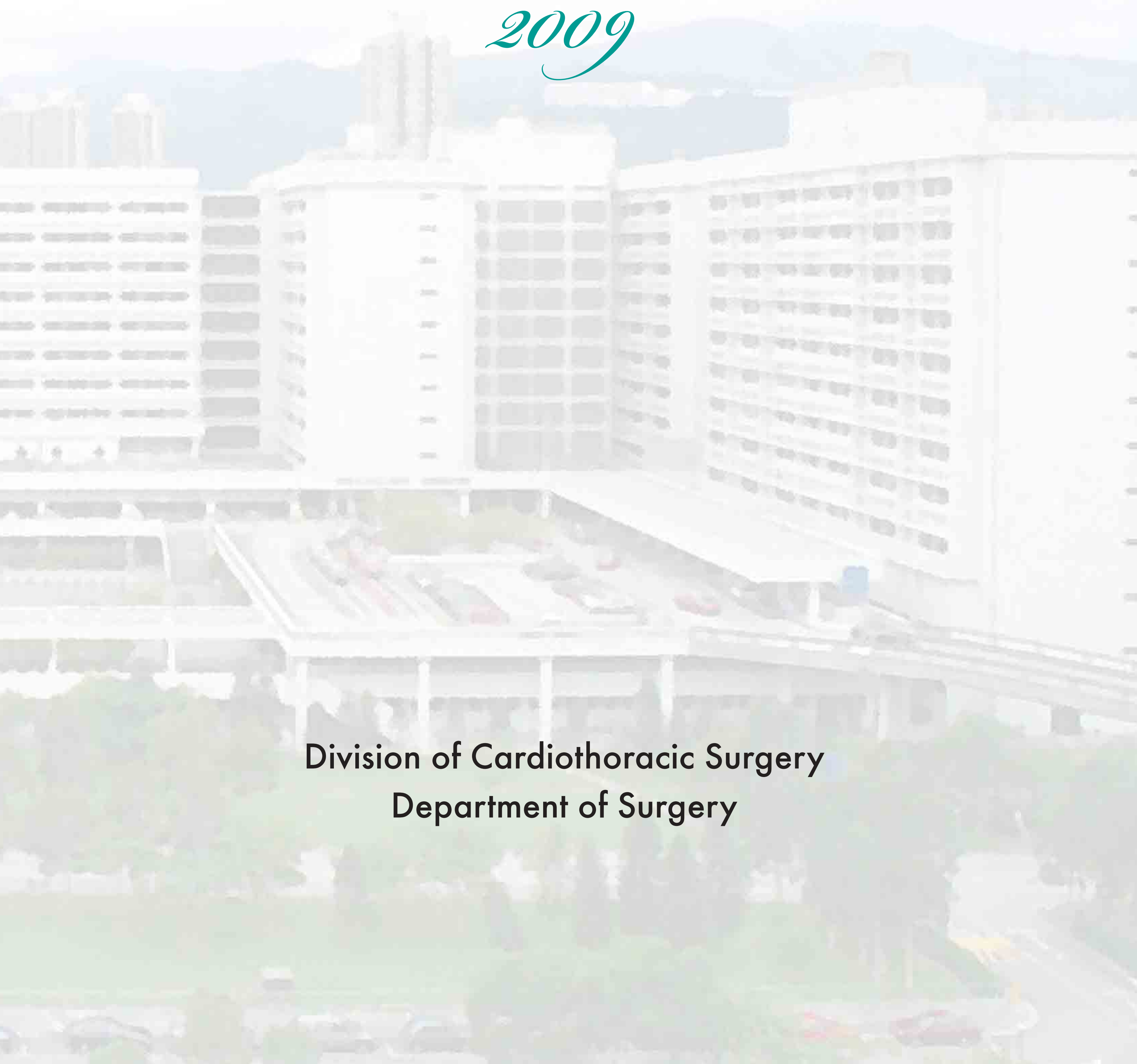
Prince of Wales Hospital
The Chinese University of Hong Kong

Cardiac Surgery Report

2009



Division of Cardiothoracic Surgery
Department of Surgery

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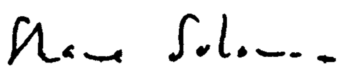
Foreword

The goal of comprehensive clinical quality assurance is, without doubt, to provide patients with a safe, least harmful journey through the hospital or medical care process. To achieve this, the understanding of clinical quality assurance should extend beyond the parameters of mortality and morbidity. A comprehensive quality framework will anchor on the core value of continuous improvement in all dimensions including patient satisfaction, access management, outcome measurement, appropriateness of care and effectiveness of resource management.

The first three areas demonstrate a process to be easily understood and implemented by healthcare workers. Appropriateness of care asks not whether patients are satisfied with their care, not whether hospital services are delivered smoothly, and not whether outcomes meet standards, but whether the treatment plan will most benefit the patient with reasonable risk. In assessing resource allocation, one asks whether the views of clinicians, administrators and patients have been taken into regard.

The report on cardiac surgery from the Prince of Wales Hospital has demonstrated HA's competence in and commitment to quality—low mortality for CABG (0.90%), continual reduction in blood usage and reasonable waiting time. With more transparency demanded by wide public concern on incidents and standards of medical services, with the introduction of hospital accreditation in the public healthcare system, and with patients' participation, our quality initiatives would be driven by alignment with the international level of care.

The "quest for quality" journey is not going to stop, as in all businesses, at meeting consumers expectations. Given our accountability as public organization, I believed that continual quality improvement by our colleagues will always drive our services at the frontier of medicine.



Shane Solomon
Chief Executive
Hospital Authority

Introduction

This is the third report of the Division of Cardiac Surgery, The Chinese University of Hong Kong, Prince of Wales Hospital, Sha Tin, New Territories, Hong Kong.

As part of our quality assurance programme for patients undergoing cardiac surgery we began collection of high quality data back in November 2005. In that year, we specifically limited the dataset so that it would conform to the requirements for risk modelling as set out and defined by the United Kingdom (UK) Society of Cardiothoracic Surgeons (UKSCTS). Our primary aim then was to be able to benchmark our results (in terms of mortality) against established risk models and other international cardiac surgical units, and it was these results that that formed the body of that first report.[1]

Prior to the report on our second year of activity, we had significantly expanded the data fields. This enabled us to look at the quality of the care we were providing in wider terms than risk adjusted mortality. We now took into account areas of post-operative morbidity, for example, blood transfusion rates. This second report also showed the variety of ways that risk adjusted mortality can be presented, together with the rationale behind this variety. Here we were seeking to clarify complex processes for our target readers—primarily the general public as well as administrators and others who were unlikely to be specialists in such areas.

In this, our third year of data collection, we have sought to bring our audit trail to maturity and monitor the accuracy of data input (Appendix 1). This helps us to ensure that we can specifically monitor real time outcomes within the total framework we are developing.

Our collection and analysis system (Dendrite) is integrated with the Computerized Medical System (CMS) of Hong Kong's Hospital Authority

(HA) and this enables automatic uploads of patient demographic data to our dedicated cardiac database. Other data fields, however, still require manual input. While this may appear somewhat burdensome, it nevertheless provides additional assurance regarding the quality and accuracy of the data.

We have maintained the initial level of support personnel and currently have two research assistants, one full-time and one part-time, who contribute to data input and validation within the audit trail. These personnel are currently financed from our own team fund with monies from generous donors and fees from private work.

There has been much debate over how long a period is needed for collected data to become valid for use in outcomes analysis. Thus far, the general consensus is that, depending on a unit's activity, data achieves appropriate levels of significance over three years. Three years is also the time period used by the Healthcare Commission (now named Care Quality Commission) in the UK to publish cardiac surgical data on its public portal.[2] While our own previous reports have shown that shorter periods and smaller numbers can still lead to very effective monitoring, we are nonetheless most gratified to have successfully reached this three year target. We have so far assembled more than 900 patient records for further analysis.

The full three year period covered in this present report, then, provides a widely accepted and secure foundation for broad data analysis while still capturing comparative changes in risk or outcome. We have also focused on outcomes within the calendar rather than the financial year since this brings us in line with other institutions and enables readier cross-comparisons.

After the successful publication of our first report, we were offered the opportunity to contribute data for benchmarking of activity and outcomes in our institution against the UK National Adult Cardiac Database Report published from time to time by the Society of Cardiothoracic Surgeons Database in their Blue Book.[3] We accordingly contributed that portion of our data which matched the time period of their report. This has been independently and remotely extracted from our server and analysed by Dendrite, in conjunction with the experts who run the UK database, and the next Blue Book is now in press. This welcome cooperation has afforded us a fresh opportunity to look at differences between two different populations of patients undergoing cardiac surgery and has allowed us to benchmark our outcomes in terms of mortality and morbidity using the world's most complete national database.

Many of the risk models used for adjusting outcomes are known to exhibit 'drift' in accuracy over time, due primarily to many complex and interrelated factors, including demographic change, the different types of surgery performed, and advances in surgical procedures and treatment regimes. We must thus be aware of these issues when using risk-scoring systems to assess surgical outcomes and ensure they are updated and 'fit for purpose'.

In the Blue Book just referred to, our outcomes have been rigorously benchmarked using the recalibrated logistic EuroSCORE, since this is currently seen as the most stringent test of predictive risk. In the present report, however, we continue to use the original logistic EuroSCORE as our risk model, since this was validated on our first dataset, has been shown to maintain its discriminatory power for our Hong Kong population over the current period, and is still widely accepted internationally (Appendix 2). For those outcomes which involve isolated coronary artery surgery we have continued to use the complex Bayes score from the UK Society as described in our second report (Appendices 3, 4).

Our patient population continues to change in several ways. Patients undergoing coronary artery surgery, for example, are now more likely to have had previous interventions, have poorer heart function, are being operated on earlier after myocardial infarctions, and are more likely to have urgent surgery (which brings with it a higher incidence of the administration of pre-operative anti-platelet, anti-coagulant and intravenous anti-anginal drugs). It thus comes as no surprise to find that the risk profiles of these patients has increased for a third consecutive year.

In addition, these changes have had an impact on resources particularly in terms of the usage of blood and blood products over the last twelve months. Despite this, the public can be assured that overall outcomes fully deserve to be classed as excellent.

Amassing three years of data has also allowed us to look at other operative groups in larger numbers and in more detail. For example, we have included patients undergoing aortic or mitral surgery and have demonstrated differences in the inherent pre-operative characteristics of these patients when compared to those described in other international reports. Outcomes in all these groups and areas are again excellent.

Providing and assuring quality care for patients undergoing cardiac surgery involves far more than being able to demonstrate acceptable risk-adjusted mortality, important though this clearly is. A major impact on surviving individual patients is any significant morbidity. We are hence continuing to monitor and report outcomes in this area as well.

Even this is not the end of the matter, since the scope of quality care is becoming greater. The latest trend is towards developing so-called composite quality end-point assessments and "quality bundles" as measures of effective service provision for patients undergoing cardiac surgery. For example, in the case of each patient undergoing coronary artery bypass grafting, we will most probably wish to consider whether the waiting time prior to surgery was acceptable, and also ask the following questions:

- Was the operation undertaken without delay or cancellation?
- During surgery, was the left internal mammary artery used as a bypass graft (in order to provide a better long term outcome).
- Was the procedure successful in terms of survival and avoidance of significant complications or amount of blood transfusion?
- Was the patient discharged within a reasonable time period and allowed home on the necessary required medication for his/her condition?
- How satisfied was each patient and were all patients given a proper opportunity to state and describe their level of satisfaction?

Only when satisfactory answers can consistently and reliably be given to **all** such questions can a service truly merit the overall ascription to it of assured quality and continued excellence. It must also be noted that a minor failure in just one area can well undermine hard-won and marked successes in others.

These are intriguing and important areas. Now that our data collection is more advanced and covers the requisite period, we can confidently address some of them. We will consider still further areas next year, always closely tracking the developments in the quality agenda which is being led internationally in large part by our cardiothoracic surgical colleagues in the UK.

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1. Division of Cardiothoracic Surgery

The Division of Cardiothoracic Surgery of the Chinese University of Hong Kong (CUHK) is based at the Prince of Wales Hospital (PWH). This is an acute regional hospital as well as the teaching hospital associated with CUHK. It is situated in Sha Tin in the New Territories and hosts the Regional Trauma Centre as well as other acute surgical specialties. The Division of Cardiothoracic Surgery provides complete services within the specialty for a population of 3–4 million people, excluding paediatric cardiac surgery, cardiac transplantation and esophageal surgery.

Within the Division of Cardiothoracic Surgery there are 30 designated beds in wards 4c and 4 a and b (Level 4, PWH). Ward 4c provides exclusive use of four high dependency beds and 12 ward beds for cardiac surgery. The Intensive Care Unit (ICU) provides 25 intensive care beds and is located on Level 3, adjacent to the operating suite. Two beds in the ICU are for the exclusive use of cardiac surgery patients for three days per week. To maintain our level of activity, however, close cooperation with colleagues in intensive care is needed to allow flexibility in this arrangement and we are fortunate to have developed this. Cardiac surgical patients are looked after by accredited intensivists while on ICU, with surgical input where appropriate.

Patients transferred from the ICU to the high dependency unit (HDU) are cared for by the cardiac surgical team with input from other support specialties when requested. We have one dedicated theatre (Theatre 11) solely for the purpose of cardiac surgery, and this is currently funded for use on three days each week. A pre-operative cardiac assessment clinic is currently held on alternate weeks. There has been no change in these facilities, which were first described in our report three years ago, although we are anticipating an increase in both facilities and resources when the new hospital building, anticipated for completion in late 2010, comes on stream.

2. Outcome reporting

As noted in the introduction, the outcomes presented in this report have once again been benchmarked against the national cardiac surgical database report from the United Kingdom (UK) (United Kingdom Cardiac Surgical Register, UKCSR).[3] We recognize that the populations treated may be inherently different but interestingly the pre-operative risk profiles are very similar. The UK publication remains one of the most authoritative and comprehensive documentations of national cardiac surgical practice available anywhere in the world and forms the gold standard for comparison. It has recently been updated and is also therefore the most current resource for information and analysis of international cardiac surgical activity.

In our report we have used our own risk adjusted data and reported observed versus expected outcomes. We have focused on cumulative three year activity but when there have been noticeable changes in profiles or trends over time we have looked at these on an annual basis.

3. Overall Cardiac Surgical Activity

During the last twelve months of activity, 312 patients had cardiac surgical procedures in our institution and we now have accumulated 931 patients in our database, a tight match with resources planned to deal with an anticipated annual workload of approximately 300 cases.

Figure 1 shows the relevant percentages of each operation by type over the three year period. Patients with descending aortic disease treated by endovascular stenting have been excluded from analysis.

Compared to the UK, we perform fewer isolated coronary artery bypass procedures and more isolated valve surgery. There have also been changes in our local population over time as shown in Figure 2

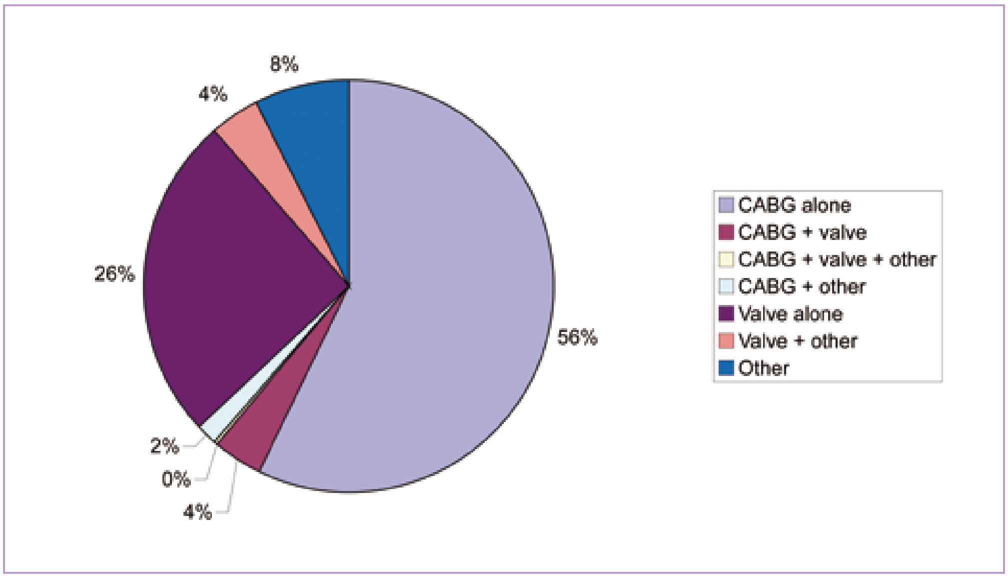
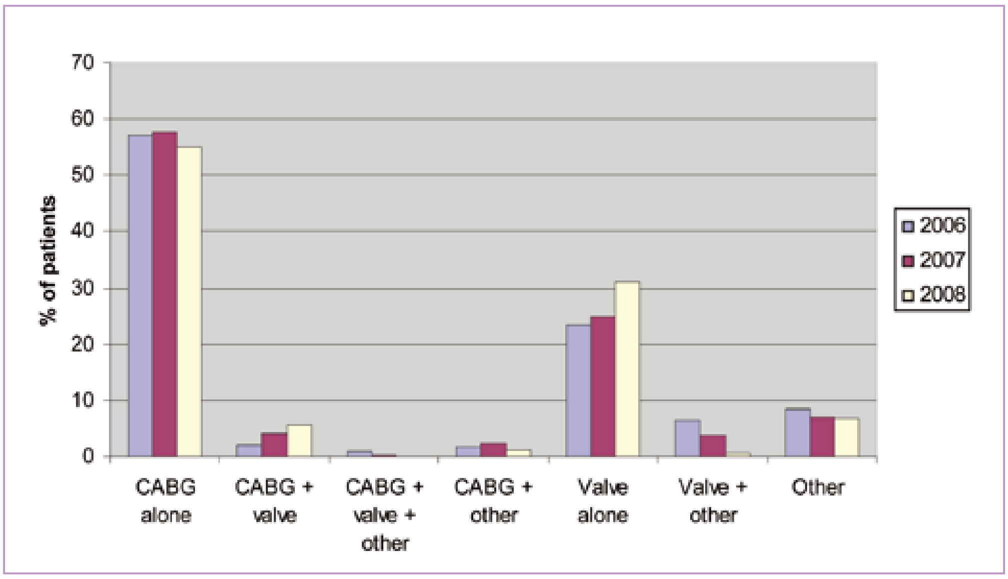


Figure 1. Case Distribution 2006–2008

Figure 2. Changes in Case Mix Over Time



with slight increases in the number of patients undergoing combined coronary and valvular surgery. This is mainly due to increasingly elderly cohorts who need aortic valve surgery and have concomitant coronary artery disease.

