Department of Cardiothoracic Surgery
Adult and Congenital Cardiac Surgery
Biennial Report
2012-2013

Abbreviations List

ABC Level	Aristotle Basic Complexity Level
ABC Score	Aristotle Basic Complexity Score
ASD	Atrial Septal Defect
ASO	Arterial Switch Operation
AVR	Aortic Valve Replacement
AVSD	Atrioventricular Septal Defects
BDCPA	Bidirectional Cavopulmonary Anastomosis
CABG	Coronary Artery Bypass Grafting
CAVSD	Complete Atrioventricular Septal Defects
CHD	Congenital Heart Disease
CPS	Cardiopulmonary support
CPB	Cardiopulmonary Bypass
CUSUM	Cumulative Sum
DCRV	Double-Chambered Right Ventricle
DIRV	Double Inlet Right Ventricle
DORV	Double Outlet Right Ventricle
EACTS	European Association for Cardio-Thoracic Surgery
ECMO	Extracorporeal Membrane Oxygenation
HLHS	Hypoplastic Left Heart Syndrome
HOCM	Hypertrophic Obstructive Cardiomyopathy
IABP	Intra-aortic Balloon Pump
IPCCC	International Pediatric and Congenital Cardiac Code
IVS	Intact Ventricular Septum
LAD	Left Anterior Descending Artery
LIMA	Left Internal Mammary Artery
LV aneurysmectomy	Left Ventricular Aneurysmectomy
MAPCA	Major Aortopulmonary Collateral Arteries
MBTS	Modified Blalock-Taussig Shunt
MVR	Mitral Valve Replacement
NACSD	National Adult Cardiac Surgical Database
O/E Ratio	Observer *versus* Expected ratio
PAB	Pulmonary Artery Banding
PAPVC	Partial Anomalous Pulmonary Venous Connection
PAVSD	Partial Atrioventricular Septal Defect
PCI	Percutaneous Coronary Intervention
PVR	Pulmonic Valve Replacement
QMH	Queen Mary Hospital
SCTS	Society of Cardiothoracic Surgeons

STS	Society of Thoracic Surgeons
TAPVC	Total Anomalous Pulmonary Venous Connection
TAVI	Trans-catheter Aortic Valve Implantation
TCPC	Total Cavopulmonary Connection
TEVAR	Thoracic Endovascular Aortic Repair
TGA	Transposition of the Great Arteries
TOF	Tetralogy of Fallot
TOF, PA	Tetralogy of Fallot, Pulmonary Atresia
VAD	Ventricular Assist Device
VLAD	Variable Life-adjusted Display
VSD	Ventricular Septal Defect

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Our Team

Foreword

I am pleased to present the second adult and congenital cardiac surgery Biennial report of Queen Mary Hospital from 2012 to 2013, which demonstrates that the service has gone from strength to strength, with attention to the very highest standards of quality and safety, and the introduction of innovative practice.

The Cardiothoracic Surgery Department of Queen Mary Hospital always strives for its best to improve clinical quality and maintain public trust in the profession. One of the most important activities to achieve this goal would be recording transparent and benchmarked clinical outcomes data through clinical audits. This second cardiac surgery report marks another important step in this journey.

This report celebrates some of the Department's proudest accomplishments. This is the first published congenital cardiac surgery audit report in Hong Kong. Despite a constant increase in the complexity and risk of surgery, we continue to see improvements in the quality of surgical outcomes. This is reflected in our congenital cardiac operative mortality of 1.63% and an overall observed versus expected mortality of 0.34, which indicates a better than expected performance. The paediatric ECMO program, which commenced in 2012, is also a proven success and we have far exceeded our original target of 10 per year.

Lung transplantation has also increased from around 1 case per year to 3-4 per year since 2012. The establishment of the artificial heart (VAD - Ventricular Assist Device) nursing team together with local and overseas on-job training programs for them aided in providing a better service for our patients. Besides, we have performed around 60 minimally invasive surgeries for heart valves per year and the demand is ever increasing. All these were achieved by the determination of our staff, who took it upon themselves to excel their skills. Their forward-looking approach to emerging technologies will bring the service to new levels of excellence.

For the adult cardiac surgical outcome audit, I can see the challenges of increasing case volume and complexity of surgeries. Our general adult cardiac surgical in-hospital morality observed versus expected ratios ranged from 0.24 to 0.68. Benchmarking of our outcomes compared favourably with the UK and European Association of Cardiothoracic Surgery databases.

I appreciate the enormous contribution made by its dedicated members who have given their persistent contribution throughout these years in spite of working under increasing pressure and a difficult climate. We look forward to the challenge of building further on this success.

Dr C.C. Luk
Hospital Chief Executive,
Queen Mary Hospital

Introduction

Audit of surgical outcomes has been performed in the Department of Cardiothoracic Surgery of Queen Mary Hospital since 2009. We are proud to publish this second biennial report for the years 2012-2013. This is also the first report incorporating the outcomes of paediatric cardiac surgery during the same period.

We adopted the Dendrite Clinical system database for collecting and analysing adult cardiac surgery outcomes. The European Association Cardiothoracic Surgery (EACTS) Congenital Database was used for congenital cardiac surgery data. Both systems are widely used in European countries. Adult and paediatric patients were risk-adjusted according to EuroScore and Aristotle Basic Complexity Score respectively. All team members contributed to data entry while intra-operative data was entered by the respective chief surgeon or first assisting surgeon in order to ensure data accuracy.

Five percent of the 922 adult and 674 congenital surgery patients were randomly selected, validated and cross-checked against hospital charts by a third party. Less than 10% of them had significant data entry errors and more than 95% of them had complete and accurate data entry.

With the support of the Hospital Authority and our dedicated team members data collection and analysis continues. We believe the service and quality will continue to improve through this audit exercise and the resulting transparency of outcome data.

We would like to thank Dr. Li Xin for spearheading the congenital cardiac research and his contribution towards the publication of this report. We are also grateful to Dr. Inderjeet Bhatia for data collection, input, analysis, preparation and publication of the report.

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

Part 1: Adult cardiac surgery

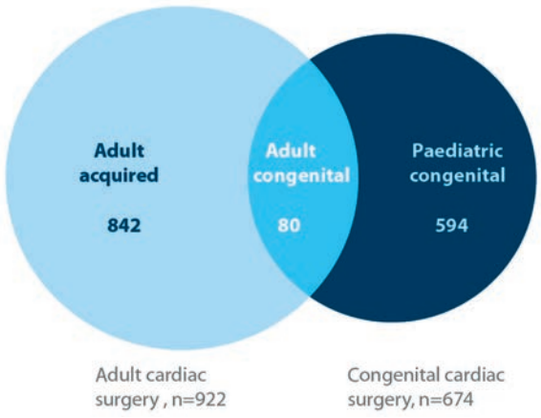
Database overview

Database overview: Adult cardiac surgery

The overall workload at QMH, Hong Kong for the calendar years 2012-2013

Procedure groupings

- All comparisons with the data from the United Kingdom come from results published by the Society for Cardiothoracic Surgeons in Great Britain & Ireland in their Sixth National Adult Cardiac Surgical Database Report 2008, and relate to the most up-to-date data in that document, from the financial year ending 2008.
- In total we have performed 922 Adult Cardiac Surgeries– defined as open heart surgeries in patients older than 18 years.
- The proportion of our Coronary Artery Bypass Graft surgeries (CABG) was lower than that in the UK (32% in QMH vs 58% in UK).
- On the other hand, the proportion of our valve surgeries was higher than in the UK (Isolated Valve + Valve & Others is 40% in QMH vs 23% in UK).
- We also have a higher work load percentage of Adult Congenital Heart Surgery, Aortic Surgery and Heart Transplantation as compared to the UK data under the 'Other' category.



Overall workload at Queen Mary Hospital, Hong Kong: calendar years 2012-2013

		Data		
		Count	Proportion	Proportion in the UK *
Procedure grouping	Isolated CABG	294	31.8%	58.3%
	Isolated valve	229	24.8%	18.9%
	CABG & valve	51	5.5%	11.5%
	CABG & other	29	3.1%	2.0%
	Valve & other	140	15.1%	4.5%
	CABG, valve & other	17	1.84%	1.6%
	Other	162	17.5%	3.2%
	All	**922**		

* Data from financial year 2008; Sixth National Adult Cardiac Surgical Database Report 2008: Demonstrating quality. The Society for Cardiothoracic Surgery in Great Britain & Ireland.

Procedure detail

- The category of *CABG , Valve & Other* refers to Atrial Sepatal Defect (ASD) , Ventricular Septal Defect (VSD) , Aortic Surgery, Atrial Fibrillation Ablation Surgery (MAZE procedure) and Thoracic Resection.
- 3 grafts or more were performed in 257 Isolated CABG surgeries which was higher than the UK data (87% in QMH vs 74% in UK).
- More detailed descriptions and explanations can be found in our CABG and Heart Valves sections.

Procedure detail

			Procedure grouping							
			Isolated CABG	Isolated valve	CABG & valve	CABG & other	Valve & other	CABG, valve & other	Other	**All**
Procedure detail	**CABG surgery**	1 graft	4	0	22	7	0	7	0	**40**
		2 grafts	29	0	10	5	0	3	0	**47**
		3 grafts	186	0	14	11	0	4	0	**215**
		4 grafts	67	0	5	5	0	2	0	**79**
		>4 grafts	4	0	0	0	0	0	0	**4**
	Valve surgery	Aortic alone	0	61	25	0	39	4	0	**129**
		Mitral alone	0	53	12	0	28	7	0	**100**
		Tricuspid alone	0	17	1	0	14	3	0	**35**
		Pulmonary alone	0	0	0	0	7	0	0	**7**
		Aortic & mitral	0	21	5	0	9	0	0	**35**
		Mitral & tricuspid	0	40	7	0	29	2	0	**78**
		Other valve combinations	0	36	1	0	12	0	0	**49**

Other procedure detail

- It is important to remember that the patient may have had more than one of the other procedures. For example, there are 5 patients who had both surgery on the aorta and congenital surgery.
- The group '*other procedures not listed above*' includes all those patients for whom there was another procedure of some kind recorded, but who do not fall into any of the categories listed above such as patients who underwent Hypertrophic Obstructive Cardiomyopathy (HOCM) myomectomy surgery, Extracorporeal Membrane Oxygenation (ECMO) Ventricular Assist Devise (VAD) implantations, thoracic organ resections, atrial reduction plasty, concomitant peripheral vascular procedures and Thoracic Endovascular Aortic/aneurysm Repair (TEVAR) under bypass.

Other procedures performed

		Data	
		Count	Proportion
Other procedures	No other procedures	574	62.2%
	All operations with an *other* component	348	37.7%
	Surgery on the aorta	96	10.4%
	Radio-frequency ablation	84	9.1%
	Adult congenital surgery	44	4.7%
	ASD	36	3.9%
	Cardiac transplant	28	3.0%
	Atrial myxoma	11	1.1%
	Pulmonary embolectomy	5	0.5%
	Pericardiectomy	5	0.5%
	Pulmonary transplant	7	0.8%
	Acquired VSD	4	0.4%
	LV aneurysmectomy	4	0.4%
	Epicardial pacemaker	2	0.2%
	Cardiac trauma	1	0.1%
	Other procedure not listed above	51	5.5%
	All	**922**	

Previous cardiac surgery

- The proportion of Isolated CABG with previous cardiac surgery was 1.0% compared to 1.6% in UK.
- Patients with coronary artery disease with a history of previous cardiac surgery who then require further coronary intervention may now more frequently undergo Percutaneous Coronary intervention (PCI) rather than surgery and the situation is similar in UK.
- The proportion of 'Isolated valve' surgery with previous cardiac surgery was 34% in QMH while 'Valve & other' surgery with previous cardiac surgery was 26%. In comparison, UK data shows 9% for isolated Aortic Valve Replacement (AVR) with previous cardiac surgery and 2% for isolated Mitral Valve Repair (MVR) with previous cardiac surgery.
- Overall 17% of our Adult Cardiac Surgery patients had previous cardiac surgery performed.

Previous surgery

		Previous cardiac surgery		
		No	Yes	Proportion prior surgery
Procedure grouping	Isolated CABG	291	3	1.0%
	Isolated valve	151	78	34.1%
	CABG & valve	47	4	7.8%
	CABG & other	26	3	10.3%
	Valve & other	104	36	25.7%
	CABG,valve & other	16	1	5.9%
	Other	129	33	19.7%
	All	**764**	**158**	**17%**

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In-hospital mortality

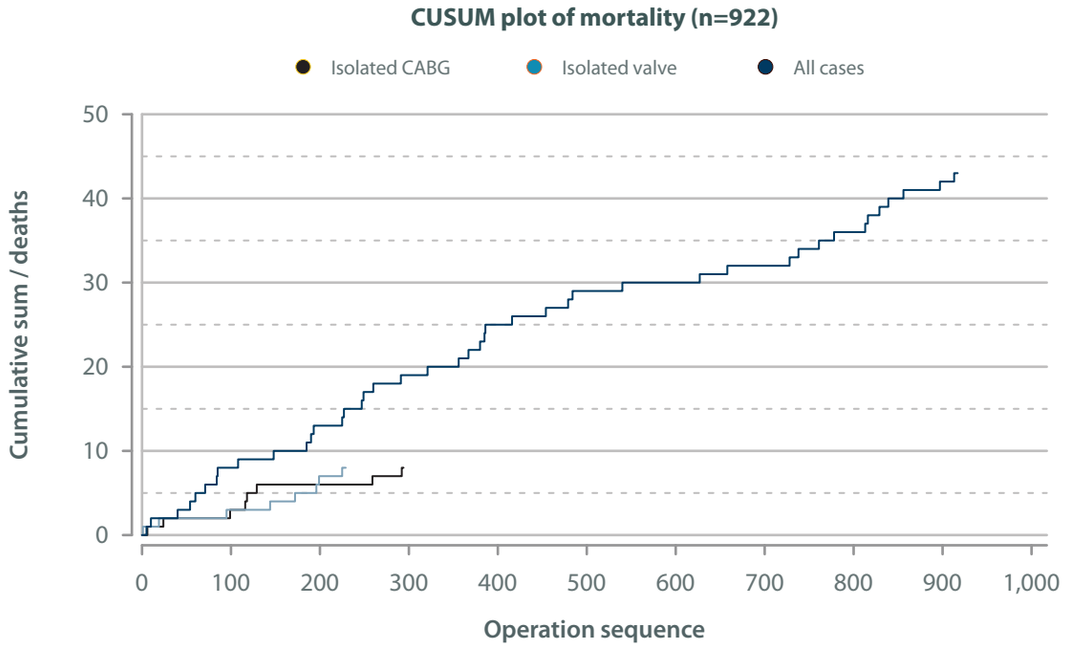
- In-hospital mortality was used as our primary outcome instead of 30 days mortality.
- Our isolated CABG crude mortality was at par with the UK data and (European Association for Cardio-Thoracic Surgery) EACTS database.
- The crude mortality rate of our Isolated Valve surgery and valves combined with other surgeries was at par with the UK data and EACTS database.
- However, the crude mortality rate of our CABG combined with other surgery groups were higher than the UK data and EACTS database.
- In our 2012-2013 QMH database, the *'CABG & other'* mortality was 13.8% vs 7.8% in UK and our *'CABG, valve & other'* mortality was 17.6% vs 11.5% in UK.

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

		Mortality data				
		Alive	Died	Queen Mary Hospital, Hong Kong	United Kingdom NACSD 2008	EACTS database 2006-2008
Procedure grouping	Isolated CABG	286	8	2.7% (294; 1.3-5.5%)	1.5% (22,808; 1.3-1.6%)	2.2% (219,053; 2.2-2.3%)
	Isolated valve	221	8	3.5% (229; 1.6-7.0%)	3.5% (7,379; 3.1-4.0%)	3.4% (75,247; 3.3-3.5%)
	CABG & valve	50	1	2.0% (51; 0.1-11.8%)	6.1% (4,508; 5.4-6.8%)	6.2% (37,721; 6.0-6.5%)
	CABG & other	25	4	13.8% (29; 4.5-32.6%)	7.8% (766; 6.1-10.0%)	7.0% (4,327; 6.3-7.8%)
	Valve & other	137	3	2.1% (140; 0.6-6.6%)	5.5% (1,780; 4.5-6.7%)	4.9% (12,883; 4.5-5.3%)
	CABG, valve & other	14	3	17.6% (17; 4.7-44.2%)	11.5% (617; 9.2-14.4%)	11.3% (3,097; 10.2-12.5%)
	Other	146	16	9.9% (162; 6.1-16.3%)	7.9% (1,271; 6.5-9.5%)	7.7% (11,562; 7.2-8.2%)

CUSUM plots of in-hospital mortality

- The cumulative sum (CUSUM) technique is a method of graph plotting of an accumulation of events [in-hospital mortality] over time.
- Cumulative risk-adjusted mortality plot provides a visual representation of the performance against the expected outcome rate of a particular risk scoring protocol.
- Observed 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.



