

# Cardiac Services

## Adult Cardiac Surgery

### Activity Report 2008–9



Photo by Paul Highnam

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## **Foreword**

This is the thirteenth annual report from the cardiac surgical unit at the Bristol Heart Institute. The database now contains detailed, prospectively collected data on more than 17,000 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.

The preparation of this document has been long delayed and hampered by the absence of a data manager. In discussion with colleagues, on this occasion, we have decided to produce a document more limited in scope than previous documents but which nevertheless serves to record the activity and the outcomes during this difficult period.

This document describes a year of transition where our activity at 1405 procedures was substantially below our target of 1500 procedures within the available clinical facilities. It must be remembered that during this timeframe, to enable the construction of the Bristol Heart Institute, there were periods where one theatre was closed or several intensive care beds were out of action. It could be argued that to manage such a major construction project with what was a relatively modest impact on activity was a significant achievement in itself. The activity for the last five years has been between 1,400-1,500 operations, suggesting that this was the ceiling within the previous facilities. Indeed, even to achieve this required a certain amount of out of hours working to cope with the demand for urgent patients.

Although since our move into the Bristol Heart Institute, things have improved significantly we continued to struggle to meet waiting list targets and reduce waiting times for urgent in-hospital patients, which remained higher than was acceptable. The main operational problem was 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. Indeed 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.

The year 2009 represented a landmark in the development of cardiac services in Bristol with the opening of the new Bristol Heart Institute in May. This has given 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 fifth 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 apparent need for perpetual reorganisation, the Healthcare Commission has been dissolved and replaced by a new organisation, the Care Quality Commission ([www.cqc.org.uk](http://www.cqc.org.uk)), the new independent regulator of healthcare in England. Although one of the stated aims of this new organisation is to publish 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, it now seems likely that the Care Quality Commission will cease to host the cardiac surgery data in the future. It remains to be seen how this will evolve. 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, as at present.

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 rate of increase in demand, in association with the limited resources to cope with this, has created a significant problem. 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.

We acknowledge the contribution of David Finch to this project over many years and wish him well in any future endeavours and we welcome Alan Davies our new data manager. We are 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.

**Alan J Bryan, Alan Cohen**

**August 2010**

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## **1. Introduction**

We are now at the end of our thirteenth year of data collection. This has been a long journey with many changes along the way. These were described in the 2005-6 report which outlined the evolution of presentation of cardiac surgical data, starting with the UK Cardiac Surgical Register in 1977, followed by the National Adult Cardiac Surgery Database (NACSD) in 1994, until this in turn was absorbed into the Central Cardiac Audit Database (CCAD) in 2004. For those interested, detailed descriptions of the evolution of the cardiac surgical database are available<sup>(1)</sup>.

In the current era 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 ( <http://heartsurgery.cqc.org.uk> ) and is one of the few surgeon-specific datasets published in the UK.

Our current understanding is that the Care Quality commission is no longer able to host the presentation of the heart surgery data. This means that there will be further change, although undoubtedly presentation of surgeon-specific outcomes data for cardiac surgery is here to stay in some form or another.

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 from every adult cardiac surgical procedure undertaken in the Bristol Royal Infirmary cardiac surgical unit between 1<sup>st</sup> April 2008 and 31<sup>st</sup> March 2009. In addition, we have used the whole database of 16,268 procedures to observe trends in practice between 1<sup>st</sup> April 1996 and 31<sup>st</sup> March 2009.

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 which are seen to be of particular importance to a research or audit project agreed by the PATS steering group (appendix 6).

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.

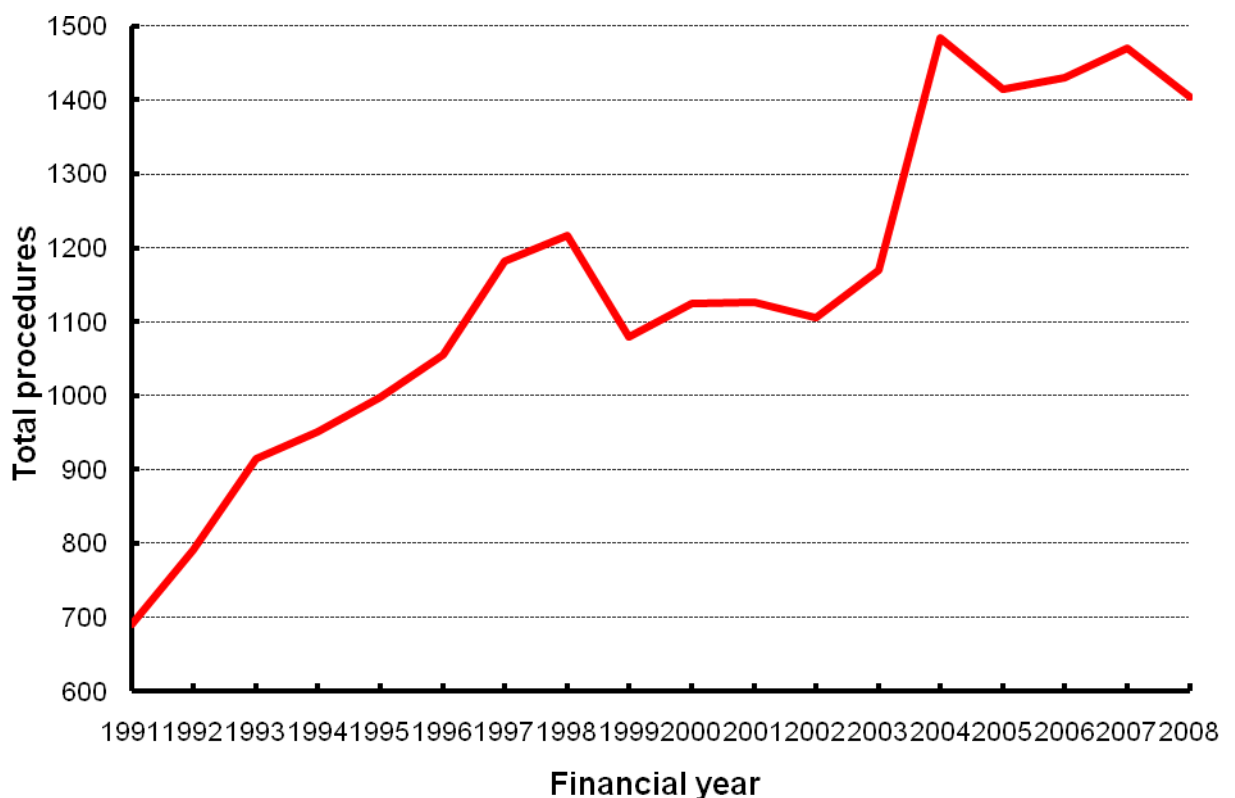
Our unit supplies data on a regular basis via a secure internet link directly to the CCAD, from which the Care Quality Commission in association with the Society for Cardiothoracic Surgery monitor clinical performance. Though the mechanics of this are largely automated and straightforward, data are not uploaded from the unit until they are thoroughly checked and validated. This is a substantial ongoing task. To date our unit has submitted over 16,000 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 clinical status and survival of every patient in the longer-term.

### 3. Overall Surgical Activity

Between April 1<sup>st</sup> 2008 and March 31<sup>st</sup> 2009 a total of 1,405 adult cardiac surgical operations were performed in the cardiac surgical unit at the Bristol Heart Institute. This was a reduction from the 1471 procedures performed in the previous year. However, as already indicated this time period was a period of transition during which both intensive care and theatre capacity were lost for periods while works for the completion of the Bristol Heart Institute were undertaken (Figure 1).

**Figure 1: Surgical Activity 1st April 1991 – 31<sup>st</sup> March 2009**

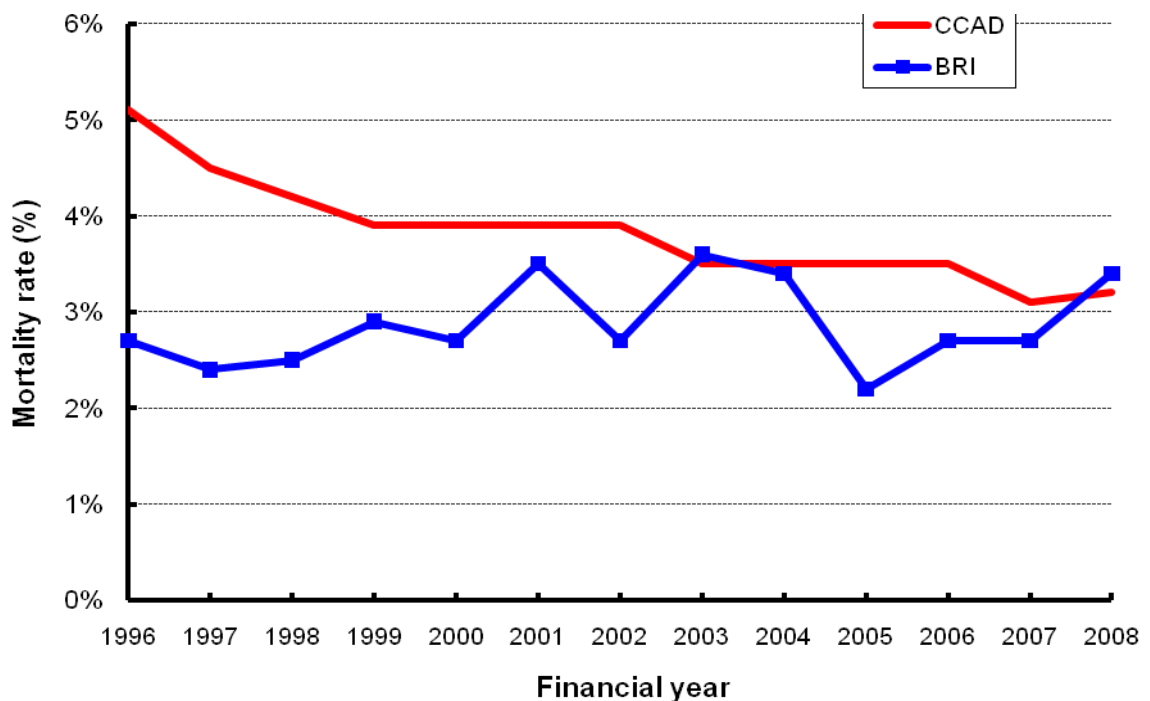


The step up in activity from 2003-4, which has been maintained, suggested that we had reached a further ceiling within the previous facility. At the time of writing we have already benefited from the enhanced facilities in the Bristol Heart Institute and as will be seen in the

next edition of this report, activity increased beyond 1500 procedures in the 2009-10 period. This high level of activity 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. Our target is to achieve an additional 100-200 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 3.4% (48 deaths in 1,405 procedures). This is slightly higher than we managed to achieve between 2005-2008 (CCAD 3.2% 2008-9) but bears comparison with other similar institutions both nationally and internationally. Figure 2 shows our annual mortality rate in comparison to the UK as a whole; in general we have managed to achieve an overall mortality rate lower than the national average in all but two of the last 12 years. It is interesting to note the convergence of the two lines as the national mortality rate has fallen to the same low level which we managed to achieve 12 years ago, while our own has hardly changed despite the deteriorating patient profile.

**Figure 2: Mortality rate comparison for all cause in-hospital deaths  
1st April 1996 – 31<sup>st</sup> March 2009**



The overall distribution of the type of cardiac surgery undertaken during 2008-9 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 53% in the current year.

**Table 1: Activity and mortality by procedure type  
1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009**

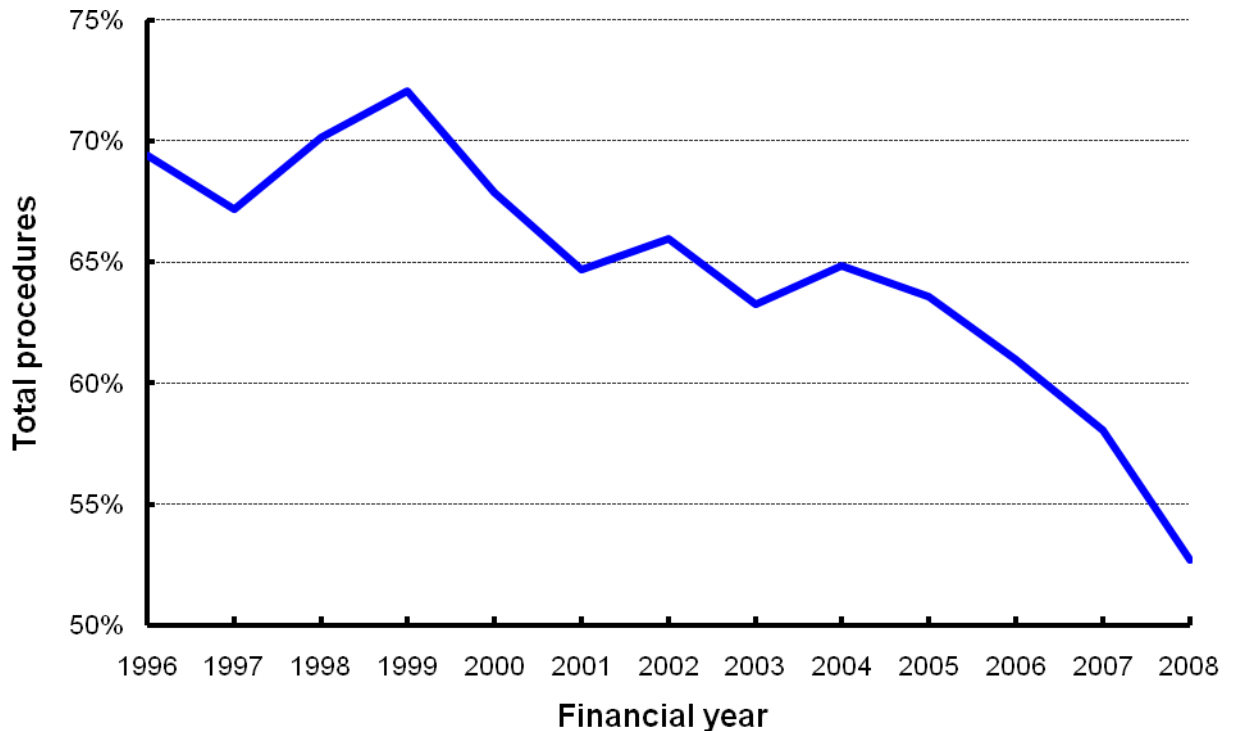
<b>Procedure</b>	<b>Number</b>	<b>%</b>	<b>Deaths</b>	<b>Rate (%)</b>
Isolated primary CABG	740	52.7	11	1.5%
Other ischaemic heart disease	37	2.6	5	13.5%
Valve	328	23.3	9	2.7%
Valve + CABG	155	11.0	15	9.7%
Thoracic Aorta	76	5.4	5	6.6%
Adult Congenital	48	3.4	0	0.0%
Other	21	1.5	3	14.3%
<b>ALL TYPES</b>	<b>1,405</b>		<b>48</b>	<b>3.4%</b>

Figure 3 clearly shows this decline with a 19% fall (as a proportion of the total procedures performed) over less than 11 years from a high of 72% in 1999-2000. This is a trend also observed nationally and internationally (CCAD 07-08; Primary CABG 56.9%) although it is likely that the reduction observed in the current year of observation has been exaggerated by the tendency to choose to send patients requiring CABG to distant centres preferentially when there is underprovision. Fortunately (for the service), this decline in CABG procedures has been matched by an increase in other areas. We have undertaken more than 480 valve procedures, and this now makes up around 34% of our overall activity. In addition, there have been modest increases in our activity in adult congenital heart disease and aortic surgery.

Valve surgery increased to a total of 483 procedures, the highest we have ever recorded and a 7% increase over 2007-8. Of all the procedures undertaken for valvular heart disease, 32% involved concomitant CABG, which is likely to be a reflection of the ageing surgical population. Operations on the thoracic aorta increased to 76 procedures per year a 23%

increase on the previous year, although it remains to be seen whether this is a sustained increase. There were also 48 procedures for adult congenital heart disease, one of our targeted areas, a further increase on the previous year's activity.

**Figure 3: Trend in isolated primary CABG activity  
1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=10,448)**

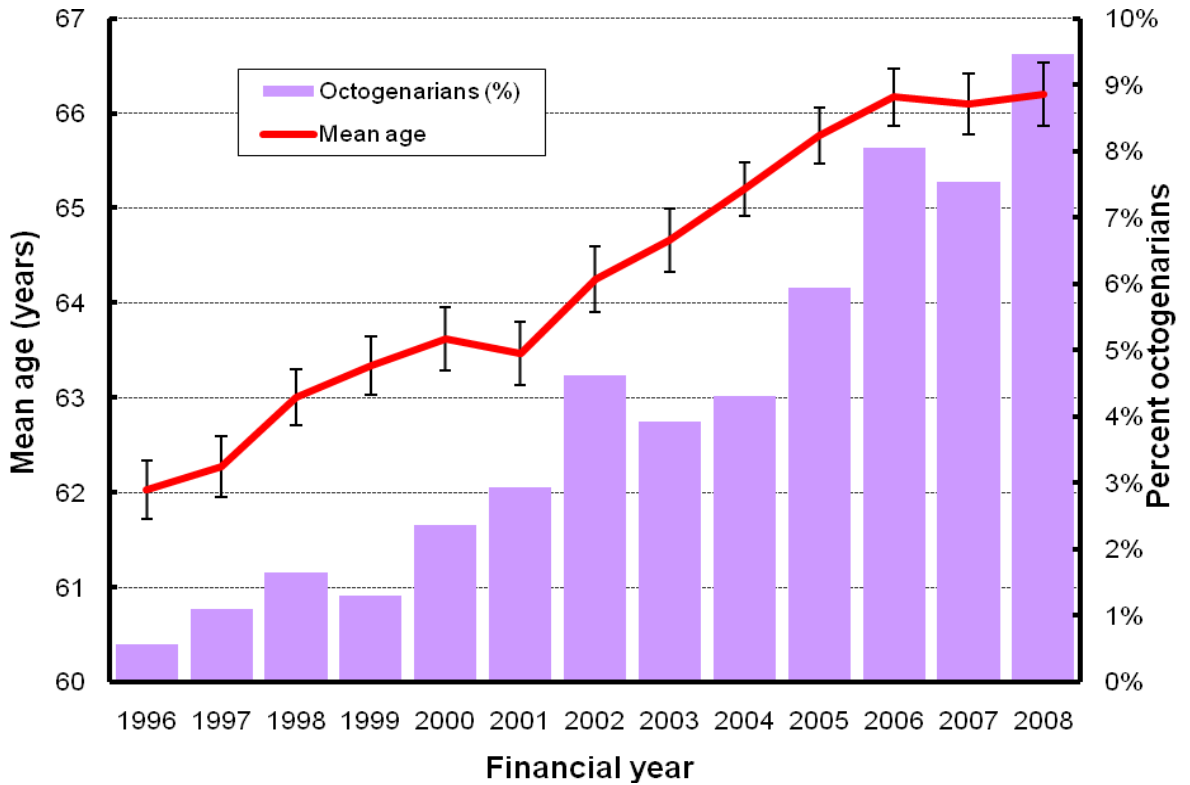


#### **4. Demographic and Geographical Characteristics**

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 66.2years (range 17 - 92 years)(CCAD 08-09 mean 66.8yrs). If we examine Figure 4 we see that the mean age increased by one year every two years of study until 2005-6 but this trend has been less marked in the last couple of years. In particular there continues to be an increase in the proportion of patients over 80 undergoing surgery with this group now forming 9.5% of our total patient population. These changes mirror many similar areas of healthcare in western

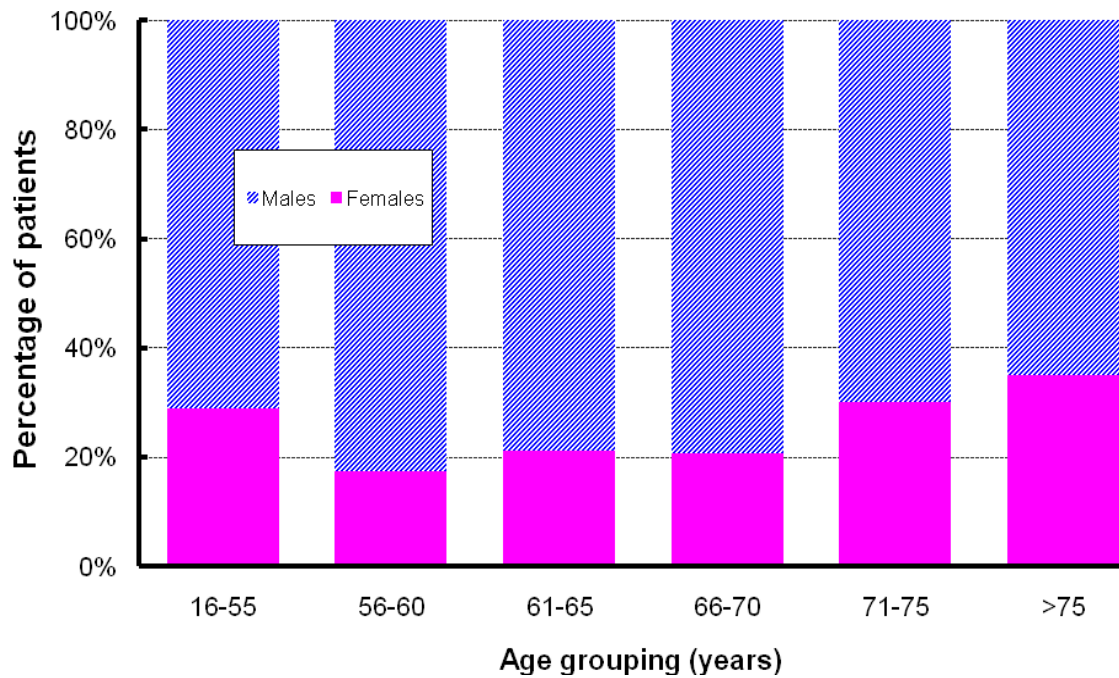
societies and it is at least reassuring that, despite the demanding techniques required to achieve good results in this age group, we are increasingly able to justify operations in elderly patients based on the acceptable mortality and functional benefit that accrues from successful surgery.