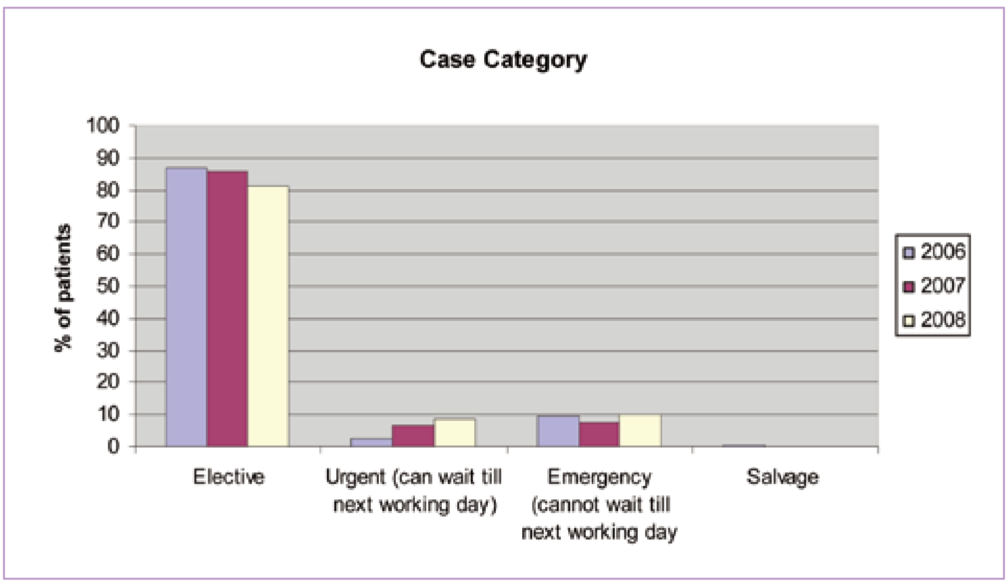
There has been a reduction over time in the number of patients undergoing elective surgery and an increase in the number of patients requiring urgent operations. After a slight fall last year, our cohort of patients requiring emergency surgery has remained static (Figure 3).

All case mortality (defined as death during the same hospital admission) for the three year period was 1.9% for all surgical activity (18 deaths) and 0.9% for isolated coronary artery bypass surgery (CABG) (5 deaths). There were no differences in annual crude mortality rates for either group over time. These outcomes compare favourably with non-risk adjusted crude mortality figures from the UK for a comparable period (UKCSR, all cases 3.5%, isolated CABG 1.5%).

In terms of isolated valve operations over the three year period, Figure 4 shows the distribution of procedures performed. A significant number of patients (n=75) underwent double valve replacement, usually for rheumatic disease. Figure 5 shows the nature of the valve pathologies we saw in the group of patients requiring valvular surgery.

Other cardiac procedures performed included atrial septal defect repair (11 patients), removal of atrial myxoma (seven patients), pericardiectomy (three patients), left ventricular aneurysm repair (seven patients), and a group of patients requiring closure of acquired ventricular septal defects (n=14). We have had one death in the

Figure 3. Urgency of surgery



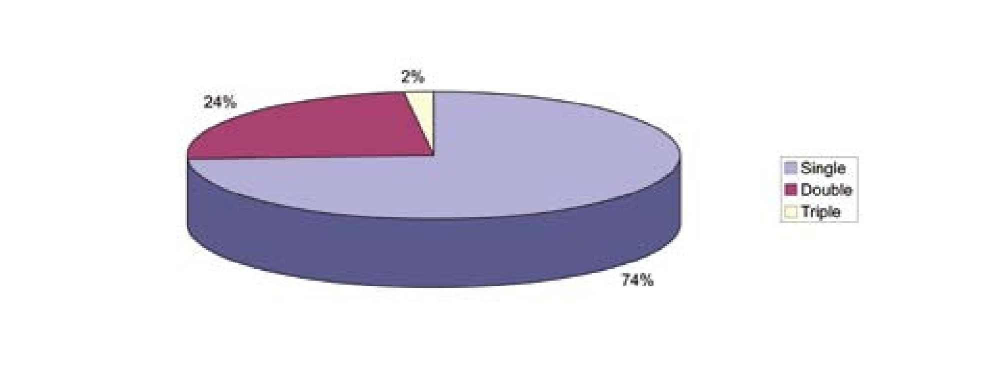
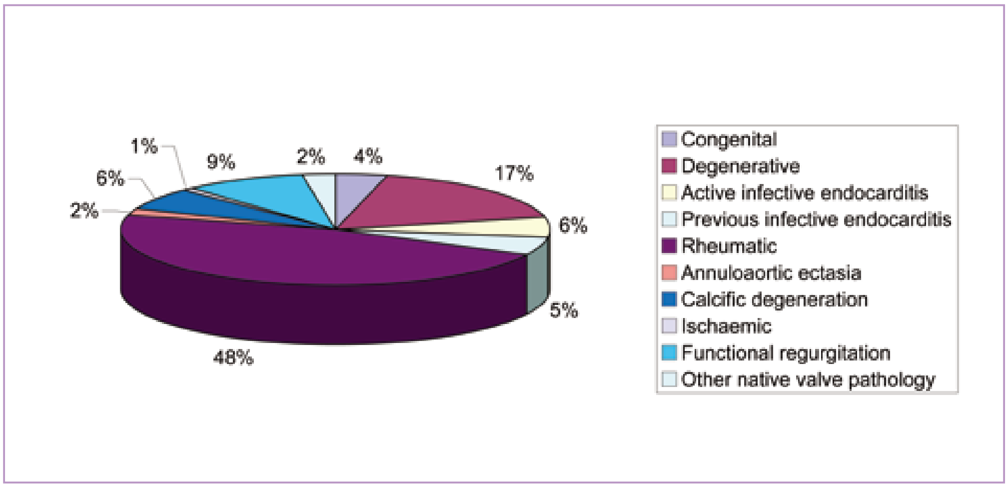


Figure 4. Valvular Procedures

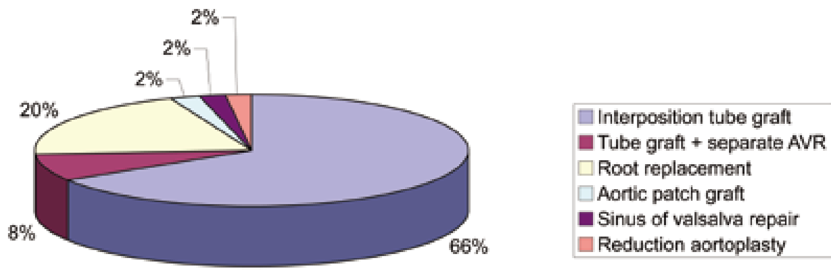
Figure 5. Pathology of Valvular Cases



latter group (crude mortality 7.1%). As stated in the last report, these numbers are far too small to allow us to offer any sustained comment, but we do wish to note that the reported UK mortality for this universally catastrophic condition is close on 35%. However limited our success with such very sick patients may be, it still remains gratifying.

A total of 21 patients underwent re-operative cardiac surgery (four patients had a third cardiac operation—2.6% of the total workload) but these numbers show a five fold increase in the last two years. This, as we have mentioned before, is commensurate with the history of our unit, which has been performing open heart surgery for nearly 10 years now, the period during which re-operation becomes required with increasing frequency.

Figure 6. Aortic Surgery: procedures



Activity for surgery of the ascending aorta +/– aortic arch has remained relatively static over time. Fifty-five cases in total have been performed with five deaths (9% UKCSR 12.9%). 67% of these cases were emergencies for acute Type A aortic dissection and four were re-operative surgeries.

Figure 6 shows the operative procedures carried out. With a preponderance of cases involving acute Type A dissection, the commonest procedure was interposition tube graft replacement of the ascending aorta with valve leaflet preservation. Root replacements were performed using composite grafts with coronary artery button re-implantation. This distribution of procedures is very similar to that found in the UK data. In 37 cases overall, circulatory arrest was used to perform reconstruction of the aortic arch +/– hemi-arch replacement. Mean arrest time was 27 minutes (range 15–44).

Stroke is a particular risk in this group of patients and in our cohort we had one transient neurological deficit and two permanent strokes (3.6%).

4. Waiting times for cardiac surgery and referral patterns

The average waiting time has remained approximately four months

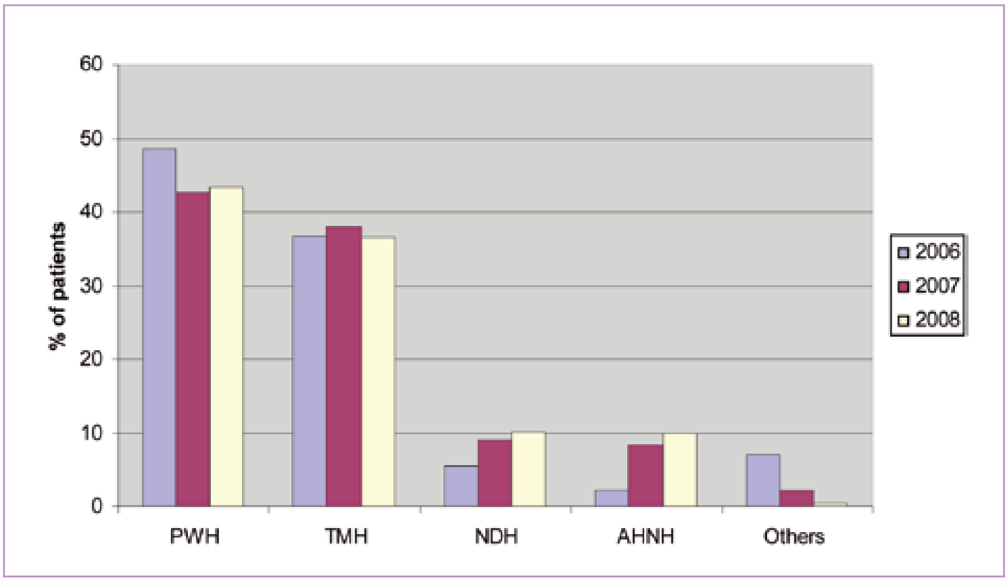


Figure 7. Referral Centre Trends

Abbreviations: PWH (Prince of Wales Hospital), TMH (Tuen Mun Hospital), NDH (North District Hospital), AHNH (Alice Ho Miu Ling Nethersole Hospital).

for elective cases during the last year. Figure 7 shows the centres we provide a service for and their contribution to our workload. There was no change in the pattern of referral over the three year period. We will continue to monitor waiting times, however, as the increase in patient risk profile and number of urgent cases may well impact on throughput in the future.

5. Patient demographics

Sixty nine percent (69%) of patients were male, 31% female. Mean patient age was 61 years (range 19–83). This has been reasonably consistent over the three year period with a slight increase in the number of patients over the age of 75 and a slight reduction in the number of patients in the age range 70 to 75.

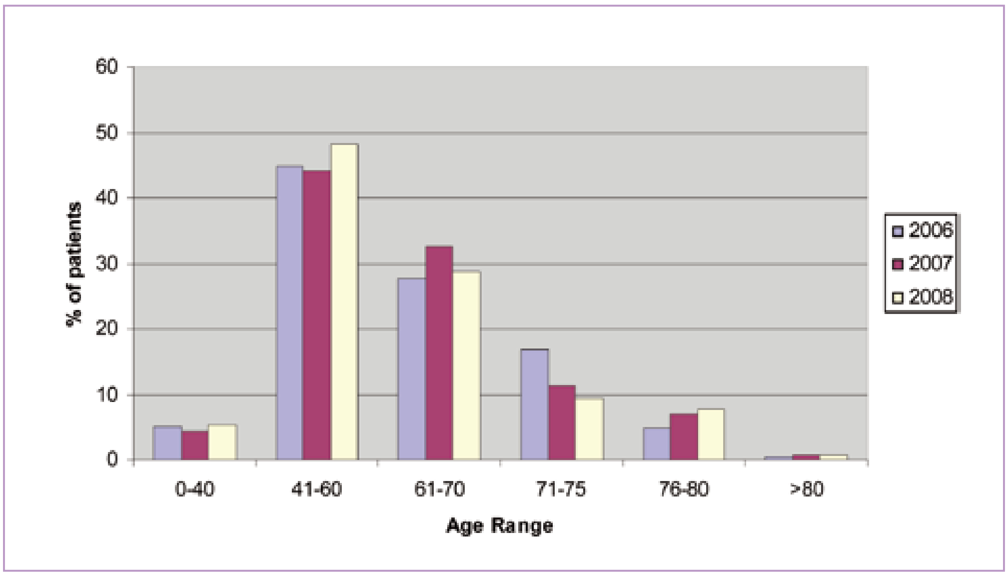
In our last report we mentioned that in Hong Kong recorded ages may not always reflect the true ages of all patients. Many of them may actually be chronologically older than stated on their official record. This remains an important consideration because advancing age has a major influence on operative risk and forms an important component of many of the published risk stratification models. The recorded age range of our patients is shown in Figure 8 and tends to be younger than that seen in the UK.

6. Risk stratification and presentation of outcomes

Introduction

A detailed discussion of risk stratification and outcome analysis can be found in our last report and also the first UK Society Blue Book.[3] As already noted, we have continued to use the logistic EuroSCORE as our risk model for overall surgical activity.[4] We do this, however, in full recognition that there may well be a drift in its accuracy. We have thus also presented some outcomes which have used the recalibrated EuroSCORE (based upon the UK population) as a rigorous and stringent benchmark. As in our previous reports, we have used a variety of graphical means to depict outcomes, each of which has its own merits.

Figure 8. Age Distribution



Risk stratification: application to PWH data

Risk profiling

Before presenting mortality as a risk adjusted outcome, it is useful to have some idea of the spread of patients within the variously designated risk groups. Last year, we compared the overall risk profile of our patient population as estimated using the additive EuroSCORE[4] with that reported by a top cardiac centre in the UK (United Bristol Hospital Trust)[5] and found that despite case mix differences, overall risk profiles were very similar. For the comparison over the last three years we used the logistic EuroSCORE and found that the mean score for our population had increased from 4.5 to 5.4. We can see in Figure 9 that this reflects a reduction in the number of patients in the lower risk group and an increase in the number of patients scored as very high (>9) risk. There may be many reasons for this but given the change in patient demographics and the increasing complexity of operations performed over time, we believe it remains a true indicator of the increasing risk profile of our patient group. This has indeed been a universal finding in international cardiac surgical practice.

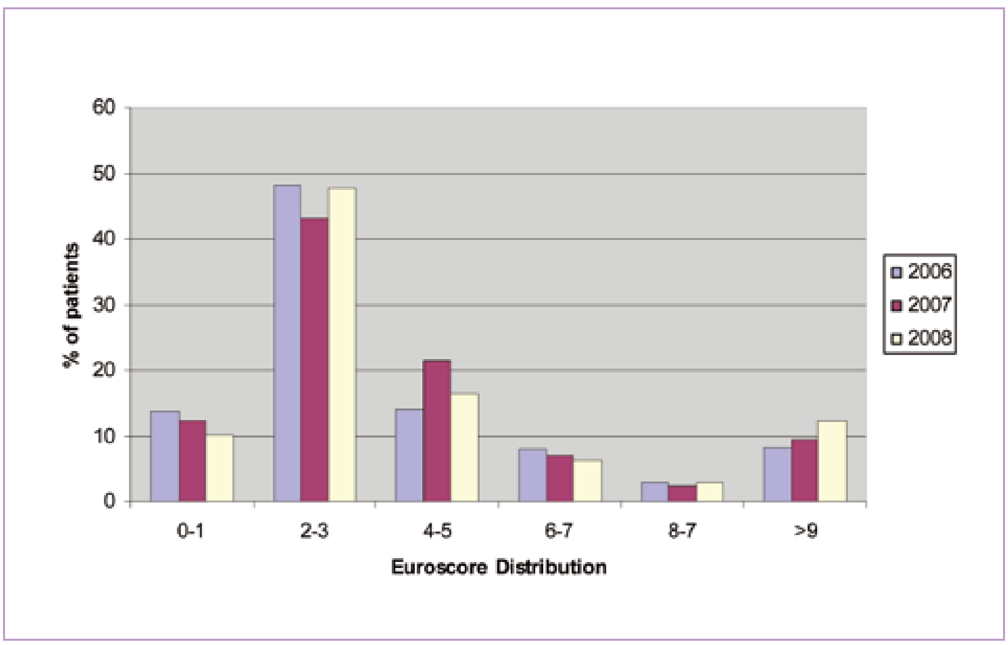


Figure 9. EuroSCORE Distribution

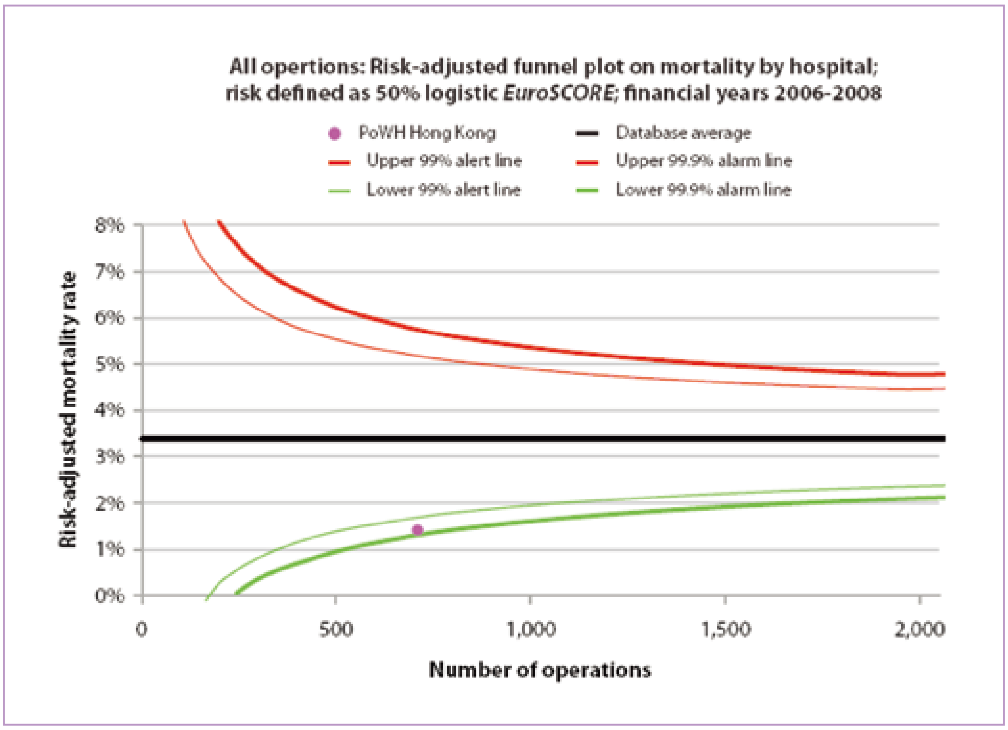
Outcome presentation: mortality

We have chosen to present our overall outcome data (mortality) in a variety of graphical formats. In essence, all these methods demonstrate the same outcomes but in slightly different ways.

