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瑪麗醫院
Queen Mary Hospital

Department of Cardiothoracic Surgery

Cardiac Surgery Biennial Report 2016-2017

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
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
ECHSA	European Congenital Heart Surgeons Association
ECMO	Extracorporeal Membrane Oxygenation
eCPR	Extracorporeal Cardiopulmonary Resuscitation
ELSO	The Extracorporeal Life Support Organization
EuroSCORE	European System for Cardiac Operative Risk Evaluation
HLHS	Hypoplastic Left Heart Syndrome
HOCM	Hypertrophic Obstructive Cardiomyopathy
IABP	Intra-aortic Balloon Pump
IMACS	ISHLT Registry for Mechanically Assisted Circulatory Support
IPCCC	International Pediatric and Congenital Cardiac Code
ISHLT	The International Society for Heart and Lung Transplantation
IVS	Intact Ventricular Septum
LAD	Left Anterior Descending Artery
LIMA	Left Internal Mammary Artery
LV aneurysmectomy	Left Ventricular Aneurysmectomy
LVAD	Left Ventricular Assist Device
LVEF	Left Ventricular Ejection Fraction
MBTS	Modified Blalock-Taussig Shunt
MVR	Mitral Valve Replacement
MICS	Minimally Invasive Cardiac Surgery
NACSD	National Adult Cardiac Surgical Database

O/E Ratio	Observed *versus* Expected ratio
PAB	Pulmonary Artery Banding
PAVSD	Partial Atrioventricular Septal Defect
PCI	Percutaneous Coronary Intervention
PVR	Pulmonic Valve Replacement
QMH	Queen Mary Hospital
RFA	Radiofrequency Ablation
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, IVS	Transposition of the Great Arteries with Intact Ventricular Septum
TGA,VSD	Transposition of the Great Arteries, Ventricular Septal Defect
TOF	Tetralogy of Fallot
TOF,PA	Tetralogy of Fallot, Pulmonary Atresia
VAD	Ventricular Assist Device
VA-ECMO	VenoArterial Extracorporeal Membrane Oxygenation
VLAD	Variable Life-adjusted Display
VSD	Ventricular Septal Defect
VSD-MAPCA	Ventricular Septal Defect, and Major Aortopulmonary Collateral Arteries
VV-ECMO	VenoVenous Extracorporeal Membrane Oxygenation

Table of contents

Part 1: Adult cardiac surgery

Table of contents

Part 2: Congenital cardiac surgery

Table of Contents

Appendices

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Foreword

I am pleased to present this foreword for the 4th biennial report. It is commendable that the Department of Cardiothoracic Surgery has been publishing its surgical outcomes determinedly every two years, showing its commitment to transparency and public accountability. They have incessantly brought out four reports in the past eight years and this is important for continued quality improvement.

The surgical caseload has grown in number and complexity. Inspite of this increase in volume, overall adult cardiac surgery outcome in 2016-2017 as indicated by the in-hospital mortality has been maintained and is 4.8%. This is at par with the UK when the complexity of the patients being operated is taken into account. The observed to expected mortality ratio is 0.35 which is the same as in the UK (2015). The pediatric cardiac surgery 30-day mortality is 2.27%, which is lower than 2.56% reported in ECHSA database. The outcome of coronary artery surgery is excellent and has been reducing over last eight years with a mortality now of 1.28%. These figures meeting international standards are an attestation of the quality of service they provide to their patients.

I appreciate their determination to continue benchmarking their advanced cardiac surgery outcomes of heart and lung transplants, ventricular assist devices and ECMO by joining the ISHLT heart/heart-lung/lung transplantation registry, the IMACS mechanically assisted circulatory support registry and the ELSO extracorporeal life support organization in 2016-2017. This would enable them to assess where they stand internationally when it comes to the most advanced treatments and enable the international community to recognize this activity in Hong Kong.

The department has been moving towards a more minimally invasive surgical approach. Robotic-assisted surgeries and TAVI programs have grown and delivered excellent outcomes. Treatment for advanced cardiac and respiratory mechanical circulatory support, ventricular assist devices, and heart and lung transplants continues to expand contributing to major increase in their caseload.

I would like to express my appreciation to the staff of the department in maintaining international standard outcomes in the landscape of increasing workload.

Dr C C Luk
Cluster Chief Executive,
HKWC/Hospital Chief Executive
(QMH/TYH)

Introduction

I am pleased to share the 2016 -2017 report regarding our activity, focusing on benchmarked patient care outcomes. The data is presented in the format of the previous three reports. All our reports are available in both hard copy form and on the Department's website at http://www.surgery.hku.hk/research_clinical.php.

In 2016-2017, we performed 1069 adult cardiac surgeries, which is a 23% increase since our first report of 2010-2011. In the same period we performed 642 pediatric cardiac surgeries. Case complexity profile, mortality and complications are regularly reported, for registry and benchmarking purposes, to both the Dendrite System for adult cardiac surgery and The European Congenital Heart Surgeons Association (ECHSA) congenital database for congenital cardiac surgery. 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 also has been benchmarked against UK data of 2015 (wherever available) from The Society for Cardiothoracic Surgery in Great Britain and Ireland. Their earlier paper version has been replaced by 'Blue Book Online' (http://bluebook.scts.org/). Our data collection methodology and validation remain the same as the previous three reports. Our databases now contains collected data of 4057 adult cardiac surgeries and 2157 congenital cardiac surgeries. Comprehensive data collection is essential for monitoring outcomes and service improvement.

2016-2017 has been an important period as we joined the International Society for Heart and Lung Transplantation (ISHLT) heart/heart-lung/lung transplantation registry, the International Society for Heart and Lung Transplantation Registry for Mechanically Assisted Circulatory Support (IMACS) and the Extracorporeal Life Support Organization (ELSO). This gives us a marvelous opportunity to participate in outcomes research about these advanced cardiac surgeries. We are proud to be among the few Asian centers who contribute to Mechanical Circulatory Support Device and Heart and Lung transplantation community.

As in previous biennial reports evaluations of the results show that we continue to maintain high standards of performance. I am extremely grateful to the entire staff of the Department of Cardiothoracic Surgery for their dedication and commitment.

Dr Timmy Wing Kuk Au
Chief of Service,
Department of Cardiothoracic Surgery,
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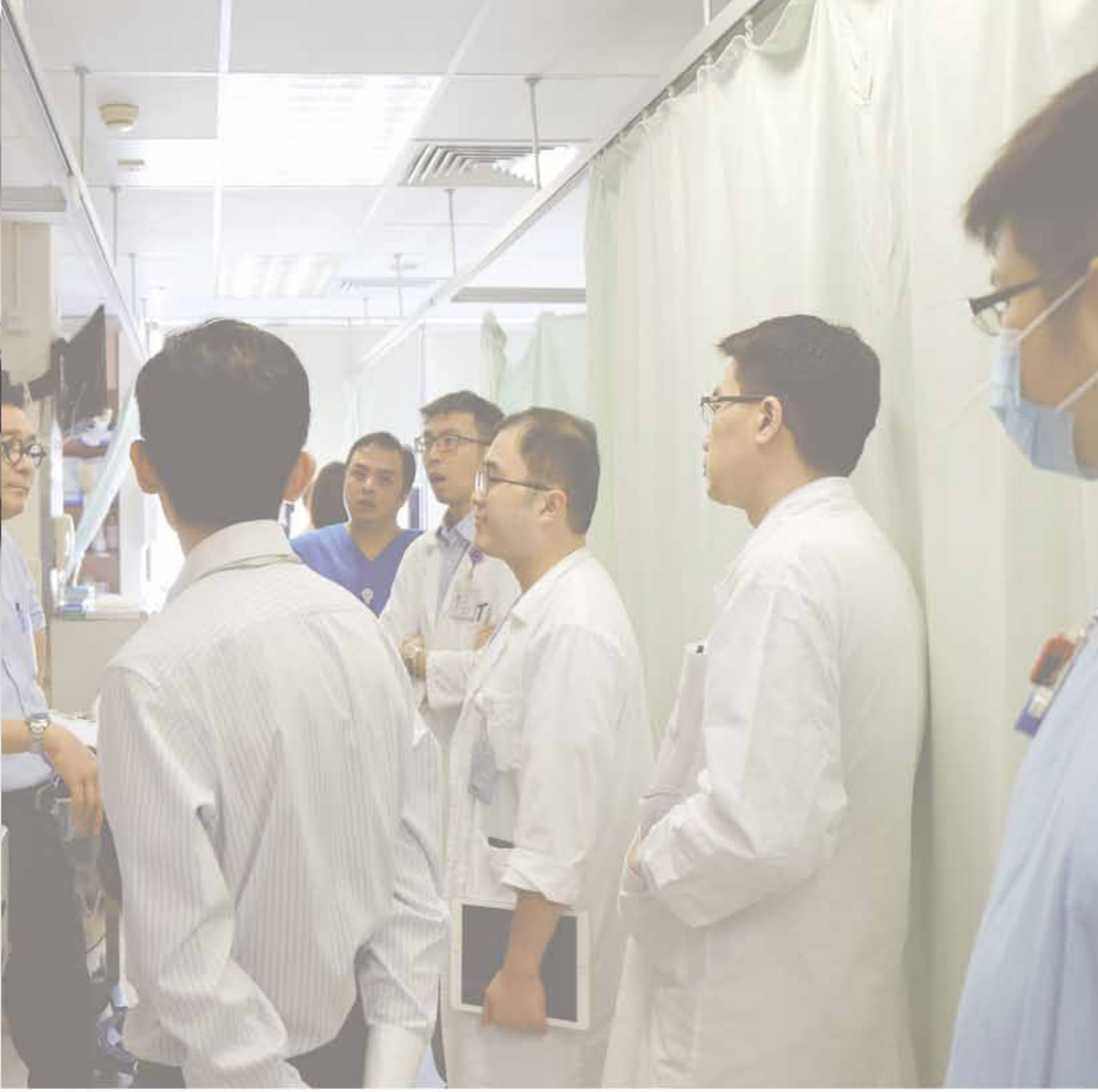
Part 1: Adult cardiac surgery



