Cardiac Services

Adult Cardiac Surgery

Activity Report 2009-10

Photo by Paul Highnam

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Key Conclusions

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

ii) The overall mortality of 2.4% for all cases and 1.4% for primary CABG represent excellent outcomes and conform to contemporary UK(CCAD 1.5% CABG, 3.2% All Cases 08-09) and European standards(EACTS 2006-8 CABG 2.2%).

iii) The proportion of primary CABG operations continues to decline and stands at around 51.8%. 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 remains around 75% which is one of the highest rates in the UK.

v) The number of patients undergoing valvular heart surgery continues to increase and exceeded 531 procedures(34%). This represented a 10% increase in the last year and 34% of the patients underwent concomitant coronary revascularisation. The mortality in this group was 2.5%. There has been 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 around 30%. There is some evidence of a recent increase in transfusion requirements and this strategy will be revisited

viii) For the period 2007-10 the mortality rate for isolated primary CABG, isolated primary AVR and all procedures was better than the predicted recalibrated EuroSCORE outcomes for the Bristol Heart Institute.

ix) The individual performance of all surgeons specialising in adult cardiac surgery serving as permanent members of staff between 2007-10, was within accepted ranges of predicted outcomes, as judged against the recalibrated euroSCORE for ipCABG, ipAVR and all cases respectively.

Foreword

This is the fourteenth annual report from the cardiac surgical unit at the Bristol Heart Institute. The database now contains detailed, prospectively collected data on more than 18,500 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 nationally.
2) A research database for the conduct of clinical research and service improvement in association with the Academic Department of Cardiac Surgery.
3) A resource for the conduct of local clinical audit projects to inform and direct our practice.
4) An administrative tool to produce operation notes and discharge summaries.

This document describes a year of transition where the new Bristol Heart Institute opened in June 2009 and in the early part of the year our activity suffered because of this transition period. Subsequently, as the new facilities became available our activity gained significant pace. 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. The activity of 1561 procedures recorded in this document represents the largest number of procedures ever performed by the Bristol unit and we hope is a pointer towards further expansion in the future.

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. There were frustrations during the first year of activity including our epidemic of flies which lead to some loss of clinical facilities for a period and in addition the hospital in general was subjected to severe winter pressures with the swine flu epidemic requiring some utilisation of cardiac surgical ICU facilities and the usual pressure on ward beds from the escalation in winter admissions. The main operational problem continues to be 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 in our area were lost to other centres.

The year 2009 represented a landmark in the development of cardiac services in Bristol with the opening of the new Bristol Heart Institute. 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 NIHR funded biomedical research unit. 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 sixth 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), 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, 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 challenges in the current twelve month period have been the adoption of the new and updated SCTS database which was a significant challenge for the database team. In addition, after years of deliberation since April this year we have moved to a totally paperless system of direct data entry and again the database team rose to a further challenge.

We are grateful to Alan Davies for his efforts in the preparation and analysis of the data, and to Jane Sims and Chris Gummer for their efforts in the collection of a comprehensive dataset. We thank Susan Elkington for her secretarial help.

Alan J Bryan, Alan Cohen

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2. Introduction

We are now at the end of our fourteenth 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(1). We have now entered the era of truly multinational data collection and with the publication of the Fourth European Association for Cardio-Thoracic Surgery Adult Cardiac Surgical Database Report 2010 we have an opportunity to benchmark our outcomes against international comparators(2).

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.

3. 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 1st April 2009 and 31st March 2010. In addition, we have used the whole database of more than 18,000 procedures to observe trends in practice between 1st April 1996 and 31st March 2010.

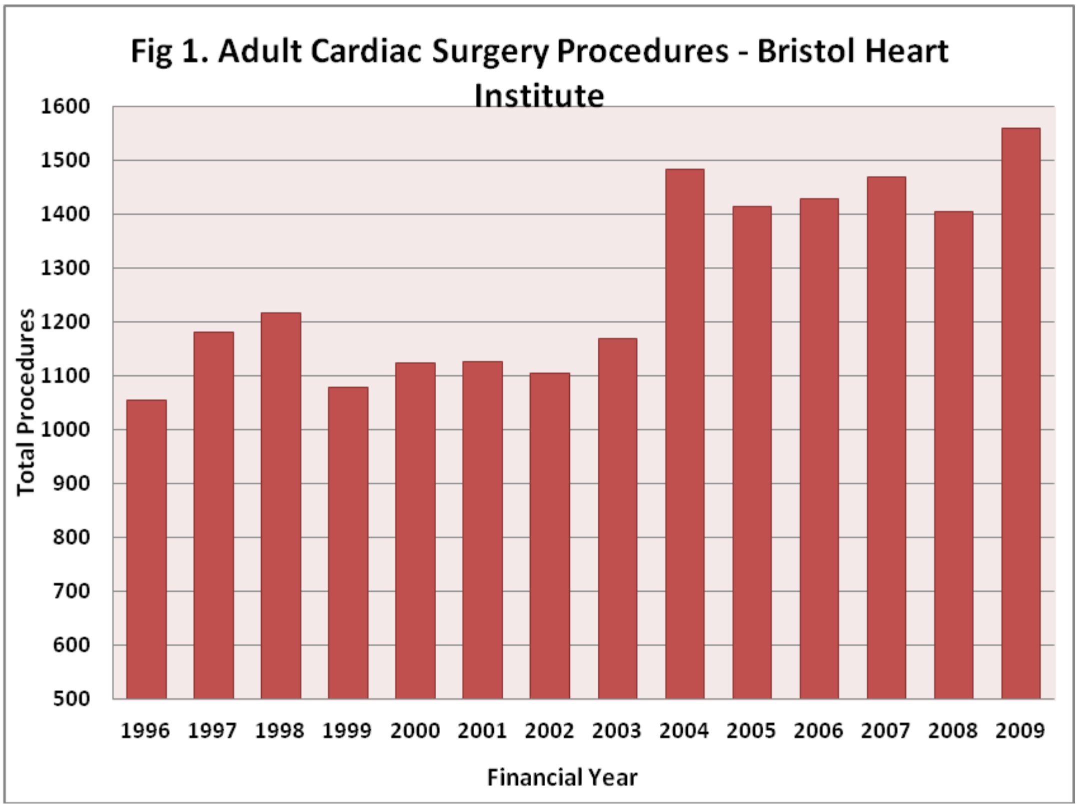
We continue to collect data prospectively using the Patient Analysis and Tracking System (PATS – as licensed by Dendrite Clinical Systems Ltd.). Data collection is very much a multidisciplinary effort. Core data items are gathered according to the guidelines of the Society for Cardiothoracic Surgery of Great Britain and Ireland (SCTS) which have recently been upgraded in April 2011, 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).

In the last year we have moved from a paper based system to a direct input system and this transition has been managed well by the data collection team. This has also freed up time to enable a proper programme of data validation to be instituted which has been one of our unrealised goals previously.

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 18,000 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 and to allow comparisons between different units.

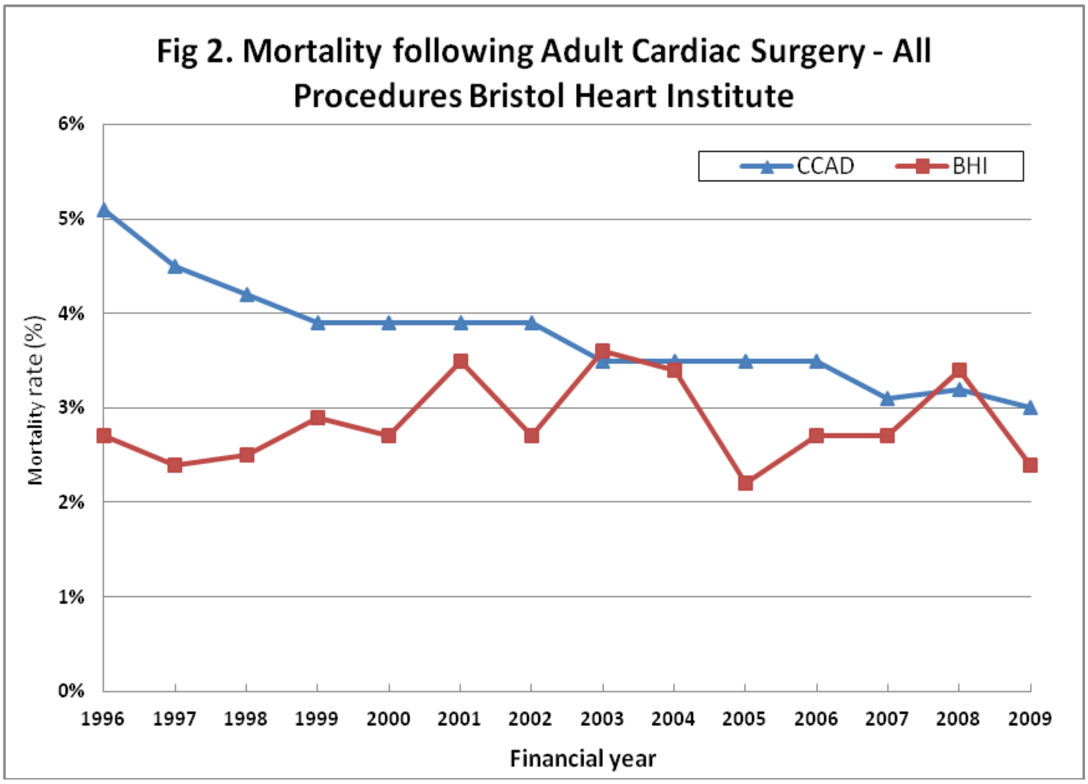
4. Overall Surgical Activity

Between April 1st 2009 and March 31st 2010 a total of 1561 adult cardiac surgical operations were performed in the cardiac surgical unit at the Bristol Heart Institute. This is the largest number of operations ever performed in the cardiac surgical unit at Bristol Royal Infirmary. It was also achieved without having the additional facilities for the whole 12 month period and with substantial obstacles which included closure of the general ICU due to infection, the plague of flies due to problems with the drainage of the BHI, the swine flu epidemic and severe winter pressures on the hospital as a whole(Figure 1).



The step up in activity from 2003-4, which has been maintained, suggested that we had reached a further ceiling within the previous facility. In the year of activity presented here we achieved a 5% increase on the previous peak level of activity of 1485 procedures achieved in 2004-5. It should be noted that, even with this level of activity, we still found 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. Since at the time of writing we have already completed a further year of activity I am disappointed to report that this has not proved possible to achieve so far.

Mortality (defined as death during the primary admission to the base hospital ie the BHI) for the period under study was 2.4% (38 deaths in 1,561 procedures). This was therefore a good year in terms of not only numbers but also patient survival and our performance compares well with available national comparisons (CCAD 3.0% 2009-2010;EACTS 3.4% 2006-8). 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 13years. 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.



The overall distribution of the type of cardiac surgery undertaken during 2009-2010 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 52% in the current year.

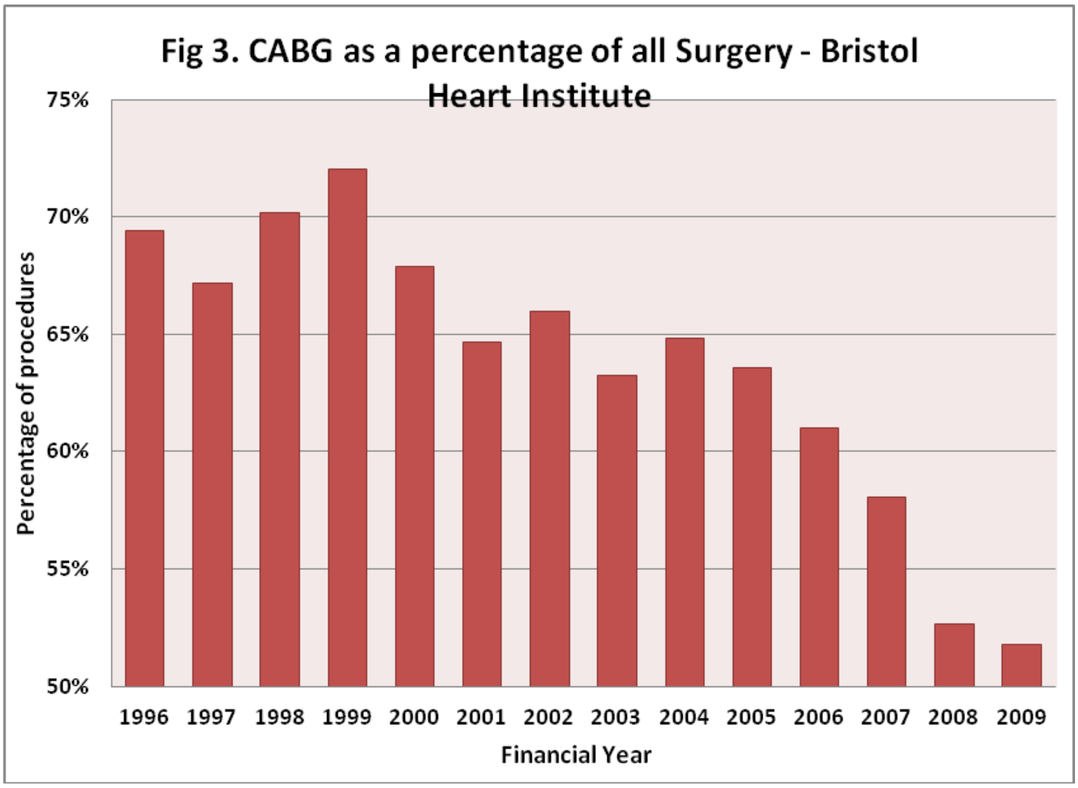
Table 1: Activity and mortality by procedure type
1st April 2009 – 31st March 2010

Procedure	Number	%	Deaths	Rate (%)
Isolated primary CABG	808	51.8	11	1.4%
Other ischaemic heart disease	37	2.4	4	10.8%
Valve	355	22.7	4	1.1%
Valve + CABG	178	11.4	10	5.6%
Thoracic Aorta	85	5.4	7	8.2%
Adult Congenital	58	3.7	1	1.7%
Other	40	2.6	1	2.5%
ALL TYPES	1,561	100.0	38	2.4%

Figure 3 clearly shows this decline with a 20% 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 09-10, Primary CABG 52.9%;EACTS 2008, 51.6%) and it seems likely that the cause of this is the expansion in the application of PCI, particularly in the acute coronary syndromes. Internationally the proportions of coronary artery surgery were higher in northern and central European centres and lower in southern European and Asian centres. This association was related to average life expectancy but not to gross national income(2)

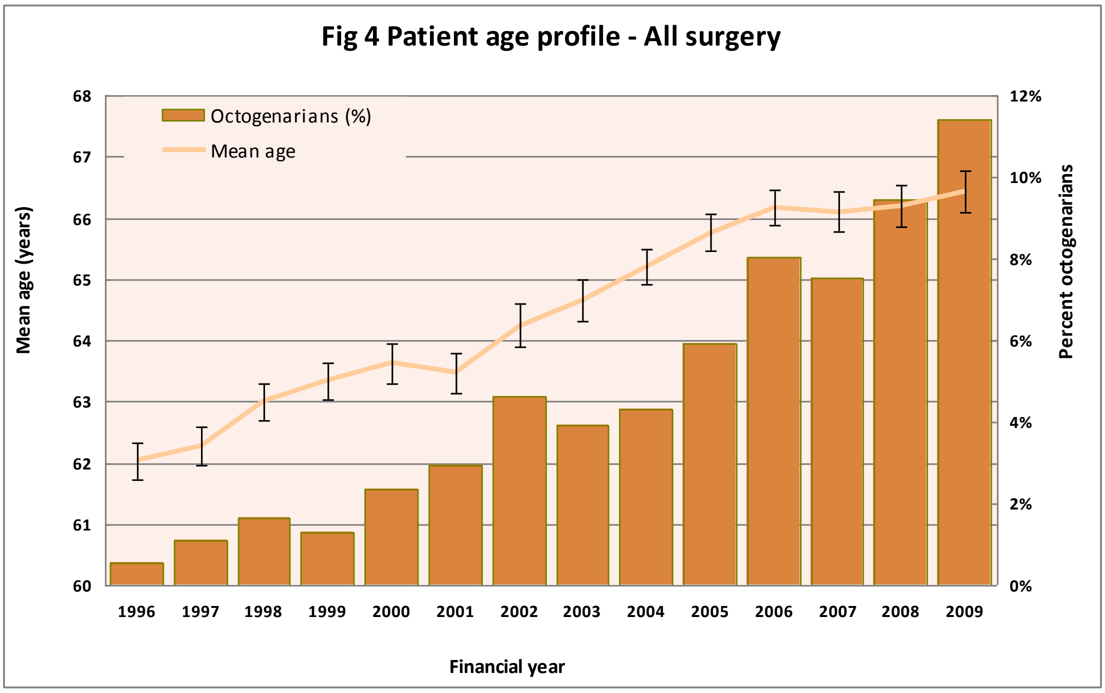
Fortunately (for the service), this decline in CABG procedures has been matched by an increase in other areas. We have undertaken more than 530 valve procedures, and this now makes up around 34% of our overall activity. In addition, there have been modest increases in our activity in adult congenital heart disease and aortic surgery.

Valve surgery increased to a total of 533 procedures, the highest we have ever recorded and a 10% increase over the 480 procedures performed in 2008-9. Of all the procedures undertaken for valvular heart disease, 33% involved concomitant CABG, which is likely to be a reflection of the ageing surgical population. Operations on the thoracic aorta increased to 85 procedures per year a further increase of 12% in addition to the 20% increase observed last year suggesting that this is an area of increasing activity. There were also 58 procedures for adult congenital heart disease, one of our targeted areas, a further increase on the previous year's activity.

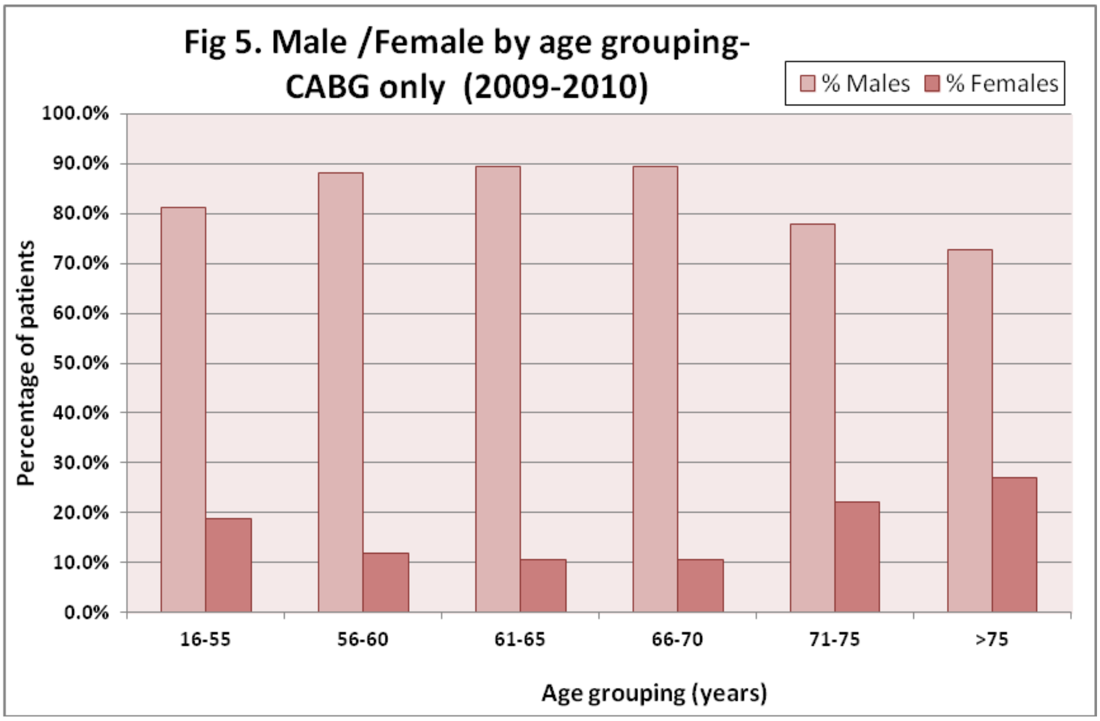


5. <u>Demographic and Geographical Characteristics</u>

The most consistent characteristic of the population undergoing cardiac surgery has been increasing age. In our unit the mean age at operation during 2009-10 was 66.4years (range 17 -92 years)(CCAD 09-10 mean 66.9yrs). 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 although the mean age inexorably increases. In particular, there continues to be an increase in the proportion of patients over 80 undergoing surgery with this group now forming 11.4% 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.