**Figure 4: Trends in age on admission for surgery**  
**1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=16225)**



With regard to gender differences in our patient population, there is an overall 2.7:1 ratio of males to females (CCAD 2008-9 2.2:1) (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. As the cardiac surgical population ages so the proportion of women should increase.

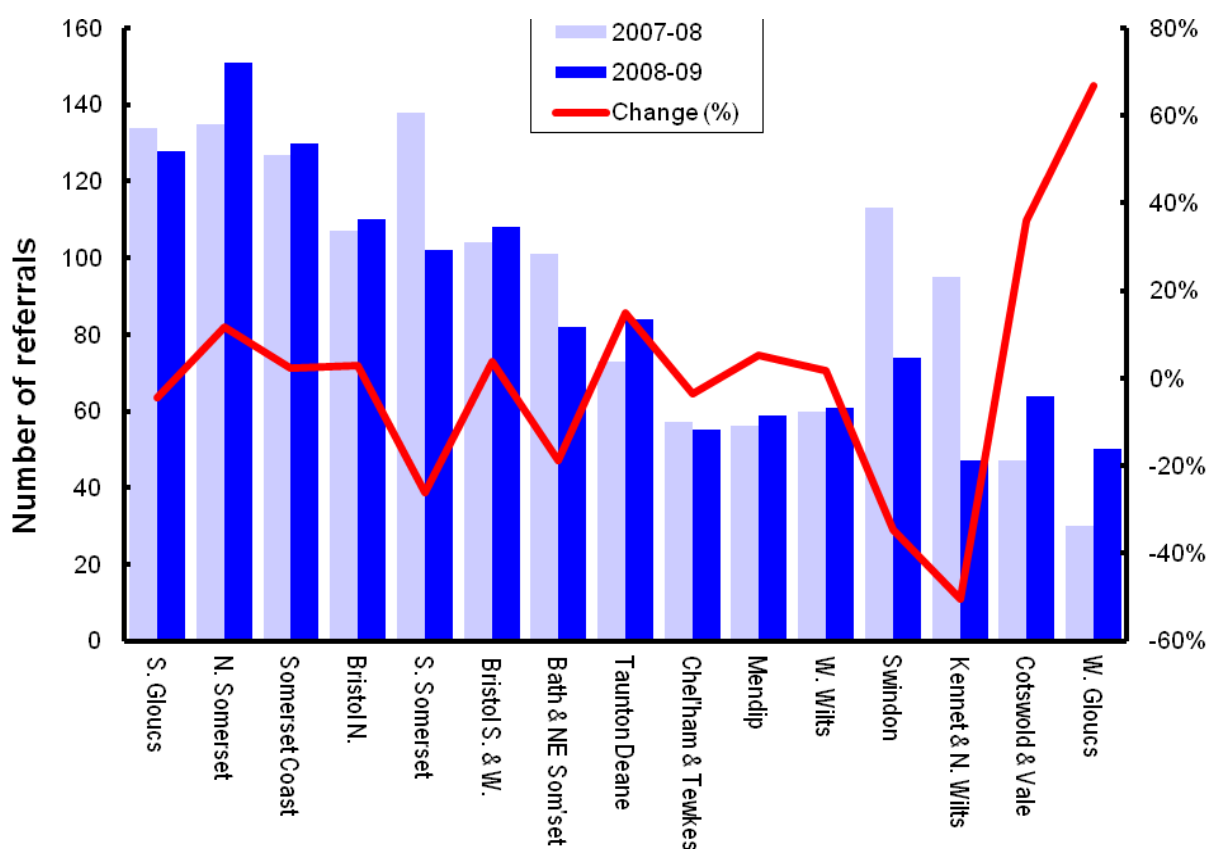
**Figure 5: The relation between age and gender**  
**1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009 (n=1,405)**



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). There were some changes in the geography of our patient population with significant decreases in referrals from Wiltshire and Swindon reflecting the referrals from these centres to London but we can be encouraged by the simultaneous major increases in patients from Gloucestershire.

We understand that to compete successfully for patients with other cardiac surgical providers 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 both timely and 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**  
**1<sup>st</sup> April 2007– 31<sup>st</sup> March 2009 (n=2,682)**



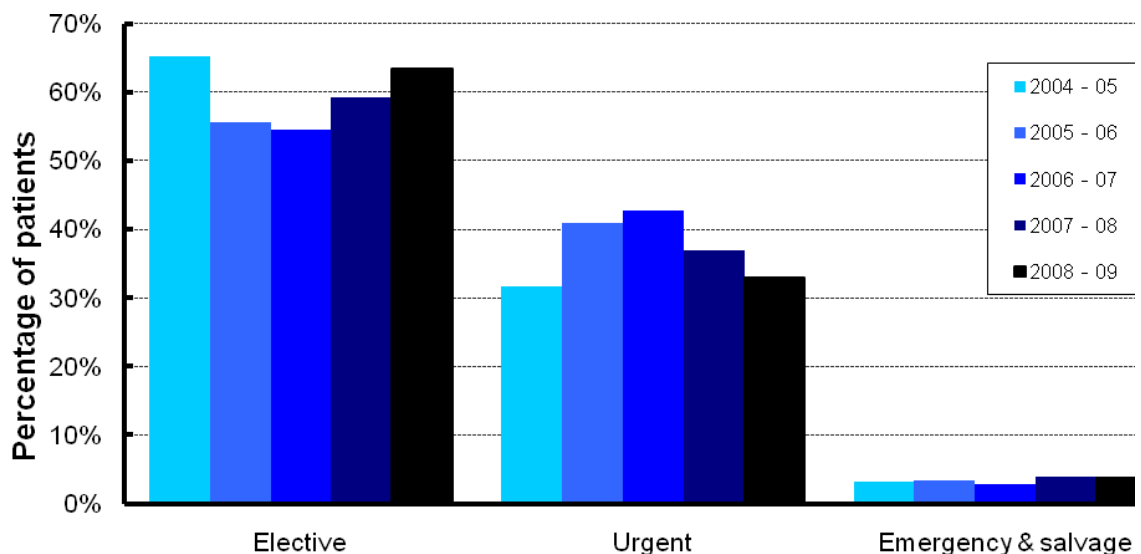
## **5. Organisation, Operative Priority and Waiting Times**

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 an 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 still need to be made with respect to urgency of treatment. There continues to be competing pressures to achieve elective waiting time targets yet also deliver clinically appropriate treatment for urgent patients.

The designations of operative priority according to the Society for Cardiothoracic Surgery (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 2008-9 the pattern of operative priority showed a certain amount of change with a fall in the proportion of urgent in hospital patients to 33% (Figure 7). This reduction may be due to a significant number of local urgent patients being sent to London. However, we must also bear in mind that the increasing application of Primary PCI to treat acute coronary syndromes may also be leading to a reduction in urgent referrals for coronary surgery. 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  
1<sup>st</sup> April 2004 – 31<sup>st</sup> March 2009**

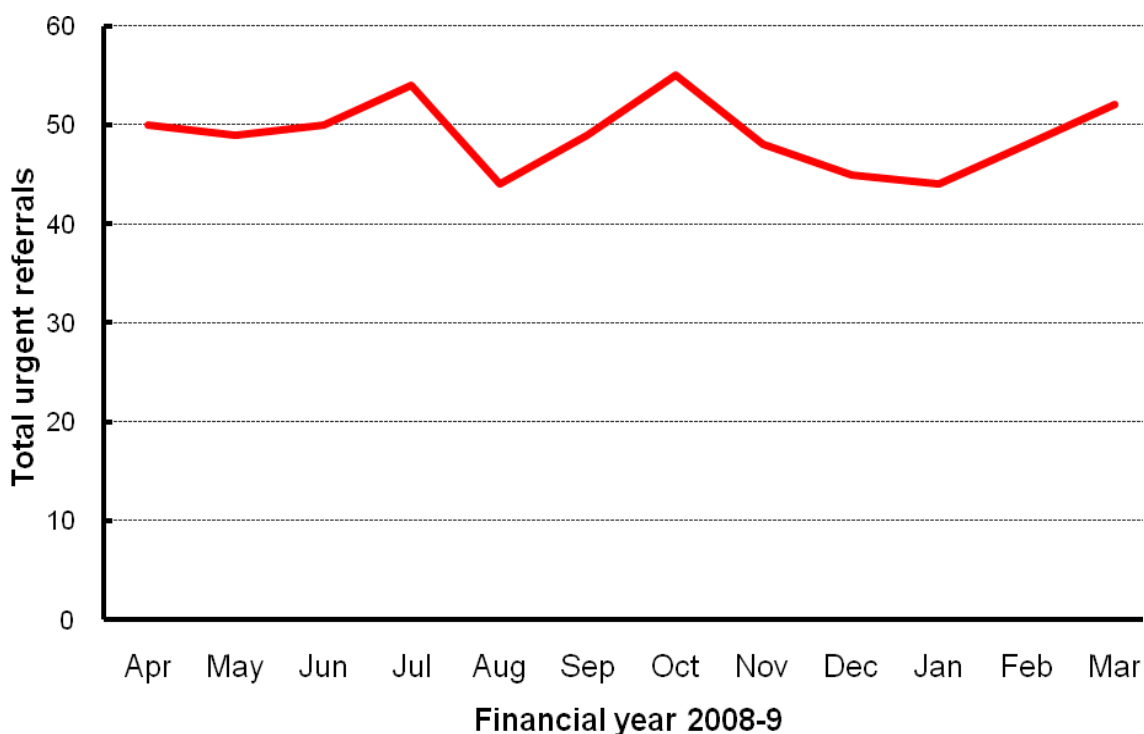


Currently within the Avon, Gloucester and Wiltshire Cardiac Network our aim is to treat urgent in-patients within 10 days of admission which is usually 5-7 days from referral. However, when a substantial proportion of the service is based around an urgent patient caseload then the fluctuation in referral 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 2008-9. The monthly rate of referral varies from 44-55 although in the previous year the variance was much larger 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  
1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009 (n=587)**



In 2008-9 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 unable to fully utilise the available theatre slots by 5% - 15% per month and it doesn't take much of a mathematician to realise we were going to struggle to realise our projected activity within the theatre base available at that time. 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 non-utilisation of theatre slots

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 underuse of theatre slots  
1<sup>st</sup> April 2005 – 31<sup>st</sup> March 2009**

	05-06	06-07	07-08	08-09
No ITU beds/Gen Surg given ICU priority	31	60	20	66
No Perfusionist	2	6	11	2
Case overran/long first case	21	44	38	51
No ITU staff	14	4	29	11
Patient unfit	10	5	12	23
No theatre staff/emergency overnight	49	29	49	24
Unable to admit(No wd bed/Norovirus/A&E alert)	11	0	22	44
Emergency in catheter laboratory	2	3	7	7
No surgeon	6	8	10	8
Miscellaneous	19	5	7	22
<b>TOTAL</b>	<b>165</b>	<b>164</b>	<b>205</b>	<b>258</b>
<b>Available Operating Slots</b>	<b>1519</b>	<b>1542</b>	<b>1577</b>	<b>1593</b>
<b>% Cancellation Rate</b>	<b>10.8</b>	<b>10.6</b>	<b>13</b>	<b>16</b>

If we examine the current year of study in comparison to the preceding year there has been a further increase in the number of cases lost, resulting in a disappointing 16% of possible operating slots not being used. 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.

One of the major issues in the year of study was the 100% increase in the number of cases lost because of inability to admit patients to the hospital either because of A&E alerts, norovirus or simply because no ward bed was available. As a consequence of these challenges we have instituted a day of surgery admission programme which is now up and running. The other challenge has been the occasional prioritised usage of the cardiac ICU facilities for general surgery patients to achieve Trust cancer targets. For the first time the activity in cardiac

surgery has been significantly reduced by the influence of the pressure on other services within the hospital . The rapid increase and success of the Primary PCI programme while it should be applauded has been a challenge to the bed base as well.

It can be argued that each cause of lost cardiac surgery is not a major issue in itself but the problem is that the sum total is 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 currently being applied.

### **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.

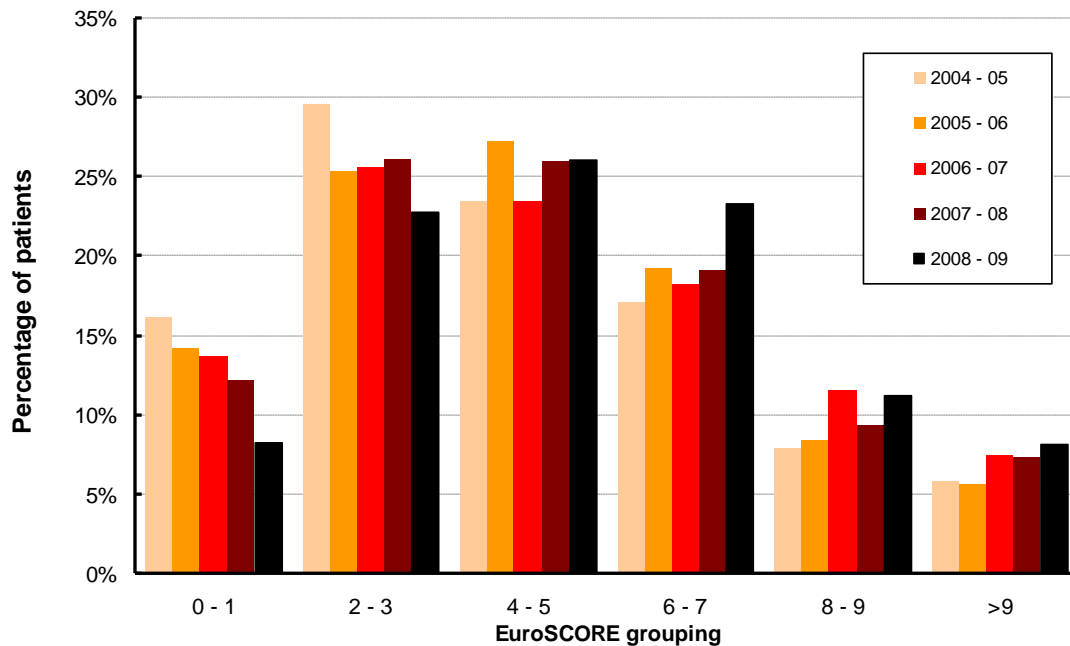
Like many units around the UK we have been using the EuroSCORE system, which was derived from a large dataset collected in the early 1990s<sup>(2)</sup>. Its application in large numbers of patients world-wide has proven successful, and it has been widely used in comparisons of surgical practice. The 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<sup>(3,4)</sup>. 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. In this document, for calculating the predicted outcomes after CABG and AVR, we have used

the updated, recalibrated EuroSCORE as derived from the data in the most recent report from the Society for Cardiothoracic Surgery<sup>(5)</sup>.

Over the last few months the Bristol Heart Institute has participated in the data collection for the updated EuroSCORE and we look forward to seeing the outcome of this important piece of work and incorporating it into clinical practice.

Figure 9 shows the change in the EuroSCORE profile of our patient population over the last five years. There has been a further increase in this profile in the last year with the mean now 5.2(CCAD 08-09 Mean EuroSCORE 5.2). We have actually observed the EuroSCORE profile for the last nine years and have seen the overall mean score increase by 1.5 over this time: a modest increase. When significant numbers of urgent patients from our overall population are referred elsewhere it is difficult to make clear judgements on how our base population is changing.

**Figure 9: EuroSCORE distribution by financial year  
1<sup>st</sup> April 2003 – 31<sup>st</sup> March 2009 (n=7179)**

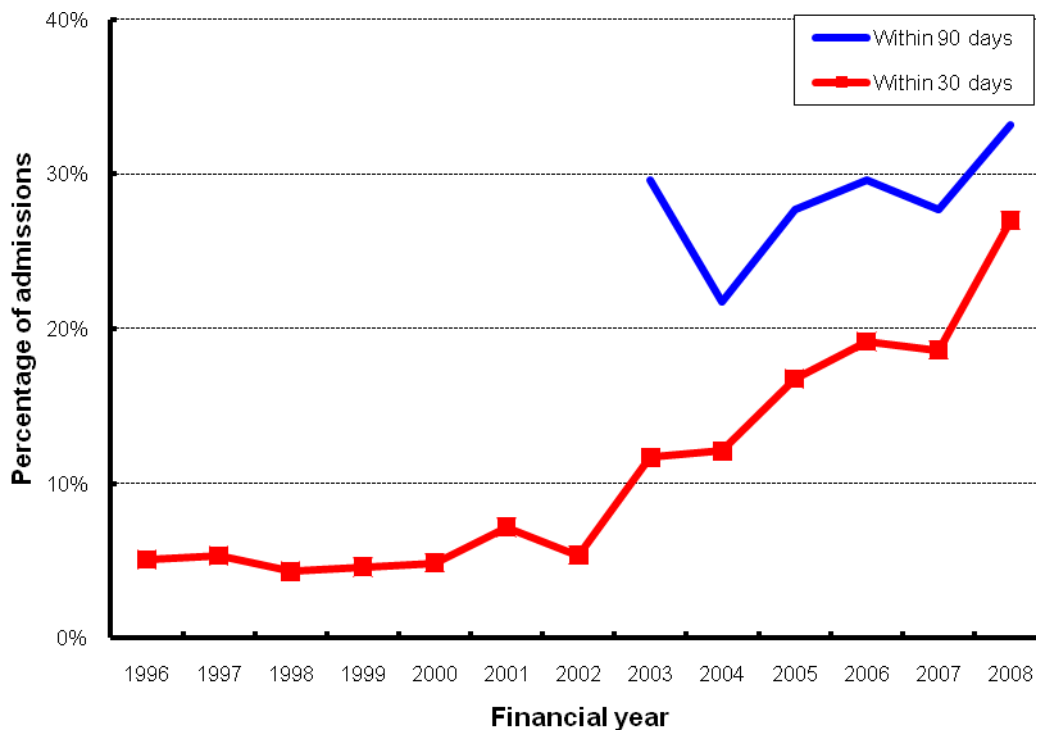


It is important, given the increasing focus (or seeming preoccupation) with cardiac surgical results, to consider whether there is any evidence of risk-averse behaviour. This is a complex area and one which our colleagues in the North-West have examined this in detail. They concluded the risk profile in their area has been maintained or worsened, there was no evidence of risk-averse behaviour<sup>(6)</sup>. 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. There is currently a working group of the SCTS looking into this important concern.

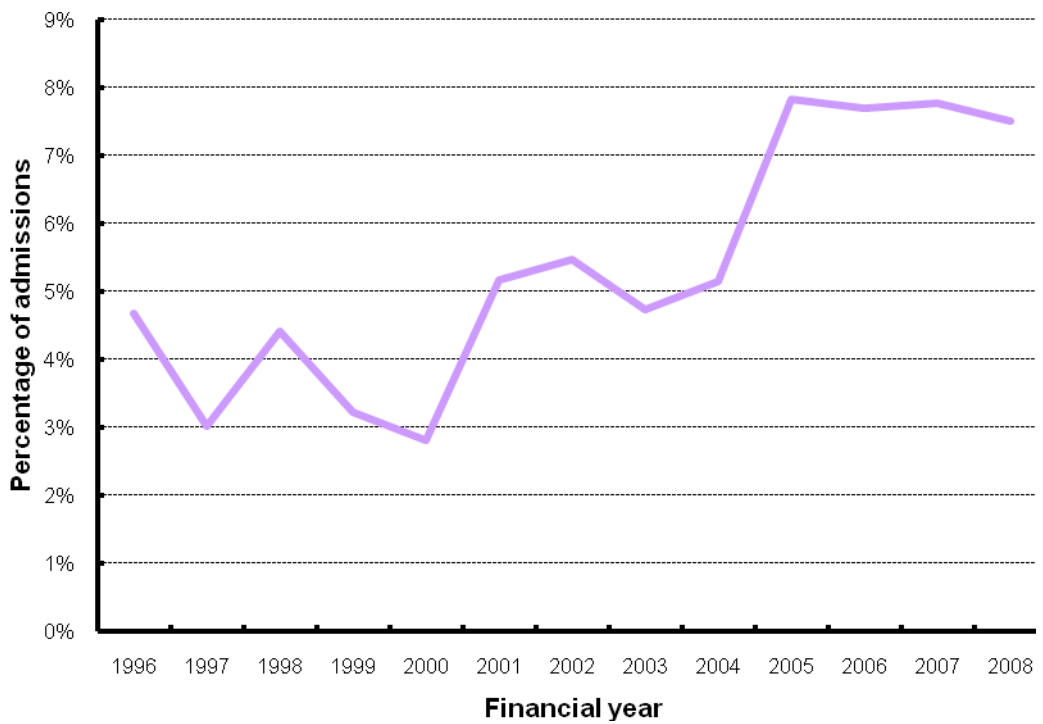
If we look at some of the ways in which our patient profile is changing (Figures 10 -11) we can observe some trends. There is an obvious trend in the timing of surgery in relation to myocardial infarction(MI), with an increase in the proportion undergoing surgery within 30 days of MI up to 27% of all patients undergoing CABG. This almost certainly reflects the increasingly acute nature of cardiovascular care with the rapid increase in primary PCI 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: Recent Myocardial Infarction**  
**Isolated primary CABG 1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=10,587)**

