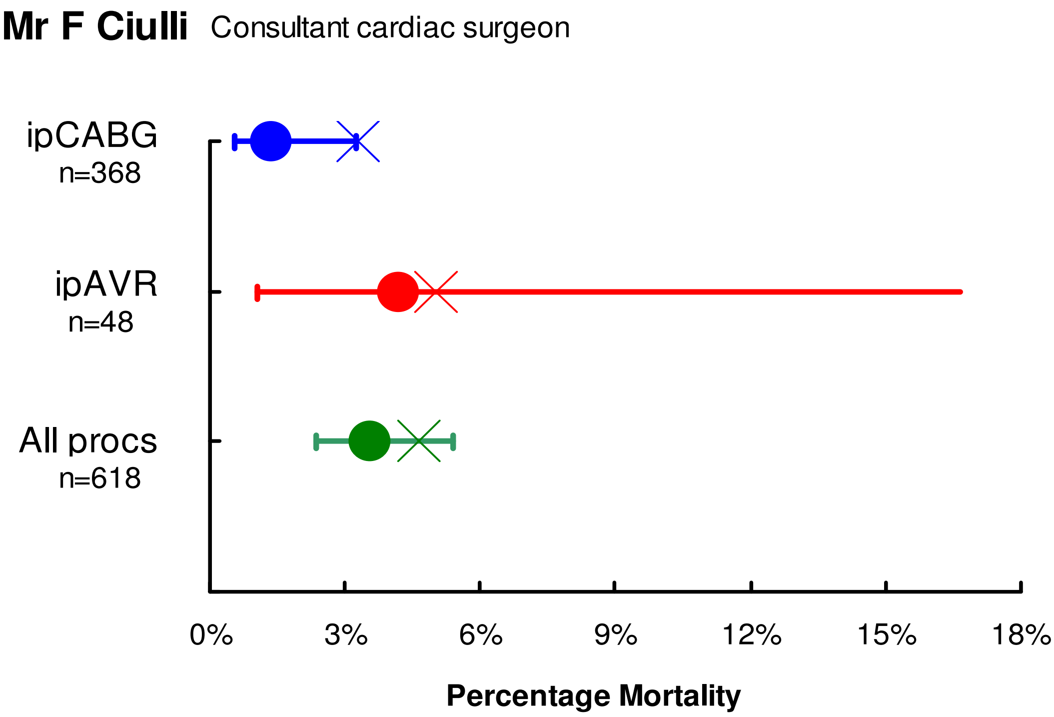
Mr R Ascione Reader in Cardiac Surgery



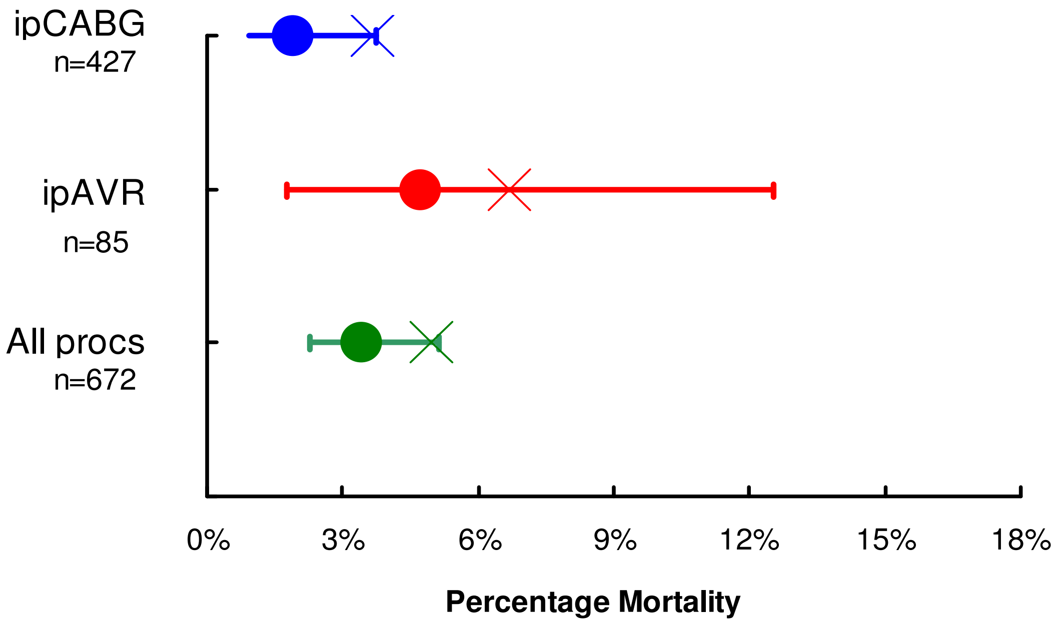
Mr A J Bryan Consultant cardiac surgeon



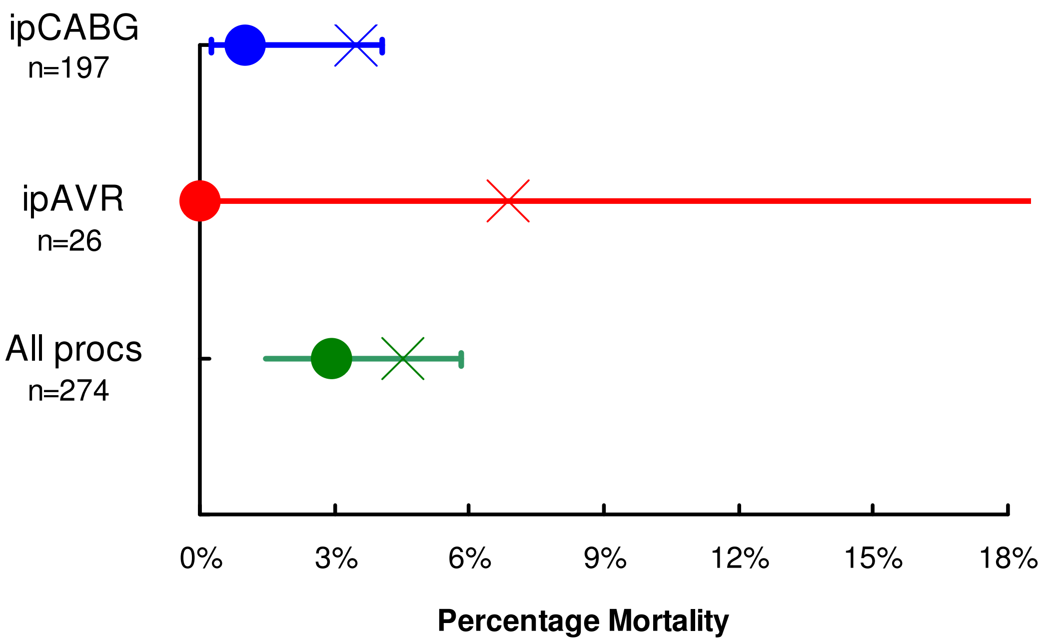

Mr M Caputo
Reader in Cardiac Surgery
ipCABG
n=175
ipAVR
n=25
All procs
n=377
0%
3%
6%
9%
12%
15%
18%
Percentage Mortality


Mr F Ciulli
Consultant cardiac surgeon
ipCABG
n=368
ipAVR
n=48
All procs
n=618
0%
3%
6%
9%
12%
15%
18%
Percentage Mortality