Database Overview

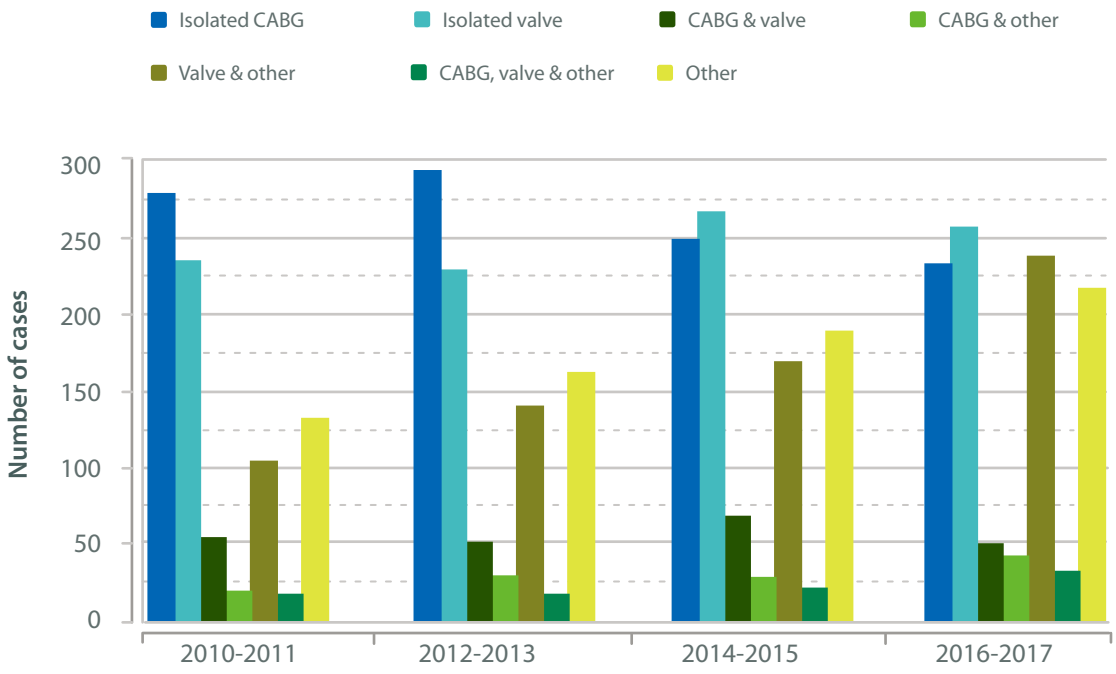
Database overview: Adult cardiac surgery

The overall workload at QMH, Hong Kong for the calendar years 2016-2017

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 1069 Adult Cardiac Surgeries–defined as open heart surgeries in patients older than 18 years.
- During the last six years, QMH's adult cardiac surgery has seen a steady and continued growth in volumes (867 in 2010-2011, 922 in 2012-2013, 991 in 2014-2015 and 1069 in 2016-2017).
- Although our overall activity has grown, there has been a steady decline in the proportion of Coronary Artery Bypass Graft (CABG) as a component of our overall activity. CABG surgeries represent 22% of all surgery types which was lower than those in the UK (58%).
- There has been a corresponding increase in valve surgery, including both Isolated Valves and Valve Surgery in combination with other procedures from 44% (2014-2015) to 46%.
- The proportion of our valve surgeries was higher than in the UK (46% 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.

Cardiac surgery activity in QMH : 2010-2017

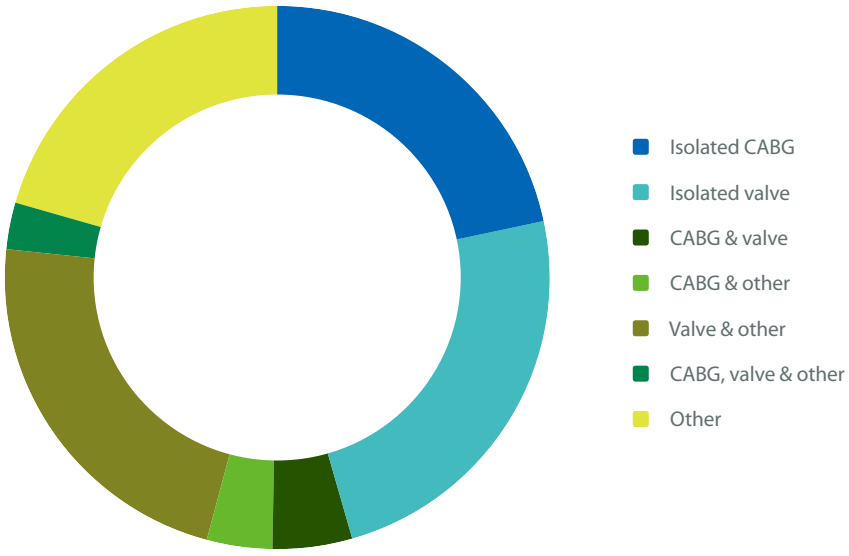


Overall workload at Queen Mary Hospital, Hong Kong: calendar years 2016-2017

		Data		
		Count	Proportion	Proportion in the UK 1
Procedure grouping	Isolated valve	257	24.0%	18.9%
	Isolated CABG	233	21.8%	58.3%
	Valve & other	238	22.2%	4.5%
	Other	217	20.3%	3.2%
	CABG & valve	50	4.7%	11.5%
	CABG & other	42	4.0%	2.0%
	CABG, valve & other	32	3.0%	1.6%
	All	**1069**		

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

Overall workload, 2016-2017 (n=1069)



Procedure detail

- The category of *CABG , Valve & Other* refers to Atrial Septal Defect (ASD) , Ventricular Septal Defect (VSD) , Aortic Surgery, MAZE (Radiofrequency Ablation Surgery and cryoablation) and Thoracic Resection *etc.*
- 3 grafts or more were performed in 205 Isolated CABG surgeries, a figure which was higher than the UK data (88% 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	3	0	19	12	0	16	0	**50**
		2 grafts	25	0	15	9	0	10	0	**59**
		3 grafts	163	0	14	18	0	5	0	**200**
		4 grafts	39	0	2	3	0	1	0	**45**
		>4 grafts	3	0	0	0	0	0	0	**3**
	Valve surgery	Aortic alone	0	77	33	0	82	17	0	**209**
		Mitral alone	0	68	12	0	51	9	0	**140**
		Tricuspid alone	0	14	0	0	18	1	0	**33**
		Pulmonary alone	0	12	0	0	12	0	0	**24**
		Aortic & mitral	0	23	2	0	11	2	0	**38**
		Mitral & tricuspid	0	33	2	0	39	3	0	**77**
		other valve combinations	0	30	1	0	25	0	0	**56**

Other procedure detail

- It is important to remember that the patient may have had more than one of the other procedures.
- Some of the more significant areas of case-volume growth in 2016-2017 compared to the previous three reports is surgery on the aorta (97 in 2010-2011, 96 in 2012-2013, 131 in 2014-2015 and 184 in 2016-2017).
- We are increasingly using newer approaches to left ventricular aneurysm resection, which involves complex procedures for the restoration of the geometry of the left ventricle.
- 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, Thoracic Organ Resections, Atrial Reduction Plasty, and Thoracic Endovascular Aortic/Aneurysm Repair (TEVAR) under bypass.

Other procedures performed

		Data	
		Count	Proportion
Other procedures	No other procedures	540	50.5%
	All operations with an *other* component	529	49.5%
	Surgery on the aorta	184	17.2%
	Radio-frequency ablation	105	9.8%
	ECMO	43	4.0%
	Ventricular assist devise	39	3.6%
	Adult congenital surgery	36	3.4%
	ASD	35	3.3%
	Cardiac transplant	24	2.2%
	Pulmonary transplant	22	2.1%
	LV aneurysmectomy	15	1.4%
	Pulmonary embolectomy	9	0.8%
	Atrial myxoma	6	0.6%
	Pericardiectomy	4	0.4%
	Acquired VSD	3	0.3%
	Epicardial pacemaker	1	0.1%
	Other procedure not listed above	99	9.3%
	All	**1069**	

Previous cardiac surgery

- The proportion of Isolated CABG with previous cardiac surgery was 0.9% compared to 1.6% in UK. It has been reducing since our first report of 2010-2011 (2.4%).
- The complexity and risk associated with re-operations, are greater than with primary (first-time) operations.
- Patients with coronary artery disease with a history of previous cardiac surgery who then require further coronary intervention may now more frequently undergo PCI rather than surgery and the situation is similar in UK.
- The proportion of 'Isolated valve' surgery with previous cardiac surgery was 30.4% in QMH while 'Valve & other' surgery with previous cardiac surgery was 19.7% and and was consistent with our previous report.
- Overall 18.5% of our Adult Cardiac Surgery patients had previous cardiac surgery performed (16% in 2010-2011, 17% in 2012-2013 and 16.8% in 2014-2015).

Previous surgery

		Previous cardiac surgery		
		No	Yes	Proportion prior surgery
Procedure grouping	Isolated CABG	231	2	0.9%
	Valve & other	191	47	19.7%
	Isolated valve	179	78	30.4%
	Other	154	63	29.0%
	CABG & valve	47	3	6.0%
	CABG & other	39	3	7.1%
	CABG,valve & other	30	2	6.3%
	All	**871**	**198**	**18.5%**

In-hospital mortality

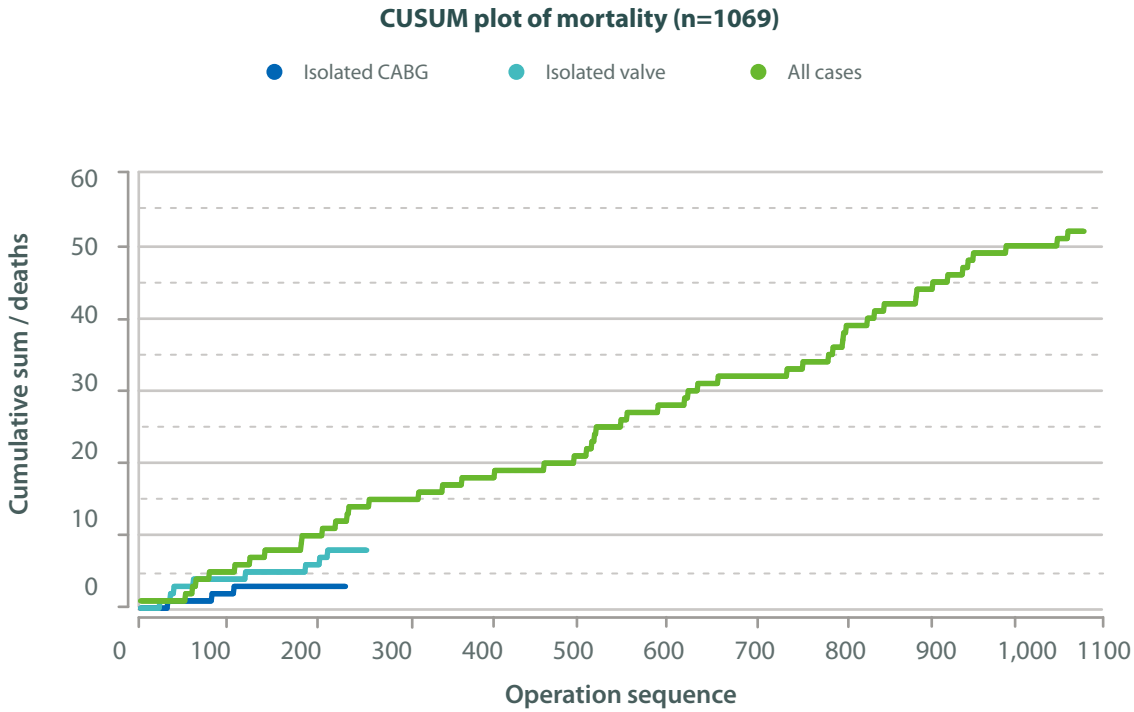
- In-hospital mortality was used as our primary outcome instead of 30 days mortality.
- Our isolated CABG crude mortality conform to contemporary UK and European Association for Cardio-Thoracic Surgery (EACTS) standards.
- The crude mortality rate of our Isolated Valve surgery was at par with the UK data and the EACTS database whereas, valves combined with other surgeries was lower than the UK data and the EACTS database.
- However, the crude mortality rate of our CABG combined with other surgery groups was higher than the UK data and EACTS database. In 2016-2017 QMH database, the '*CABG & other*' mortality was 9.5% vs 7.8% in UK and our '*CABG, valve & other*' mortality was 12.5% vs 11.5% in UK.
- The mortality rate for combined CABG with valve, CABG with other surgery and CABG with valve is higher than isolated CABG. Combined procedures involve more than one procedure during surgery and are generally more complex than isolated procedures.
- Compared to our report of 2014-2015, mortality rate for isolated CABG and CABG and valve surgery and CABG with valve/+ other surgery has fallen and mortality rate for 'Other' surgeries has increased. The mortality in the 'Other category' was mainly in ventricular assist devices, cardiac and lung transplants and surgery on the aorta procedures.