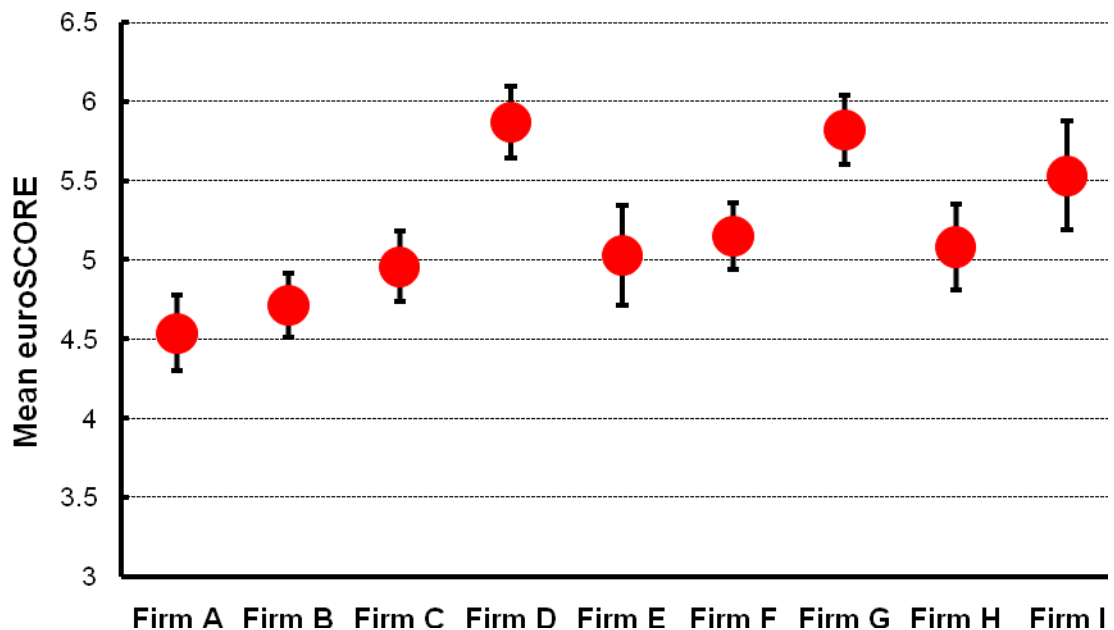


**Figure 11: Previous Percutaneous Coronary Intervention**  
**Isolated primary CABG 1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=10,616)**

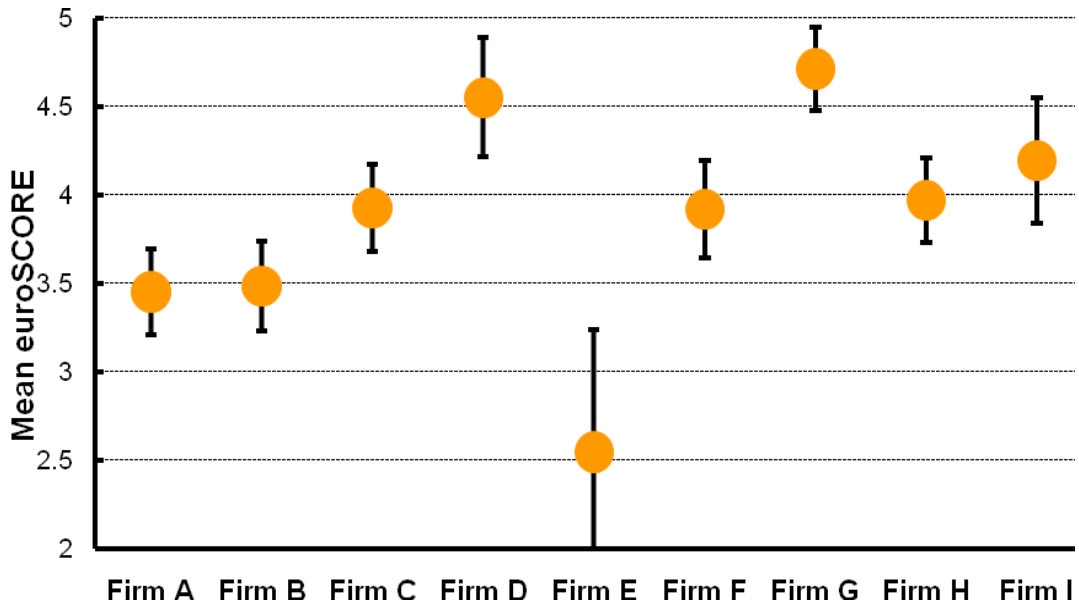


Analysis of the risk profile of patients under the care of individual surgical firms using non-parametric testing we found significant differences in the risk profile for both CABG( $p<0.006$ ) and all cases( $p<0.016$ )(see figures 12 and 13). The cause of such variation is complex. Some surgeons may have a stated expertise in treating patients at high operative risk and it may be right that they are encouraged to do so. However, 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 in everyday surgical practice.

**Figure 12: euroSCORE by surgeon firm with standard errors of mean**  
**All procedures 1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009**



**Figure 13: euroSCORE by surgeon firm with standard errors of mean  
Isolated primary CABG 1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009 (n=735)**



## **6. Surgery of Ischaemic Heart Disease**

The surgery of ischaemic heart disease remains the major component of our workload, comprising some 55% of our workload (777/1405 procedures). In the year under scrutiny a total of 741 isolated primary CABG (ipCABG) operations were undertaken, with a total of 11 deaths (1.5%; 1.5% CCAD 2008-9). This represented a significant 13% fall in CABG cases undertaken from the 854 procedures undertaken in 07-08 with mortality equal to the national average of 1.5%. The proportion of our work constituted by ipCABG continues to fall year by year and is now 53% (CCAD 08-09 53.7%). If we add our activity this year to the previous 10 years we have undertaken a total of 10,443 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 14).

**Figure 14: Isolated primary CABG mortality rate trend**  
 1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=10,443)

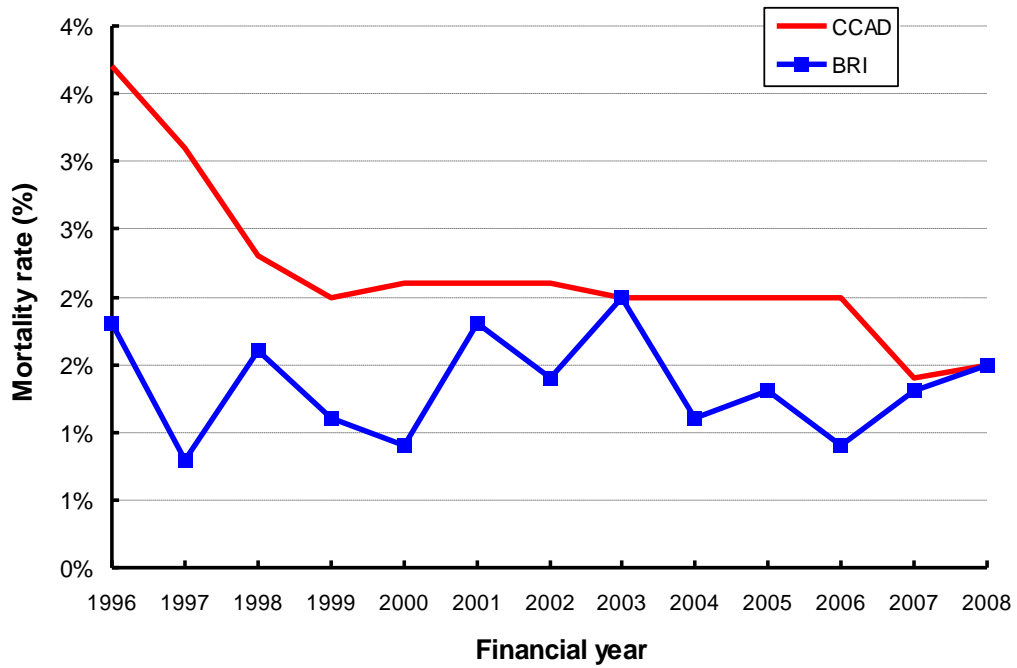
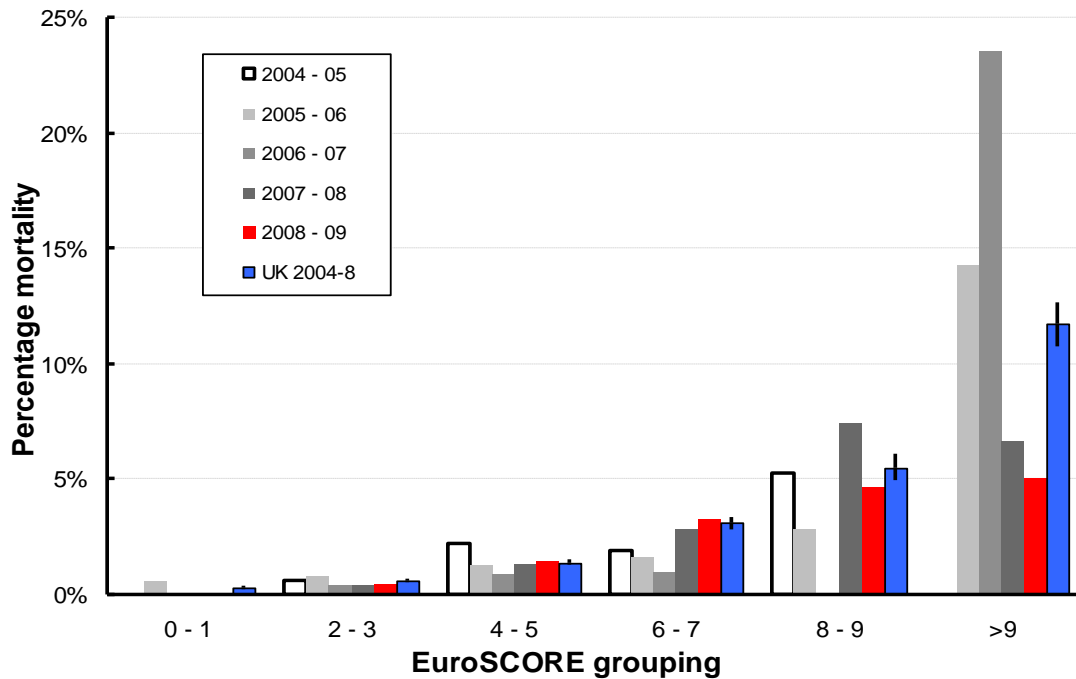


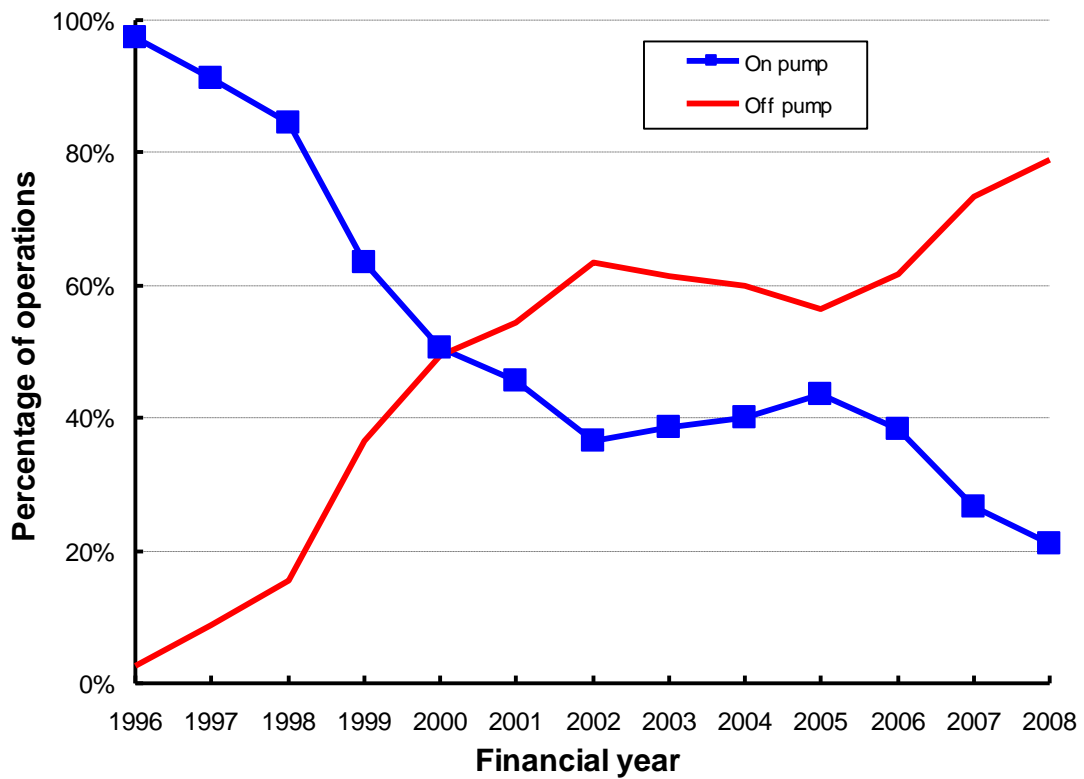
Figure 15 shows our mortality rates for ipCABG for the last five years stratified for EuroSCORE, and compared to UK outcomes for the financial year 2003-4. In the current year of study, in all but one group, our mortality rate was lower than the UK figure available for comparison. In the highest risk group the numbers are very small with large confidence intervals.

**Figure 15: Mortality rates by EuroSCORE group  
Isolated primary CABG (n=4,325)**



The proportion of off-pump CABG cases has increased further over the last twelve months to around 80% of all CABG work (Figure 16) 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 off-pump centres in the UK with a very high percentage of cases undertaken without cardiopulmonary bypass. In the UK, the figure is around 17% (CCAD2008) and this has not increased substantially for a number of years. In our centre, with non risk-adjusted data, the mortality rates for on and off pump CABG surgery were 1.3%(2/156) and 1.5%(9/584) respectively. This difference is not statistically significant (chi squared p=0.81). 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<sup>(7)</sup>.

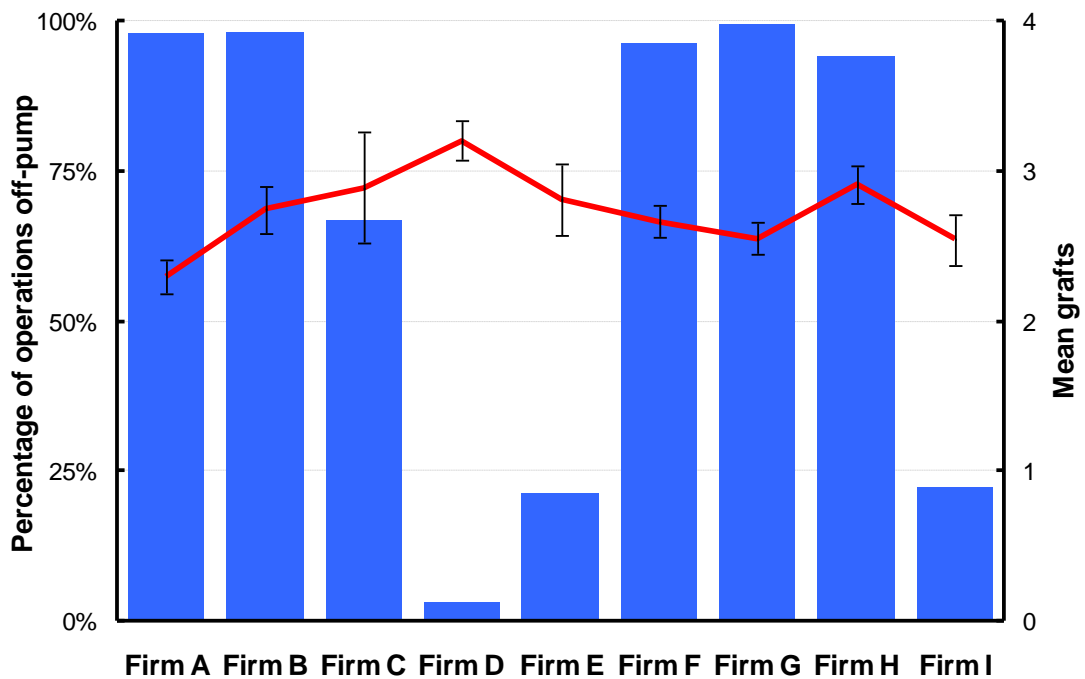
**Figure 16: Trend in cardiopulmonary bypass use**  
**Isolated primary CABG April 1<sup>st</sup> 1996-March 31<sup>st</sup> 2009 (n=10,479)**



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 17 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 nevertheless, that the technique will be adopted by the majority of our cardiac surgeons.

It is also worth noting that Mr Asimakopoulos has successfully reactivated a programme of minimally invasive CABG through a small anterior thoracotomy, predominantly in patients with single vessel disease with the additional possibility of hybrid procedures with PCI.

**Figure 17: Cardiopulmonary bypass use (blue column) and mean graft rate (red line) by surgical firm for isolated primary CABG 1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009 (n=740)**



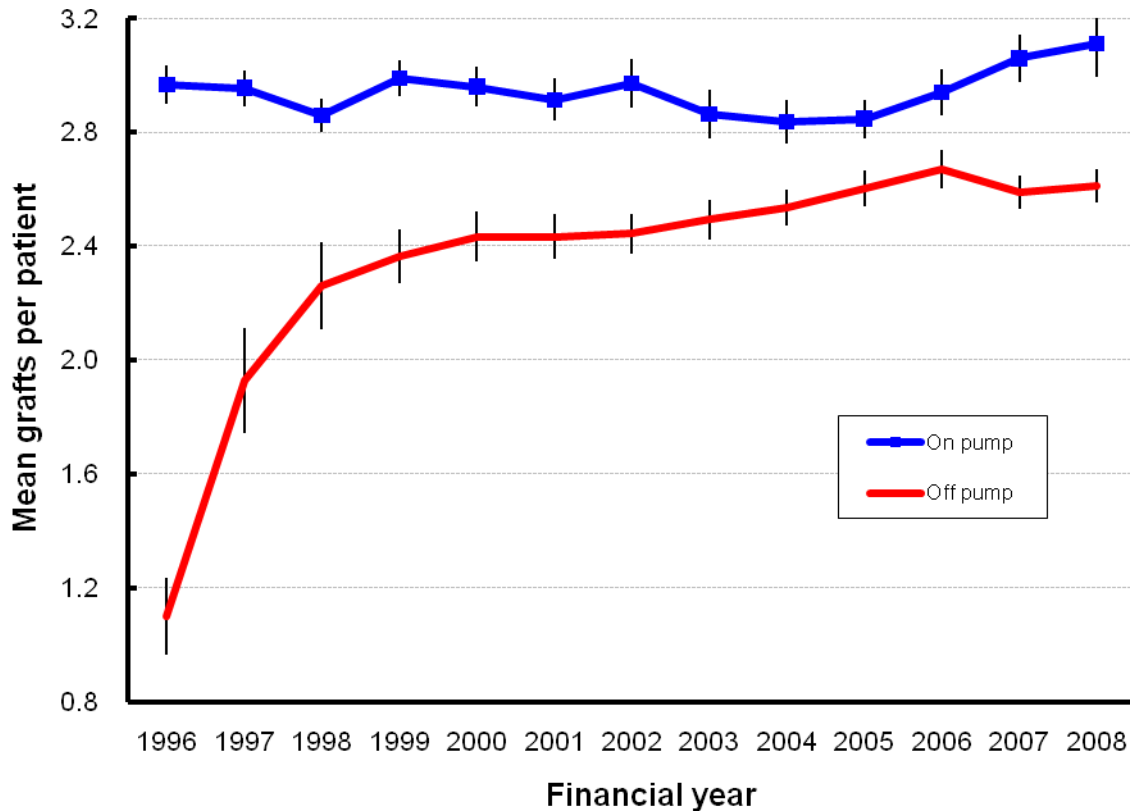
The mean number of grafts per patient in isolated primary CABG was 2.72, which is exactly the same as last year. This is interesting as for the previous few years a steady increase has been observed which has been attributed to the evolution of off-pump surgery.

**Table 3: Trends in graft rate for isolated primary CABG  
1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009(n=10,443)**

<b>Financial Year</b>	<b>Mean grafts per patient</b>	<b>Number of procedures</b>
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
2008-09	2.72	740

Figure 18 shows that although the mean number of grafts has remained the same there has been a decline 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 3.11 and 2.61 respectively which is still statistically significantly different (Mann-Witney  $p < 0.001$ ).

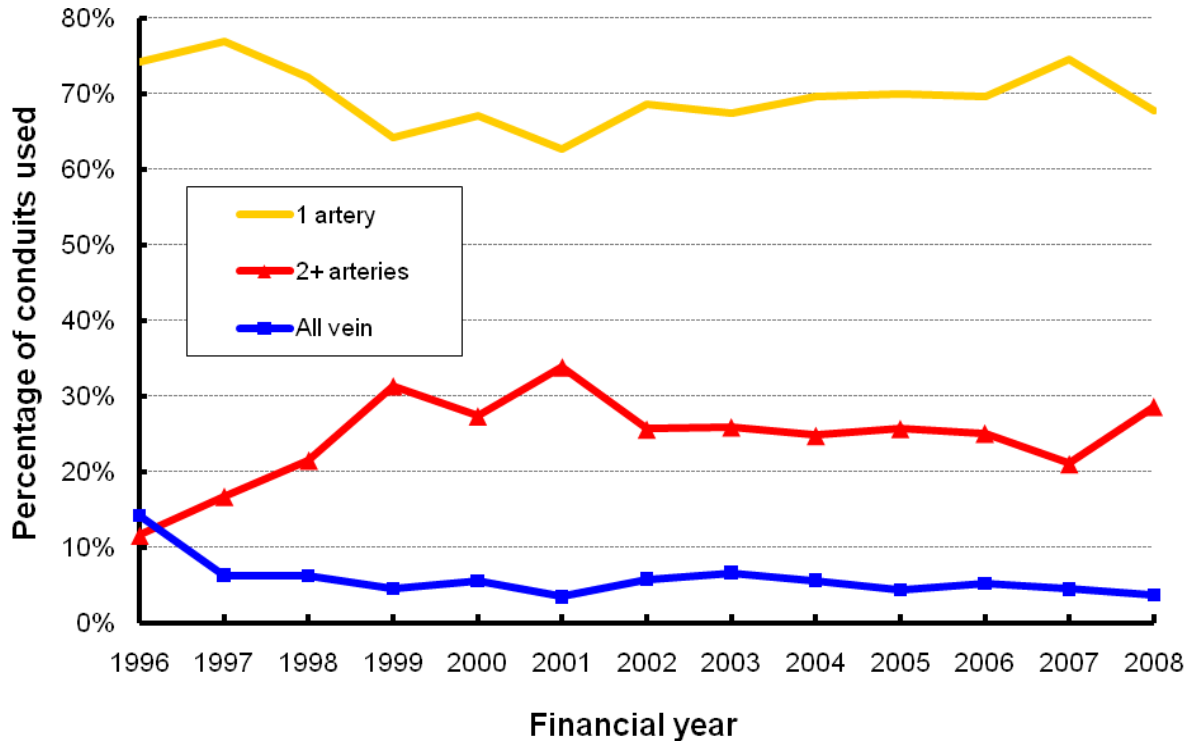
**Figure 18: Mean graft rate by cardiopulmonary bypass use**  
 With 95% confidence intervals for mean  
**Isolated primary CABG: 1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=10,443)**



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 96.3%. 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 also increased to around 28% (fig 19). 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; 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. On the other hand, 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 2008

– 09 the majority of our multiple arterial graft patients(167) received a radial artery graft(22.6%), with only 8.6%(8.6%) receiving a second internal mammary artery graft.