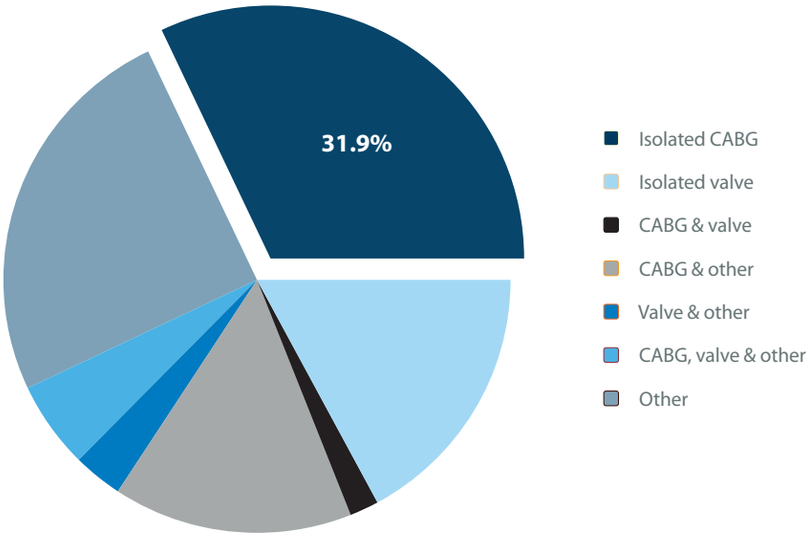
Isolated CABG surgery

Isolated CABG surgery

CABG in the context of overall workload

- Total 294 patients had isolated CABG in the year 2012 to 2013.
- Coronary surgery contributed to 31.9% of the workload (adult cardiac surgery) in our department, which is similar to the previous report (33%).
- This distribution was different from Western countries where CABG is usually 70% of the case load.

Workload overview (n=922)

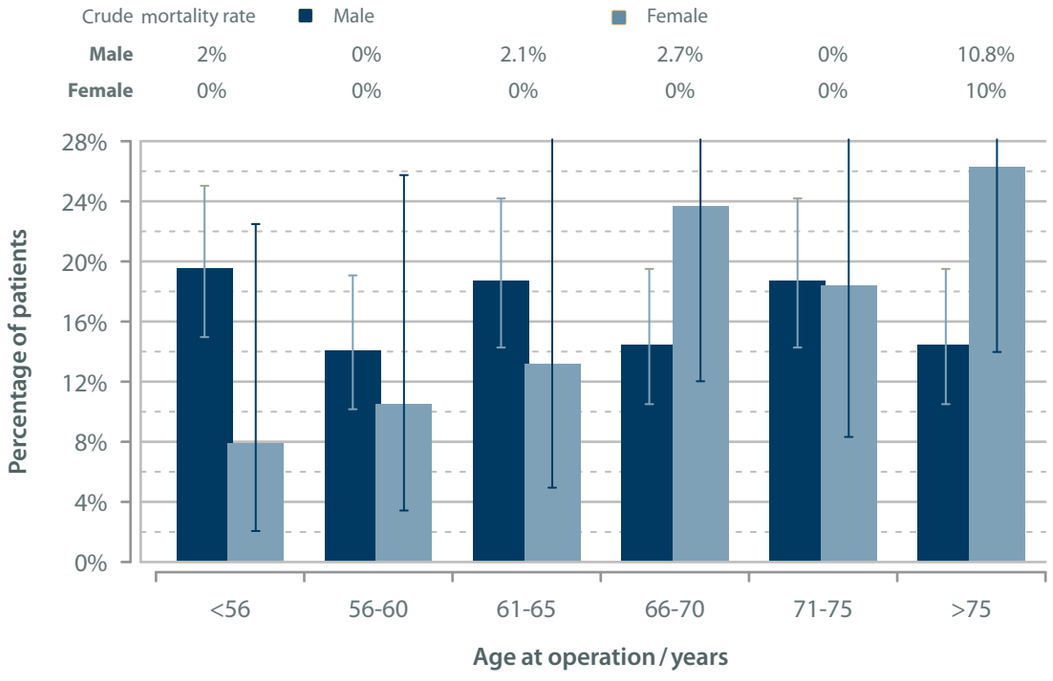


Pre-operative risk factors

Age and gender

- More male patients (256) underwent CABG compared to female (38) patients
- Old age and female gender were considered as risk factors for CABG in general.
- Our crude mortality figures showed that old age (>75 years old) had a higher mortality, irrespective of gender
- Gender showed no significant difference in mortality in this cohort.

Isolated CABG: Age, gender and crude mortality (n=294)



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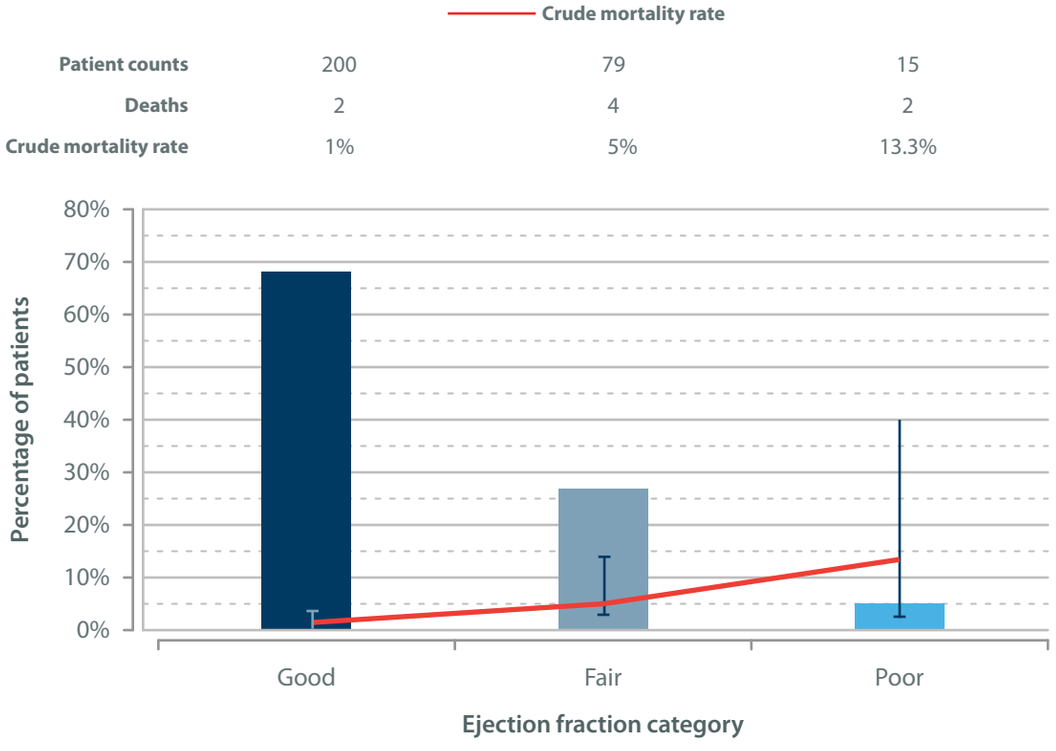
Left ventricular ejection fraction and crude mortality distribution

- Ventricular function is mainly assessed by an echocardiogram and expressed as Ejection Fraction.
- Poor left ventricular function is a well known risk factor in revascularization surgery.
- Before operation, 31.6% of patients had impaired left ventricular function - significantly increased compared to the last report (21.7% of patients).
- An intra-aortic balloon pump (IABP) was inserted before operation if the patient's ejection fraction was poor, or had unstable angina or unstable haemodynamics. 52 of our patients (17.9%) fell into this category which is higher than our previous report (31, 12.9%)
- Mortality was correlated with left ventricular function in our patient population. There was only 1% mortality in the good function group compared to 5% and 13.3% mortality in the fair and poor function groups respectively.

Isolated CABG: Ejection fraction and crude mortality (n=294)



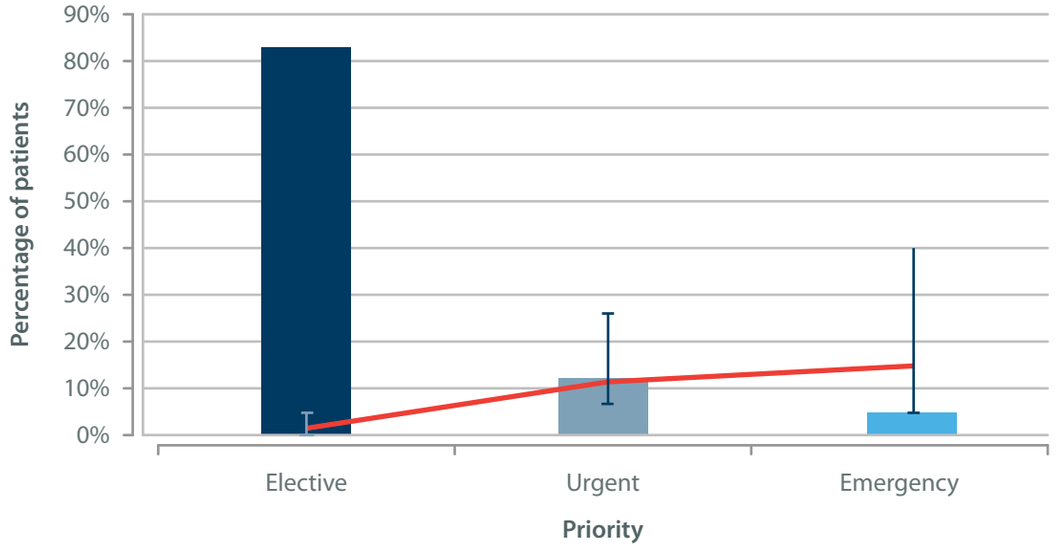
Priority distribution and mortality

- As shown in the chart, most of the patients underwent CABG on an elective basis (83.0%).
- Urgent CABG is defined as operation on the next available working day while emergency CABG (including salvaging surgery) indicates patients need surgery the same day because of their clinical situation. These represented 12.2% and 4.8% of all coronary operations respectively.
- This report showed a higher rate of urgent and emergency operations compared the United Kingdom National Adult Cardiac Database Report 2008 (2.5% of all cases 560/22831).
- Operations performed in urgent or emergency situations are always considered as high risk because of less pre-operative preparation. Moreover, patients in these situations might have on-going ischemia of the myocardium, frequent malignant arrhythmia or even unstable haemodynamics.
- Mortality was 11.1% in urgent situations and 14.2% in emergency settings compared to 0.8% in those performed electively.
- According to the United Kingdom National Adult Cardiac Database Report 2008. Mortality rate was 10.5% (59/560).

Isolated CABG: Priority and crude mortality (n=294)

Crude mortality rate

Patient counts	244	36	14
Deaths	2	4	2
Crude mortality rate	0.8%	11.1%	14.2%



Mortality and other risk factors

- The table below shows risk factors that are considered significant for coronary surgery.
- Patient characteristics in the table shows that most of them are hypertensive (91.5%) and diabetic (50.0%). Unlike those in western countries, our patients were not overweight, and even more than half of them had low body mass index.
- Among these factors, pre-operative intra-aortic balloon pump (IABP) insertion and renal failure requiring dialysis were two important factors for operative mortality.

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

			Mortality		
			Alive	Dead	Rate
Risk factors	Gender	Male	249	7	2.7%
		Female	37	1	2.6%
	Body mass index	≥25 kg m^{-2}	128	4	3.0%
		<25 kg m^{-2}	156	4	2.5%
	Left main stem disease	No	140	3	2.1%
		Yes	144	5	3.4%
	Previous cardiac surgery	No	283	8	2.7%
		Yes	3	0	0.0%
	Diabetes	No	142	4	2.7%
		Yes	142	4	2.7%
	Hypertension	No	23	0	0.0%
		Yes	261	8	3.0%
	Extra-cardiac arteriopathy	No	263	7	2.6%
		Yes	23	1	4.2%
	Previous CVA	No	261	8	3.0%
		Yes	25	0	0.0%
	Pre-op IABP insertion	No	264	4	1.5%
		Yes	22	4	18.1%
	Renal failure requiring dialysis	No	264	3	1.1%
		Yes	22	5	22.7%

The grafting process

Arterial grafting

Total number of grafts = 908 in 290 patients. (4 patients with incomplete data)

Average number of grafts= 3.1

Patients with LIMA graft= 256/ 290 (88.27%)

Patients with LIMA and Radial Artery graft = 55/ 290 (18.9%)

Arterial grafting

- There were 908 distal anastomoses made in 290 patients (4 with incomplete data). On average, each patient received 3.1 grafts in isolated CABG.
- Arterial grafts, especially the Left Internal Mammary Artery (LIMA), are considered as better conduits in CABG. Younger patients may benefit from a second arterial graft, usually the radial artery or the right internal mammary artery.
- 88.3% of patients (256/290) had the LIMA grafted to the Left Anterior Descending (LAD) artery in isolated CABG.
- 3 grafts or more were performed in 257 Isolated CABG surgeries which was higher than the UK data (87% in QMH vs 74% in UK).

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Endoscopic harvest of conduits

- Our department began to use endoscopic vein harvesting techniques in 2005 and endoscopic radial artery harvesting in 2007. This has now become the standard and preferred way of harvesting these conduits in our practice.
- As seen from the table below, the usage rate of the endoscopic method slightly increased from 98.1% to 100% for the radial artery and from 85.1% to 88.9% for vein graft harvest when compared to the previous report.

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

		Endoscopic harvest of the names conduit		
		No	Yes	Endoscopic harvest rate
Conduit	Radial artery used	0	55	100.0%
	Any vein used	26	209	88.9%

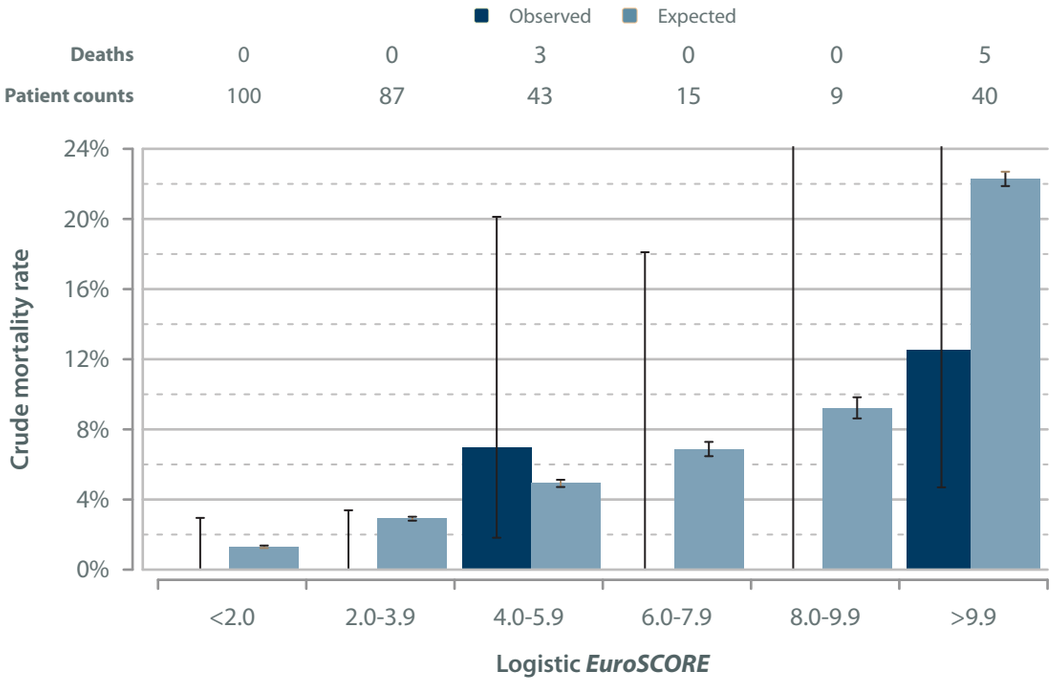
Isolated CABG: Radial artery graft usage at each of the coronary artery sites treated (n=55 grafts)

		Data	
		Count	Proportion
Coronary site	Diag 1	4	7.2%
	Diag 2	2	3.6%
	Distal Cx	1	1.8%
	Distal LAD	1	1.8%
	Int	3	5.4%
	Mid LAD	1	1.8%
	OM1	30	54.5%
	OM2	11	20%
	RCA-LV	1	1.8%
	RCA-PDA	1	1.8%
	All	**55**	

Logistic *EuroSCORE* and mortality

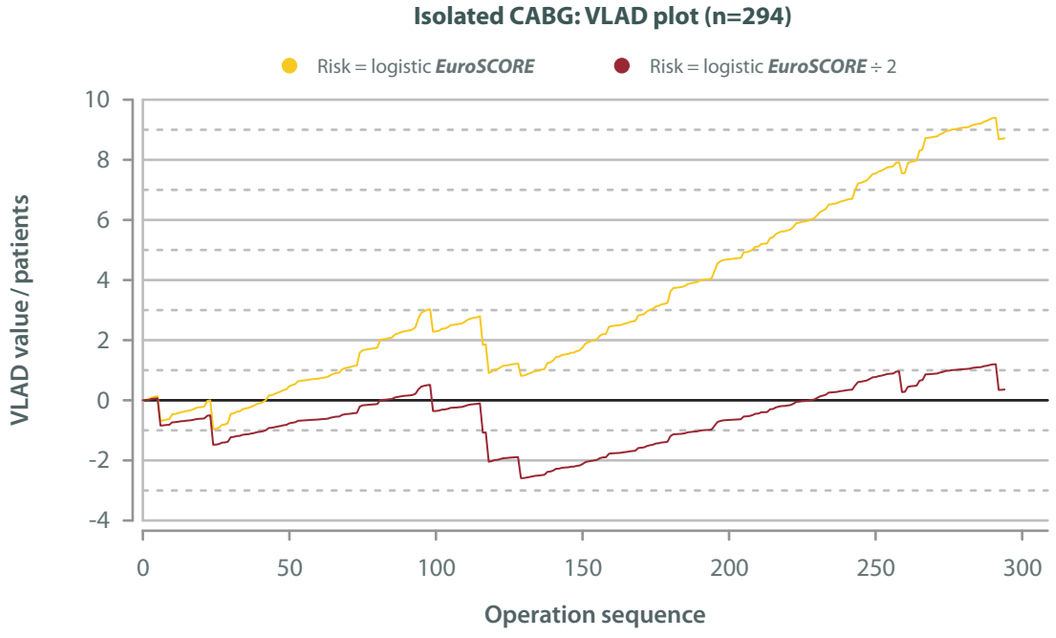
- Logistic EuroSCORE is a commonly used risk stratification and prediction method in cardiac surgery. The value equals to the expected mortality risk for a particular patient.
- In the isolated CABG group, 34.0% of patients fell into the low risk group (<2% mortality) and the number decreased in higher risk groups.
- We observed that the patient risk profile was higher since a EuroSCORE higher than 9.9 contributes 13.6% of patients, which was only 11.6% in the last report. We performed more high risk coronary surgeries as compared to UK data, 8.1% of their patients fell into EuroSCORE >9.9.
- Observed mortality rates were close to the expected rates. Most of the mortality was associated with the higher-risk groups.
- The overall expected mortality in isolated CABG group of patients was 5.8% (14 patients). While the observed mortality was 2.7% (8 patients). Thus, the observed *versus* expected mortality ratio was 0.47 for isolated CABG. Our previous report of 2010-2011 reported observed *versus* expected mortality ratio of 0.44.