With regard to gender differences in our patient population, there is an overall 2.7:1 ratio of males to females(CCAD 2009-10 2.7:1) (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. The differences in the proportion of women undergoing CABG surgery across international boundaries is also striking ranging from a low of 13% in Greece to a high of 30% in Lithuania[(2)]. The reasons for these observed differences is unclear.



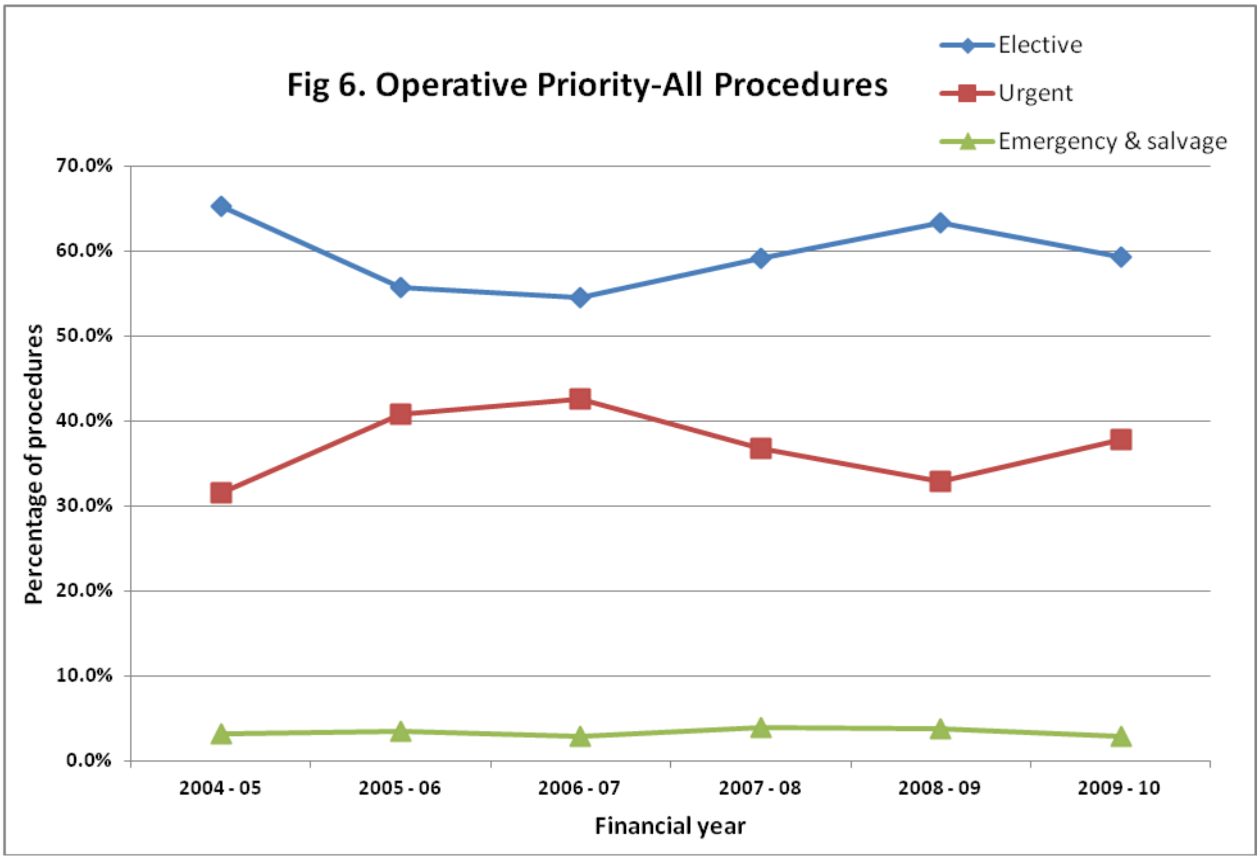
The geographical origins of the majority of our patients have been stable over the period of observation with the patients coming from Bath, Cheltenham and Gloucester, Swindon, Taunton, Weston-Super-Mare and Yeovil, as well as our Bristol patients. There were some changes in the geography of our patient population with significant decreases in referrals from Wiltshire and Swindon reflecting the referrals from these centres to London (apparently due to dissatisfaction in the service we were able to provide) 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.

6. 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). Across Europe there are significant variations in the rates of urgent CABG surgery with most Northern European centres in the range of 25-40%(EACTS 2006-8)



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. 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.

Prior to 2009-10 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 had an additional theatre available one day per week). Thus working a 50-week year we could theoretically attain a maximum activity of 1,500 cases provided there are no cases lost. With the additional theatre facilities that became available within the Bristol Heart Institute opening our theoretical activity increased to 1700-1800 operations. 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
1st April 2005 – 31st March 2010

	05-06	06-07	07-08	08-09	09-10
No ITU beds/Gen Surg given ICU priority	31	60	20	66	56
No Perfusionist	2	6	11	2	4
Case overran/long first case	21	44	38	51	51
No ITU staff	14	4	29	11	11
Patient unfit	10	5	12	23	27
No theatre staff/emergency overnight	49	29	49	24	15
Unable to admit(No wd bed/Norovirus/A&E alert)	11	0	22	44	9
Emergency in catheter laboratory	2	3	7	7	0
No surgeon	6	8	10	8	7
Miscellaneous	19	5	7	22	42
TOTAL	**165**	**164**	**205**	**258**	**222**
Available Operating Slots	**1519**	**1542**	**1577**	**1593**	**1739**
% Cancellation Rate	**10.8**	**10.6**	**13**	**16**	**13**

If we examine the current year of study in comparison to the preceding year there was a small decrease in the number of cases lost, resulting in 13% 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.

In 2008-9 one of the major issues 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 and is currently being further refined . The dramatic reduction in this area suggests that at least in this timeframe this was an effective strategy. 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.

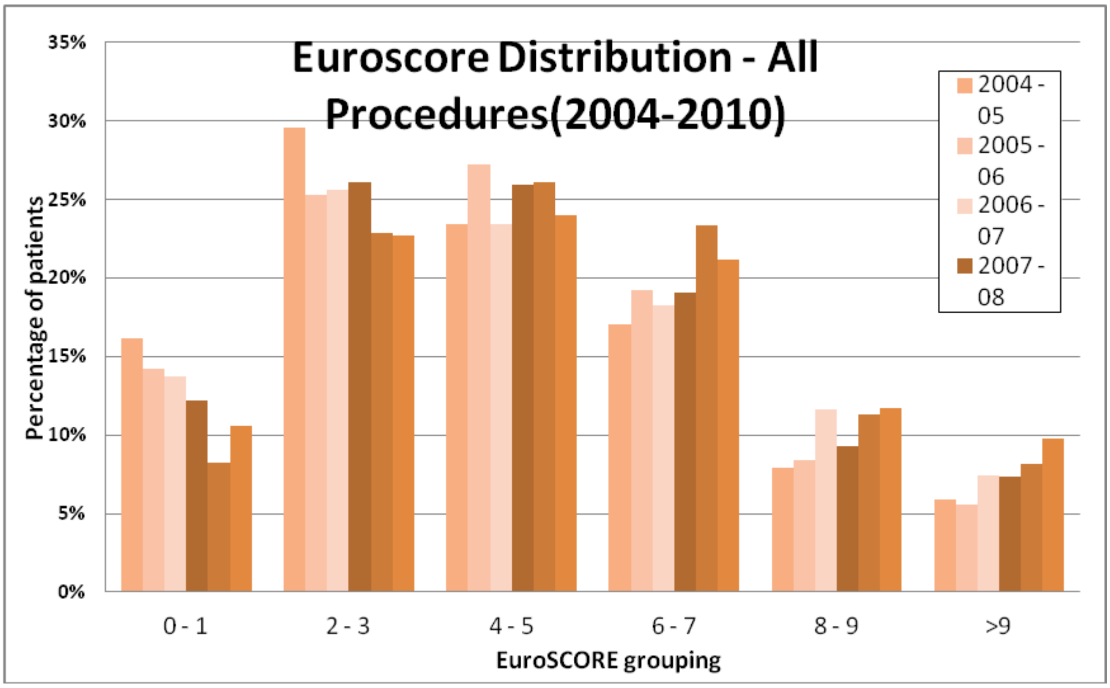
Risk Stratification

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[(3)]. 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[(4,5)]. 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[6].

Over the last few months the Bristol Heart Institute has participated in the data collection for a completely new and updated EuroSCORE II and we look forward to seeing the outcome of this important piece of work and incorporating it into clinical practice(www.euroscore.org).

Figure 7 shows the change in the EuroSCORE profile of our patient population over the last six years. There was no change in this profile in the last year with the mean now 5.2(CCAD 09-10 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. Overall the trend is towards a reduction in the proportion of lower risk patients and an increase in the proportion of higher risk patients .



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 in detail. They concluded that, because the risk profile in their area had been maintained or worsened, there was no evidence of risk-averse behaviour[7]. 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.

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 all cases($p<0.027$) but not for CABG($p<0.44$) (see figures 8 and 9). The cause of such variation is complex. In general the CABG group of patients is a large group with a reasonable spread of risk among surgeons. 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 to everyday surgical practice.

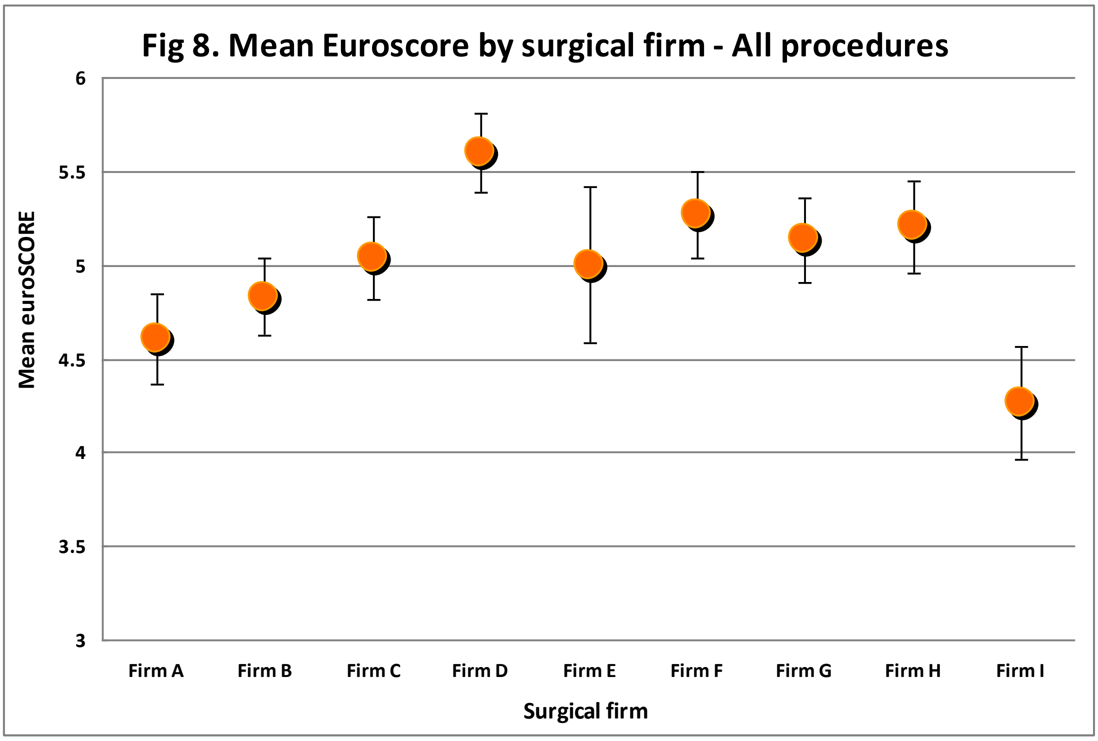


Fig 8. Mean Euroscore by surgical firm - All procedures
Mean euroSCORE
6
5.5
5
4.5
4
3.5
3
Firm A
Firm B
Firm C
Firm D
Firm E
Firm F
Firm G
Firm H
Firm I
Surgical firm

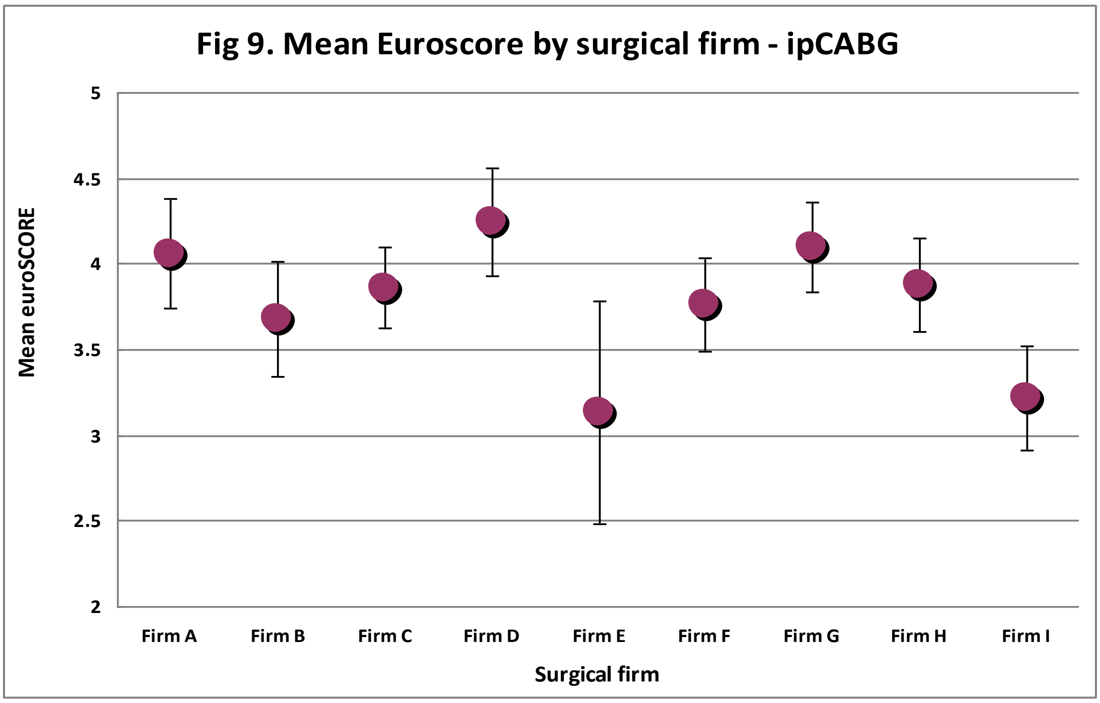


Fig 9. Mean Euroscore by surgical firm - ipCABG
Mean euroSCORE
5
4.5
4
3.5
3
2.5
2
Firm A
Firm B
Firm C
Firm D
Firm E
Firm F
Firm G
Firm H
Firm I
Surgical firm

7. Surgery of Ischaemic Heart Disease

The surgery of ischaemic heart disease remains the major component of our workload comprising some 54.2% of our workload (845/1561 procedures). In the year under scrutiny a total of 808 isolated primary CABG (ipCABG) operations were undertaken with a total of 11 deaths (1.4% vs 1.5% CCAD 2009-2010;2.2% EACTS 2006-8). This represented an increase in CABG cases undertaken from the 741 procedures undertaken in 08-09 with mortality just below the national average of 1.5%. The proportion of our work constituted by ipCABG continues to fall year by year and is now 51.8% (CCAD 09-10 52.5%;EACTS 2008 51.6%) the lowest proportion so far recorded in our recent history. If we add our activity this year to the previous 3 years we have undertaken a total of 3,274 ipCABG operations with an overall institutional mortality of 1.25%. These are excellent results which will stand comparison with any national or international standard (Figure 9).