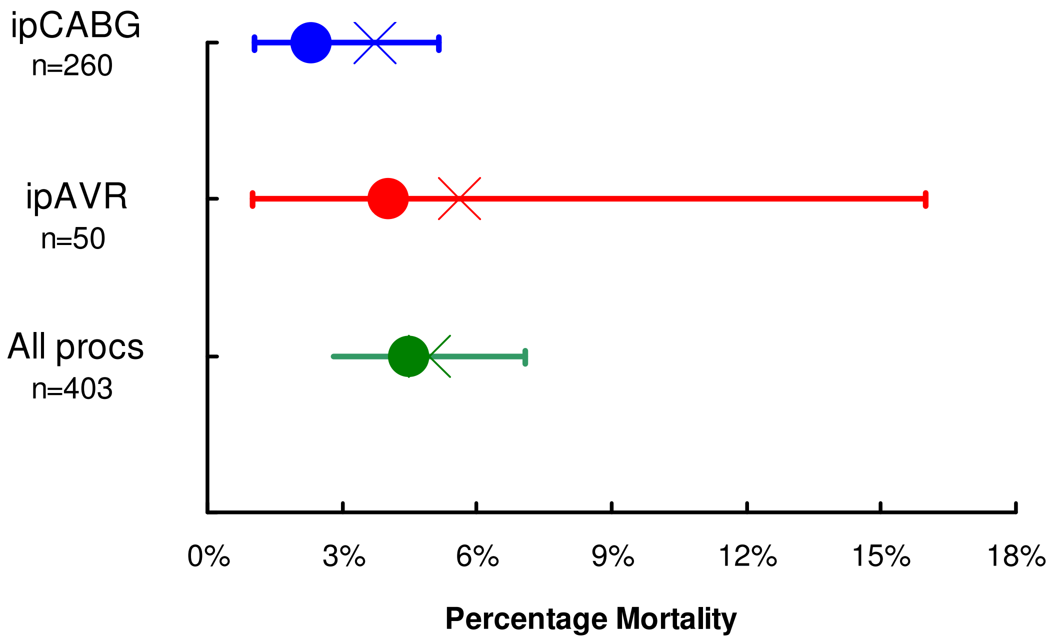
Mr J A Hutter Consultant cardiac surgeon