Isolated CABG: Logistic *EuroSCORE* distribution (n=294)



VLAD plot for isolated CABG

- The following Variable Life-Adjusted Display (VLAD) graph covers all risk-scored isolated CABG procedures performed during 2012 and 2013.
- The plot is risk adjusted and performance as predicted should run approximately around the horizontal zero line (the heavy black line).
- The plotted line goes up for each survival and down for each death. The degree of rise and fall is determined by the predicted risk associated with the case.
- The upslope of the curve demonstrated a net gain of patients' life and that the performance was better than expected. At the end of the curve, almost 9 extra lives had been saved at Queen Mary Hospital.
- A EuroSCORE divided by 2 is also shown in the graph. This graph demonstrates performance very close to the expected value.



International benchmarking of results

- 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 (2.7%) fell well within the alert lines. Although it was higher than the average from United Kingdom, it is not risk adjusted. The higher number of emergency CABG and higher risk profile of patients could account for the higher mortality.
- 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 2.6%, which fell within the alert lines and actually lower than the average reported in 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 again fell well within the funnel plot alert lines, and QMH has a much lower dialysis rate compared to United Kingdom data.
- The results of these four key outcomes at Queen Mary Hospital demonstrated that the performance is at par with the internationally-published results from the United Kingdom.

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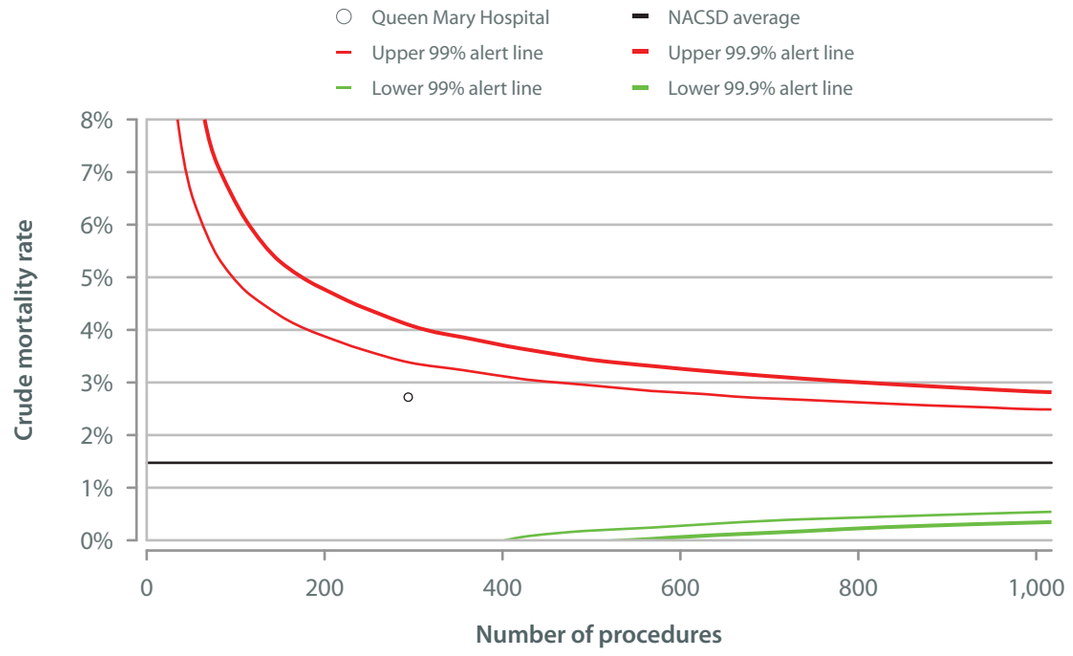
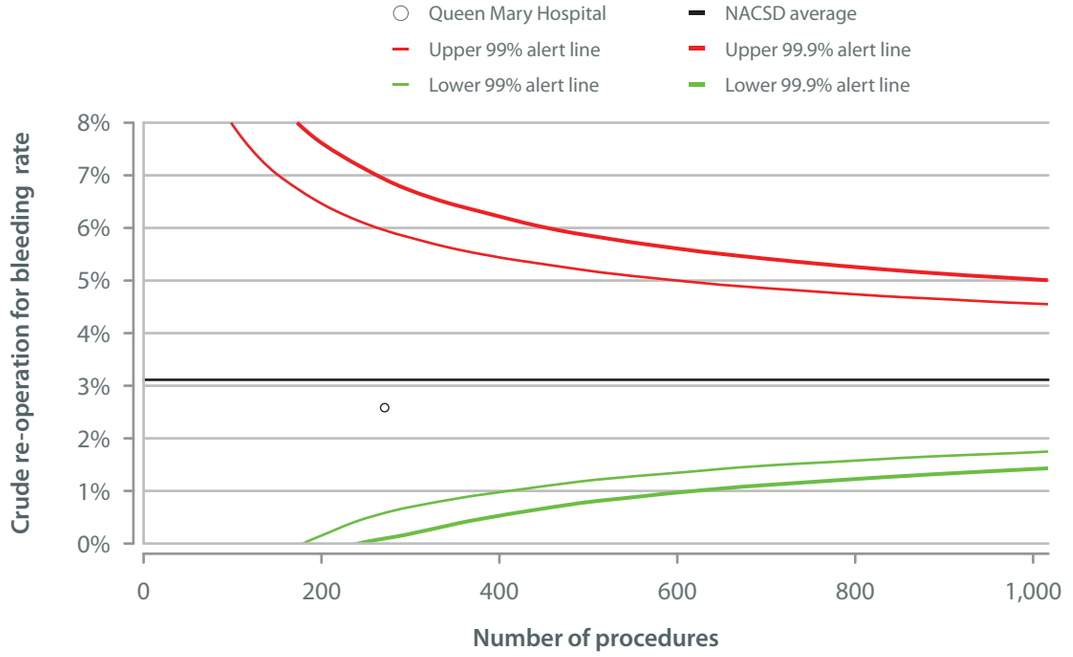
In-hospital mortality

Isolated CABG: Crude mortality rate for QMH (n=294) compared to the data from the financial year 2008 in the United Kingdom NACSD



Re-operation for bleeding

Isolated CABG: Crude re-operation for bleeding rate for QMH (n=271) compared to the data from the financial year 2008 in the United Kingdom NACSD



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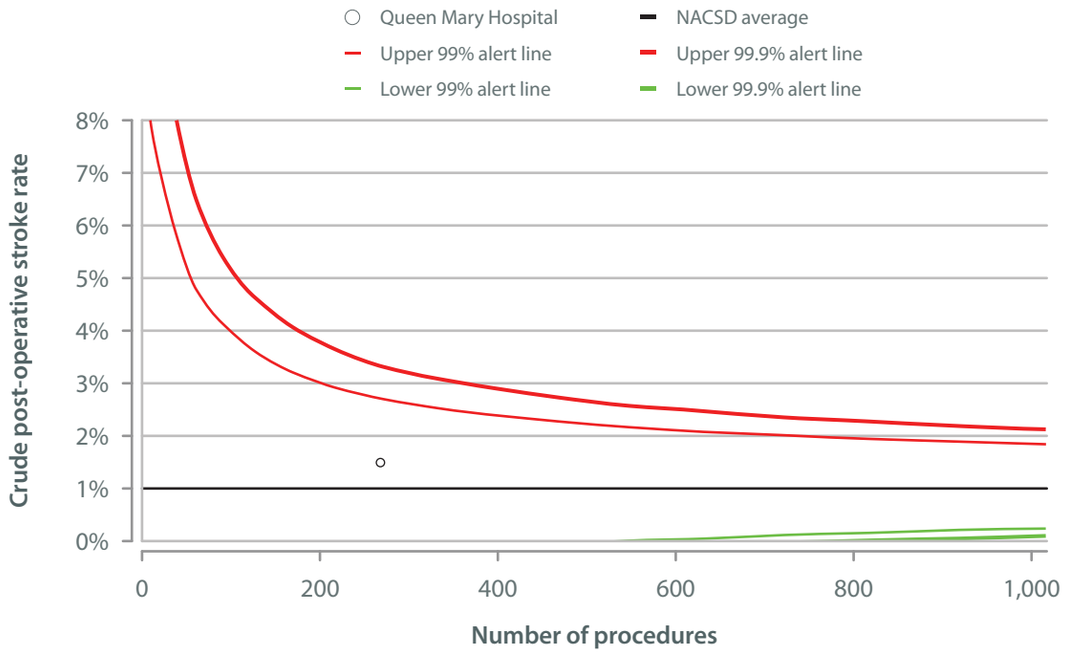
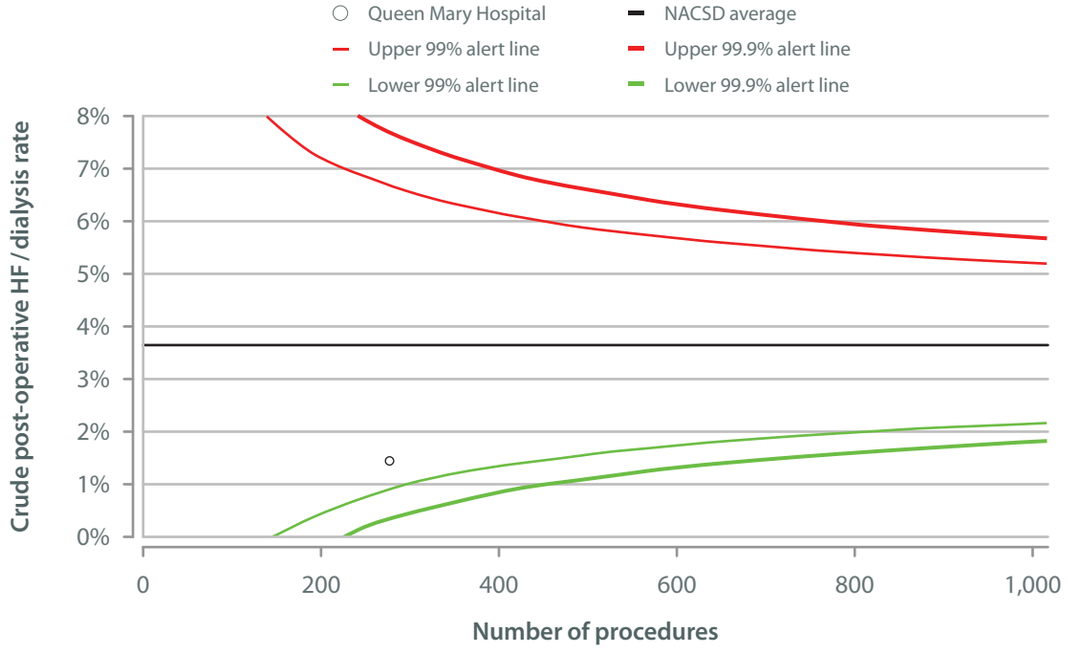
Post-operative stroke

Isolated CABG: Crude post-operative stroke rate for QMH (n=268) compared to the data from the financial year 2008 in the United Kingdom NACSD



Post-operative HF / dialysis

Isolated CABG: Crude post-operative HF / dialysis rate for QMH (n=277) compared to the data from the financial year 2008 in the UK NACSD



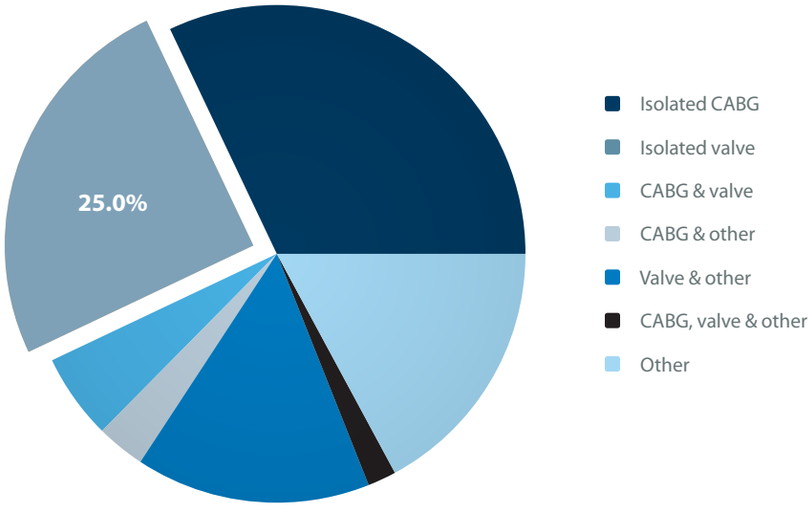
Isolated valve surgery

Isolated valve surgery

Isolated valve surgery in the context of overall workload

- During the year 2012 & 2013, there were 229 isolated valve operations performed at Queen Mary Hospital, contributing to 25% of the overall adult cardiac surgery workload.
- Other than that, there were 208 (22.8%) valvular operations performed in combination with the other procedures like CABG, atrial fibrillation ablation, aortic surgery, septal defect repair, *etc.*

Workload overview (n=922)



Priority

- There were 139 isolated single valve operations performed during the year 2012 & 2013.
- 123 out of 139 (88.4%) 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

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Priority	Elective	51	47	25
	Urgent	7	3	0
	Emergency	2	3	0
	Salvage	1	0	0
	All	**61**	**53**	**25**

Previous cardiac surgery

- Redo operations contributed a significant workload in the isolated valve operation group. Out of 229 isolated valve surgeries in the years 2012 & 2013, 78 (34.1%) operations were redo cardiac operations.
- Among all single valve operations, 43 (30.9%) had previous cardiac operations.
- Among those redo cardiac operations, some of them were second or more redo operations.

Isolated single valve surgery: prior cardiac surgery

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Previous surgery	No previous cardiac surgery	54	41	1
	Previous cardiac surgery	7	12	24
	All	**61**	**53**	**25**

Haemodynamic pathology

- More than half of the isolated aortic valve operations, 34/61 (55.7%), were for patients with aortic stenosis.
- Among all patients who had isolated mitral valve surgery, 44/52 (84.6%) had mitral regurgitation.