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

		Mortality data					
		Alive	Died	QMH 2016-2017	QMH 2014-2015	United Kingdom NACSD 2008	EACTS database 2006-2008
Procedure grouping	Isolated CABG	230	3	1.3% (233; 0.3-4.0%)	2.0% (249; 0.7-4.9%)	1.5% (22,808; 1.3-1.6%)	2.2% (219,053; 2.2-2.3%)
	Isolated valve	249	8	3.1% (257; 1.5-6.4%)	3.3% (267; 1.7-6.7%)	3.5% (7,379; 3.1-4.0%)	3.4% (75,247; 3.3-3.5%)
	CABG & valve	49	1	2.0% (50; 0.1-12.0 %)	8.8% (68; 4.0-20%)	6.1% (4,508; 5.4-6.8%)	6.2% (37,721; 6.0-6.5%)
	CABG & other	38	4	9.5% (42; 3.0-23.5%)	14.2% (28; 5.4-38.1%)	7.8% (766; 6.1-10.0%)	7.0% (4,327; 6.3-7.8%)
	Valve & other	228	10	4.2% (238; 2.0-8.1%)	2.9% (169; 1.1-7.3%)	5.5% (1,780; 4.5-6.7%)	4.9% (12,883; 4.5-5.3%)
	CABG, valve & other	28	4	12.5% (32; 4.0-30.0%)	14.2% (21; 4.4-42.2%)	11.5% (617; 9.2-14.4%)	11.3% (3,097; 10.2-12.5%)
	Other	195	22	10.1% (217; 6.6-15.1%)	6.8% (189; 4.1-12.5%)	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.
- CUSUM charts are based on sequential monitoring of cumulative performance over a period of time.
- 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.



Overall mortality and risk scores, 2016-2017

- Mortality rate is the percentage of patients who died in hospital (before they were discharged) after having a heart operation.
- The risk associated with cardiac surgery depends on a number of different factors including the type of surgery, the status of the heart for that particular patient and that patient's other associated illnesses. Risk stratification models, such as European System for Cardiac Operative Risk Evaluation (EuroSCORE)- Logistic EuroSCORE and EuroSCORE-II, predict mortality based on these risk factors.
- Values of the EuroSCORE broadly correlate with the predicted operative mortality in percentage terms.
- Overall hospital mortality in this cohort was 4.8% (4.5% in 2014-2015). Cardiac surgery outcomes in the UK (http://www.bluebook.scts.org/, Blue Book online) report mortality of 2.57% in 2015.
- In our cohort Logistic EuroSCORE predicted a mortality of 13.67%. The average Logistic EuroSCORE in UK was 7.42% in 2015. Thus our O/E ratio was at par with the O/E ratio in UK, 0.35 and 0.34 respectively.
- The average EuroSCORE-II predicted a mortality of 7.59% resulting in O/E ratio of 0.63 in our cohort.
- EuroSCORE-II yielded the higher predictive value in our patient population.

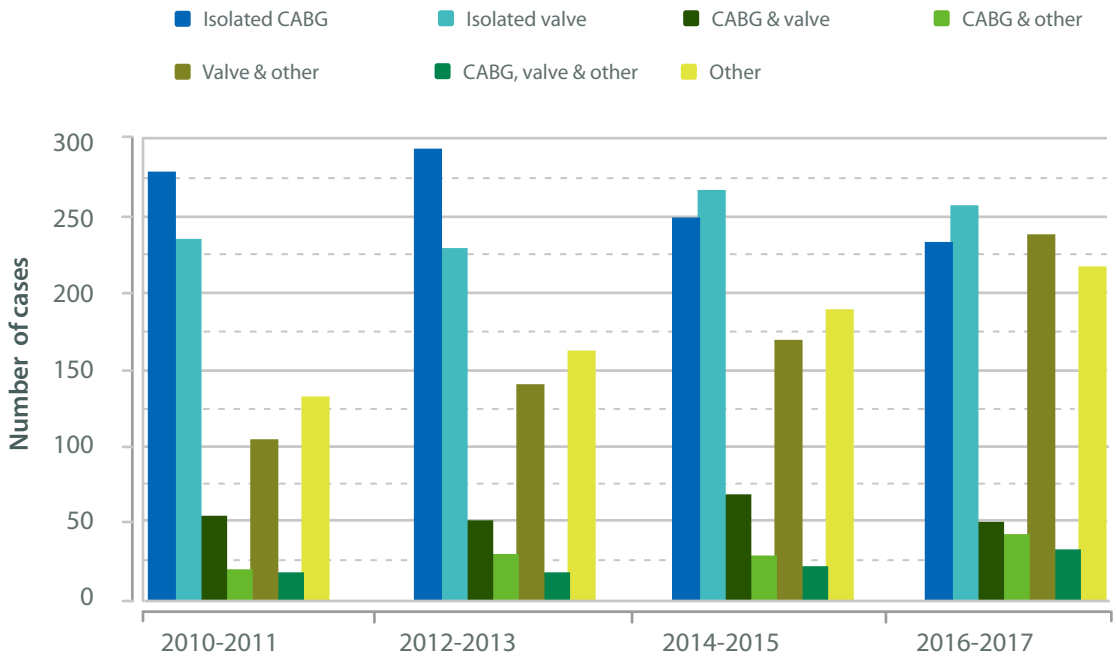
CABG surgery

Isolated CABG surgery

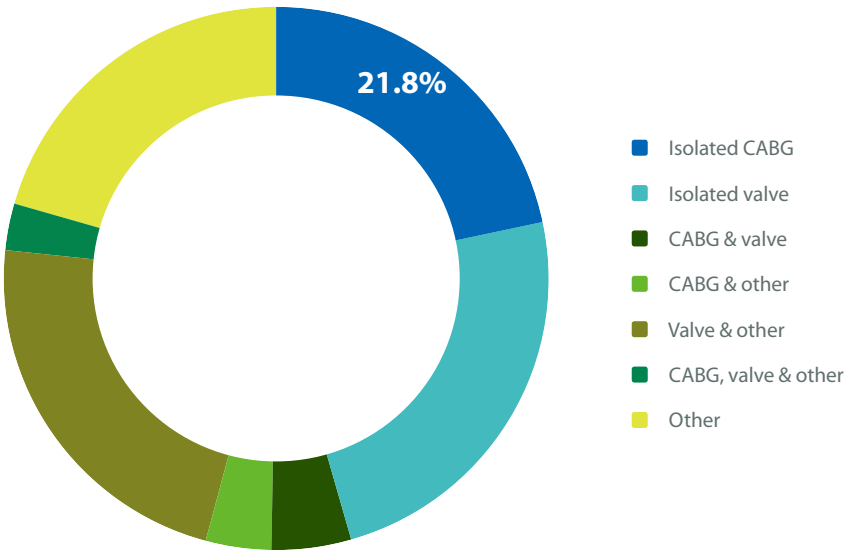
Isolated CABG in the context of overall workload

- Total 233 patients had isolated CABG in the year 2016 to 2017.
- Coronary surgery contributed to 21.8% of the workload (adult cardiac surgery) in our department, there has been a steady decrease over last eight years. This is a trend observed internationally.
- This decrease has been balanced by a corresponding increase in other areas of our activity.

Cardiac surgery activity in QMH : 2010-2017



Workload overview, 2016-2017 (n=1069)

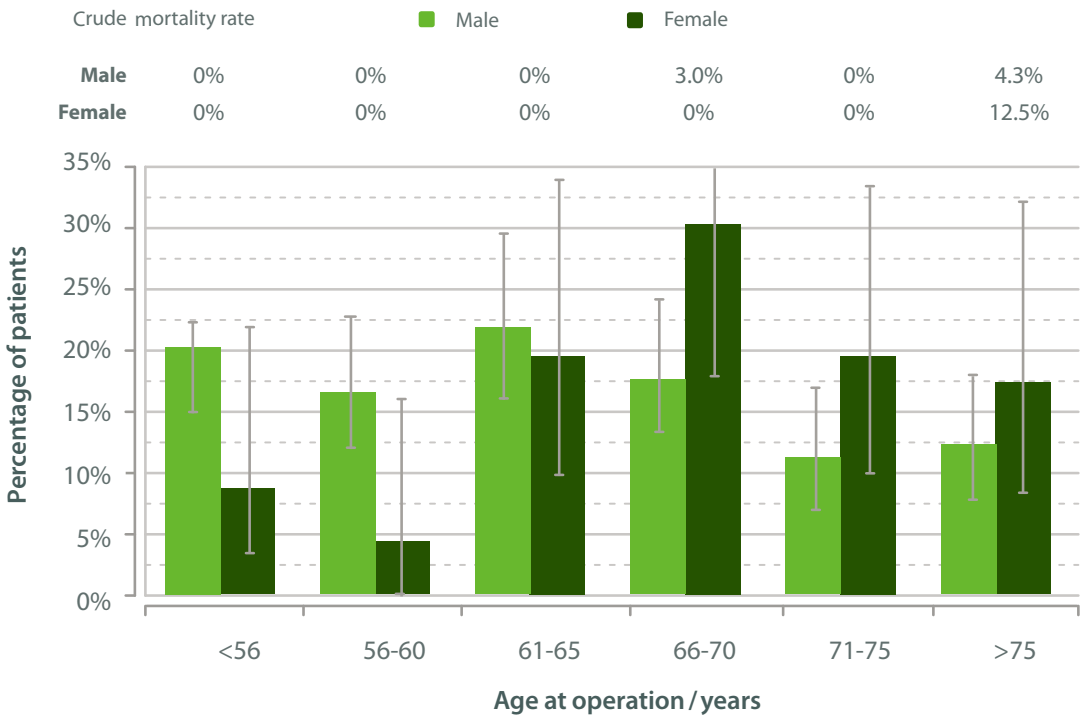


Pre-operative risk factors

Age and gender

- Higher proportion of male patients, 80.2% (187) underwent CABG compared to female patients, 19.7% (46) . A similar trend was also seen in our previous two reports. This is consistent with report of Cardiac surgery activity and outcomes in the UK in 2015 (http://www.bluebook.scts.org/, Blue Book online) where proportion of females is 18.1%. These are a reflection of widely known gender differences in prevalence of coronary artery disease.
- Old age and female gender are considered as risk factors for CABG in general.
- Proportion of females is more in the higher age groups. Highest proportion of female patients undergoing CABG are aged between 66 and 70 years.

