Queen Mary Hospital

醫院管理局
HOSPITAL AUTHORITY

Department of Cardiothoracic Surgery

Cardiac Surgery Biennial Report

2010 - 2011

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Message From Chief Executive

by Dr P.Y. Leung, Chief Executive, Hospital Authority

Patient safety is always of utmost priority to the Hospital Authority (HA) and it must never be compromised. Yet, we could not be able to fully understand our performance without the support from data.

I am glad to see the release of this biennial Cardiothoracic Surgery Report, the first comprehensive review aiming at a better understanding of the performance in the Queen Mary Hospital. The report provides a systemic approach and structured analysis for us to plan and determine the direction for improving the quality of care for cardiac patients.

I would like to take this opportunity to express my appreciation to our dedicated professionals for their unrelenting efforts in ensuring patient safety and building a culture of continuous improvement. This will enable us to move toward our vision of being trusted by the community. I am confident that we will see greater achievements together in the years to come, and more substantial contributions to patient care, to the HA and to the community.

Foreword

by Professor Chung-Mau LO, Chair Professor and Head of Department of Surgery, The University of Hong Kong

This is the first report on cardiac surgery at Queen Mary Hospital for the year 2010 to 2011 based on data generated by the Dendrite Clinical System. The report clearly shows that Hong Kong has a world-class cardiac surgery service.

Despite a more complex and diverse case mix, the data indicates that the outcomes of cardiac surgery at Queen Mary Hospital are comparable if not superior to those of the United Kingdom as published by the Society of Cardiothoracic Surgeons in Great Britain & Ireland. Of the 867 adult cardiac surgical procedures performed over the two-year period, the most common operation was isolated coronary artery bypass surgery, followed by isolated valve surgery. There were more valvular and re-do valvular operations, aortic operations and transplantation compared to centers in the United Kingdom.

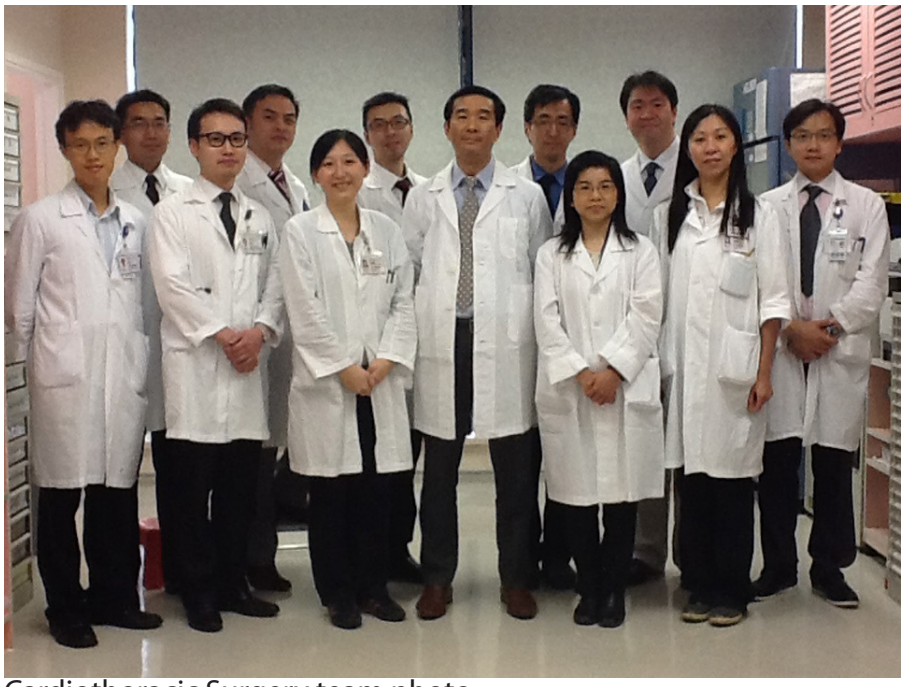
Our crude mortality rate for coronary artery bypass surgery, isolated or combined with other kinds of cardiac surgery, was on a par with that in the United Kingdom and that reported by the European Association for Cardio-Thoracic Surgery. For isolated coronary artery bypass surgery, the ratio of observed mortality to predicted mortality was 0.44 only. The results of valve surgery were even more impressive as our crude mortality of different kinds of valve surgery, isolated or combined, were consistently lower than that in the United Kingdom and Europe. The predicted mortality rate for all single valve surgery was 6.9% and the observed rate was 1.6%, with an observed-to-predicted-mortality ratio of 0.23. For all kinds of valve surgery, the observed mortality rates were lower than the predicted mortality rates.

It is heartening to see that cardiac surgery at Queen Mary Hospital is another clinical practice par excellence. This outstanding achievement could not have been possible without the skill and hard work of a dedicated and committed team of surgeons, nurses, anaesthesiologists, and allied health, of which we are proud.

Introduction

by Dr Timmy Wing Kuk Au, Chief of Service, Department of Cardiothoracic Surgery, Queen Mary Hospital

The Department of Cardiothoracic Surgery is very proud to publish our first biennial adult cardiac surgical report for the year 2010 and 2011. Cardiac surgery has been performed in our department for nearly 50 years but systematic clinical data collection and outcome audit were not carried out at the Grantham Hospital (our predecessor) until the late 1990s. Risk stratification using EuroSCORE protocol was then our main program in the adult cardiac surgery outcome audit at that time. This prospective surgical audit in adult cardiac surgery was fully supported by our previous Chief of Service Dr Chiu Shiu-Wah and Dr Cheng Lik-Cheung. Reports had been published in peer review journals and our data presented in various local and international meetings with good feedback. With the support of the Hong Kong West Cluster, we moved on to adopt the Dendrite Clinical System for our data management in late 2009. Currently, we have a dedicated team of 2 cardiothoracic surgeons and one nursing officer who are responsible for data collection and follow ups. We believe that this report could act as our continuous quality improvement program as well as unveil our practice of adult cardiac surgery to our colleagues in the Hospital Authority and to the public both locally and overseas. Finally, this report would never



Cardiothoracic Surgery team photo

have been accomplished without the untiring efforts, skill and passionate countenance of our staffs and their devotion towards excellence in patient care.

Database overview

The overall workload at QMH, Hong Kong for the calender years 2010 & 2011

Procedure groupings

- All data comparisons are made to the data from United Kingdom published by the Society for Cardiothoracic Surgeon in Great Britain & Ireland in their Sixth National Adult Cardiac Surgical Database Report 2008, & relate to the most up-to-date data in that document, from the financial year ending 2008.
- We have performed 867 adult cardiac surgical procedures (defined as open heart surgery for patients over the age of 18 years).
- Percentage of our coronary artery bypass graft surgery (CABG) was lower than the United Kingdom data (33% in Queen Mary Hospital *versus* 58% in United Kingdom).
- On the other hand, percentage of our valves surgery was higher than the United Kingdom data (Isolated Valves + Valves & Others is 40% in Queen Mary Hospital *versus* 23% in United Kingdom).
- Adult congenital heart surgery comprised a greater proportion of our workload than reported for the United Kingdom in their Sixth National Adult Cardiac Surgical Database Report 2008.
- Aortic surgery and heart transplantation were also relatively more common in Queen Mary Hospital compared to the data reported by the United Kingdom surgeons.

Overall workload at Queen Mary Hospital, Hong Kong; calendar years 2010 & 2011

		Data		
		Count	Proportion	Proportion in the UK
Procedure grouping	Isolated CABG	286	33.0%	58.3%
	Isolated valve	240	27.7%	18.9%
	CABG & valve	56	6.5%	11.5%
	CABG & other	21	2.4%	2.0%
	Valve & other	107	12.3%	4.5%
	CABG, valve & other	17	2.0%	1.6%
	Other	140	16.1%	3.2%
	All	**867**		

For details on the other procedures, please see the data on page 16.

Procedure detail

- The procedure groupings that contain other in their description (CABG & other; CABG, valve & other; Valve & other; Other) describe operations that involve a cardiac surgical procedure other than coronary artery bypass and valve surgery.
- These other procedures include : atrial septal defect (ASD) repair, ventricular septal defect repair (VSD), aortic surgery, radiofrequency ablation surgery (MAZE) and thoracic resection.
- 3 or more grafts were performed in 257 isolated coronary artery surgery, which was a higher rate than that reported in the United Kingdom data (89% in Queen Mary Hospital *versus* 74% in United Kingdom).
- More detail information on CABG and valve surgery at Queen Mary Hospital can be found in dedicated sections later in this report.

Procedure detail

			Procedure groupings							
			Isolated CABG	Isolated valve	CABG & valve	CABG & other	Valve & other	CABG, valve & other	Other	**All**
Procedure detail	CABG surgery	1 graft	2	0	25	9	0	12	0	**48**
		2 grafts	25	0	15	5	0	3	0	**48**
		3 grafts	185	0	12	5	0	2	0	**204**
		4 grafts	69	0	3	2	0	0	0	**74**
		≥5 grafts	3	0	0	0	0	0	0	**3**
	Valve surgery	Aortic alone	0	64	28	0	19	7	0	**118**
		Mitral alone	0	65	14	0	23	0	0	**102**
		Aortic & mitral	0	18	1	0	5	2	0	**26**
		Mitral & tricuspid	0	35	9	0	22	3	0	**69**
		Other valve combinations	0	52	4	0	29	3	0	**88**

Other procedure detail

- It is important to remember that the patients may have more than one of the other procedures. For example, there are 3 patients who had both surgery on the aorta **and** congenital surgery.
- The group 'other procedures not listed above' included all those patients for whom there was an other procedure of some kind recorded, but who did not fall into any of the categories listed above; examples of these kinds of procedures would be: myxomas, HOCM myomectomy surgery, lung resections, atrial reduction plasty, concomitant peripheral vascular procedures and TEVAR with cardiopulmonary bypass.

Other procedures performed

		Data	
		Count	Proportion
Other procedures	No other procedures	582	67.1%
	All operations with an other component	285	32.9%
	Surgery on the aorta	97	11.2%
	Cardiac transplant	21	2.4%
	Adult congenital surgery	40	4.6%
	Pulmonary embolectomy	4	0.5%
	Pericardiectomy	2	0.2%
	Epicardial pacemaker	2	0.2%
	LV aneurysmectomy	2	0.2%
	Radio-frequency ablation	51	5.9%
	Other procedure not listed above	51	5.9%
	All	**867**	

Previous cardiac surgery

- All comparisons to data from the United Kingdom come from results published by the Society for Cardiothoracic Surgeon in Great Britain & Ireland in their Sixth National Adult Cardiac Surgical Database Report 2008, & relate to the most up-to-date data in that document, from the financial year ending 2008.
- Isolated CABG with previous cardiac surgery was 2.4% compared to 1.6% in United Kingdom.
- Patients with coronary artery diseases with previous cardiac surgery who then require further coronary intervention may now more frequently undergo PCI rather than surgery and the situation is similar in United Kingdom.
- Isolated valve surgery with previous cardiac surgery was 30% in Queen Mary Hospital while all valves & other surgery with previous cardiac surgery was 26% compared to 9% for isolated AVR with previous cardiac surgery and 2% for isolated MVR with previous cardiac surgery from United Kingdom data.
- Overall 16% of our adult cardiac surgery patients had previous cardiac surgery done.

Previous surgery

		Previous cardiac surgery		
		No	Yes	Proportion prior surgery
Procedure grouping	Isolated CABG	279	7	2.4%
	Isolated valve	169	71	29.6%
	CABG & valve	53	3	5.4%
	CABG & other	20	1	4.8%
	Valve & other	79	28	26.2%
	CABG, valve & other	15	2	11.8%
	Other	112	28	20.0%
	All	**727**	**140**	

Mortality

- In-hospital mortality is used as our primary outcome rather than 30-day mortality.
- Our isolated CABG and CABG combined surgery crude mortality were on par with the United Kingdom data and EACTS database.
- Our isolated valve surgery and valves combined surgery crude mortality was lower than the United Kingdom data and EACTS database.

In-hospital, post-operative mortality rates for each procedure group

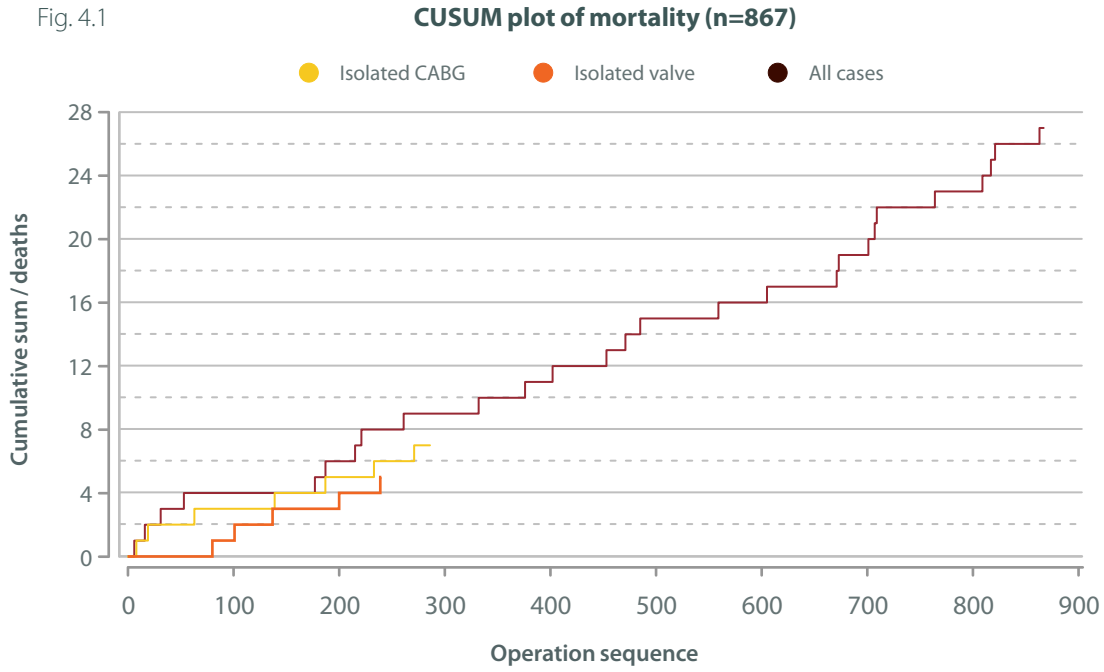
		Mortality		
		Alive	Died	Rate (95% CI)
Procedure grouping	Isolated CABG	279	7	2.4% (1.1-5.2%)
	Isolated valve	235	5	2.1% (0.8-5.1%)
	CABG & valve	54	2	3.6% (0.6-13.4%)
	CABG & other	19	2	9.5% (1.7-31.8%)
	Valve & other	104	3	2.8% (0.7-8.6%)
	CABG, valve & other	17	0	0.0% (0.0-16.2%)
	Other	132	8	5.7% (2.7-11.3%)
	All	**840**	**27**	

International comparison of in-hospital, post-operative mortality rates for each procedure group

		Mortality data		
		Queen Mary Hospital, Hong Kong	United Kingdom NACSD 2008	EACTS database 2006-2008
Procedure grouping	Isolated CABG	2.4% (286; 1.1-5.2%)	1.5% (22,808; 1.3-1.6%)	2.2% (219,053; 2.2-2.3%)
	Isolated valve	2.1% (240; 0.8-5.1%)	3.5% (7,379; 3.1-4.0%)	3.4% (75,247; 3.3-3.5%)
	CABG & valve	3.6% (56; 0.6-13.4%)	6.1% (4,508; 5.4-6.8%)	6.2% (37,721; 6.0-6.5%)
	CABG & other	9.5% (21; 1.7-31.8%)	7.8% (766; 6.1-10.0%)	7.0% (4,327; 6.3-7.8%)
	Valve & other	2.8% (107; 0.7-8.6%)	5.5% (1,780; 4.5-6.7%)	4.9% (12,883; 4.5-5.3%)
	CABG, valve & other	0.0% (17; 0.0-16.2%)	11.5% (617; 9.2-14.4%)	11.3% (3,097; 10.2-12.5%)
	Other	5.7% (140; 2.7-11.3%)	7.9% (1,271; 6.5-9.5%)	7.7% (11,562; 7.2-8.2%)

- The cumulative sum technique is a method of plotting an accumulation of events over time.
- The cumulative mortality plot provides visual representation of performance against the expected outcome rate of a particular risk scoring protocol.
- When observed CUSUM mortality plot compares with the predicted CUSUM mortality plot allows the detection of trends and corrective actions and it provides an excellent audit to surgeons and hospital administrators.
- There were no indications of odd results in the CUSUM plot for Queen Mary Hospital.