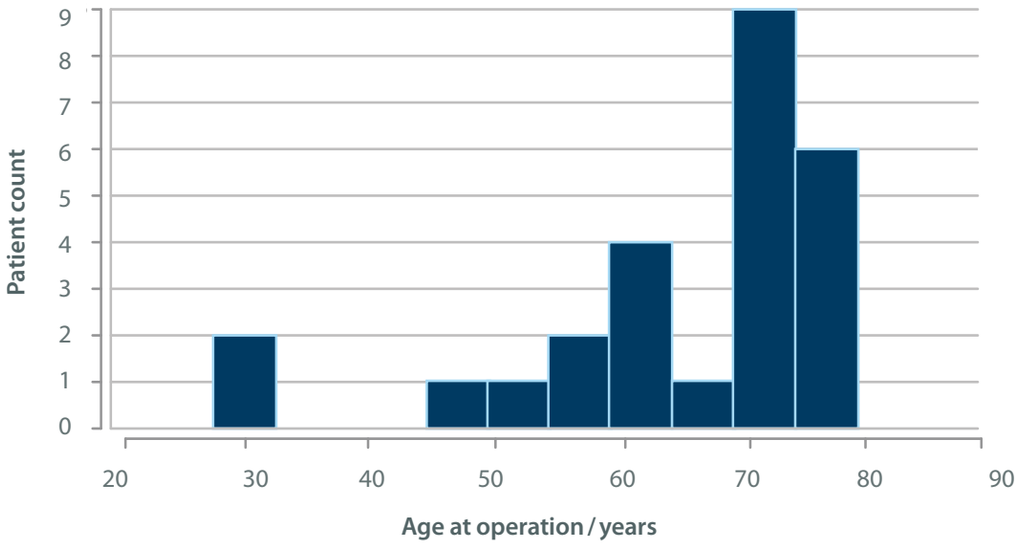
Isolated single valve surgery: haemodynamic pathology

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Haemodynamic pathology	Stenosis	34	3	1
	Regurgitation	19	44	20
	Mixed	8	5	2
	All	**61**	**52**	**23**

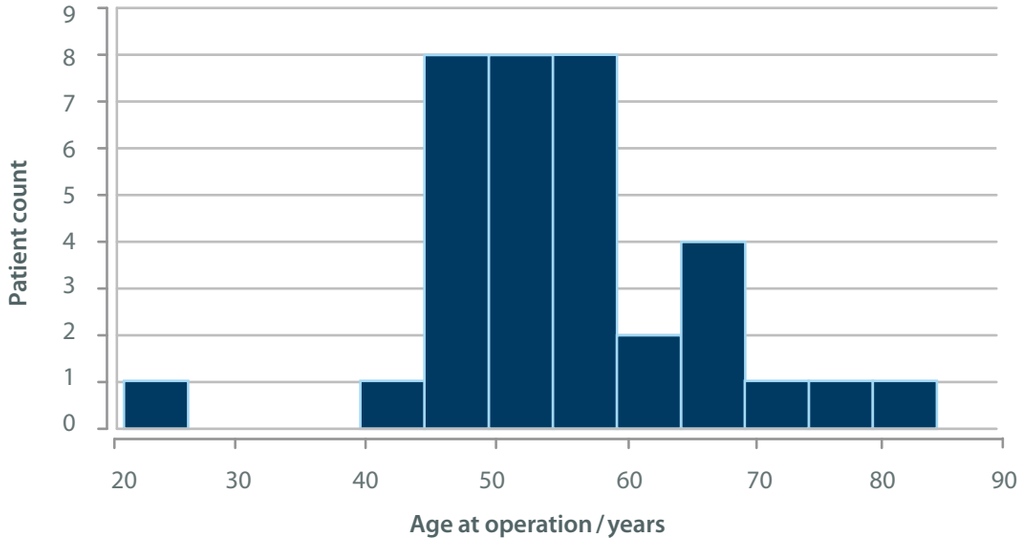
Aortic valve implants

- Most of the biological prostheses were implanted in patients above 65 years of age, however between 2012 and 2013, younger patients (<65 years) also received biological aortic valve prostheses.
- Among the patients who had isolated aortic valve replacement, 26 (42.6%) received biological valves while the remaining 35 (57.4%) received mechanical prostheses.
- Compared to the previous report we used more biological prostheses during 2012-2013 (31.3% in 2010-2011 vs. 42.6% in 2012-2013).

Aortic valve implants: Biological (n=26)



Aortic valve implants: Mechanical (n=35)



Native valve pathology

- As in 2010-2011, calcific degenerative disease and bicuspid aortic valve disease were still the two most common pathologies for aortic valve operations.
- Degenerative myxomatous changes in mitral valve pathology contributed mainly to mitral valve surgery in this cohort.
- Chronic rheumatic changes of mitral and tricuspid valves also represented one of the major causes for valvular heart surgery.
- The overall distribution of ischemic mitral pathology cannot be represented by this table alone because surgery for ischemic mitral disease is usually in combination with coronary revascularization procedure.

Isolated single valve surgery: native valve pathology

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Native valve pathology	Calcific degeneration	27	1	0
	Congenital	27	3	6
	Degenerative	22	31	4
	Active infective endocarditis	5	4	1
	Native valve not present	4	3	1
	Previous infective endocarditis	3	5	1
	Annuloaortic ectasia	2	0	2
	Other native valve pathology	1	1	1
	Rheumatic	1	10	11
	Ischaemic	0	3	0
	Functional regurgitation	0	2	5

Mitral valve surgery

Mitral valve repair in the context of all mitral valve surgeries

- Out of the 25 mitral valve replacements for mitral valve regurgitation pathology, 16 were regurgitant paravalvular leakage at old mitral valve prostheses.
- During the year 2012-2013, mitral valve repair surgery was successful in 63 out of 72 native valve regurgitant patients and contributed to 87.5% of our native mitral valve pathology group. In the previous report of 2010-2011 only 81.1% native regurgitant valves were successfully repaired.
- The major causes of failure to repair in native mitral valve pathology group were infective endocarditis, acute ischemic pathology and complex rheumatic changes.
- 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.

Isolated mitral valve surgery: haemodynamic pathology and valve procedure

		Haemodynamic pathology		
		Stenosis	Regurgitation	Mixed
Valve procedure	Replacement	22	25	16
	Repair	1	63	1
	All	**23**	**88**	**17**

Type of mitral valve repair

- Most of the isolated mitral valve repair operations were complex repairs, involving two or more repair procedures.
- Most (89.3%) of mitral valve repair operations had ring annuloplasty.
- Artificial chordal implantation and leaflet resection were the two most commonly performed techniques in mitral valve repair surgery following annuloplasty.

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

		Data	
		Count	Percentage
Type of mitral valve repair	Annuloplasty (ring)	58	89.2%
	Artificial chord	28	43.1%
	Leaflet resection	27	41.5%
	Subvalvar release	13	20.0%
	Other	11	16.9%
	Commisurotomy	8	12.3%
	Chordal transfer	3	4.6%
	Decalcification / debridement	3	4.6%
	Leaflet patch	3	4.6%
	Leaflet extension	3	4.6%
	Annuloplasty (suture)	2	3.1%
	Papillary muscle repositioning	0	0.0%
	Chordal shortening	0	0.0%

Tricuspid valve surgery

Tricuspid valve repair in the context of all tricuspid valve surgeries

- More than one third, 85/229, (37.1%) of all isolated valve(s) surgeries involved tricuspid valve procedures.
- Most of the tricuspid valve pathologies, 75/85 (88.2%), were managed by repair techniques instead of replacement with biological prostheses.
- Isolated tricuspid valve surgery was rare, only 17 patients during the year 2012-2013 had isolated tricuspid valve operation.

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

		Tricuspid valve procedure		
		Replacement	Repair	All
Valve treated	Tricuspid alone	4	13	**17**
	Tricuspid and another valve	6	62	**68**
	All that include tricuspid valve surgery	**11**	**75**	**85**

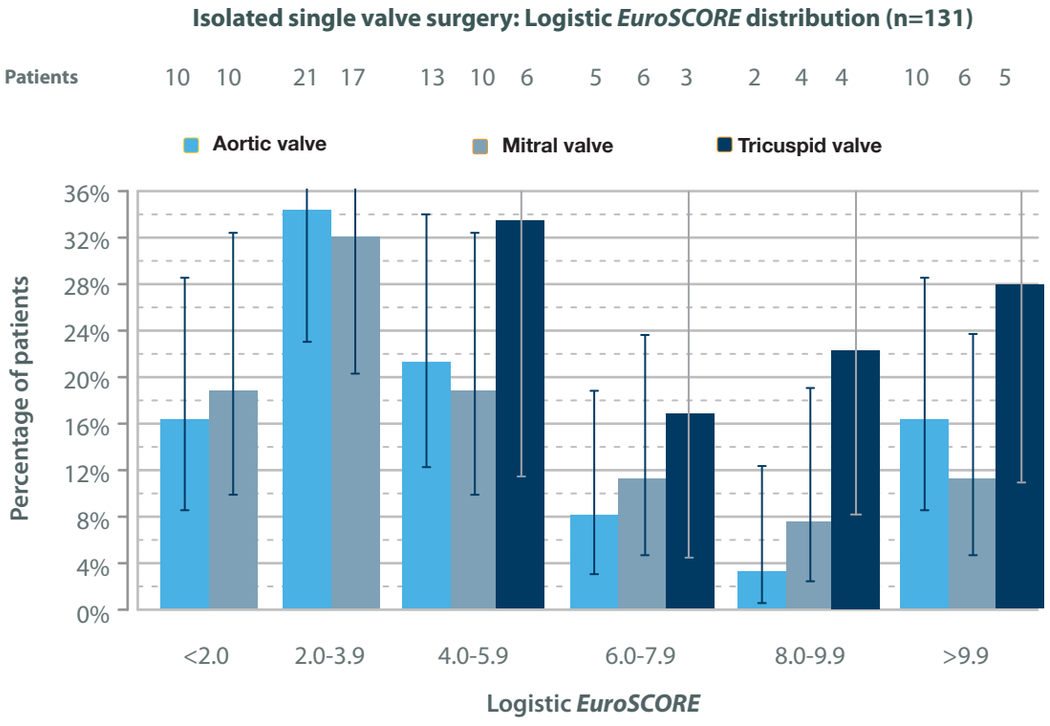
Details of tricuspid valve surgery

		Data	
		Count	Percentage
Valve procedure	Replacement	4	23.5%
	Repair	13	76.4%
	All	**17**	
Haemodynamic pathology	Regurgitation	16	94.1%
	Stenosis (previous TVR)	1	5.9%
	All	**17**	
Previous cardiac surgery	No previous cardiac surgery	1	5.9%
	1 previous cardiac surgery	10	58.8%
	2 previous cardiac surgeries	6	35.3%
	All	**17**	
Repair technique	Annuloplasty ring	11	64.7%
	Annuloplasty suture	2	11.7%
Valve pathology	Rheumatic	14	82.3%
	Infective (endocarditis)	2	11.7%
	Functional regurgitation	1	5.8%
	All	**17**	

Logistic *EuroSCORE*

EuroSCORE distributions

- The expected mortality risk for isolated aortic valve surgery alone in this cohort was 6.7%.
- The expected mortality risk for isolated mitral valve surgery alone in this cohort was 6.2%.
- The expected mortality risk for isolated tricuspid valve surgery alone in this cohort was 9.3%.



Logistic *EuroSCORE* and mortality

- The observed mortality for isolated single aortic valve surgery and isolated single mitral valve surgery was lower than expected, with the observed/expected ratio of 0.23 and 0.29 respectively.
- The observed mortality for isolated single tricuspid valve surgery was higher than expected with the observed/expected ratio of 1.25.
- The reason for higher observed/ expected ratio in isolated single tricuspid valve group was underestimation of risk using logistic *EuroSCORE* in this cohort. >90% of this group was redo operation. These patients were usually cachexic with very low BMI, right heart dysfunction, deranged liver function and high bilirubin level. These unfavourable factors are not accounted for by the logistic *EuroSCORE* and therefore *EuroSCORE* usage in tricuspid valve surgery may not be accurate.

Isolated single valve surgery: *EuroSCORE* and mortality

		Count		Mortality		
		All	Deaths	Observed(O)	Expected(E)	**O/E Ratio**
Valve treated	Aortic alone	61	1	0.016	0.067	**0.23**
	Mitral alone	53	1	0.018	0.062	**0.29**
	Tricuspid alone	17	2	0.117	0.093	**1.25**

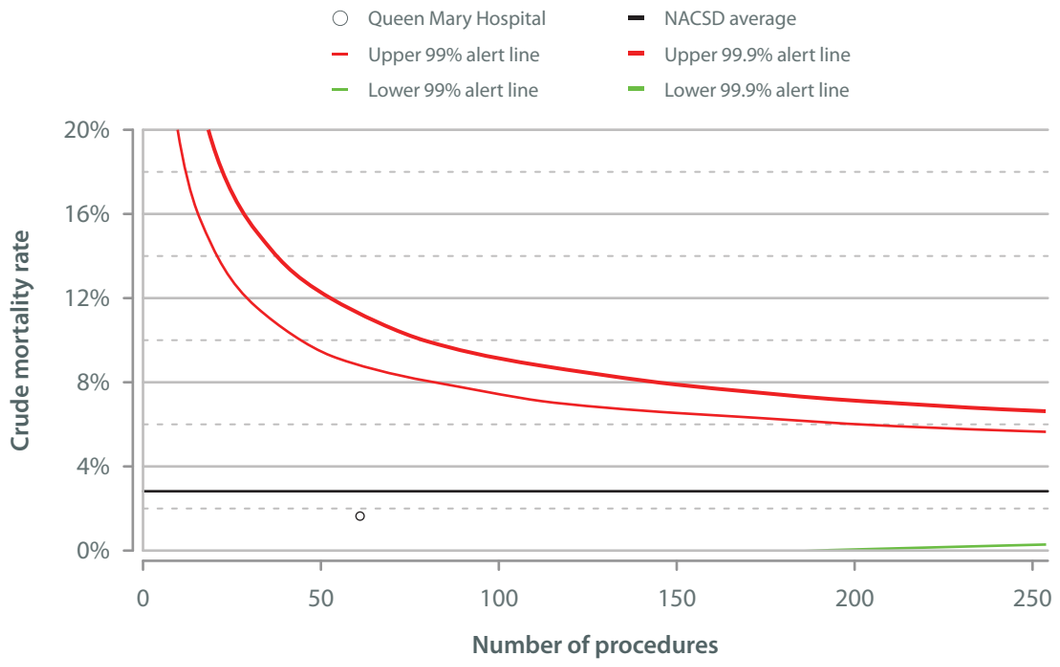
Isolated multiple valve surgery: *EuroSCORE* and mortality

		Count		Mortality		
		All	Deaths	Observed(O)	Expected(E)	**O/E Ratio**
Valve treated	Aortic & mitral	21	0	0	0.040	**0**
	Mitral & tricuspid	40	2	0.050	0.087	**0.57**
	Aortic, mitral & tricuspid	19	1	0.052	0.081	**0.64**

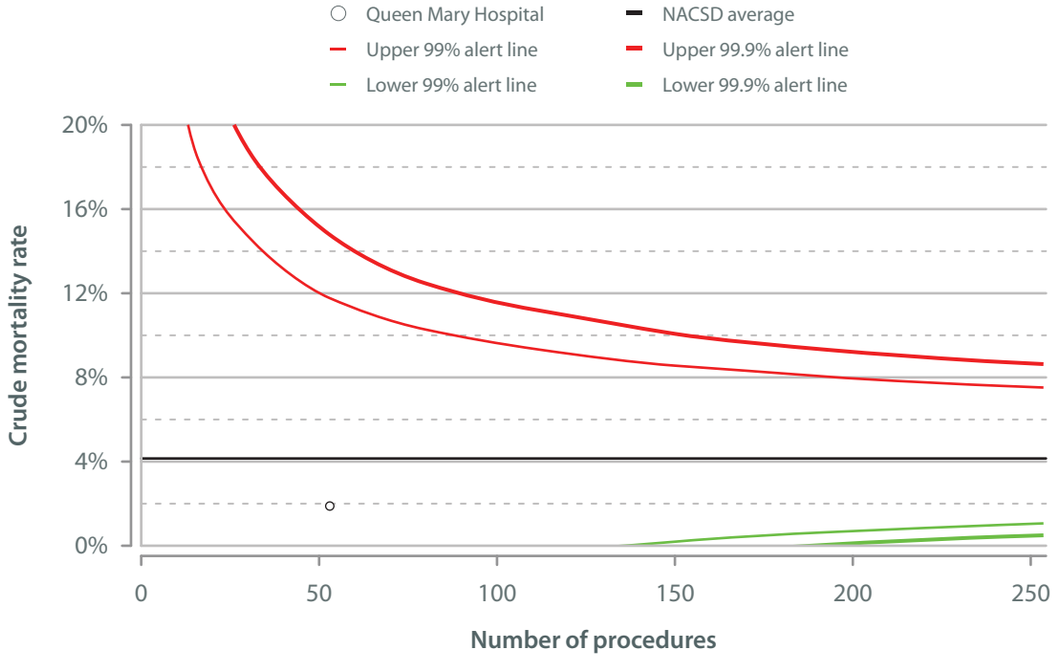
International benchmarking of mortality

- The graph here is a funnel plot of in-hospital crude mortality for isolated aortic valve and isolated mitral valve surgery . It was 1.6% and1.8% respectively. In both the cases it was lower than the average mortality in United Kingdom National Adult Cardiac Surgical Database (2008).