1) *Comparative to the UK* Here, funnel plots provide a strong visual indication of any divergent performance or specific cause variation.

For this report, we have used the plot generated independently by the UKSCTS and Dendrite using the recalibrated EuroSCORE to allow us to model the risk (Figure 10). The period during which we extracted data for this comparison does not represent the totality of our three years of work, but is still a good example of how these processes can be used for international comparisons. Figure 11 shows observed versus predicted outcomes for all cases and also for coronary artery bypass surgery and aortic valve replacement. For all of these procedures, the recalibrated EuroSCORE has again been used as the risk model and compared with UK data.

Figure 10. Risk-adjusted Funnel Plot: all case mortality



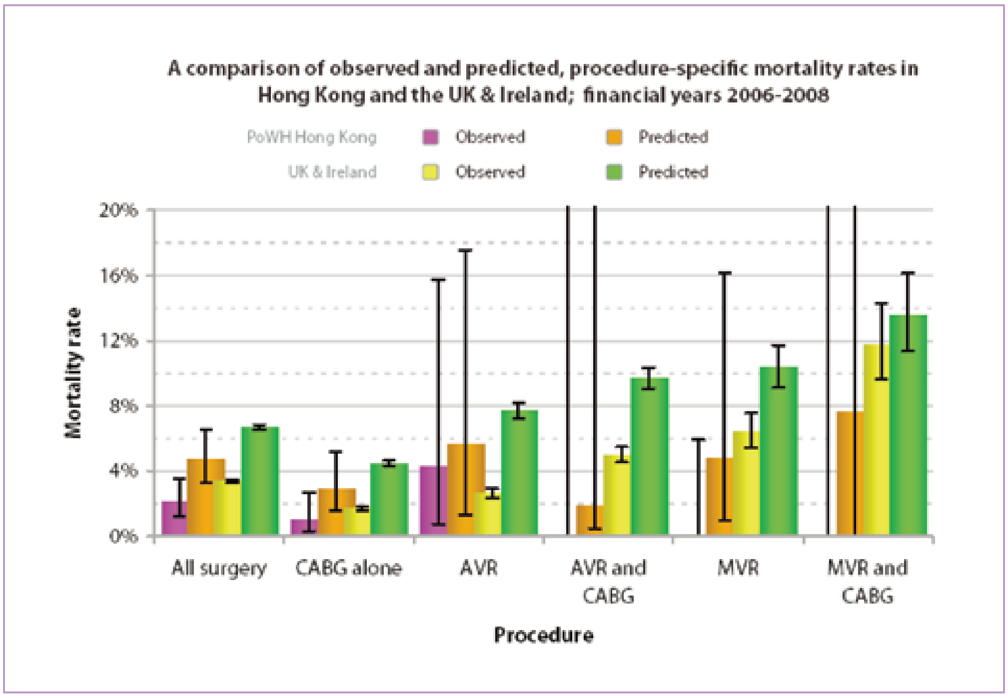


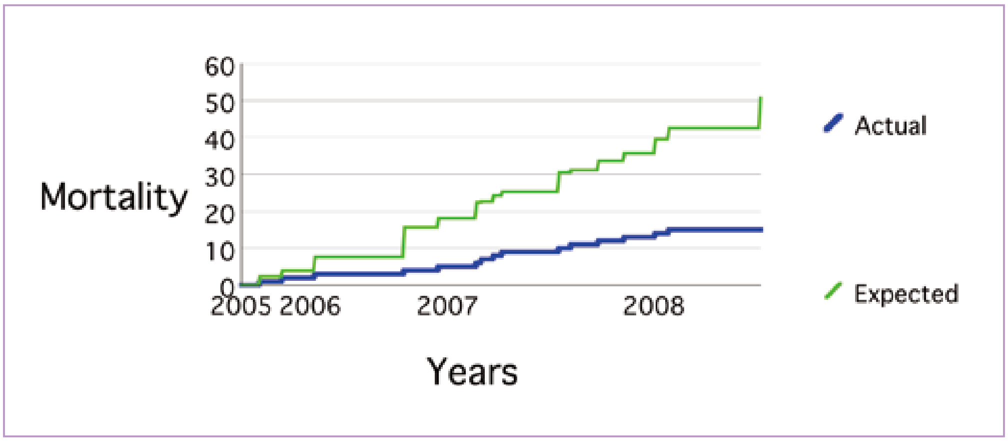
Figure 11. Observed and Predicted Procedure Specific Mortality Rates

2) *As a plot of cumulative events against time (CUSUM chart plot)* To incorporate adjustment for risk a complex statistical analysis uses odds ratios to produce risk adjusted CUSUM charts (RA-CUSUM). This provides a clear graphical depiction of risk adjusted performance over time with comparative observed versus expected outcomes.

Figure 12 shows our RA-CUSUM plot for all cases over the three year period, again using the logistic EuroSCORE as our predictive tool. We should note, however, that given potential changes in the applicability of this risk model, most competent cardiac surgical units reporting data using this tool are actually performing better than predicted.

3) *As presented publicly for UK cardiac surgery by the UK Healthcare Commission*[2] Explained simply, the chosen risk scoring system is used to generate a percentage range of patients who could realistically be expected to survive taking into account their specific risk factors. This is indicated by the '2' in Figure 13. This range can then be plotted along with the observed survival for that patient group, indicated by the '1' in Figure 13. If the observed survival percentage falls anywhere within

Figure 12. Risk-adjusted CUSUM for All Case Mortality



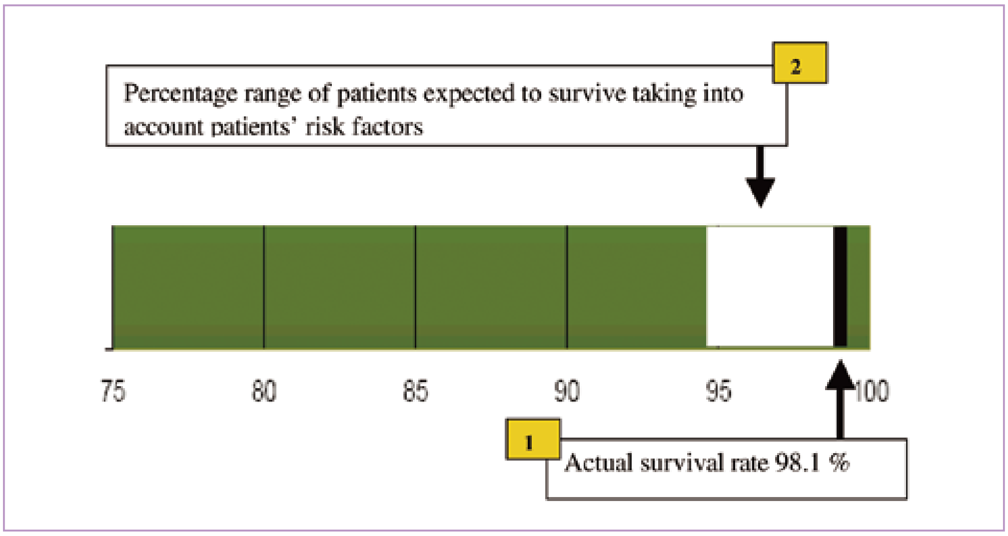


Figure 13. Actual and Expected Survival for All Cases

the expected survival range, we can surmise that this reflects entirely adequate performance with respect to the calculated risk profile of that patient group.

An observed survival percentage that falls to the left of the expected range (towards the 70 mark) would indicate a worse outcome than that predicted by the risk scoring system; an observed survival percentage which falls outside the expected range to the right hand side (towards the 100 mark) would indicate a better than predicted performance.

Figure 13 shows the chart plot for our cumulative three year data for all patient groups. With a similar observed mortality and only small changes in expected outcomes, it is visually very like the plot shown in last year's report.

It is reassuring that our performance is currently better than expected when modelling risk for our local patient population and that it is comparable to international standards set in the UK using recalibrated scoring systems.

Outcome presentation: morbidity

As well as the presentation of outcomes in the form of mortality, it is important to recognize that a outcome which would generally be classed as poor includes not only death but also a variety of events which may lead to significant morbidity and be detrimental to the patient. Since iIt is difficult to collect data on every single possible complication, a number of typical cardiac surgery outcomes are used as broad markers of morbidity.

These are: re-operation for haemorrhage, permanent stroke, need for new dialysis post-operatively, need for post-operative intra aortic balloon support (IABP) (CABG only), and early re-operation for mediastinitis. We have used the UK comparative data from a sample patient population as shown in Table 1 for re-operation for haemorrhage, stroke and dialysis. Table 2 shows we have indicated the crude percentage occurrence for all morbidities during the full three year period of our activity.

All crude figures fall well within expected and reported international standards.

7. Blood transfusion, re-operation and blood loss

As with our last report, we have chosen the areas of re-operation for bleeding, blood transfusion and blood loss for detailed investigation

Table 1. Actual survival and expected survival range for PWH

Operation group	Re-operation for bleeding: PoWH HK	Re-operation for bleeding: UK & I	New post-operative stroke: PoWH HK	New post-operative stroke: UK & I	New post-operative HF / dialysis: PoWH HK	New post-operative HF / dialysis: UK & I
CABG alone	1.5 402	3.3 56,057	1.0 396	1.1 57,632	0.3 400	2.6 56,683
AVR alone	0.0 47	5.5 9,683	2.1 47	1.7 10,234	0.0 47	3.1 9,970
AVR & CABG	0.0 8	6.9 7,101	0.0 8	2.7 7,405	0.0 8	5.8 7,187
MV repair alone	0.0 9	3.8 1,905	0.0 9	1.3 1,942	0.0 9	2.1 1,866
MVR repair & CABG	33.3 3	6.0 1,141	0.0 2	2.5 1,190	0.0 3	9.0 1,135
MVR alone	4.2 48	5.3 1,786	0.0 46	2.8 1,875	0.0 49	6.5 1,827
MVR & CABG	0.0 5	8.5 692	20.0 5	3.7 721	0.0 5	12.2 711
All	**1.9** 700	**4.7** 94,636	**1.5** 688	**1.7** 97,170	**0.4** 690	**3.9** 95,153

Table 2. Morbidities Over Three Years Crude Percentages

	PWH	UKCSR
Re-operation	1.8%	5.5%
Stroke	0.5%	3.5%
Dialysis	0.6%	No Data
Mediastinitis	0.5%	No Data
IABP	3.0%	1.4%

since they represent important areas of potential morbidity for individual patients. Another reason is that re-operation rates for bleeding can potentially be used as quality indicators and we can easily compare our outcomes in graphical form as a CUSUM chart, with comparative indices taken as fixed values from international data. For example, Figure 14 shows the CUSUM chart for re-operation for bleeding with the reported UK figure of 5% (estimated) set as the gold standard for comparison.

In the last report we demonstrated a reduction in the number of patients transfused and a reduction in actual blood loss as well as significant

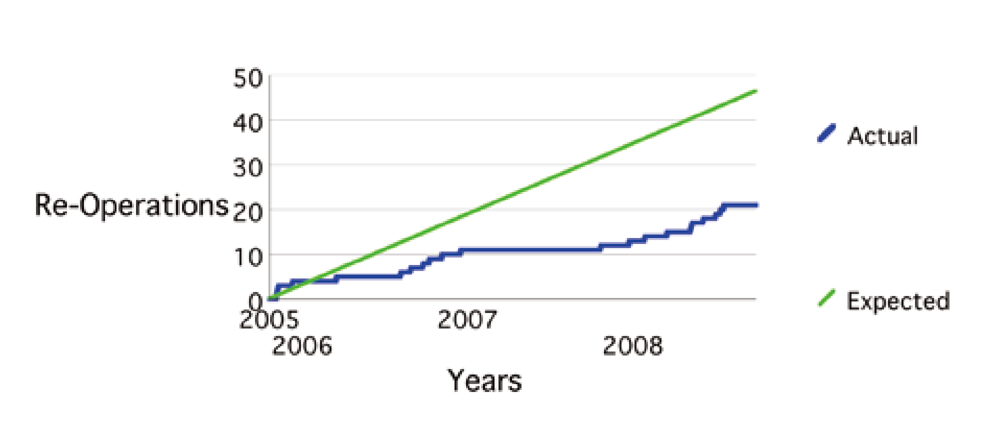


Figure 14. CUSUM chart for Re-operation for Bleeding or Tamponade

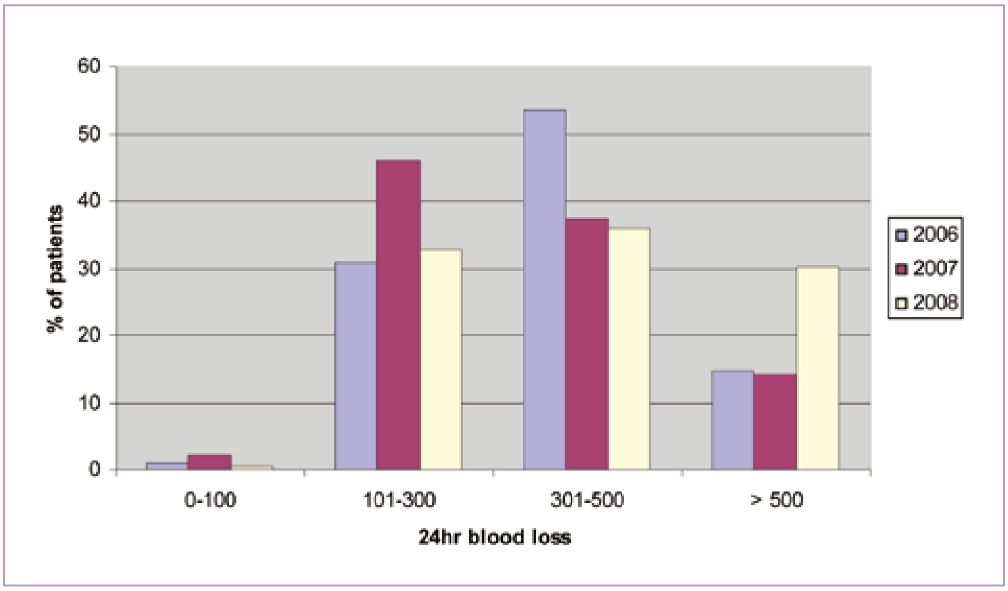
reductions in the use of blood products such as fresh frozen plasma (FFP) and platelets. These were very encouraging changes which we have continued to monitor.

Carrying out more detailed data collection for the last two years has now enabled us to look at not just blood and blood product transfusion in overall terms, but also the point in the patient journey at which the transfusion occurred. The time points we have recorded are transfusion in the operating theatre, in the ICU and back on the cardiac HDU ward.

If we look at actual blood loss, we can see that during the period under review there has been an increase in the number of patients in the higher blood loss range and that the previously seen reductions in blood loss have not been sustained (Figure 15). This can to some extent be explained by a factors such as the increased risk profile of the patient population, the increase in the number of patients presenting for urgent operation while still on anti platelet and anticoagulant drugs, and the increase in re-operative surgery. In recent cases, the withdrawal by the manufacturers of aprotinin (a haemostatic agent)—a drug which was previously used in high risk cases—may also have had an impact.

We have further indirect evidence of the contributory effect of an increasingly complex caseload in that the use of cell salvage techniques during surgery (in which shed blood is processed and returned to the patient) has been introduced in recent years but only for cases thought

Figure 15. Blood Loss



to be at high risk of bleeding such as complex aortic and re-operative surgery (Figure 16). Our re-operation rate for bleeding as shown previously remains well within acceptable limits.

If we look closely at blood transfusion practice over the last two years, we can see that the reduction in red cell transfusion that we reported last year has been sustained in the ICU and on the ward, but there has been an increase in the number of patients receiving a peri-operative transfusion (Figure 17). This again may reflect a changing patient population but is a factor which must now be looked at in more detail in order that these changes can be better understood. Our overall transfusion rate—at just over 40%—is still very much within international norms for all cardiac activity (Figure 18 reproduced with permission).