**Figure 19: Use of arterial grafts in isolated primary CABG  
1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=10,443)**



In our practice the proportion of patients undergoing re-operative CABG remains low at 2.0% (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 285 procedures with 10 deaths (3.5%;CCAD 6.6% 2004-8). 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 CABG patient who develops recurrent ischaemia.

There were 22 other procedures for ischaemic heart disease with five 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 2008-9 a total of 483 procedures were undertaken for valvular heart disease, which represents 34% of the overall workload. This is a 7% increase from the 453 procedures undertaken in the previous year. Of these patients, 150 (31%) underwent concomitant CABG in association with their valve surgery. Within this group of 483 patients 24 (5%) did not survive their primary hospital stay.

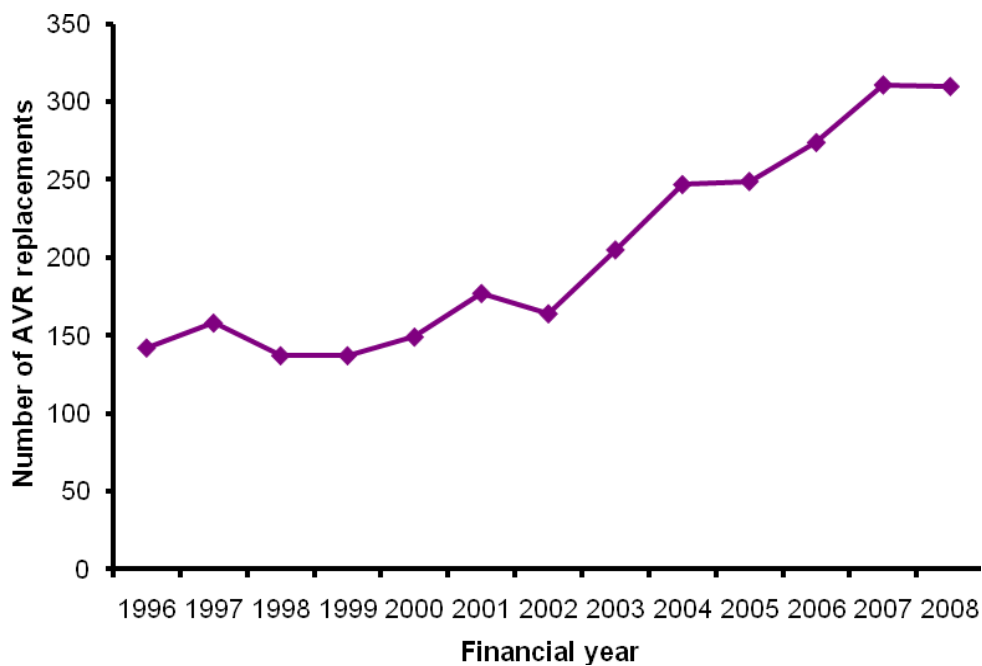
Aortic valve replacement (AVR) is the commonest procedure undertaken for valvular heart disease. A total of 307 procedures on the aortic valve were undertaken with 16 deaths (5.2%). This was very similar to the 311 procedures undertaken in 2006-7. There has been a major and consistent increase in the number of aortic valve procedures undertaken in our institution from around 150 between 1996-2000 to more than 300 in 2008-9 (Fig 20) . 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 its 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 a doubling of activity from 1964 aortic valve replacements in 2001-2 up to 3968 procedures in 2007-8.

There were 171 primary isolated AVR with three deaths (1.8%), which is below the national figure of 2.8% (CCAD 2004-8). Over the last 11 years we have undertaken 1,584 primary isolated AVR with 45 deaths, giving a mortality of 2.8%. In the current period 10 patients underwent redo AVR with one death, over the last 2 years this is 25 procedures with only one

death 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 103 patients underwent primary aortic valve replacement in association with CABG with 9 deaths (8.7%). This rate is a little higher than in recent years, but again, if we examine our performance in the larger cohort, we have undertaken 997 procedures since 1996 with 48 deaths (4.8%), which compares favourably with the UK figure of 5.3% (CCAD 2004-8)

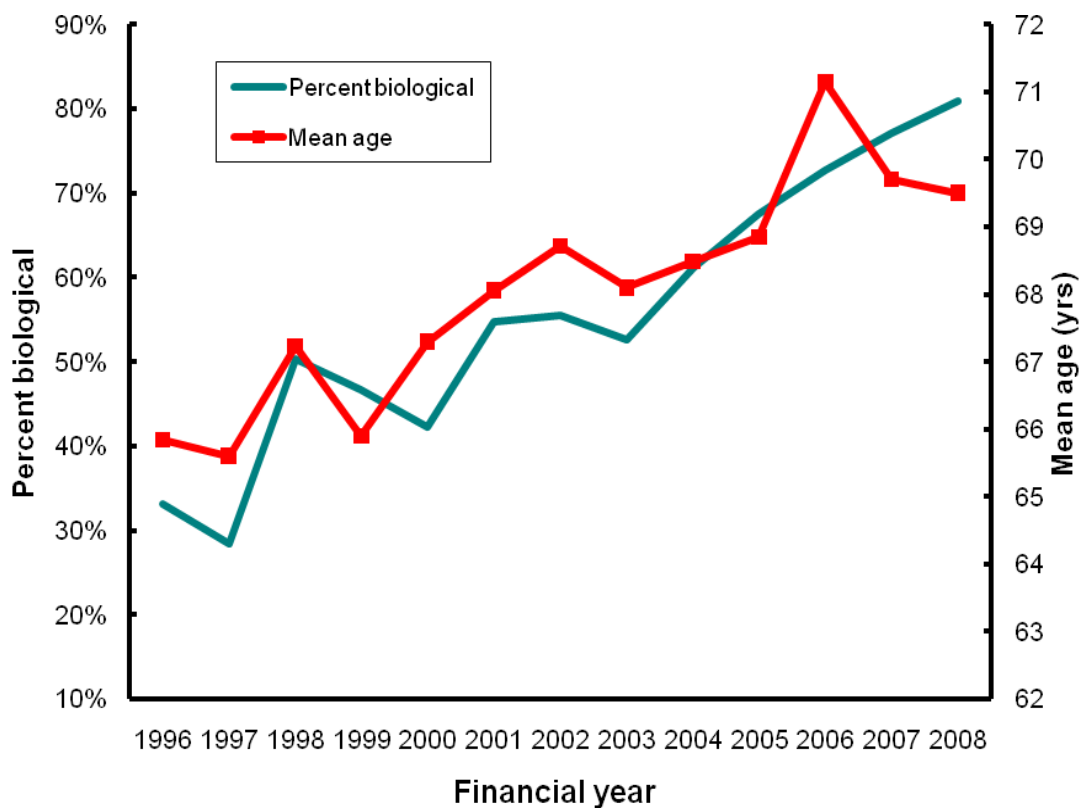
**Fig 20. Trends in Aortic Valve Replacement Bristol Royal Infirmary  
1<sup>st</sup> April 1996- 31<sup>st</sup> March 2009 (n=2,660)**



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 further 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 81% this is the highest proportion we have yet recorded (Figure 21).

In our centre, in the last three years, a multidisciplinary team including cardiologists, surgeons and anaesthetists has embarked on a programme of percutaneous aortic valve replacement (TAVI). The carefully selected patients have predominantly been elderly and at the higher end of the surgical risk spectrum. To date this has been very successful with a total of 61 procedures with 3 hospital deaths so far recorded. It remains to be seen what impact this will have on the applicability of surgical valve replacement.

**Figure 21: Trend in biological prosthesis use for aortic valve replacement  
1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=2,660)**



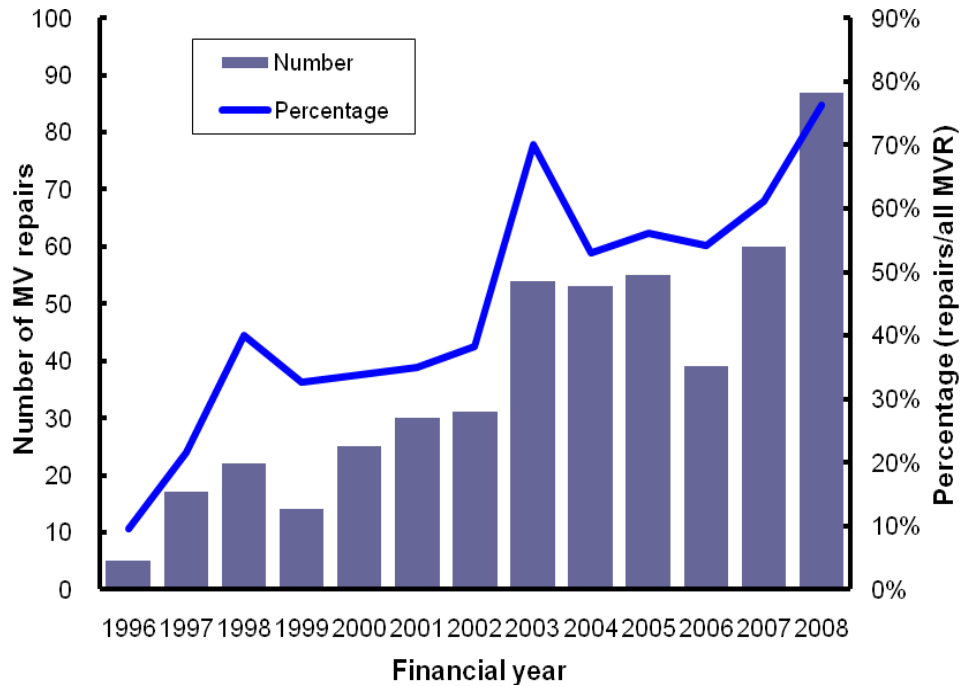
In recent years the profile of mitral valve disease has changed. The aetiology is now predominantly ischaemic or degenerative rather than rheumatic. In degenerative cases mitral valve repair is preferred because of better long-term survival and preservation of left ventricular function as well as potential 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 perioperative imaging to precisely define the nature of the mitral valve abnormality and to provide quality control for the surgical repair. Secondly, a range of surgical techniques need to be acquired. Lastly, the very best results are likely to be achieved by limiting activity to surgeons performing higher volumes of these procedures; in our centre this is Professor Raimondo Ascione and Mr Franco Ciulli

During 2008-9 a total of 125 procedures were performed for mitral valve disease. Of these 33 procedures involved concomitant CABG (26%). This was a further increase (13%) over the 111 procedures performed in 2007-8. In this year there were 114 primary mitral valve procedures with or without ablation of atrial fibrillation (AF) with four deaths (3.5%). This compares favourably to the UK mortality of 4.2% for isolated primary mitral valve procedures (CCAD2004-8). Over a total of 13 years we have achieved an institutional mortality of 4.1% which is similar to the current UK average of 4.2%. 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 11 procedures with no deaths.

**Figure 22: Trend in isolated primary mitral valve repair  
1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009(n=1029)**



Valve replacement was undertaken in 34 patients, and of these 18 underwent mechanical valve replacement (53%). The proportion of patients undergoing mechanical valve replacement is now relatively small. In 33 procedures for mitral valve repair/replacement with concomitant CABG (with or without AF ablation) there were three deaths (9%). This takes the outcome for our patients over the 13 year period of study to 23 deaths in 322 patients or 7.1%, which is again below the UK average of 9.4% (CCAD 2004-8)

In the 114 patients who underwent primary mitral valve procedures (+/- CABG,+/-ablation) there were 87 who underwent valve repair (76%). This is the largest number of mitral valve repairs yet undertaken in the Bristol unit in a single year and represented a 45% increase over the 60 valve repairs completed in 2007-8. This big increase in both the numbers of mitral valve repairs and the proportion of those undergoing mitral valve surgery is clearly shown in Fig 22. This should be highlighted as one of the most successful areas of our surgical practice

and the prospects for further developments are promising with a successful series of minimally invasive mitral procedures well underway.

There were seven primary procedures involving concomitant mitral and tricuspid surgery in all of whom tricuspid valve repair was possible.

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 35 patients underwent AF ablation in association with other valve surgery, the most common of which was mitral valve repair (20 patients).

Primary combined aortic and mitral valve procedures were undertaken in 13 patients with one death (7.7%). Over the last 13 years we have undertaken 131 procedures with only eight deaths (6.1%), which is an excellent institutional record.

## **8. Other Procedures**

### **a) Adult Congenital Heart Disease**

The Royal Bristol Hospital for Children together with Bristol Heart Institute 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 16 are treated in the BHI. Patients with congenital heart disease are living 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 under represented because congenital heart disease patients who undergo valvular heart surgery are classified along with acquired heart disease patients in Chapter 8 since the way the data is presented here is procedure based.

In the current period there were 48 procedures with no deaths but probably a similar number of these type of patients end up being classified as undergoing surgery for valvular heart disease . This is a group with a wide range of complexity - from the 12 patients who underwent closure of an atrial septal defect to those patients requiring reoperative reconstructions of their right or left ventricular outflow tracts. 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 there continues to be expansion of this service.

### **b) Surgery of the Thoracic Aorta**

This year saw us increase our activity in this area by 23% to a total of 76 aortic reconstructions. This is the largest number of thoracic aortic reconstructions so far performed

in a single year. There were five deaths in this relatively high risk group with an overall mortality of 6.6% (Table 4). Over the last 12 years as a group we have now undertaken 600 thoracic aortic reconstructions with 72 deaths - an overall mortality of 12% - which is just below the last published UK figure of 12.9% (CCAD 2004-8 12.9%). Within this group the most challenging patients are those with acute dissection of which there were 24 patients this year with 3 deaths.

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

We have continued to develop our multidisciplinary team for endovascular stent grafting for thoracic aortic disease. 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 complicated type B (descending) aortic dissection where the indications are still evolving.

**Table 4: Aortic surgery, 1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2008**

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Aortic procedures	45	37	41	43	46	34	67	62	76
Total procedures	1,124	1,127	1,105	1,170	1,485	1,414	1,430	1,471	1,405
Percentage	4.0%	3.3%	3.7%	3.7%	3.1%	2.4%	4.7%	4.2%	5.4%
Deaths	7	3	3	9	7	4	5	7	5
Mortality rate	15.6%	8.1%	7.3%	20.9%	15.2%	11.8%	7.5%	11.3%	6.6%

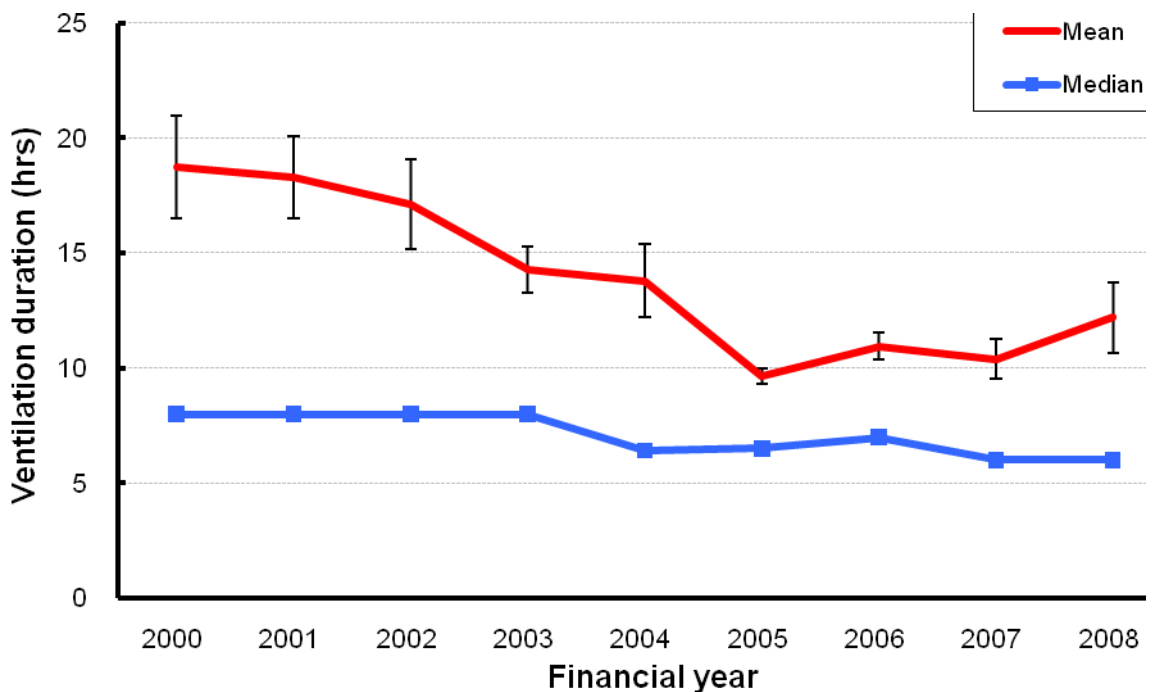
## 9. Postoperative Recovery

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

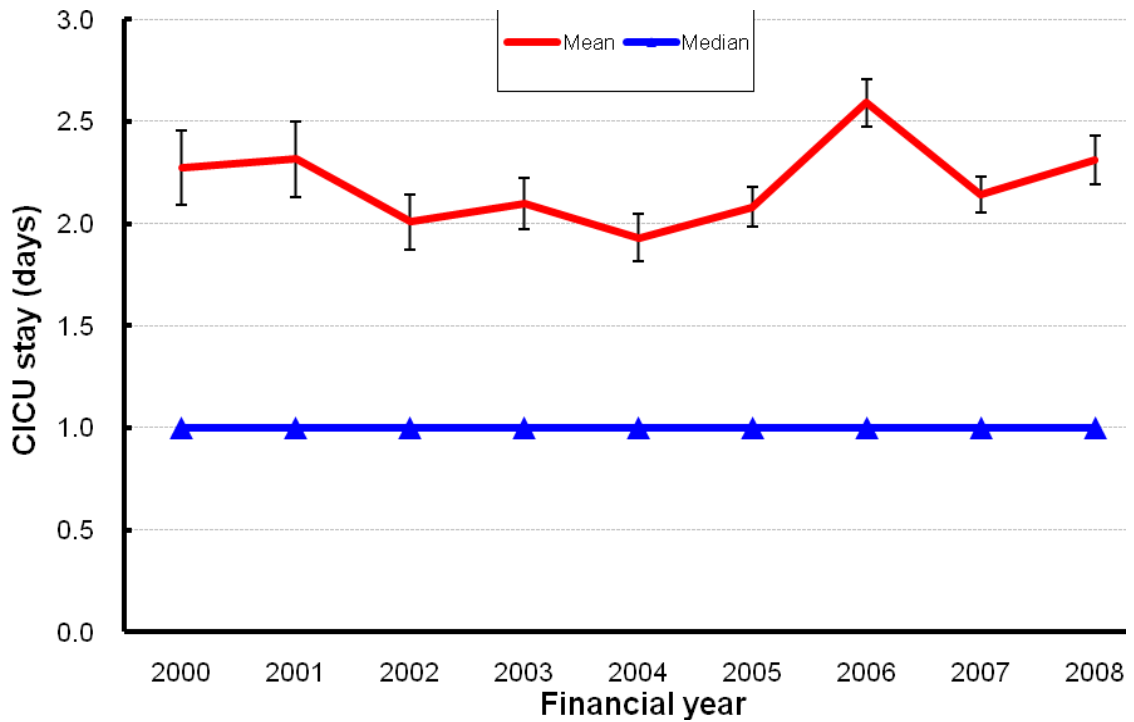
- duration of postoperative mechanical ventilation;
- intensive care unit length of stay;
- hospital length of stay

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 patients with more comorbidities as shown earlier in Figures 4, 9, and 10. Despite this, the overall trend is towards quicker recovery with decreased times to extubation and hospital discharge.