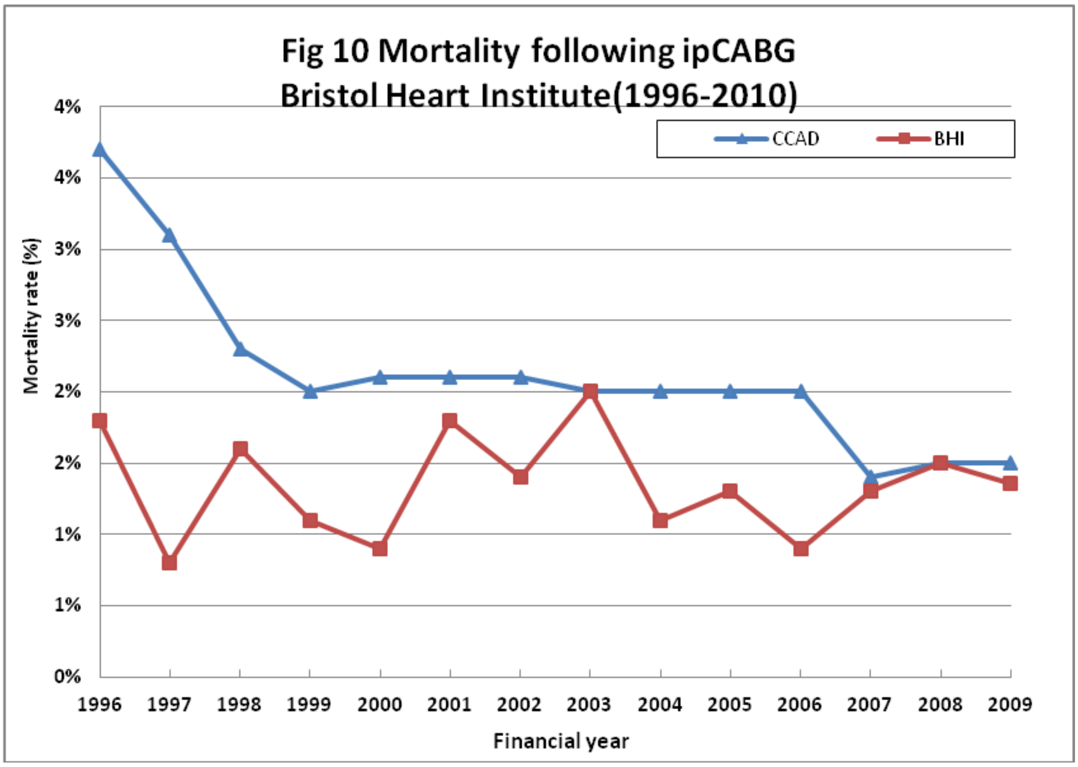
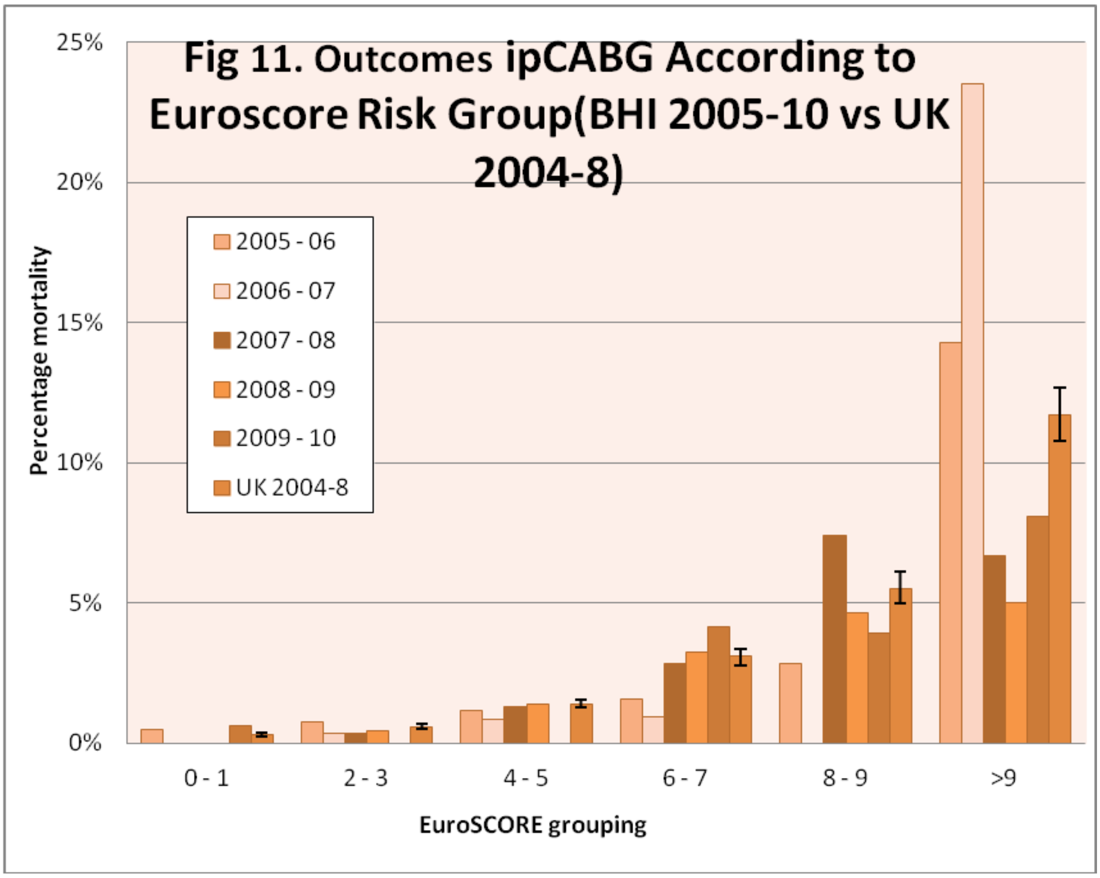
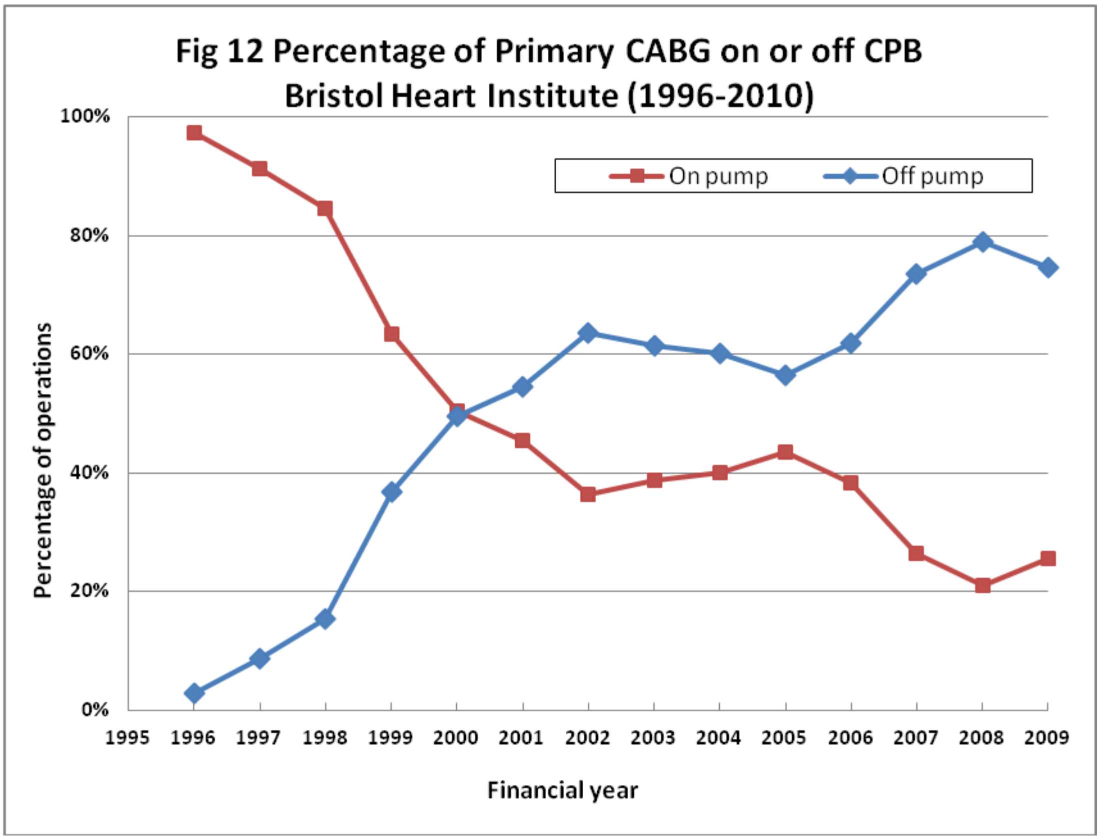


Figure 11 shows our mortality rates for ipCABG for the last five years stratified for EuroSCORE, and compared to UK outcomes for the financial year 2004-8. In the current year of study, in all but one group, our mortality rate was lower than the UK figure available for comparison. In the highest risk group the numbers are very small with large errors around the mean.

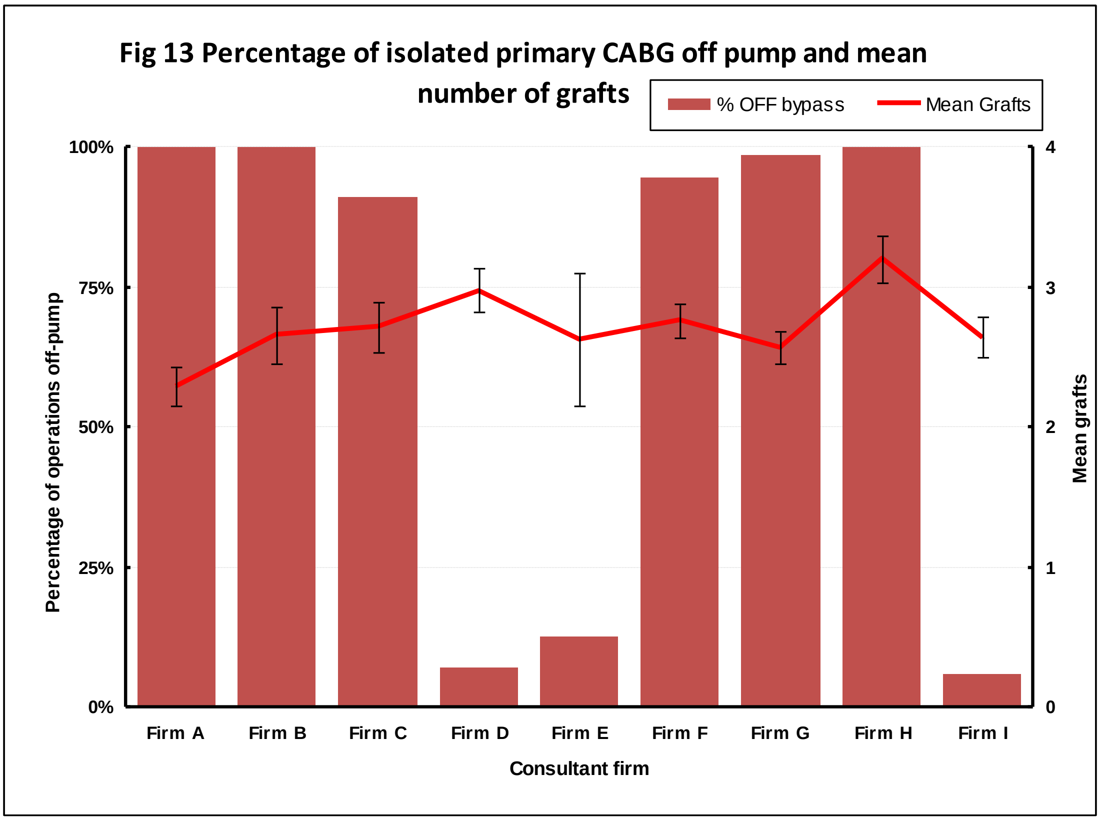


The proportion of off-pump CABG cases has remained stable over the last twelve months at around 75% of all CABG work (Figure 12). Bristol continues to be one of the leading off-pump centres in the UK with a very high percentage of cases undertaken without cardiopulmonary bypass. In the UK the figure is around 17% (CCAD2008) and in Europe around 21%(EACTS 2006-8) 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 2.91%(6/206) and 0.83%(5/602) respectively. This difference is statistically significant (Fisher exact $p=0.037$). This is the first year in our institution that there has been a significant difference. This compares to international data with sample figures from EACTS of 2.9% and 1.4% for on and off pump surgery (EACTS 2006-8). Whether such differences reflect differences in the patient profile or a genuine reduction in mortality related to the off pump technique is uncertain. 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[8] .



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 13 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.



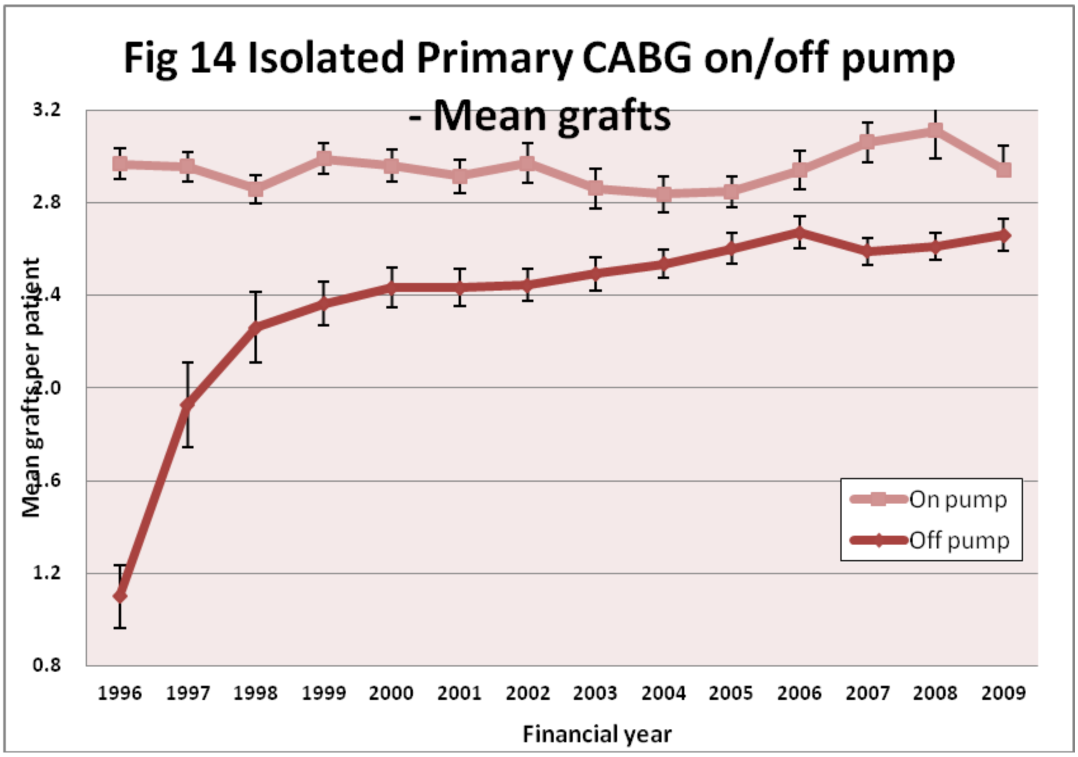
The mean number of grafts per patient in isolated primary CABG was 2.73, which is slightly higher than last year. Overall the pattern for the previous few years has been a decrease followed by a steady increase which has been attributed to the evolution of off-pump surgery.

Table 3: Trends in graft rate for isolated primary CABG
1st April 1996 – 31st March 2010(n=11,251)

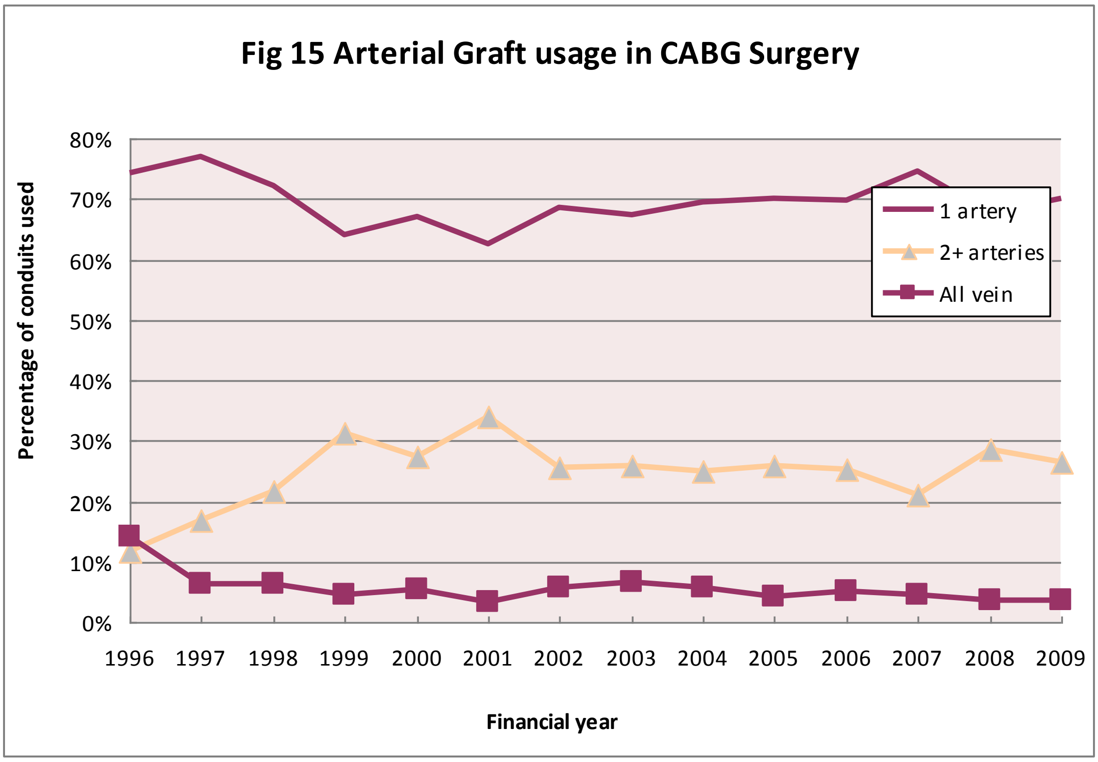
ISOLATED PRIMARY CABG		
Financial Year	**Mean grafts per patient**	**Number of procedures**
1996	2.92	733
1997	2.87	794
1998	2.77	853
1999	2.76	777
2000	2.70	763
2001	2.65	728
2002	2.64	727
2003	2.64	740
2004	2.66	963
2005	2.71	899
2006	2.77	872
2007	2.72	854
2008	2.72	740
2009	2.73	808

Figure 14 shows that although the mean number of grafts has remained more or less the same there has been a decline within the on-pump group as the mean has increased for the off-pump group.

The picture evolving are of small changes in the main in both groups but with the overall picture one of less grafts in the off pump group. This follows a number of years where there was increasing convergence of the curves as the number of grafts by both techniques approached each other. In the last year the mean number of grafts in the on and off-pump groups were 2.94 and 2.66 respectively which is still statistically significantly different (Independent samples median test p=0.017).



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 92.1%. 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 been maintained at around 26.4% (fig 13). 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 2009 – 10 the majority of our multiple arterial graft patients 186/808 received a radial artery graft (23%) with only 57 (7.1%) receiving a second internal mammary artery graft.



In our practice the proportion of patients undergoing re-operative CABG remains low at 1.3% (11 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 296 procedures with 10 deaths (3.4%;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 27 other procedures for ischaemic heart disease with four 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.

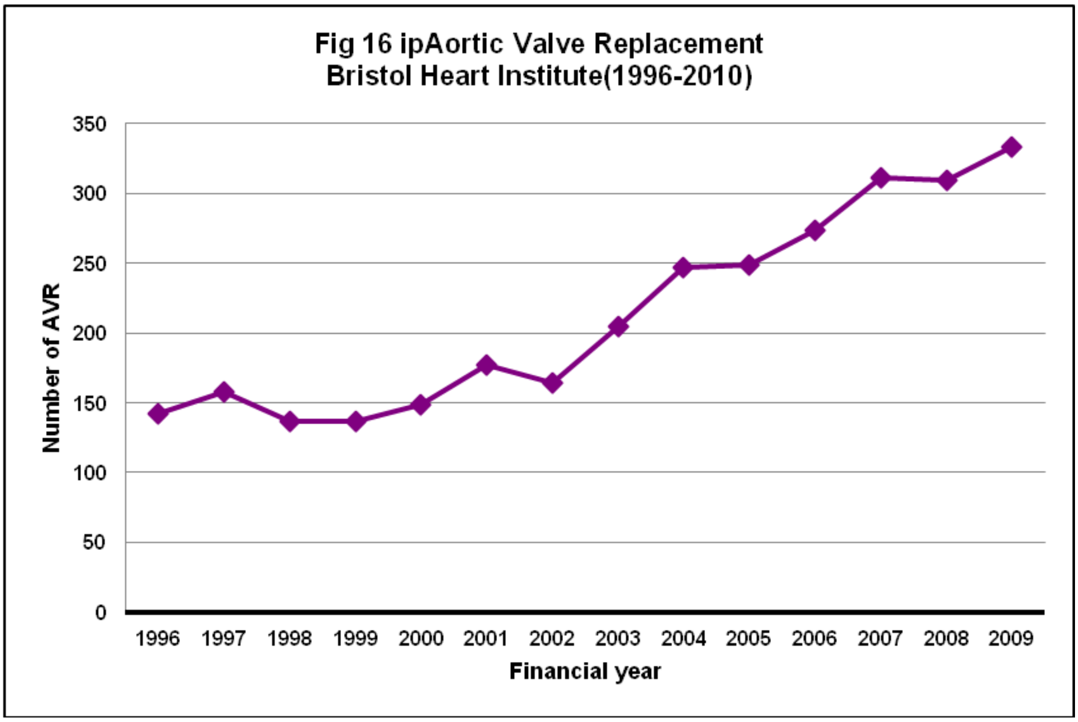
8. Surgery of Valvular Heart Disease

In 2009-10 a total of 531 procedures were undertaken for valvular heart disease, which represents 34% of the overall workload. This was a 10% increase from the 483 procedures undertaken in the previous year. Of these patients, 178 (34%) underwent concomitant CABG in association with their valve surgery. Within this group of 531 procedures 14 (2.5%) did not survive their primary hospital stay.

Aortic valve replacement (AVR) is the commonest procedure undertaken for valvular heart disease. A total of 337 procedures on the aortic valve were undertaken with 7 deaths (2.1%). This was a further increase on the 307 procedures undertaken in 2008-9and the outcomes were better in comparison to the 5.2% mortality recorded in that year. 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 337 in 2009-10(fig 16). 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 more than doubling of activity from 1964 aortic valve replacements in 2001-2 up to 4440 procedures in 2009-10.