Isolated aortic valve surgery: Crude mortality rate for QMH (n=61) compared to the data from the financial years 2004-2008 in the United Kingdom NACSD



Isolated mitral valve surgery: Crude mortality rate for QMH (n=53) compared to the data from the financial years 2004-2008 in the United Kingdom NACSD



Minimally invasive cardiac surgery

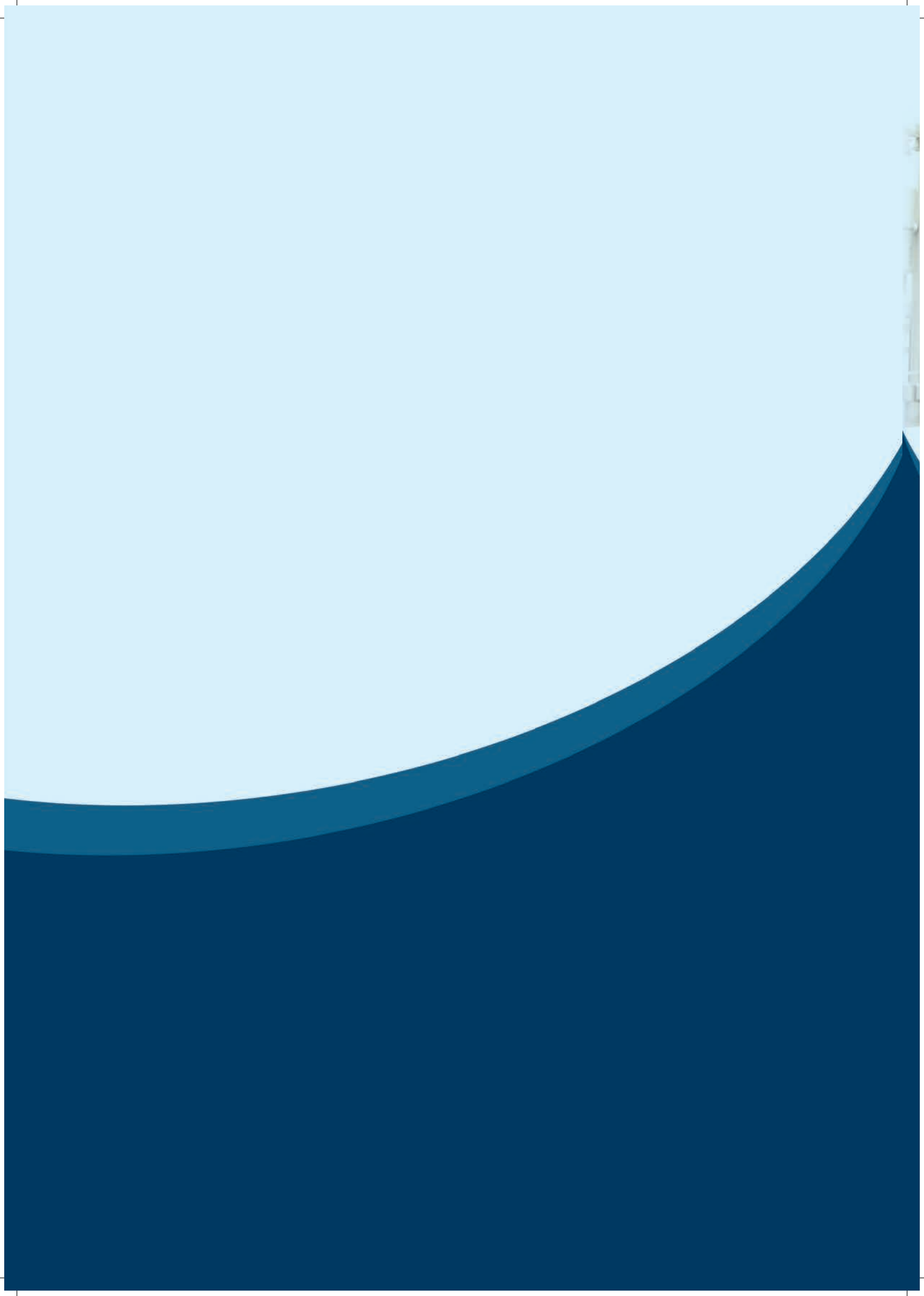
Developments and workload in QMH

- Most surgery developments would go towards minimally invasive in order to lower patient morbidity, yet keep the same result compared to the traditional approach.
- Our department started performing minimally invasive cardiac surgery since 2007. Here are the brief developments:

		Developments
Year	2006	- Off pump surgery - Endoscopic harvest of vein graft
	2007	- Para-sternal approach for valve surgery
	2010	- Hemi-sternotomy approach - Para-sternal approach for complex surgery and ECMO
	2012	- Endoscopic- assisted minithoracotomy approach for valve surgeries
	2013	- Transcatheter aortic valve implantation (TAVI)

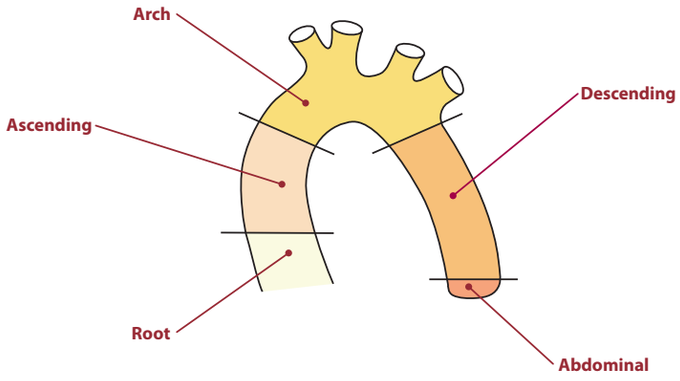
- There was an increase in the number and complexity of minimally invasive cardiac surgeries.
- Types of surgery performed: mitral valve repair, mitral valve replacement, aortic valve replacement, combined mitral and tricuspid valve surgery, combined mitral and atrial ablation surgery and congenital problems.
- There was no in-hospital mortality in this group of patients. There were no major complications except 2 patients (2.1%) had re-operation due to bleeding.

		Year	
		2010-2011	2012-2013
Type of MIS approach	Hemi-sternotomy / Para-sternal approach	36	36
	Endoscopic-assisted minithoracotomy approach	0	59
	Total	**36**	**95**



Other procedures

Surgery on the aorta



Surgery on the aorta: number and details of segments treated

			Cardiac procedure group				
			CABG & other	Valve & other	CABG, valve & other	Other	**All**
Segments treated	**1**	Root	3	9	2	9	**23**
		Asecending	2	14	2	30	**48**
		Arch	1	0	0	3	**4**
		Descending	0	0	0	3	**3**
	2	Root & ascending	0	6	2	2	**10**
		Ascending & arch	1	1	0	1	**3**
		Descending & abdominal	0	0	0	1	**1**
	3	Root, ascending & arch	0	0	0	1	**1**
		Ascending, arch & descending	0	0	0	2	**2**
	4	Root, ascending, arch & descending	0	1	0	0	**1**
		All	**7**	**31**	**6**	**52**	**96**

Surgical technique

- Aortic dissection constitutes 60% of aortic surgery, of which 70% were acute aortic dissections.
- In 33 out of 36 patients (92%) with aortic dissection repair, subclavian artery cannulation was utilized to achieve antegrade systemic perfusion during cardiopulmonary bypass.
- In 93% (40/43) of patients undergoing aortic dissection repair, antegrade cerebral perfusion by direct cannulation of the neck vessels was utilized to achieve cerebral protection during circulatory arrest. These patients were monitored using Cerebral oximetry with near infra-red spectrometry .
- Valve-sparing root replacement using David IV reimplantation technique was used in 28% of all aortic root surgeries.

Surgery on the aorta: Root

		Count
Aortic procedure	Bentall	25
	Valve-sparing	7
	Other	3
	All	**35**

Surgery on the aorta: Pathophysiology

			Count
pathiphysiology	**Aneurysm**		35
	Aneurysm with dissection	Acute	36
		Chronic	16
		Iatrogenic	2
	Others		7
	All		**96**

Surgery on the aorta: cerebral perfusion

		Count
Cerebral perfusion	Antegrade	40
	Retrograde	3

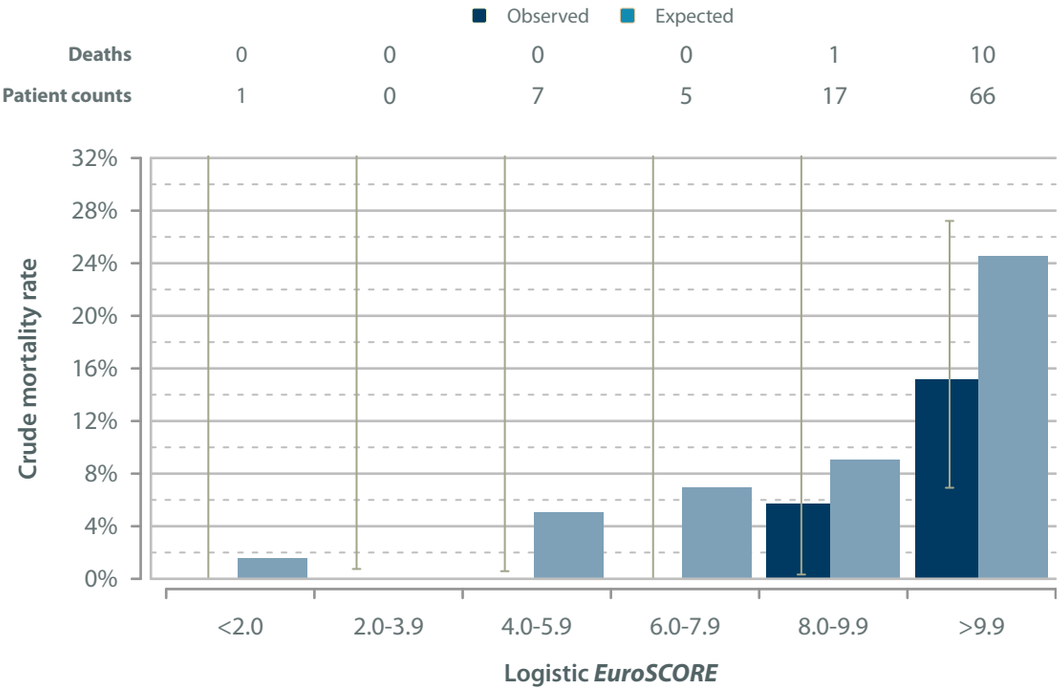
Surgery on the aorta: cannulation

		Count
Arterial cannulation	Ascending Aorta	42
	Arch	1
	Axillary/subclavian	33
	Femoral	20

Mortality and morbidity

- The overall mortality for aortic surgery was 11.5%. The expected mortality using Logistic *EuroSCORE* was 19.3%. The O/E ratio was 0.6.
- The rates of cerebral vascular accidents and transient ischaemic attacks were 2% (2/96) and 2% (2/96) respectively.

Surgery on the aorta: Logistic *EuroSCORE* and mortality (n=96)



Other cardiac procedures

Other procedures

- There was a significant increase in number of cardiac (28 vs 21) and lung transplants (7 vs 2) when compared to the 2010-11 biennial report.
- The in-hospital mortality rate for heart transplantation was 10.7% (3/28).
- There was no in-hospital mortality for lung transplantation.
- Atrial ablation had also been more frequently performed (84 vs 51) as compared to the 2010-11 report
- The number of patients with poor left ventricular function and ischaemic cardiomyopathy undergoing LV aneurysmectomy / Dor's procedure increased significantly compared to the previous report, 2110-1011.
- There were 10 implantable LVADs performed. There was no in-hospital mortality for LVAD implantation.

Procedure detail

		Cardiac procedure group				
		CABG & other	Valve & other	CABG, valve & other	Other	**All**
Other cardiac procedures	LV aneurysmectomy	3	0	1	0	**4**
	Acquired VSD (post MI VSD)	1	0	1	2	**4**
	Atrial myxoma	0	1	0	10	**11**
	Pulmonary embolectomy	0	0	0	5	**5**
	Cardiac transplant	1	0	0	27	**28**
	Pulmonary transplant	0	0	0	7	**7**
	Cardiac trauma	1	0	0	0	**1**
	Epicardial pacemaker	0	1	0	1	**2**
	Pericardiectomy	0	1	1	3	**5**
	Atrial Ablation	6	67	7	4	**84**
	Other procedure not listed above	4	19	1	26	**51**
	LVAD- implantable	0	6	0	4	**10**
	LVAD- peripheral	0	1	0	12	**13**
	ECMO	2	1	1	21	**25**

Atrial ablation

Patients and procedures

- Patients scheduled for elective open heart surgery with documented atrial fibrillation for less than 10 years and a left atrial dimension of <7cm were offered radiofrequency atrial ablation or cryoablation.
- 61% (51/84) achieved sinus rhythm post ablation before discharge.
- 2% (2/84) of patients had heart block after atrial ablation surgery.
- From our cohort, at one year post-op, 83.3% patients were converted to sinus rhythm after ablation surgery.

Atrial ablation age and concomitant procedures

		Concomitant procedures					
		CABG & other	Valve & other	CABG, valve & other	Other	All	Percentage
Age at surgery / years	<56	4	26	4	3	**37**	44.0%
	56-60	0	14	1	0	**15**	17.9%
	61-65	0	10	0	1	**11**	13.1%
	66-70	1	11	0	0	**12**	14.3%
	71-75	1	2	1	0	**4**	4.8%
	>75	0	4	1	0	**5**	6.0%
	All					**84**	**100%**

Part 2: Congenital cardiac surgery

Congenital cardiac surgery

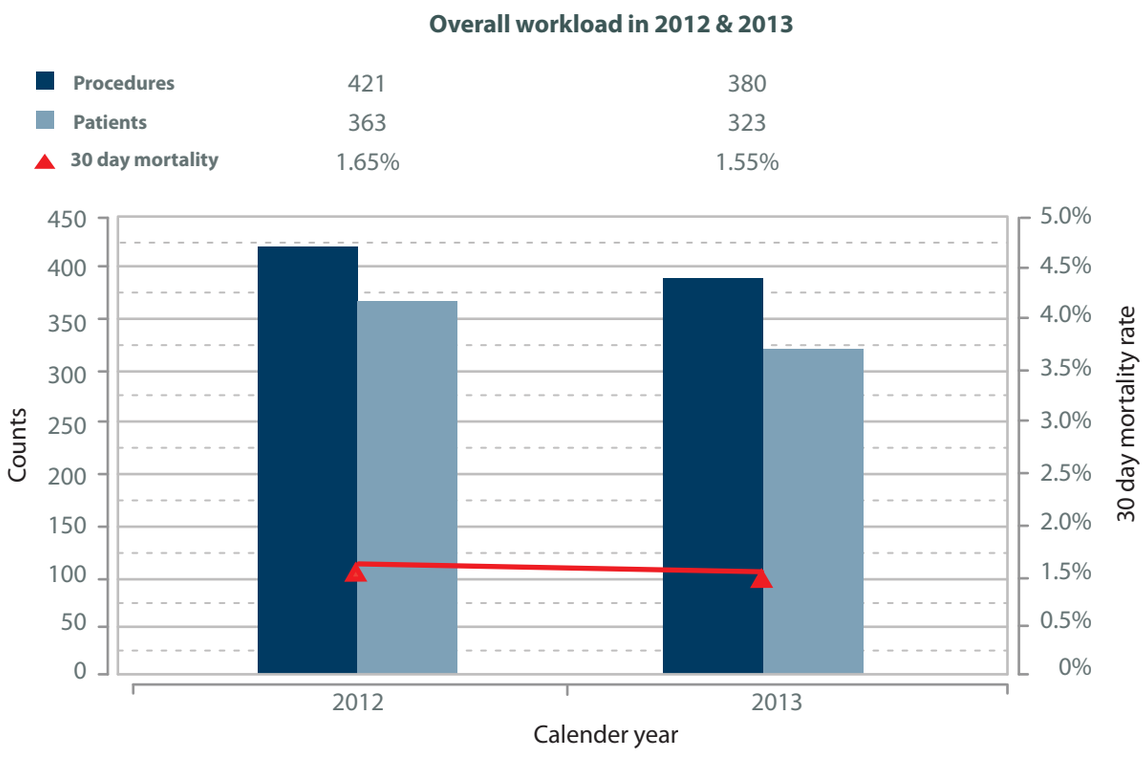
Database overview: Congenital cardiac surgery

- The paediatric and congenital cardiac surgical programme started in1967 in this unit. It is now an important proportion of work at the Department of Cardiothoracic Surgery, Queen Mary Hospital.
- Evaluation of the quality of congenital heart surgery and measurement of performance of surgical outcomes have been particularly complex and difficult because of the relative low number of cases, heterogeneity of patients and the diversity of operations in this subspeciality.
- The European Association for Cardio-Thoracic Surgery (EACTS) Congenital Heart Database, one of the largest congenital heart databases in the world, offers an excellent platform for systematic data collection under a standard nomenclature (International Paediatric and Congenital Cardiac Code, IPCCC), and provides risk stratification tools (e.g. Aristotle Basic Complexity Score and Level) for benchmarking.
- We joined the EACTS Congenital Heart Database in 2012 and have since established our database with the collaborative work of our paediatric cardiology team. This is the first congenital heart surgical report of our department.

The Overall workload in 2012 & 2013

Workload by year

- Overall 801 procedures were performed in 674 patients in the year 2012 and 2013 at QMH with a mean 30-day mortality of 1.63%.
- Note that if split by year, the total number of patients from period 2012-2013 is not equal to the sum of patients in the individual years 2012 and 2013. If a patient has undergone multiple operations in both the years, he/she is counted separately in each year, however, he/she is counted only once during the period from 2012-2013.



Workload by procedure category

- Open heart surgery accounted for about 2/3 of the workload in QMH. The proportion was slightly lower than that in the EACTS database.

Workload by procedure category

		Data		
		Count	Proportion	Proportion in the EACTS Database
Procedure Category	Open heart surgery	521	65.0%	71.6%
	Closed heart surgery	224	28.0%	20.3%
	Other surgery*	56	7.0%	8.7%
	All	**801**		

* Other surgery refers to ECMO procedure, VAD implantation and thoracic procedures (e.g. closure of sternum, etc.)