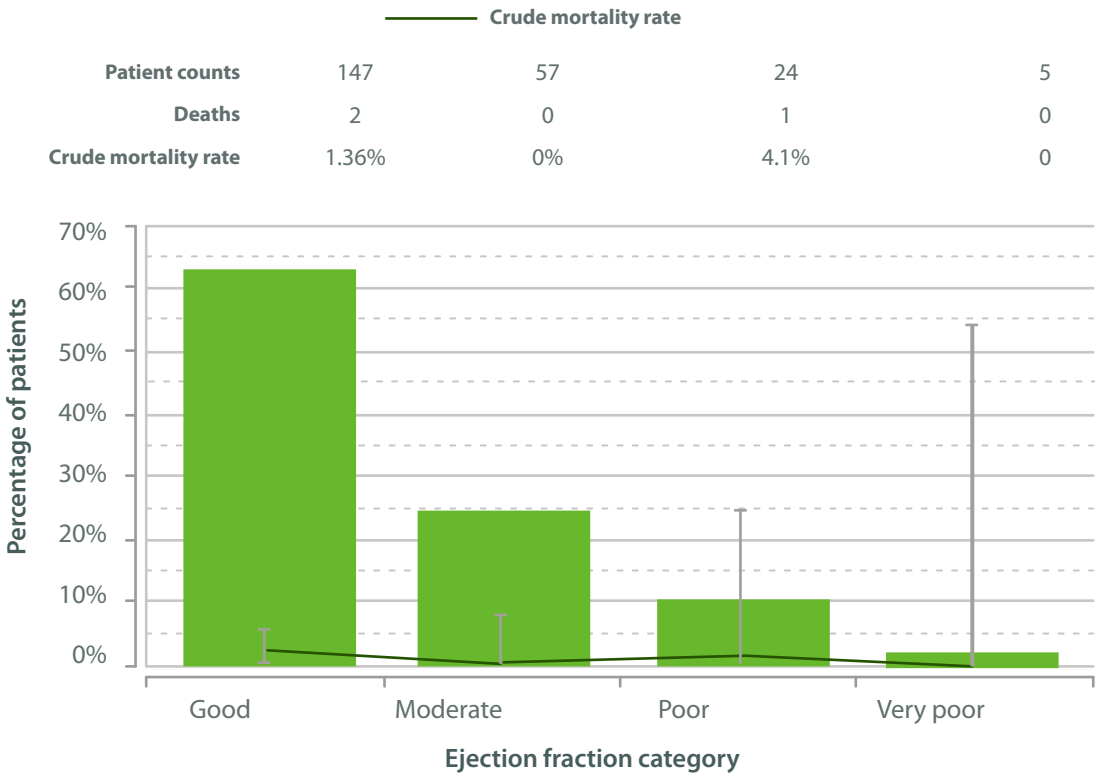
Isolated CABG: Age, gender and crude mortality (n=233)



Left ventricular ejection fraction and crude mortality distribution

- Ventricular function is mainly assessed by an echocardiogram and expressed as Left Ventricular Ejection Fraction (LVEF).
- Poor left ventricular function is a well known risk factor in re-vascularization surgery.
- European System for Cardiac Operative Risk Evaluation ***(EuroSCORE II)*** has four categories of Left Ventricular Ejection fraction- Good (LVEF>50%), Moderate (LVEF 31-50%), Poor (LVEF 21-30%), Very poor (LVEF 20% or less).
- The proportion of patients with good ejection fraction is 63% .
- There were 2.1% patients with very poor ejection fraction and only 10.3% with poor ejection fraction in this cohort.

Isolated CABG: Ejection fraction and crude mortality (n=233)



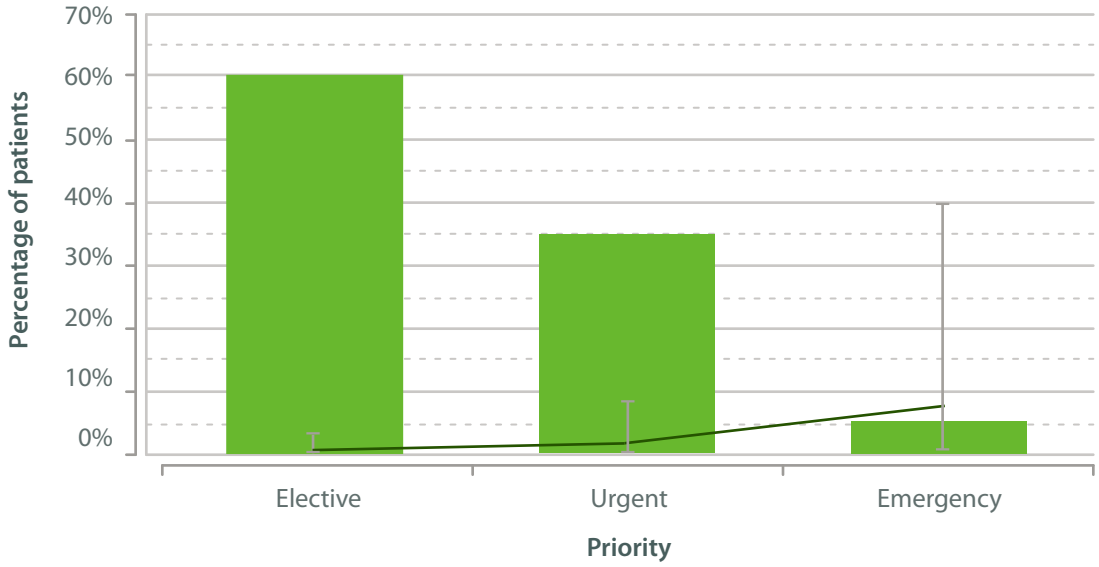
Priority distribution and mortality

- Most of the patients underwent CABG on an elective basis (60.1%). Comparing to CABG data from report of Cardiac surgery activity and outcomes (http://www.bluebook.scts.org/, Blue Book online), in UK in 2015, 54.4% underwent CABG on elective basis.
- Urgent CABG is defined as operation on the next available working day while emergent CABG (including salvaging surgery) indicates patients need surgery the same day because of their clinical situation. These represent 34.8% and 5.2% of all coronary operations respectively and is higher than our previous report of 2014-2015, 11.2% and 4.8% respectively.
- We performed 34.7% of CABG surgeries on urgent basis compared to 43.3% in UK in 2015.
- Operative priority is generally associated with in-hospital mortality. Patients in urgent or emergency situations might have on-going ischemia of the myocardium, frequent malignant arrhythmia or even unstable haemodynamics.
- For elective CABG a mortality of 0.7% was comparable to mortality of 0.58% for elective CABG reported in UK in 2015. Mortality in QMH was 1.23% in urgent situations which is consistent with 1.26% reported in UK in 2015. Mortality in urgent and emergent categories was lower than reported in 2014-2015 report (7.1% and 16.6% respectively).

Isolated CABG: Priority and crude mortality (n=233)

Crude mortality rate

Patient counts	140	81	12
Deaths	1	1	1
Crude mortality rate	0.7%	1.2%	8.3%



Mortality and other risk factors

- The table below shows certain pre-operative risk factors affecting surgical outcome in coronary surgery.
- The proportion of patients with hypertension, renal failure requiring dialysis and pre-op Intra-aortic Balloon Pump (IABP) insertion in isolated CABG was 91.0%, 7.3% and 5.1% respectively.
- The risk factors for coronary artery surgery in this cohort are pre-op IABP insertion, renal failure requiring dialysis and hypertension.
- Among all the risk factors, the mortality rate for pre-op IABP usage is the highest, 9%.
- Risk factors remain same as our previous two reports.

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

			Mortality		
			Alive	Dead	Rate
Risk factors	Gender	Male	185	2	1.0%
		Female	45	1	2.2%
	Body mass index	≥25 kg m^{-2}	105	2	1.9%
		<25 kg m^{-2}	125	1	0.8%
	Left main stem disease	No	109	2	1.8%
		Yes	121	1	0.8%
	Previous cardiac surgery	No	228	3	1.3%
		Yes	2	0	0.0%
	Diabetes	No	108	3	2.7%
		Yes	122	0	0.0%
	Hypertension	No	21	0	0.0%
		Yes	209	3	1.4%
	Extra-cardiac arteriopathy	No	207	3	1.4%
		Yes	23	0	0.0%
	Previous CVA	No	213	3	1.4%
		Yes	17	0	0.0%
	Pre-op IABP insertion	No	219	2	0.9%
		Yes	11	1	9.0%
	Renal failure requiring dialysis	No	214	2	0.9%
		Yes	16	1	6.3%

The grafting process

Arterial grafting

Total number of grafts = 713 in 233 patients.

Average number of grafts= 3.06

Patients with LIMA graft= 222/ 233 (95.2%)

Patients with LIMA and Radial Artery graft = 40/ 233 (17.1%)

Arterial grafting

- There were 713 distal anastomoses made in 233 patients. On average, each patient received 3.06 grafts in isolated CABG. This has remained constant over last four years.
- 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.
- Arterial grafting was performed in 95.2% of 233 isolated CABG. 222 patients had the LIMA grafted to the Left Anterior Descending (LAD) artery in isolated CABG.
- 3 grafts or more were performed in 205 Isolated CABG surgeries which was higher than the UK data (87.9 % in QMH vs 74% in UK).
- In addition to internal thoracic arteries, other arteries are available for use as conduits. Radial arteries were the second most common conduit used for arterial grafts (40/233).

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 was 100% for the radial artery and 88.5% for vein graft harvest. 5 endoscopic vein harvests were converted to open vein harvests.