Fig. 4.1



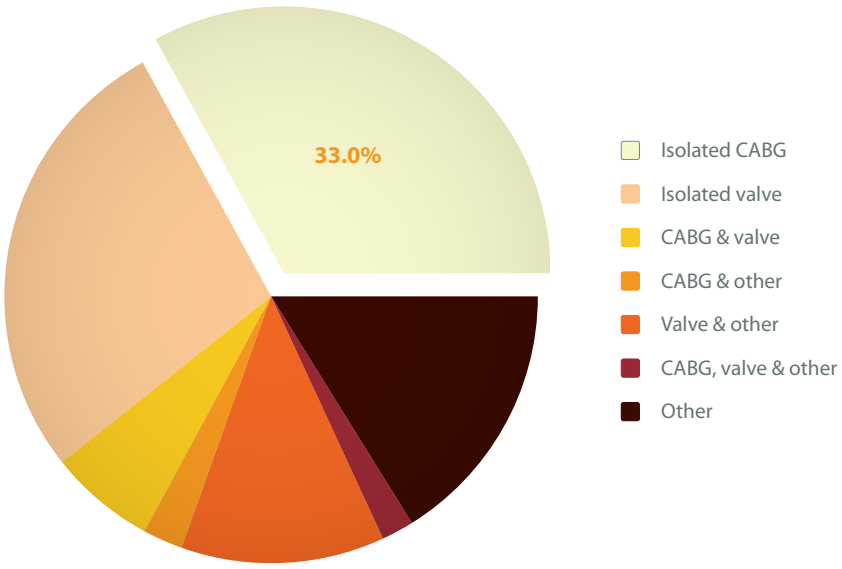
Isolated CABG surgery

Isolated coronary surgery

CABG in the context of overall workload

- Coronary surgery contributed 33% of workload in our department.
- In contrast to western countries that CABG usually attributes 70% of case load.
- Total 286 patients had isolated CABG in the year 2010 to 2011.

Fig. 5.1 **Workload overview (n=867)**



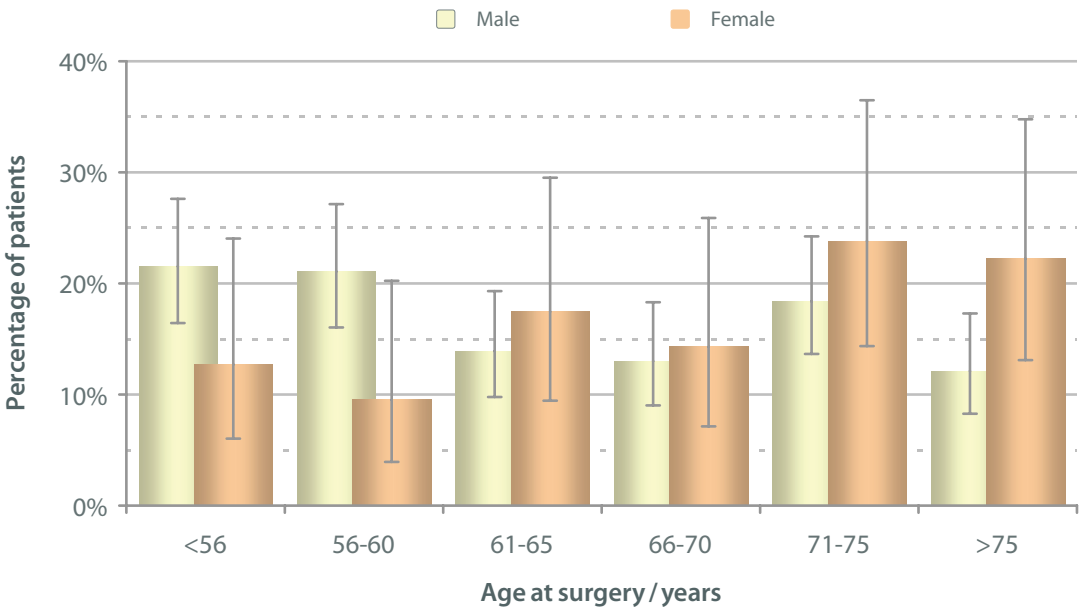
Pre-operative risk factors

Age and gender

Age and gender distributions

- 286 patients (223 male and 63 female) had undergone isolated coronary surgery in year 2010 and 2011.
- Patients undergoing coronary artery bypass grafting was dominated by male (78%).
- Overall number was distributed similarly in different age groups. However, male patients tended to present at younger age.

Fig. 5.2 **Isolated CABG: Age and gender (n=286)**



Age, gender and mortality

- Crude mortality showed female patients had lower mortality rate, which is different from the ***EuroSCORE*** where female itself as a risk factor.
- When different age groups are taken into consideration, older men had higher mortality while this trend is not seen in women.

Isolated CABG surgery: crude mortality, age and gender

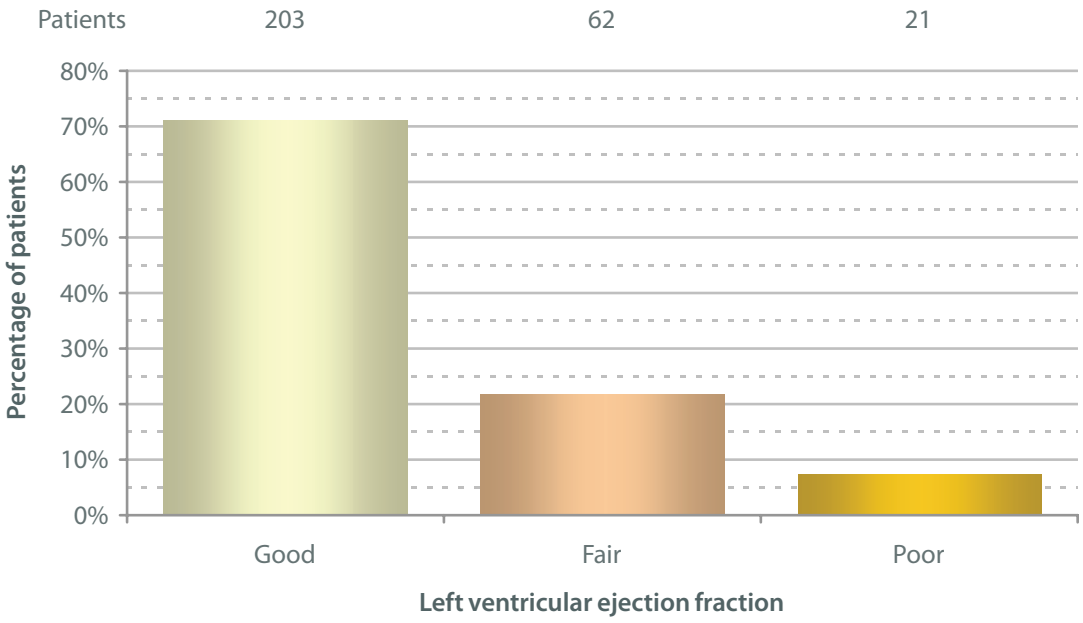
		Gender	
		Male	Female
Age at surgery / years	<56	0.0% (0.0-6.1%)	0.0% (0.0-31.2%)
	56-60	2.1% (0.1-12.7%)	0.0% (0.0-39.3%)
	61-65	0.0% (0.0-9.2%)	9.1% (0.5-42.9%)
	66-70	3.4% (0.2-19.6%)	0.0% (0.0-28.3%)
	71-75	4.9% (0.8-17.8%)	0.0% (0.0-18.1%)
	>75	7.4% (1.3-25.8%)	0.0% (0.0-19.3%)
	All	**2.7% (1.1-6.0%)**	**1.6% (0.1-9.7%)**

Left ventricular ejection fraction

Left ventricular ejection fraction distributions

- Ventricular function is mainly assessed by echocardiogram and expressed as ejection fraction.
- Before operation, 21.7% of patients had impaired left ventricular function while 7.3% of them were considered as poor (ejection fraction <30%).
- An intra-aortic balloon pump (IABP) would be inserted before operation if the patient's ejection fraction were poor, or had unstable angina or unstable haemodynamics. 37 of our patients (12.9%) fell into this category.

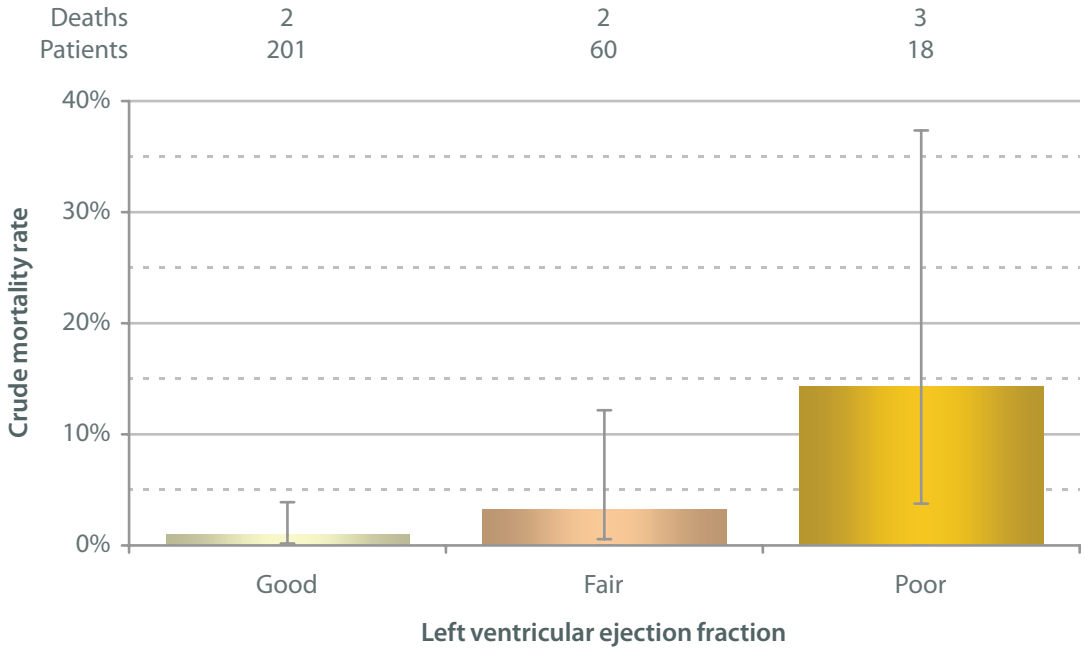
Fig. 5.3 **Isolated CABG: Ejection fraction (n=286)**



Left ventricular ejection fraction and mortality

- Poor left ventricular function is a well known risk factor in revascularization surgery.
- Mortality was correlated to left ventricular function in our patient population. There was only 1% mortality in good function group.

Fig. 5.4 **Isolated CABG: Crude mortality and ejection fraction (n=286)**

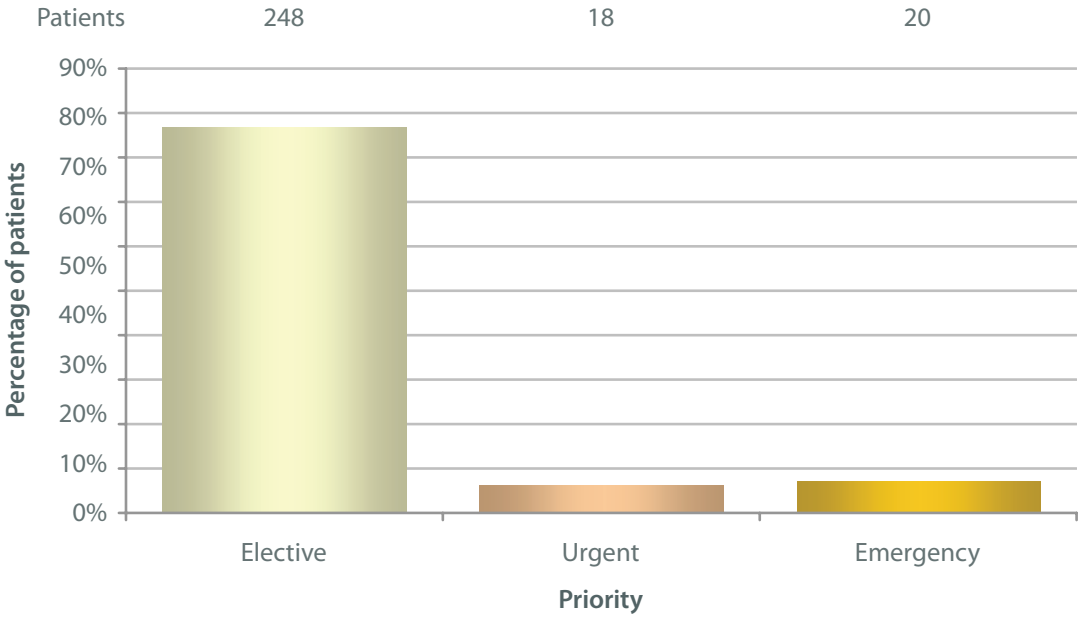


Priority

Priority distributions

- As shown in the chart, most of the patients underwent CABG on elective basis (86.7%).
- Urgent CABG is defined by operation on next available working day while emergent CABG (including salvaging surgery) indicates patients need surgery the same day because of clinical situation. These represented 6.3% and 7% of all coronary operation respectively.
- According to the United Kingdom National Adult Cardiac Database Report 2008, emergent and salvage coronary surgery comprised 2.5% of all cases ($^{560}/_{22831}$).

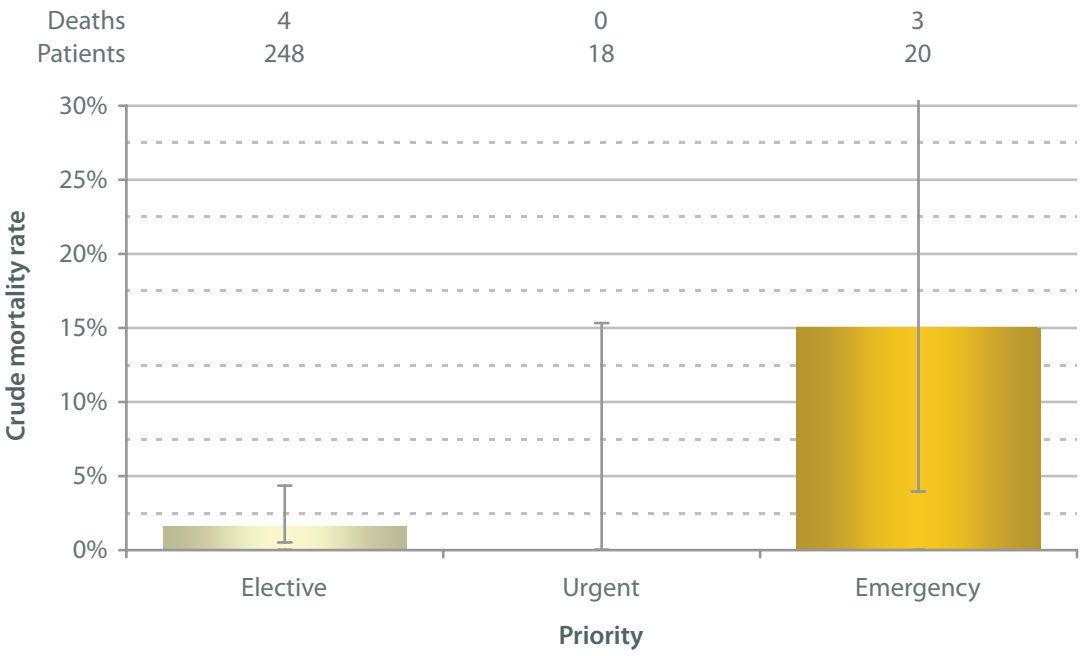
Fig. 5.5 **Isolated CABG: Priority (n=286)**



Priority and mortality

- Operations performed in urgent or emergency setting are always considered as high risk. This is because patients in these situations might have on-going ischemia of myocardium, frequent malignant arrhythmia or even unstable haemodynamics.
- Our data correlate with this idea. Mortality was 15% in emergency setting compared to 1.6% in those performed electively.
- According to the United Kingdom National Adult Cardiac Database Report 2008, emergent and salvaging coronary surgery contributed 2.5% of cases (560/22831). Mortality rate was 10.5% (5/560).

Fig. 5.6 **Isolated CABG: Crude mortality and priority (n=286)**



Mortality and other risk factors

The table below shows risk factors that are considered significant for coronary surgery. Being female, low body mass index, presence of left main disease, previous cardiac surgery, diabetic, hypertensive and presence of other arterial diseases would have higher mortality according to ***EuroSCORE***.