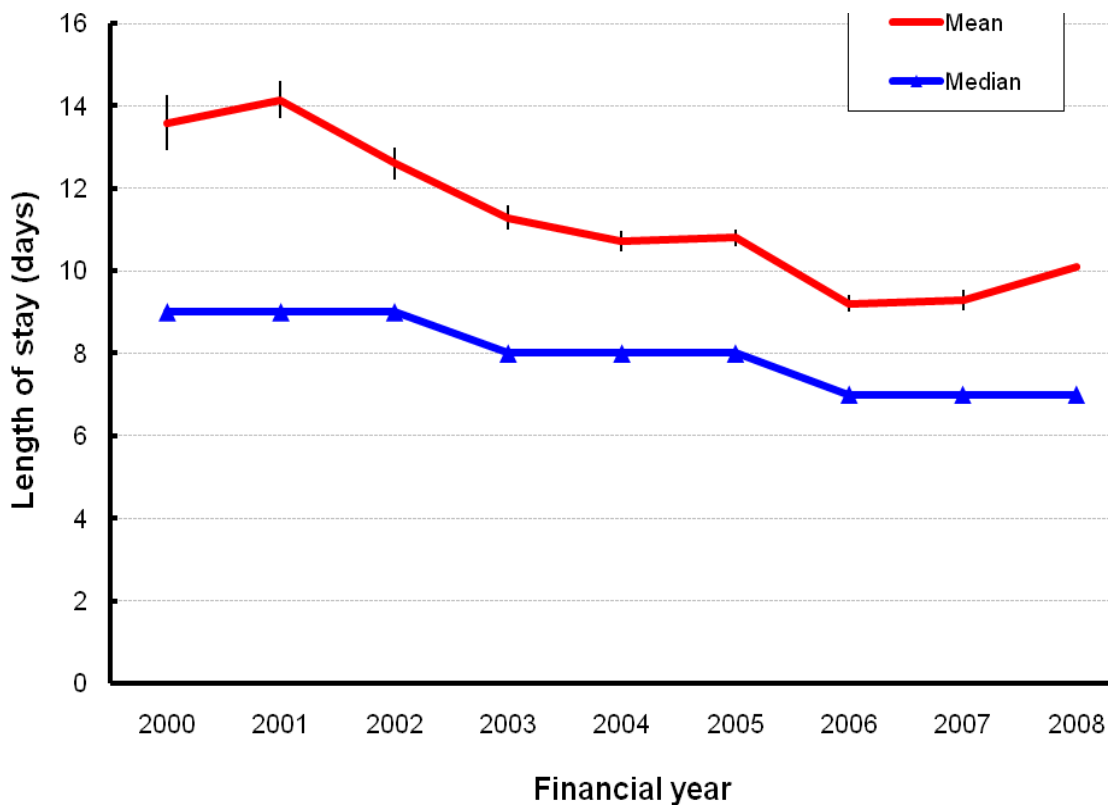
**Figure 23: Duration of mechanical ventilation**  
With standard errors for the mean  
1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,241)



**Figure 24: Cardiac Intensive Care Unit (CICU) length of stay**  
 (With standard errors for the mean)  
 1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,660)



**Figure 25: Post-operative length of stay**  
 (With standard errors for the mean)  
 1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,735)



The median duration of stay on the cardiac surgical intensive care unit(Fig 24) (CICU) remains at one day and the mean which had risen last year shows a further small but probably insignificant rise. 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 (CCAD 08-09 mean 8.2 days) 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. Postoperative Morbidity**

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 from 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 of 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.

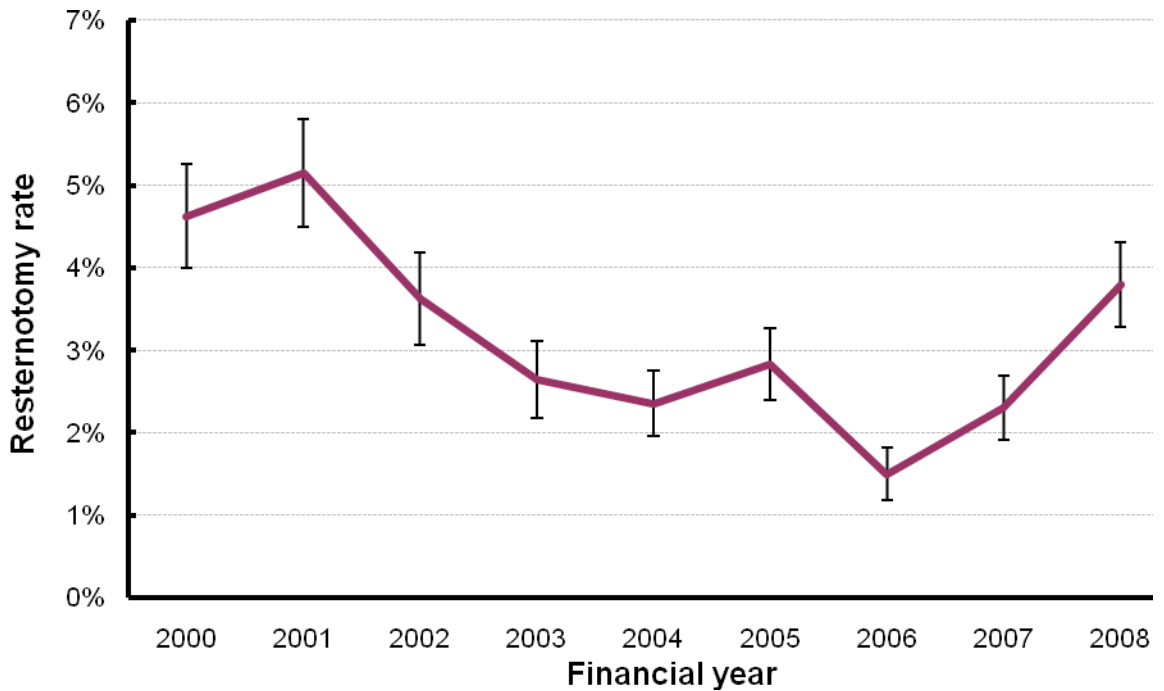
The following areas of postoperative morbidity are presented in Figures 27 – 33:

- Reoperation for 'early' postoperative bleeding;
- Renal deterioration (rise in creatinine to greater than 200  $\mu\text{mol/L}$ ; 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)

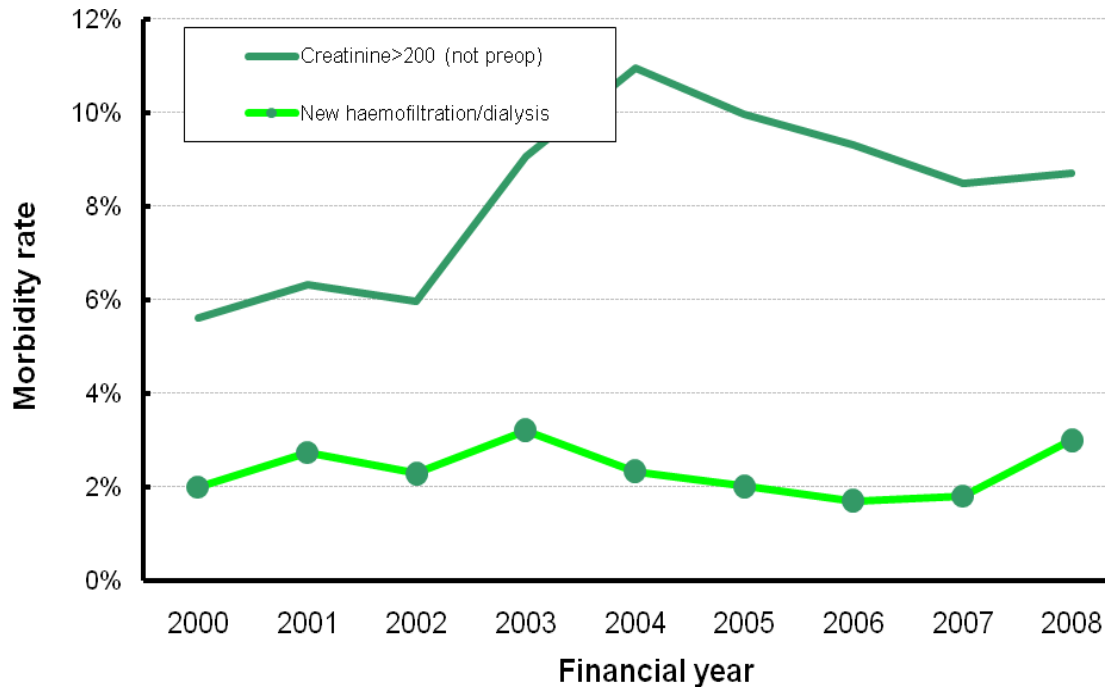
In general, the data presented shows little change in the incidence of most postoperative complications over the past two to three years. However, one area to highlight has been the recent increase in re-sternotomy for bleeding up to 3.8%. This is disappointing because the rate

had fallen significantly in the preceding five years to a low of less than 2%. The past two years has shown an increase and this is important because this can have important deleterious effects on ICU stay, hospital stay and blood and blood product usage. Whether the increase in numbers of patients on potent antiplatelet agents is responsible, for example, or whether there are other factors responsible is worth exploring as a separate audit project.

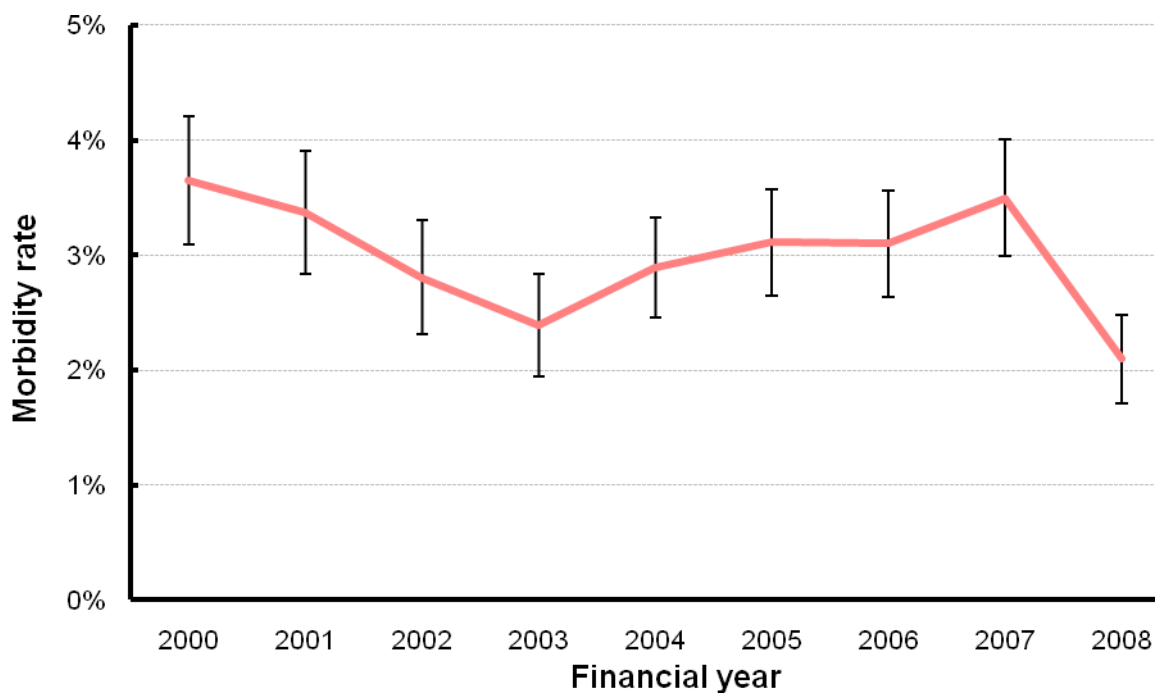
**Figure 26: Trend in resternotomy for bleeding/tamponade – all cases**  
(With standard error bars for binomial proportions)  
1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,713)



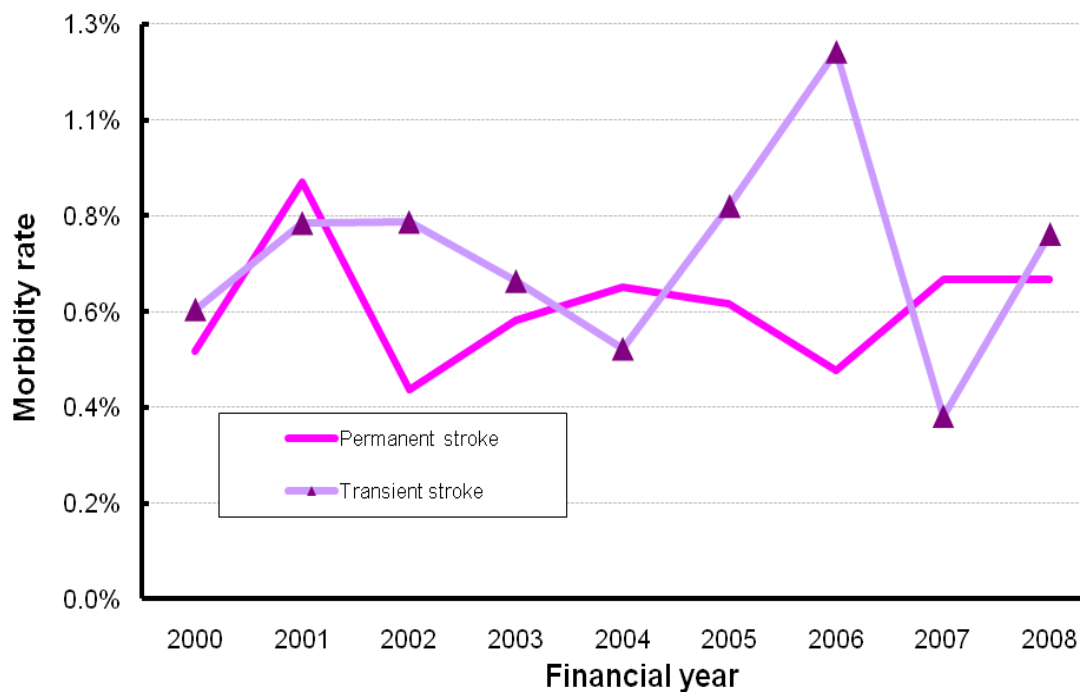
**Figure 27: Trend in post-operative renal morbidity**  
1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,195)



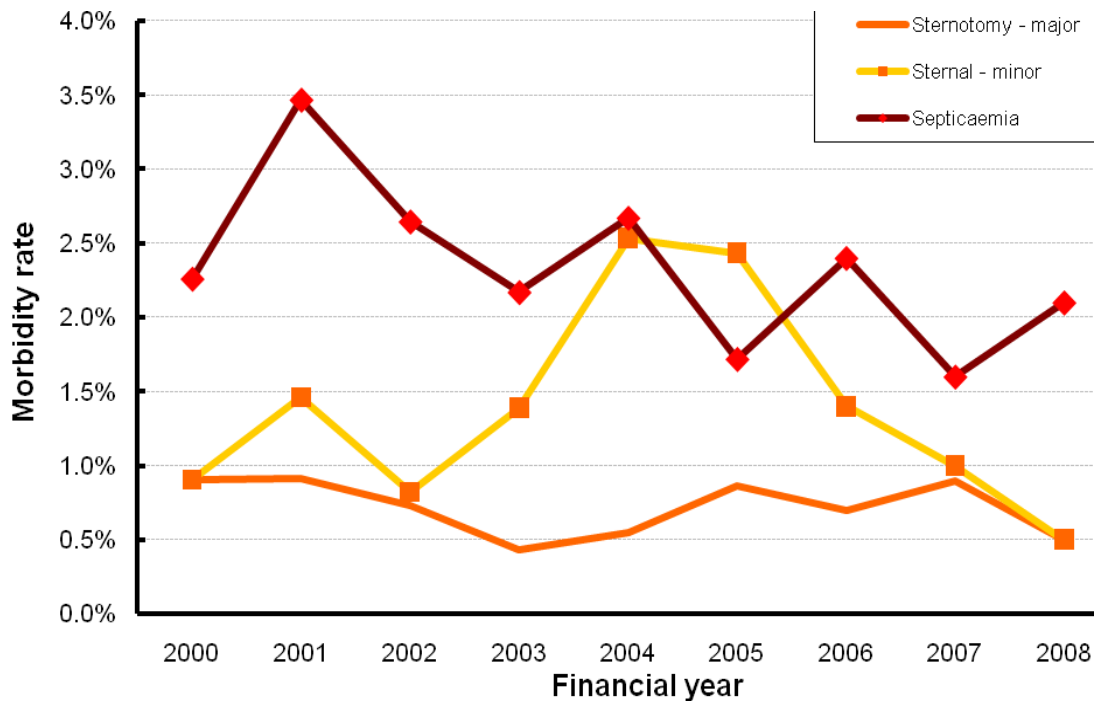
**Figure 28: Trend in post-operative IABP support**  
 (with standard error bars for binomial proportions)  
 1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,551)



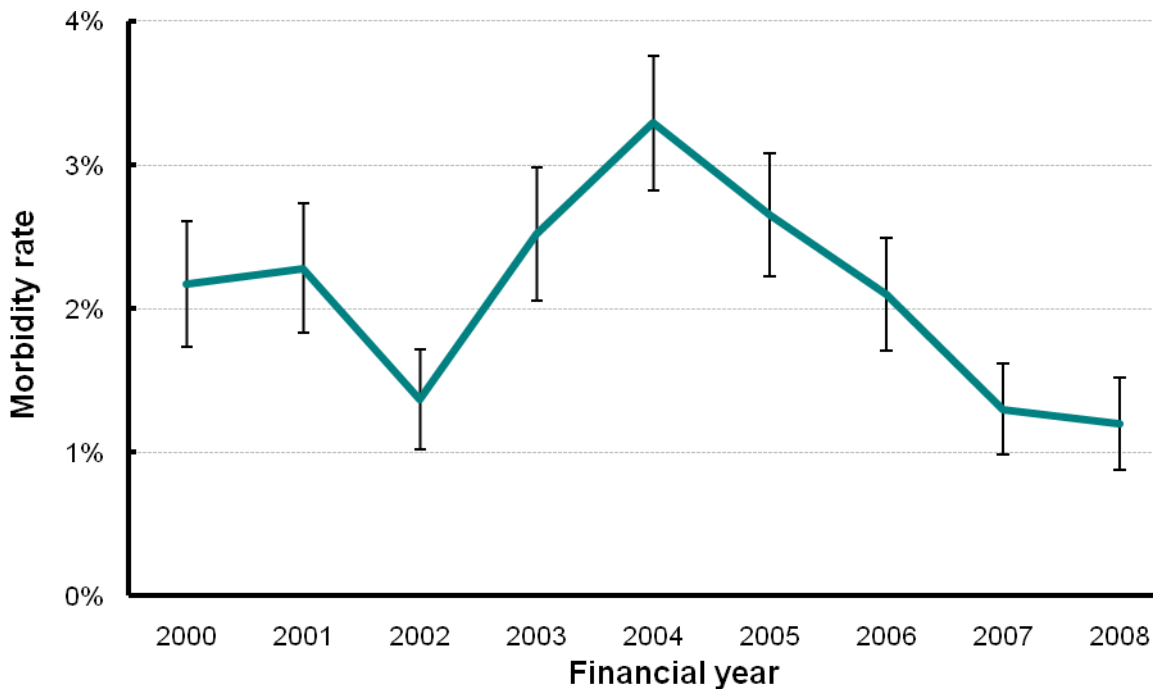
**Figure 29: Trend in post-operative neurological morbidity**  
 1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,551)



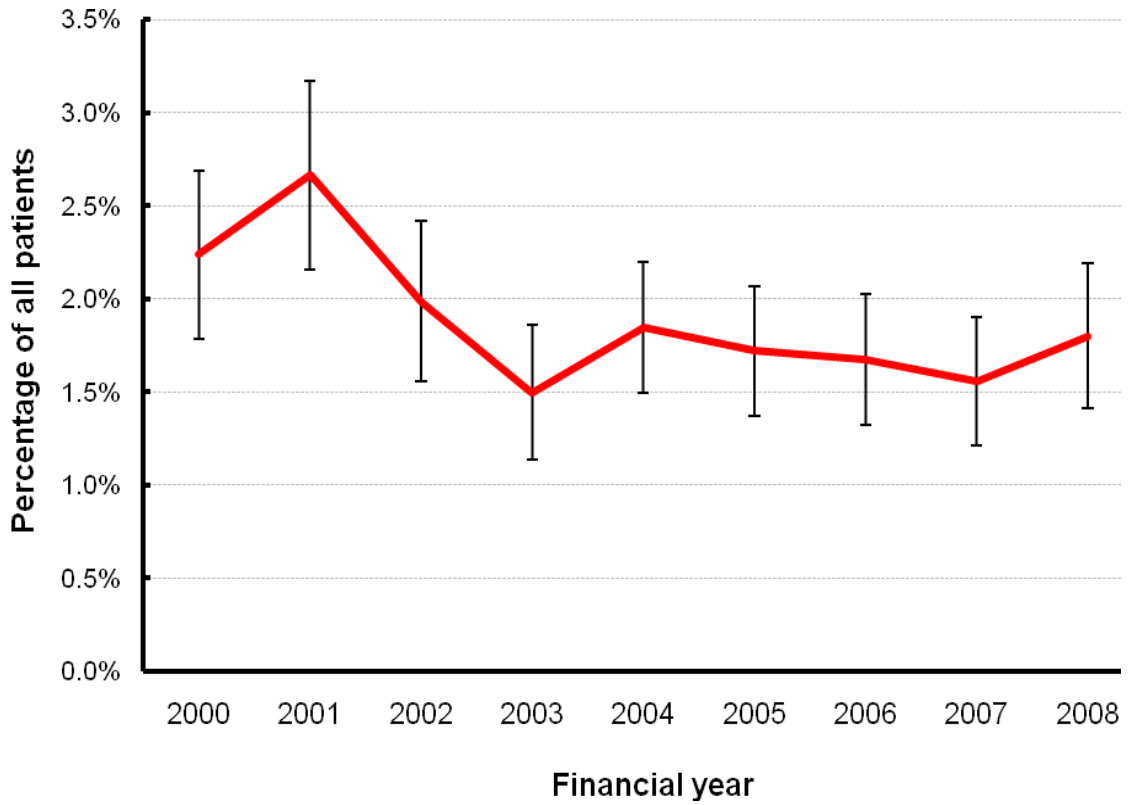
**Figure 30: Trend in major infective complications**  
**1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009**



**Figure 31: Trend in Gastrointestinal complications**  
 (With standard error bars for binomial proportions)  
**1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=11,057)**



**Figure 32: Trend in tracheostomy rate  
(with standard error bars for binomial proportions)  
1<sup>st</sup> April 2000 – 31<sup>st</sup> March 2009 (n=10,698)**