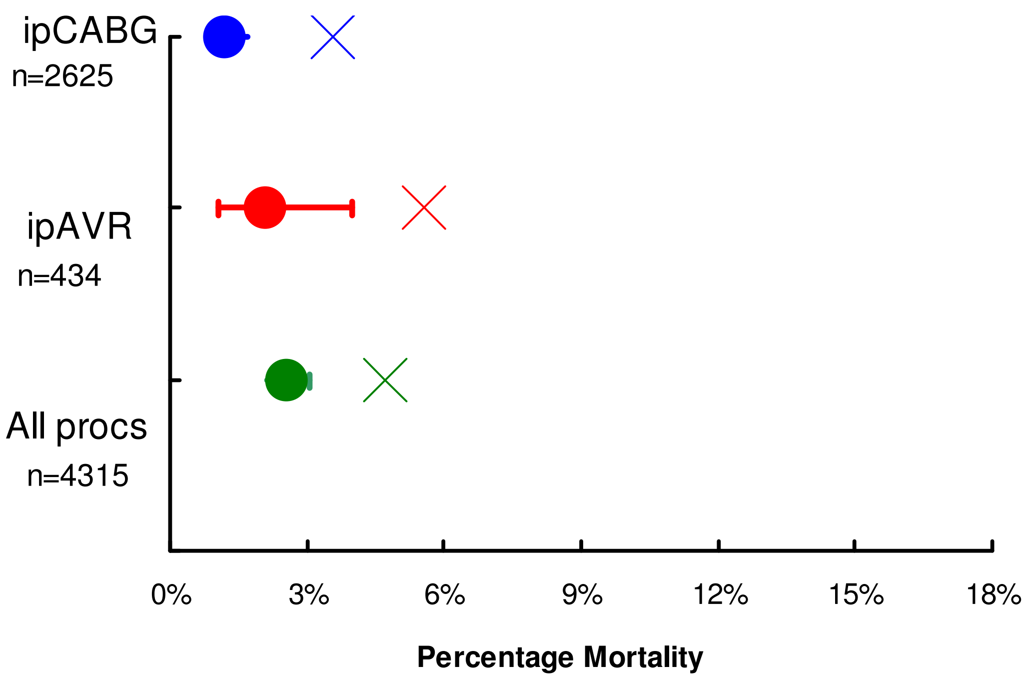
Mr G Murphy Consultant senior lecturer



Mr M Yeatman Consultant cardiothoracic surgeon



Bristol Royal Infirmary All surgeons



Isolated primary CABG

	2005 - 06						2006 - 07						2007 - 08						Cumulative 2005 - 08				
		Actual		Expected				Actual		Expected				Actual		Expected				Actual		Expected	
Name	No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate
Angelini, G D	102	1	1.0%	3	3.3%		95	0	0.0%	3	3.2%		90	1	1.1%	3	3.6%		287	2	0.7%	10	3.4%
Ascione, R	122	1	0.8%	4	3.3%		131	0	0.0%	4	3.1%		103	2	1.9%	4	3.6%		356	3	0.8%	12	3.3%
Asimakopoulos G	N/a	N/a	N/a	N/a	N/a		N/a	N/a	N/a	N/a	N/a		27	0	0.0%	1	3.7%		27	0	0.0%	1	3.7%
Bryan, A J	115	1	0.9%	5	4.0%		106	0	0.0%	4	3.8%		99	1	1.0%	4	4.1%		320	2	0.6%	13	4.0%
Caputo, M	77	0	0.0%	3	3.3%		56	0	0.0%	2	3.6%		42	0	0.0%	2	4.2%		175	0	0.0%	6	3.6%
Ciulli, F	117	1	0.9%	4	3.1%		122	3	2.5%	4	3.3%		129	1	0.8%	4	3.5%		368	5	1.4%	12	3.3%
Hutter, J A	158	4	2.5%	6	3.6%		130	3	2.3%	5	3.8%		139	1	0.7%	5	3.5%		427	8	1.9%	16	3.7%
Kanellopoulos G	73	0	0.0%	3	4.5%		84	0	0.0%	3	3.6%		N/a	N/a	N/a	N/a	N/a		157	0	0.0%	6	4.0%
Murphy, G	N/a	N/a	N/a	N/a	N/a		62	1	1.6%	2	3.2%		135	1	0.7%	5	3.6%		197	2	1.0%	7	3.5%
Underwood, M J	51	3	5.9%	2	4.1%		N/a	N/a	N/a	N/a	N/a		N/a	N/a	N/a	N/a	N/a		51	3	5.9%	2	4.1%
Yeatman, M	84	1	1.2%	3	3.8%		86	1	1.2%	3	3.5%		90	4	4.4%	3	3.8%		260	6	2.3%	10	3.7%