Fisher's exact test showed that there were no significant differences in mortality rates for the different classes of these risk factors (p=0.520; p=0.630; p=0.067; p=0.839; p=0.207; p=0.568; p=0.491 respectively)

Isolated CABG surgery: in-hospital, post-operative mortality rates for various risk factors

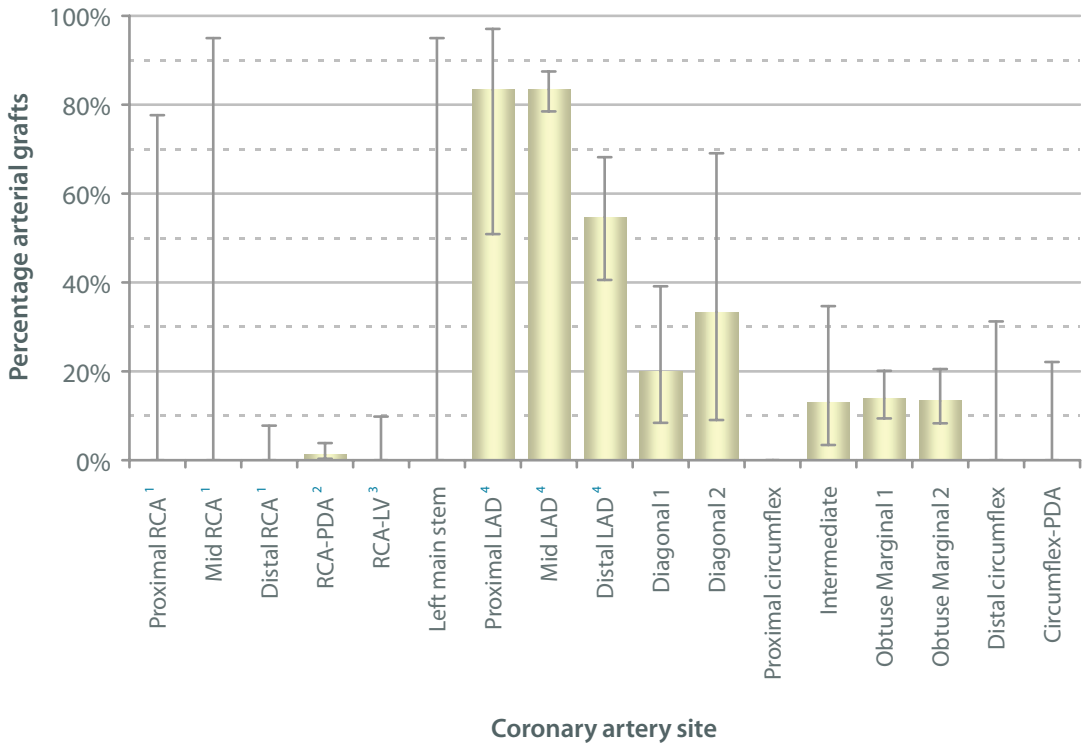
			Mortality		
			Alive	Died	Rate
Risk factors	Gender	Male	217	6	2.7%
		Female	62	1	1.6%
	Body Mass Index	≥25 kg m^{-2}	117	3	2.5%
		<25 kg m^{-2}	160	4	2.4%
	Left main stem disease	No	138	1	0.7%
		Yes	139	6	4.1%
	Previous cardiac surgery	No	272	7	2.5%
		Yes	7	0	0.0%
	Diabetes	No	144	2	1.4%
		Yes	135	5	3.6%
	Hypertension	No	31	1	3.1%
		Yes	248	6	2.4%
	Extra-cardiac arteriopathy	No	254	6	2.3%
		Yes	25	1	3.8%

The grafting process

Arterial grafting at each site

- There were 1,067 distal anastomoses made in 286 patients. On average, each patient received 3.7 grafts in isolated CABG.
- Arterial grafts, especially the left internal mammary artery (LIMA), are considered as better conduit in CABG. Younger patients may benefit from a second arterial graft, usually radial artery or right internal mammary artery.
- We had approaching 90% arterial graft usage in isolated CABG (243 LIMA and 54 radial artery). While almost 20% of them had 2 or more arterial graft conduit.
- Usage of left internal mammary artery in United Kingdom was around 93% in 2008 and 18% of patients received 2 or more arterial grafts.

Fig. 5.7 **Isolated CABG: Arterial graft usage at each of the coronary artery sites treated (n=1,059 conduits)**



1. RCA → Right coronary artery.
2. PDA → Posterior descending artery.
3. LV → Left ventricle.
4. LAD → Left anterior descending artery.

Endoscopic harvest of conduits

- Our department began using endoscopic vein harvesting techniques in 2005; we began endoscopic radial artery harvesting in 2007. This is now become the standard and preferred way of harvesting these conduits in our practice.
- 54 patients had a radial artery used as conduit. In all but one of these patients the radial artery was harvested using the endoscopic technique.
- For the 262 patients who had a vein graft 85.1% of them were harvested by endoscopic method.

Isolated CABG surgery: endoscopic conduit harvest for patients where the named conduit was used in the CABG

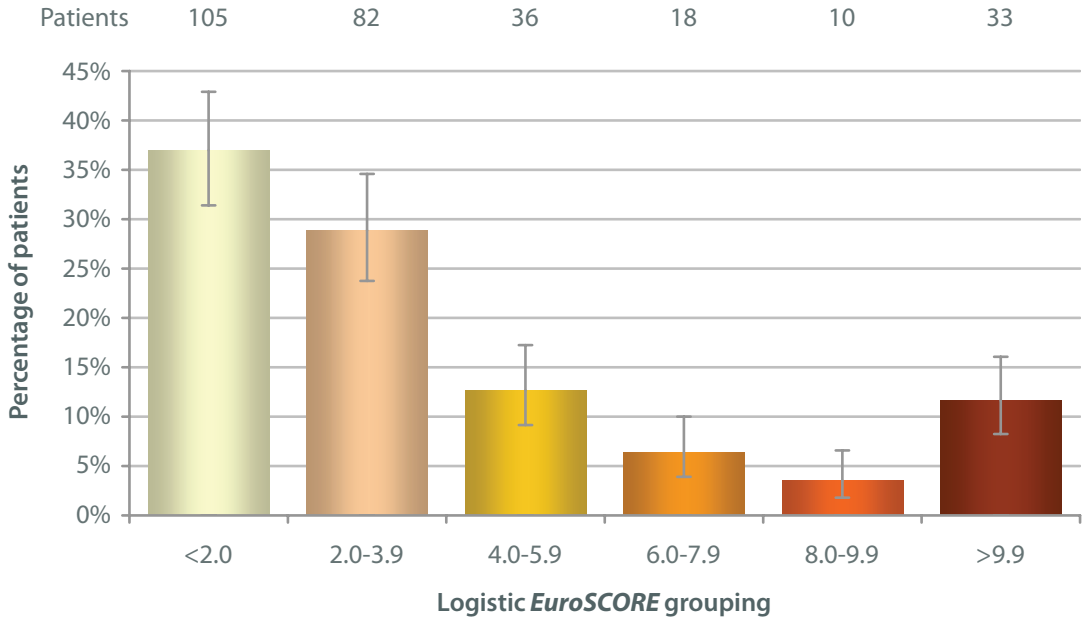
		Endoscopic harvest of the named conduit		
		No	Yes	Endoscopic harvest rate
Conduit	Radial artery used	1	53	98.1%
	Vein used	39	223	85.1%

Risk adjustment

Logistic *EuroSCORE* distributions

- Logistic ***EuroSCORE*** is a commonly used risk stratification and prediction method in cardiac surgery. The value equals to the predicted mortality risk for a particular patient.
- In the isolated CABG group, 37% of patients fell into low risk group (<2% mortality) and the number descended in higher risk groups.
- We performed more high risk coronary surgery. As 11.6% of patients were in the highest risk group (>9.9% mortality). When compare to UK data, 8.1% of patients fell into this group.

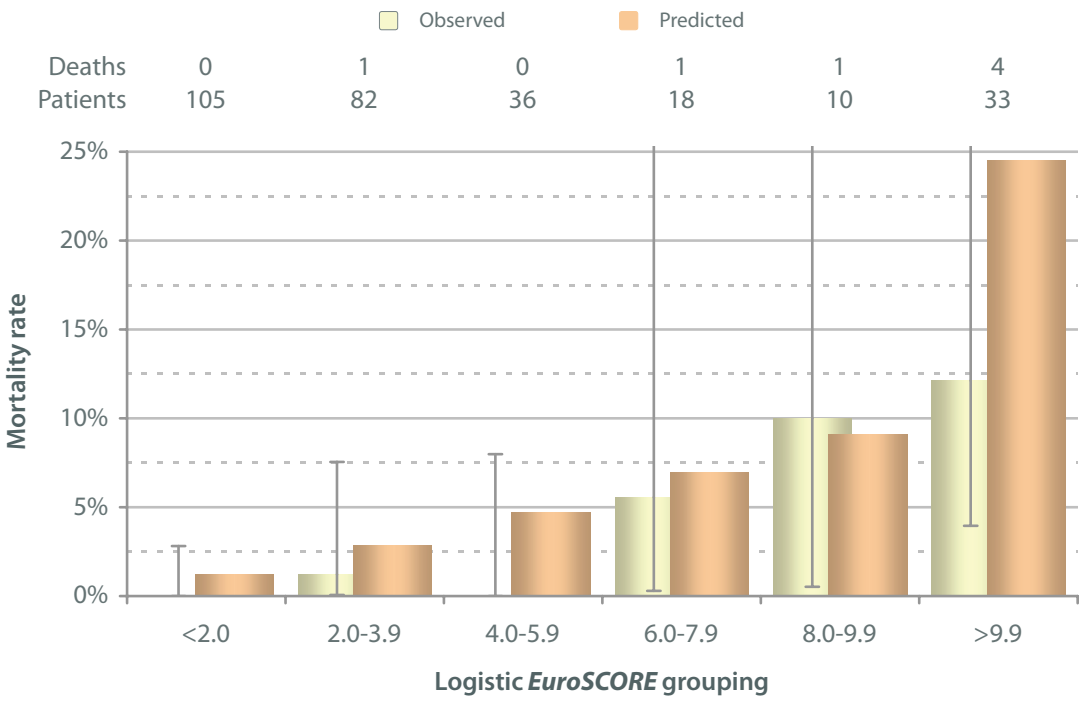
Fig. 5.8 **Isolated CABG: Logistic *EuroSCORE* distribution (n=284)**



Logistic *EuroSCORE* and mortality

- Observed mortality rates were close to the predicted rates. Most of the mortality was associated with the higher-risk groups.
- Overall predicted mortality was 5.5% (15.6 patients). While observed mortality was 2.4% (7 patients). The observed *versus* predicted mortality ratio was 0.44 for isolated CABG.

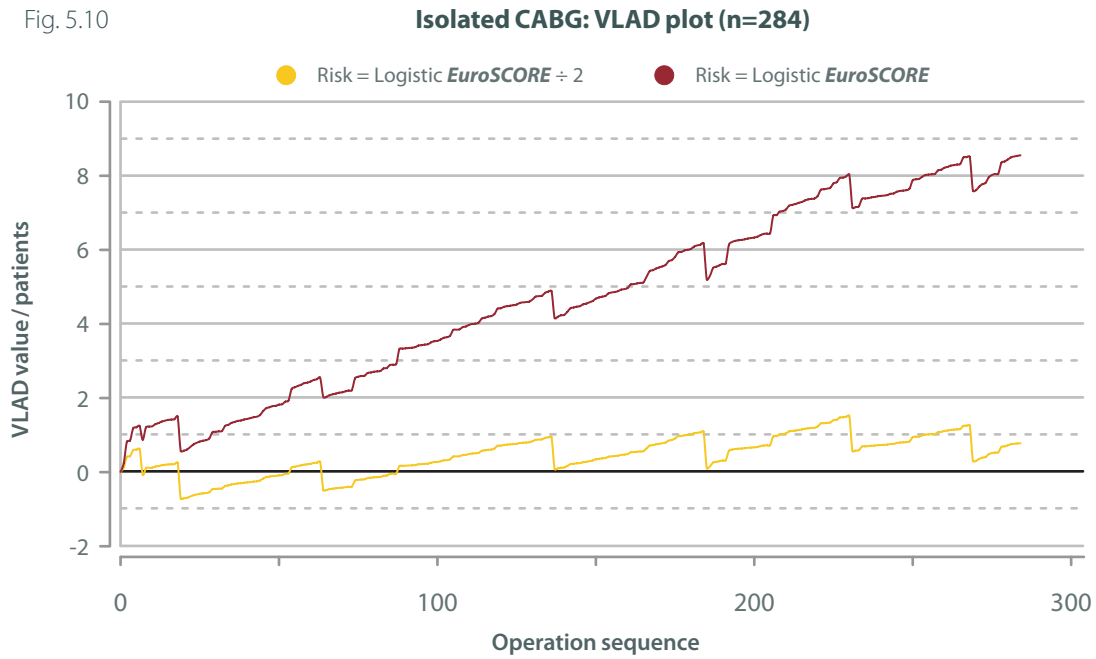
Fig. 5.9 **Isolated CABG: Mortality and logistic *EuroSCORE* distribution (n=284)**



- This Variable Life-Adjusted Display (VLAD) covers all risk-scored isolated CABG procedures performed during 2010 and 2011. The plot is risk adjusted and performance as predicted should run approximately around the horizontal zero line (the heavy black line).
- The upslope of the curve demonstrated a net gain of patients' life and the performance was better than predicted.
- At the end of the curve, almost 9 lives had been saved at Queen Mary Hospital.

- An ***EuroSCORE*** divided by 2 is also shown in the graph. This graph demonstrates performance very close to the predicted value.

Fig. 5.10

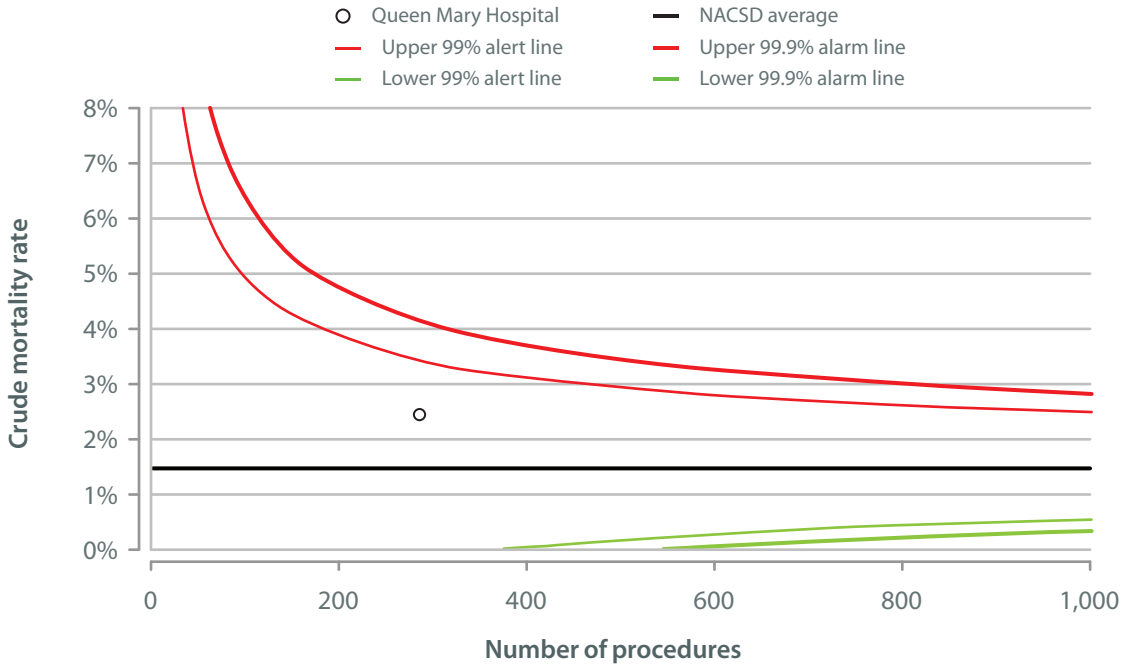


International benchmarking of outcomes

- Funnel plots are a graphical means of displaying outcomes compared to a given standard, with upper and lower control limits to define a range of acceptable results.
- The following pages show funnel plots for the outcomes:
  - Crude mortality
  - Re-operation for bleeding
  - Post-operative stroke
  - New haemofiltration / dialysis
- All four of the following charts compare the results at Queen Mary Hospital against the 2008 results from the United Kingdom National Adult Cardiac Surgical Database Report, with alert and alarm lines set at 99.0% and 99.9% respectively.
- The first plot shows that the crude mortality at Queen Mary Hospital rate (2.4%) fell well within the alert lines. Although it was slightly higher than the average from United Kingdom, the rate is not adjusted to take account of the patients' risk profile.
- The second chart places the Queen Mary Hospital bleeding rate in the context of United Kingdom results. Queen Mary Hospital's re-operation rate was 2.1%, which was between the alert lines of the funnel plot, and actually lower than the average reported from the United Kingdom database.
- The third and fourth charts represent the crude stroke rate and the proportion of patients that need haemofiltration / dialysis for acute renal failure; the rates for both of these outcomes at Queen Mary Hospital fell well within the funnel plot alert lines, and almost exactly on the United Kingdom average line.
- There is evidence that the results for these four outcomes at Queen Mary Hospital are in line with internationally-published results from the United Kingdom.