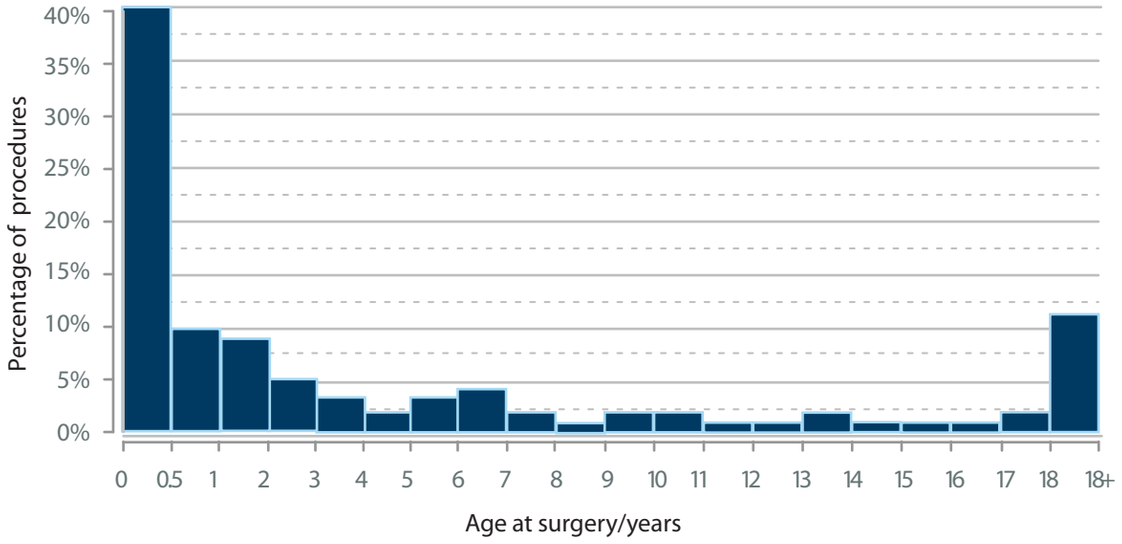
Workload by age group

- Nearly 50% of the operations were performed on patients below 1 year of age.
- The proportion of the number of neonatal surgeries at QMH (21.2%) was higher than that in the EACTS database (16.3%).
- Adult congenital heart surgery contributed a considerable proportion (11.1%) of the workload at QMH.

Workload By age group

		Data		
		Count	Proportion	Proportion in the EACTS Database
Age group	Neonates (0-30 days)	170	21.2%	16.3%
	Infants (31-365 days)	226	28.2%	33.3%
	Children (1-18 years)	316	39.5%	40.5%
	Adults (>18 years)	89	11.1%	10.0%

Level histogram of age at operation



Demographic and perioperative data

- In QMH, the average postoperative ventilation support time was 49 hours (2.1 days), which was much shorter than that in the EACTS Database (75 hours or 3.1 days).
- Patients undergoing closed heart surgery were much younger than those undergoing open heart surgery and also required longer hospital stay.

Demographic and perioperative data and data by procedure category

		Overalll		Procedure category			
				Open heart surgery		Closed heart surgery	
		QMH	EACTS	QMH	EACTS	QMH	EACTS
Mean value	Age at operation (months)	80.17	73.42	105.88	83.31	18.96	38.67
	Weight at operation (kg)	17.33	17.58	21.45	19.15	6.83	11.45
	Post-op ventilation time (hours)	49.42	75.16	44.67	65.32	37.76	98.77
	Length of stay (days)	17.71	15.66	15.01	14.47	20.72	18.41
	Total CPB time (min)	100.55	104.72				
	Total aortic cross-clamp time (min)	62.72	61.56				

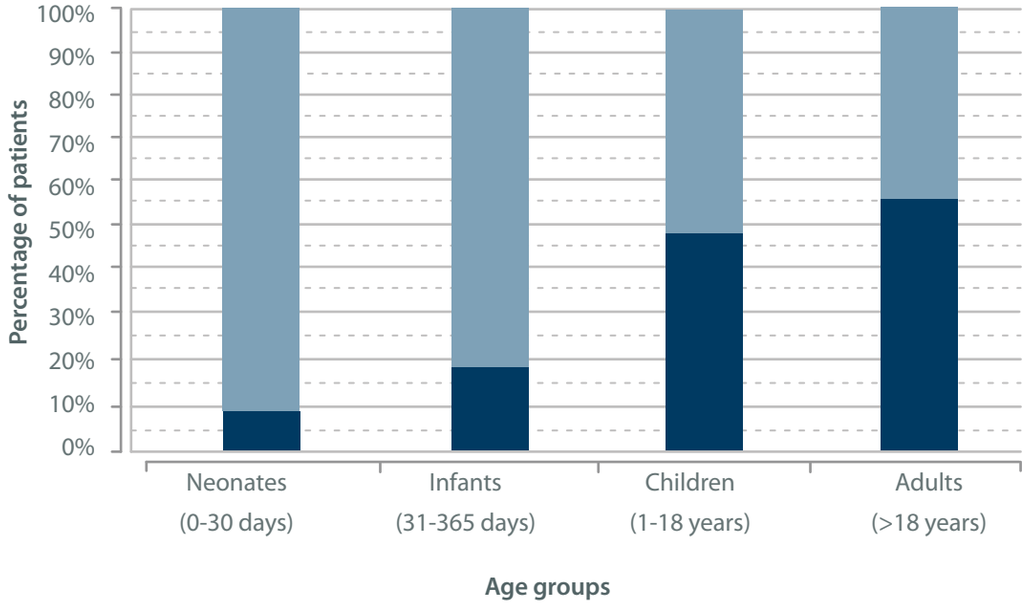
Previous cardiac surgery

Previous cardiac surgery within age groups

- Overall 28.9% of the patients had undergone previous cardiac surgery.
- In adult congenital heart surgery >50% of the patients had previous cardiac surgery done.
- Previous cardiac surgery was common in patients >1 year of age.

Previous cardiac surgery: Age groups

Previous surgery	15	39	129	49
Total procedures	170	226	316	89
Rate	8.8%	17.2%	40.8%	55.5%



List of primary diagnoses, primary procedures and complications in QMH, 2012-2013

Primary diagnoses

- To get a better understanding of the variety of diagnoses present in congenital cardiac surgery in QMH, the table lists the most frequent primary diagnoses with the number of cases and their proportion.
- The diagnosis listed in the table was the patient's most important or the primary diagnosis.

35 most frequent primary cardiac diagnoses in QMH , 2012-2013

Primary diagnosis	Count	Proportion
Patent ductus arteriosus	99	14.7%
VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	83	12.3%
ASD, Secundum	73	10.8%
TOF, Pulmonary stenosis	58	8.6%
VSD,Type 1 (Subarterial) (Supracristal) (Conal septal defect) (Infundibular)	35	5.2%
Coarctation of aorta	26	3.9%
AVC (AVSD), Partial (incomplete) (PAVSD) (ASD, primum)	22	3.3%
Single ventricle	17	2.5%
AVC (AVSD), Complete (CAVSD)	14	2.1%
Pulmonary atresia, VSD (Including TOF, PA)	13	1.9%
Aortic stenosis, Subvalvar	11	1.6%
Pulmonary insufficiency	11	1.6%
Pulmonary atresia, VSD-MAPCA (pseudotruncus)	10	1.5%
Single ventricle, Tricuspid atresia	9	1.3%
Aortic insufficiency	8	1.2%
Partial anomalous pulmonary venous connection (PAPVC)	8	1.2%
Pulmonary atresia, IVS	8	1.2%
ASD, Sinus venosus	7	1.0%
DCRV	7	1.0%
TGA, IVS	7	1.0%
Total anomalous pulmonary venous connection (TAPVC), Type 1 (supracardiac)	7	1.0%
Miscellaneous (respiratory failure, septic shock etc.)	6	0.9%
Mitral regurgitation	6	0.9%
Pulmonary stenosis, Subvalvar	6	0.9%
TGA,VSD	6	0.9%
Aortic stenosis, Supravalvar	4	0.6%
Cardiac, other (acute myocarditis, etc.)	4	0.6%
Hypoplastic left heart syndrome (HLHS)	4	0.6%
Pericardial effusion	4	0.6%
Pulmonary artery sling	4	0.6%
Pulmonary stenosis, Valvar	4	0.6%
Pulmonary venous stenosis	4	0.6%
Single ventricle, DIRV	4	0.6%
Single ventricle, Mitral atresia	4	0.6%
Tricuspid regurgitation, non-Ebstein's related	4	0.6%

Primary procedures

- The following table lists the most frequent primary procedures performed in QMH with total number of cases, their proportion and their complexity scores.
- Primary procedure is the most important, the most significant procedure in a specific operation. In most cases it's the procedure with the highest Basic Score.

35 most frequent primary cardiac procedures in QMH , 2012-2013

Primary procedure	Count	Proportion	ABC score
VSD repair, Patch	123	15.4%	6
PDA closure, Surgical	102	12.7%	3
Modified Blalock-Taussig Shunt (MBTS)	38	4.7%	6
ASD repair, Patch	36	4.5%	3
ASD repair, Primary closure	33	4.1%	3
Tetralogy of Fallot (TOF) repair, Ventriculotomy, Transanular patch	29	3.6%	8
Fontan TCPC, External conduit	26	3.2%	9
Pulmonic Valve replacement (PVR)	24	3.0%	7
Delayed sternal closure	22	2.7%	2
Mediastinal exploration	22	2.7%	-
Coarctation repair, End to end, Extended	19	2.4%	8
ECMO cannulation	15	1.9%	6
AV Canal AVC (AVSD) repair, Partial (Incomplete) (PAVSD)	15	1.9%	6
TAPVC repair	15	1.9%	9
AV Canal AVC (AVSD) repair, Complete (CAVSD)	13	1.6%	9
Tetralogy of Fallot, TOF repair, Ventriculotomy, Nontransanular patch	13	1.6%	8
RVOT procedure	13	1.6%	7
Pericardial drainage procedure	13	1.6%	3
Valvuloplasty, Mitral	11	1.4%	8
Arterial switch operation (ASO)	10	1.2%	10
Bidirectional cavopulmonary anastomosis (BDCPA) (bidirectional Glenn)	9	1.1%	7
Pulmonary atresia - VSD (including TOF PA) repair	8	1.0%	9
Valvuloplasty, Tricuspid	8	1.0%	7
DCRV repair	8	1.0%	7
ASD repair, Patch + PAPVC repair	7	0.9%	-
ECMO decannulation	7	0.9%	6
PA banding (PAB)	7	0.9%	6
Aortic stenosis, Subvalvar, Repair	7	0.9%	6
Pericardiectomy	7	0.9%	6
Coarctation repair, End to end	6	0.7%	6
Pacemaker implantation, Permanent	6	0.7%	3
Thoracic and/or mediastinal procedure, Other	6	0.7%	-
Pulmonary venous stenosis repair	6	0.7%	12
Arterial switch operation (ASO) and VSD repair	5	0.6%	11
DORV intraventricular tunnel repair	4	0.5%	10

Common post operative events/ major complications

- The following table lists the common postoperative events and major complications.

Postoperative event/complication details

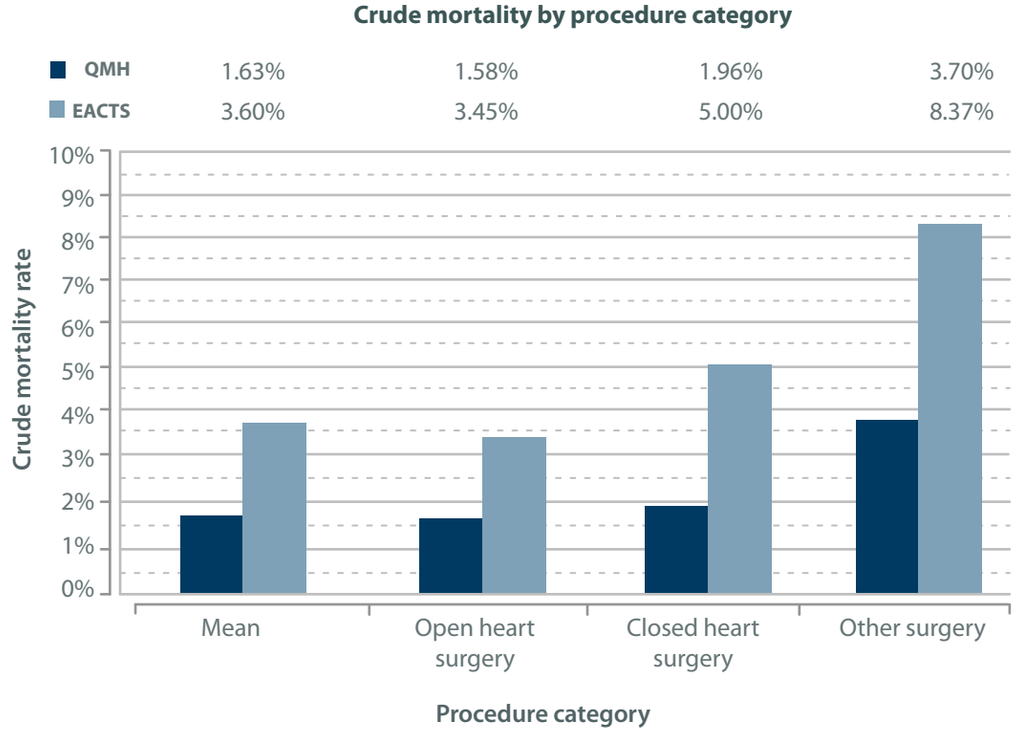
		Data	
		Count	Event/Complication rate
Post operative event/major complication	Postoperative/Postprocedural respiratory insufficiency requiring mechanical ventilatory support > 7 days	95	11.8%
	Renal failure - acute renal failure, Acute renal failure requiring temporary dialysis with the need for dialysis not present at hospital discharge	29	3.6%
	Sternum left open	24	2.9%
	Bleeding, Requiring reoperation	20	2.4%
	Reoperation during this admission (unplanned reoperation)*	12	1.4%
	Unplanned cardiac reoperation during the postoperative or postprocedural time period, exclusive of reoperation for bleeding	10	1.2%
	Paralyzed diaphragm (possible phrenic nerve injury)	8	0.9%
	Postoperative/Postprocedural mechanical circulatory support (IABP, VAD, ECMO, or CPS)	5	0.6%
	Postoperative complete AV block requiring permanent pacemaker	5	0.6%
	Respiratory failure, Requiring tracheostomy	4	0.4%

*Mainly refers to reoperation for residual or recurrent lesions, exclusive of reoperation for bleeding, sternal closure etc.

Mortality

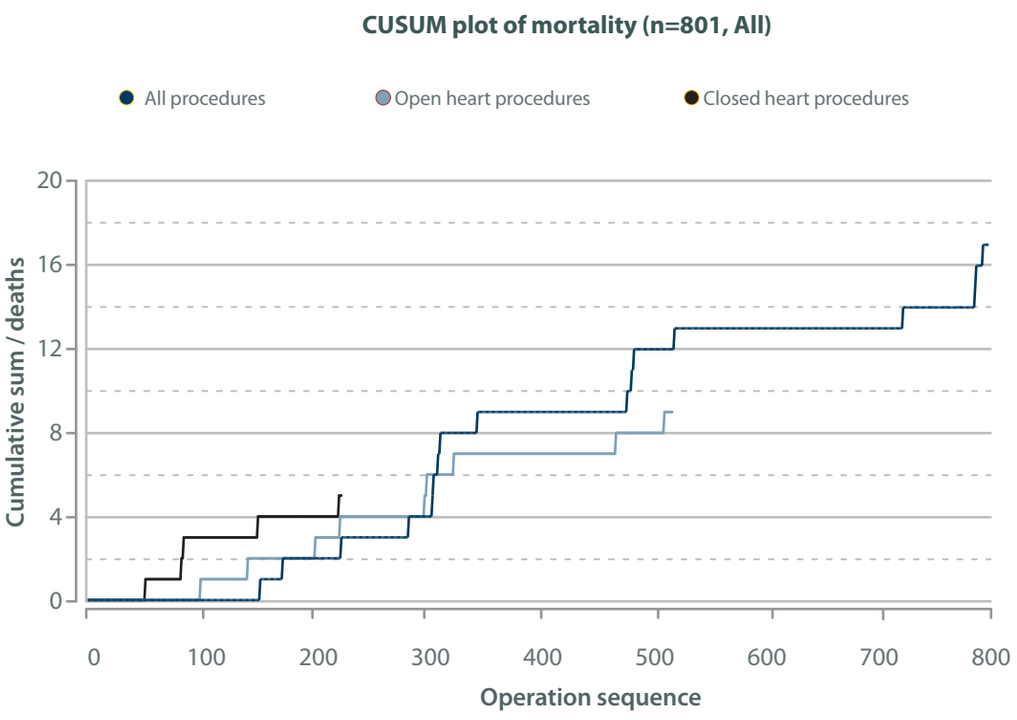
Crude mortality by procedure category

- 30-day mortality was used as our primary outcome. It is not uncommon for patients with congenital heart disease to have multiple congenital abnormalities or syndromes. The in-hospital mortality of these patients after cardiac surgery can be affected by the coexisting non-cardiac abnormalities. Therefore, 30-day mortality is preferably used.
- In QMH the overall crude mortality was 1.63%, which was lower than that in the EACTS database (3.6%).
- A higher mortality rate was seen in '*other surgery*' procedure category and could be attributed mainly to ECMO procedures which were the primary procedures in this category.