Our data includes all cardiac surgical activity (including emergency and complex aortic surgery) and still compares favourably to UK units, acknowledged for their stability in this area, that have been reporting similar transfusion rates for the groups of patients undergoing coronary artery surgery and aortic valve surgery only (Figure 18). We have noted, however, a consistent proportion of patients receiving a single unit transfusion. To the extent that this might sometimes represent an inessential transfusion we are in the process of isolating another

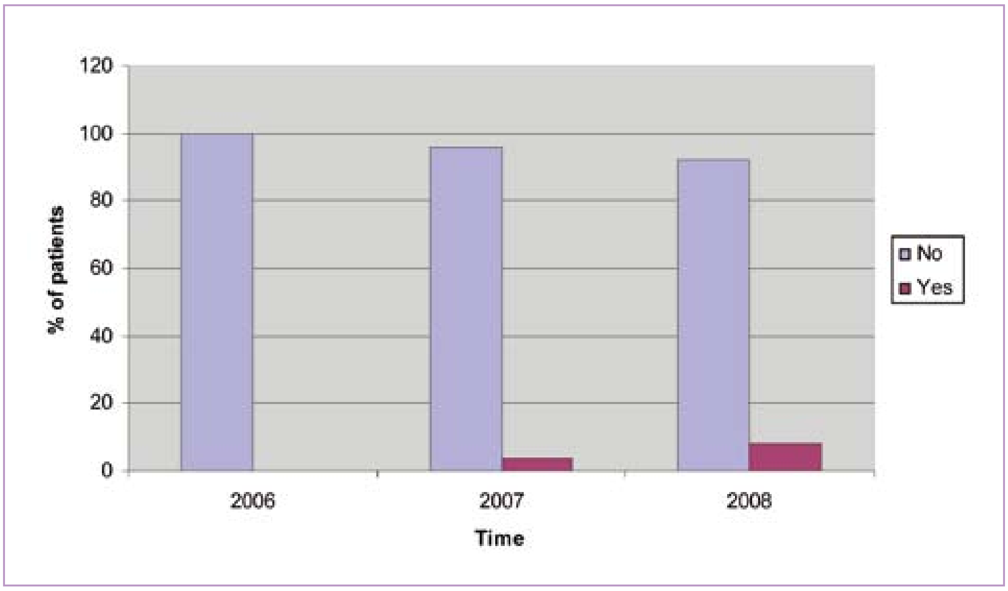


Figure 16. Cell Salvage Useage

Figure 17. Peri-operative Blood Transfuction

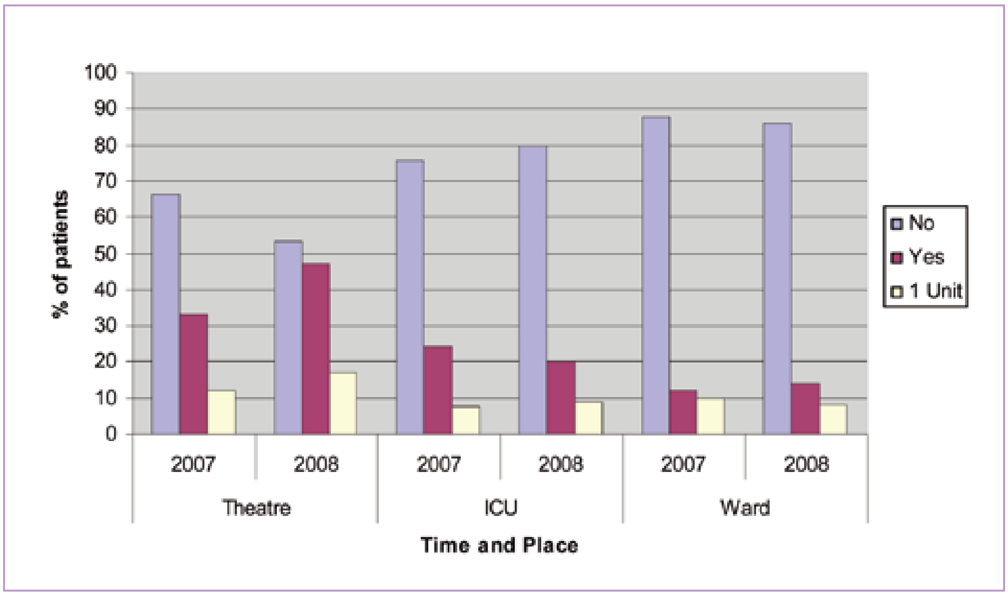
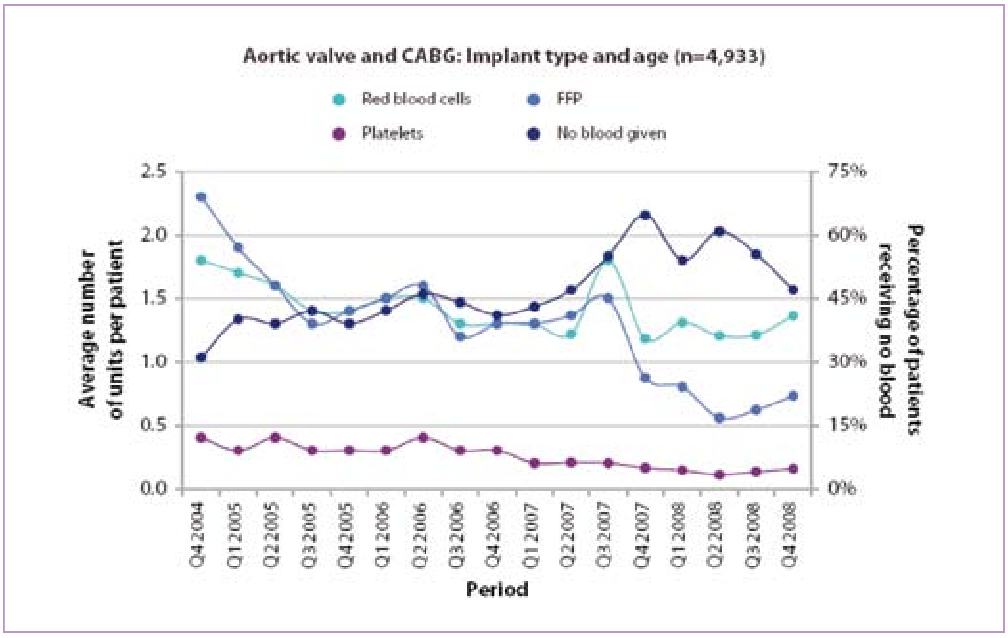


Figure 18. UK Comparison



factor for future more detailed address. Finally, transfusion of blood products such as fresh frozen plasma and platelets has mirrored red cell transfusion practices.

8. Valvular Surgery

We have used our three year data to look at our valvular surgery in more detail (in particular our mitral valve practice) because we note a preponderance of mitral valve disease due to the residual impact of rheumatic valve disease in the region (Figure 19). Rheumatic disease accounted for nearly 60% of mitral interventions as against only 30% in the UK.

Patients undergoing mitral surgery presented in NYHA Class III or IV in 38% of cases. Mitral valve replacement was the commonest intervention for all groups except patients with degenerative and ischemic mitral disease. In this group of 44 patients, 32 underwent valve repair (73%). Associated tricuspid surgery, usually placement of an annuloplasty ring, was performed along with interventions on the mitral valve in 19% of

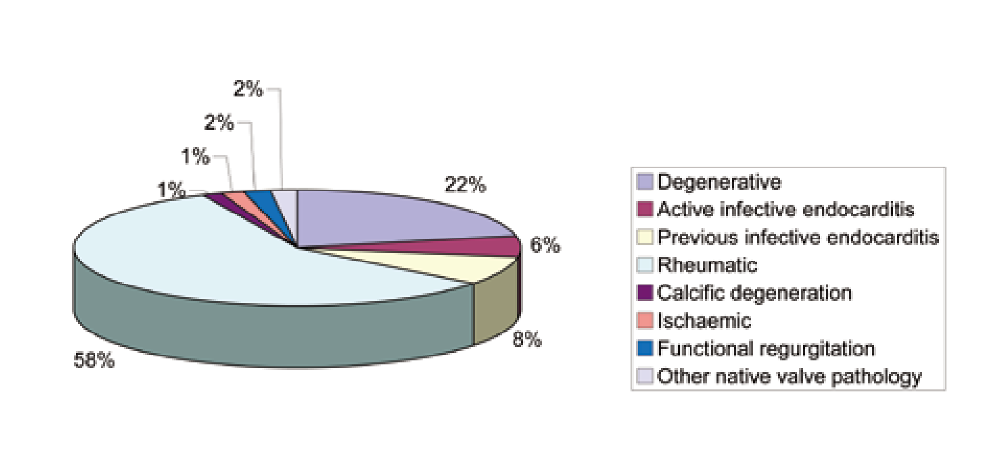


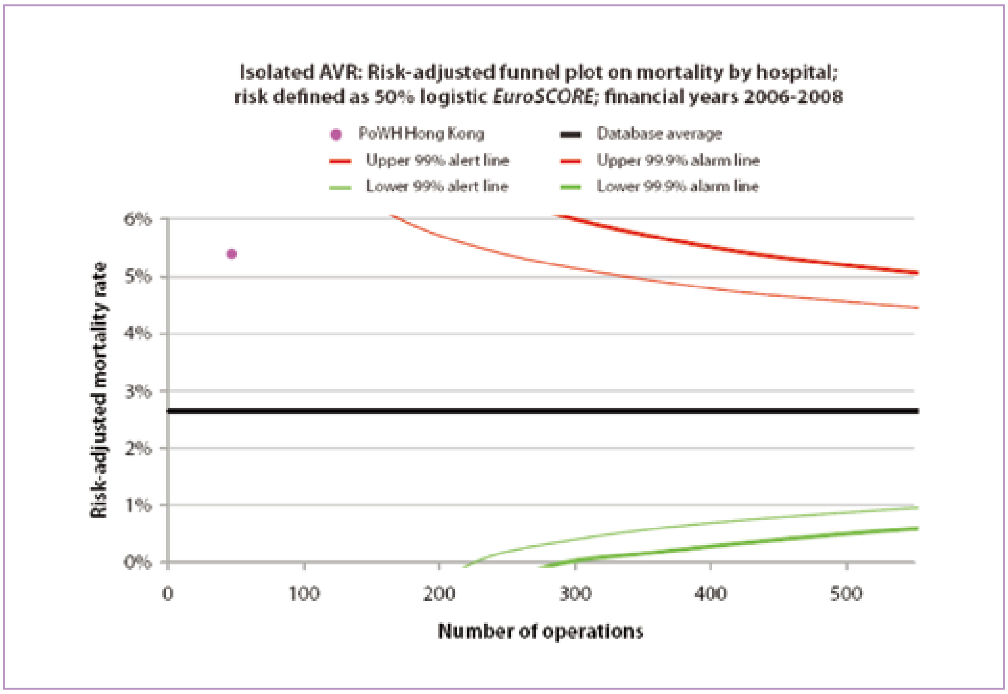
Figure 19. Mitral Valve Pathology

cases (45 patients). In the group of 205 patients who had intervention on the mitral valve (elective, urgent and emergency, with or without concomitant procedures) there was one death (crude mortality 0.5%).

Along with coronary artery bypass grafting, aortic valve replacement has been considered as a marker operation for monitoring outcomes. One hundred and forty-five aortic valve procedures (including associated coronary artery bypass grafting) were performed in our unit with three deaths (2.1%) and a mean logistic EuroSCORE of 7.2 for this patient population. UK mortality was 3.8% for comparative groups. A sample selection of our patient group undergoing aortic valve replacement was extracted to provide a comparative time of activity with the UK. Mortality (observed 4.3%, expected 5.6%) for this period was plotted on a funnel plot using the recalibrated EuroSCORE as the risk model and with the control limits set using current UK data. This is shown in Figure 20. It can be seen that observed mortality is higher than the mean derived from UK data but still well within the control lines. This observation in part reflects the small number of cases analysed for this comparison (n=47).

If we plot current activity and mortality (Figure 21), we can see how over time and with increasing numbers the observed mortality moves towards the expected mean and the control limits tighten as accuracy improves. This plot is included only for the sake of clear exposition as

Figure 20. Funnel Plot for Isolated Aortic Valve Replacement



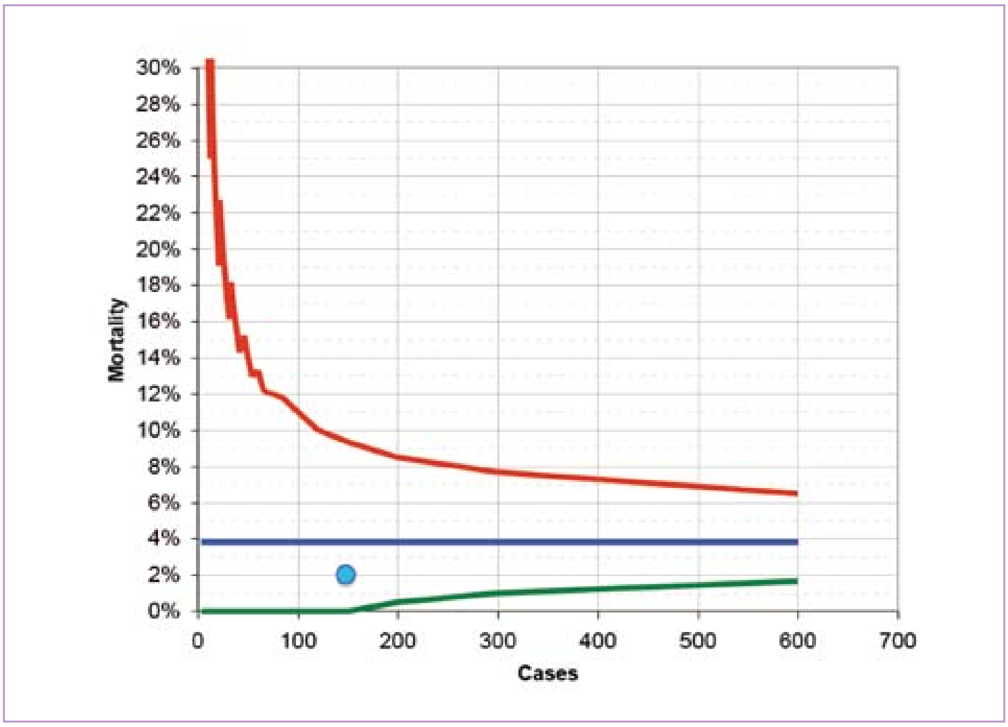


Figure 21. Funnel Plot Showing Cumulative 3 Year Aortic Mortality

it uses UK data based on all valvular surgery from 2004. Nevertheless, it does illustrate usefully, along with Figure 20, some of the advantages and disadvantages of using funnel plots for data monitoring.

We also looked at body mass index (BMI) in our group of patients undergoing valvular surgery and this confirmed our observation that a significant number of patients are classified as underweight (Figure 22). Smaller patients, particularly those having aortic valve replacement, can present particular technical challenges during valve implantation. UK data has shown patients with a BMI of 0–20 to have a mortality almost double that of patients with a higher BMI—crude mortality 5.8%, UKCSR. Our data shows comparable differences, albeit with very small numbers of patients (mortality BMI <20, 3.3%, n=30 patients).

As our patients who undergo valve replacement are comparatively young, we find that a mechanical valve prosthesis is used in the main. As the population gradually ages, particularly among those presenting for replacement of the aortic valve due to age related aortic stenosis, we have by contrast seen an increasing number of biological valves being implanted over time (Figure 23). This is a common international

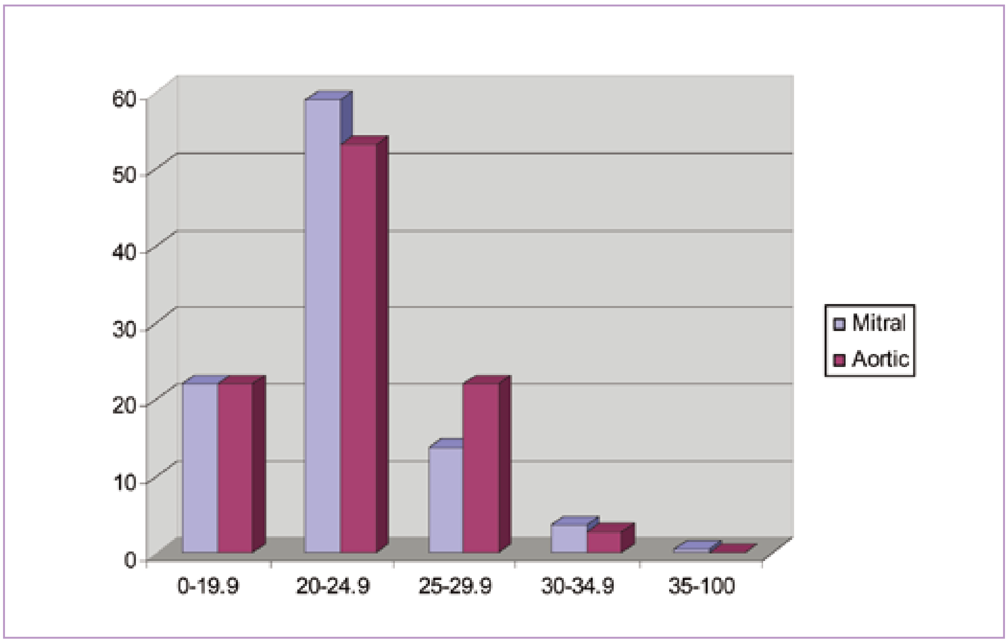
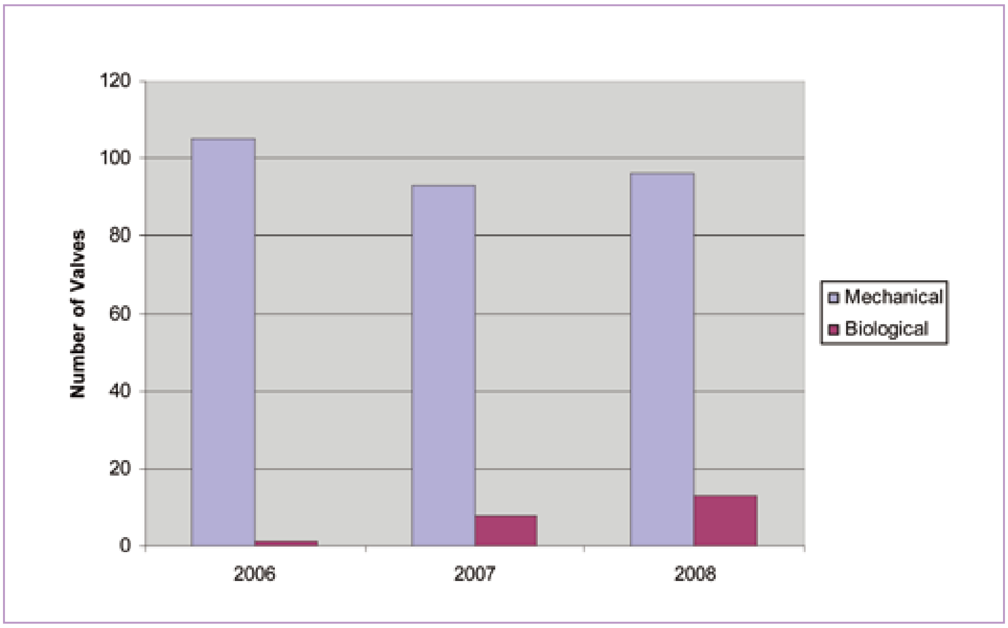


Figure 22. Body Mass Index for Valvular Patients

Figure 23. Trends in Type of Valve Implant



trend and it is also consistent with reports that the improved durability of certain types of biological valve is now leading to their use in younger patients.

9. Coronary Artery Bypass Grafting

As we mentioned previously, the operation of coronary artery bypass grafting has been chosen by the UK Society as the marker operation for outcomes since it has been analyzed in depth. It is commonly and routinely performed and the outcomes are reproducible and well delineated. We have therefore looked at this sub-group of patients in considerable detail.