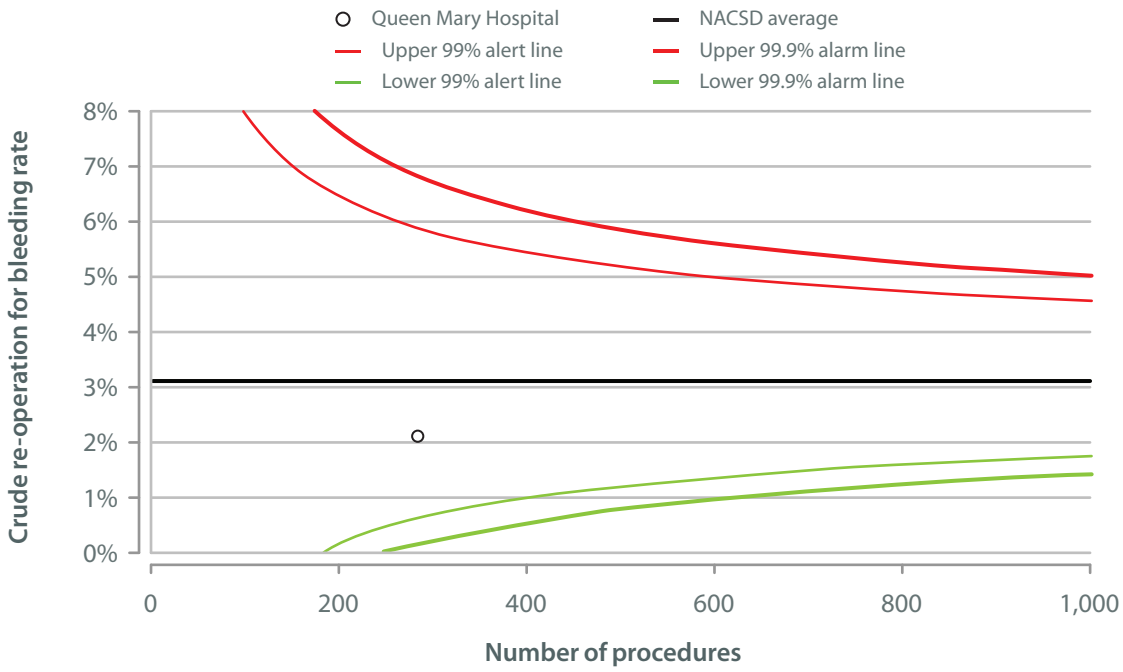
In-hospital mortality

Fig. 5.11 **Isolated CABG: Crude mortality rate for QMH (n=286) compared to the data from the financial year 2008 in the United Kingdom NACSD**



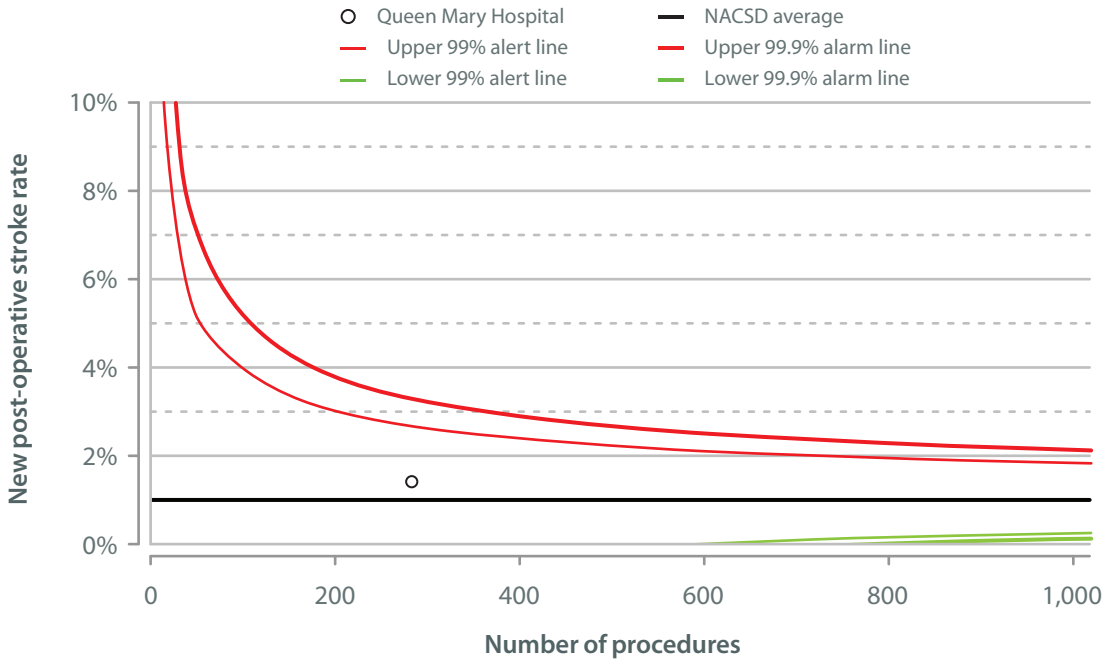
Re-operation for bleeding

Fig. 5.12 **Isolated CABG: Crude re-operation for bleeding rate for QMH (n=284) compared to the data from the financial year 2008 in the United Kingdom NACSD**



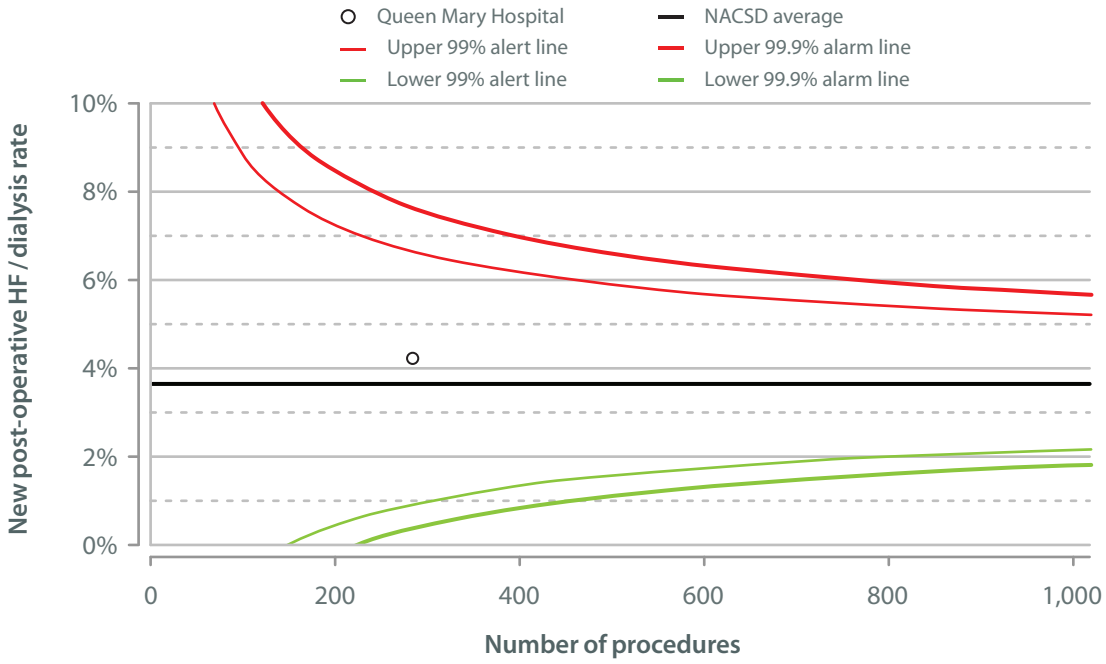
Post-operative stroke

Fig. 5.13 **Isolated CABG: Crude post-operative stroke rate for QMH (n=283) compared to the data from the financial year 2008 in the United Kingdom NACSD**



New haemofiltration / dialysis

Fig. 5.14 **Isolated CABG: New post-operative HF / dialysis rate for QMH (n=284) compared to the data from the financial year 2008 in the United Kingdom NACSD**



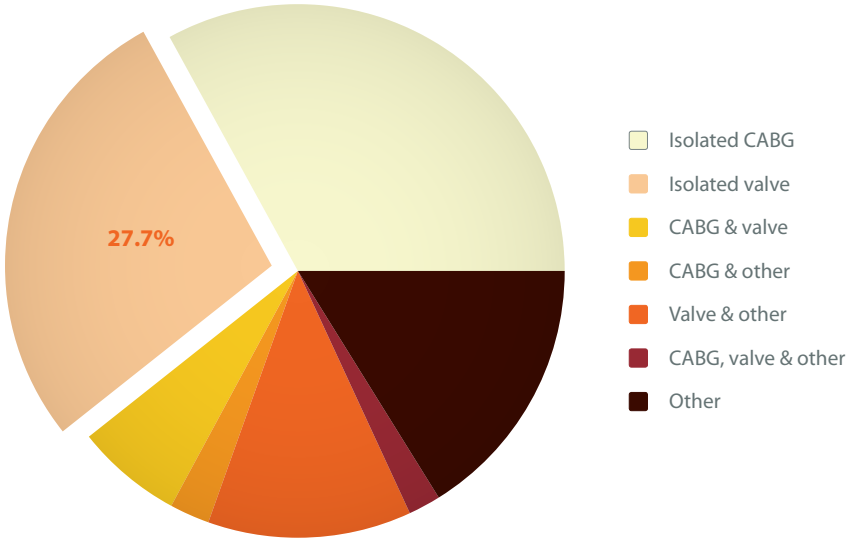
Isolated valve surgery

Isolated single valve surgery

Isolated valve surgery in the context of overall workload

- During the year 2010 & 2011, there were 240 isolated valve operations performed at Queen Mary Hospital, contributing to 27.7% of the overall workload.
- Other than that, there were 180 (20.8%) valve operations performed in combination with the other procedures like CABG, radiofrequency atrial ablation, aortic surgery, septal defect repair, *etc.*
- Among the 240 isolated valve operations, there were 11 isolated tricuspid valve operations and 11 isolated pulmonary valve operations.

Fig. 6.1 **Workload overview (n=867)**



Priority

- There were 151 isolated single valve operations performed during the year 2010 & 2011.
- 135 out of 151 (89.4%) isolated single valve operations were performed electively.
- The remaining urgent or emergency operations were carried out for infection, jammed mechanical valves, acute decompensated heart failure or patients with unstable haemodynamics.

Isolated single valve surgery: operative urgency distribution

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Priority	Elective	56	57	22
	Urgent	5	5	0
	Emergency	3	3	0
	All	**64**	**65**	**22**

Previous cardiac surgery

- In all isolated single valve operations, 41 out of 151 (27.7%) had previous cardiac operations.
- In all isolated multiple valve operations, 30 out of 89 (33.7%) had previous cardiac surgeries.
- Among those redo cardiac operations, some of them are second or more redo operations.

Isolated single valve surgery: prior cardiac surgery

		Valve treated			
		Aortic alone	Mitral alone	Other singles	**All**
Previous surgery	No previous cardiac surgery	58	51	1	**110**
	Previous cardiac surgery	6	14	21	**41**
	All	**64**	**65**	**22**	**151**

Haemodynamic pathology

- Over 50% isolated aortic valve operations were for patients with aortic stenosis.
- For patients who had isolated aortic valve replacement, 20 out of 64 (31.3%) received biological valves while remaining 44 (68.7%) received mechanical prostheses.
- In all patients who had isolated mitral valve surgery, 67.7% of them had mitral regurgitation.

Isolated single valve surgery: haemodynamic pathology distribution

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Haemodynamic pathology	Stenosis	33	14	0
	Regurgitation	18	44	16
	Mixed	12	5	1

Native valve pathology

- Calcific degenerative disease (46.9%) and bicuspid aortic valve disease (43.8%) represented the two most common pathology for aortic valve operations.
- While for the isolated mitral valve surgery, more than half were for degenerative changes (56.9%), and nearly a quarter were for chronic rheumatic changes (24.6%), and these 2 etiologies were the two major causes for mitral valve surgery in this locality.
- There were 2 cases of aortitis in this cohort.

Isolated single valve surgery: native valve pathology distribution

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Native valve pathology	Native valve not present	3	3	0
	Congenital	28	1	9
	Degenerative	17	37	1
	Active infective endocarditis	4	5	0
	Previous infective endocarditis	0	8	0
	Rheumatic	6	16	7
	Annuloaortic ectasia	4	0	0
	Calcific degeneration	30	1	0
	Ischaemic	0	1	0
	Functional regurgitation	0	0	4
	Other	2	1	0

Mitral valve repair

Mitral valve repair in the context of all mitral valve surgery

- For isolated valve surgery, there were 136 operations involving mitral valve in year 2010 & 2011.
- Out of these 136 operations, 71 (52.2%) were operated for regurgitant valves. The rest of them were mainly for rheumatic mitral stenosis, which is still a common pathology in this locality.
- Mitral valve repair is always the procedure of choice for treatment of mitral regurgitation in Queen Mary Hospital. The goals of valve repair include preservation of leaflet mobility, restoration of leaflet coaptation and stabilization of repair with remodeling annuloplasty.
- Based on The Society for Cardiothoracic Surgery (SCTS) in Great Britain & Ireland 6th National Adult Cardiac Surgical Database Report, in 2008, 67% underwent mitral valve repair for degenerative mitral valve disease.
- Our proportion of mitral valve repair surgery was comparable to international benchmark. During the year 2010 to 2011, 58 out of 71 (81.7%) regurgitant mitral valves were successfully repaired.

Mitral valve surgery: haemodynamic pathology and type of valve procedure

		Haemodynamic pathology		
		Stenosis	Regurgitation	Mixed
Valve treated	Replacement	43	13	18
	Repair	0	58	0
	All	**43**	**71**	**18**

Type of mitral vale repair

- All isolated mitral valve repair operations were complex repairs, involving two or more repair procedures.
- The reconstructive techniques are systematic that involve intra-operative valve inspection & analysis, meticulous application of repair techniques, implantation of remodeling annuloplasty and finally evaluation of repair by saline test and transesophageal echocardiogram.
- More than 90% of mitral valve repair operations had ring annuloplasty.
- Nearly 60% of operations had implanted one or more artificial chords.

Isolated valve surgery involving the mitral valve repair: type of valve repair

		Data	
		Count	Rate
Type of mitral valve repair	Commisurotomy	3	5.8%
	Annuloplasty (ring)	48	92.3%
	Annuloplasty (suture)	1	1.9%
	Leaflet resection	19	36.5%
	Leaflet extension	1	1.9%
	Chordal transfer	3	5.8%
	Chordal shortening	0	0.0%
	Artificial chord	30	57.7%
	Papillary muscle repositioning	0	0.0%
	Decalcification/debridement	1	1.9%
	Leaflet patch	3	5.8%
	Sub-valvar release	5	9.6%
	Re-suspension	2	3.8%
	Other	0	0.0%

Tricuspid valve repair

Tricuspid vale repair in the context of all triscupid valve surgery

- At tricuspid valve position, repair surgery is the preferred technique for correcting tricuspid regurgitation because of its better surgical outcome and lower mortality.
- Tricuspid valve surgery mirror the surgical techniques used in mitral valve repair surgery.
- Most of the tricuspid valve surgery (85.5%) were performed in the presence of other valves pathology.
- Majority of the tricuspid valve alone operations were redo operations for rheumatic etiology, few of them were due to infective endocarditis.
- In our cohort, 73 out of 76 (96%) tricuspid valve pathology were being repaired.