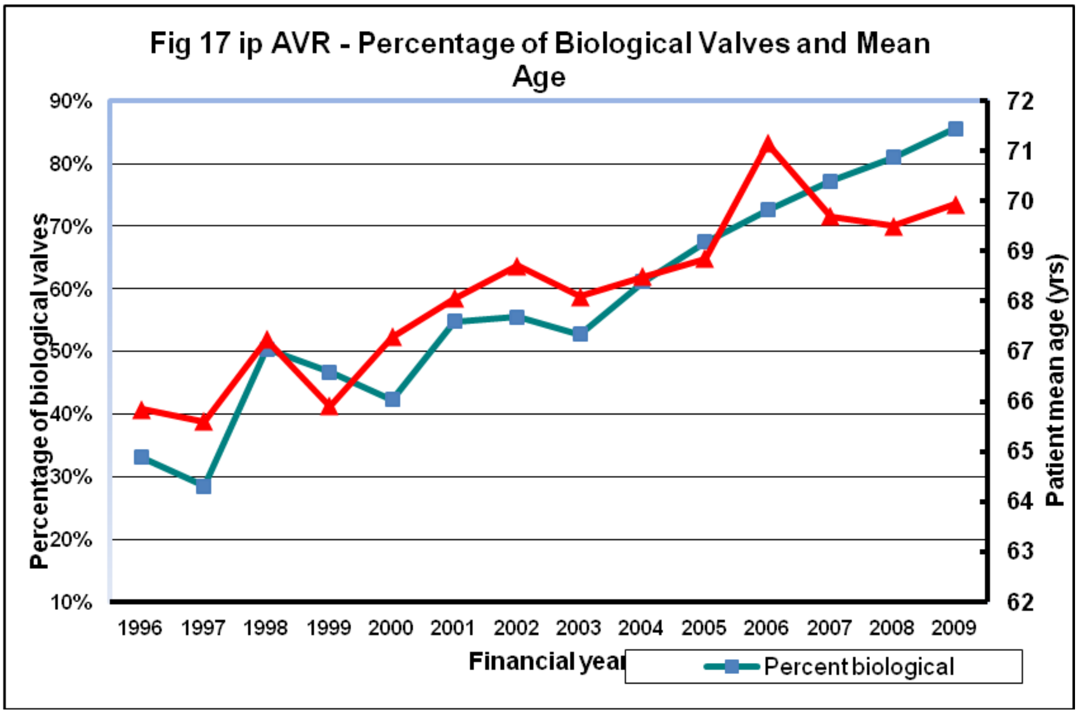
There were 187 primary isolated AVR with one death (0.6%), which is below the national figure of 1.7% (CCAD 2009-10; 2.9% EACTS 2006-8) which is an outstanding achievement for the whole of our multiprofessional cardiac surgical team and our best results ever. Over the last 11 years we have undertaken 1,778 primary isolated AVR with 46 deaths, giving a mortality of 2.6%. In the current period 7 patients underwent redo AVR with no deaths, over the last 3 years this is 32 procedures with only one death(3.1%) 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 116 patients underwent primary aortic valve replacement in association with CABG with 5 deaths (4.3%CCAD 09-10 4.1%;EACTS 2006-8 5.5%). This rate is consistent with our performance in recent years, but again, if we examine our performance in the larger cohort, we have undertaken 1114 procedures since 1996 with 53 deaths (4.6%), which compares favourably with the UK figure of 5.3% (CCAD 2004-8)



As was stated earlier, there continues to be a marked predominance of biological prostheses, which is a reflection of our aging population. The age of patients undergoing aortic valve replacement is around 70 and the overall trend is one of increasing age. There is a continuing trend towards the implantation of biological substitutes and at 88% this is the highest proportion we have yet recorded (Figure 17).

In our centre in the last three years a multidisciplinary team including cardiologists, surgeons and anaesthetists has embarked on a programme of Transcatheter Aortic Valve Implantation (TAVI). This technique has now been successfully expanded to include both the transapical and transfemoral approaches. The carefully selected patients have predominantly been elderly and at the higher end of the surgical risk spectrum. To date a total of 97 procedures with 9 hospital deaths have been completed. It remains to be seen what impact this will have on the applicability of surgical valve replacement.



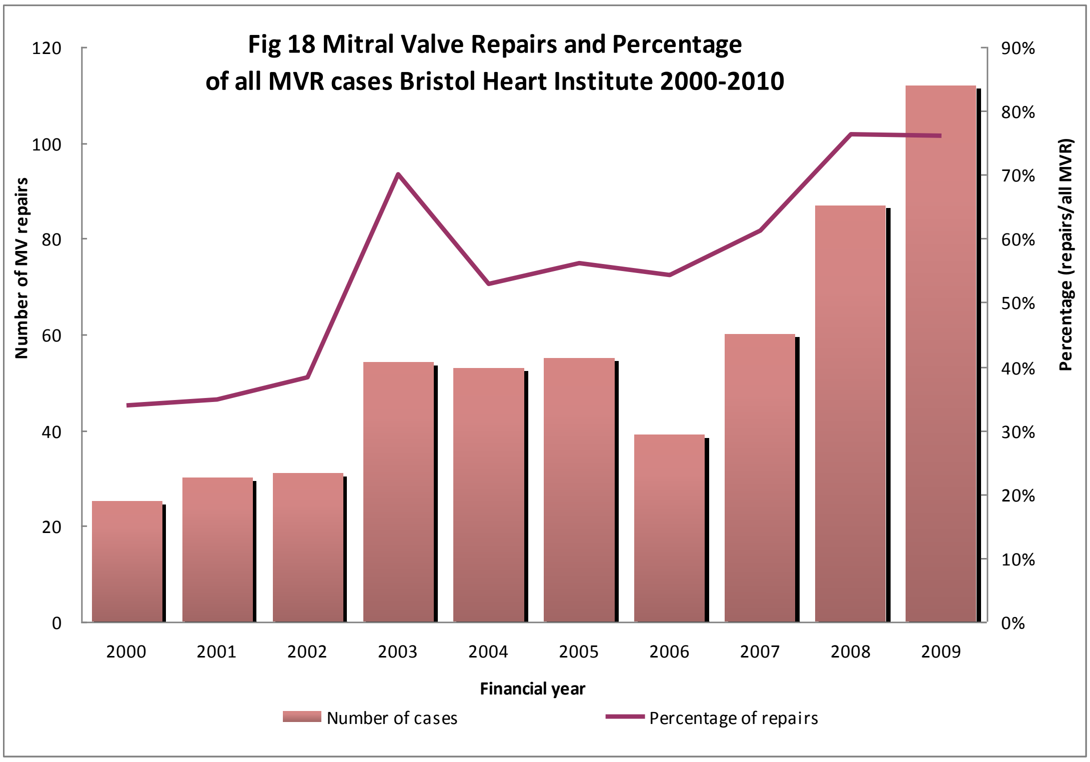
In recent years the profile of <u>mitral valve disease</u> has changed. The aetiology is now predominantly ischaemic or degenerative rather than rheumatic. In degenerative cases mitral valve repair is preferred because of better long-term survival and preservation of left ventricular function as well 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 2009-10 a total of 151 procedures were performed for mitral valve disease. This represents a 20% increase in activity over the 125 procedures performed in 2008-9. Of these 41 procedures involved concomitant CABG (27%). In this year there were 106 primary mitral valve procedures with or without ablation of atrial fibrillation (AF) with no deaths. This compares favourably to the UK mortality of 4.2% for isolated primary mitral valve procedures (CCAD2004-8). Over a total of 14 years we have achieved an institutional mortality of 3.8% (30 deaths in 797 procedures) 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 6 procedures with one death. The low rate of reoperative surgery is encouraging and is an indirect indicator that the repairs undertaken are by and large working well in the longer term.

Valve replacement was undertaken in 39 patients, and of these 11 underwent mechanical valve replacement (28.2%). The proportion of patients undergoing mechanical valve replacement is now relatively small. In 41 procedures for mitral valve repair/replacement with concomitant

CABG (with or without AF ablation) there were two deaths (4.9%). This takes the outcome for our patients over the 14 year period of study to 25 deaths in 363 patients or 6.9%, which is again below the UK average of 9.4% (CCAD 2004-8)



In the 147 patients who underwent primary mitral valve procedures (+/- CABG,+/-ablation) there were 112 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 further 29% increase over the 87 valve repairs completed in 2008-9. 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 18.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 ten primary procedures involving concomitant mitral and tricuspid surgery in all of whom tricuspid valve repair was possible with one death(10%)

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 76 patients underwent AF ablation in association with other valve surgery, the most common of which was mitral valve repair (27 patients).

Primary combined aortic and mitral valve procedures were undertaken in 9 patients with one death (11%). Over the last 13 years we have undertaken 131 procedures with only eight deaths (6.4%), which is an excellent institutional record.

9. Other Procedures

a) Adult Congenital Heart Disease

The Bristol Royal 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 58 procedures with one death 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 18 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 a further 12% to a total of 85 aortic reconstructions following on from the 23% increase the previous year. This is the largest number of thoracic aortic reconstructions so far performed in a single year. There were 7 deaths in this relatively high risk group with an overall mortality of 8.2% (Table 4). Over the last 13 years as a group we have now undertaken 685 thoracic aortic reconstructions with 79 deaths - an overall mortality of 11.5% - which is just below the last published UK figure of 12.9% (CCAD 2004-8). Within this group the most challenging patients are those with acute dissection of which there were 20 patients this year with 4 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, 1st April 2001 – 31st March 2010

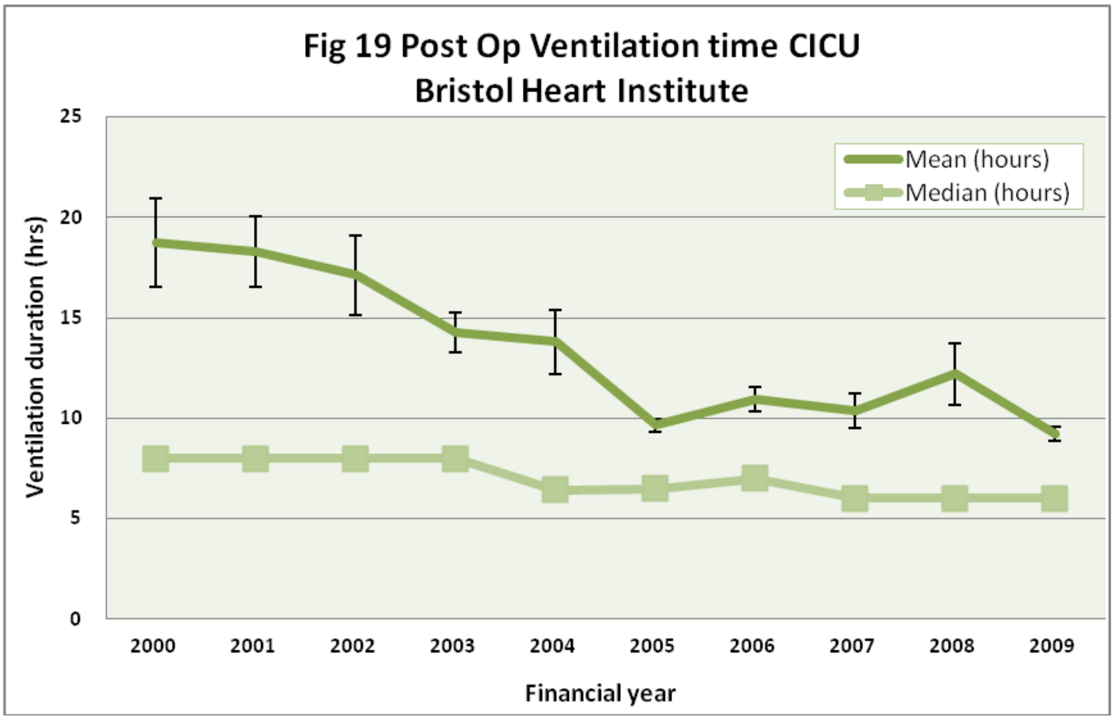
	2001	2002	2003	2004	2005	2006	2007	2008	2009
Aortic procedures	37	41	43	46	34	67	62	76	85
Total procedures	1,127	1,105	1,170	1,485	1,414	1,430	1,471	1,405	1561
Percentage	3.3%	3.7%	3.7%	3.1%	2.4%	4.7%	4.2%	5.4%	5.4%
Deaths	3	3	9	7	4	5	7	5	7
Mortality rate	8.1%	7.3%	20.9%	15.2%	11.8%	7.5%	11.3%	6.6%	8.2%

10. 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 19-21 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 with a change towards more complex surgical groups with increases, in valvular, aortic and adult congenital surgery and reducing volumes of CABG surgery. Despite this, the overall trend is towards quicker recovery with decreased times to extubation and hospital discharge.



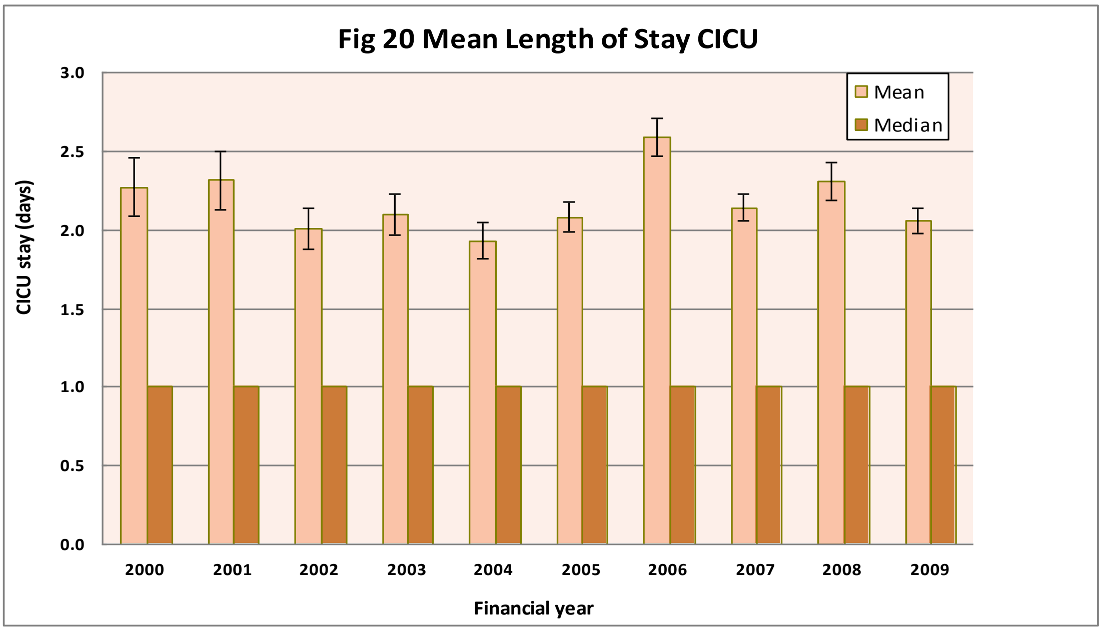


Fig 20 Mean Length of Stay CICU
Mean
Median
CICU stay (days)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Financial year

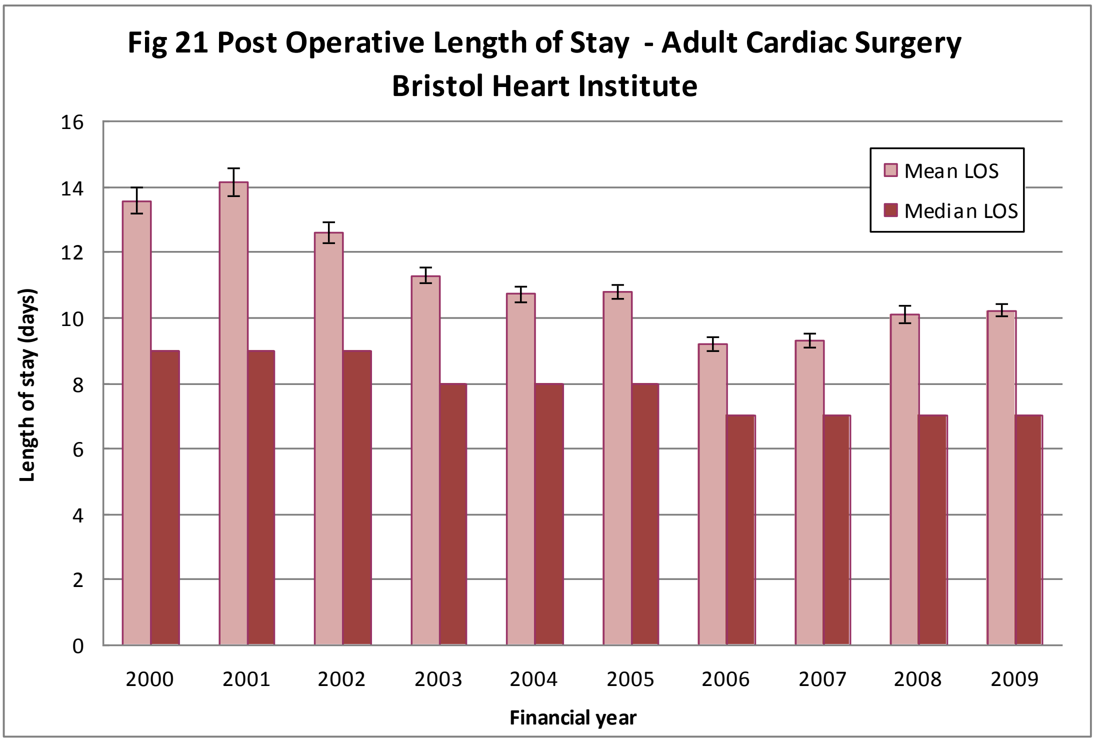


Fig 21 Post Operative Length of Stay - Adult Cardiac Surgery
Bristol Heart Institute
Mean LOS
Median LOS
Length of stay (days)
16
14
12
10
8
6
4
2
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
Financial year

The trend towards earlier extubation following cardiac surgery continues, with the lowest period of postoperative ventilation at a mean of 9.2 hours is the shortest period so far observed. The median duration of stay on the cardiac surgical intensive care unit(Fig 20) (CICU) remains at one day and the mean of 2.1 days is very similar to our previous performance. We have been able to reduce postoperative hospital stay from a mean of around 14 days in 2000 to just over 10 in the current year of study (CCAD 09-10 mean 10.2 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.

It is interesting to compare our own performance with the national picture with a postoperative stay of around 10 days(CCAD 09-10) and a mean total hospital stay of 13.2 days(BHI 11.8 days 2009-10). Over a number of years hospital stays both locally and nationally have changed very little despite increasing efforts by hospital teams to reduce bed occupancy and improve efficiency.

11. <u>Postoperative Morbidity</u>

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

1. The practical issues of clinical staff entering data while working on a busy intensive care (or ward environment), where clinical care tasks obviously carry greater priority. This differs to data entry in theatre which can usually be carried out at moments of convenience during quieter parts of the procedure or, in the case of entry of surgical data, after completion on the operation. In the CICU, for example,

such quiet moments do not always arise since there is often pressure to move the patient to a different part of the unit to create space for a new patient.;

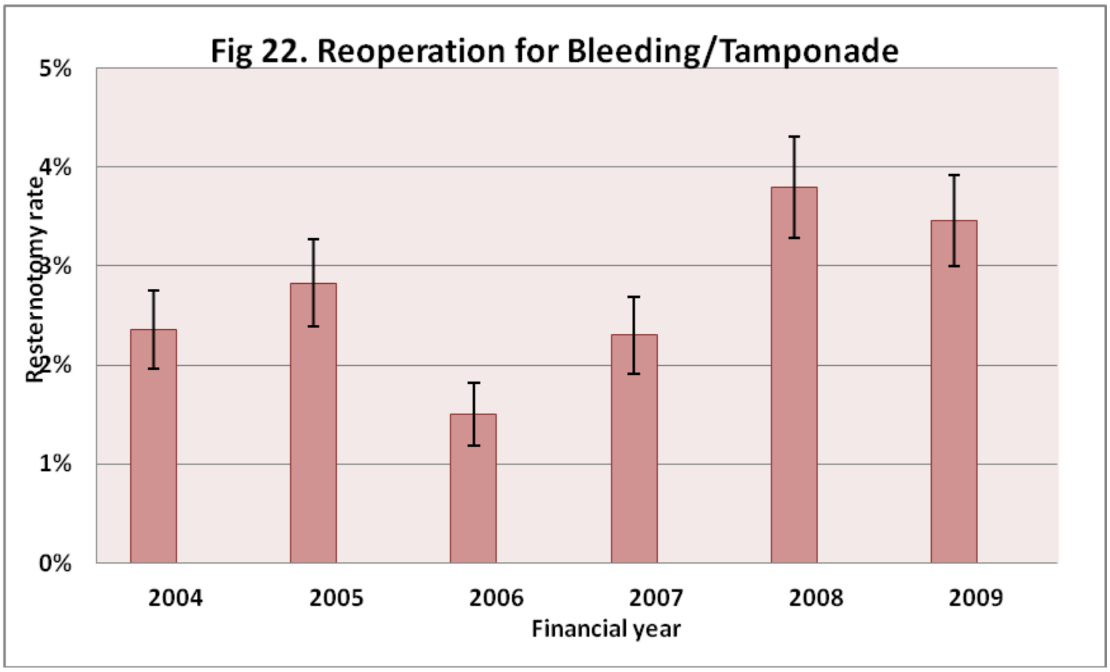
2. The person entering the data will not have looked after the patient throughout the postoperative period and may therefore be less familiar with all aspects of the patient's postoperative course. For example, when entering data for a patient who has been in CICU for over three weeks, it may be possible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

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

A number of areas of postoperative morbidity are presented in Figures 22-24 and in Table 5. There will be an increasing focus on postoperative morbidity as the SCTS tries to broaden the quality initiative to include morbidity as well as mortality. Four key areas that are likely to be specifically recorded and require specific attention are :

- Reoperation for 'early' postoperative bleeding/tamponade;
- Renal deterioration (rise in creatinine to greater than 200 µmol/L; requirement for haemofiltration);
- Requirement for intra-aortic balloon pump support;
- New neurological deficits (either temporary or permanent);

There are other areas of morbidity which are also important and these are recorded in Table 5 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 3-4%. 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 such as the increasing complexity of the surgery which could be responsible is worth exploring as a separate audit project.