Patient Demographics

Eighty percent of patients were male. This is comparable to the UK series where women have consistently represented around 20% of the cohort group undergoing coronary artery bypass grafting (UKCSR). Thirty percent of our patient population are over 70 years of age. This is again identical to the UK data, with the proviso mentioned previously

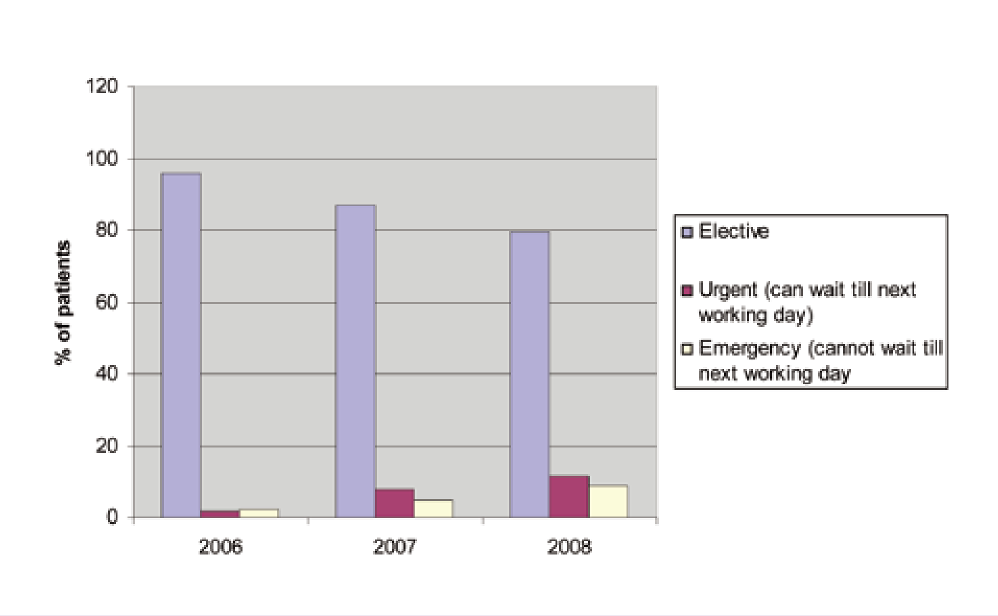


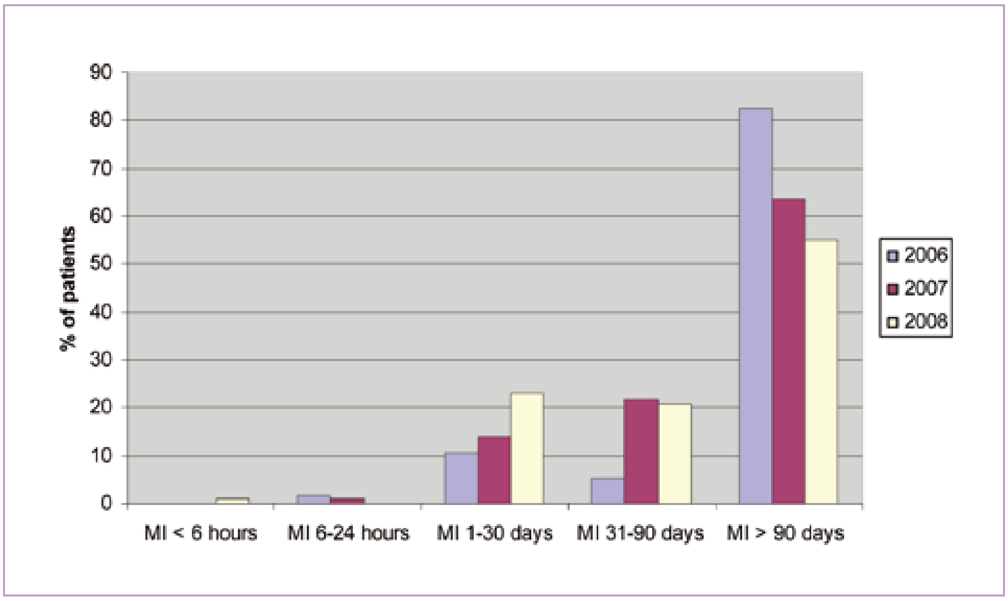
Figure 24. Trend in Urgency of Coronary Surgery

about the difficulties in Hong Kong of determining precise chronological age. This consistent finding, mirrored in the last report, has in fact been sustained over the three year period of data collection.

In terms of pre-operative symptoms, 36% of our patients have class III/IV angina, which is lower than the UK figure. Overall, 13% of our cohort underwent an urgent or emergency operation but we can see from Figure 24 that over time the trend towards non-elective surgery is increasing.

Fifty-two percent of the patients operated on overall had suffered a previous myocardial infarction. This is slightly higher than in the UK, where just over 40% of patients have had previous myocardial infarctions. Eight percent of our patients had suffered two or more myocardial infarctions. In general terms, the sooner after a myocardial infarction patients undergo coronary artery bypass grafting, the higher the potential risk. Figure 25 shows the change in the timing of surgical intervention we have seen over the past three years. There are still very few patients who require surgery within 6–24 hours of myocardial infarction, but we have seen a dramatic increase in the number of patients operated upon within 1–30 and 31–90 days and a dramatic

Figure 25. Timing of Surgery in Relationship to Previous Myocardial Infarction



decrease in the number of patients with myocardial infarction, i.e. >90 days old. This fits with the observation that, as a whole, our population requiring coronary revascularisation seems to be presenting with more severe symptoms and hence requires earlier surgery despite a theoretical increase in risk.

Overall, 17% of our patients had undergone prior percutaneous coronary intervention, and we have seen changes in the incidence of this over time (Figure 26). Hypertension (defined using the EuroSCORE classification) was present in 70% (UKCSR 62%) and the number and type of patients with diabetes is shown in Figure 27. This incidence has remained relatively stable over the last three years (UKCSR 23%).

Stroke is a cause of major post-operative morbidity following CABG and the risk is increased in patients with a history of neurological disease. In terms of pre-operative neurological problems, 8.5% of our patients had had a previous stroke with either a full recovery (5.5%) or a residual neurological deficit (3%) and the incidence of this pre-operative morbidity has remained constant over the three years.

Many patients with severe coronary disease are prescribed protective drugs such as aspirin and clopidigrel. These, however beneficial, can

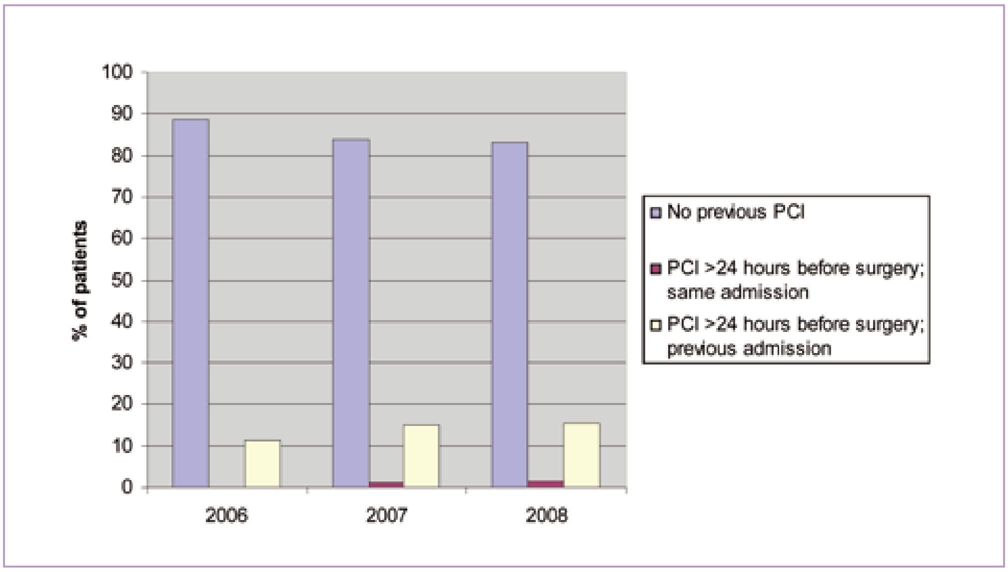
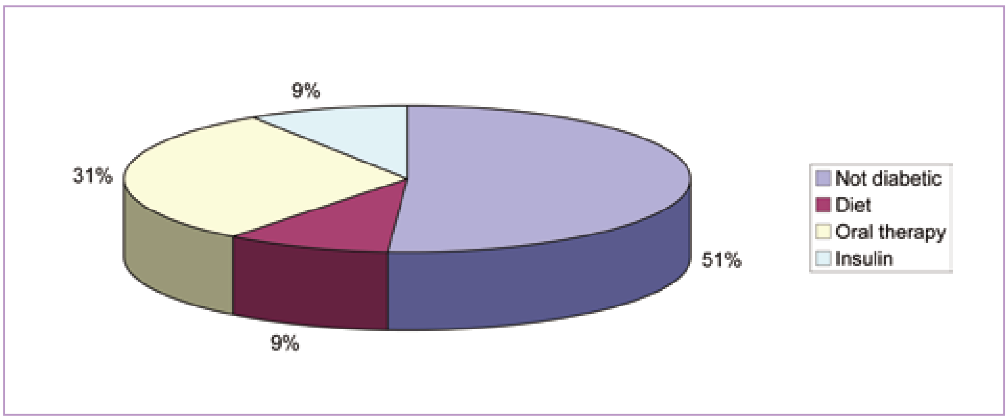


Figure 26. Previous Percutaneous Interventions

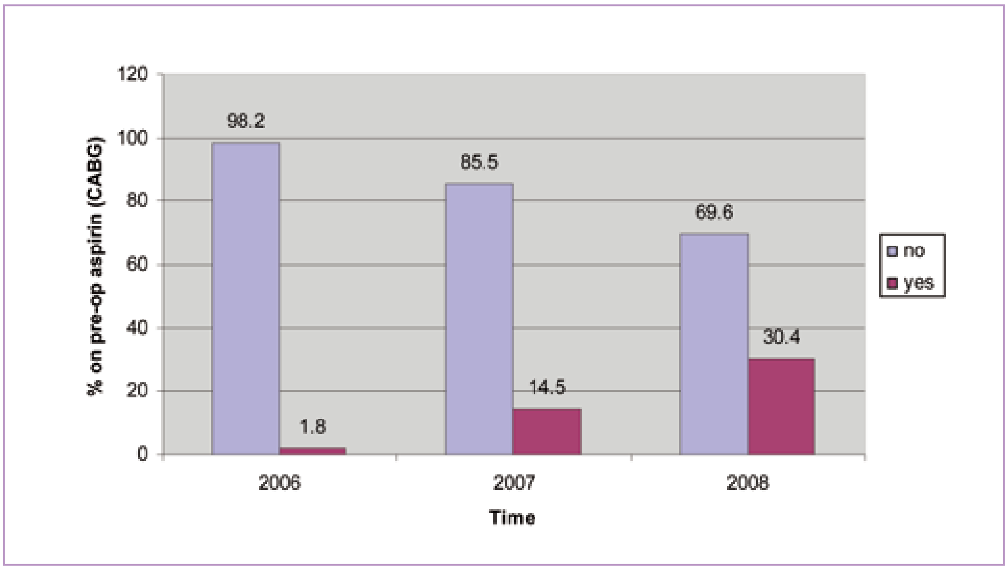
Figure 27. Incidence of Diabetes



cause problems with post-operative bleeding by interfering with the coagulation cascade in patients undergoing surgery. We have noted a dramatic increase in the number of patients operated on over the past three years who have continued to be prescribed aspirin (Figure 28) and clopidigrel (Figure 29).

Ideally, such medications should be stopped prior to surgery, but the trend we have found is that the increasing severity of coronary disease in our patients is leading us to think it unsafe to discontinue them,

Figure 28. Pre-operative Aspirin



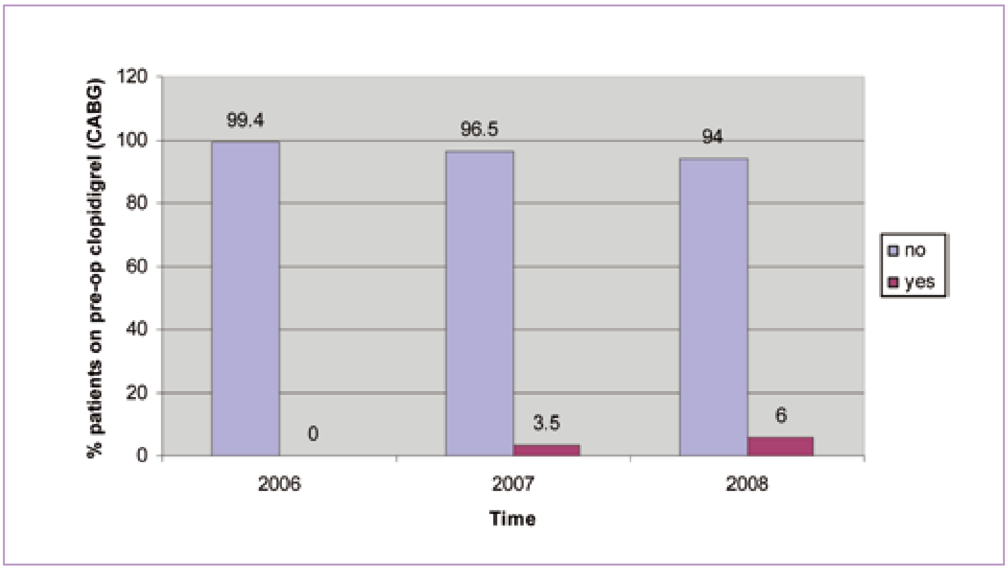


Figure 29. Pre-operative Clopidigrel

despite the additional risks posed during revascularization. We detect an analogous trend in the increasing numbers of patients being treated with intravenous nitrates or heparin who are undergoing surgery either within one week of discontinuation or without any discontinuation (Figure 30).

Coronary disease and heart function

Just over 70% of our cohort had triple vessel coronary disease, a

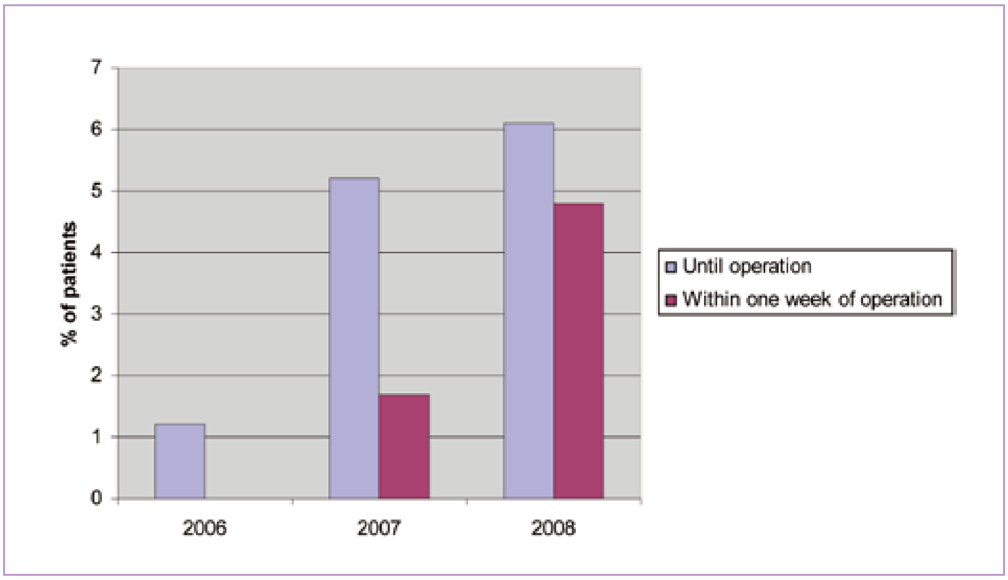


Figure 30. Use of Heparin and Nitrates Pre-operatively

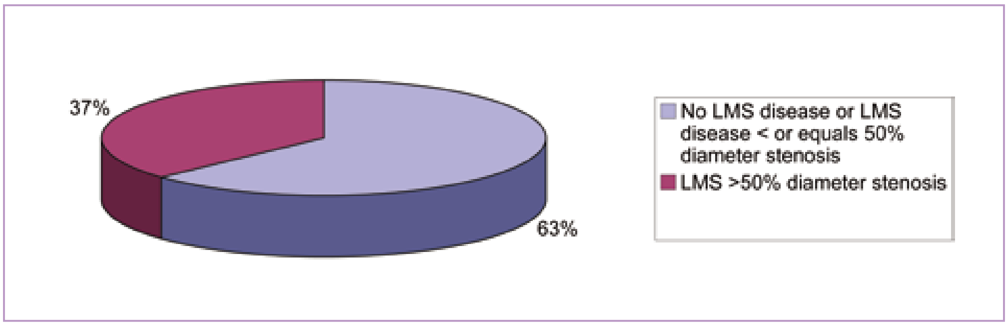
constant finding over the three years with little variation. The incidence of left main stem (LMS) stenosis (37%) shown in Figure 31 is higher than in the UK series (21%).

Heart function (ejection fraction) remains one of the most important predictors of post-operative outcome. Overall, 28% of our patients undergoing CABG had moderate or poor left ventricular function but over time there has been an increase in the number of patients presenting with poor left ventricular function (Figure 32).