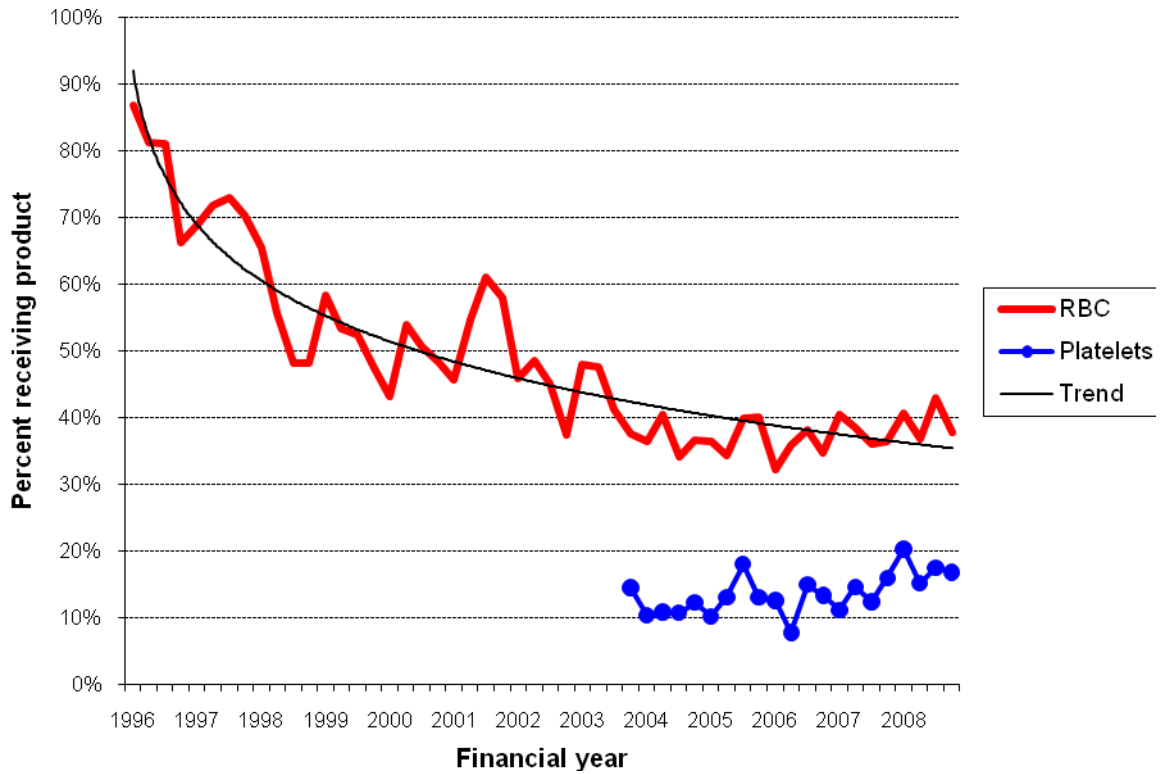


There is a drive in the UK to compare and benchmark different units with respect to both mortality and morbidity. There is some contemporary information available for morbidity with respect to major morbidity and with respect to these we represent the UK figures for 2008-9 in parentheses after our own local figures: Mortality 3.4%(3.2%), Reoperation for Bleeding/Tamponade 3.8% (4.3%), Neurological deficit/stroke 1.5%(1.5%). 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 33: Trend in blood product use – all cases**  
**1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=16,136)**



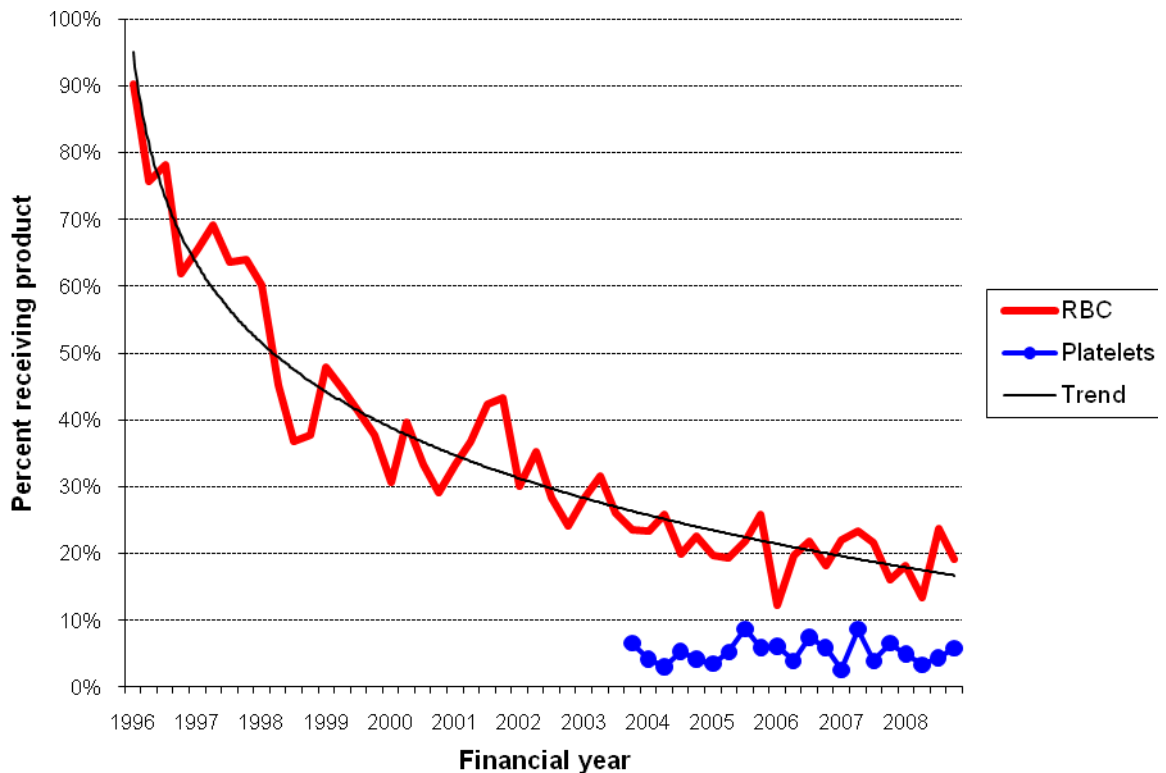
In order to minimise the confounding effect of the change in patient age and fitness, we also examine transfusion figures in a subset of our patients deemed ‘low risk for transfusion’:

- *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 34: Trend in blood product use – cohort group  
1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=8,330)**



## **11. Assessment of Surgical Performance**

At Bristol we have now completed 13 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 fifth 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](http://www.cqc.org.uk)

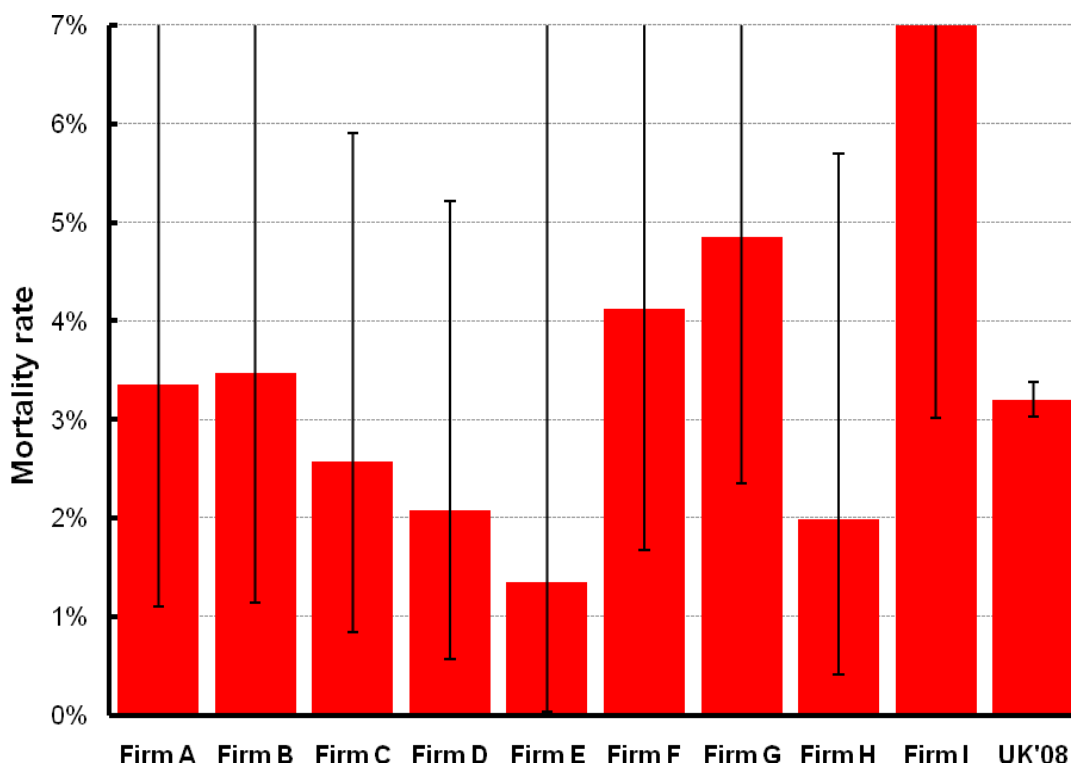
There continues to be controversy in the cardiothoracic surgical community as to whether this approach is beneficial or not; indeed not all centres contribute to this initiative or present their own surgeon-specific data.

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 (1.69%, CCAD 2006/8) 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 1<sup>st</sup> April 2006 to 31<sup>st</sup> March 2009. 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 at the lower 95% confidence limit of the national rate, which is an excellent outcome .

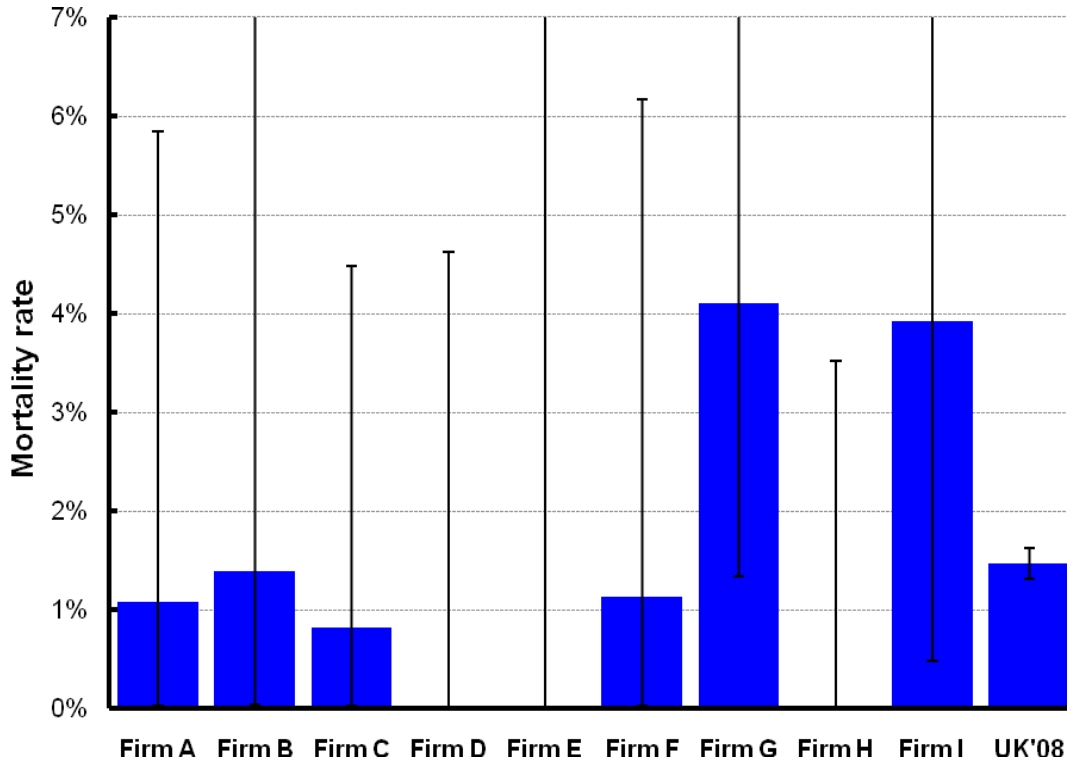
However, we have already identified differences in the risk profile of the caseloads of the individual consultant surgeons (Figures 13 & 14). While comparisons of outcomes for CABG

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.

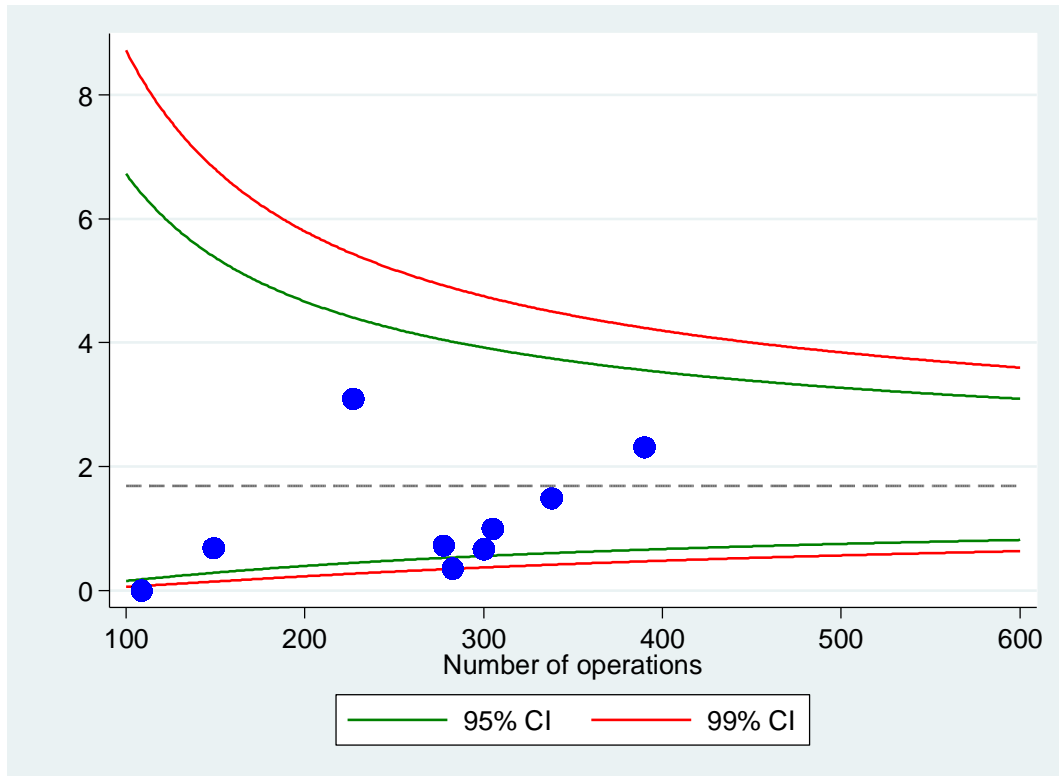
**Figure 35: Mortality rates for all procedures by surgeon firm**  
(with 95% confidence intervals for Poisson rates)  
1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009 (n=1,405)



**Figure 36: Mortality rates for ipCABG by surgeon firm**  
 (with 95% confidence intervals for Poisson rates)  
 1<sup>st</sup> April 2008 – 31<sup>st</sup> March 2009 (n=740)

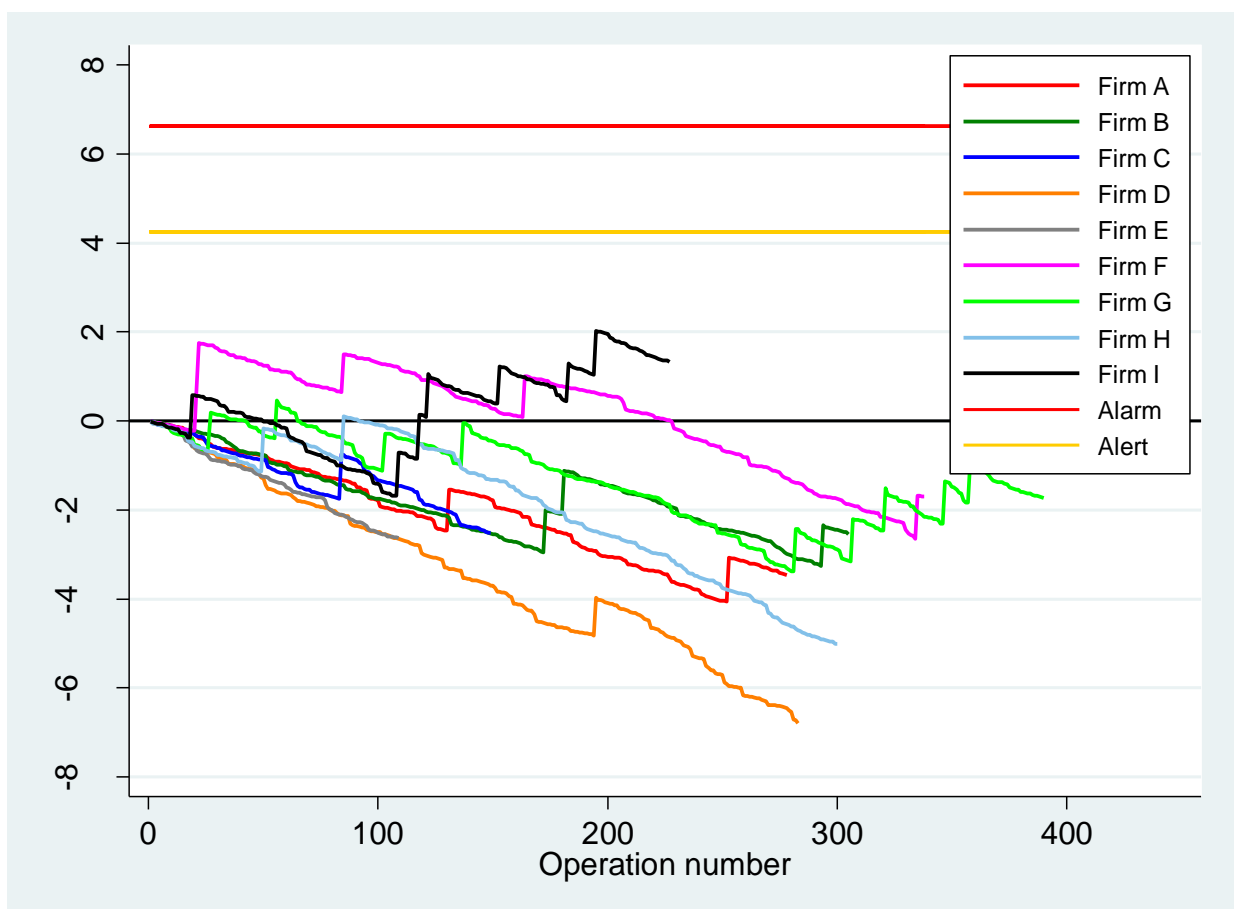


**Figure 38: Funnel plot for isolated primary CABG**  
 1<sup>st</sup> April 2006 – 31<sup>st</sup> March 2009 (n=2,379)

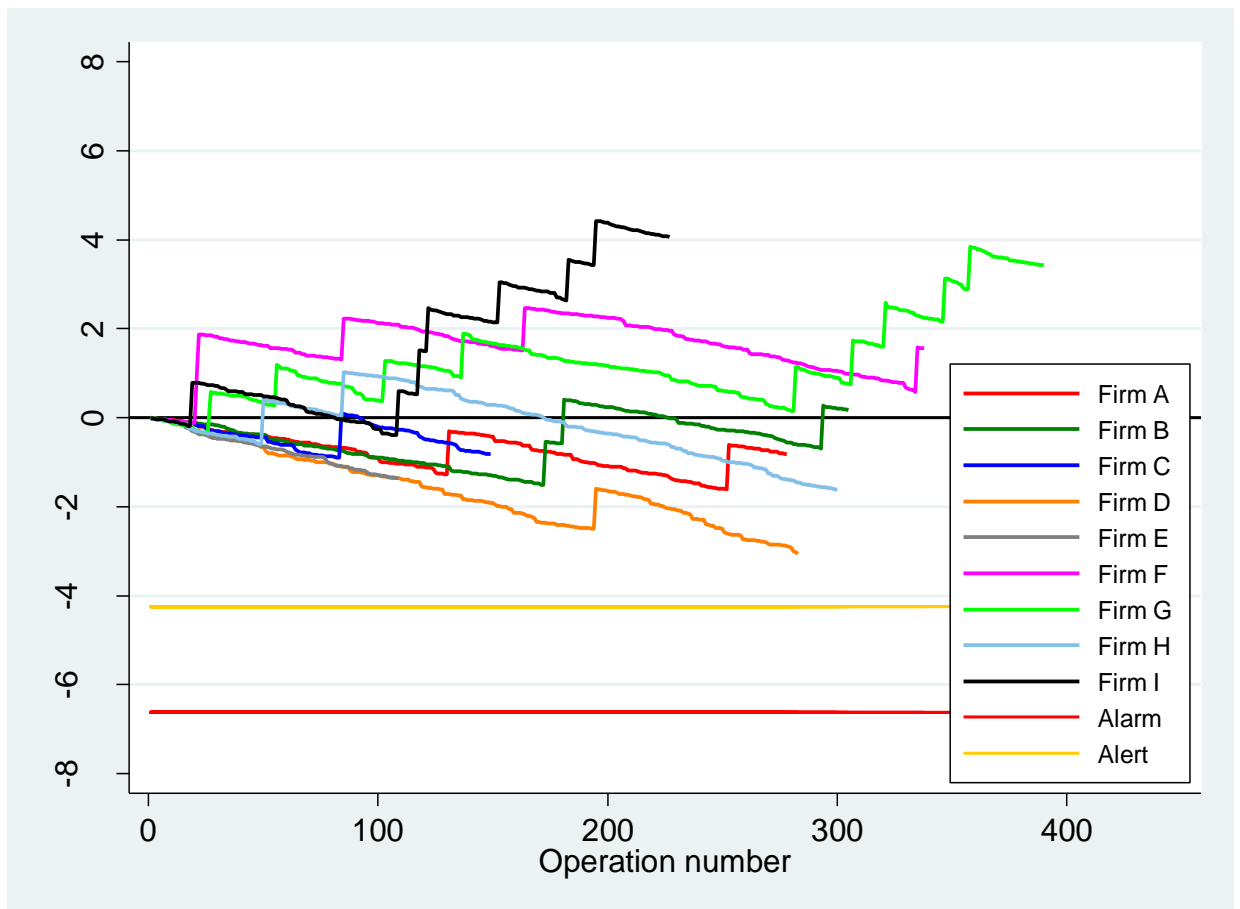


For ongoing monitoring of outcomes after CABG we have been using the Sequential Probability Ratio Test (SPiRiT)<sup>(8)</sup>. This test takes the form of a simple adaptation of a cumulative “observed-expected” plot, with horizontal thresholds which are risk-adjusted. Figure 39 shows the SPiRiT plot for the last three 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 40 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, 1<sup>st</sup> April 2006 – 31<sup>st</sup> March 2009 (n=2,379)**



**Figure 40: Sequential Probability Ratio Test (SPiRiT) plot for halved mortality rate isolated primary CABG, 1<sup>st</sup> April 2006 – 31<sup>st</sup> March 2009 (n=2,379)**



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. The updated and recalibrated EuroSCORE predicted outcomes have been applied for the first time. 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 almost 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 <sup>(8)</sup>. 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<sup>(9)</sup>. Indeed, around 12% of patients have been found to consult surgeon-specific data prior to treatment <sup>(10)</sup>. There is also no evidence from North America of a shift of patients from high to low mortality centres<sup>(11)</sup>, 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 which may be detrimental in the long term. 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 Society of Thoracic Surgeons (STS) in the USA has published a detailed “manifesto” in relation to quality measurement in cardiac surgery<sup>(12-15)</sup>. 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](http://www.qualitycabg.org)** and published by Guru et al<sup>(15)</sup>. 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.