Total	899	12	1.3%	33	3.6%		872	8	0.9%	30	3.4%		854	11	1.3%	31	3.7%		2625	31	1.2%	94	3.6%

Isolated primary AVR

	2005 - 06						2006 - 07						2007 - 08						Cumulative 2005 - 08				
		Actual		Expected				Actual		Expected				Actual		Expected				Actual		Expected	
Name	No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate
Angelini, G D	11	0	0.0%	1	4.9%		19	0	0.0%	1	5.3%		18	0	0.0%	1	5.3%		48	0	0.0%	2	5.2%
Ascione, R	6	0	0.0%	0	7.7%		7	0	0.0%	0	0.0%		9	0	0.0%	0	5.1%		22	0	0.0%	1	4.2%
Asimakopoulos G	N/a	N/a	N/a	N/a	N/a		N/a	N/a	N/a	N/a	N/a		5	0	0.0%	0	4.0%		5	0	0.0%	0	4.0%
Bryan, A J	30	1	3.3%	2	5.6%		19	0	0.0%	1	5.3%		47	0	0.0%	2	4.9%		96	1	1.0%	5	5.2%
Caputo, M	8	0	0.0%	0	4.0%		7	0	0.0%	0	0.0%		10	0	0.0%	0	4.6%		25	0	0.0%	1	3.1%
Ciulli, F	7	1	14.3%	0	5.4%		22	1	4.5%	1	4.5%		19	0	0.0%	1	5.4%		48	2	4.2%	2	5.0%
Hutter, J A	26	1	3.8%	2	6.0%		28	2	7.1%	2	7.1%		31	1	3.2%	2	6.9%		85	4	4.7%	6	6.7%
Kanellopoulos G	9	0	0.0%	1	5.6%		10	0	0.0%	1	10.0%		N/a	N/a	N/a	N/a	N/a		19	0	0.0%	2	7.9%
Murphy, G	N/a	N/a	N/a	N/a	N/a		12	0	0.0%	1	8.3%		14	0	0.0%	1	5.6%		26	0	0.0%	2	6.9%
Parry, A	1	0	0.0%	0	3.0%		N/a	N/a	N/a	N/a	N/a		N/a	N/a	N/a	N/a	N/a		1	0	0.0%	0	3.0%
Underwood, M J	9	0	0.0%	1	5.9%		N/a	N/a	N/a	N/a	N/a		N/a	N/a	N/a	N/a	N/a		9	0	0.0%	1	5.9%
Yeatman, M	18	0	0.0%	1	5.3%		17	1	5.9%	1	5.9%		15	1	6.7%	1	5.7%		50	2	4.0%	3	5.6%
Total	125	3	2.4%	7	5.6%		141	4	2.8%	8	5.7%		168	2	1.2%	9	5.5%		434	9	2.1%	24	5.6%