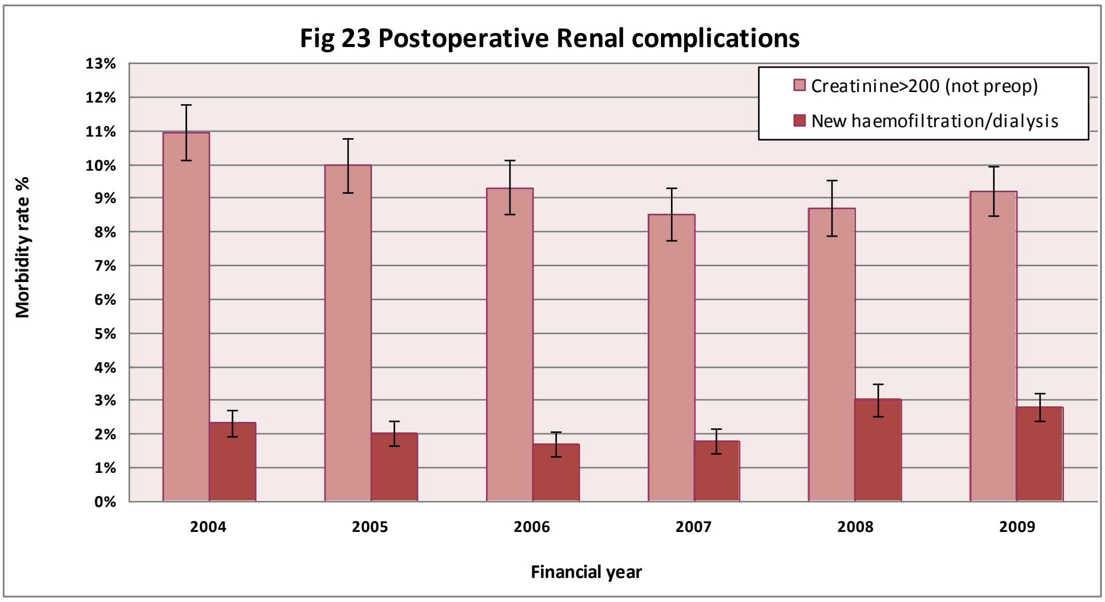


Fig 23 Postoperative Renal complications
Creatinine>200 (not preop)
New haemofiltration/dialysis
Morbidity rate %
13%
12%
11%
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
2004
2005
2006
2007
2008
2009
Financial year

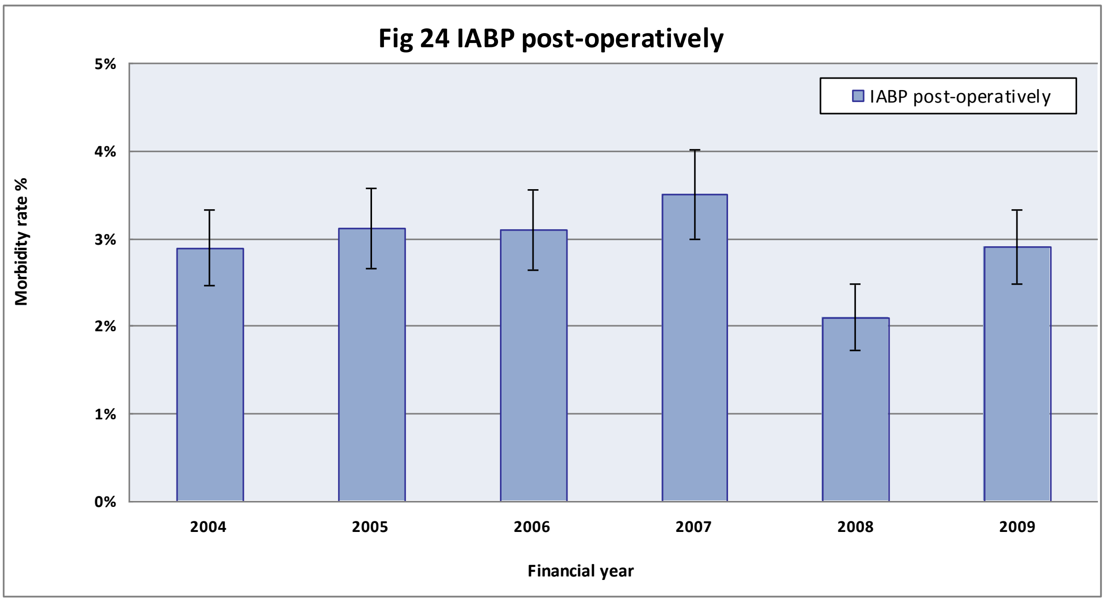


Fig 24 IABP post-operatively
IABP post-operatively
Morbidity rate %
5%
4%
3%
2%
1%
0%
2004
2005
2006
2007
2008
2009
Financial year

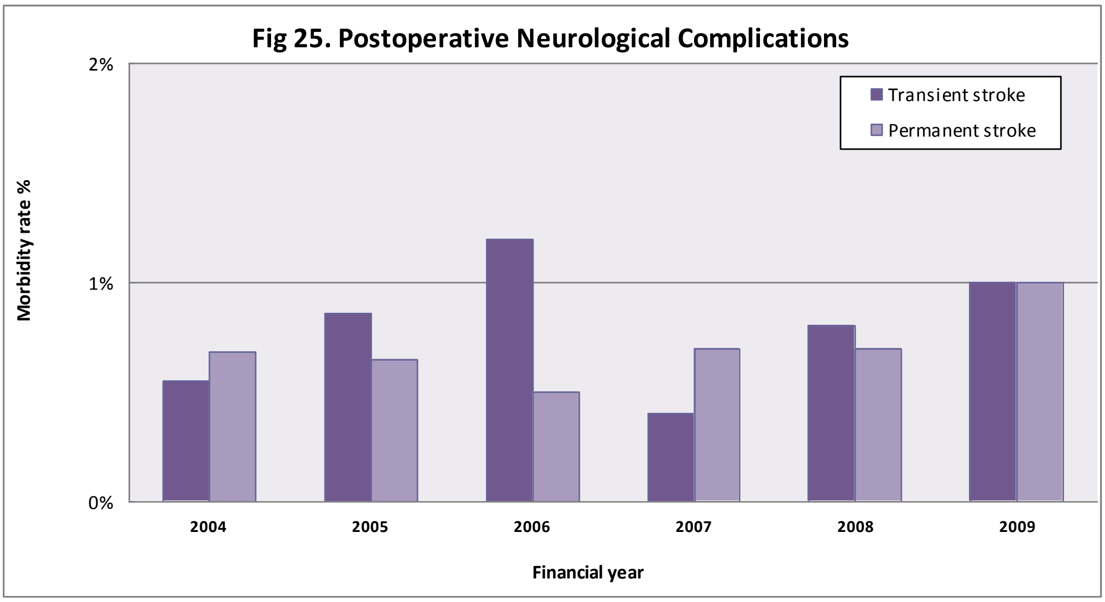


Fig 25. Postoperative Neurological Complications
Transient stroke
Permanent stroke
Morbidity rate %
2%
1%
0%
2004
2005
2006
2007
2008
2009
Financial year

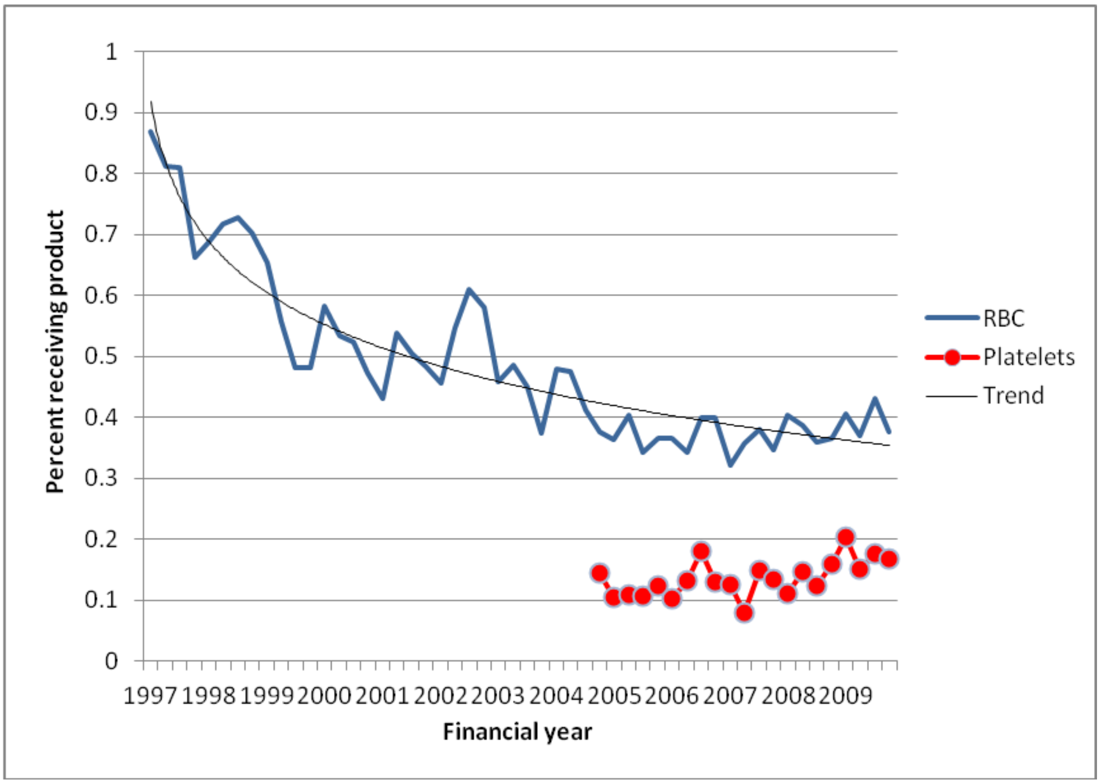
	2005-06	2006-07	2007-08	2008-09	2009-10
IABP post operatively	3.11%	3.10%	3.50%	2.10%	2.90%
Tracheostomies	1.72%	1.67%	1.56%	1.80%	1.28%
Rebleeding or tamponade	2.83%	1.50%	2.30%	3.80%	3.46%
New haemodialysis	2.00%	1.70%	1.80%	3.00%	2.80%
Strokes - Perm	0.90%	1.20%	0.40%	0.80%	1.00%
Strokes - TIA	0.60%	0.50%	0.70%	0.70%	1.00%

Table 5 Postoperative Complications 2005-2010

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 major morbidity and with respect to these we represent the UK figures for 2009-10 in parentheses after our own local figures: Reoperation for Bleeding/Tamponade 3.5% (4.1%), Neurological deficit/stroke 1.0%(1.4%), new haemodialysis for acute renal failure 2.8% (3.2%). All of these figures can act as encouragement to us to continue to develop our practice. We must also remember that as well as the practical consequences of these complications for patients and their families there is also a major consequence in terms of the cost of the additional care that must be provided and therefore there are multiple reasons to minimise their occurrence

Figure 26 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 around 40% of our patients are given red cells and 8% to 18% are given platelets. Looking at the year under study there is evidence of an upward trend and further investigation and attention to this if necessary may be required. Again, this has to be set against the decreased fitness of our current patients.

Figure 26: Trend in blood product use – all cases
1st April 1997 – 31st March 2010 (n=16,658)

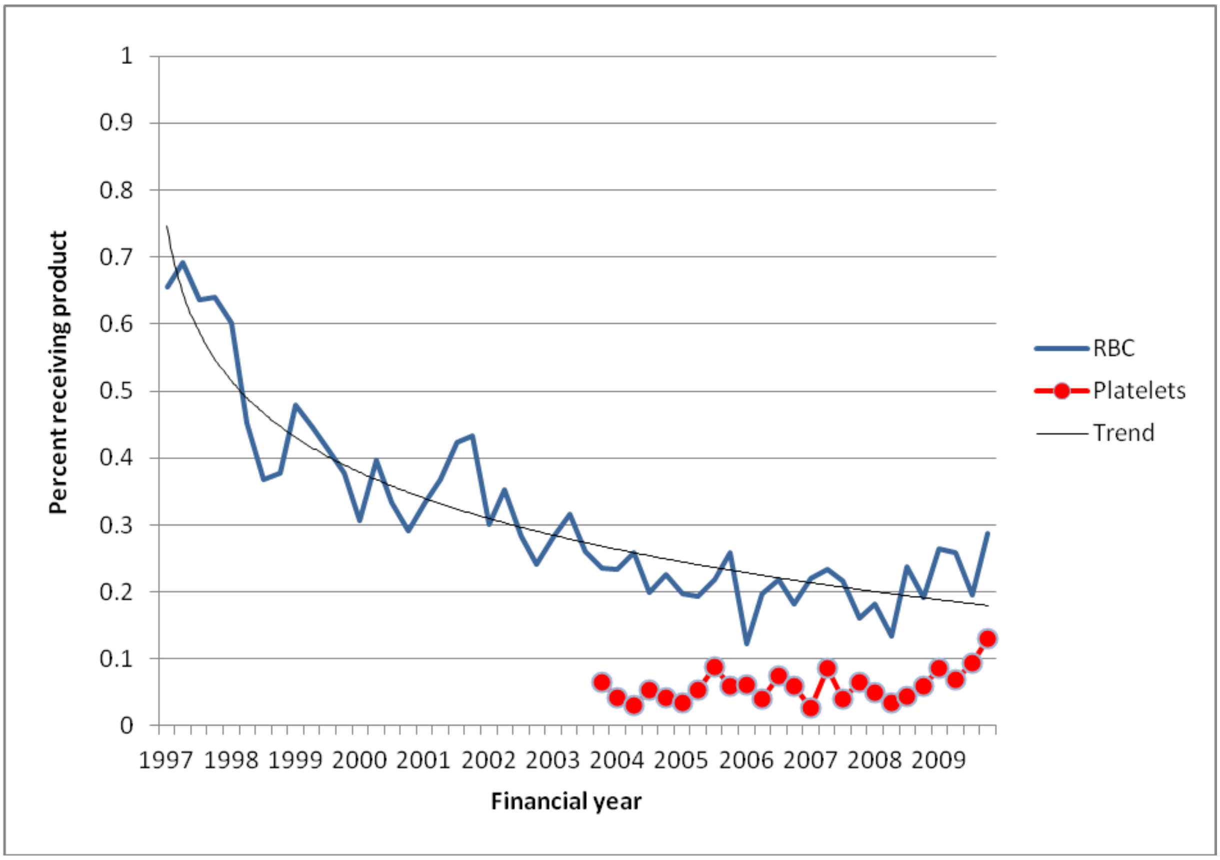


In order to minimise the confounding effect of the change in patient age and fitness, we also examine transfusion figures in a subset of our patients deemed 'low risk for transfusion':

- *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 27. The transfusion rates are generally lower (12% – 25% for red cells; 3% – 15% for platelets) and there is a similar picture of a reduction in transfusion but with the suggestion of a recent increase which will require further intensive effort.

Figure 27: Trend in blood product use – cohort group
1st April 1997 – 31st March 2010 (n=8,300)



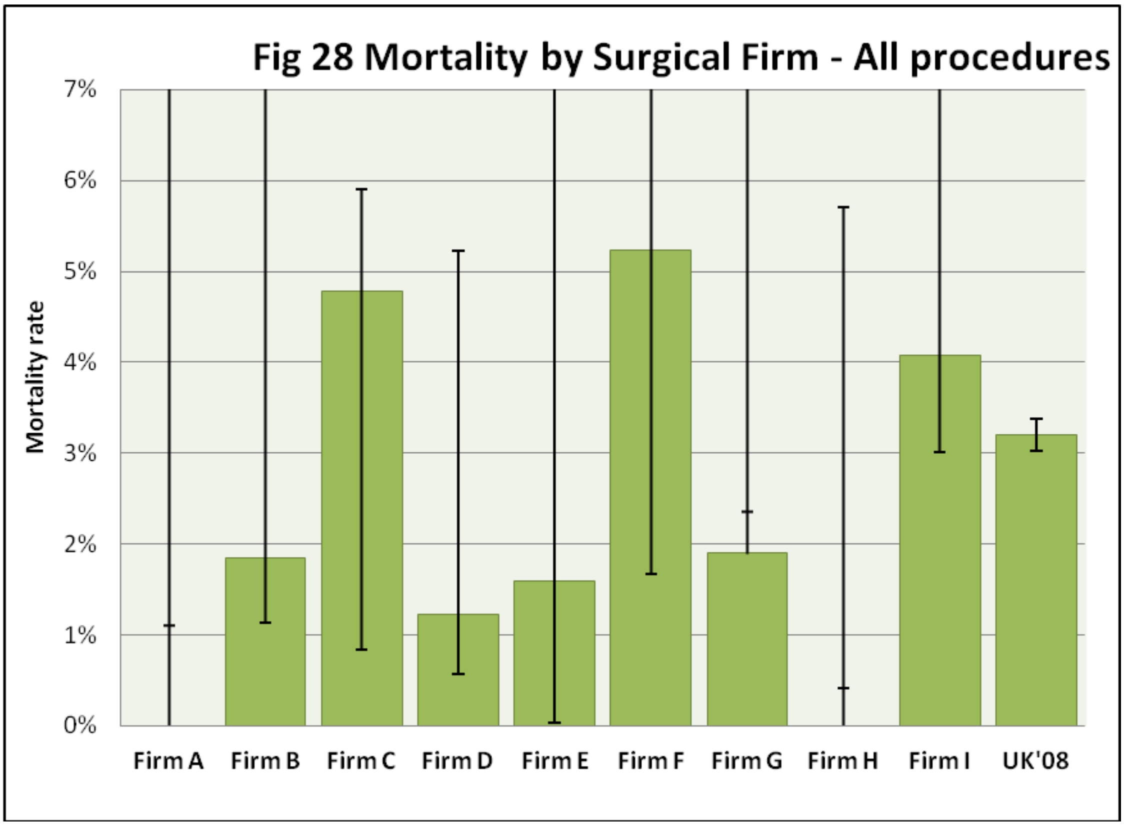
12. Assessment of Surgical Performance

At Bristol we have now completed 14 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 sixth year we are presenting surgeon-specific outcomes for ipCABG, ipAVR and for all procedures (Appendix 4). 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 has been presented on the Care Quality Commission website. Since the Care Quality Commission has declined to continue to host this information a new website is under discussion but has not been finalised.

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 28 & 29), or we can produce a 'funnel plot' (Figure 30) 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 30 shows the crude mortalities for all nine surgical firms in the unit for ipCABG procedures during the period 1st April 2007 to 31st March 2010. As can be seen, the performance of seven of our firms falls within the inner 95% confidence envelope, whilst the performance of one firm 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 8 & 9). 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.