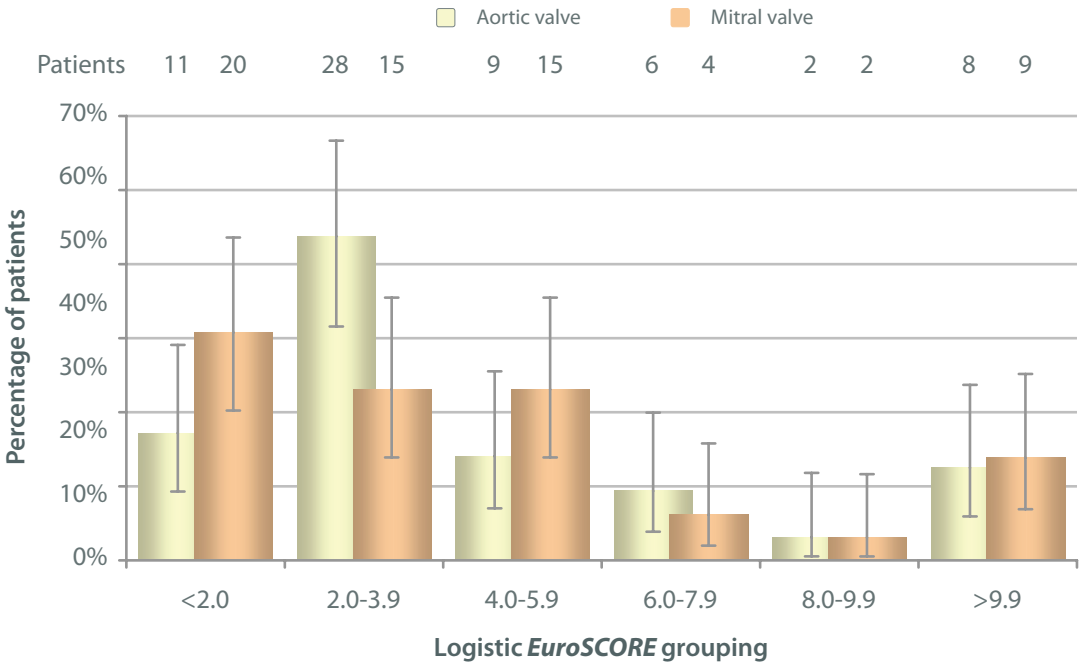
Isolated valve surgery involving the tricuspid valve: type of valve procedure

		Tricuspid valve procedure		
		Replacement	Repair	All
Valve treated	Tricuspid alone	2	9	**11**
	Tricuspid plus another valve	1	64	**65**
	All that include tricuspid valve surgery	**3**	**73**	**76**

Logistic *EuroSCORE*

- Using the logistic ***EuroSCORE***, most of our isolated single valve surgery had the predicted operation risks between 2-4%.
- While only around 15% of patients had their predicted risks greater than 9.9%.
- The mean ICU stay after isolated aortic valve surgery and mitral valve surgery were 2.4 days and 2.2 days respectively.
- The predicted risk for isolated aortic valve surgery alone in this cohort was $^{3.5}/_{64}$= 5.5%.
- The predicted risk for isolated mitral valve surgery alone in this cohort was $^{4.1}/_{65}$= 6.3%.
- The predicted risk for all single valve (Aortic + Mitral) in this cohort was $^{8.9}/_{129}$= 6.9%.

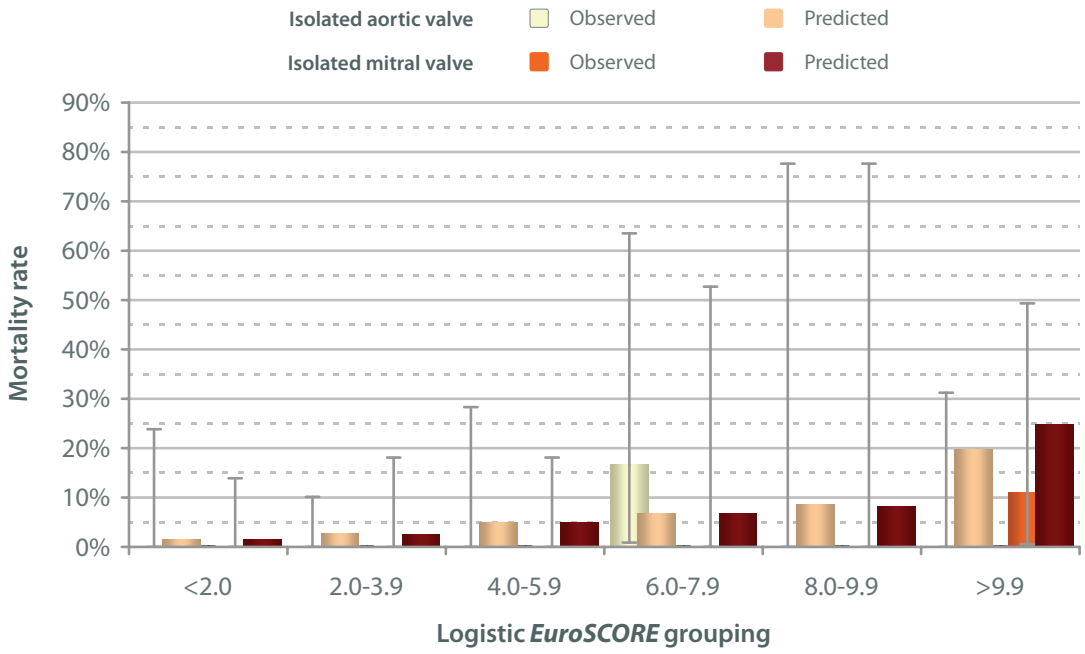
Fig. 6.2 **Isolated single valve surgery: Logistic *EuroSCORE* (n=129)**



Mortality

- There were 2 deaths following single valve surgery:
  - a 75-year-old male patient who had an isolated AVR; ***EuroSCORE*** = 6.8
  - a 78-year-old NYHA 4 female patient who had an emergency MVR; ***EuroSCORE*** = 63.8
- The observed mortality for isolated aortic valve surgery was 1/64=1.6% and observed/predicted ratio was 0.29
- The observed mortality for isolated mitral valve surgery was 1/65= 1.5% and observed/predicted ratio was 0.24
- The observed mortality for all single valve (aortic + mitral) was 2/129= 1.6% and the observed/ predicted ratio was 0.23
- The observed mortality was lower than the predicted mortality in all groups of valvular patients.

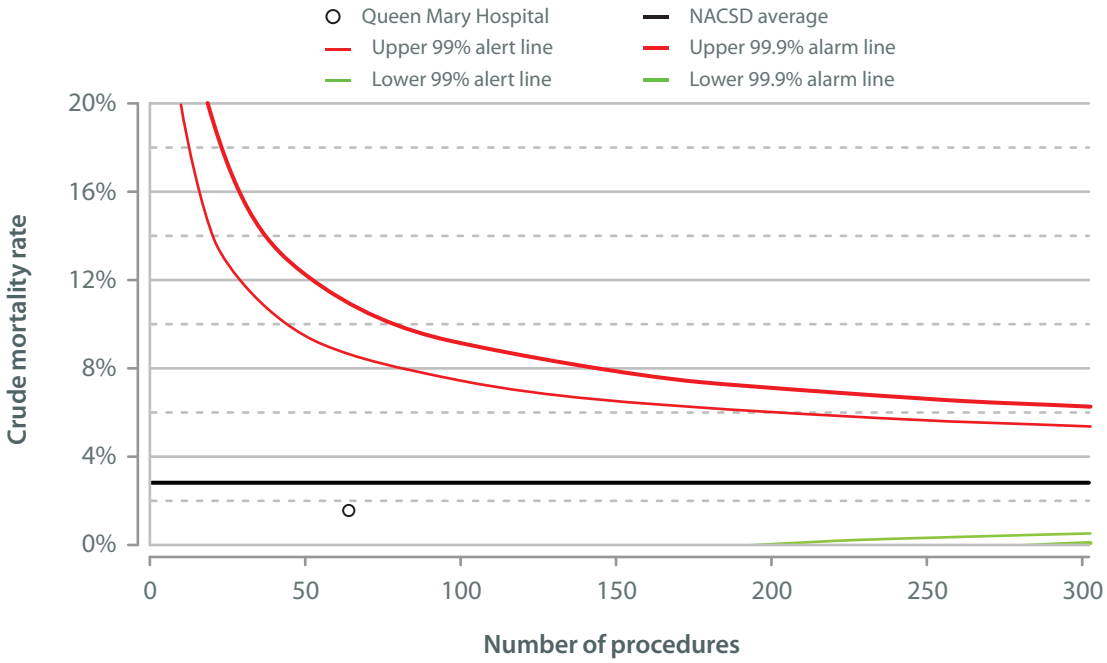
Fig. 6.3 **Isolated single valve surgery: Mortality and logistic *EuroSCORE* (n=129)**



International benchmarking of mortality

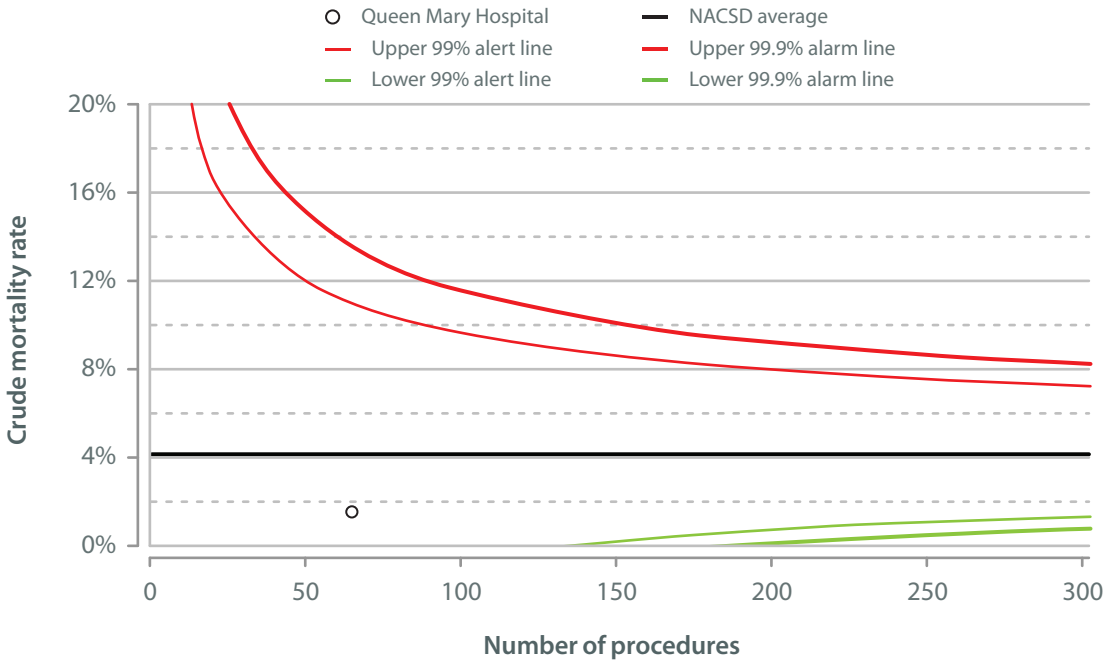
- The graph here is a funnel plot of in-hospital crude mortality for isolated aortic valve surgery, with alert lines and United Kingdom National Adult Cardiac Surgical Database (2008) average line.
- The crude mortality in isolated aortic valve was 1.6%, which was lower than the average mortality in United Kingdom. And this number fell in the normal distribution.

Fig. 6.4 **Isolated aortic valve surgery: Crude mortality rate for QMH (n=64) compared to the data from the financial years 2004-2008 in the United Kingdom NACSD**



- The graph here is a funnel plot of in-hospital crude mortality for isolated mitral valve surgery, with alert lines and United Kingdom National Adult Cardiac Surgical Database (2008) average line.
- The crude mortality in isolated mitral valve surgery was 1.5%, which fell in the normal distribution and lower than the average from United Kingdom.

Fig. 6.5 **Isolated mitral valve surgery: Crude mortality rate for QMH (n=65) compared to the data from the financial years 2004-2008 in the United Kingdom NACSD**



Isolated multiple valve surgery

Valves treated

- There were 83 patients having multiple valve surgery contributing to 34.6% (83/240) of the overall isolated valve operations.
- Among these 83 patients, more than 20% (18/83) had triple valve surgery.

Isolated multiple valve surgery: valves treated

		Valve treated		
		Male	Female	**All patients**
Valves treated	Aortic & mitral	8	10	**18**
	Aortic & tricuspid	4	6	**10**
	Mitral & tricuspid	11	24	**35**
	Pulmonary & tricuspid	1	1	**2**
	Aortic, mitral & tricuspid	6	12	**18**
	All	**30**	**53**	**83**

Mortality

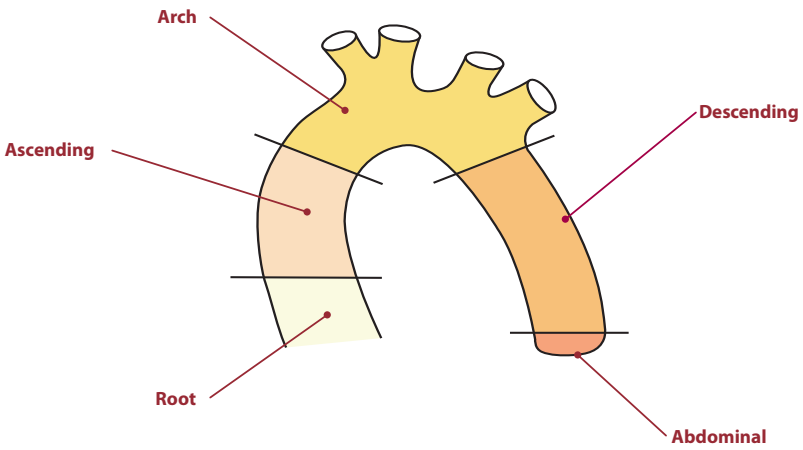
There were only 3 deaths in this group: all were female patients undergoing elective surgery:

- The first patient had a combined mitral valve repair & tricuspid valve repair; she was a 65-year-old patient, with a NYHA grade of 3 and a logistic ***EuroSCORE*** of 3.1; she had not had any cardiac surgery in the past.
- The second patient had a combined mitral valve replacement & tricuspid valve repair; she was a 46-year-old patient, with a NYHA grade of 3 and a logistic ***EuroSCORE*** of 5.5; she had had a cardiac surgical procedure in the past.
- The third patient had a combined aortic valve replacement, mitral valve replacement & tricuspid valve repair; she was a 59-year-old patient, with a NYHA grade of 3 and a logistic ***EuroSCORE*** of 14.5; she had had a cardiac surgical procedure in the past.

Other procedures

Surgery on the aorta

Segments treated



Surgery on the aorta: number and details of segments treated

			Cardiac procedure group				
			CABG & Other	Valve & other	CABG, valve & other	Other [1]	**All**
Segments treated	1	Root	2	7	3	5	**17**
		Ascending	2	7	3	40	**52**
		Arch	0	0	0	2	**2**
		Descending	0	1	0	2	**3**
		Abdominal	0	0	0	0	**0**
	2	Root & ascending	1	6	0	5	**12**
		Ascending & arch	1	1	0	6	**8**
		Descending & abdominal	1	0	0	0	**1**
	3	Root, ascending & arch	0	1	0	1	**2**
		All	**7**	**23**	**6**	**61**	**97**

1. Includes surgery aorta ± another procedure (other than CABG and valve surgery).

Surgical technique

- In aortic surgery involving the ascending aorta and the aortic arch, the preferred cannulation site is through the axillary or subclavian artery, both in emergency and elective settings, to achieve antegrade flow to end-organs and avoid obliterations of the true lumen, which is more seen in retrograde arterial perfusion.
- In aortic aneurysm with no dissection, femoral artery and ascending is still used for arterial cannulation.
- Descending thoracic aorta has also been used as a cannulation site for cases where a left thoracotomy is required
- 60 patients required deep hypothermic circulatory arrest (DHCA)
- 98.3% (59 out of 60) of DHCA had antegrade cerebral perfusion *via* direct cannulation of the neck vessels at the aortic arch for cerebral protection.
- Cerebral oximetry with near infra-red spectrometry was used through out the operation to assess adequacy of cerebral oxygenation

Surgery on the aorta: cannulation

		Count
Arterial cannulation	Ascending aorta	31
	Axillary / subclavian	50
	Femoral	21
	Other	1
	All	**97**

		Count
Venous cannulation	Right atrial	5
	RA / IVC 2-stage	71
	Bi-caval	7
	Femoral	18
	All	**97**

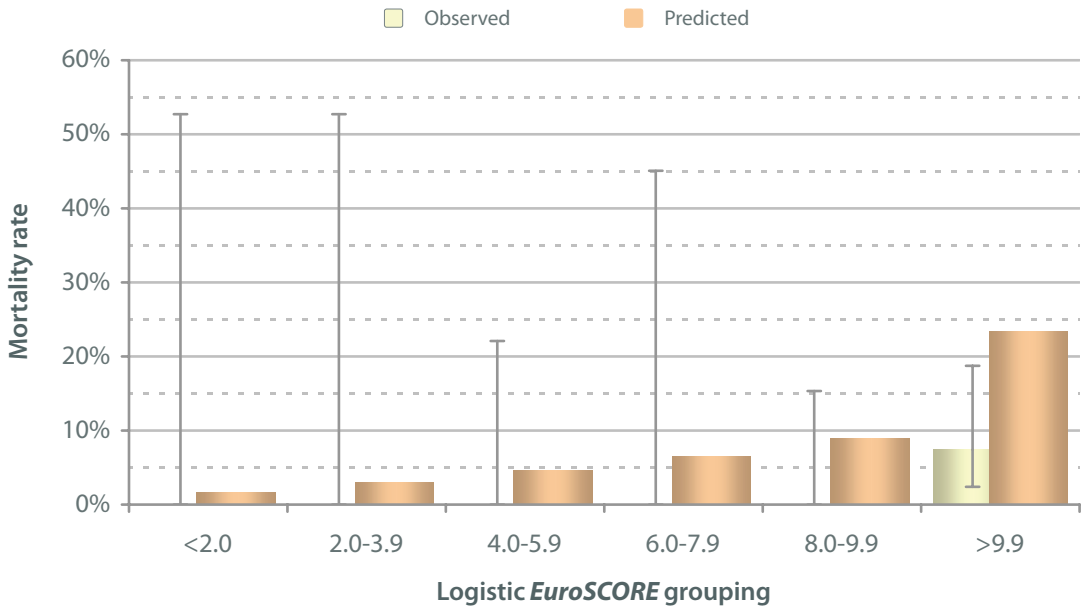
Surgery on the aorta: cerebral perfusion

		Count
Cerebral perfusion	None	30
	Antegrade	59
	Retrograde	1

Mortality and morbidity

- Out of the 97 patients operated, there were 3 (3.1%) transient ischaemic attacks and 7 (7.2%) cerebral vascular accidents.
- 15 (15.5%) required reopen for haemostasis.
- 4 (4.1%) patients required renal replacement therapy.
- Predicted mortality of aortic surgery was 15.7% by using logistic ***EuroSCORE***. The observed mortality was 4.1%. Predicted / observed mortality ratio was 0.26 in our centre.
- All 4 deceased patients fell in the highest risk group.