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

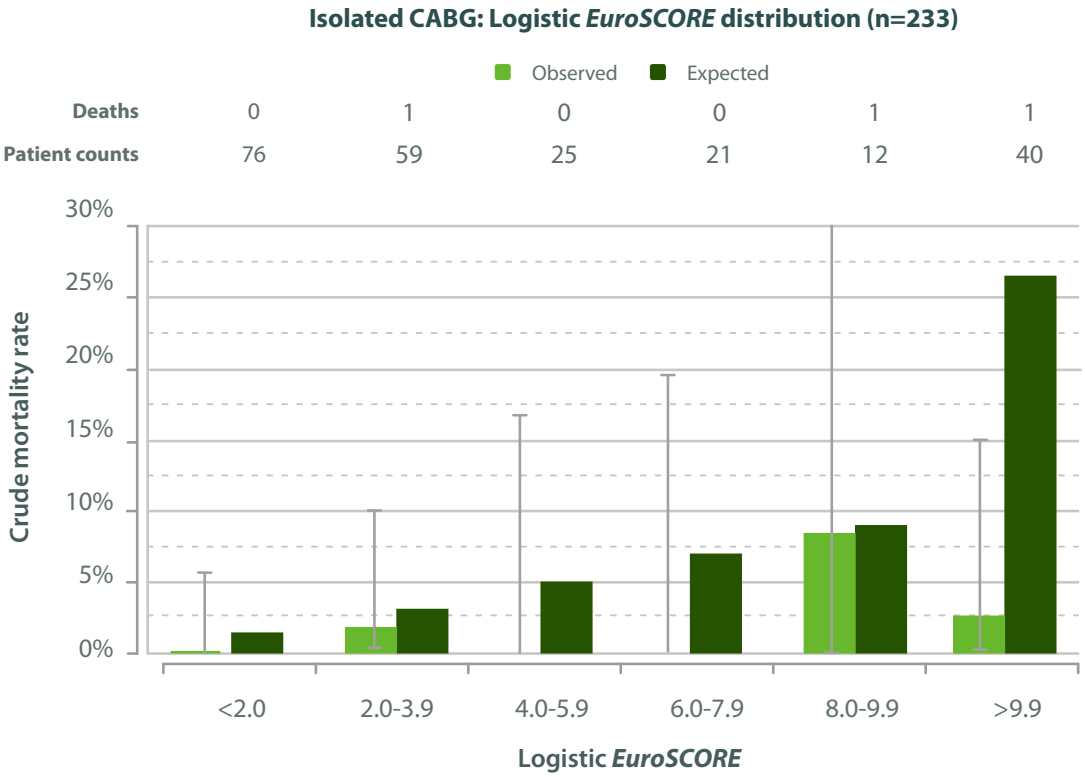
		Endoscopic harvest of the named conduit		
		No	Yes	Endoscopic harvest rate
Conduit	Radial artery used	0	40	100.0%
	Vein used	26	202	88.5%

Isolated CABG: Radial artery graft usage at each of the coronary artery sites treated (n=39 grafts)

		Data	
		Count	Proportion
Coronary site	OM1	23	57.5%
	OM2	9	22.5%
	RCA-PDA	3	7.5%
	Distal Cx	2	5.0%
	Int	2	5.0%
	Diag 1	1	2.5%
	All	**40**	

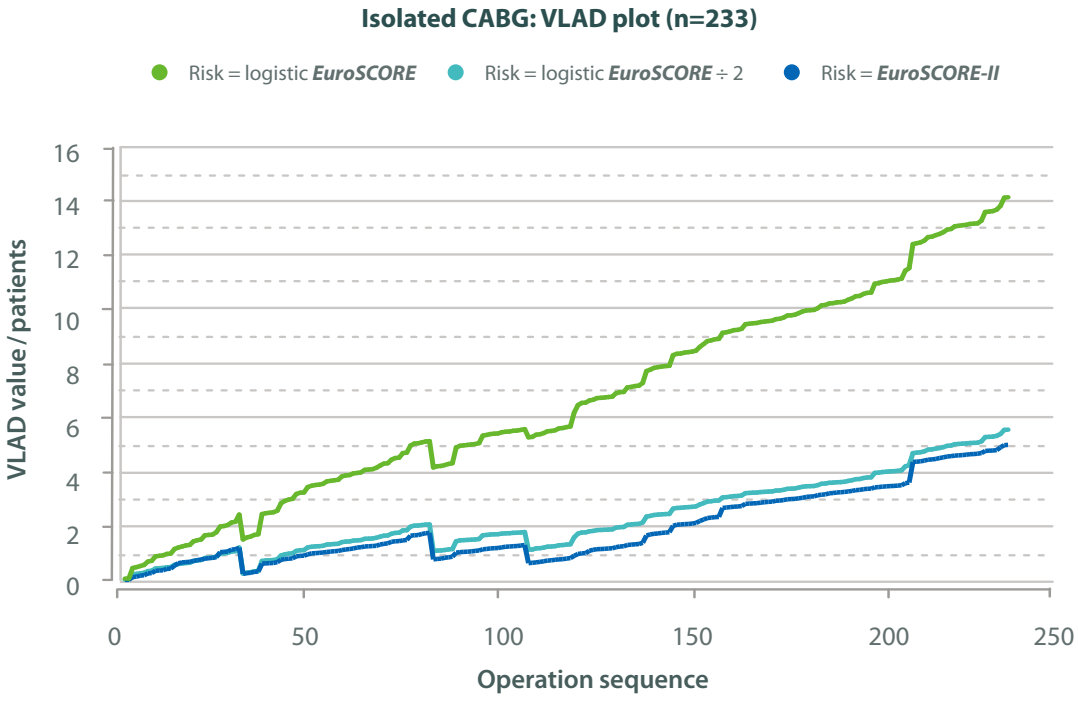
Logistic *EuroSCORE, EuroSCORE II* and mortality

- 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.
- At QMH, the patient risk profile was higher since a Logistic EuroSCORE higher than 9.9 contributes 17.1% of patients.
- Most of the mortality was associated with the higher-risk groups.
- The overall expected mortality in isolated CABG group of patients was 7.34% (17 patients). While the Observed mortality was 1.28% (3 patients). Thus, the observed *versus* expected mortality ratio was 0.17 for isolated CABG. In 2014-2015 we reported observed *versus* expected mortality ratio of 0.31.
- Predicted mortality for isolated first-time CABG (overall cohort) in 2015 in UK was 4.37% and the observed mortality was 1.05%. Thus observed *versus* expected mortality ratio was 0.24.
- EuroSCORE II predicted an overall mortality of 3.43% (8 patients) and the O/E ratio was 0.37.
- Since only Logistic EuroSCORE was available from UK data it was used for benchmarking.



VLAD plot for isolated CABG

- The following Variable Life-Adjusted Display (VLAD) graph covers all risk-scored isolated CABG procedures performed during 2016 and 2017.
- 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 14 extra lives had been saved at Queen Mary Hospital.
- A Logistic EuroSCORE divided by 2 is also shown in the graph. This graph demonstrates performance very close to the expected value.

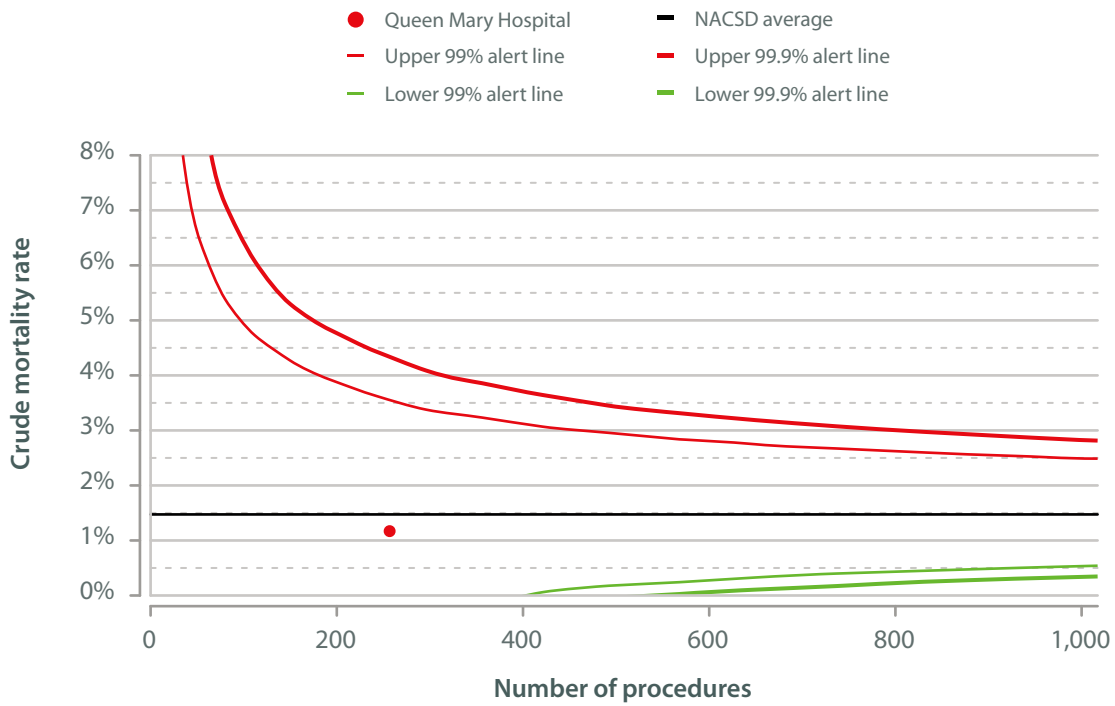


International benchmarking of results

- 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 NACSD 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 (1.28%) fell well within the alert lines.
- The second chart shows re-operation for bleeding rate at Queen Mary Hospital at 3% and this also fell well within the alert lines.
- The third and the fourth charts represent the crude stroke rate and the proportion of patients that need haemofiltration / dialysis for acute renal failure; the rates were 1.28% and 0.85% respectively. The stroke rate at Queen Mary Hospital again fell well within the funnel plot alert lines, and the dialysis rate fell within the lower alert lines.
- 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.

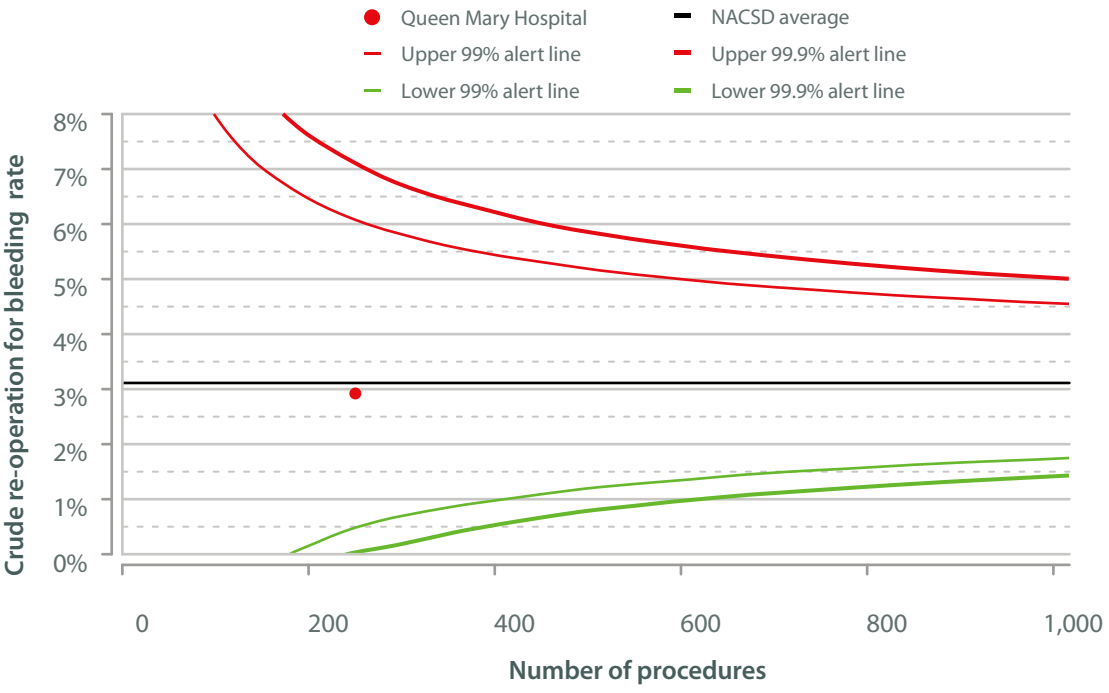
In-hospital mortality

Isolated CABG: Crude mortality rate for QMH (n=233) compared to the data from the financial year 2008 in the United Kingdom NACSD