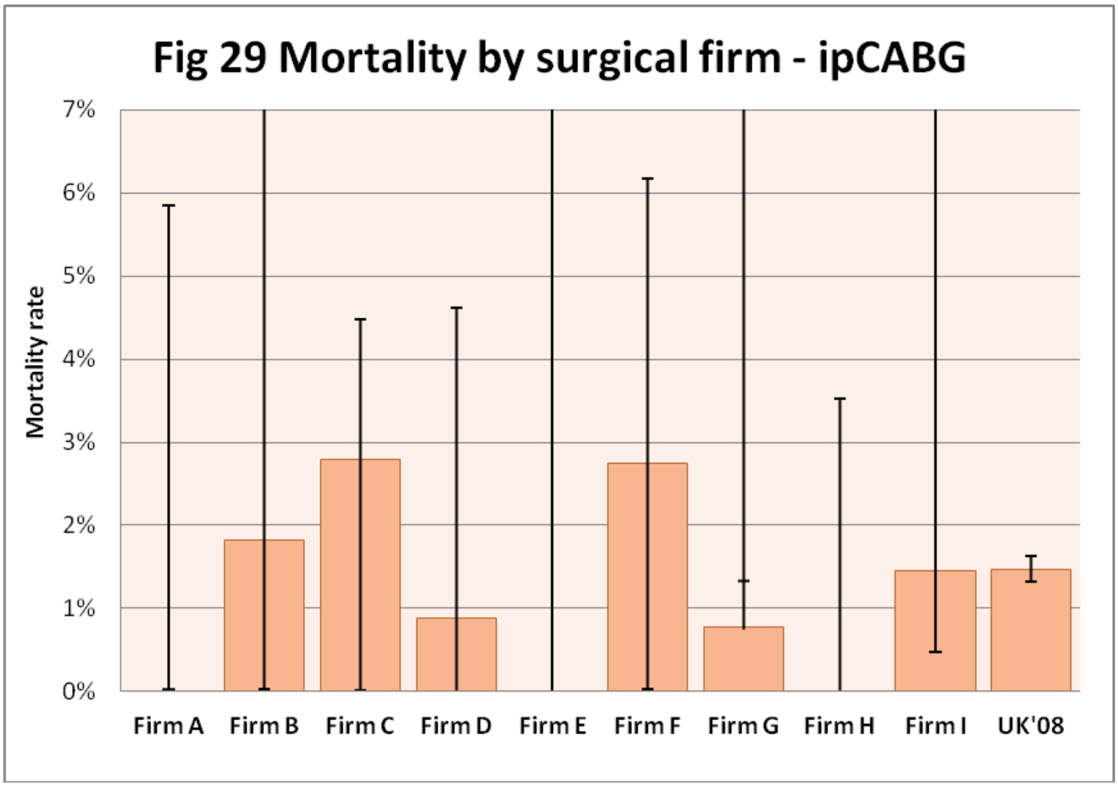
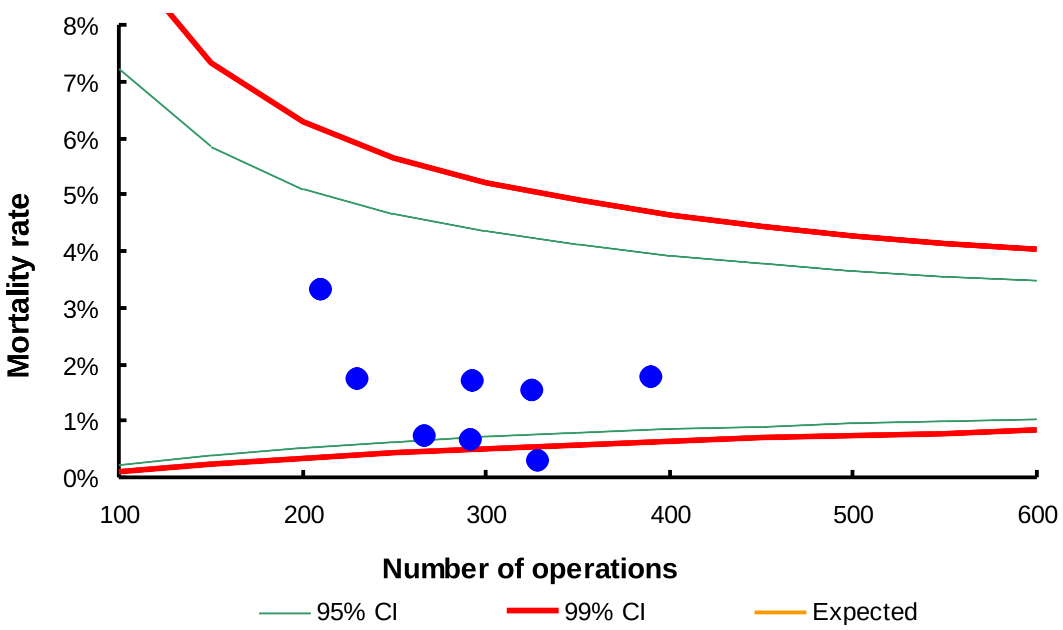


Fig 30 Funnel Plot CABG Mortality 2007-2010 Bristol Heart Institute



For ongoing monitoring of outcomes after CABG we have been using the Sequential Probability Ratio Test(SPiRiT)[9]. This test takes the form of a simple adaptation of a cumulative "observed-expected" plot, with horizontal thresholds which are risk-adjusted. Figure 31 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 32 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 31: Sequential Probability Ratio Test (SPiRiT) plot for doubled mortality rate isolated primary CABG, 1st April 2007 – 31st March 2010 (n=2,397)

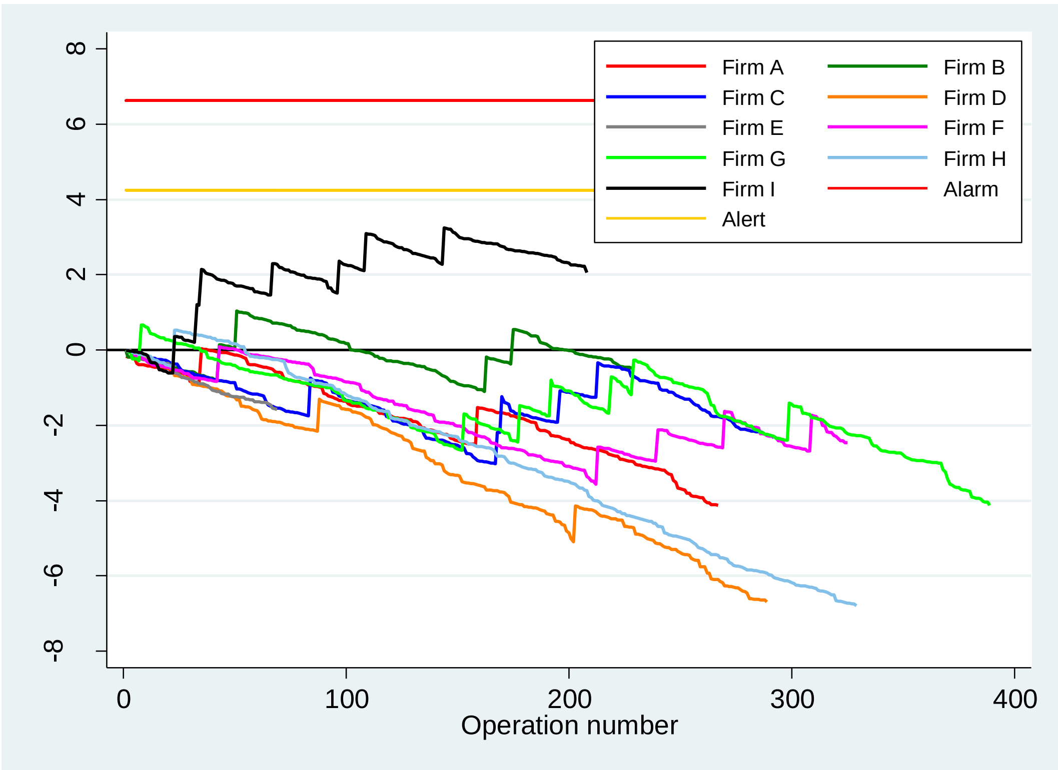
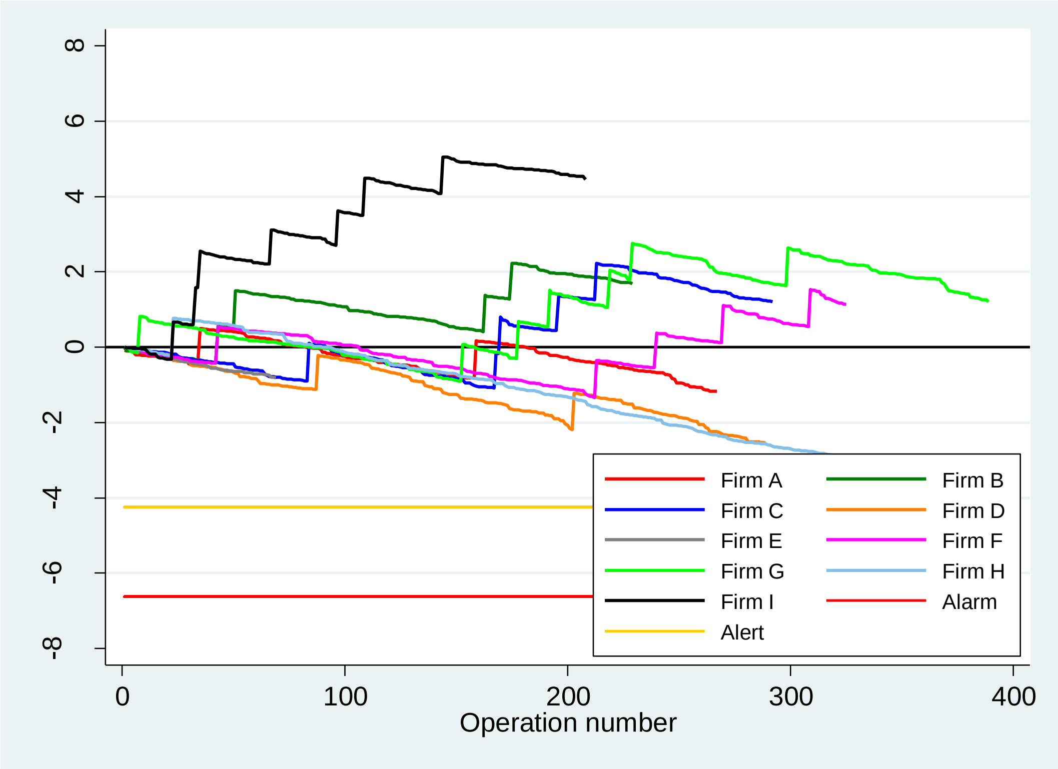


Figure 32: Sequential Probability Ratio Test (SPiRiT) plot for halved mortality rate isolated primary CABG, 1st April 2007 – 31st March 2010 (n=2,397)



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 second time. Charts for individually named surgeons and the unit as a whole are presented in Appendix 4. 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 [10]. 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[10]. Indeed, around 12% of patients have been found to consult surgeon-specific data prior to treatment [11]. There is also no evidence from North America of a shift of patients from high to low mortality centres[12], 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 the surgeons 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.

13. 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[13-16] . 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. The STS have gone on to implement their STS CABG Composite Score which has now been reported for three years and the implementation has been thoroughly described.[17,18] It is of interest that after a lot of discussion the STS has decided to present the data relating to cardiac surgical programs or group practices rather than individual surgeon performance, stating however that -"Program leaders have a ethical and professional responsibility to carefully monitor the performance of their individual surgeons".[18]

One of the most detailed initiatives of this kind is described by Guru et al [16]. 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^{th} 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.

Evaluation of our data over the last 8 years presented this way in figures 33 and 34 indicates that if we consider the raw data then there has been a small but steady reduction in the overall CABG quality score. However if we take into account the deteriorating risk profile which will almost inevitably impact on some of these indices then outcomes and quality has been maintained. In the last 12 months the decline has mostly been related to a decline in the patients discharged early from both the ICU and the hospital. Of course these kind of measures can be affected by multiple factors and may be more a reflection of factors outside of the control of the Bristol Heart Institute. Nevertheless, hospital in patient stay and its reduction continue to be an important focus and we must maintain our efforts to bring this down.

Figure 33: Trend in Bristol Royal Infirmary CABG Quality score and operative risk isolated primary CABG, 1st April 2002 – 31st March 2010 (n=6,640)

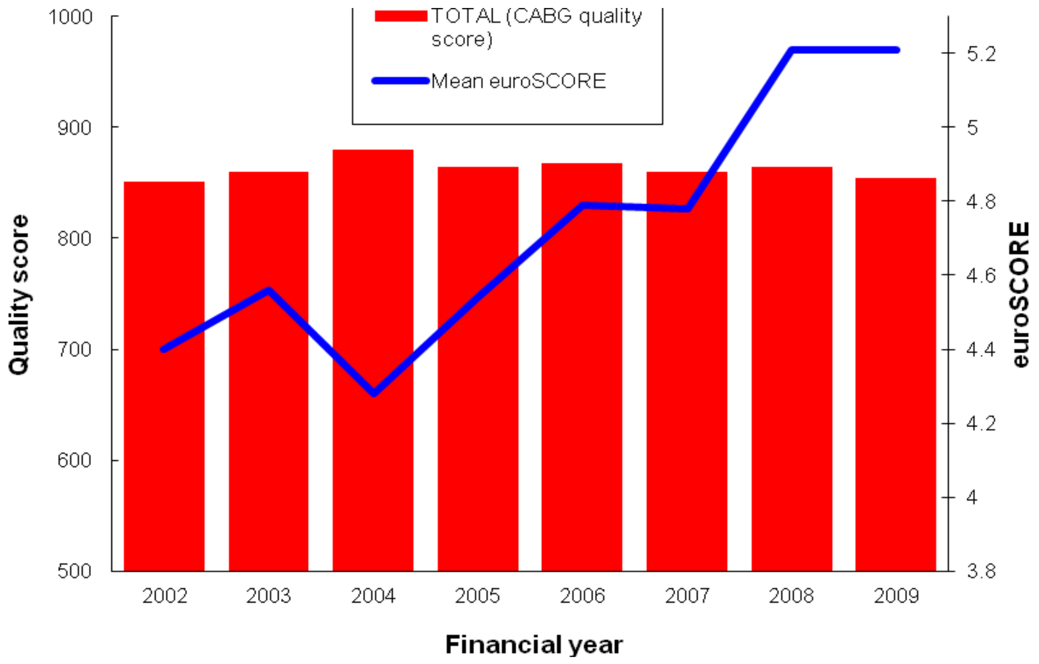
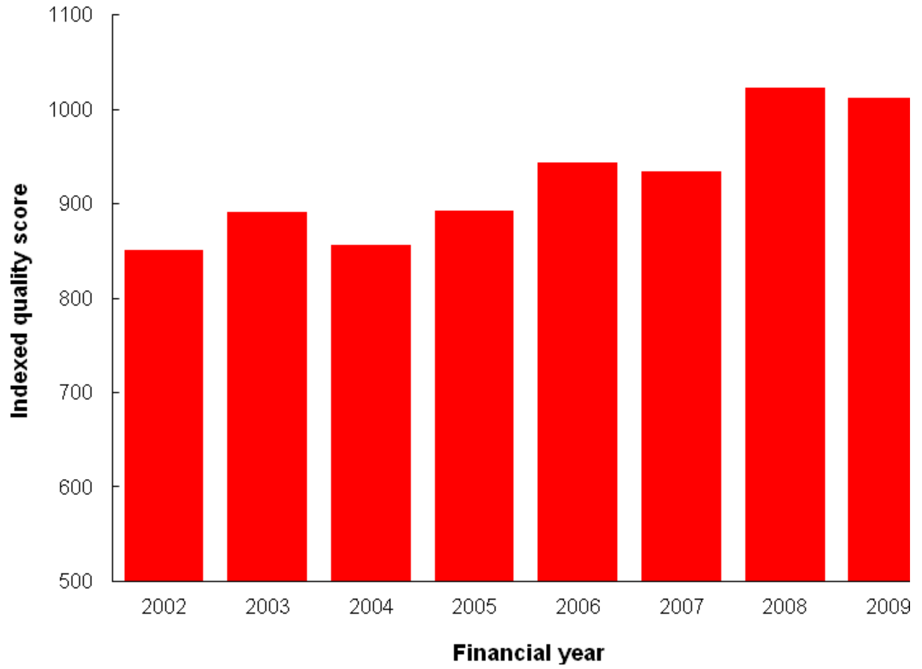


Figure 34: Indexed CABG Quality score (2002 as base year for risk) isolated primary CABG, 1st April 2002 – 31st March 2009 (n=6,640)



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Ann Thorac Surg 92:S2-S11

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Ann Thorac Surg 92:S12-S23

Appendix 1 - Mortality rates for commonly performed procedures 1st April 1996 – 31st March 2010 (n=16,415)

**95 percent confidence interval for mortality rate*

	Number	Deaths	Mortality Rate	Lower bound	Upper bound	CCAD 2008
Isolated CABG	11,251	144	1.3%	1.1%	1.5%	1.5%
Redo CABG	296	10	3.4%	1.7%	6.4%	4.1%
Aortic valve procedure	1,778	46	2.6%	2.1%	3.8%	2.8%
AV + CABG	1,114	53	4.8%	3.6%	6.3%	5.3%
Mitral Valve procedure	797	31	3.9%	2.8%	5.9%	4.1%
MV + CABG	354	25	7.1%	4.6%	10.5%	9.4%
AV + MV Procedure	140	9	6.4%	2.7%	11.7%	8.1%
Aortic	685	79	11.5%	9.5%	14.9%	12.9%

Appendix 2 - Distribution of procedure types between surgical firms 1st April 2009– 31st March 2010

	Isolated primary CABG	Other IHD	Valve, Valve + CABG	Thoracic Aorta	Adult Congenital	Other	Total
Angelini, G D	83	2	46	1	0	0	132
Ascione, R	55	7	93	2	0	5	162
Asimakopoulos, G	143	14	58	12	0	3	230
Bryan, A J	114	4	89	36	0	3	246
Caputo, M	16	0	16	10	18	2	62
Ciulli, F	109	6	79	2	0	14	210
Hutter, J A	129	0	76	4	0	1	210
Murphy, G	90	3	43	12	0	3	151
Parry, A	0	0	8	3	26	0	37
Stoica, S	0	0	6	0	14	3	23
Yeatman, M	69	1	19	3	0	6	98
Grand total	808	37	533	85	58	40	1561

Appendix 3

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

		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 %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST 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%
Total	207			5	207	2.4%	26	1207	2.2%

Mortality Rate Analysis

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

Mortality Rate Analysis

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

Mortality Rate Analysis

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

Mortality Rate Analysis

Arterial grafts (isolated primary CABG)	Count	IC %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST 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 %age	REST %age	IC Deaths	IC Procs	IC Rate	REST Deaths	REST Procs	REST 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%
Total	34			1	34	2.9%	2	164	1.2%

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

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

		IC	**REST**
Median time to extubation (hours)		7.0	7.0
ICU stays > 24 hours	Count	1	11
	Total	205	1205
	Rate	0.5%	0.9%

SCTS marker operation: ipCABG mortality

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

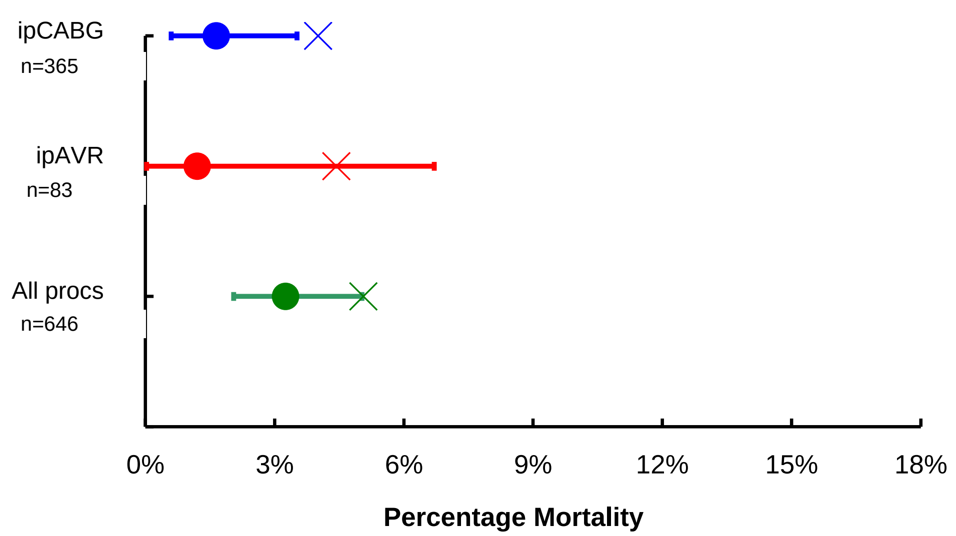
SCTS marker operation: ipCABG Mortality by EuroSCORE Group