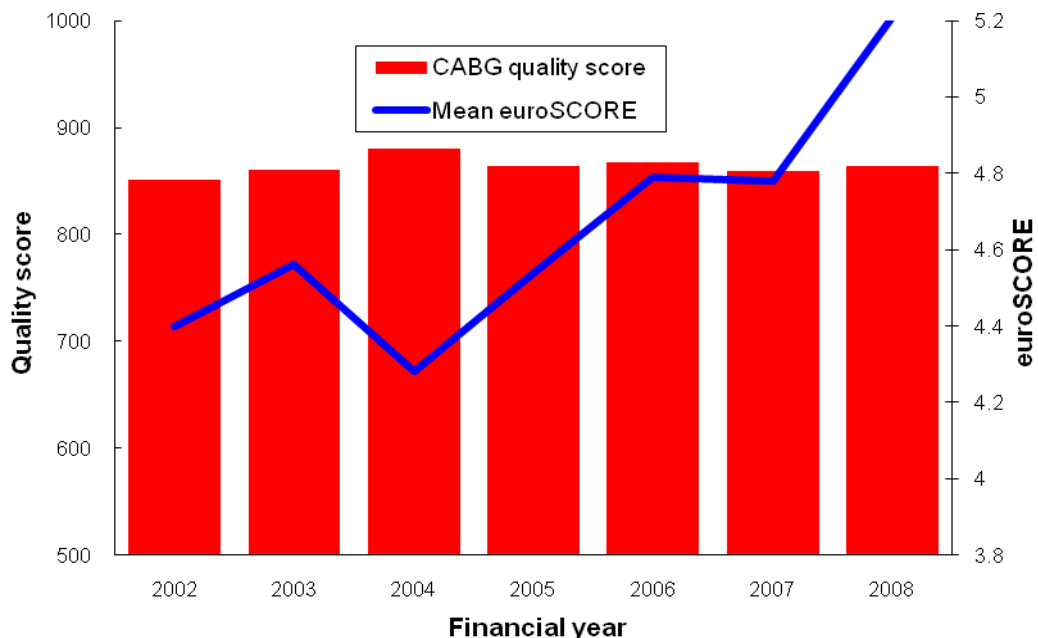
Our proposal is to develop a scale of multiple indicators that reflect the care we provide, and which relate to process delivery and outcome. These factors will be presented as percentages and will be summated to generate an overall CABG Quality Score. This will inevitably be an evolving process to begin 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:

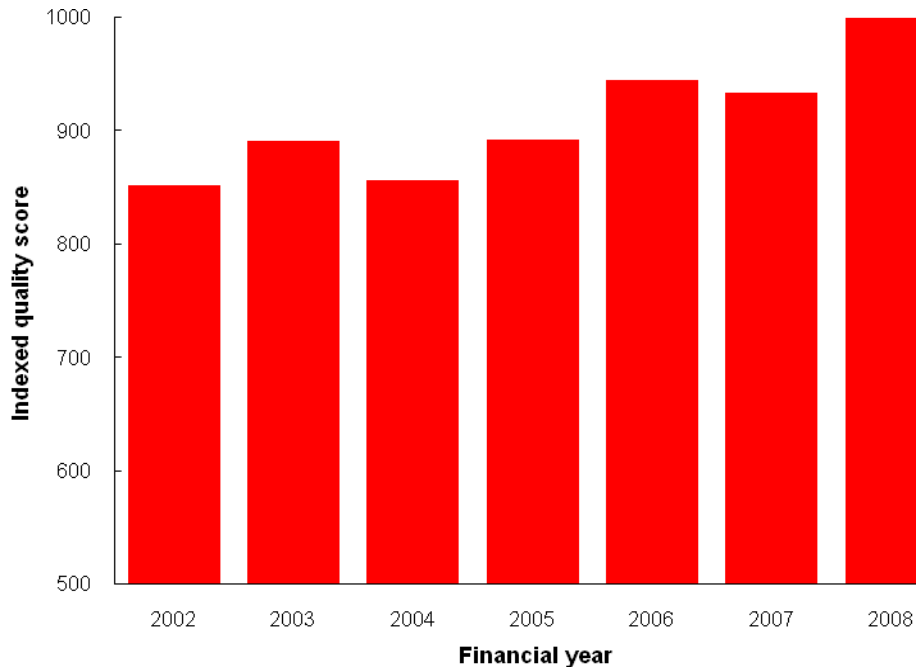
1. % of patients where the LAD is grafted when the IMA is used;
2. % of patients leaving the base hospital alive after surgery;
3. % of patients leaving the base hospital without evidence of a stroke;
4. % of patients who do not require insertion of an IABP either intra or postoperatively;
5. % of patients 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 5<sup>th</sup> 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, 1<sup>st</sup> April 2002 – 31<sup>st</sup> March 2009 (n=5,832)**



**Figure 42: Indexed CABG Quality score (2002 as base year for risk) isolated primary CABG, 1<sup>st</sup> April 2002 – 31<sup>st</sup> March 2009 (n=5,832)**



### **13. Key Conclusions**

- i) A thirteenth 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 3.4% for all cases and 1.5% for primary CABG represent excellent outcomes and conform to contemporary UK(CCAD 1.5% CABG, 3.2% All Cases 08-09) and European standards.
- iii) The proportion of primary CABG operations continues to decline and stands at around 53%. Around 33% of the patients are urgent in-hospital referrals and the significant variation in this workload makes service planning difficult. The cancelled operations rate of 10-16% 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 80% which is one of the highest rates in the UK.
- v) The number of patients undergoing valvular heart surgery continues to increase and exceeded 480 procedures(34%). 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.

- vi) 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.
  
- vii) 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%
  
- viii) For the period 2006-2009 the mortality rate for isolated primary CABG, isolated primary AVR and all procedures was better than the predicted recalibrated EuroSCORE outcomes.
  
- ix) The individual performance of all surgeons specialising in adult cardiac surgery serving as permanent members of staff between 2006-2009, was within accepted ranges of predicted outcomes, as judged against the recalibrated EuroSCORE for ipCABG, ipAVR respectively..

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## Appendix 1

### Mortality rates for commonly performed procedures 1<sup>st</sup> April 1996 – 31<sup>st</sup> March 2009 (n=15,080)

*\*95 percent confidence interval for mortality rate*

	Number	Deaths	Mortality Rate	Lower bound	Upper bound	CCAD 2008
Isolated CABG	10,443	133	1.3%	1.1%	1.5%	1.5%
Redo CABG	285	10	3.5%	1.7%	6.4%	4.1%
Aortic valve procedure	1,584	45	2.8%	2.1%	3.8%	2.8%
AV + CABG	997	48	4.8%	3.6%	6.3%	5.3%
Mitral Valve procedure	718	30	4.2%	2.8%	5.9%	4.1%
MV + CABG	322	23	7.1%	4.6%	10.5%	9.4%
AV + MV Procedure	131	8	6.1%	2.7%	11.7%	8.1%
Aortic	600	72	12.0%	9.5%	14.9%	12.9%

## Appendix 2

### Distribution of procedure types between surgical firms 1<sup>st</sup> April 2008– 31<sup>st</sup> March 2009

	CABG	Valve	Valve + CABG	Aortic	Congenital	Other	Total
Angelini, G D	97	37	13	1	0	1	149
Ascione, R	74	46	19	4	0	1	144
Asimakopoulos, G, G	126	28	29	8	0	3	194
Bryan, A J	85	42	33	30	0	3	193
Caputo, M	11	27	2	4	30	0	74
Ciulli, F	90	56	19	5	0	0	170
Hutter, J A	132	37	27	8	0	2	206
Murphy, G	107	26	8	9	0	1	151
Parry, A	0	8	0	3	18	0	29
Yeatman, M	55	21	5	4	0	10	95
<b>Total</b>	<b>777</b>	<b>328</b>	<b>155</b>	<b>76</b>	<b>48</b>	<b>21</b>	<b>1,405</b>



# Appendix 4

## Individualised Surgical Record

United Bristol Healthcare   
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



	Count	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%			

#### Mortality Rate Analysis

Operative Priority	Count	IC REST		IC			REST		
		%age	%age	Deaths	Procs	Rate	Deaths	Procs	Rate
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%
<b>Total</b>	<b>207</b>			<b>5</b>	<b>207</b>	<b>2.4%</b>	<b>26</b>	<b>1207</b>	<b>2.2%</b>

#### Mortality Rate Analysis

Cardiac Procedures	Count	IC REST		IC			REST		
		%age	%age	Deaths	Procs	Rate	Deaths	Procs	Rate
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%
<b>Total</b>	<b>207</b>			<b>5</b>	<b>207</b>	<b>2.4%</b>	<b>26</b>	<b>1207</b>	<b>2.2%</b>

#### Mortality Rate Analysis

Use of Bypass (isolated primary CABG)	Count	IC REST		IC			REST		
		%age	%age	Deaths	Procs	Rate	Deaths	Procs	Rate
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%
<b>Total</b>	<b>115</b>			<b>1</b>	<b>115</b>	<b>0.9%</b>	<b>11</b>	<b>784</b>	<b>1.4%</b>

#### Mortality Rate Analysis

All grafts (isolated primary CABG)	Count	IC REST		IC			REST		
		%age	%age	Deaths	Procs	Rate	Deaths	Procs	Rate
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%
<b>Total</b>	<b>115</b>			<b>1</b>	<b>115</b>	<b>0.9%</b>	<b>11</b>	<b>784</b>	<b>1.4%</b>

#### Mortality Rate Analysis

Arterial grafts (isolated primary CABG)	Count	IC REST		IC			REST		
		%age	%age	Deaths	Procs	Rate	Deaths	Procs	Rate
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%

#### Mortality Rate Analysis

isolated primary valve replace/repair	Count	IC REST		IC			REST		
		%age	%age	Deaths	Procs	Rate	Deaths	Procs	Rate
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%
<b>Total</b>	<b>34</b>			<b>1</b>	<b>34</b>	<b>2.9%</b>	<b>2</b>	<b>164</b>	<b>1.2%</b>

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%

Median time to extubation (hours)	IC	REST
	7.0	7.0

ICU stays > 24 hours	Count	IC	REST
	1	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

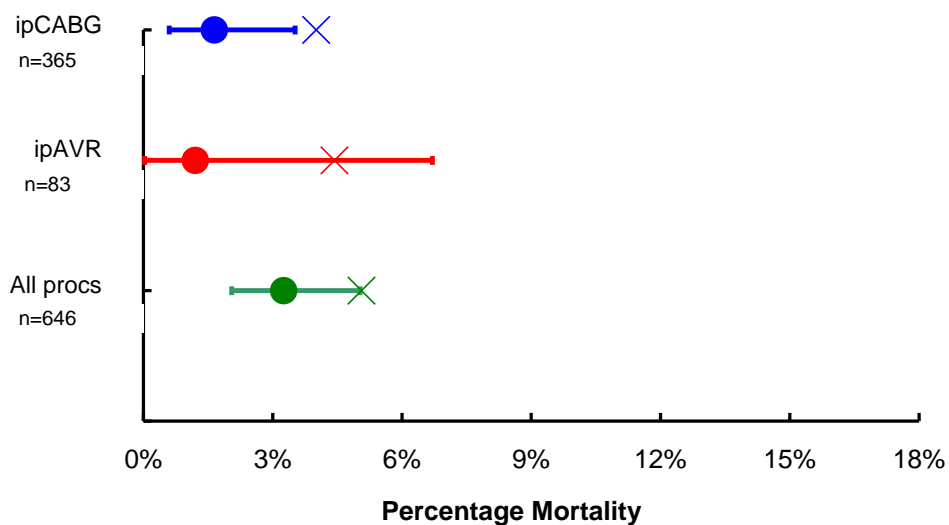
**SCTS marker operation: ipCABG Mortality by EuroSCORE Group**

EuroSCORE Group	IC				REST				UK2003
	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	Oupdate	Procedure	EuroSCORE
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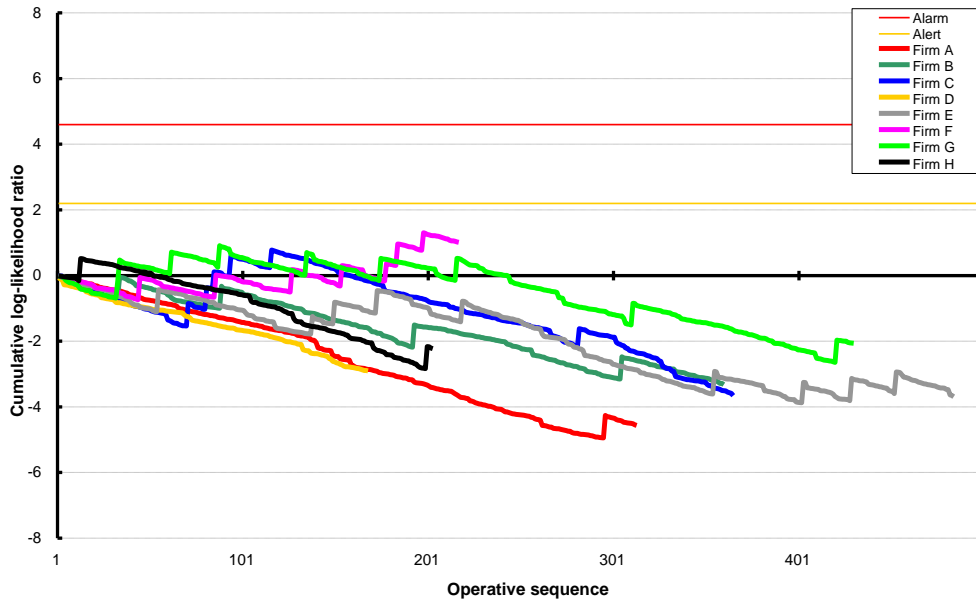
**Mr I Cutwell** Consultant cardiac surgeon



### Sequential Probability Ratio Test (SPRT) Plot: Doubled mortality

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

Using NACSD 2003 mortality rates for EuroSCORE

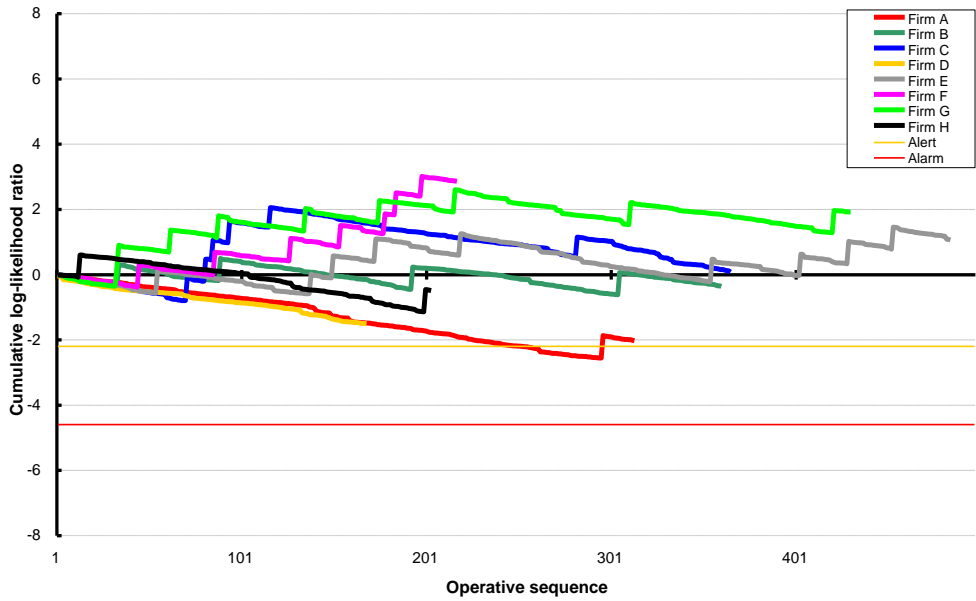


Mr I Cutwell is firm C

### 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 2006 – 31<sup>st</sup> March 2009

#### 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 the recalibrated additive EuroSCORE in a three-year period for each of the following groups:

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

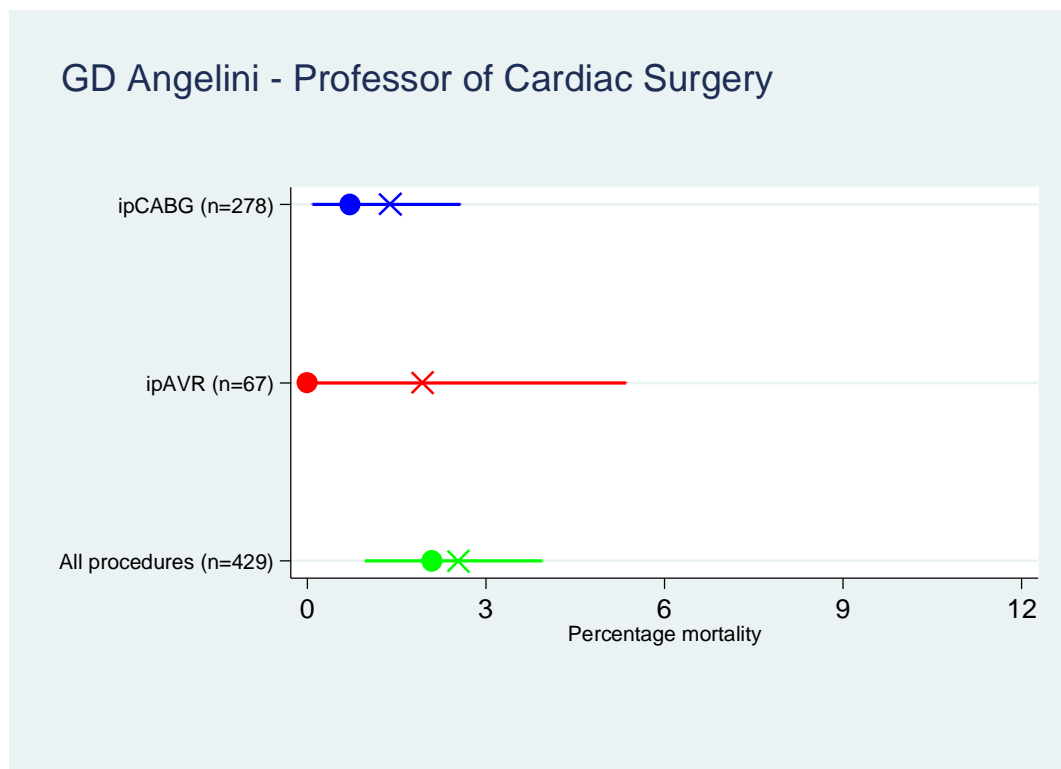
(N.B The recalibrated EuroSCORE was used for CABG and AVR but the standard EuroSCORE for the rest of the cases as a recalibration was not available.)

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.

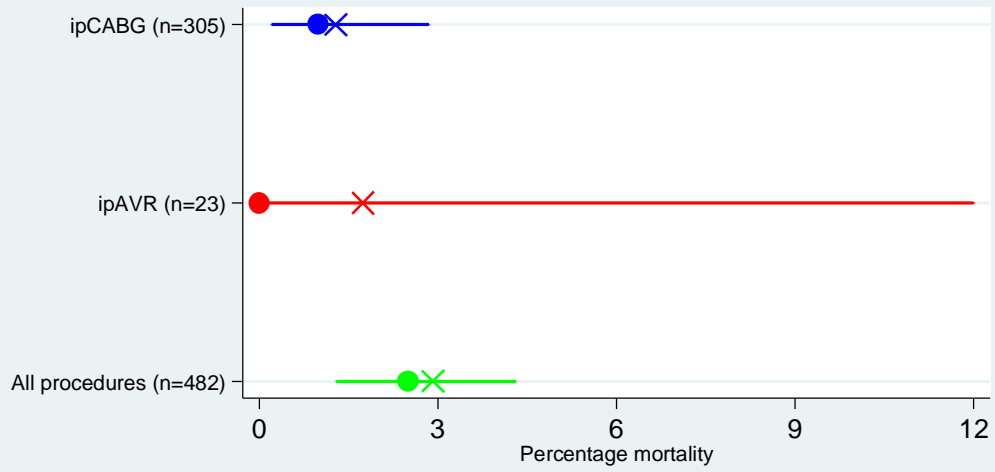
c). The predicted mortality rate is shown on the charts as a large ‘X’. This is an estimate derived from application of the EuroSCORE to each patient. Each score point represents a one percent change of death, and the accumulative score across all patients in the operative group for the period is calculated 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.