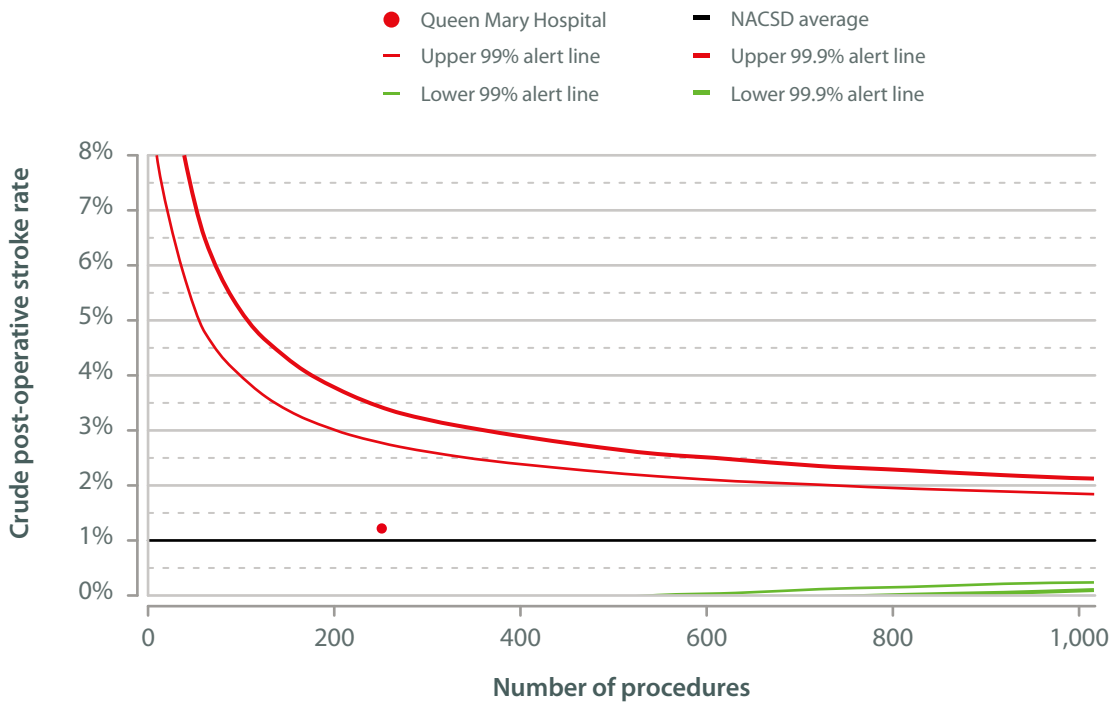
Re-operation for bleeding

Isolated CABG: Crude re-operation for bleeding rate for QMH (n=233) compared to the data from the financial year 2008 in the United Kingdom NACSD



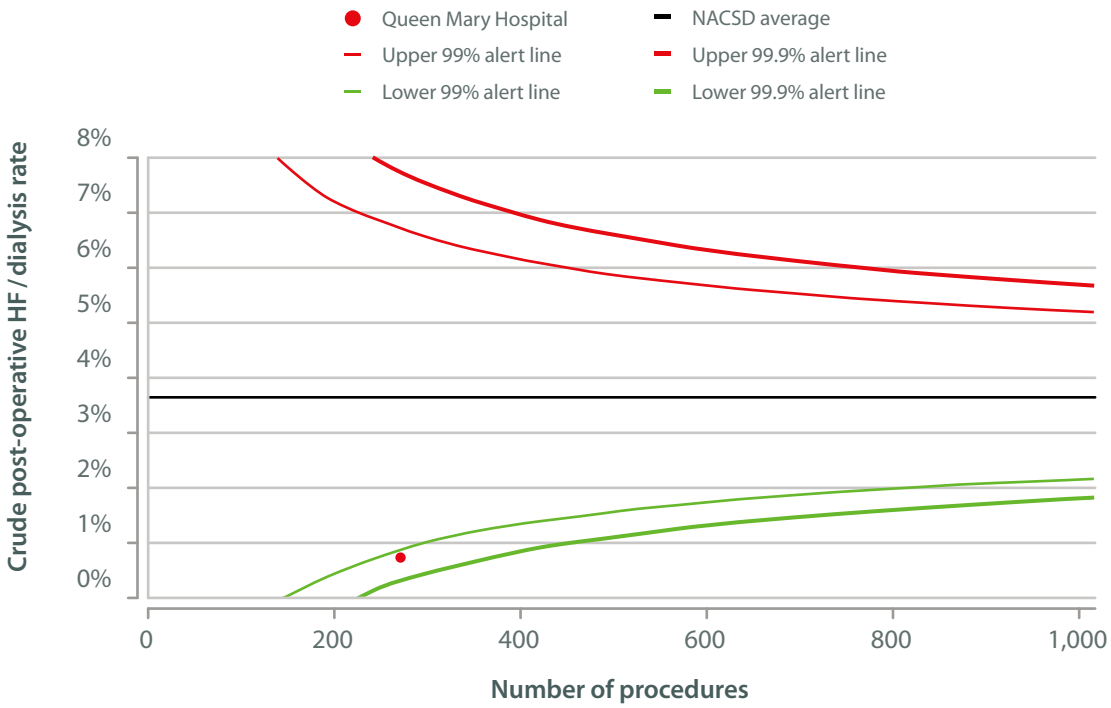
Post-operative stroke

Isolated CABG: Crude post-operative stroke rate for QMH (n=233) 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=233) compared to the data from the financial year 2008 in the UK NACSD



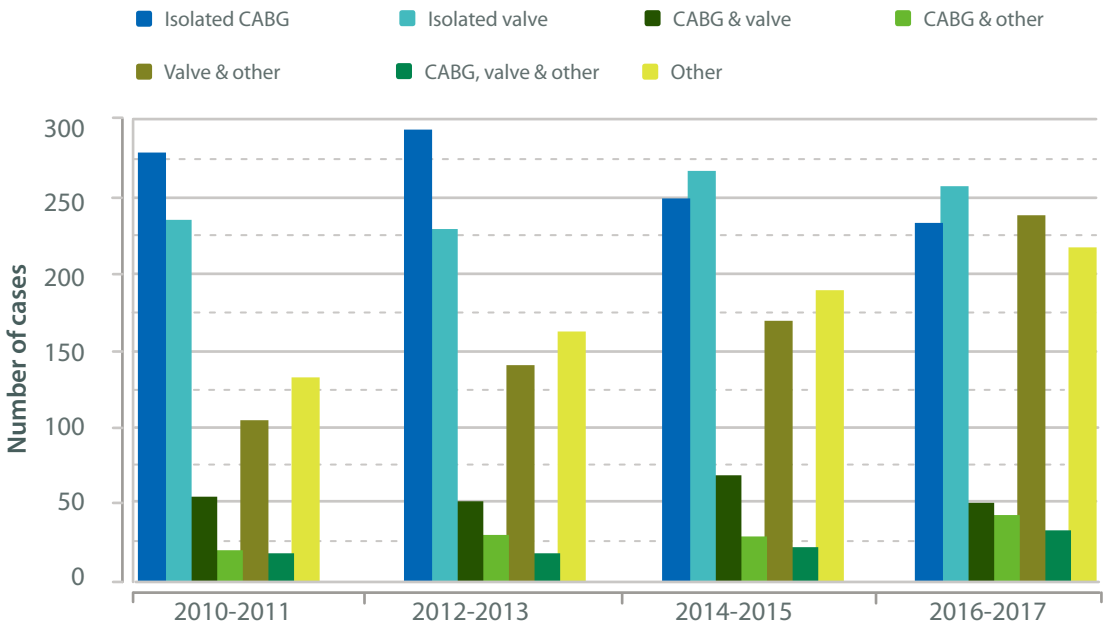
Valve surgery

Isolated valve surgery

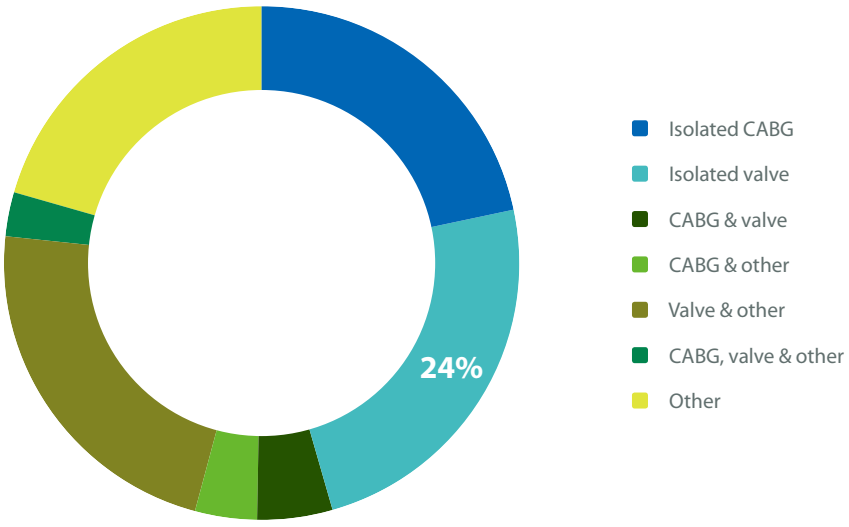
Isolated valve surgery in the context of overall workload

- During the year 2016 & 2017, there were 257 isolated valve operations performed at Queen Mary Hospital, contributing to 24% of the overall adult cardiac surgery workload.
- The proportion of isolated valve operations have remained relatively static over the last six years.
- Other than that, there were 320 (30%) valvular operations performed in combination with the other procedures like CABG, radiofrequency atrial ablation, aortic surgery, septal defect repair, *etc.*

Cardiac surgery activity in QMH : 2010-2017



Workload overview, 2016-2017 (n=1069)



Priority

- There were 171 isolated single valve operations performed during 2016-2017.
- 157 out of 171 (92%) isolated single valve operations were performed electively.
- The remaining 8% were urgent or emergency operations.