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

DEATHS DURING PRIMARY ADMISSION

First name	Last name	MRN	DOB	Opdate	Procedure	EuroSCORE

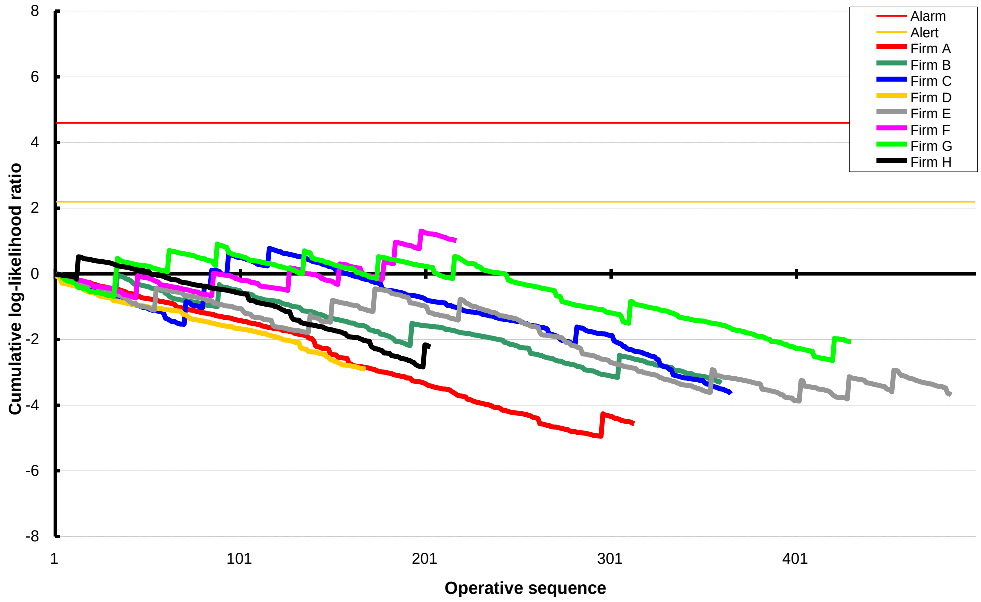
Mr I Cutwell Consultant cardiac surgeon



Sequential Probability Ratio Test (SPRT) Plot: Doubled mortality

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

Using NACSD 2003 mortality rates for EuroSCORE

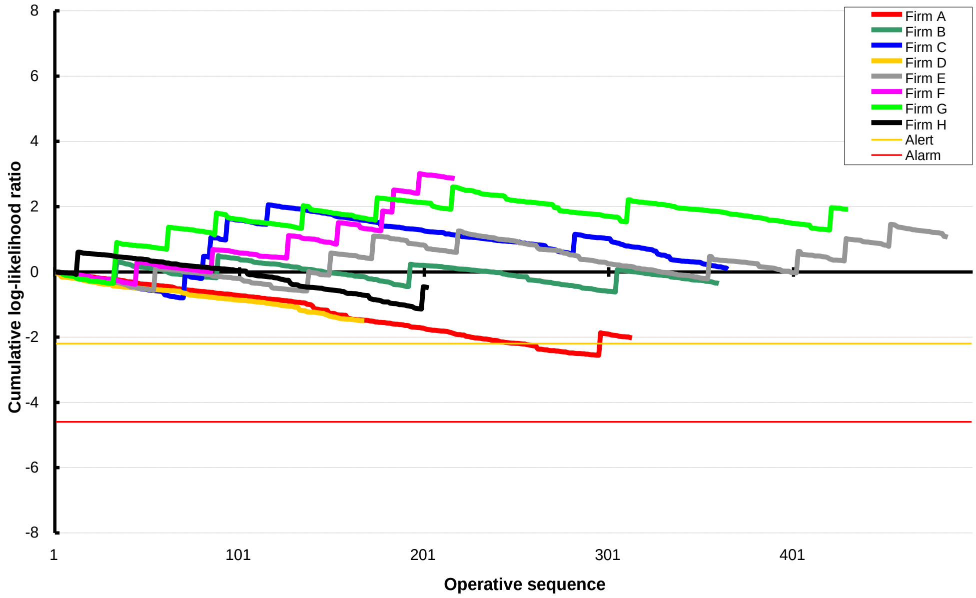


Mr I Cutwell is firm C

Sequential Probability Ratio Test (SPRT) Plot: Halved mortality

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

Using NACSD 2003 mortality rates for EuroSCORE



Mr I Cutwell is firm C

Appendix 4

Surgeon-specific results for adult cardiac surgery
1st April 2007 – 31st March 2010

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*

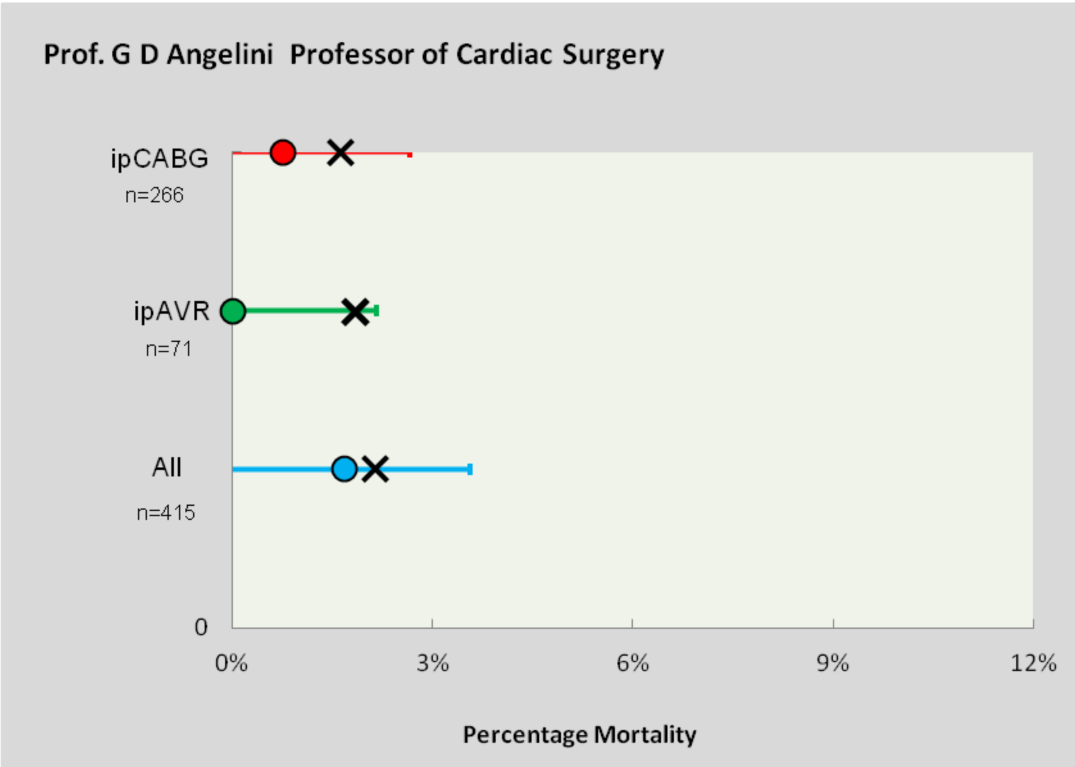
(N.B The recalibrated euroSCORE was used for CABG and AVR but the standard EuroSCORE for the rest of the cases as a recalibration was not available.)

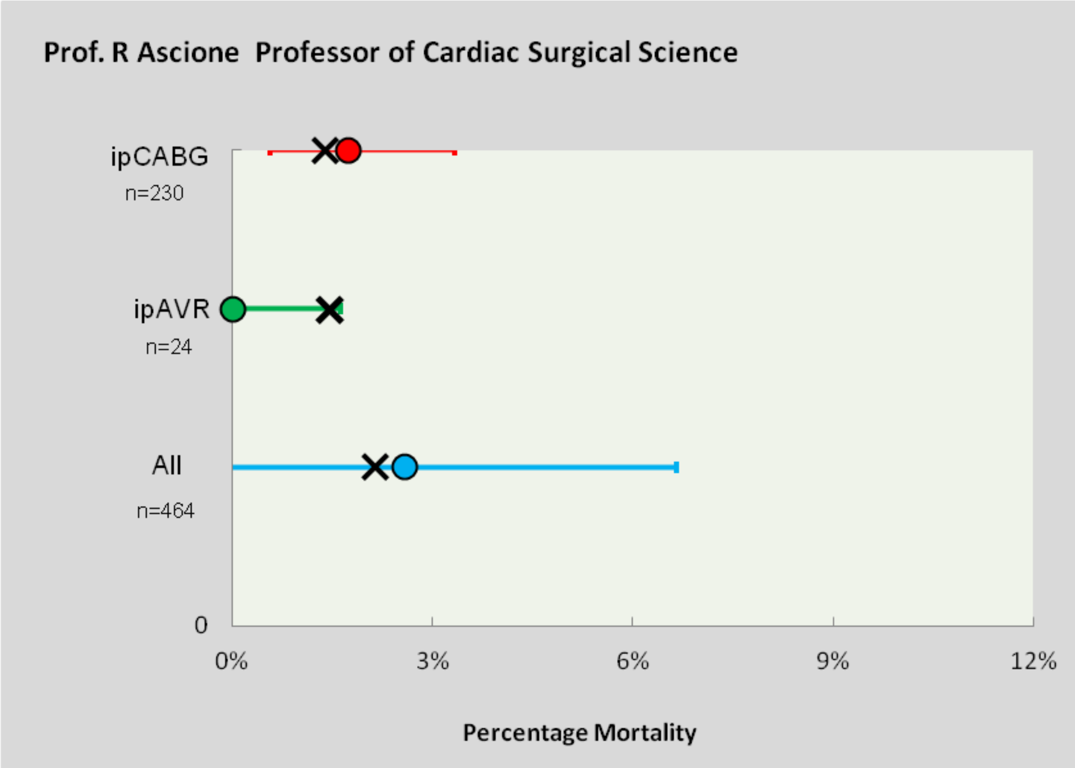
b). In the charts that follow the large 'dots' are the actual (observed) mortality rates over the three-year period for each procedure category. The horizontal bars around these show the 95 percent confidence interval associated with the observed rate. The figures expressed as 'n=' indicate the total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

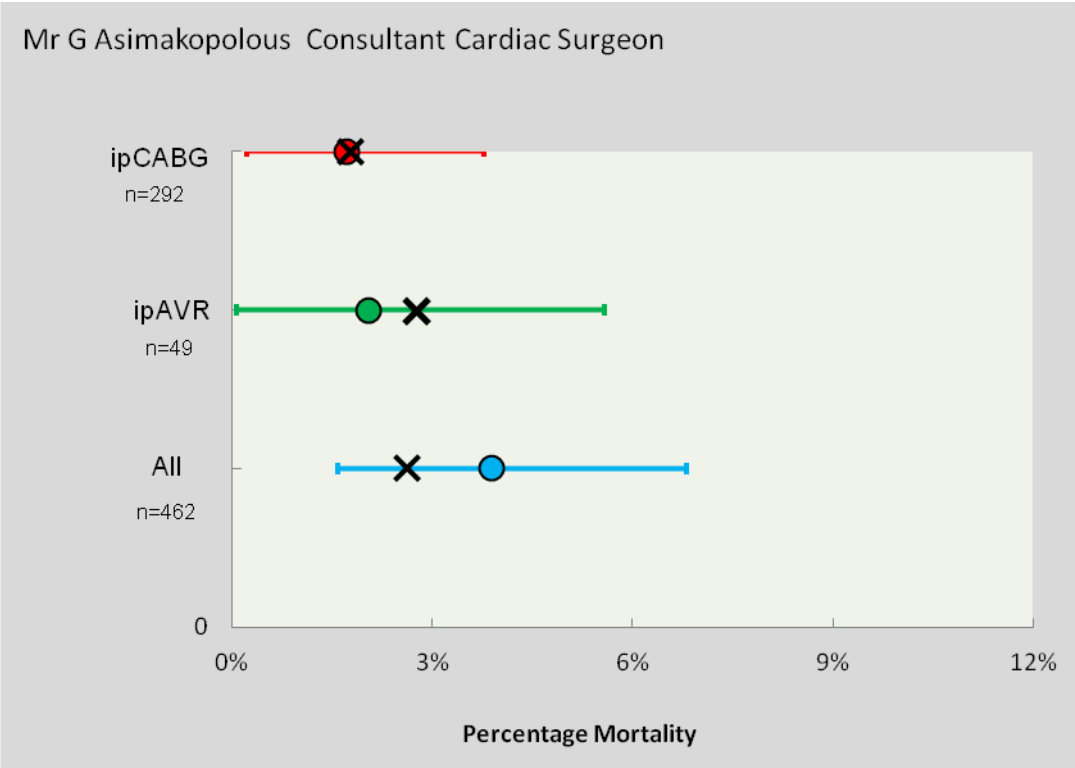
c). The predicted mortality rate is shown on the charts as a large 'X'. This is an estimate derived from application of the euroSCORE to each patient. Each score point represents a one percent change of death, and the accumulative score across all patients in the operative group for the period is calculated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

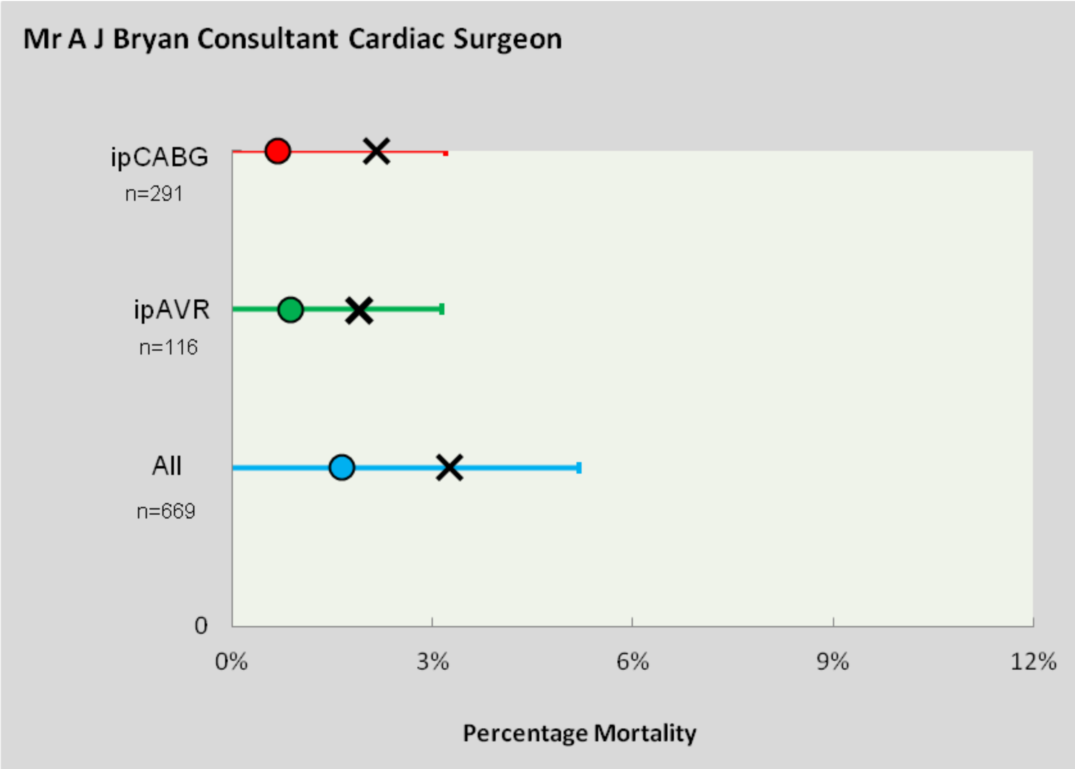
d). With surgeon performance statistically significantly better than predicted, the 'X' would be to the right of the dot and clear of the dot's right-hand 95% confidence interval bar. With surgeon performance statistically significantly worse than predicted, the 'X' would be to the left of the dot and 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.

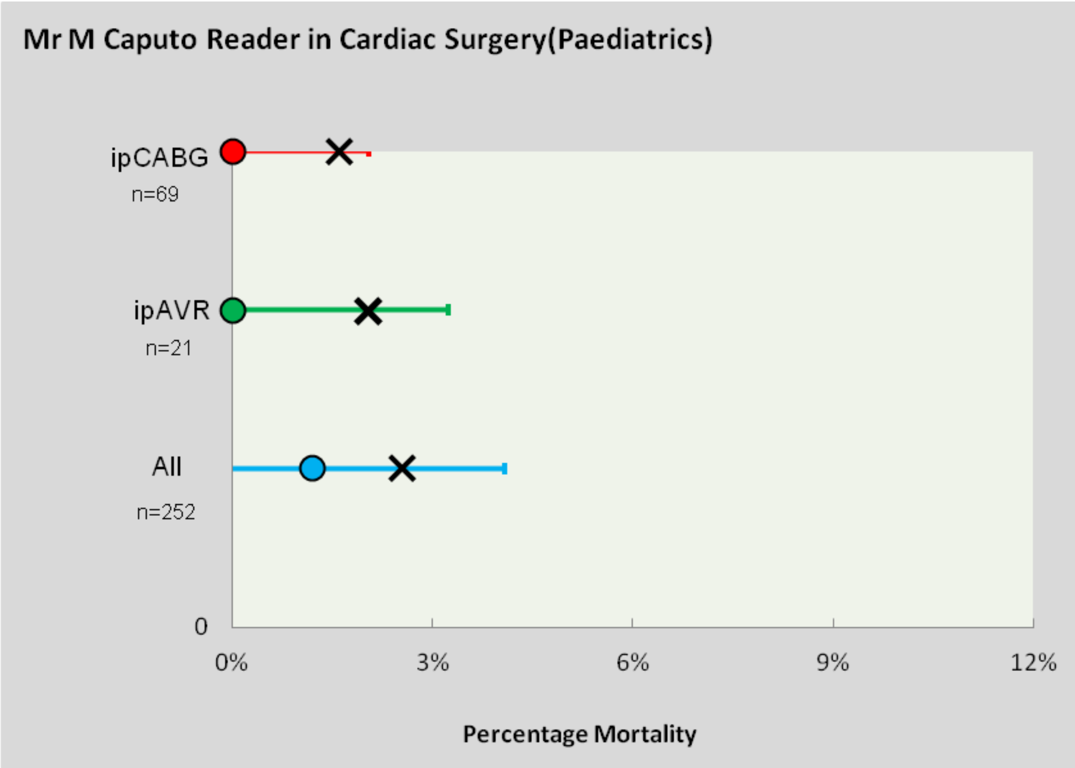



Prof. R Ascione Professor of Cardiac Surgical Science
ipCABG
n=230
ipAVR
n=24
All
n=464
0
0%
3%
6%
9%
12%
Percentage Mortality

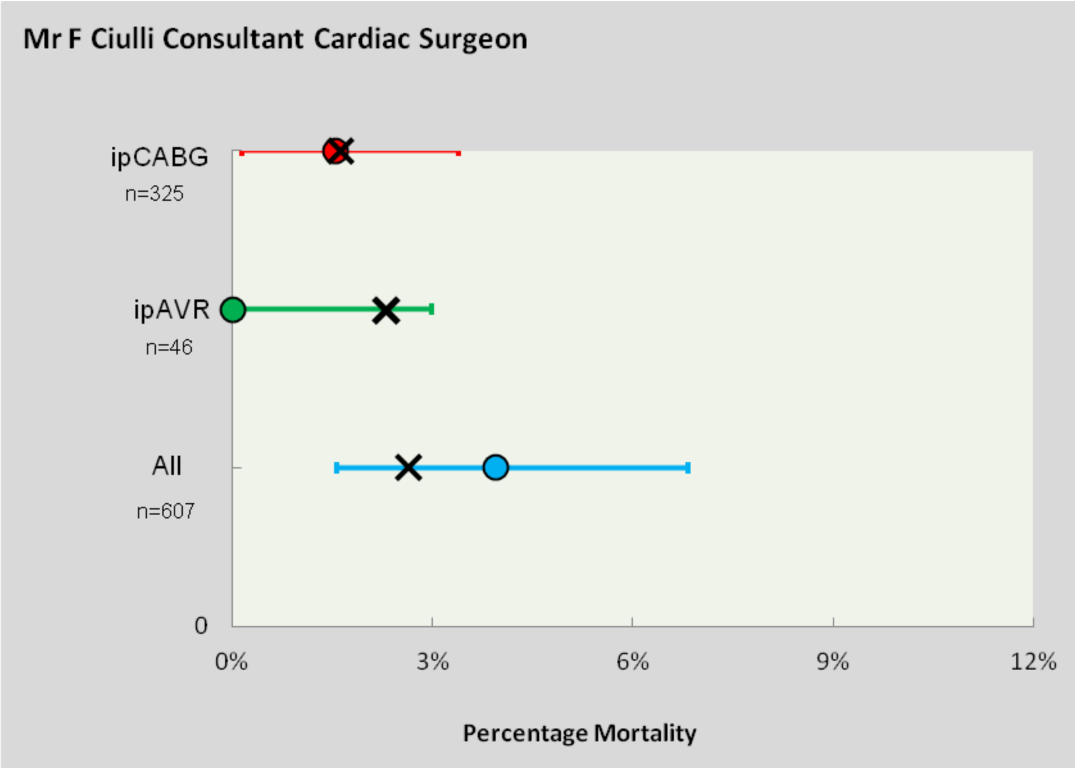

Mr G Asimakopolous Consultant Cardiac Surgeon
ipCABG
n=292
ipAVR
n=49
All
n=462
0
0%
3%
6%
9%
12%
Percentage Mortality