Fig. 7.1 **Surgery on the aorta: Mortality and logistic *EuroSCORE* distribution (n=97)**



Other cardiac procedures

Adult congenital

- In this report, we have defined surgery for adult congenital heart disease as patients >18 years-old who underwent surgery for congenital heart conditions.
- Any patients <18 years of age undergoing surgery for congenital heart conditions will be included in the paediatric population and therefore will not be reported in this section.
- In 2010 and 2011, 50 and 41 patients respectively underwent surgery for congenital heart conditions. Amongst these, 17 were repair of atrial septal defects (ASD), 15 were repair of ventricular septal defects (VSD), 25 were procedures on the right ventricular outflow tract with or without pulmonary valve replacement (PVR), 4 were heart transplantation, and the others include complex repair including surgery for Ebstein anomaly, aortic surgeries, *etc.*
- There was one mortality reported. This is a 70-year-old patient with secundum ASD, severe pulmonary hypertension and severe tricuspid regurgitation. He was unfortunately complicated by post-operative mediastinitis. Radical wound debridement and flap reconstruction was performed and prolonged antibiotics were given. However, the patient's condition deteriorated and finally succumbed from overwhelming sepsis.

Procedure detail

		Procedure groupings							
		Isolated CABG	Isolated valve	CABG & valve	CABG & other	Valve & other	CABG, valve & other	Other	**All**
Other cardiac procedures	None recorded	284	235	56	9	19	6	59	**668**
	LV aneurysmectomy	0	0	0	1	0	0	1	**2**
	Acquired VSD	0	0	0	1	0	2	0	**3**
	Atrial myxoma	0	0	0	0	0	0	5	**5**
	Pulmonary embolectomy	0	0	0	0	0	0	4	**4**
	Cardiac transplant	0	0	0	0	0	0	21	**21**
	Pulmonary transplant	0	0	0	0	0	0	2	**2**
	Epicardial pacemaker	0	0	0	0	1	0	1	**2**
	Pericardiectomy	0	0	0	1	1	0	0	**2**
	ASD	0	2	0	0	16	0	14	**32**
	Congenital surgery	0	2	0	1	17	1	19	**40**
	Atrial ablation	0	0	0	3	42	5	1	**51**
	Other procedures	2	2	0	5	22	3	19	**53**
	Patient denominator	**286**	**240**	**56**	**21**	**107**	**17**	**140**	**867**

Atrial ablation

Patients and procedures

- 51 atrial ablation were performed in the year 2010 to 2011. All of them were performed with other procedures.
- We adopted the modified Cox-Maze III procedure, using radiofrequency ablation for surgery for atrial fibrillation.
- From our own database in 2005 to 2009, amongst the 122 patients who underwent concomitant radiofrequency ablation for atrial fibrillation during open heart surgery, 77.5% patients were in sinus rhythm at 1 year follow-up. Positive predictors for success in radiofrequency ablation surgery were a left atrial size of < 55mm (p = 0.032) and a patient age < 60 years old (p = 0.004).
- Nowadays, we would offer concomitant radiofrequency ablation during cardiac surgery in all suitable cardiac surgery candidates presenting to us with atrial fibrillation.

Atrial ablation: age and gender

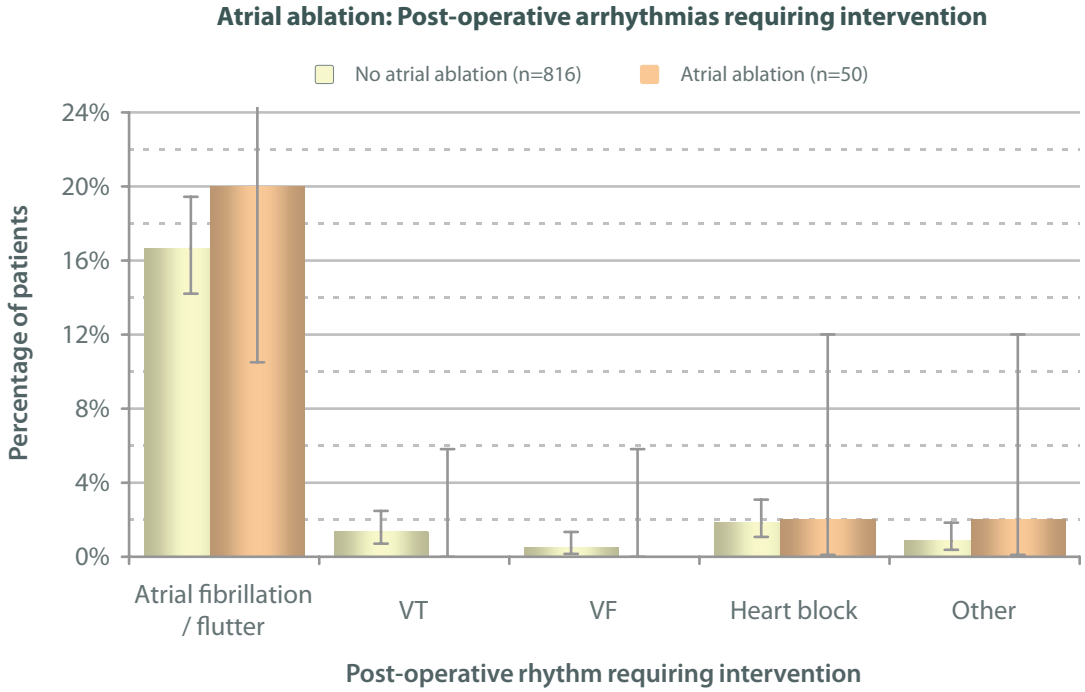
		Gender			
		Male	Female	**All**	Percentage
Age at surgery / years	<56	13	8	**21**	41.2%
	56-60	2	6	**8**	15.7%
	61-65	5	7	**12**	23.5%
	66-70	4	2	**6**	11.8%
	>70	2	2	**4**	7.9%
	All	**26**	**25**	**51**	
	Percentage	51.0%	49.0%		

Outcomes

- No deaths were recorded in the group of patients who had an atrial ablation procedure.
- The immediate post-operative success rate, defined as maintenance of sinus rhythm in the in-patient period, was 74.5% ($^{38}/_{51}$).
- Risk of heart block after atrial ablation was similar to patients without any arrhythmia surgery.

Atrial ablation: post-operative arrhythmia requiring intervention

		Procedure	
		No atrial ablation	Atrial ablation
Post-operative arrhythmia	None	651	38
	Atrial fibrillation / flutter	136	10
	VT	11	0
	VF	4	0
	Heart block	15	1
	Other	7	1



Appendices

Appendices

Database form

Queen Mary Hospital, Hong Kong

Adult Cardiac Surgical Database

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Patient identification and demographics

Hospital number		**Date of birth**	dd / mm / yyyy
Given name		**Date / time of operation**	dd / mm / yyyy hh:mm
Family name		**Gender**	○ 1. Male ○ 2. Female

Admission details & cardiac history

Date of referral	dd / mm / yyyy	**Outpatient clinic**	select from list
Date of admission	dd / mm / yyyy		

Admission category
- ○ 1. Health Authority
- ○ 2. Private

Mode of admission
- ○ 1. Elective
- ○ 2. Planned inpatient transfer
- ○ 3. Emergency

Angina status pre-surgery
- ○ 0. No angina
- ○ 1. No limitation of physical activity
- ○ 2. Slight limitation of ordinary activity
- ○ 3. Marked limitation of ordinary physical activity
- ○ 4. Symptoms at rest or minimal activity

Dyspnoea status pre-surgery
- ○ 1. No limitation of physical activity
- ○ 2. Slight limitation of ordinary activity
- ○ 3. Marked limitation of ordinary physical activity
- ○ 4. Symptoms at rest or minimal activity

Congestive cardiac failure
- ○ 0. Never
- ○ 1. In the past
- ○ 2. Now

Symptom status
- ○ 1. Stable
- ○ 2. Unstable / recent deterioration

Number of previous MIs
- ○ 0. None
- ○ 1. One
- ○ 2. Two or more
- ○ 9. Unknown

Interval between surgery and last MI
- ○ 0. No previous MI
- ○ 1. MI < 6 hours
- ○ 2. MI 6-24 hours
- ○ 3. MI 25-48 hours
- ○ 4. MI 2-30 days
- ○ 5. MI 31-90 days
- ○ 6. MI > 90 days

Previous interventions

Previous PCI
- ○ 0. No previous PCI
- ○ 1. PCI < 24 hours before surgery
- ○ 2. PCI > 24 hours before surgery; same admission
- ○ 3. PCI > 24 hours before surgery; previous admission

Date of last PCI dd / mm / yyyy

Previous cardiac surgery
- ○ 0. No previous cardiac surgery
- ☐ 1. CABG
- ☐ 2. Valve
- ☐ 3. Congenital cardiac
- ☐ 4. Other cardiac
- ☐ 5. Aortic - ascending / arch
- ☐ 6. Aortic - descending / abdominal
- ☐ 7. Other thoracic
- ☐ 8. Carotid endarterectomy
- ☐ 9. Other peripheral vascular

Date of last cardiac operation dd / mm / yyyy

This form is designed so that questions requiring a single response-option are identified with round radio-buttons next to the options, whereas questions where more than one response option may be selected are identified by square tick boxes next to the options

Queen Mary Hospital, Hong Kong

Adult Cardiac Surgical Database

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Hospital number _____ Date of surgery dd / mm / yyyy

Previous interventions

Previous PCI
- ○ 0. No previous PCI
- ○ 1. PCI < 24 hours before surgery
- ○ 2. PCI > 24 hours before surgery; same admission
- ○ 3. PCI > 24 hours before surgery; previous admission

Date of last PCI dd / mm / yyyy

Previous cardiac surgery
- ○ 0. No previous cardiac surgery
- ☐ 1. CABG
- ☐ 2. Valve
- ☐ 3. Congenital cardiac
- ☐ 4. Other cardiac
- ☐ 5. Aortic - ascending / arch
- ☐ 6. Aortic - descending / abdominal
- ☐ 7. Other thoracic
- ☐ 8. Carotid endarterectomy
- ☐ 9. Other peripheral vascular

Date of last cardiac operation dd / mm / yyyy

Risk factors for acquisition of coronary disease

Diabetes
- ○ 0. Not diabetic
- ○ 1. Diet
- ○ 2. Oral therapy
- ○ 3. Insulin

Cigarette smoking history
- ○ 0. Never smoked
- ○ 1. Ex smoker
- ○ 2. Current smoker

Hypercholesterolaemia
- ○ 0. No
- ○ 1. Yes

History of hypertension
- ○ 0. No hypertension
- ○ 1. Treated or BP>140 / 90 on >1 occasion prior to admission
- ○ 9. Unknown

Family history of IHD
- ○ 0. No
- ○ 1. Yes

Renal function / dialysis
- ○ 0. None
- ☐ 1. Functioning transplant
- ☐ 2. Creatinine >200 µmol ℓ^{-1}
- ☐ 3. Dialysis for acute renal failure; onset within 6 weeks of cardiac surgery
- ☐ 4. Dialysis for chronic renal failure; onset more than 6 weeks prior to cardiac surgery
- ☐ 5. Unknown

Hyperthyroidism
- ○ 0. No
- ○ 1. Yes

History of pulmonary disease
- ○ 0. No pulmonary disease
- ☐ 1. COAD / ephysema
- ☐ 2. Asthma
- ☐ 3. Neoplasm
- ☐ 4. Infective lung disease
- ☐ 9. Other

Neurological dysfunction
- ○ 0. No
- ○ 1. Yes

Extra-cardiac arteriopathy
- ○ 0. No
- ○ 1. Yes

This form is designed so that questions requiring a single response-option are identified with round radio-buttons next to the options, whereas questions where more than one response option may be selected are identified by square tick boxes next to the options

Queen Mary Hospital, Hong Kong

Adult Cardiac Surgical Database

Page 3; Version 1.1

Hospital number _____ Date of surgery dd / mm / yyyy

Additional medical history and risk factors

History of gastrointestinal disease
- ○ 0. None
- ☐ 1. Peptic ulcer disease
- ☐ 2. Malignancy
- ☐ 3. Inflammatory bowel disease
- ☐ 4. Major abdominal surgery
- ☐ 5. Other

Major abdominal surgery
- ○ 0. No
- ○ 1. Yes

Pre-operative heart rhythm
- ○ 0. Sinus rhythm
- ○ 1. Atrial fibrillation / flutter
- ○ 2. Complete heart block / pacing
- ○ 3. VF / VT
- ○ 4. Other abnormal rhythm

Saphenous vein
- ○ 0. Normal
- ☐ 1. Minor varicosites
- ☐ 2. Major varicosites
- ☐ 3. Previous varicose vein surgery
- ☐ 4. Previous DVT

Capillary refill (non-dominant hand)
- ○ 0. <5 seconds
- ○ 1. 5-10 seconds
- ○ 2. >10 seconds

Pre-operative haemoglobin _____ g $d\ell^{-1}$

Pre-operative creatinine _____ µmol ℓ^{-1}

Cardiac investigations

Left- or right-heart catheterisation
- ○ 0. Normal
- ☐ 1. Minor varicosites
- ☐ 3. Previous varicose vein surgery

Date of last catheterisation _____ dd / mm / yyyy

Extent of coronary vessel disease
- ○ 0. No vessel with >50% diameter stenosis
- ○ 1. One vessel with >50% diameter stenosis
- ○ 2. Two vessels with >50% diameter stenosis
- ○ 3. Three vessels with >50% diameter stenosis
- ○ 9. Not investigated

Left main stem disease
- ○ 0. No LMS disease or LMS disease <= 50% diameter stenosis
- ○ 1. LMS >50% diameter stenosis
- ○ 9. Not investigated

Left ventricular function _____ %

Ejection fraction category
- ○ 1. Good (LVEF > 50%)
- ○ 2. Fair (LVEF 30-50%)
- ○ 3. Poor (LVEF < 30%)
- ○ 9. Not measured

Ejection fraction estimate based upon
- ☐ 1. Left ventriculogram
- ☐ 2. Echocardiogram
- ☐ 3. MR scan
- ☐ 3. Other investigation

PA systolic _____ mm Hg

AV gradient _____ mm Hg

LVEDP _____ mm Hg

Mean PAWP LA _____ mm Hg

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Queen Mary Hospital, Hong Kong