Body Mass Index (BMI)

As with our valvular patients, we have looked at pre-operative body mass index in our coronary population. We see fewer patients classified as overweight or obese by international standards but a significant number (6.5% of our population) have a BMI of <20 and are considered underweight (Figure 33). Again, smaller patients may present unique technical challenges in terms of grafting smaller coronary vessels and a smaller conduit diameter of conduit. Underweight patients treated by coronary artery bypass grafting in the UK have a higher mortality (crude mortality 4.1%), double that of other BMI groups. Our numbers in these groups are again small but a similar pattern seems to

Figure 31. Incidence of Left Main Stem Disease



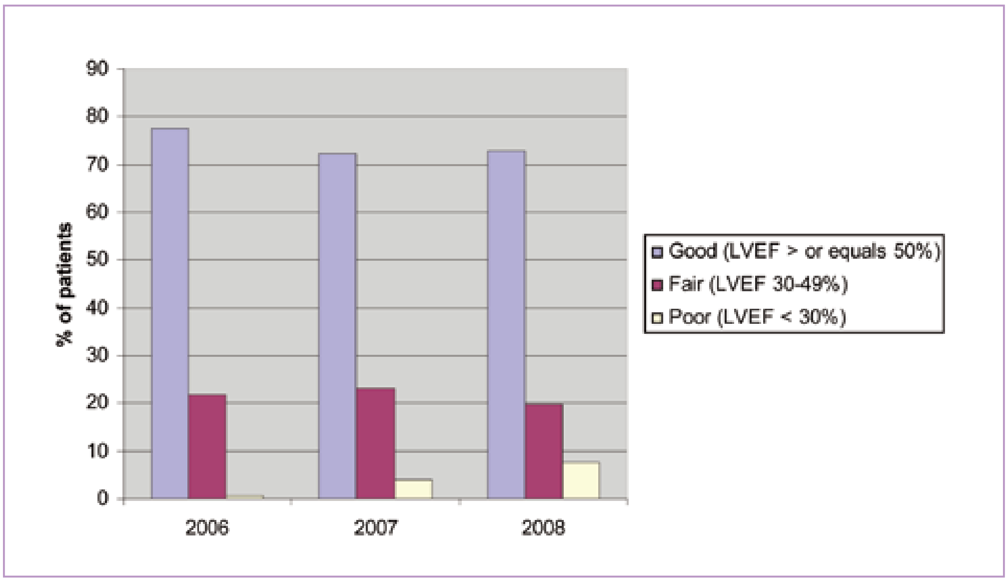
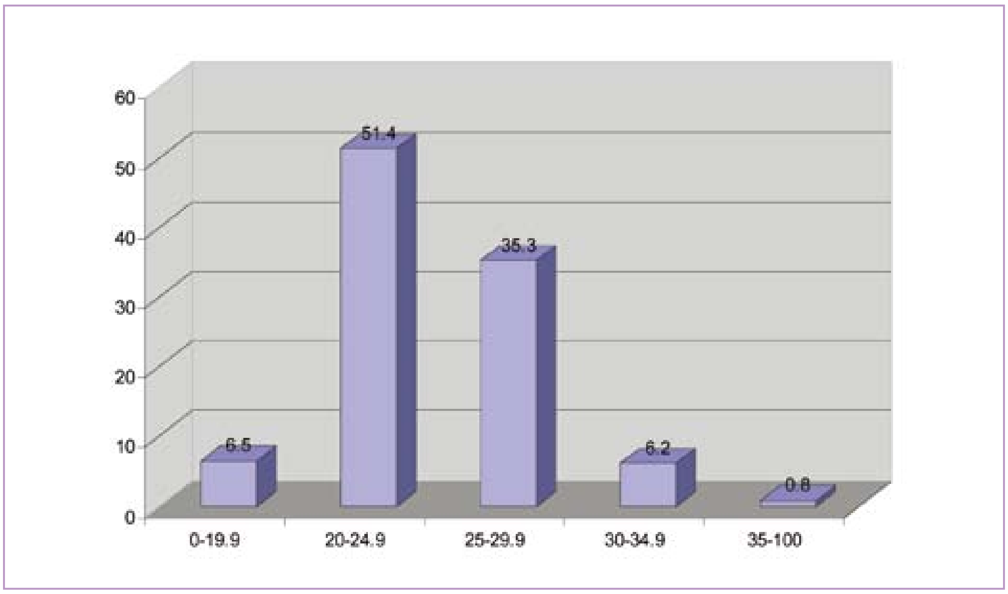


Figure 32. Left Ventricular Function

Figure 33. Body Mass Index for Coronary Patients



be present. Our mortality in patients with BMI <20 was 3.5% (n=28) compared with 0.8% in the rest of the coronary surgery group (n=489).

Conduits for CABG

Ninety-five percent of our patients receive one or more arterial grafts, usually the left internal mammary artery (LIMA) to the left anterior descending artery. This is an important factor in long term outcome and compares well with the UK national figure (UKCSR 94%).

Summary

We have obtained interesting demographic data indicating a change in the patient population referred to us for surgical revascularization. The incidence of comorbidities like diabetes and hypertension has remained static, as has the incidence of left main stem stenosis, but all are still much higher than in other international series. This has been a consistent finding over the three year period.

Patients now referred have more severe symptoms and are more likely to have had previous myocardial infarction; within this cohort the number of patients with two or more infarctions has increased. Due to severe symptoms, we have had to operate on patients sooner after their myocardial infarction than in previous years; they are more likely to have undergone percutaneous intervention or to be receiving treatment with clopidigrel or aspirin and they are also more likely to be operated upon while receiving nitrate or heparin administration. We have noted an increasing proportion of patients with poor left ventricular function. All of these factors will result in an increase in the risk profile of this patient population and each of the relevant indices has steadily increased in proportion over time. This has been reflected in changes in the risk scores using the complex (9-factor) Bayes score (Figure 34). Over time, there have been reductions in the number of patients in the low score (<1 – 2.9) and increases in the proportion of patients with a higher score, particularly in the >9.9 region.

10. CABG Outcomes: Mortality and Bleeding

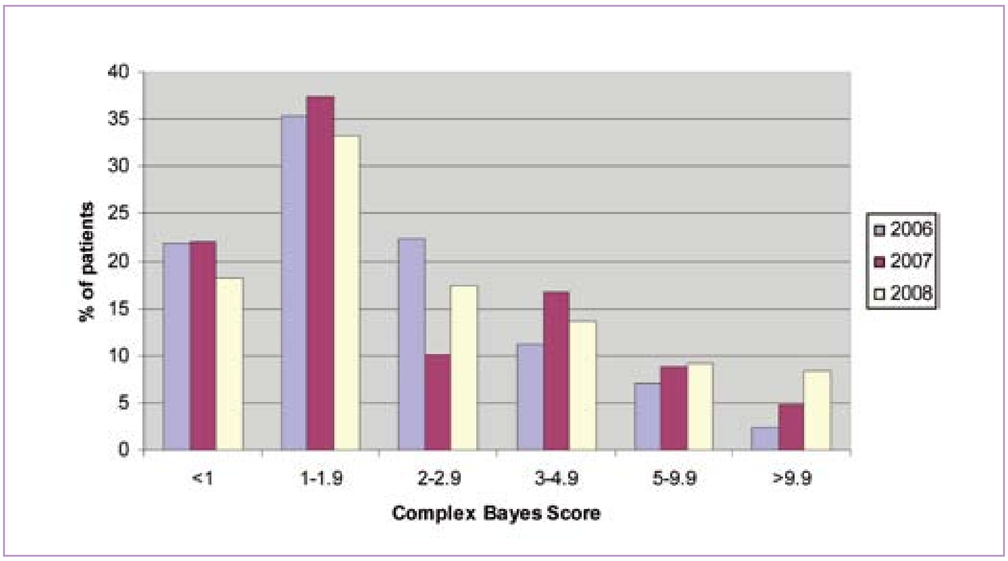
Our overall crude mortality for coronary artery bypass grafting was 0.9%. There has been no significant change over time despite the increasing risk profile. A trend towards increasing risk but reduced mortality has been recognised internationally in this cohort of patients.[1]

In the UK, a complex Bayes score has been demonstrated to be a valid and accurate risk profiling score for the subgroup of patients undergoing coronary artery bypass grafting (Appendix 3) and we have validated the applicability of this scoring system for our CABG population.

Figure 35 shows outcomes in our CABG population for the period of data collection in the format previously described using observed survival and ranges of expected survival. This time the complex Bayes score was used as the risk scoring system and performance again is shown to be entirely acceptable.

We have also looked at our outcomes using a risk adjusted funnel plot with risk defined as 44% logistic EuroSCORE for a sample of 402

Figure 34. Complex Bayes Score Distribution



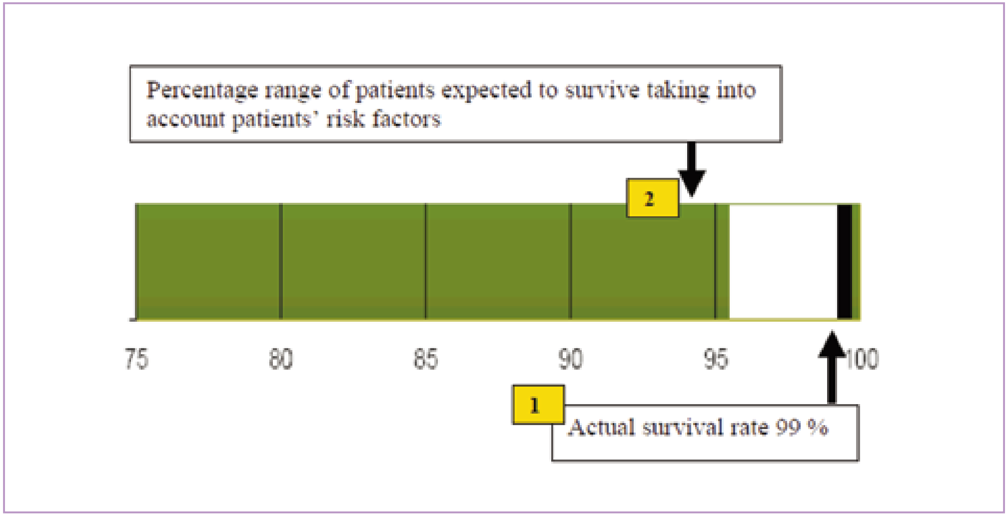
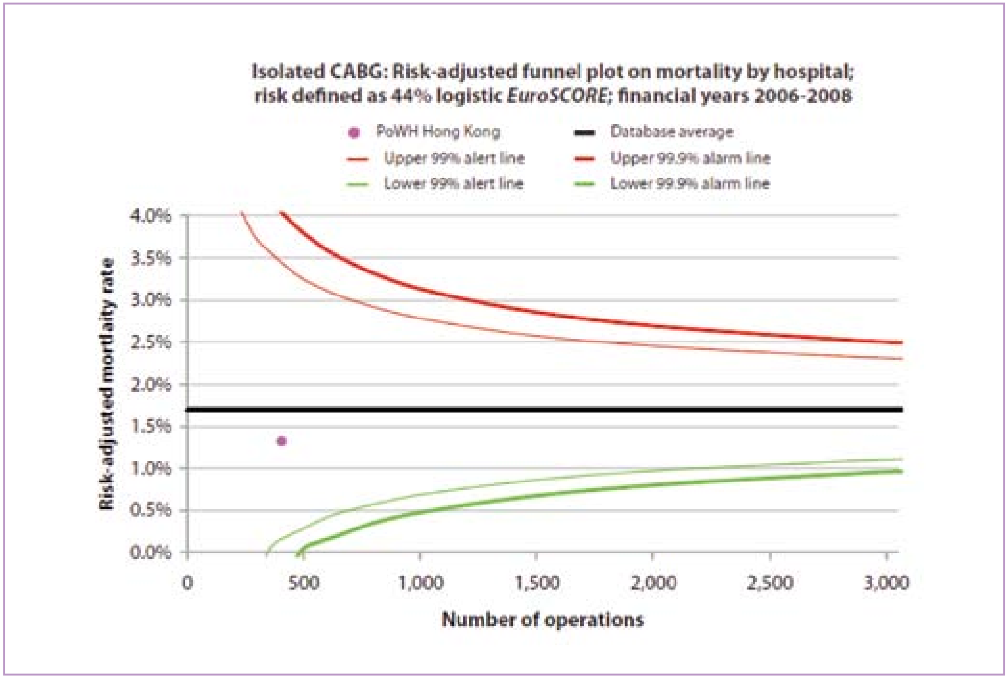


Figure 35. Observed and Expected Outcomes

Figure 36. Funnel Plot for Isolated Coronary Surgery

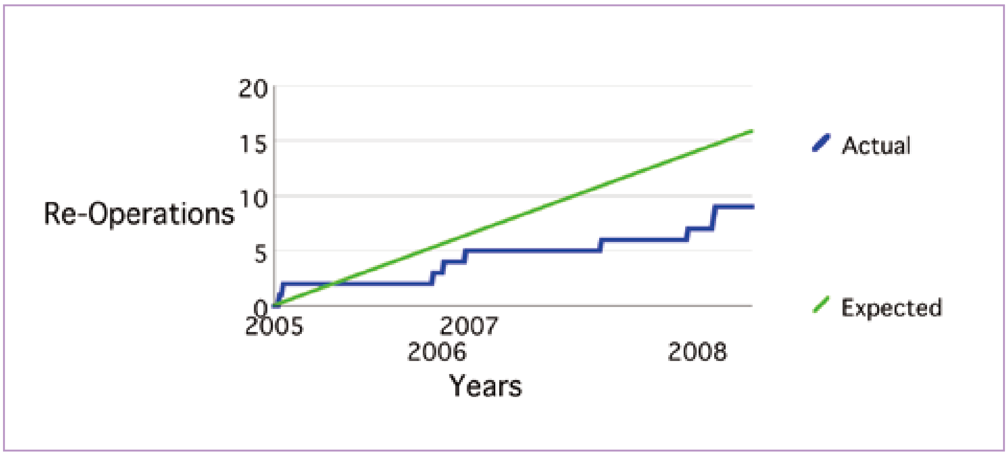


patients undergoing coronary artery bypass grafting alone (recalibrated EuroSCORE) from data extracted and analysed by Dendrite and the UKSCTS. This is shown in Figure 36.

In view of the changing risk profile of our CABG population and the increasing number of patients on drugs which may increase the risk of post-operative bleeding we looked at our blood transfusion and re-operation rates in this subgroup of patients as we did last year but now with a three year period of comparison. Figure 37 shows the CUSUM plot for re-operation using a reported 3% fixed comparator from international (UK) data and despite the increased potential risk we are still performing well.

In terms of blood loss, we have noticed similar trends reported for our overall activity in that we have noted an increase in the number of patients in the higher blood loss group (Figure 38). Despite this, nearly 60% of our patients do not receive a blood transfusion although we

Figure 37. CUSUM Curve for Re-operation for Bleeding or Tamponade



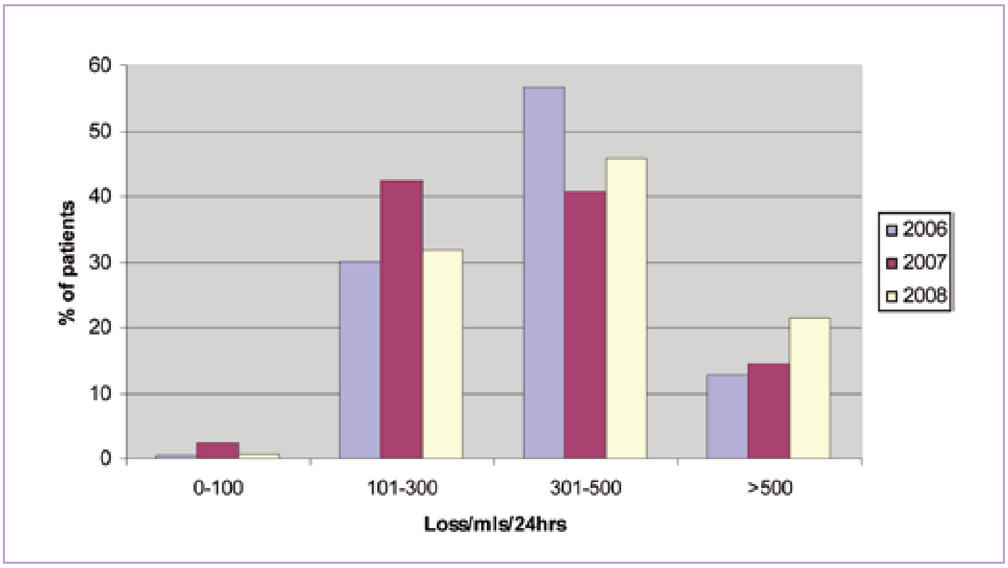


Figure 38. Blood Loss

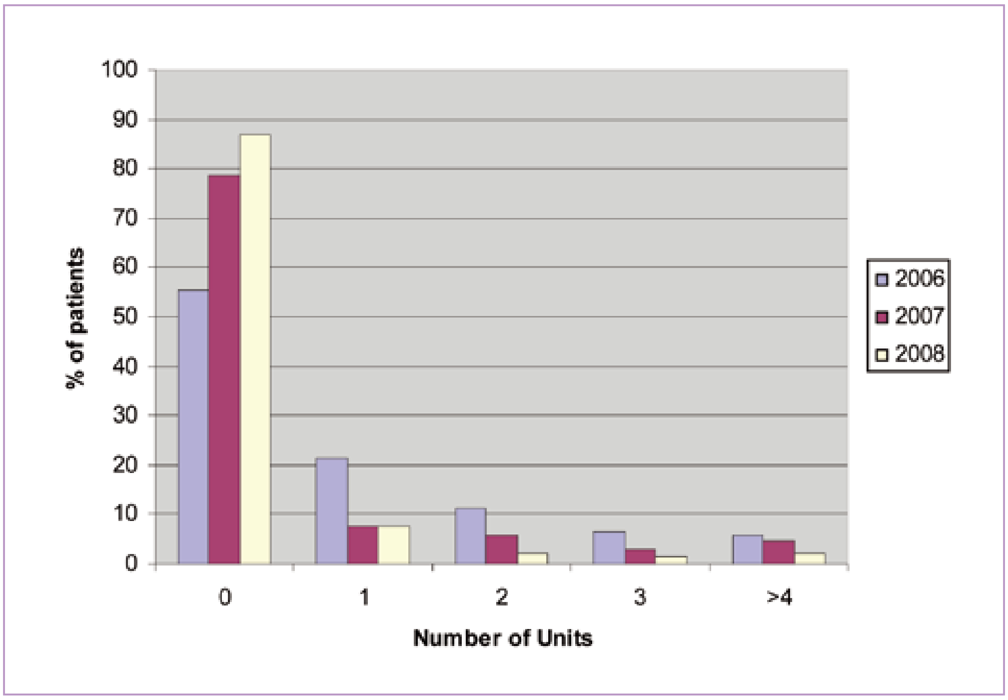
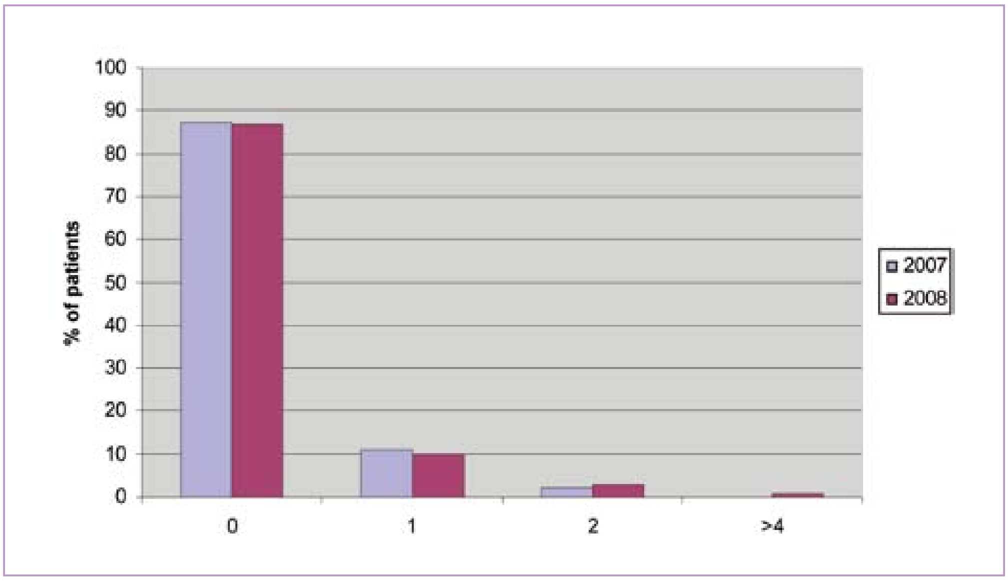