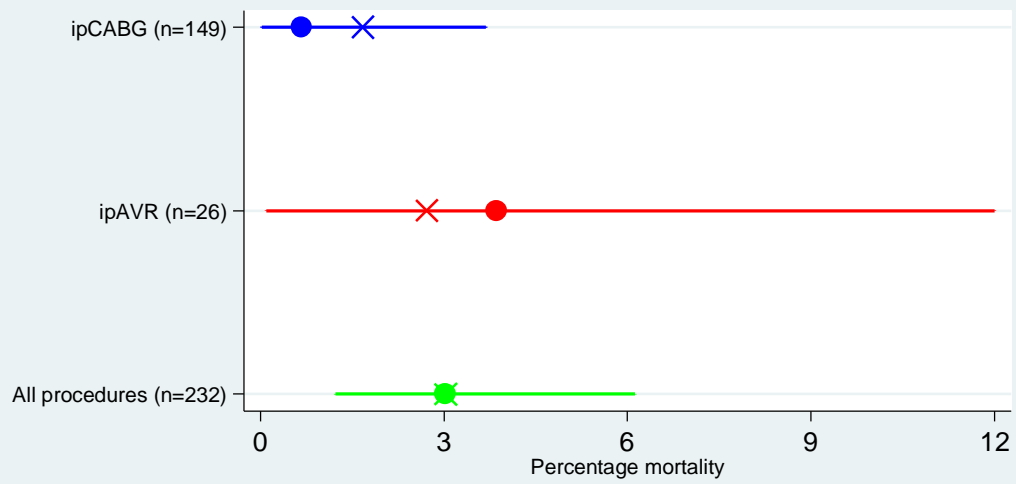
e). Only individualised charts for permanent members of staff specialising in adult cardiac surgery who have served for the majority of the time period have been provided.



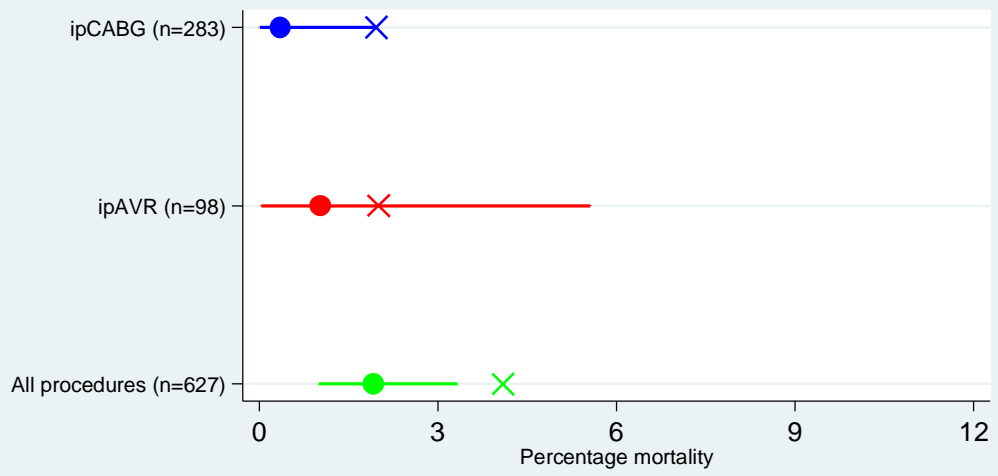
### R Ascione - Professor of Cardiac Surgery and Translational Research



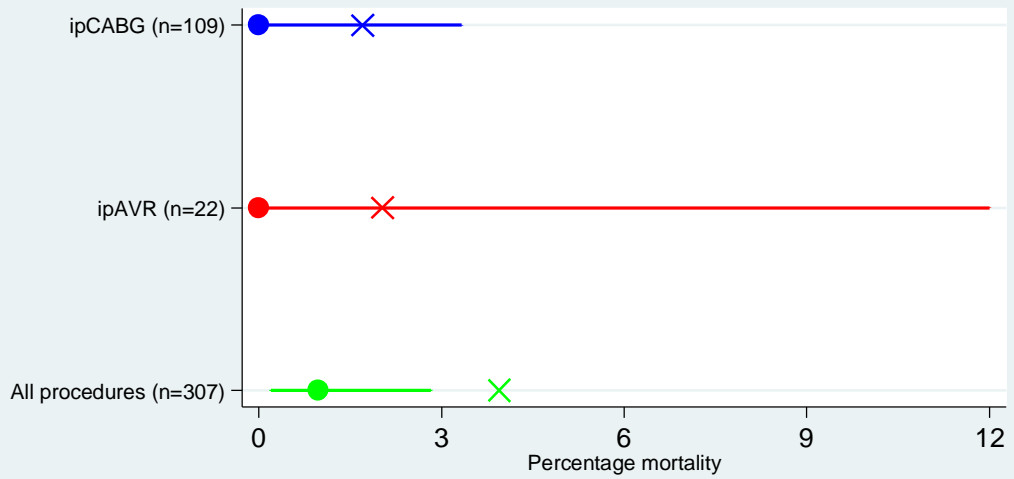
### G Asimakopoulos - Consultant Cardiac Surgeon



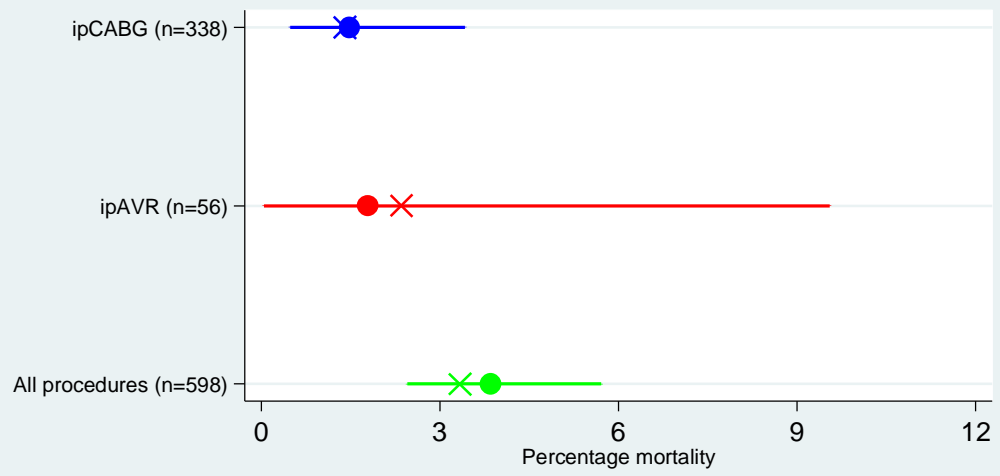
## A Bryan - Consultant Cardiac Surgeon



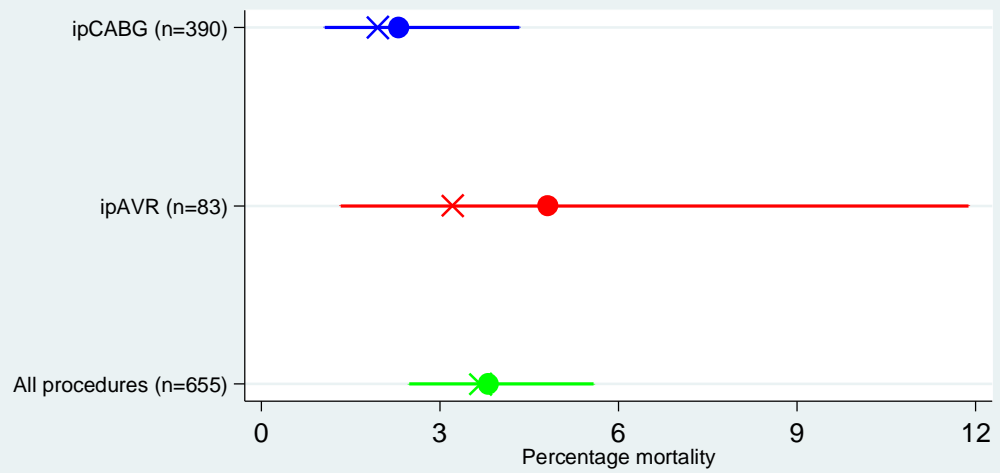
## M Caputo - Reader in Cardiac Surgery (Paeds)



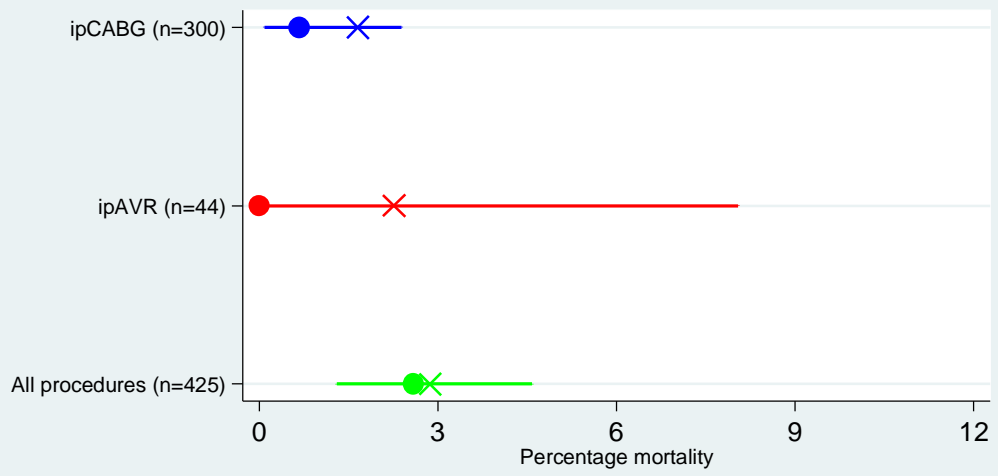
## F Ciulli - Consultant Cardiac Surgeon



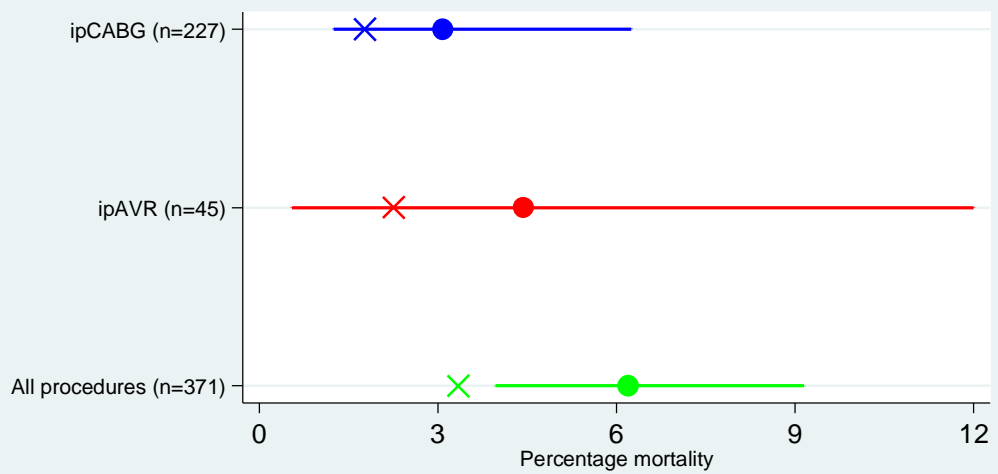
## J Hutter - Consultant Cardiac Surgeon



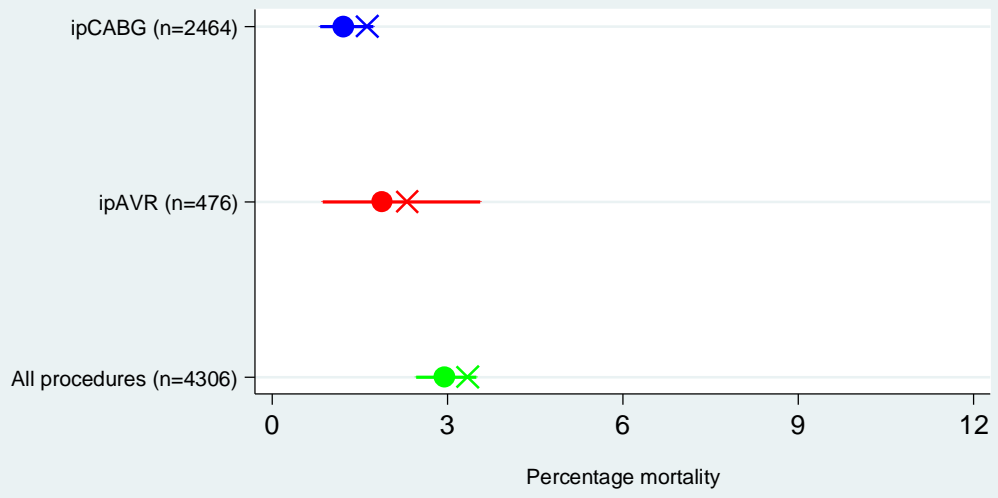
## G Murphy - Reader in Cardiac Surgery



## M Yeatman - Consultant Cardiac Surgeon



## Bristol Royal Infirmary - All surgeons



## Isolated primary CABG

Name	2006-07					2007-08					2008-09					Cumulative 2006-09				
	No.	Actual		Expected		No.	Actual		Expected		No.	Actual		Expected		No.	Actual		Expected	
		Deaths	Rate	Deaths	Rate		Deaths	Rate	Deaths	Rate		Deaths	Rate	Deaths	Rate		Deaths	Rate		
Angelini, G D	95	0	0.0%	1.1	1.2%	90	1	1.1%	1.5	1.7%	93	1	1.1%	1.2	1.3%	278	2	0.7%	3.8	1.4%
Ascione, R	130	0	0.0%	1.5	1.2%	103	2	1.9%	1.4	1.4%	72	1	1.4%	1.0	1.4%	305	3	1.0%	3.9	1.3%
Asimakopoulos, G	N/a	N/a	N/a	N/a	N/a	27	0	0.0%	0.4	1.5%	122	1	0.8%	2.1	1.7%	149	1	0.7%	2.5	1.7%
Bryan, A J	106	0	0.0%	1.9	1.8%	99	1	1.0%	1.9	1.9%	78	0	0.0%	1.8	2.3%	283	1	0.4%	5.6	2.0%
Caputo, M	56	0	0.0%	1.0	1.8%	42	0	0.0%	0.8	1.9%	11	0	0.0%	0.1	0.9%	109	0	0.0%	1.9	1.7%
Ciulli, F	122	3	2.5%	1.5	1.2%	128	1	0.8%	1.8	1.4%	88	1	1.1%	1.4	1.6%	338	5	1.5%	4.7	1.4%
Hutter, J A	129	3	2.3%	2.6	2.0%	139	1	0.7%	2.3	1.7%	122	5	4.1%	2.7	2.2%	390	9	2.3%	7.6	1.9%
Kanellopoulos, G	84	0	0.0%	1.1	1.3%	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	84	0	0.0%	1.1	1.3%
Murphy, G	62	1	1.6%	1.0	1.6%	135	1	0.7%	2.2	1.6%	103	0	0.0%	1.8	1.7%	300	2	0.7%	5.0	1.7%
Parry, A	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Pawade, A	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Yeatman, M	86	1	1.5%	1.5	1.7%	90	4	4.4%	1.5	1.7%	51	2	3.9%	1.0	2.0%	227	7	3.1%	4.0	1.8%
<b>Total</b>	<b>870</b>	<b>8</b>	<b>0.9%</b>	<b>13.2</b>	<b>1.5%</b>	<b>853</b>	<b>11</b>	<b>1.3%</b>	<b>13.8</b>	<b>1.6%</b>	<b>740</b>	<b>11</b>	<b>1.5%</b>	<b>13.1</b>	<b>1.8%</b>	<b>2463</b>	<b>30</b>	<b>1.2%</b>	<b>40.1</b>	<b>1.6%</b>

## Isolated primary AVR

Name	2006-07					2007-08					2008-09					Cumulative 2006-09				
	No.	Actual		Expected		No.	Actual		Expected		No.	Actual		Expected		No.	Actual		Expected	
		Deaths	Rate	Deaths	Rate		Deaths	Rate	Deaths	Rate		Deaths	Rate	Deaths	Rate		Deaths	Rate		
Angelini, G D	20	0	0.0%	0.5	2.5%	17	0	0.0%	0.4	2.4%	30	0	0.0%	0.5	1.7%	67	0	0.0%	1.4	2.1%
Ascione, R	7	0	0.0%	0.2	2.9%	9	0	0.0%	0.1	1.1%	7	0	0.0%	0.1	1.4%	23	0	0.0%	0.4	1.7%
Asimakopoulos, G	N/a	N/a	N/a	N/a	N/a	5	0	0.0%	0.1	2.0%	21	1	4.8%	0.6	2.9%	26	1	3.8%	0.7	2.7%
Bryan, A J	19	0	0.0%	0.6	3.2%	46	0	0.0%	0.9	2.0%	33	1	3.0%	0.5	1.5%	98	1	1.0%	2.0	2.0%
Caputo, M	7	0	0.0%	0.1	1.4%	10	0	0.0%	0.2	2.0%	5	0	0.0%	0.2	4.0%	22	0	0.0%	0.5	2.3%
Ciulli, F	22	1	4.5%	0.5	2.3%	18	0	0.0%	0.4	2.2%	16	0	0.0%	0.4	2.5%	56	1	1.8%	1.3	2.3%
Hutter, J A	27	2	7.4%	0.9	3.3%	29	1	3.4%	0.9	3.1%	27	1	3.7%	0.8	3.0%	83	4	4.8%	2.6	3.1%
Kanellopoulos, G	10	0	0.0%	0.2	2.0%	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	10	0	0.0%	0.2	2.0%
Murphy, G	12	0	0.0%	0.2	N/a	14	0	0.0%	0.3	2.1%	18	0	0.0%	0.5	2.8%	44	0	0.0%	1.0	2.3%
Parry, A	N/a	N/a	N/a	N/a	N/a	1	0	0.0%	0.0	0.0%	1	0	0.0%	0.0	0.0%	2	0	0.0%	0.0	0.0%
Pawade, A	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a
Yeatman, M	17	1	5.9%	0.3	1.8%	15	1	6.7%	0.3	2.0%	13	0	0.0%	0.3	2.3%	45	2	4.4%	0.9	2.0%
<b>Total</b>	<b>141</b>	<b>4</b>	<b>2.8%</b>	<b>3.5</b>	<b>2.5%</b>	<b>164</b>	<b>2</b>	<b>1.2%</b>	<b>3.6</b>	<b>2.2%</b>	<b>171</b>	<b>3</b>	<b>1.8%</b>	<b>3.9</b>	<b>2.3%</b>	<b>476</b>	<b>9</b>	<b>1.9%</b>	<b>11.0</b>	<b>2.3%</b>

## All procedures

Name	2006-07					2007-08					2008-09					Cumulative 2006-09				
	No.	Actual		Expected		No.	Actual		Expected		No.	Actual		Expected		No.	Actual		Expected	
		Deaths	Rate	Deaths	Rate		Deaths	Rate	Deaths	Rate		Deaths	Rate	Deaths	Rate		Deaths	Rate		
Angelini, G D	146	2	1.4%	3.6	2.5%	134	2	1.5%	3.5	2.6%	149	5	3.4%	3.7	2.5%	429	9	2.1%	10.8	2.5%
Ascione, R	180	3	1.7%	4.7	2.6%	158	4	2.5%	4.3	2.7%	144	5	3.5%	5.0	3.5%	482	12	2.5%	14.0	2.9%
Asimakopoulos, G	N/a	N/a	N/a	N/a	N/a	38	2	N/a	0.9	N/a	194	5	2.6%	6.1	3.1%	232	7	3.0%	7.0	3.0%
Bryan, A J	204	4	2.0%	8.5	4.2%	230	4	1.7%	8.6	3.7%	193	4	2.1%	8.6	4.5%	627	12	1.9%	25.7	4.1%
Caputo, M	118	1	0.8%	4.1	3.5%	115	1	0.9%	4.6	4.0%	74	1	1.4%	3.4	4.6%	307	3	1.0%	12.1	3.9%
Ciulli, F	201	10	5.0%	6.4	3.2%	227	6	2.6%	7.5	3.3%	170	7	4.1%	6.1	3.6%	598	23	3.8%	20.0	3.3%
Hutter, J A	223	9	4.0%	8.9	4.0%	226	6	2.7%	7.3	3.2%	206	10	4.9%	7.9	3.8%	655	25	3.8%	24.1	3.7%
Kanellopoulos, G	114	1	0.9%	2.6	2.3%	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	114	1	0.9%	2.6	2.3%
Murphy, G	88	3	3.4%	2.2	2.5%	186	5	2.7%	5.3	2.8%	151	3	2.0%	4.6	3.0%	425	11	2.6%	12.1	2.8%
Parry, A	10	0	0.0%	0.5	5.0%	19	0	0.0%	0.9	4.7%	29	1	3.4%	1.4	4.8%	58	1	1.7%	2.8	4.8%
Pawade, A	7	0	0.0%	0.3	4.3%	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	N/a	7	0	0.0%	0.3	4.3%
Yeatman, M	140	6	4.3%	4.3	3.1%	136	10	7.4%	4.5	3.3%	95	7	7.4%	3.6	3.8%	371	23	6.2%	12.4	3.3%
<b>Total</b>	<b>1431</b>	<b>39</b>	<b>2.7%</b>	<b>46.1</b>	<b>3.2%</b>	<b>1469</b>	<b>40</b>	<b>2.7%</b>	<b>47.4</b>	<b>3.2%</b>	<b>1405</b>	<b>48</b>	<b>3.4%</b>	<b>50.4</b>	<b>3.6%</b>	<b>4305</b>	<b>127</b>	<b>3.0%</b>	<b>143.9</b>	<b>3.3%</b>

## **Appendix 6**

### **PATS Steering Group membership**

<b>Staff member</b>	<b>Representing</b>
Mr Alan Bryan	Cardiac Surgeons
Dr Alan Cohen	Cardiac Anaesthetists & Intensivists
Dr Chris Rogers	Academic Unit of Cardiac Surgery & Clinical Trials Unit
Chris Gummer	Data entry & validation
Jane Sims	Data entry & validation
Alan Davies	Database Manager