Cumulative sum (CUSUM) plot of mortality

- The CUSUM technique is a method of graph plotting of an accumulation of events [in-hospital mortality] over time.
- Cumulative risk-adjusted mortality plot provides a visual representation of the performance against the expected outcome rate of a particular risk scoring protocol.
- Observed 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.



Queen Mary Hospital, Hong Kong

Risk stratification

Complexity Score benchmarking

- The mean ABC score in QMH was lower than that in the EACTS database; the overall mortality at QMH in eligible patients was also lower than that in the EACTS database.

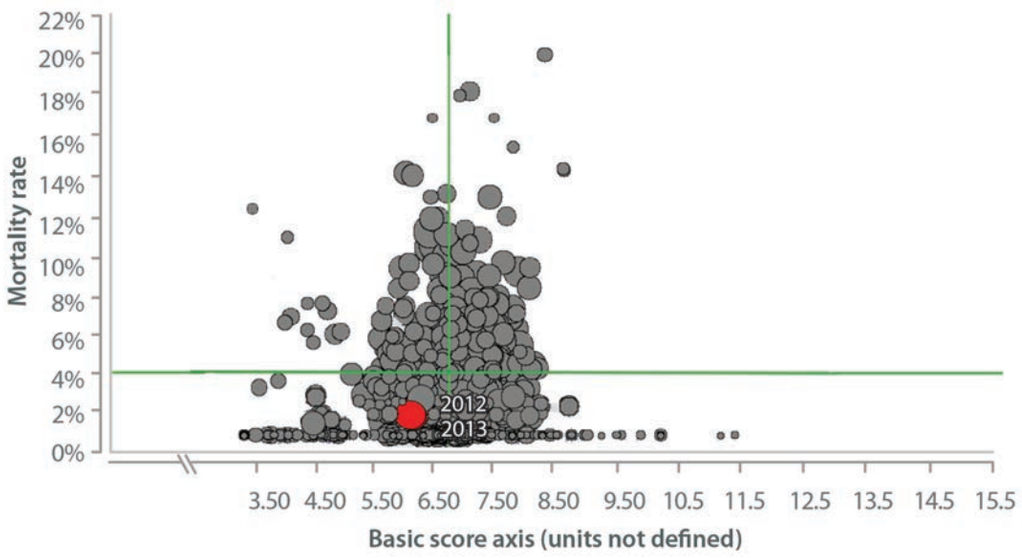
Complexity score and mortality 2012-2013

		Procedure count		Mortality		ABC score	
		All	Eligible*	QMH	EACTS	QMH	EACTS
Year	2012	421	400	1.25%	3.24%	6.04	6.71
	2013	380	344	0.87%	2.71%	6.12	6.81
	All	**801**	**753**	**1.06%**	**2.97%**	**6.08**	**6.76**

* Eligible procedures refer to the procedures with ABC scores. 48 patients underwent procedures that did not have assigned ABC score for example ECMO cannulation, VAD implantation, Potts shunt etc.

- The bubble chart is a scatter chart showing a center's performance in terms of mortality of the EACTS database.
- Every bubble represents one centre, with larger bubbles indicating a larger volume of the centre.
- The green lines show the mean values in the EACTS database.
- The red bubbles relating to the QMH performances of each year located in the left lower quadrant, show a satisfactory performance in either year.

International comparison of mortality rate and complexity score



Observed versus expected (O/E) mortality

- The overall mortality O/E ratio in QMH, 2012-2013 was 0.34, indicating a better outcome than expected.
- Outcomes in every calendar year and every age group were better than expected as suggested by the mortality O/E ratio.

Mortality O/E ratio by year

		Count			O/E ratio calculation		
		All procedures	Eligible procedures*	Eligible deaths**	Observed mortality	Expected mortality	O/E Ratio
Year	2012	421	387	5	1.29%	3.21%	0.40
	2013	380	344	3	0.87%	3.04%	0.28
	All	**801**	**731**	**8**	**1.09%**	**3.12%**	**0.34**

* Eligible procedures refer to procedures with expected mortalities. 70 patients underwent procedures that did not have ABC expected mortality for example ECMO cannulation, VAD implantation, Delayed sternal closure etc.
** Eligible deaths refer to deaths occurring within the eligible procedures.

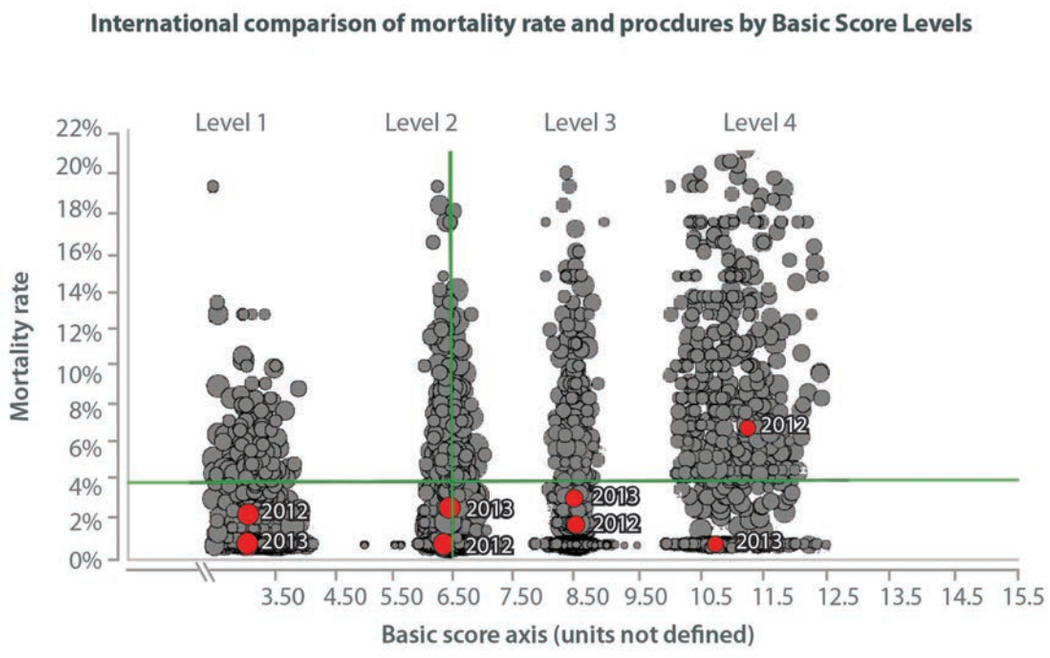
Mortality O/E ratio by age group

		Count			O/E ratio calculation		
		All procedures	Eligible procedures*	Eligible deaths**	Observed mortality	Expected mortality	O/E Ratio
Age group	Neonates (0-30 days)	170	153	4	2.61%	3.33%	0.78
	Infants (31-365 days)	226	211	1	0.47%	2.91%	0.16
	Children (1-18 years)	316	286	1	0.34%	3.26%	0.10
	Adults (>18 years)	89	81	2	2.46%	2.87%	0.85

* Eligible procedures refer to procedures with expected mortalities.
** Eligible deaths refer to deaths occurring within the eligible procedures.

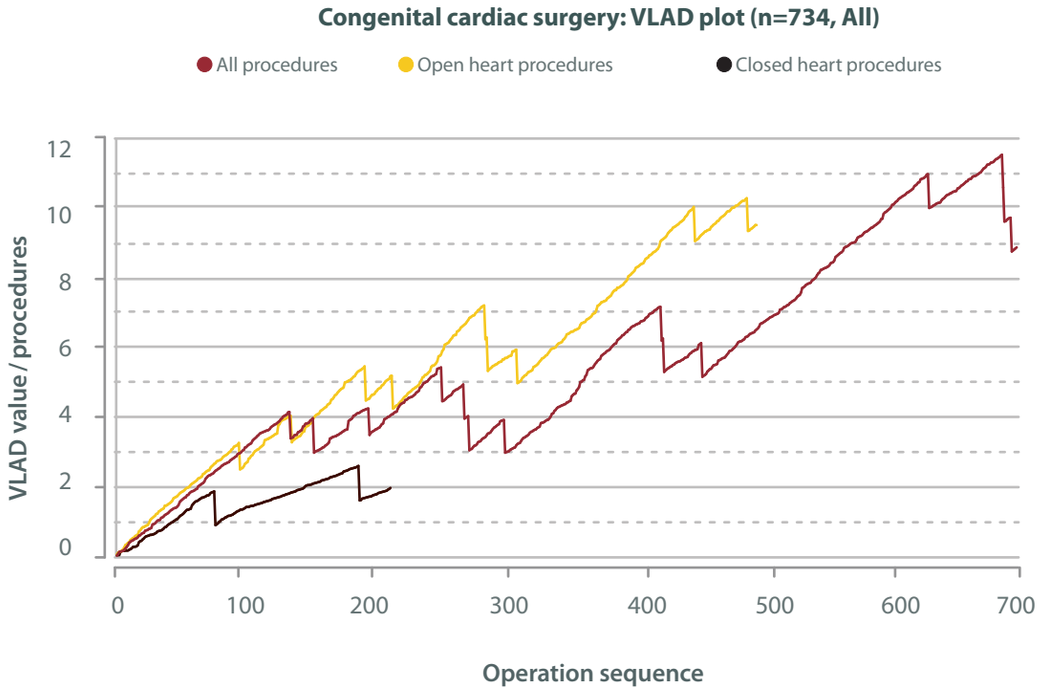
Risk adjusted mortality

- This bubble chart shows the performances in the procedures with different risk levels according to the ABC scores.
- The ABC score allocates a basic score to each operation varying from 1.5-15, in addition each procedure is also assigned an ABC level, an integer from 1 to 4 (see appendix).
- At QMH the mortality for procedures with ABC levels 1, 2 and 3 was well below EACTS mean mortality rate. Procedures with ABC level 4 (more complex procedures) showed mortality rate below EACTS mean in the year 2013 but in 2012 the rate was higher than EACTS mean mortality rate.



Variable Life -Adjusted Display (VLAD) plot of risk adjusted mortality

- The following VLAD graph covers all risk-scored procedures performed during 2012 and 2013.
- The plotted line goes up for each survival and down for each death. The degree of rise and fall is determined by the predicted risk associated with the case.
- The upslope of the curve demonstrated a net gain of patients' life and that the performance was better than expected.
- At the end of the curve, almost 9 extra lives had been saved at Queen Mary Hospital.



Queen Mary Hospital, Hong Kong

Neonates (0-30 days)

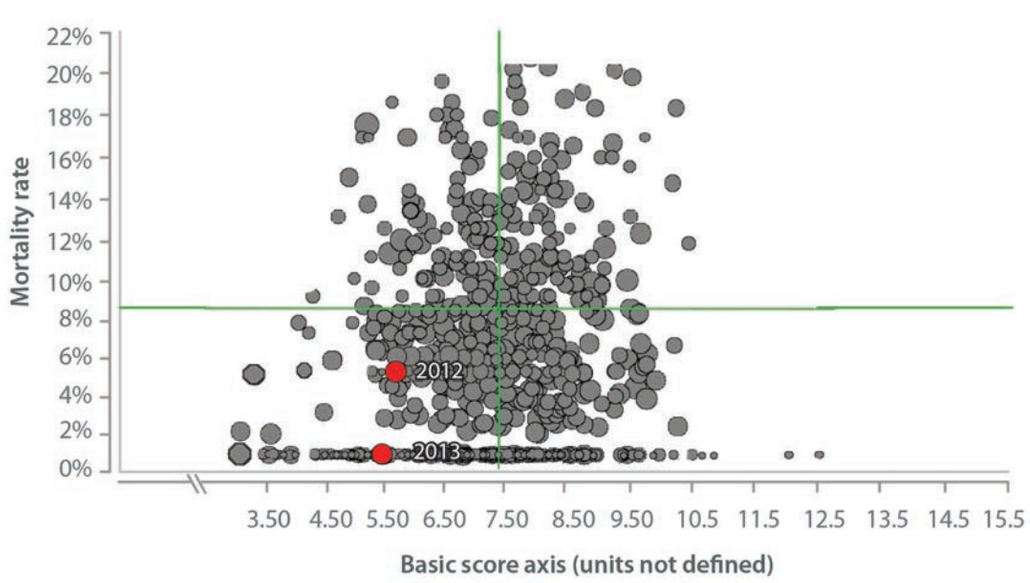
5 most frequent primary diagnoses in neonates

		Data	
		Count	Proportion
Diagnosis	Patent ductus arteriosus	56	39.7%
	Coarctation of aorta	22	15.6%
	TGA, IVS	7	5.0%
	Pulmonary atresia,VSD (Including TOF,PA)	6	4.3%
	Pulmonary atresia, IVS	5	3.5%

5 most frequent primary procedures in neonates

		Data		
		Count	Proportion	ABC score
Procedure	PDA closure	60	35.3%	3
	Modified Blalock-Taussig Shunt (MBTS)	22	12.9%	6
	Coarctation repair, End to end, Extended	18	10.6%	8
	TAPVC repair	11	6.5%	9
	Arterial switch operation (ASO)	10	5.9%	10

Mortality and complexity benchmarking in neonates



Infants (31-365 days)

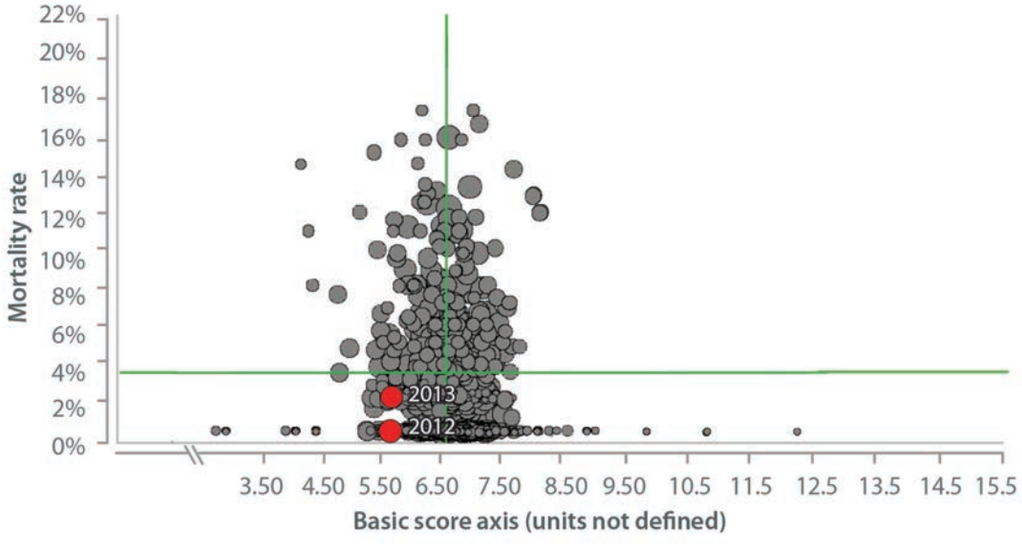
5 most frequent primary diagnoses in Infants

		Data	
		Count	Proportion
Diagnosis	VSD, Type 2 (Perimembranous)	58	31.4%
	Patent ductus arteriosus	43	23.2%
	TOF, Pulmonary stenosis	12	6.5%
	VSD, Type 1 (Subarterial)	12	6.5%
	AVC (AVSD), Complete (CAVSD	11	5.4%

5 most frequent primary procedures in Infants

		Data		
		Count	Proportion	ABC score
Procedure	VSD repair, Patch	78	34.5%	6
	PDA closure, Surgical	42	18.6%	3
	Modified Blalock-Taussig Shunt (MBTS)	16	7.1%	6
	AVC (AVSD) repair, Complete (CAVSD)	11	4.9%	9
	TOF repair, Ventriculotomy, Nontransanular patch	5	2.2%	8

Mortality and complexity benchmarking in infants



Queen Mary Hospital, Hong Kong

Children (1-18 years)

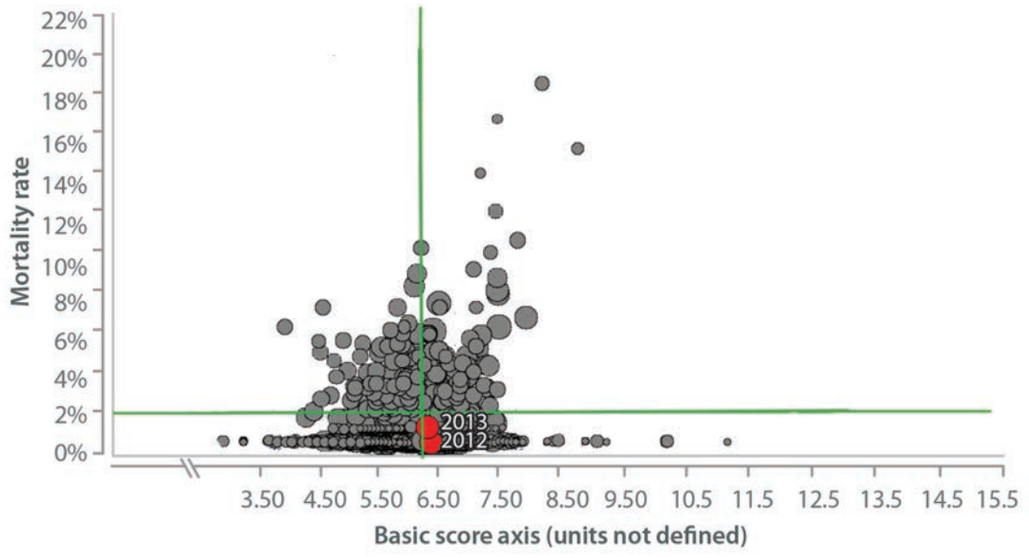
5 most frequent primary diagnoses in children