Isolated single valve surgery: operative urgency

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Priority	Elective	70	62	25
	Urgent	4	3	0
	Emergency	3	3	1
	All	**77**	**68**	**26**

Previous cardiac surgery

- Redo operations contributed a significant workload in the isolated valve operation group. In 2016-2017, out of 257 isloated valve surgeries 78 (30%) have had previous cardiac surgery.
- The majority of isolated single valve procedures (76%) at QMH were first-time operations.
- Among all isolated single valve operations, 41 (24%) 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	66	62	2
	Previous cardiac surgery	11	6	24
	All	**77**	**68**	**26**

Haemodynamic pathology

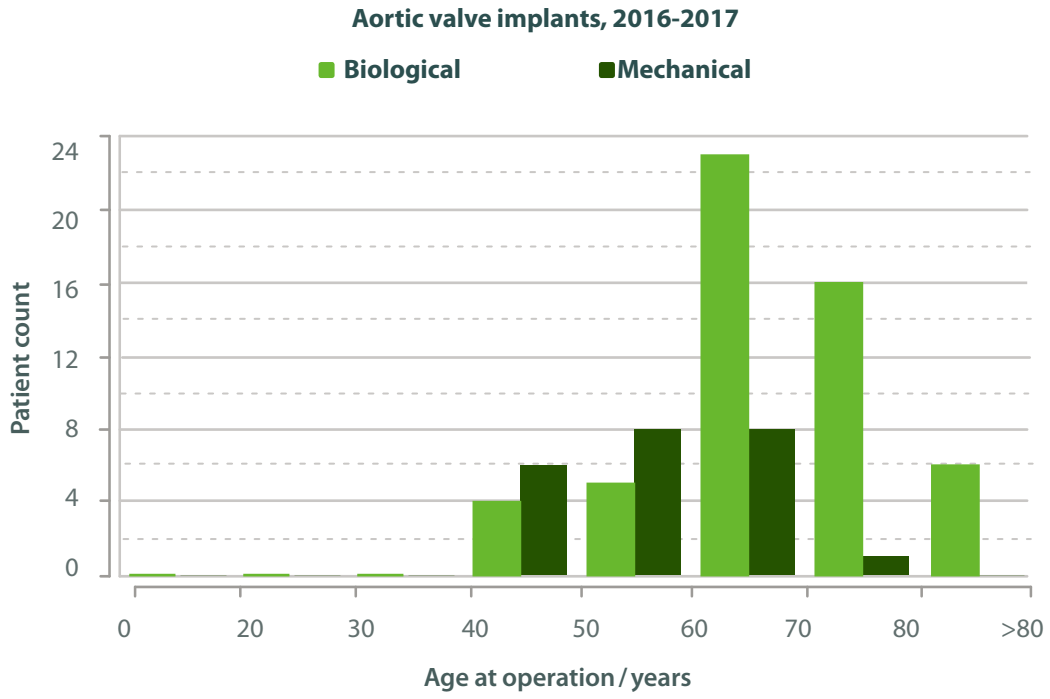
- More than half of the isolated aortic valve operations, 46/77 (60%), were for patients with aortic stenosis.
- Among all patients who had isolated mitral valve surgery, 56/68 (82%) had mitral regurgitation.

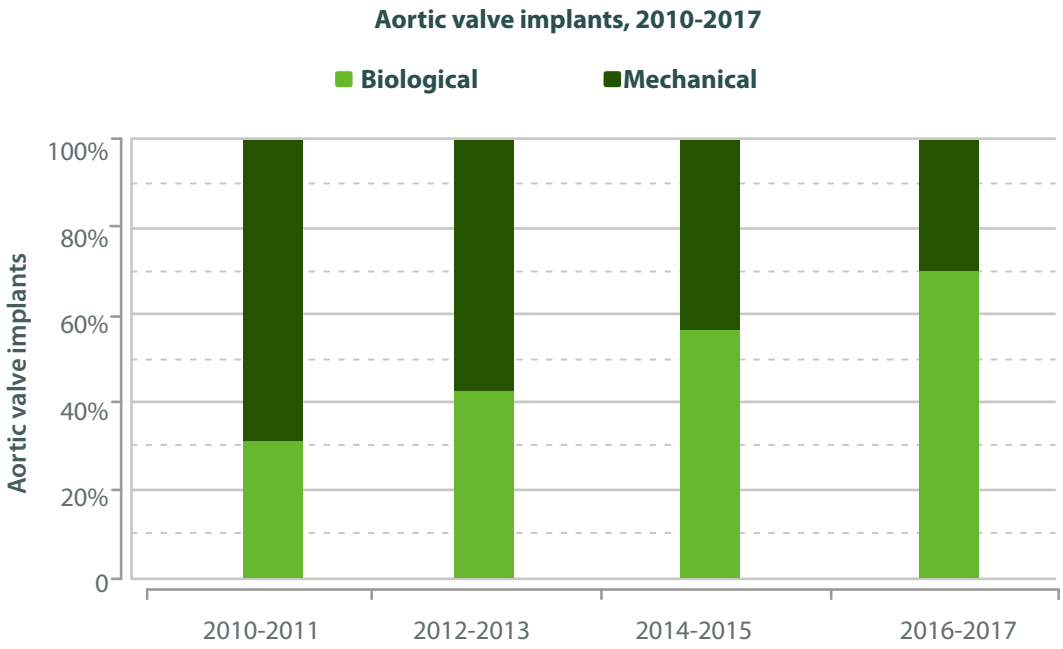
Isolated single valve surgery: haemodynamic pathology

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Haemodynamic pathology	Stenosis	46	7	1
	Regurgitation	17	56	24
	Mixed	14	5	1
	All	**77**	**68**	**26**

Aortic valve implants

- Most of the biological prostheses were implanted in patients above 65 years of age, however since the last few years, younger patients (<65 years) also received biological aortic valve prostheses.
- A majority of the prostheses for all AVR were biological, 54 (70%) received biological valves while the remaining 23 (30%) received mechanical prostheses.
- Compared to the previous reports we used more biological prostheses during 2016-2017 (70%). Over time, there has been a trend of using less and less mechanical prosthesis.





Native valve pathology

- Majority of aortic valve pathology was degenerative.
- Dominant pathology for mitral valve surgery was also degenerative valve disease .
- Chronic rheumatic changes of mitral and tricuspid valves also accounted for one of the major cause of valvular heart disease.
- In the other singles group, tricuspid valve pathology was mainly rheumatic (57%). Pathology of the pulmonary valve was all congenital, all patients had previous congenital cardiac surgery and now presented with pulmonary regurgitation.

Isolated single valve surgery: native valve pathology

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Native valve pathology	Degenerative	36	44	5
	Calcific degeneration	28	1	0
	Congenital	15	2	12
	Rheumatic	9	12	8
	Native valve not present	6	1	1
	Other native valve pathology	3	2	2
	Previous infective endocarditis	2	6	2
	Active infective endocarditis	1	6	0
	Annuloaortic ectasia	1	0	0
	Functional regurgitation	0	0	6

Mitral valve surgery

Mitral valve repair and replacement in the context of all mitral valve surgeries

- Majority of mitral valve repairs were for mitral regurgitation. Regurgitation was mainly due to degenerative valve disease (48/71). 71 out of 83 native regurgitant (7 prosthetic valves) valves were successfully repaired (85.5%).
- Mitral valve replacement was most performed for mitral stenosis which was mainly of rheumatic aetiology (21/28). Replacement was also performed for mitral regurgitation caused by mainly active infective endocarditis of the native valve (8/19). Prosthesis failure (7/19) due to paravalvular leak, infective endocarditis, thrombus formation was the other important cause.
- Based on The Society for Cardiothoracic Surgery (SCTS) in Great Britain & Ireland, 6th NACSD 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	28	19	14
	Repair	0	71	3
	All	**28**	**90**	**17**

Type of mitral valve repair

- Most of the isolated mitral valve repair operations were complex repairs, involving two or more repair procedures.
- Most (89.2%) 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	Proportion
Type of mitral valve repair	Annuloplasty (ring)	66	89.2%
	Artificial chord	33	44.6%
	Leaflet resection	24	32.4%
	Other	16	21.6%
	Leaflet patch	7	9.5%
	Subvalvar release	4	5.4%
	Commisurotomy	4	5.4%
	Annuloplasty (suture)	2	2.7%
	Chordal shortening	2	2.7%
	Decalcification/debridement	1	1.4%
	Leaflet extension	1	1.4%

Tricuspid valve surgery

Tricuspid valve repair in the context of all tricuspid valve surgeries

- 76/257, (30%) of all isolated valve(s) surgeries involved tricuspid valve procedures.
- Isolated single valve tricuspid surgery was rare, only 14 patients during the year 2016-2017 had the isolated single valve tricuspid operation.
- All isolated single valve tricuspid repairs were for regurgitation. Rheumatic disease was the most common pathology (57.1%) in isolated tricuspid valve surgery. Tricuspid valve repair using an annuloplasty ring was the preferred surgical approach (100%).

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

		Tricuspid valve procedure		
		Replacement	Repair	All
Valve treated	Tricsupid alone	10	4	**14**
	Tricuspid plus another valve	6	56	**62**
	All that include tricuspid valve surgery	**16**	**60**	**76**

Details of isolated tricuspid valve surgery

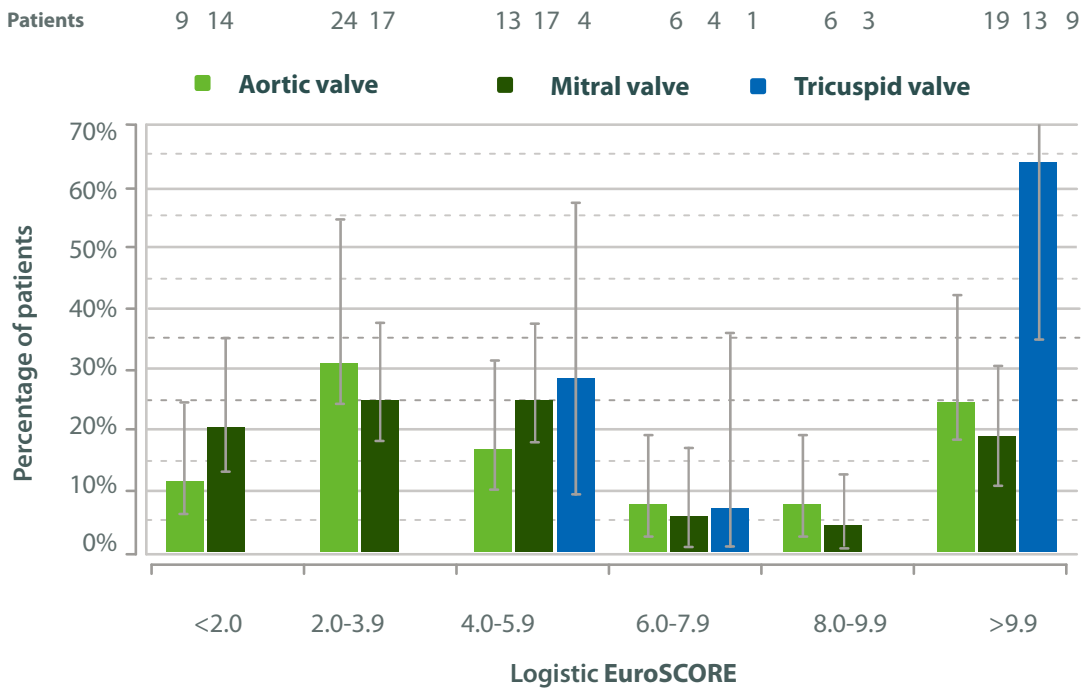
		Data	
		Count	Percentage
Haemodynamic pathology	Regurgitation	12	85.7%
	Stenosis (prosthesis failure)	1	7.1%
	Mixed	1	7.1%
	All	14	
Previous cardiac surgery	No previous cardiac surgery	2	14.2%
	1 previous cardiac surgery	6	43.0%
	≥2 previous cardiac surgeries	6	43.0%
	All	14	
Valve pathology	Rheumatic	8	57.1%
	Infective (endocarditis)	2	14.2%
	Other	2	14.2%
	Congenital	1	7.1%
	Functional Regurgitation	1	7.1%
	All	14	

Logistic EuroSCORE and EuroSCORE II

EuroSCORE distributions

- The expected mortality risk for isolated aortic valve surgery alone as predicted by Logistic EuroSCORE and EuroSCORE II was 9.34% and 3.51% respectively.
- The expected mortality risk for isolated mitral valve surgery alone as predicted by Logistic EuroSCORE and EuroSCORE II was 7.0 % and 2.55% respectively.
- The expected mortality risk for isolated tricuspid valve surgery alone as predicted by Logistic EuroSCORE and EuroSCORE II was 16.98% and 7.59% respectively.