All procedures

	2005 - 06						2006 - 07						2007 - 08						Cumulative 2005 - 08				
		Actual		Expected				Actual		Expected				Actual		Expected				Actual		Expected	
Name	No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate		No.	Deaths	Rate	Deaths	Rate
Angelini, G D	145	3	2.1%	6	4.2%		145	2	1.4%	6	4.1%		135	2	1.5%	6	4.3%		425	7	1.6%	18	4.2%
Ascione, R	172	3	1.7%	7	4.3%		180	3	1.7%	7	3.9%		159	4	2.5%	7	4.4%		511	10	2.0%	21	4.2%
Asimakopoulos G	N/a	N/a	N/a	N/a	N/a		N/a	N/a	N/a	N/a	N/a		38	2	5.3%	2	4.3%		38	2	5.3%	2	4.3%
Bryan, A J	207	5	2.4%	11	5.2%		204	4	2.0%	11	5.4%		230	4	1.7%	12	5.3%		641	13	2.0%	34	5.3%
Caputo, M	144	0	0.0%	6	4.2%		118	1	0.8%	6	5.1%		115	1	0.9%	6	5.1%		377	2	0.5%	18	4.7%
Ciulli, F	190	6	3.2%	8	4.2%		201	10	5.0%	10	5.0%		227	6	2.6%	11	4.7%		618	22	3.6%	29	4.6%
Hutter, J A	223	8	3.6%	10	4.7%		223	9	4.0%	12	5.4%		226	6	2.7%	11	4.8%		672	23	3.4%	33	5.0%
Kanellopoulos G	93	1	1.1%	5	4.8%		114	1	0.9%	5	4.4%		N/a	N/a	N/a	N/a	N/a		207	2	1.0%	10	4.6%
Murphy, G	N/a	N/a	N/a	N/a	N/a		88	3	3.4%	4	4.5%		186	5	2.7%	8	4.5%		274	8	2.9%	12	4.5%
Parry, A	13	0	0.0%	1	4.0%		10	0	0.0%	0	0.0%		19	0	0.0%	1	5.0%		42	0	0.0%	1	3.5%
Pawade, A	2	0	0.0%	0	6.0%		7	0	0.0%	0	0.0%		N/a	N/a	N/a	N/a	N/a		9	0	0.0%	0	1.3%
Underwood, M J	98	3	3.1%	5	4.6%		N/a	N/a	N/a	N/a	N/a		N/a	N/a	N/a	N/a	N/a		98	3	3.1%	5	4.6%
Yeatman, M	127	2	1.6%	6	4.7%		140	6	4.3%	7	5.0%		136	10	7.4%	7	5.1%		403	18	4.5%	20	4.9%
Total	1414	31	2.2%	64	4.5%		1430	39	2.7%	68	4.8%		1471	40	2.7%	70	4.8%		4315	110	2.5%	202	4.7%

Appendix 6

PATS Steering Group membership

Staff member	**Representing**
Mr Alan Bryan	Cardiac Surgeons
Dr Alan Cohen	Cardiac Anaesthetists & Intensivists
Ruth Bowles	Cardiac Nursing
Dr Chris Rogers	Academic Unit of Cardiac Surgery & Clinical Trials Unit
Chris Gummer	Data entry & validation
Jane Sims	Data entry & validation
David Finch	Clinical Audit (Database Manager)