Adult Cardiac Surgical Database

Page 4; Version 1.1

Hospital number | Date of surgery: dd / mm / yyyy

Pre-operative status and support

IV nitrates or any heparin	○ 0. Never smoked ○ 1. Until operation	○ 2. Within one week of surgery
Pre-operative aspirin [1]	○ 0. No	○ 1. Yes
Pre-operative clopidogrel [1]	○ 0. No	○ 1. Yes
Other anticoagulant	○ 0. No	○ 1. Yes
IV inotropes prior to anaesthesia	○ 0. No	○ 1. Yes
Ventilated	○ 0. No	○ 1. Yes
Cardiogenic shock	○ 0. No	○ 1. Yes

Operation data

Operative urgency	○ 1. Elective ○ 2. Urgent	○ 3. Emergency ○ 4. Salvage

Number of previous heart operations

Responsible consultant anaesthetist — select from list

First operator — select from list

First operator: grade	○ 1. Consultant ○ 2. Professor ○ 3. Associate professor ○ 4. Specialist	○ 5. Associate consultant ○ 6. HST ○ 9. Other
First operator: year of HST	○ 1. Year 1 ○ 2. Year 2 ○ 3. Year 3	○ 4. Year 4 ○ 5. Year 5 ○ 6. Year 6 ○ 8. Not applicable

First assistant — select from list

First assistant: grade	○ 1. Consultant ○ 2. Professor ○ 3. Associate professor ○ 4. Specialist	○ 5. Associate consultant ○ 6. HST ○ 9. Other
First assistant: year of HST	○ 1. Year 1 ○ 2. Year 2 ○ 3. Year 3	○ 4. Year 4 ○ 5. Year 5 ○ 6. Year 6 ○ 8. Not applicable

1. Within the last 7 days

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Queen Mary Hospital, Hong Kong

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Hospital number | Date of surgery: dd / mm / yyyy

Operation data continued …

Chest opened by	select from list
IMA harvested by	select from list
Vein harvested by	select from list
Radial artery harvest by	select from list
Cannulation by	select from list
Chest closed by	select from list

Endoscopic vein harvest

- ○ 0. No
- ○ 1. Yes
- ○ 2. Converted

Endoscopic radial artery harvest

- ○ 0. No
- ○ 1. Yes
- ○ 2. Converted

Arterial cannulation

- ○ 0. Not applicable
- ☐ 1. Ascending aorta
- ☐ 2. Arch
- ☐ 3. Axillary / subclavian
- ☐ 4. Femoral
- ☐ 5. Other

Venous cannulation

- ○ 0. Not applicable
- ☐ 1. Right atrial
- ☐ 2. RA / IVC 2-stage
- ☐ 3. Bicaval
- ☐ 4. Femoral
- ☐ 5. Other

Procedures classified by group

Cardiac procedures

- ○ 1. CABG alone
- ○ 2. CABG & valve
- ○ 3. CABG, valve & other
- ○ 4. CABG & other
- ○ 5. Valve alone
- ○ 6. Valve & other
- ○ 7. Other

Other cardiac procedures

- ○ 0. None
- ☐ 1. LV aneurysmectomy
- ☐ 2. Acquired VSD
- ☐ 3. Atrial myxoma
- ☐ 4. Pulmonary embolectomy
- ☐ 5. Cardiac transplant
- ☐ 6. Pulmonary transplant
- ☐ 7. Cardiac trauma (not iatrogenic)
- ☐ 8. Epicardial pacemaker
- ☐ 9. Pericardiectomy
- ☐ 10. ASD closure
- ☐ 11. Other (for congenital condition)
- ☐ 12. Atrial ablation
- ☐ 19. Other procedure not listed above

Other thoracic & vascular procedures

- ○ 0. None
- ☐ 1. Aortic
- ☐ 2. Peripheral vascular
- ☐ 3. Carotid endarterectomy
- ☐ 4. Other thoracic

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Hospital number | Date of surgery: dd / mm / yyyy

Coronary artery surgery

Number of DCAs [1]

	Graft 1	Graft 2	Graft 3	Graft 4	Graft 5	Graft 6	
Graft site	code	code	code	code	code	code	see below
Coronary quality [3]	code	code	code	code	code	code	see below
Coronary lumen at anastomosis	code	code	code	code	code	code	see below
Graft conduit	code	code	code	code	code	code	see below
Conduit quality	code	code	code	code	code	code	see below
Graft anastomosis	code	code	code	code	code	code	see below

CABG: Graft sites

1 → 1. Prox RCA
2 → 2. Mid RCA
3 → 3. Distal RCA
4 → 4. RCA-PDA
5 → 5. RCA-LV
6 → 6. LMS
7 → 7. Prox LAD
8 → 8. Mid LAD
9 → 9. Distal LAD
10 → 10. Diag 1
11 → 11. Diag 2
12 → 12. Prox Cx
13 → 13. Int
14 → 14. OM1
15 → 15. OM2
16 → 16. Distal Cx
15 → 17. Cx-PDA

CABG: Coronary quality

1 → 1. Good
2 → 2. Moderate / patchy disease
3 → 3. Severe / diffuse disease
4 → 4. Endarterectomy required

CABG: Coronary lumen

1 → 1. <1.5 mm
2 → 2. 1.5-2.0 mm
3 → 3. >2.0 mm

CABG: Graft conduits

1 → 1. Pedicle LIMA
2 → 2. Pedicle RIMA
4 → 4. Free LIMA
5 → 5. Free RIMA
7 → 7. Radial artery
8 → 8. Long SV
9 → 9. Short SV
11 → 11. Other artery
12 → 12. Other vein

CABG: Conduit quality

1 → 1. Good
2 → 2. Moderate
3 → 3. Poor

CABG: Graft anastomosis

2 → 2. End-to-side
3 → 3. Side-to-side

2. Distal coronary anastomoses
3. At and beyond the anastomosis

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Hospital number | Date of surgery: dd / mm / yyyy

Valve surgery

Number replaced / repaired

	Aortic	Mitral	Tricuspid	Pulmonary
Haemodynamic pathology	1. Stenosis 2. Regurgitation 3. Mixed	1. Stenosis 2. Regurgitation 3. Mixed	1. Stenosis 2. Regurgitation 3. Mixed	1. Stenosis 2. Regurgitation 3. Mixed
Native valve pathology	code	code	code	code
Other native valve pathology	text	text	text	text
Explant valve type	1. Native valve 2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Ring	1. Native valve 2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Ring	1. Native valve 2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Ring	1. Native valve 2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Ring
Reason for repeat valve operation	1. Thrombosis 2. Dehiscence 3. Embolism 4. Infection 5. Intrinsic failure 6. Haemolysis 19. Other reason	1. Thrombosis 2. Dehiscence 3. Embolism 4. Infection 5. Intrinsic failure 6. Haemolysis 19. Other reason	1. Thrombosis 2. Dehiscence 3. Embolism 4. Infection 5. Intrinsic failure 6. Haemolysis 19. Other reason	1. Thrombosis 2. Dehiscence 3. Embolism 4. Infection 5. Intrinsic failure 6. Haemolysis 19. Other reason
Other reason for repeat	text	text	text	text
Valve procedure	1. Replacement 2. Repair	1. Replacement 2. Repair	1. Replacement 2. Repair	1. Replacement 2. Repair
Valve repair procedures	codes	codes	codes	codes
Valve implant type	2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Annulopl. ring	2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Annulopl. ring	2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Annulopl. ring	2. Mechanical 3. Biological 4. Homograft 5. Autograft 6. Annulopl. ring
implant prosthesis name				
implant prosthesis model				
Implant prosthesis serial number				
implant prosthesis size	mm	mm	mm	mm

Valve surgery: native valve pathology

0 → 0. Native valve not present
1 → 1. Congenital
2 → 2. Degenerative
3 → 3. Active infective endocarditis
4 → 4. Previous infective endocarditis
5 → 5. Rheumatic
6 → 6. Annuloaortic ectasia
7 → 7. Calcific degeneration
8 → 8. Ischaemic
9 → 9. Functional regurgitation
19 → 19. Other native valve pathology

Valve surgery: valve repairs

1 → 1. Commisurotomy
2 → 2. Annuloplasty (ring)
3 → 3. Annuloplasty (suture)
4 → 4. Leaflet resection
5 → 5. Leaflet extension
6 → 6. Chordal transfer
7 → 7. Chordal shortening
8 → 8. Artificial chord
9 → 9. Papillary muscle repositioning
10 → 10. Decalcification / debridement
11 → 11. Leaflet patch
12 → 12. Sub-valvar release
13 → 13. Re-suspension
19 → 19. Other

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Adult Cardiac Surgical Database

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Hospital number | Date of surgery: dd / mm / yyyy

Major aortic procedure data

Number of aorta segments

	Root	Ascending	Arch	Descending	Abdominal	
Aortic pathology	code	code	code	code	code	see below
Aortic procedure	code	code	code	code	code	see below

Major aortic: pathology

1 → 1. Aneurysm
2 → 2. Syphilis
3 → 3. Dissection
4 → 4. Transection
5 → 5. Coarctation
6 → 6. Atheromatous
7 → 7. Marfan's
9 → 9. Mycotic
10 → 10. Other connective tissue disorders
11→ 11. Congenital
12 → 12. Infection - native
13 → 12. Infection - graft
99 → 99. Unknown

Major aortic: procedure

1 → 1. Interposition tube graft
2 → 2. Tube graft + separate AVR
3 → 3. Root replacement + composite valve graft & coronary re-implantation
4 → 4. Root replacement + preservation of native valve & coronary re-implantation
5 → 5. Homograft root replacement
6 → 6. Autograft root replacement (Ross procedure)
7 → 7. Aortic patch graft
8 → 8. Sinus of Valsalva repair
9 → 9. Reduction aortoplasty

Status at the end of the procedure

Native rhythm
- ○ 1. Sinus rhythm
- ○ 2. Atrial fibrillation / flutter
- ○ 3. Nodal rhythm
- ○ 4. Heart block
- ○ 5. Other

Pacing
- ○ 0. None
- ○ 1. Atrial
- ○ 2. Ventricular
- ○ 3. Dual chamber

Inotropes
- ○ 0. None
- ○ 1. Low dose (<10 ml hr^{-1})
- ○ 2. High dose (>10 ml hr^{-1})

Closure

Arterial cannulation
- ○ 0. Not applicable
- ☐ 1. Atrial
- ☐ 2. Ventricular

Drains
- ☐ 1. Mediastinal
- ☐ 2. Pericardial
- ☐ 3. Left pleural
- ☐ 4. Right pleural

Sternal closure
- ○ 1. Routine
- ○ 2. Modified

Intra-operative TOE
- ○ 0. No
- ○ 1. Yes

TOE findings

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Hospital number | Date of surgery: dd / mm / yyyy

Cardiopulmonary support

Cardiopulmonary bypass	○ 0. No	○ 1. Yes	
Conversion to off pump	○ 0. No	○ 1. Yes	
Predominant method of myocardial protection	○ 0. Non-cardioplegic	○ 1. Cardioplegia	
Cardioplegia: solution	○ 1. Blood	○ 2. Crystalloid	○ 8. Not applicable
Cardioplegia: temperature	□ 1. Cold	□ 2. Warm	○ 8. Not applicable
Cardioplegia: infusion mode	□ 1. Antegrade	□ 2. Retrograde	○ 8. Not applicable
Cardioplegia: timing	○ 1. Intermittent	○ 2. Continuous	○ 8. Not applicable
Hot shot	○ 0. No	○ 1. Yes	

Non-cardioplegic myocardial protection
- ○ 1. Aortic cross clamping with fibrillation
- ○ 2. Fibrillation with perfusion
- ○ 3. Cross clamp with direct coronary perfusion
- ○ 4. Cross clamp and beating heart
- ○ 5. Beating heart without cross clamp

Chest opened by: select from list

Lowest systemic temperature: ℃

Antegrade highest concentration:

Intra-aortic balloon pump used	○ 0. No	□ 2. Intra-operation
	□ 1. Pre-operation	□ 3. Post-operation
Reason for IABP use	○ 1. Haemodynamic instability	○ 3. CPB wean
	○ 2. Unstable angina	○ 4. Prophylactic

IABP serial number:

Date IABP removed: dd / mm / yyyy

Transamin	○ 0. No	○ 1. Yes
Novo 7	○ 0. No	○ 1. Yes
Filtration	○ 0. No	○ 1. Yes

Volume filtered: ml

Height: cm

Weight: kg

Cumulative bypass time: min

Cumulative cross clamp time: min

Total circulatory arrest time: min

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Adult Cardiac Surgical Database

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Hospital number | Date of surgery: dd / mm / yyyy

Cardiopulmonary support continued …

Cerebral perfusion during HCA
- ○ 0. None
- ○ 1. Antegrade
- ○ 2. Retrograde

Cell salvage used
- ○ 0. No
- ○ 1. Yes

Volume heparinized saline	ml
Other volume (blower mister etc)	ml
Blood from circuit	ml
Volume processed	ml
Volume re-infused	ml
Perfusion notes	

Blood products used

Blood	units
Platelets	units
FFP	units
Cryoprecipitate	units

Post-operative course (CCU)

PA catheter
- ○ 0. No
- ○ 1. Yes

Inotropes
- ○ 0. None
- ☐ 1. Dopamine
- ☐ 2. Dobutamine
- ☐ 3. Adrenaline
- ☐ 4. Noradrenaline
- ☐ 5. Vasopressin
- ☐ 6. Milrinone
- ☐ 7. Enoxamine

Inotropes >5 ml hour^{-1}
- ○ 0. No
- ○ 1. Yes

Vasoconstrictor >5 ml hour^{-1}
- ○ 0. No
- ○ 1. Yes

Chest drainage (first 24 hours)	ml
Date of discharge from CCU	dd / mm / yyyy

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Queen Mary Hospital, Hong Kong

Adult Cardiac Surgical Database

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Hospital number _____ Date of surgery dd / mm / yyyy

Post-operative course

Post-operative complications
- ○ 0. No
- ○ 1. Yes

Re-admission to CCU
- ○ 0. No
- ○ 1. Yes

Return to theatre
- ○ 0. No re-operation necessary
- ☐ 1. Re-operation for bleeding or tamponade
- ☐ 2. Re-operation for valvular problems
- ☐ 3. Re-operation for graft problems
- ☐ 4. Re-operation for other cardiac problems
- ☐ 5. Sternum resuturing (sterile)
- ☐ 6. Surgery for deep sternal wound infection

Arrhythmias requiring intervention
- ○ 0. None
- ☐ 1. Atrial fibrillation / flutter
- ☐ 2. VT
- ☐ 3. VF
- ☐ 4. Heart block
- ☐ 5. Other

Intervention
- ☐ 1. Pharmocological
- ☐ 2. Electrical cardioversion
- ☐ 3. Permanent pacemaker
- ☐ 4. Other

Secondary airway support
- ○ 0. None
- ☐ 1. Mini-tracheostomy
- ☐ 2. Facial CPAP
- ☐ 3. Re-intubation
- ☐ 4. Tracheostomy

Pulmonary complications requiring intervention
- ○ 0. None
- ☐ 1. Chest infection
- ☐ 2. Pleural effusion
- ☐ 3. Pneumothorax
- ☐ 4. Pulmonary embolus
- ☐ 5. Other

Infective complications
- ○ 0. None
- ☐ 1. Superficial sternal
- ☐ 2. Deep sternal / mediastinal
- ☐ 3. Pulmonary
- ☐ 4. Leg or arm wound
- ☐ 5. Septicaemia
- ☐ 6. Other

Post-operative fever
- ○ 0. No
- ○ 1. Yes

Gastro-intestinal complications
- ○ 0. None
- ☐ 1. GI bleed
- ☐ 2. Perforated peptic ulcer
- ☐ 3. Ischaemic bowel
- ☐ 4. Pancreatitis
- ☐ 5. Ileus requiring intervention
- ☐ 6. Other

Renal impairment
- ○ 0. No
- ○ 1. Yes

New HF / dialysis post-operatively
- ○ 0. No
- ○ 1. Yes

Renal replacement therapy
- ○ 0. No
- ○ 1. Yes

Type of renal replacement therapy
- ☐ 1. Peritoneal dialysis
- ☐ 2. CWH
- ☐ 3. HD

Peak post-operative creatinine _____ μmol ℓ^{-1}

New post-operative stroke
- ○ 0. None
- ○ 1. Yes (prophylatic)
- ○ 2. Yes (clinically indicated)

Post-operative antibiotics
- ○ 0. None
- ○ 1. Transient stoke
- ○ 2. Permanent stroke

Complication notes

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Adult Cardiac Surgical Database

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Hospital number | Date of surgery: dd / mm / yyyy