		Data	
		Count	Proportion
Diagnosis	ASD, Secundum	48	17.8%
	TOF, Pulmonary stenosis	35	13.0%
	VSD, Type 1 (Subarterial)	18	6.7%
	VSD, Type 2 (Perimembranous)	14	5.2%
	AVC (AVSD), Partial (incomplete) (PAVSD) (ASD,primum)	12	4.5%

5 most frequent Primary procedures in Children

		Data		
		Count	Proportion	ABC score
Procedure	VSD repair, Patch	28	8.9%	6
	Fontan, TCPC, External conduit, Fenestrated	26	8.2%	9
	ASD repair, Patch	25	7.9%	3
	TOF repair, Ventriculotomy, Transanular patch	25	7.9%	8
	ASD repair, Primary closure	24	7.6%	3

Mortality and complexity benchmarking in children



Adults (18 years or above)

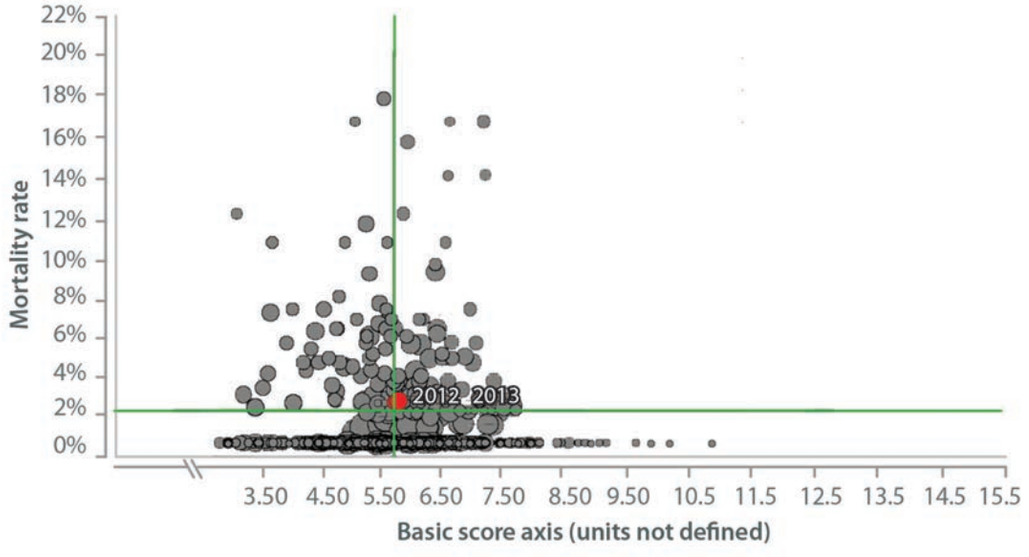
5 most frequent primary diagnoses in adults

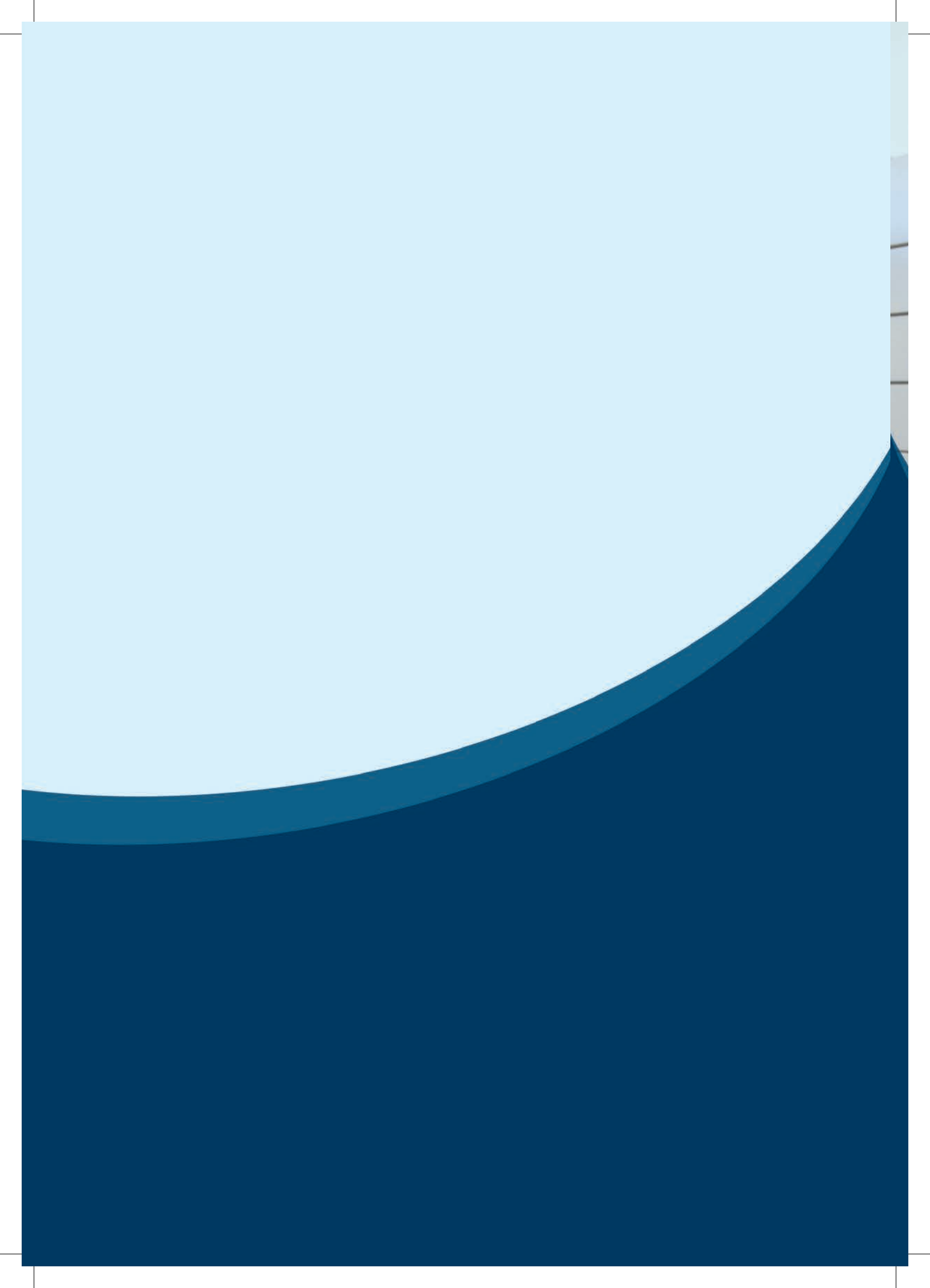
		Data	
		Count	Proportion
Diagnosis	Pulmonary insufficiency	17	21.5%
	ASD, Secundum	15	19.0%
	VSD, Type 2 (Perimembranous)	10	12.7%
	VSD, Type 1 (Subarterial)	5	6.3%
	Aortic stenosis, Subvalvar	4	5.1%

5 most frequent primary procedures in Adults

		Data		
		Count	Proportion	ABC score
Procedure	Valve replacement, Pulmonic (PVR)	17	19.1%	7
	VSD repair, Patch	16	18.0%	6
	ASD repair, Patch	9	10.1%	3
	ASD repair, Primary closure	6	6.7%	3
	Valvuloplasty, Tricuspid	5	5.6%	7

Mortality and complexity benchmarking in adults






5 C翼
Wing C5
A5，B5翼
Wings A5 & B5
C5心肺外科病房
C5 Cardiothoracic Surgical Ward
D5心肺外科病房
D5 Cardiothoracic Surgical Ward
E5心肺外科深切治療部
E5 Cardiothoracic Surgical Intensive Care Unit
F5手術大樓
Wing F5 Operating Theatres

Appendices

Appendices

Appendix 1 Adult cardiac database- 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 ○ 2. Two or more
○ 1. One ○ 9. Unknown

Interval between surgery and last MI
○ 0. No previous MI
○ 1. MI < 6 hours ○ 4. MI 2-30 days
○ 2. MI 6-24 hours ○ 5. MI 31-90 days
○ 3. MI 25-48 hours ○ 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 ☐ 5. Aortic - ascending / arch
☐ 2. Valve ☐ 6. Aortic - descending / abdominal
☐ 3. Congenital cardiac ☐ 7. Other thoracic
☐ 4. Other cardiac ☐ 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

Queen Mary Hospital, Hong Kong
Adult Cardiac Surgical Database
Page 2; Version 1.1

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

Queen Mary Hospital, Hong Kong
Adult Cardiac Surgical Database
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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

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 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
Adult Cardiac Surgical Database
Page 5; Version 1.1

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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Queen Mary Hospital, Hong Kong

Adult Cardiac Surgical Database

Page 6; Version 1.1

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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Adult Cardiac Surgical Database

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Hospital number | Date of surgery dd / mm / yyyy

Valve surgery

	Aortic	Mitral	Tricuspid	Pulmonary
Number replaced / repaired				
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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Queen Mary Hospital, Hong Kong
Adult Cardiac Surgical Database
Page 8; Version 1.1

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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Adult Cardiac Surgical Database
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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
- □ 1. Pre-operation
- □ 2. Intra-operation
- □ 3. Post-operation

Reason for IABP use

- ○ 1. Haemodynamic instability
- ○ 2. Unstable angina
- ○ 3. CPB wean
- ○ 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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Queen Mary Hospital, Hong Kong
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 dℓ$^{-1}$

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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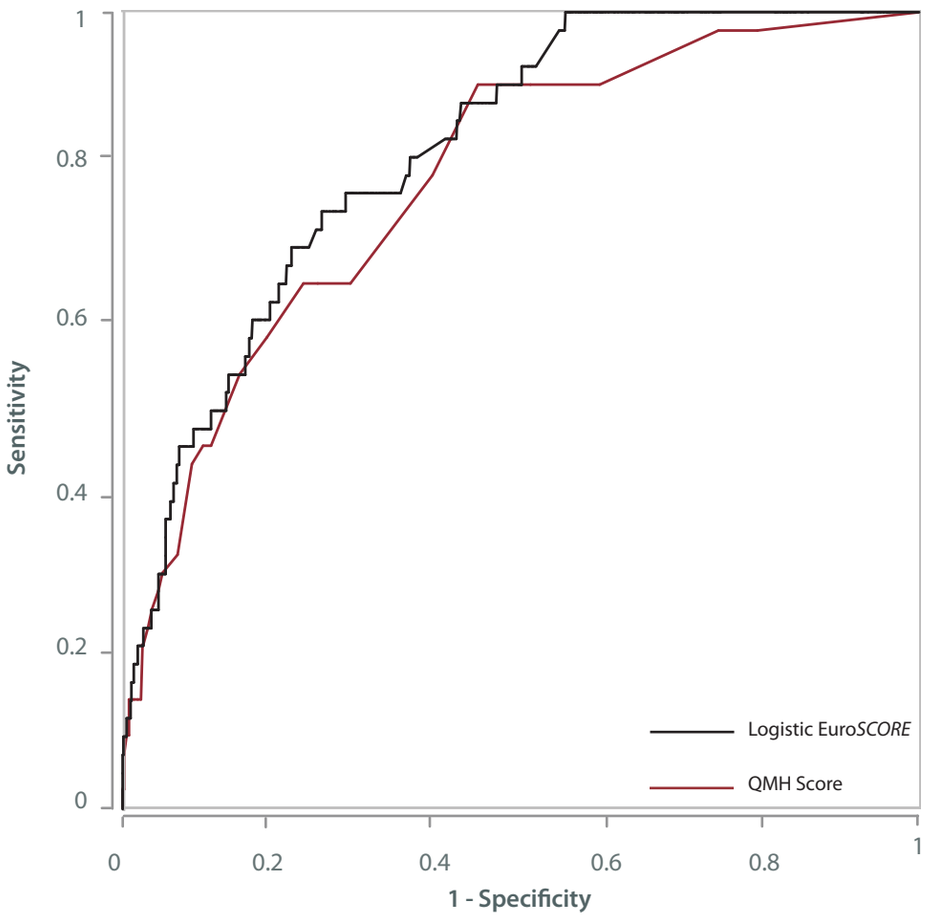
Queen Mary Hospital, Hong Kong

Comparing QM Score and Logistic EuroSCORE ROC for adult cardiac surgery



	Area under the curve	Asymptotic 95% Confidence Interval	
		Lower Bound	Upper Bound
QMH Score	0.789	0.723	0.855
Logistic Euro*SCORE*	0.825	0.773	0.878

Appendix 2 Congenital cardiac database

Nomenclature & Database

The International Congenital Heart Surgery Nomenclature and Database Project was started in 1998. A common nomenclature, along with a common core minimal data set, was adopted by the STS and EACTS and published in 2000. The International Paediatric and Congenital Cardiac Code (IPCCC) was finally presented[1] and published in 2005.

International Paediatric and Congenital Cardiac Code (IPCCC)

- Available *via* the Internet at www.IPCCC.NET
- Assigned to 180 diagnoses, 257 Procedures
- Integrated in both the STS and EACTS Congenital Heart Databases

World's Largest Congenital Heart Databases

- EACTS Congenital Heart Database (since 1992)
- STS Congenital Heart Surgery Database (since 2002)

1. The Fourth World Congress of Pediatric Cardiology and Cardiac Surgery. Buenos Aires, Argentina. September 19, 2005.

Risk Stratification: Aristotle Basic Complexity (ABC) Score and level[1]

Two methods of risk stratification are currently included in the EACTS Congenital Heart Database – The Aristotle Basic Complexity (ABC) Score and The STS-EACTS (STAT) Mortality and Morbidity Score. The former is used for the report in this book. The Aristotle Project was conceived in 1999, with input from members of the EACTS, the STS, the European Congenital Heart Surgeons, and the Congenital Heart Surgeons Society. The ABC Score was created by the International Aristotle Committee using the opinions of a panel of experts, made up of 50 congenital heart surgeons in 23 countries representing multiple societies. It is a concept to evaluate quality of care based on procedure complexity. It contains score values for single procedures. The ABC Score was originally assigned to 145 primary congenital cardiac procedures based upon mortality, morbidity, and technical difficulty. Each component receives a score of between 0.5 and 5 points. The ABC defined as the sum of the three components: overall ABC score = mortality component + morbidity component + technical difficulty component.

Score	Mortality	Morbidity	Difficulty
1 point	<1%	ICU 0-24H	elementary
2 points	1-5%	ICU 1D-3D	simple
3 points	5-10%	ICU 4D-7D	average
4 points	10-20%	ICU1W-2W	important
5 points	> 20%	ICU > 2W	major

The overall ABC ranging from 1.5 to 15 points, 1 to 4 levels, with higher scores / levels indicating greater overall risk. 156 congenital cardiac procedures are assigned to the score currently.

ABC Score	1.5-5.9	6.0-7.9	8.0-9.9	10.0-15.0
Level	1	2	3	4

Since 2003, the EACTS and the STS incorporate the Aristotle Basic Complexity Score into their congenital heart databases. The accuracy of the ABC Score was validated using 3-year-data of 35,862 operations from both the STS and EACTS Databases. The results published in 2007 showed the ABC score generally discriminates between low-risk and high-risk congenital procedures making it a potentially useful covariate for case-mix adjustment in congenital heart surgery outcomes analysis[2].

1. Lacour-Gayet *et al.* The Aristotle Score for congenital heart surgery. Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu 2004;7:185–91

2. O'Brien SM, *et al.* Accuracy of the Aristotle Basic Complexity Score for Classifying the Mortality and Morbidity Potential of Congenital Heart Surgery Operations. Ann Thorac Surg 2007;84:2027–37

Data Management & Reports

Data collection and input

- The data of all the congenital cardiac operations was retrieved prospectively using a standard form by the first-line clinical staffs.
- The surgeons are responsible for the operative data, while paediatricians in charge of the ICU and the general ward are responsible for the pre- and postoperative data.
- The department research staffs are responsible for data collection and input the data into the local computer and submit to the online server of the EACTS Database.

Data validation and verification

- The EACTS Database has intrinsic data validation rules (see next page) to ensure the internal data integrity in the process of data validation. The system reminds the user whenever there is an improper input of the data, which are corrected before final submission.
- Data verification is to compare the data collected in the database with the patient record in the hospital chart and the electronic medical system. This eliminates unintentional and organizational mistakes in the data, and is carried out by the department research staff.

Local database and data analysis

- The complete export from EACTS database writes file in csv format which is imported into relational database, Microsoft Access. Tables are linked using unique identifiers and files are then imported into SPSS for further analysis.
- The local database gets updated automatically as new data is entered. A regular backup of the local database is done by our research staff.

The central database & database online reports

- The central database is located in Warsaw, Poland. It contains the data gathered from the centers. The Software Development Team is working on the EACTS Database Software, maintaining the servers and this wiki website. The members of the database team can be contacted through email or phone.
- The ONLINE REPORT includes primary report and complication report of the whole database, gold standards report, basic score report and benchmark, quality of care benchmark report (bubble charts) and outcome prognosis report based on the primary diagnosis.