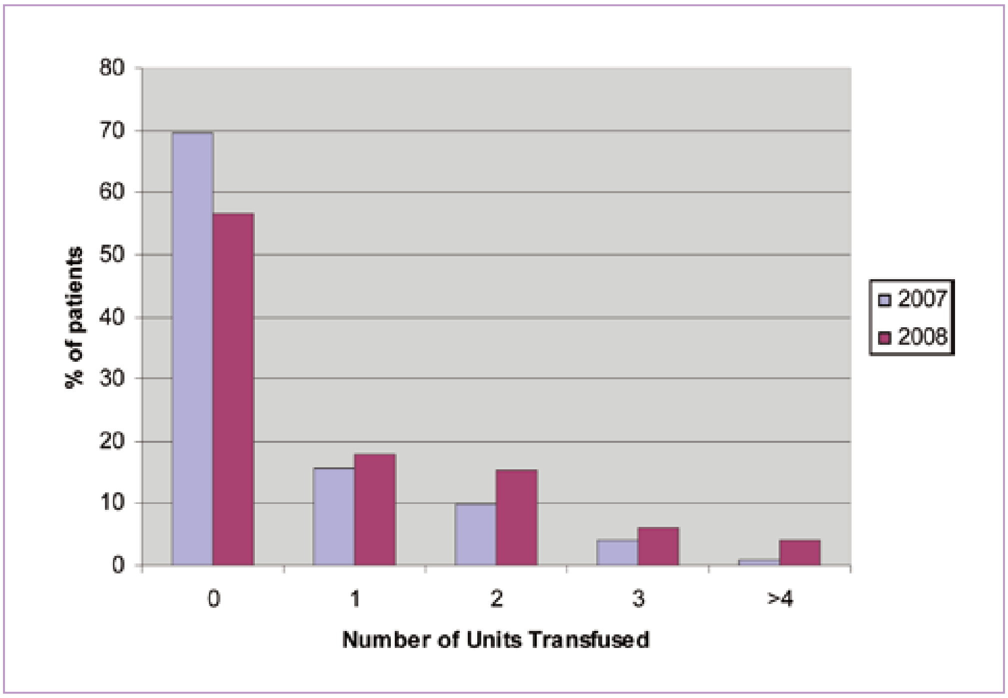
Figure 39. Blood Transfusion in Intensive Care

Figure 40. Blood Transfusion on Ward



have noticed interesting trends over the last two years. The reduction in the number of patients receiving blood in the ICU has continued over time and over 80% of patients leave ICU transfusion free (Figure 39). Blood usage in the ward setting has remained static (Figure 40) but again we have seen a slight increase in patients receiving a

Figure 41. Blood Transfusion in Theatre



perioperative transfusion (Figure 41). The trend in this subgroup of patients is almost certainly responsible for the trend we saw in our overall activity in terms of transfusion practice. Transfusion of blood products again mirrored whole blood usage. This is a complex issue which we will audit formally in future years. Certainly, the changes may be understood in terms of the change in risk profile of this patient group, and in particular the increase in risk factors which may promote bleeding. However, we need to be sure that there are no other contributory factors and to enquire if we can still make improvements in this area despite the changing risk.

In our last report we noted a significant increase in the use of intra-aortic balloon pump (IABP) support for patients undergoing coronary artery surgery and indicated that we would monitor this in the future. Figure 42 shows the use of IABP over the last three years and the timing of insertion. Post-operative use has decreased from last year despite the increasing risk profile of our patient cohort and we will continue to monitor this in future.

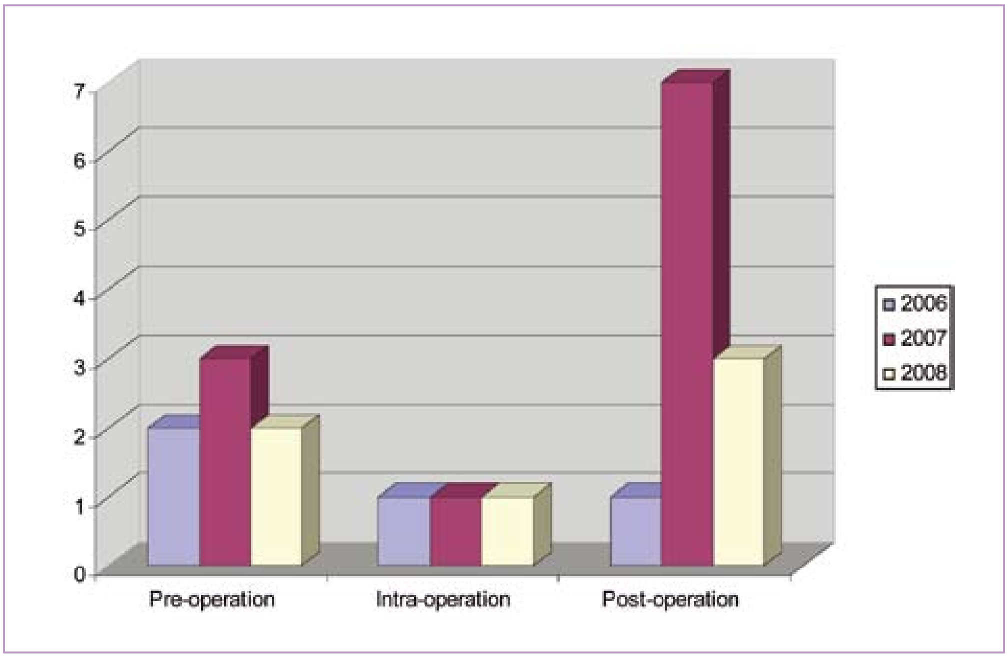


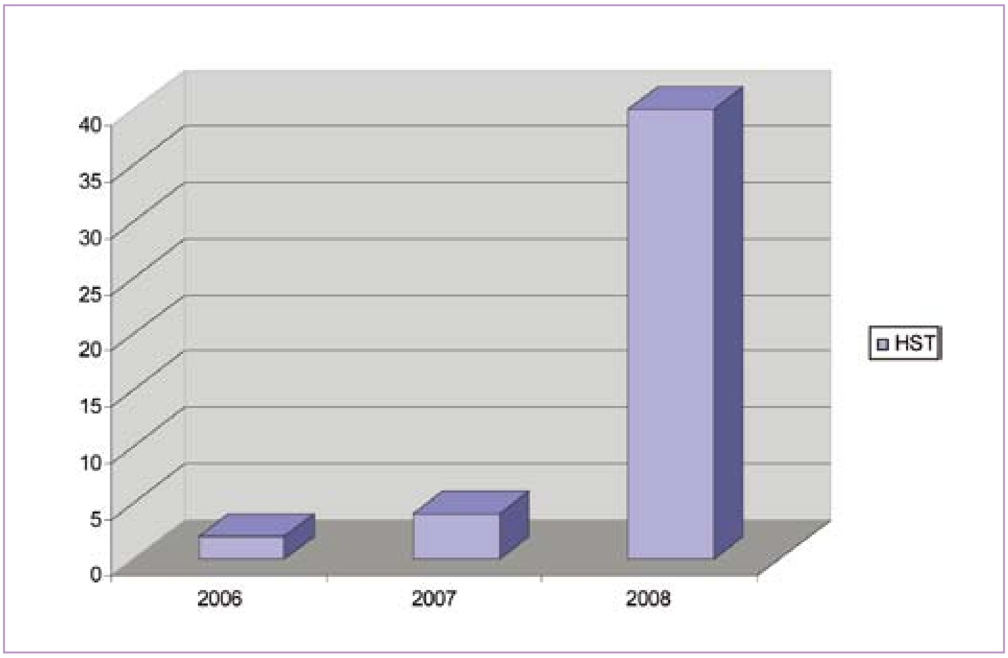
Figure 42. Intra-aortic Balloon Pump Trends

11. Training in Cardiac Surgery

We are a recognised training centre for cardiac surgery, accredited by the Royal College of Surgeons of Edinburgh (UK), which carries out on-site inspections of the programme at three yearly intervals. We view the training of cardiac surgeons of the future as a priority. Training programmes comprise many aspects but one important area is the development of technical skills which will allow independent operative practice in the future. There has been much discussion within the profession of how this may be accomplished while maintaining quality of outcomes. Our philosophy is that if the programme of operative supervision and mentorship is properly structured, it should never compromise patient outcomes.

With this principle in mind, we have also monitored the activity and outcomes associated with the differing groups of individuals who are allowed the privilege of first operator status in our unit. Figure 43 shows

Figure 43. Trainees as Primary Operators



the increase in numbers of cases performed by our higher surgical trainees (HST) as first operators over time. It seems intuitively clear that, as their experience increases, so does the potential for them to act as primary operators given opportunity. Figure 44 shows the case mix of the primary operating surgeons who are at differing stages of their career. As would be anticipated, senior members of the team tend to be primary operators in the more complex cases (denoted as 'other' in this figure) but there is a good distribution of case mix amongst surgical personnel at differing stages of their career pathway. This is also reflected in the number of cases performed according to the predicted pre-operative risk (Figure 45), since there is a preponderance of higher risk cases undertaken by senior staff with lower risk cases being sensibly allocated to trainees early in their career.

It should be recognized however that breaking down case mix by operator in this way is not entirely representative, since we run the unit very much as a team and there are often multiple levels of input depending upon the features of a particular case. Senior people may only take the lead in the pre-operative decision making process or an operating team consisting entirely of senior surgeons may work together

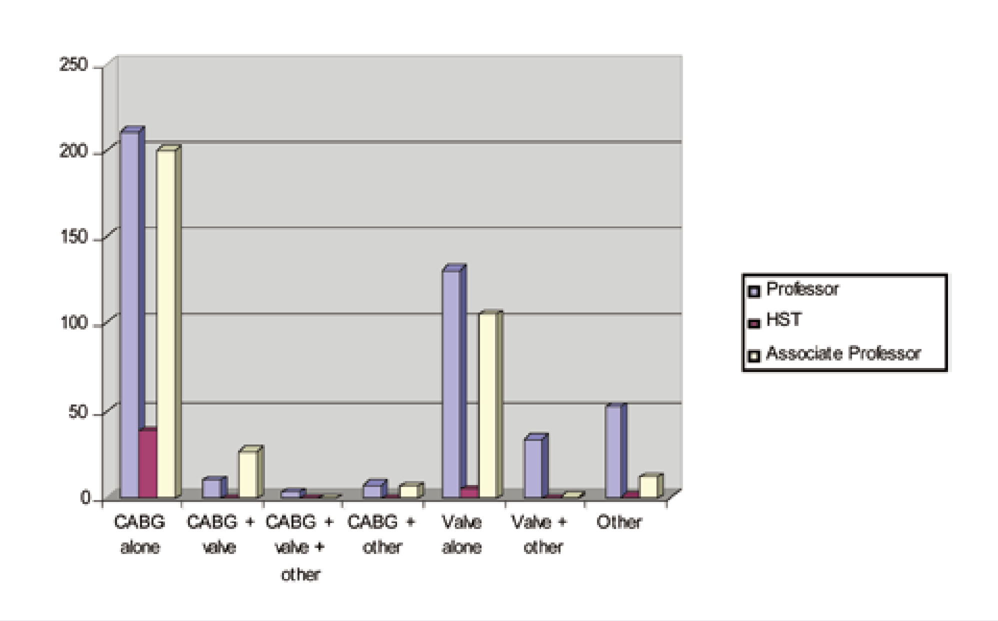


Figure 44. Case Mix by Primary Operator

Figure 45. Distribution of EuroSCORE

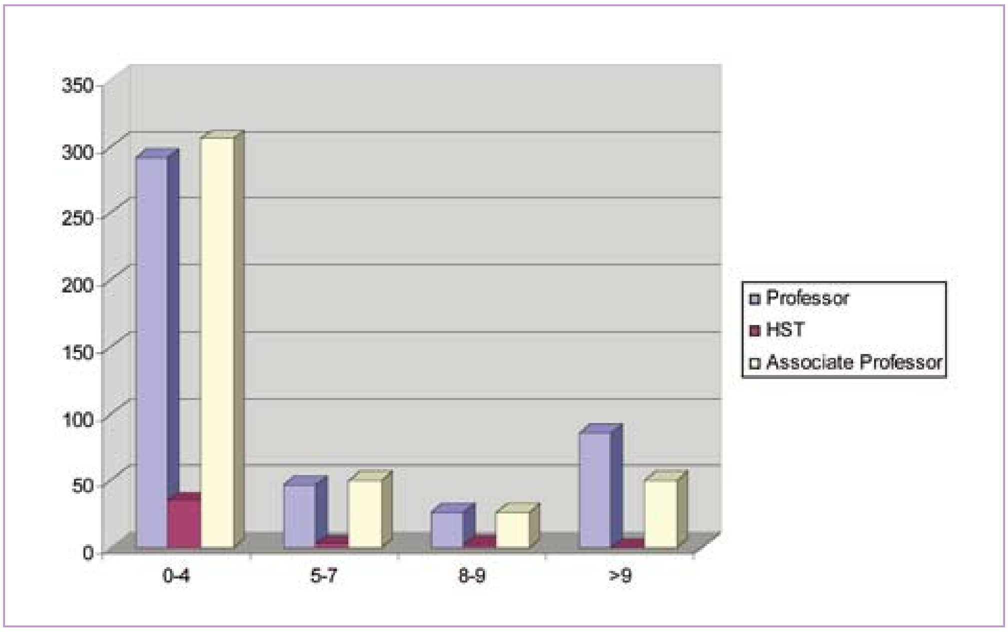
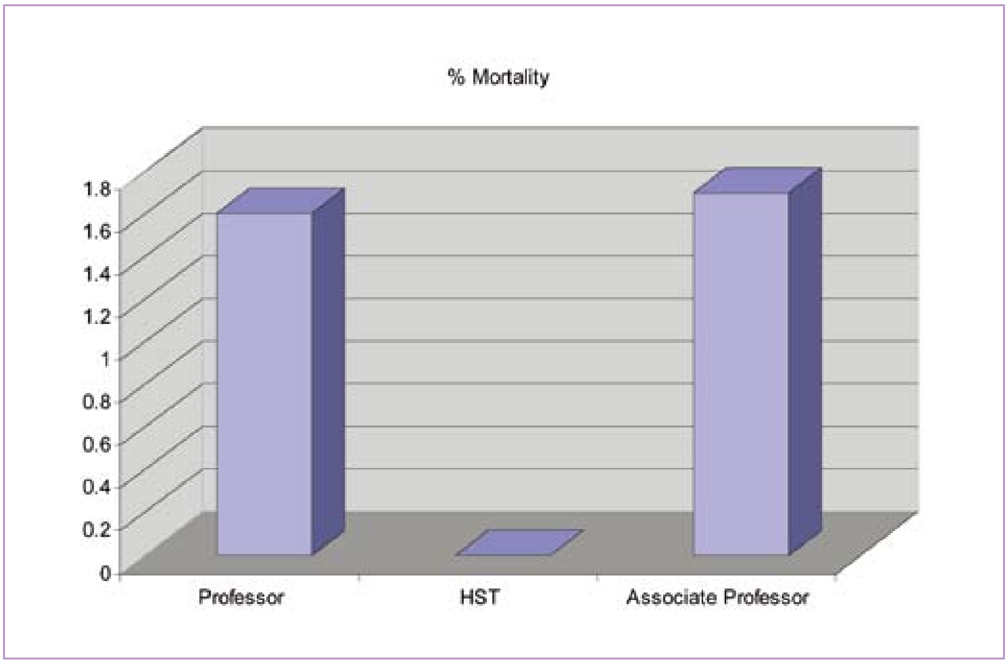


Figure 46. Mortality by Primary Operator Grade



to perform particularly complex surgeries. Figure 46 demonstrates no differences in crude mortality related to primary operator status and this was also true for observed compared to expected mortality rates when risk stratified.

12. Data Quality and Validation

For our first year of data collection, we collated information directly from patients' notes using a dedicated research assistant together with senior cardiac surgical input. The aim was to collect only the minimum dataset needed for risk modelling, and so for these factors we saw 100% accuracy and no missing data when validating this period of time. Since then, we have developed the infrastructure to allow monitoring of outcomes in real time and consolidated our audit trail in adherence to the principle that the most accurate data is that which is collected at the point of clinical care. We share responsibility for data collection amongst professionals responsible for patient wellbeing and then use an independent party for direct data entry and data checking on completion of the patient journey.

Incorporating these processes, despite their obvious advantages, is of necessity time consuming. By increasing the number of responsible personnel we may potentially increase the risk of missing data. We have therefore instituted a quarterly spot-check on missing data in random fields. This means that at the time of writing this report we have 100% data on the outcomes, risk scores and variables presented in the report. We are now instituting a validation process whereby every outcome reported as death is double checked for all data entry fields and crosschecked with patient and perfusion records. The process also calls for random sampling of 10% of patient entries at different points in time in order to crosscheck all entered fields with case note and/or computerized patient records. In the next phase of our work, we shall include this strategy to maintain and validate our database to ensure that it is fit for purpose because it is playing an ever more important role in the way we monitor total quality of care.

13. Quality of Care for Cardiac Surgical Patients

As mentioned before, overall assessment and provision of quality care for cardiac surgical patients today relates to far more than mortality. We are progressively working towards a system like that now being led by the UK under which we formulate quality bundles for our patients. We can then use these to benchmark a variety of markers of quality used by other international organizations.

Although quality bundles may be inherently different for different operative groups, they do provide a composite measure of the delivery of care. Such a measure will become increasingly important as we move towards payment by results within the region and also respect other locally driven quality agendas. Many of the areas we have already described—for example, monitoring blood transfusion rates—can form part of such a package.