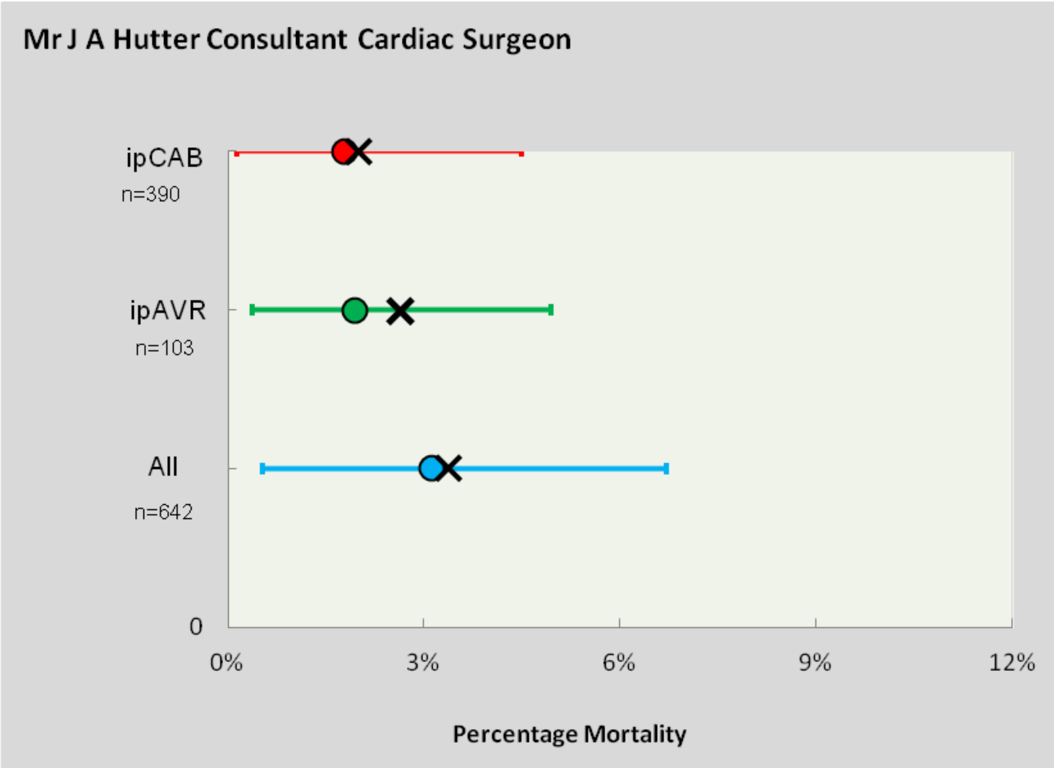


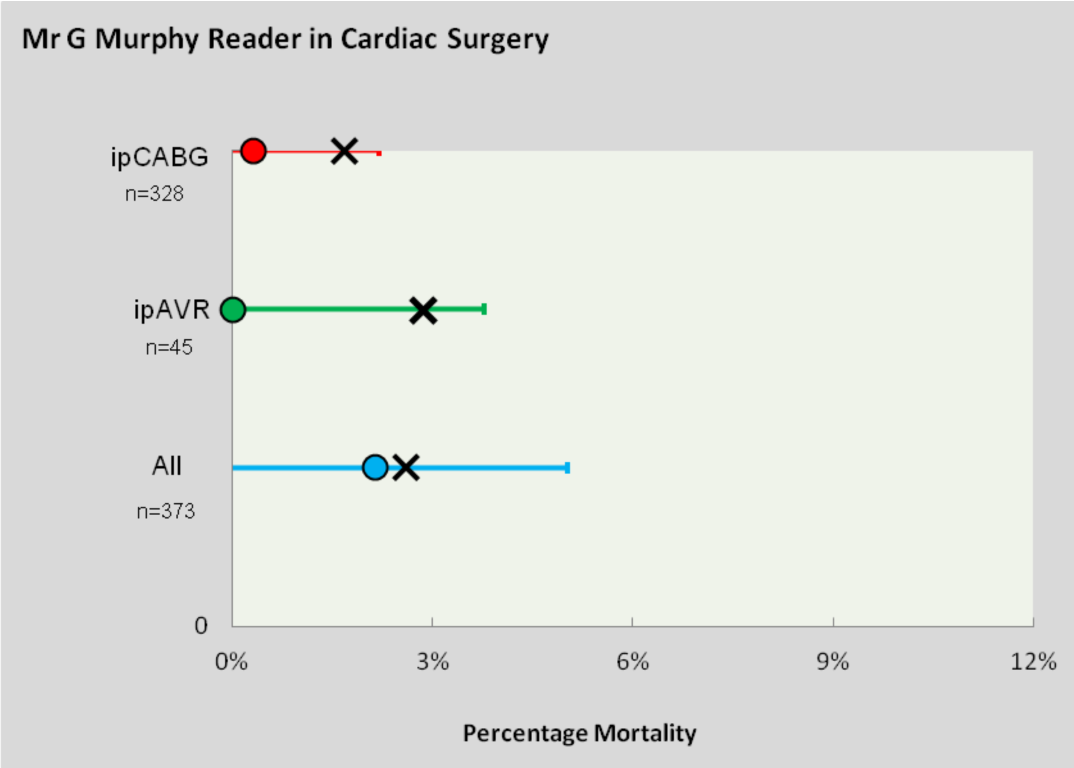
Mr A J Bryan Consultant Cardiac Surgeon
ipCABG
n=291
ipAVR
n=116
All
n=669
0
0%
3%
6%
9%
12%
Percentage Mortality

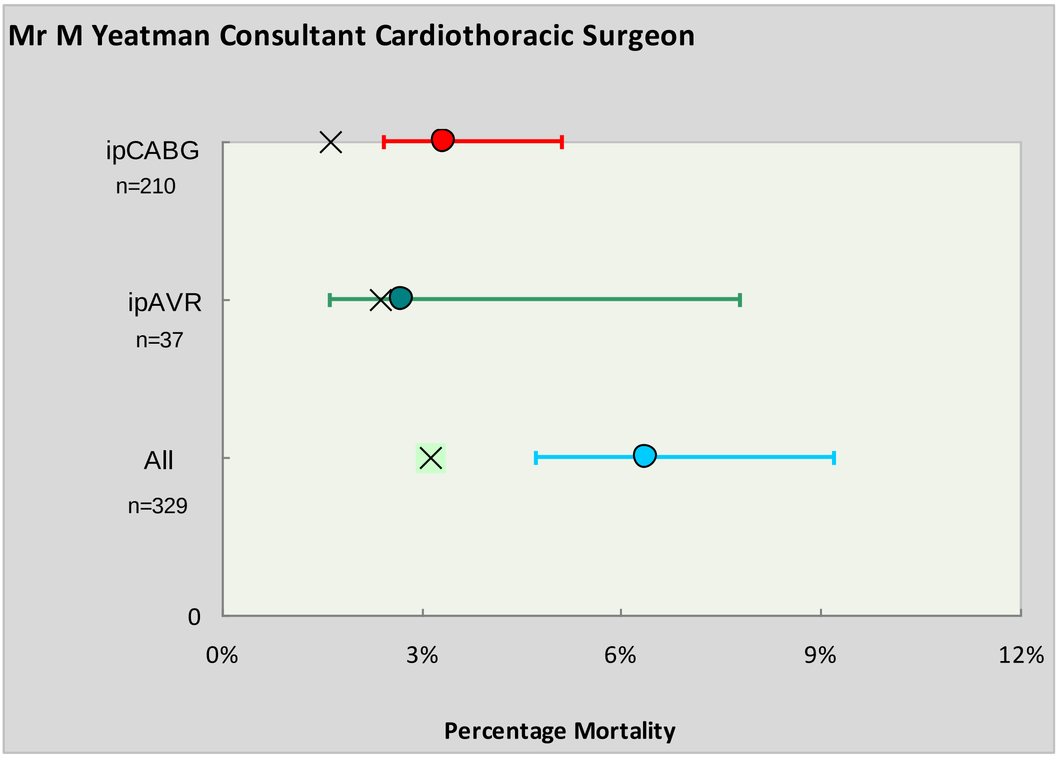


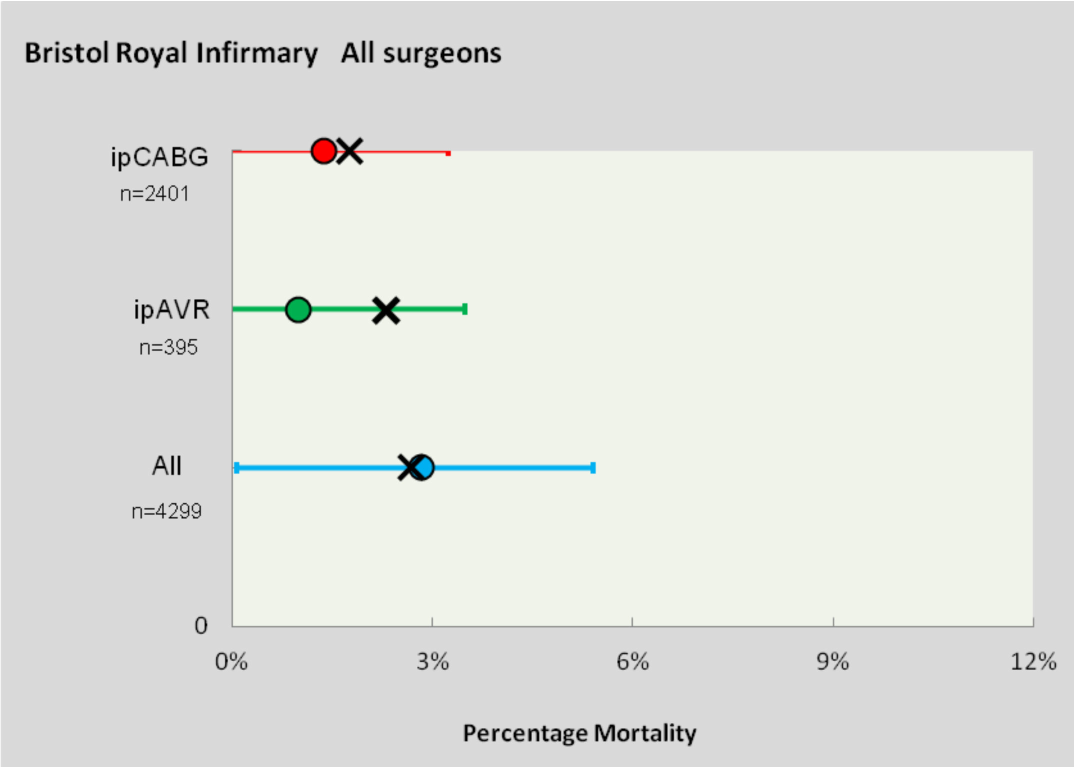
Mr M Caputo Reader in Cardiac Surgery(Paediatrics)
ipCABG
n=69
ipAVR
n=21
All
n=252
0
0%
3%
6%
9%
12%
Percentage Mortality


Mr F Ciulli Consultant Cardiac Surgeon
ipCABG
n=325
ipAVR
n=46
All
n=607
0
0%
3%
6%
9%
12%
Percentage Mortality


Mr J A Hutter Consultant Cardiac Surgeon
ipCAB
n=390
ipAVR
n=103
All
n=642
0
0%
3%
6%
9%
12%
Percentage Mortality


Mr G Murphy Reader in Cardiac Surgery
ipCABG
n=328
ipAVR
n=45
All
n=373
0
0%
3%
6%
9%
12%
Percentage Mortality


Mr M Yeatman Consultant Cardiothoracic Surgeon
ipCABG
n=210
ipAVR
n=37
All
n=329
0
0%
3%
6%
9%
12%
Percentage Mortality


Bristol Royal Infirmary All surgeons
ipCABG
n=2401
ipAVR
n=395
All
n=4299
0
0%
3%
6%
9%
12%
Percentage Mortality

Isolated primary CABG

Name	2007-08					2008-09					2009-10					Cumulative 2007-10				
		Actual		Expected			Actual		Expected			Actual		Expected			Actual		Expected	
	No.	Deaths	Rate	Deaths	Rate	No.	Deaths	Rate	Deaths	Rate	No.	Deaths	Rate	Deaths	Rate	No.	Deaths	Rate	Deaths	Rate
Angelini, G D	90	1	1.1%	1.5	1.7%	93	1	1.1%	1.2	1.3%	83	0	0.0%	1.5	1.8%	266	2	0.8%	4.2	1.6%
Ascione, R	103	2	1.9%	1.4	1.4%	72	1	1.4%	1.0	1.4%	55	1	1.8%	0.8	1.4%	230	4	1.7%	3.2	1.4%
Asimakopoulos, G	27	0	0.0%	0.4	1.5%	122	1	0.8%	2.1	1.7%	143	4	2.8%	2.6	1.8%	292	5	1.7%	5.1	1.7%
Bryan, A J	99	1	1.0%	1.9	1.9%	78	0	0.0%	1.8	2.3%	114	1	0.9%	2.5	2.2%	291	2	0.7%	6.2	2.1%
Caputo, M	42	0	0.0%	0.8	1.9%	11	0	0.0%	0.1	0.9%	16	0	0.0%	0.2	1.3%	69	0	0.0%	1.1	1.6%
Ciulli, F	128	1	0.8%	1.8	1.4%	88	1	1.1%	1.4	1.6%	109	3	2.8%	1.9	1.8%	325	5	1.5%	5.1	1.6%
Hutter, J A	139	1	0.7%	2.3	1.7%	122	5	4.1%	2.7	2.2%	129	1	0.8%	2.8	2.2%	390	7	1.8%	7.8	2.0%
Murphy, G	135	1	0.7%	2.2	1.6%	103	0	0.0%	1.8	1.7%	90	0	0.0%	1.5	1.7%	328	1	0.3%	5.5	1.7%
Yeatman, M	90	4	4.4%	1.5	1.7%	51	2	3.9%	1.0	2.0%	69	1	1.4%	0.9	1.3%	210	7	3.3%	3.4	1.6%
Unit Total	853	11	1.3%	13.8	1.6%	740	11	1.5%	13.1	1.8%	808	11	1.4%	14.7	1.8%	2401	33	1.4%	41.6	1.7%

Isolated primary AVR

	2007-08					2008-09					2009-10					Cumulative 2007-10				
		Actual		Expected			Actual		Expected			Actual		Expected			Actual		Expected	
Name	**No.**	**Deaths**	**Rate**	**Deaths**	**Rate**	**No.**	**Deaths**	**Rate**	**Deaths**	**Rate**	**No.**	**Deaths**	**Rate**	**Deaths**	**Rate**	**No.**	**Deaths**	**Rate**	**Deaths**	**Rate**
Angelini, G D	17	0	0.0%	0.4	2.4%	30	0	0.0%	0.5	1.7%	24	0	0.0%	0.5	1.9%	71	0	0.0%	1.4	1.9%
Ascione, R	9	0	0.0%	0.1	1.1%	7	0	0.0%	0.1	1.4%	8	0	0.0%	0.1	1.3%	24	0	0.0%	0.3	1.3%
Asimakopoulos, G	5	0	0.0%	0.1	2.0%	21	1	4.8%	0.6	2.9%	23	0	0.0%	0.6	2.7%	49	1	2.0%	1.3	2.7%
Bryan, A J	46	0	0.0%	0.9	2.0%	33	1	3.0%	0.5	1.5%	37	0	0.0%	0.8	2.2%	116	1	0.9%	2.2	1.9%
Caputo, M	10	0	0.0%	0.2	2.0%	5	0	0.0%	0.2	4.0%	6	0	0.0%	0.1	1.0%	21	0	0.0%	0.5	2.2%
Ciulli, F	18	0	0.0%	0.4	2.2%	16	0	0.0%	0.4	2.5%	12	0	0.0%	0.2	1.9%	46	0	0.0%	1.0	2.2%
Hutter, J A	29	1	3.4%	0.9	3.1%	27	1	3.7%	0.8	3.0%	47	0	0.0%	1.0	2.1%	103	2	1.9%	2.7	2.6%
Murphy, G	14	0	0.0%	0.3	2.1%	18	0	0.0%	0.5	2.8%	13	0	0.0%	0.5	3.6%	45	0	0.0%	1.3	2.8%
Yeatman, M	15	1	6.7%	0.3	2.0%	13	0	0.0%	0.3	2.3%	9	1	11.1%	0.3	3.1%	37	2	5.4%	0.9	2.4%
Unit Total	163	2	1.2%	3.6	2.2%	170	3	1.8%	3.9	2.3%	179	1	0.6%	4.1	2.3%	512	6	1.2%	11.6	2.3%

All procedures

	2007-08					2008-09					2009-10					Cumulative 2007-10				
		Actual		Expected			Actual		Expected			Actual		Expected			Actual		Expected	
Name	No.	Deaths	Rate	Deaths	Rate	No.	Deaths	Rate	Deaths	Rate	No.	Deaths	Rate	Deaths	Rate	No.	Deaths	Rate	Deaths	Rate
Angelini, G D	134	2	1.5%	3.5	2.6%	149	5	3.4%	3.7	2.5%	132	0	0.0%	2.9	2.2%	415	7	1.7%	10.1	2.4%
Ascione, R	158	4	2.5%	4.3	2.7%	144	5	3.5%	5.0	3.5%	162	3	1.9%	3.6	2.2%	464	12	2.6%	12.9	2.8%
Asimakopoulos, G	38	2	N/a	0.9	N/a	194	5	2.6%	6.1	3.1%	230	11	4.8%	6.3	2.7%	462	18	3.9%	13.3	2.9%
Bryan, A J	230	4	1.7%	8.6	3.7%	193	4	2.1%	8.6	4.5%	246	3	1.2%	8.4	3.4%	669	11	1.6%	25.6	3.8%
Caputo, M	115	1	0.9%	4.6	4.0%	74	1	1.4%	3.4	4.6%	63	1	1.6%	1.6	2.5%	252	3	1.2%	9.6	3.8%
Ciulli, F	227	6	2.6%	7.5	3.3%	170	7	4.1%	6.1	3.6%	210	11	5.2%	6.6	3.1%	607	24	4.0%	20.2	3.3%
Hutter, J A	226	6	2.7%	7.3	3.2%	206	10	4.9%	7.9	3.8%	210	4	1.9%	6.5	3.1%	642	20	3.1%	21.7	3.4%
Murphy, G	186	5	2.7%	5.3	2.8%	151	3	2.0%	4.6	3.0%	151	0	0.0%	4.5	12.4%	488	8	2.9%	14.4	3.9%
Yeatman, M	136	10	7.4%	4.5	3.3%	95	7	7.4%	3.6	3.8%	98	4	4.1%	2.2	2.2%	329	21	6.4%	10.3	3.1%
Unit Total	1450	40	2.8%	46.5	3.2%	1376	47	3.4%	49.0	3.6%	1561	37	2.4%	42.6	2.7%	4387	124	2.8%	138.1	3.1%

Appendix 5

PATS Steering Group membership

Staff member	Representing
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