Discharge

Pre-discharge haemoglobin	g $d\ell^{-1}$
Pre-discharge creatinine	µmol ℓ^{-1}
Aspirin	○ 0. Not given ○ 1. Given ○ 2. Contra-indicated ○ 3. Other antiplatelet given ○ 4. Unknown
Statin	○ 0. Not given ○ 1. Given ○ 2. Contra-indicated ○ 3. Unknown
Warfarin	○ 0. No ○ 1. Yes
Discharge destination from cardiothoracic ward	○ 1. Home ○ 2. Convalescence (Non acute Hospital) ○ 3. Other hospital ○ 4. Not applicable - patient deceased ○ 5. Other specialty
Patient status at discharge	○ 0. Alive ○ 1. Dead ○ 2. Dead (theatre) ○ 3. Dead (ICU) ○ 4. Dead (cardiothoracic ward) ○ 5. Dead (other wards / hospital)
Date of discharge from CTS	dd / mm / yyyy
Date of discharge / death	dd / mm / yyyy

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QMH Score - Components of the additive model

Risk Factor		Score
Age		
	<60	0
	60-64	2
	65-69	2.5
	70-74	3
	>74	4
Renal failure		4
EF<30%		3
Pre-operative Cardiac Conditions		2
Transmyocardial infarction <48hrs		3.5
Congestive cardiac failure		1.5
Endocarditis		2.5
Pulmonary hypertension		2.5
Redo operation		2
Emergency surgery		2
Valves & CABG		2

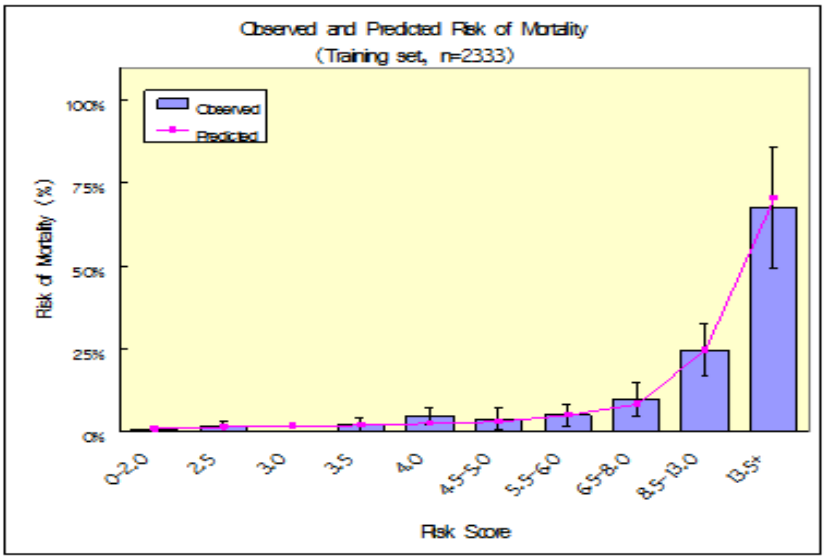
Total _____

Predicted risk of mortality with individual Risk Scores and the distribution of Total Risk Score among patients of Training set (n=2333)

Total Risk Score	Predicted Risk	No. of Patients	Cumulative % of Patients with this risk score or less	Total Risk Score	Predicted Risk	No. of Patients	Cumulative % of Patients with this risk score or less
0	0.47%	426	18.26%	10	23.42%	18	97.34%
1.5	0.87%	319	31.93%	10.5	27.37%	8	97.69%
2	1.07%	182	39.73%	11	31.72%	6	97.94%
2.5	1.31%	199	48.26%	11.5	36.41%	6	98.20%
3	1.61%	182	56.07%	12	41.37%	7	98.50%
3.5	1.98%	195	64.42%	12.5	46.51%	7	98.80%
4	2.43%	271	76.04%	13	51.73%	3	98.93%
4.5	2.98%	106	80.58%	13.5	56.91%	6	99.19%
5	3.64%	24	81.61%	14	61.94%	4	99.36%
5.5	4.45%	83	85.17%	14.5	66.73%	0	99.36%
6	5.43%	79	88.56%	15	71.20%	6	99.61%
6.5	6.61%	68	91.47%	15.5	75.29%	2	99.70%
7	8.03%	18	92.24%	16	78.97%	1	99.74%
7.5	9.71%	25	93.31%	16.5	82.23%	1	99.79%
8	11.70%	21	94.21%	17	85.08%	2	99.87%
8.5	14.04%	30	95.50%	17.5	87.55%	1	99.91%
9	16.76%	8	95.84%	18	89.65%	0	99.91%
9.5	19.88%	17	96.57%	18.5+	>90.00%	2	100.00%

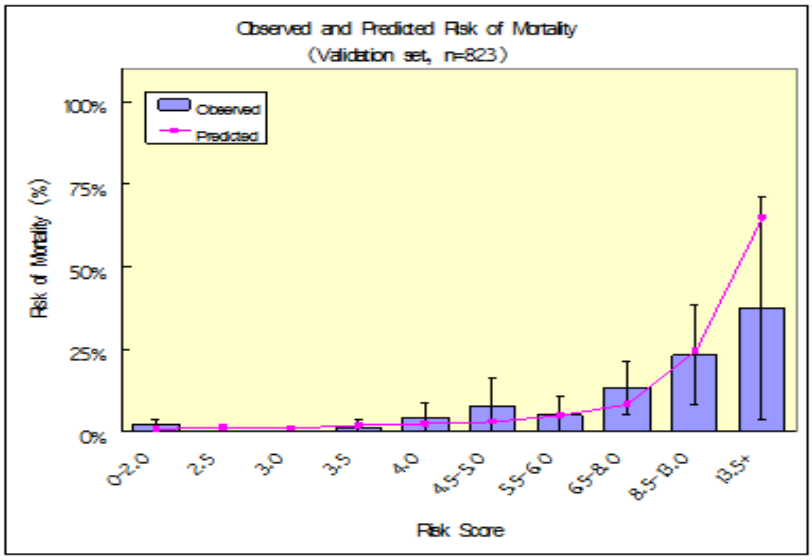
**The highest observed total risk score was 18.5, and there were no patients had total risk score of 14.5 and 18.*

Graph of a comparison of Predicted and Observed mortality (Training set, n=2333)



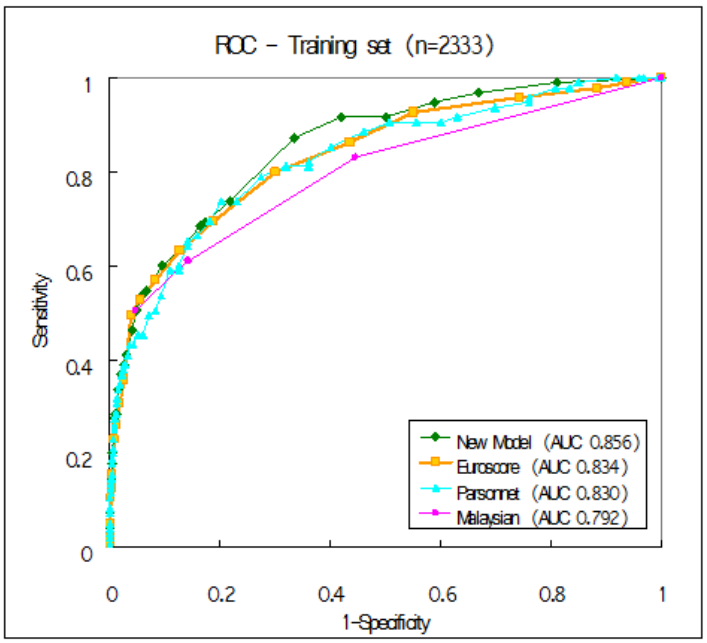
**Narrow vertical bars depict the 95% CI for each observed value*

Graph of a comparison of Predicted and Observed mortality (Validation set, n=823)

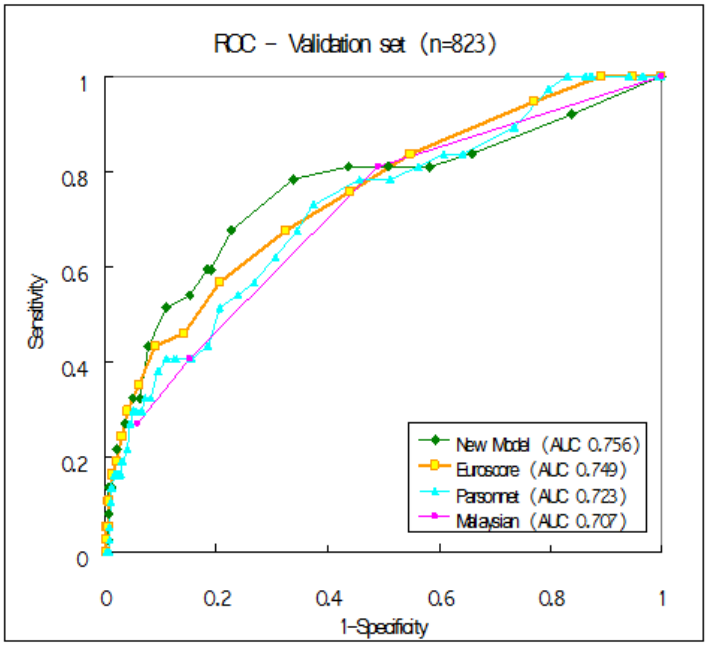


**Narrow vertical bars depict the 95% CI for each observed value*

Comparing different Model ROC – Training Set



Comparing Model ROC – Validation Set



Impact of diabetes on early and mid-term survival after coronary artery bypass graft surgery in the Hong Kong Chinese population

Hong Kong Med J 2009 Jun;15(3):173-8

WK Au; KT Lam; LC Cheng; SW Chiu
Division of Cardiothoracic Surgery, Department of Surgery, University of Hong Kong, Grantham Hospital, Hong Kong

Objective: To determine the impact of diabetes on early and mid-term survival in the Hong Kong Chinese population undergoing coronary artery bypass graft surgery.

Design. Prospective study.

Setting. Regional hospital, Hong Kong.

Patients. A total of 904 consecutive patients following coronary artery bypass graft surgery from November 1999 to December 2003 were prospectively analysed. Among them, 377 (42%) diabetic and 527 (58%) non-diabetic patients were evaluated.

Main outcome measures. Hospital mortality, mid-term mortality, and percutaneous coronary intervention–free survival.

Results: The diabetic group had a higher risk score than the non-diabetic group (mean+/-standard deviation: EuroScore 4.7+/-3.4 and 3.6+/-3.4, respectively; P<0.001). Hospital mortality was 3.4% in the diabetic group compared to 2.9% in the non-diabetic group (P=0.37). Multiple logistic regression analysis identified left ventricular ejection fraction of less than 30% and preoperative intubation as independent risk factors for early hospital death. There were 81 late deaths and the actuarial survival at 48 months for the diabetic and non-diabetic patients were 86% and 90%, respectively (P=0.298). The angina-free survival and percutaneous coronary intervention–free survival at 48 months for the diabetic and non-diabetic patients yielded no statistically significant difference.

Conclusions: Diabetes mellitus was not a predictor of early and mid-term mortality after coronary artery bypass graft surgery in our Chinese

population. Furthermore, diabetes did not affect angina recurrence or intervention free–survival up to 4 years.

Key words
Coronary artery bypass; Coronary disease; Diabetes mellitus; Survival analysis

Mortality prediction in adult cardiac surgery patients: comparison of two risk stratification models.

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Objective: To assess and compare the two commonly applied models, EuroSCORE model and the Parsonnet model in our local adult cardiac surgery patients by quantifying risk factors and relating them to mortality using risk stratification protocol in order to assess the quality of cardiac surgical care.

Design: Prospective study.

Patients: All adult patients undergoing Coronary Artery Bypass Graft Surgery (CABG) and Heart Valve Surgery at the Grantham Hospital were collected prospectively since November 1999.

Main outcome measures: In-hospital mortality was the defined end-point. Statistical analysis consisted of observed vs. expected mortality, Hosmer-Lemeshow goodness-of-fit test for calibration accuracy and Receiver-Operating-Characteristic (ROC) curve for discrimination performance.

Results: From November 1999 to July 2005, 2653 patients underwent either CABG (1247) or heart valve surgery (1406). Observed mortalities in CABG and valve surgery patients in the study were 2.9% and 4.8% respectively. The expected mortalities of CABG and valve surgery patients as predicted by EuroSCORE were 4.0 +/- 3.3% and 5.2 +/- 3.0% respectively and by the Parsonnet model were 5.9 +/- 4.2 % and 7.3 +/- 4.4 % respectively. EuroSCORE performed better than the Parsonnet model at predicting in-hospital mortality assessed by Hosmer-Lemeshow goodness-to-fit test.

Area under the ROC curves in CABG surgery was: EuroScore 0.76, Parsonnet 0.74 and ROC curve areas in valves surgery was: EuroScore 0.77, Parsonnet 0.79.

Conclusion: Despite significant geographic and demographic differences between European and Asian patients, EuroScore performed well with good calibration and discrimination in predicting mortality in our local adult cardiac surgery patients. There was a tendency for both models to over predict. However, EuroSCORE can serve as a baseline for the development of a local risk model.

Key words:
Risk stratification, cardiac surgery, Asian, EuroSCORE, prospective

Predicting major early surgical morbidity and intensive care length of stay (ICLOS) after adult cardiac surgery using the EuroSCORE.

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Introduction: The ability to predict early morbidity and mortality after major cardiac surgery is known to be useful in many areas when providing quality surgical care. The European System for Cardiac Operative Risk Evaluation (EuroSCORE) has been widely validated for predicting in-hospital mortality. Few studies however exist that evaluate the performance of the EuroSCORE in predicting early morbidity. The aim of this study is to evaluate the performance of EuroSCORE in predicting major in-hospital morbidity and the need for prolonged intensive care after cardiac surgery.

Methods: 745 consecutive adult cardiac surgical patients who underwent CABG and/or valve surgery at the Grantham Hospital from July 2004 till December 2005 were included in this study. EuroSCOREs, predefined postoperative in-hospital major morbidity and ICLOS data were collected prospectively and analyzed using SPSS 11. The ability of the EuroSCORE to discriminate outcomes was assessed using C statistic (area under receiver operating characteristic curve) while the calibration was evaluated by the Hosmer-Lemeshow goodness-of-fit statistic.

Results: EuroSCORE showed good discriminatory ability and good calibration in predicting prolonged ICLOS > 3 days (C statistic: 0.713, Hosmer-Lemeshow: $p = 0.43$), need for ventilatory support > 2 days (C statistic: 0.829, Hosmer-Lemeshow: $p = 0.2$), and new postoperative renal failure (C statistic: 0.789, Hosmer-Lemeshow: $p = 0.3$). Its ability to predict the development of postoperative strokes, myocardial infarction, major

sepsis (pneumonia, septicaemia or mediastinitis), and need to reopen for bleeding and/or tamponade were however unsatisfactory.

Conclusions: EuroSCORE can be used to predict prolonged ICU stay and specific morbidities such as the development of new post-operative renal failure and prolonged ventilatory support. And this has clinical implications in terms of providing more detail informed consent, quality of care assessment and hospital resources allocation.

A simple new risk stratification model for adult cardiac surgery in Hong Kong.

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Objective: Significant geographic and demographic differences are obvious between European and Asian patients in adult cardiac surgery. Western population-based risk stratification models may not be optimal for local application. This study aims to develop a simple risk model to predict the in-hospital mortality for patients undergoing coronary artery bypass graft surgery (CABG) and valves surgery in a single institution.

Patients and methods: Between Nov 1999 to May 2006, pre-operative risk factors and in-hospital mortality of 3156 adults undergoing CABG and valves surgery were prospectively collected for analyses. The new risk model was derived from multivariate logistic regression. The discrimination performance was evaluated using Receiver-Operating-Characteristic (ROC) curve.

Results: The overall in-hospital mortality was 4.18%. The risk model included 11 factors, in order of importance (all $P<0.01$), age, renal failure, transmyocardial infarction < 48 hours, left ventricular ejection fraction < 30%, active endocarditis, pulmonary hypertension, redo operation, emergency surgery, combined valve and CABG, critical pre-operative status and congestive heart failure. The new risk model exhibited good discriminated between high- and low-risk patients (ROC curve area 0.856).

Conclusion: This is the first local risk model that predicts in-hospital mortality for adult cardiac surgery in Hong Kong. This model has been

evaluated with good discrimination accuracy. This simple additive non-linear model can provide a useful tool for patient consent and institutional quality assessment. Application of this new model to other local and regional institutions shall be carrying out for further validation.

Key words:
Risk stratification, cardiac surgery, new model, EuroSCORE, prospective