As a start, we have focused on the population of patients undergoing coronary surgery and benchmarked a preliminary dataset. This includes operative indicators (use of LIMA), in-hospital non-mortality indicators (stroke, re-operation, prolonged length of stay >10 days, prolonged ventilation >24hrs) and peri-operative care indicators (discharge medication to include aspirin and statins). We have mentioned re-operation previously in this report. Figures 47 and 48 show the

Figure 47. Aspirin Prescription on Discharge

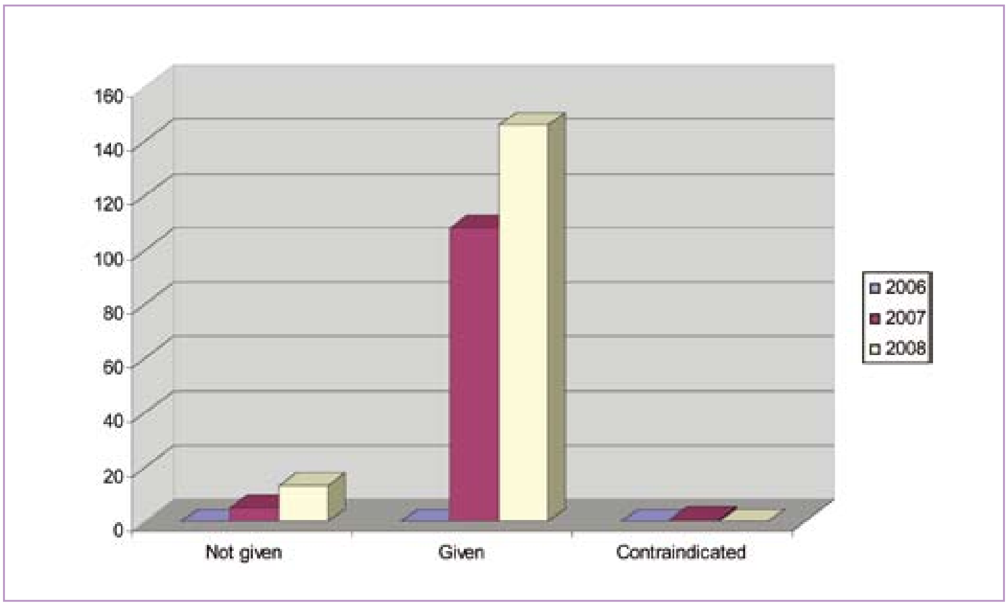
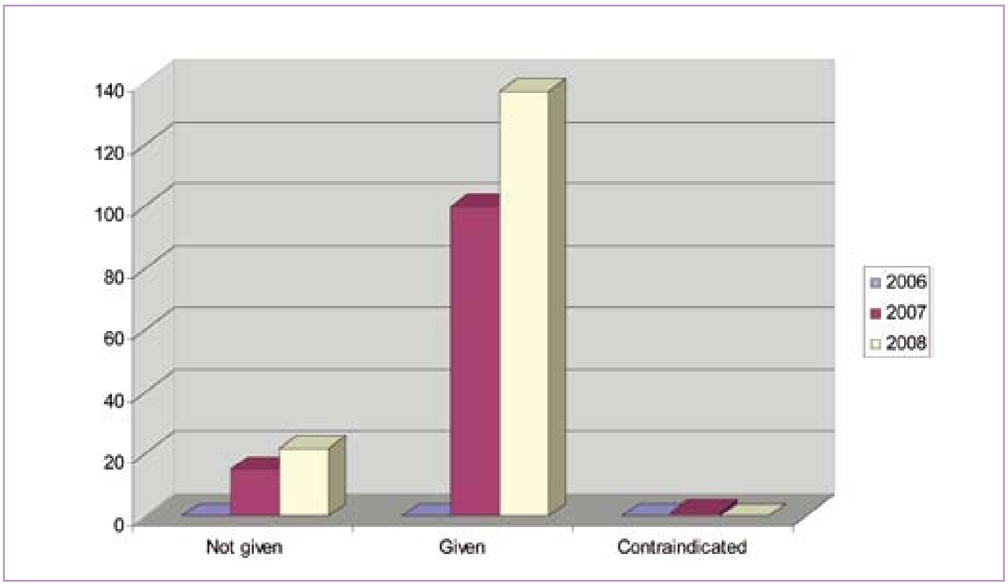


Figure 48. Statin Prescription on Discharge



percentage prescription of aspirin or statins to patients following coronary artery surgery upon their discharge. We have progressed from no available data for these variables during 2006 to 100% data collection for these end points in 2008.

The overall outcomes of our basic coronary surgery quality bundle, benchmarked with data from UK units are shown in Table 3. Our operative and in-hospital non-mortality indicators benchmark well. The lower incidences of prolonged ventilation and post-operative stay at PWH may well reflect the younger age of our patient population and it will be interesting to see how this changes over time as our population ages.

LIMA Usage			
PWH 95%	UK 94%		
In-Hospital Non-Mortality Indicators (Stroke).			
Transient		Permanent	
PWH	UK	PWH	UK
0.6%	0.4%	0.4%	1.2%
Prolonged Post-op Length of Stay (>10 days)			
PWH	UK		
9%	21.1%		
Prolonged Ventilation (>24 hrs)			
PWH	UK		
1%	5.3%		
Peri-Operative Indicators			
Discharge Medication Includes Aspirin			
PWH	UK		
92%	96.4%		
Discharge Medication Includes a Statin			
PWH	UK		
86%	96.4%		

Table 3. Composite Quality Assessment

We measure length of stay (as well as incidence of prolonged stay) as a quality indicator; our mean length of stay for all patients is six days. However, we must always look at this in the context of discharge facilities within our local area. While we can to some extent transfer patients back to their referring centre, just fewer than 50% of our patient group are referred locally and we have no option but to discharge them home. On occasion, this may actually delay discharge, since the availability of primary care for patients at home is sharply limited in our region.

We have slightly lower percentages of patients who have been prescribed either aspirin or statins in the absence of any documented contraindication. Now that we have had the opportunity to look into this we can begin to understand why this may be the case but overall we benchmark well in all areas. Over time, these various bundles can be modified and developed for differing operative categories and with regard to varying content.

Summary

1. In our third full year of data collection we have benchmarked our outcomes using the recalibrated EuroSCORE with data from the UKSCTS.

2. We have shown that where risk adjusted outcomes are concerned, we are performing in line with international standards for all cardiac surgical activity and operative subgroups.

3. Outcomes other than mortality are also excellent and well within international standards.

4. We have confirmed previous observations that there are inherent differences between our patient population and that of the UK but that, despite this, the risk profiles are similar.

5. We have shown that in terms of overall activity we still perform fewer coronary artery bypass grafting operations and more valve operations than comparable units in the United Kingdom.

6. We have seen a continued change in overall surgical practice with an increasing risk profile of our patients when they are assessed using the logistic EuroSCORE.

7. We have recorded finer detail about our valvular surgery patients and this has again shown again significant differences from the UK population but led to excellent outcomes for mitral and aortic valve operations

8. We have seen other significant changes in the demographics of our CABG population. They are now more likely to have had previous percutaneous intervention, a higher incidence of previous myocardial infarction, more severe symptoms, worse left ventricular function and to be taking anti-coagulant medication.

9. The demographic changes in the CABG population have resulted in surgery being undertaken earlier after previous myocardial infarction and in many instances whilst the patient is still on intravenous treatment with heparin and nitrates.

10. Despite demographic changes resulting in increasing risk, we have shown that risk adjusted outcomes for the subset of patients undergoing CABG is excellent and has been sustained over a three year period.

11. Changing demographics have affected blood loss and transfusion practice and we have instigated an audit in this area.

12. We have started constructing quality bundles for our patient population in order to benchmark overall provision of quality service with international standards; initial observations are favourable.

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Acknowledgements

A whole range of multidisciplinary team work is required to provide a comprehensive cardiac surgical service. Much attention is naturally given to the surgical arm of this effort but as we noted in previous reports and must continue to affirm:

'The activity and outcomes presented here demonstrate par excellence the benefits of teamwork. None would have been possible without a wide range of associated personnel, including cardiology, anaesthetic and intensive care colleagues, junior medical colleagues, ward, intensive care and theatre nurses, perfusionists, physiotherapists, pharmacists, blood bank technicians, laboratory technicians and many other support personnel. Outcomes and service provision in this and future reports reflect the dedicated effort of all these professionals'.

All of their efforts are crucial in maintaining our excellent outcomes particularly in the face of changing and increasing patient risk profiles. We face many pressures as we seek to deliver even higher quality care for our patients; all of the above mentioned professional groups have worked and continue to work above and beyond expectations to ensure that our standards are consistently maintained. In particular we acknowledge all of the doctors, nurses and associated personnel who have contributed to data collection and enabled us to do so prospectively and at the point of clinical care. The research personnel we are employing on the database project have contributed more than just validation and data entry and are now an integral part of a well established team. Their dedication to the project has been immense.

We would also like to particularly thank all our cardiac anaesthetists and intensivists who have embraced our efforts at quality assurance and who now so actively contribute to the thought processes involved in monitoring outcomes and implementing changes in practice should the need arise. Our nursing staffs on the ward have been active as well

Acknowledgements

and last year embarked upon the development of nurse-led protocols for the improved quality of care for our patients. The first project, nurse-led defibrillation, has already proved fruitful and saved a life. Our intensive care colleagues have also collaborated and written and implemented a new resuscitation guideline for cardiac surgical patients on the ICU based on new European Guidelines which again demonstrates their commitment to the optimal care of our patients.

We thank cardiac surgical colleagues represented by the Cardiothoracic Specialty Group in Hong Kong for their support of this venture, and we look forward to the collaborative efforts as we extend this process to a national level. Our colleagues have been visionary and brave enough to embrace the challenge. The entire exercise would not have been possible without support from Dr Fung Hong, Chief Executive, New Territories East Cluster, Professor CA van Hasselt past-Chairman Department of Surgery CUHK, Dr A Yuen and the Central Audit Unit of the Hospital Authority (HA) and also the Department of Quality and Safety at the HA who have facilitated discussions to develop the process further. We are also grateful to Dr NT Cheung and all the HA IT team who have made a contribution.

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Appendix 1 The Audit Trail

The Audit Trail

The primary outcome is in-hospital death.

Patient Admitted for Cardiac Surgery
Automated Demographic Data Entry

↓

Patient Journey
Data Entry at 'Point of Clinical Care'

↓

Case Note Goes to Ward Clerk
Patient Discharge Completed
Database Form Checked and Completed
Case Notes Returned to Medical Records Dept
Data Entry to Computerised Database by Research Assistant

↓

Data Analysis and Review

Periodic Data Review Involves:

a) Checking if case is on the database with correct demographic details.
b) Reviewing completeness of the data. All fields must be complete from admission to discharge. Any blank fields are flagged for subsequent completion
c) Validating the accuracy of the data. Research Assistant reviews all variables for consistency between database and case note. Identified discrepancies are reviewed with Clinical Staff and database amended as appropriate. A final audit check is done to ensure changes have been made accurately and the record is then locked. This process ensures data cannot be altered once validated, without the intervention of the Senior Database Manager.

The above process is completed for all adult cardiac surgery cases. The process ensures that the data on the database is complete and accurate, hence ensuring validated quality data.

Appendix 2 Definitions Used For the EuroSCORE

Definitions used in the EuroSCORE Calculation

Notes

[1] **Chronic pulmonary disease** Long term use of bronchodilators or steroids for lung disease

[2] **Extracardiac arteriopathy** One or more of claudication, carotid occlusion or >50% stenosis, previous or planned intervention on the abdominal aorta, limb arteries or carotids

[3] **Neurological dysfunction** Disease severely affecting ambulation or day-to-day functioning

[4] **Active endocarditis** Patient still on antibiotic treatment for endocarditis at time of surgery

[5] **Critical preoperative state** Ventricular tachycardia / ventricular fibrillation or aborted sudden death, preoperative cardiac massage, preoperative ventilation before anaesthetic room, preoperative inotropes or IABP, preoperative acute renal failure (anuria or oliguria <10ml/hr)

[6] **Unstable angina** Rest angina requiring i.v. nitrates until arrival in anaesthetic room

[7] **Recent MI** Myocardial infarction within 90 days

[8] **Pulmonary hypertension** Systolic pulmonary artery pressure >60mmHg

[9] **Emergency** Operation before beginning of next working day

Appendix 3 SCTS UK Complex Bayes Score

The complex (9-factor) CABG Bayes score

		r[1]	n[2]	p[3]	odds[4]	LR[5]	weight[6]
OVERALL		**835**	**33,392**	**2.5%**	**0.026**	**NA**	**-36.63**
Age	<56 years old	84	6,626	1.3%	0.013	0.501	-6.92
	56-60 years old	70	5,250	1.3%	0.014	0.527	-6.41
	61-65 years old	134	6,670	2.0%	0.021	0.799	-2.24
	66-70 years old	183	6,730	2.7%	0.028	1.090	0.86
	71-75 years old	195	4,952	3.9%	0.041	1.598	4.69
	>75 years old	153	2,325	6.6%	0.070	2.747	10.10
Body Surface Area	<1.7 m2	118	2,941	4.0%	0.042	1.630	4.88
	1.70-1.89 m2	201	6,979	2.9%	0.030	1.156	1.45
	1.90-2.39 m2	355	16,490	2.2%	0.022	0.858	-1.53
	>2.39 m2	38	2,280	1.7%	0.017	0.661	-4.14
Diabetes	No	162	5,055	3.2%	0.033	1.291	2.55
	Yes	559	23,486	2.4%	0.024	0.951	-0.51
HT	No	310	14,776	2.1%	0.021	0.836	-1.80
	Yes	462	15,773	2.9%	0.030	1.177	1.63
LMS	No	418	19,431	2.2%	0.022	0.857	-1.54
	Yes	138	3,919	3.5%	0.036	1.423	3.53
Ejection fraction	Good	317	19,652	1.6%	0.016	0.639	-4.47
	Fair	248	8,410	2.9%	0.030	1.185	1.70
	Poor	185	2,044	9.1%	0.100	3.880	13.56
Priority	Elective	374	21,098	1.8%	0.018	0.704	-3.51
	Urgent	247	8,142	3.0%	0.031	1.220	1.99
	Emergency	126	914	13.8%	0.160	6.235	18.30
Renal disease	Dialysis	12	138	8.7%	0.095	3.713	13.12
	Elevated creatinine	85	1,071	7.9%	0.086	3.361	12.12
	None	463	21,778	2.1%	0.022	0.847	-1.66
Prior op'ns	None	679	29,278	2.3%	0.024	0.926	-0.77
	One or more	87	1,335	6.5%	0.070	2.718	10.00

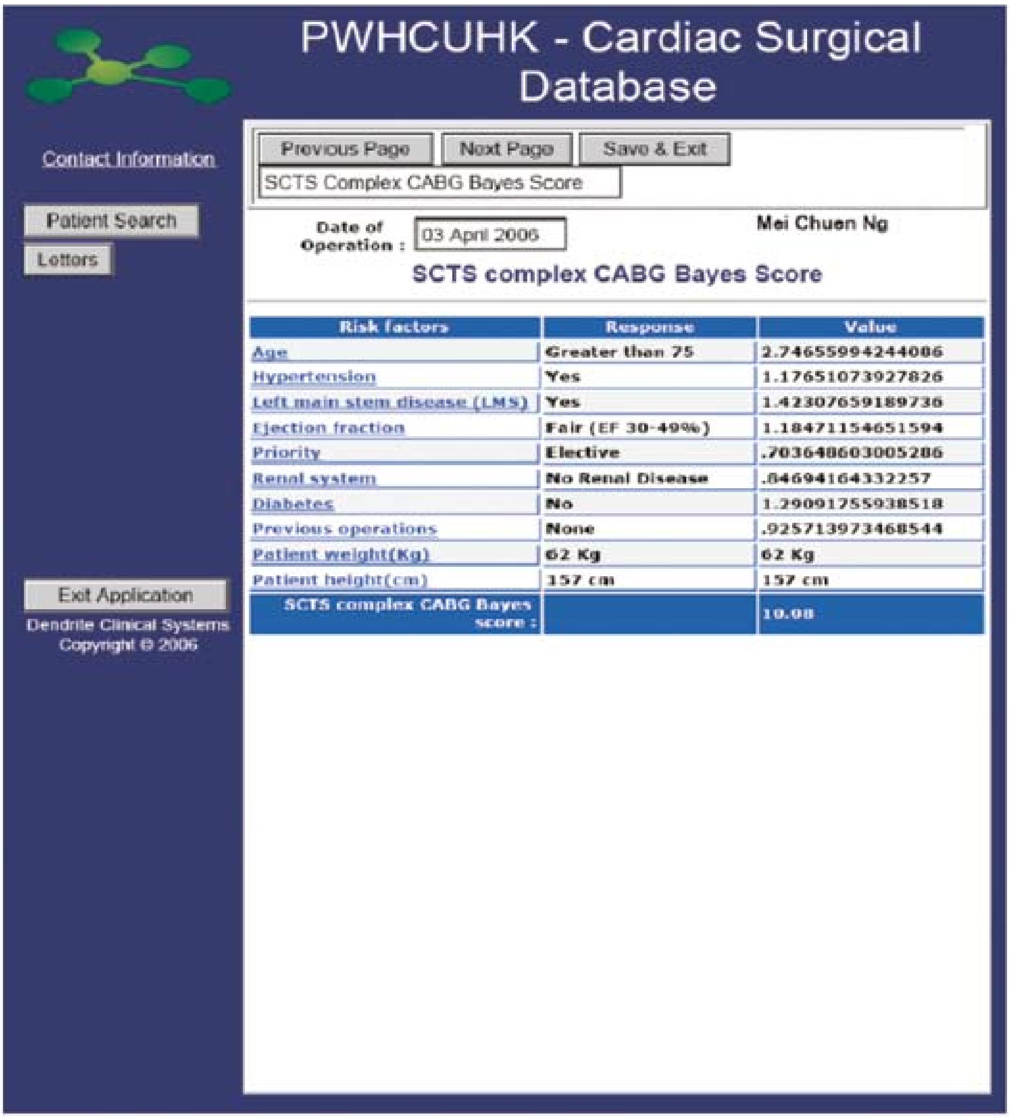
[1] number of deaths

[2] number of operations in the group / sub-group

[3] probability of death

[4] odds on death

Appendix 4 Theoretical Bayes Calculation


PWHCUHK - Cardiac Surgical Database

Contact Information

Patient Search

Letters

Exit Application

Dendrite Clinical Systems
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SCTS Complex CABG Bayes Score

Date of Operation : 03 April 2006

Mei Chuen Ng

SCTS complex CABG Bayes Score

Risk factors	Response	Value
Age	Greater than 75	2.74655994244086
Hypertension	Yes	1.17651073927826
Left main stem disease (LMS)	Yes	1.42307659189736
Ejection fraction	Fair (EF 30-49%)	1.18471154651594
Priority	Elective	.703648603005286
Renal system	No Renal Disease	.84694164332257
Diabetes	No	1.29091755938518
Previous operations	None	.925713973468544
Patient weight(Kg)	62 Kg	62 Kg
Patient height(cm)	157 cm	157 cm
SCTS complex CABG Bayes score :		10.08