Isolated single valve surgery: Logistic EuroSCORE distribution (n=159)



Logistic EuroSCORE and mortality

- According to the Blue book online, in UK in 2015, for isolated first time aortic valve replacement the mortality reported was 1.55% (predicted mortality was 7.56%) and the O/E ratio was 0.20. Similarly, the mortality reported for isolated first-time mitral procedure was 2.83% (predicted mortality was 7.80%) and the O/E ratio was 0.36.
- Predominant multiple-valve surgery at QMH was combined mitral and tricuspid valve surgery.

Isolated single valve surgery: Logistic EuroSCORE and mortality

		Count		Mortality		
		All	Deaths	Observed (O)	Expected(E)	O/E Ratio
Valve treated	Aortic alone	77	2	0.025	0.093	0.27
	Mitral alone	68	1	0.015	0.07	0.21
	Tricuspid alone	14	2	0.142	0.169	0.84

Isolated single valve surgery: EuroSCORE II and mortality

		Count		Mortality		
		All	Deaths	Observed (O)	Expected(E)	O/E Ratio
Valve treated	Aortic alone	77	2	0.025	0.035	0.71
	Mitral alone	68	1	0.015	0.026	0.58
	Tricuspid alone	14	2	0.142	0.075	1.89

Isolated multiple valve surgery: Logistic EuroSCORE and mortality

		Count		Mortality		
		All	Deaths	Observed (O)	Expected(E)	O/E Ratio
Valve treated	Mitral &tricuspid	33	2	0.06	0.133	0.45
	Aortic &mitral	23	1	0.043	0.163	0.26
	Aortic, mitral and tricuspid	11	0	0	0.092	0

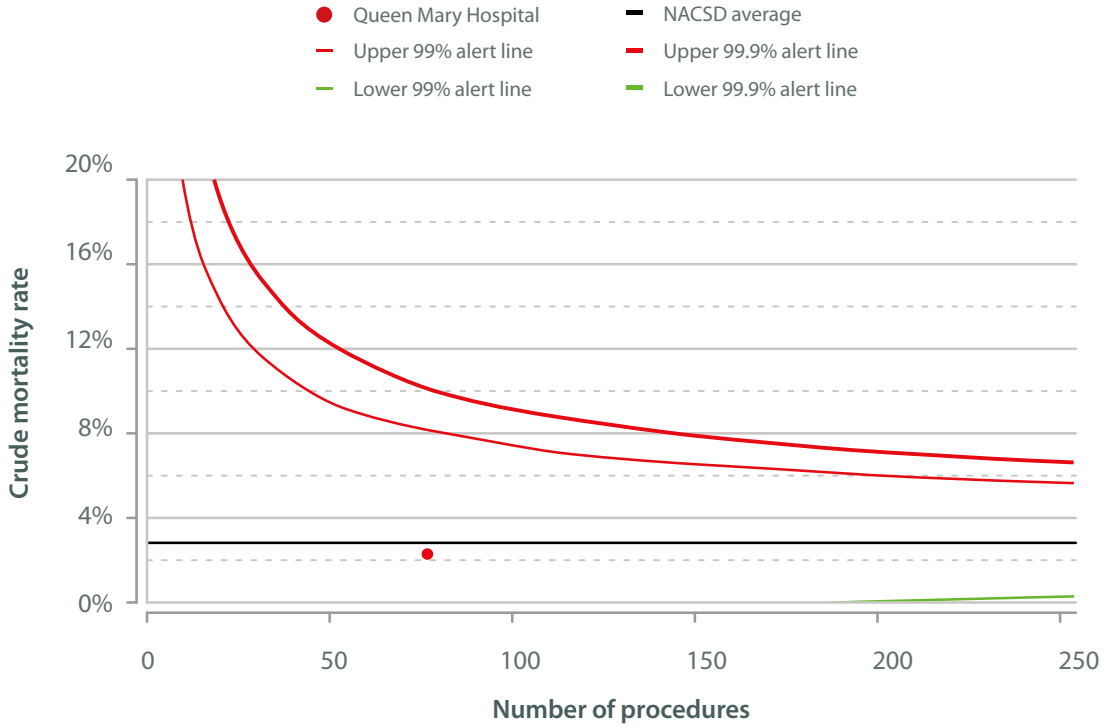
Isolated multiple valve surgery: EuroSCORE II and mortality

		Count		Mortality		
		All	Deaths	Observed (O)	Expected(E)	O/E Ratio
Valve treated	Mitral &tricuspid	33	2	0.06	0.045	1.33
	Aortic &mitral	23	1	0.043	0.089	0.48
	Aortic, mitral and tricuspid	11	0	0	0.025	0

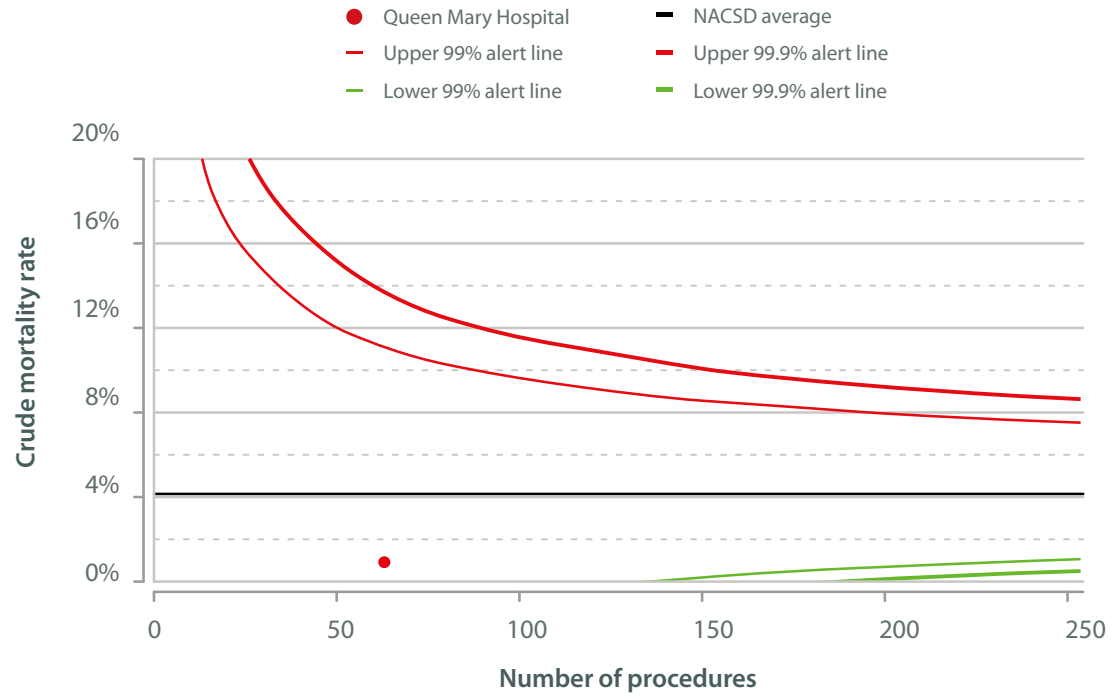
International benchmarking of mortality

- The graph here is a funnel plot of in-hospital crude mortality for isolated aortic valve and isolated mitral valve surgery .

Isolated aortic valve surgery: Crude mortality rate for QMH (n=77) 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=68) compared to the data from the financial years 2004-2008 in the United Kingdom NACSD



Minimally Invasive Cardiac Surgery (MICS)

Developments and workload in QMH

- Our department started performing minimally invasive cardiac surgery since 2007.
- In 2016-2017, about 15.0% (161/1069) of cardiac surgical procedures were performed using a minimally invasive approach, which is more than reported in 2014-2015 (11.4%).
- The most common minimally invasive approach was mini thoracotomy. This utilizes a five to seven centimeter incision between the ribs without cutting the sternum.
- Robotic-assisted procedures undertaken so far were mainly for mitral valve annuloplasty and an atrial septal defect closure. The proportion of MICS performed using robotic-assisted approach increased from 4.4% in 2014-2015 to 11.8%.

MICS approach

		Data	
		Count	Proportion
Type of MICS approach	Mini-thoracotomy	87	54.0%
	Hemi-sternotomy	51	31.7%
	Robot-assisted surgery	19	11.8%
	Others	3	1.9%
	Parasternal approach	1	0.6%
	Total	**161**	**100.0%**

Procedures performed using MICS

- A wide range of MICS procedures for heart conditions were performed.
- In 2016-2017, 40% (103/257) of isolated valve procedures were performed using a MICS technique. Nowadays, surgical approach has shifted from replacement to repair and from open surgery to minimally invasive approach.

Procedures performed using MICS

		Data	
		Count	Proportion
Procedure grouping	Valve alone	103	64.0%
	Valve and concomitant surgery	42	26.1%
	Surgery other than valve	16	9.9%
	Total	**161**	**100.0%**

Concomitant surgeries with valve surgery using MICS approach

- It was not uncommon to correct more than one heart problem during a minimally invasive procedure.
- Along with the valve surgery following procedures were done during the same operation without conventional surgery.

Concomitant surgeries with valve

		Data	
		Count	Proportion
Concomitant surgery	Atrial Ablation	26	61.9%
	Surgery on the aorta	7	16.6%
	ASD closure	5	11.9%
	Atrial Ablation and LAA closure	1	2.3%
	Peripheral vascular procedure	1	2.4%
	RA appendage excision	1	2.4%
	PPM insertion	1	2.4%
	Total	**42**	**100.00%**

Procedures other than valve surgery using MICS

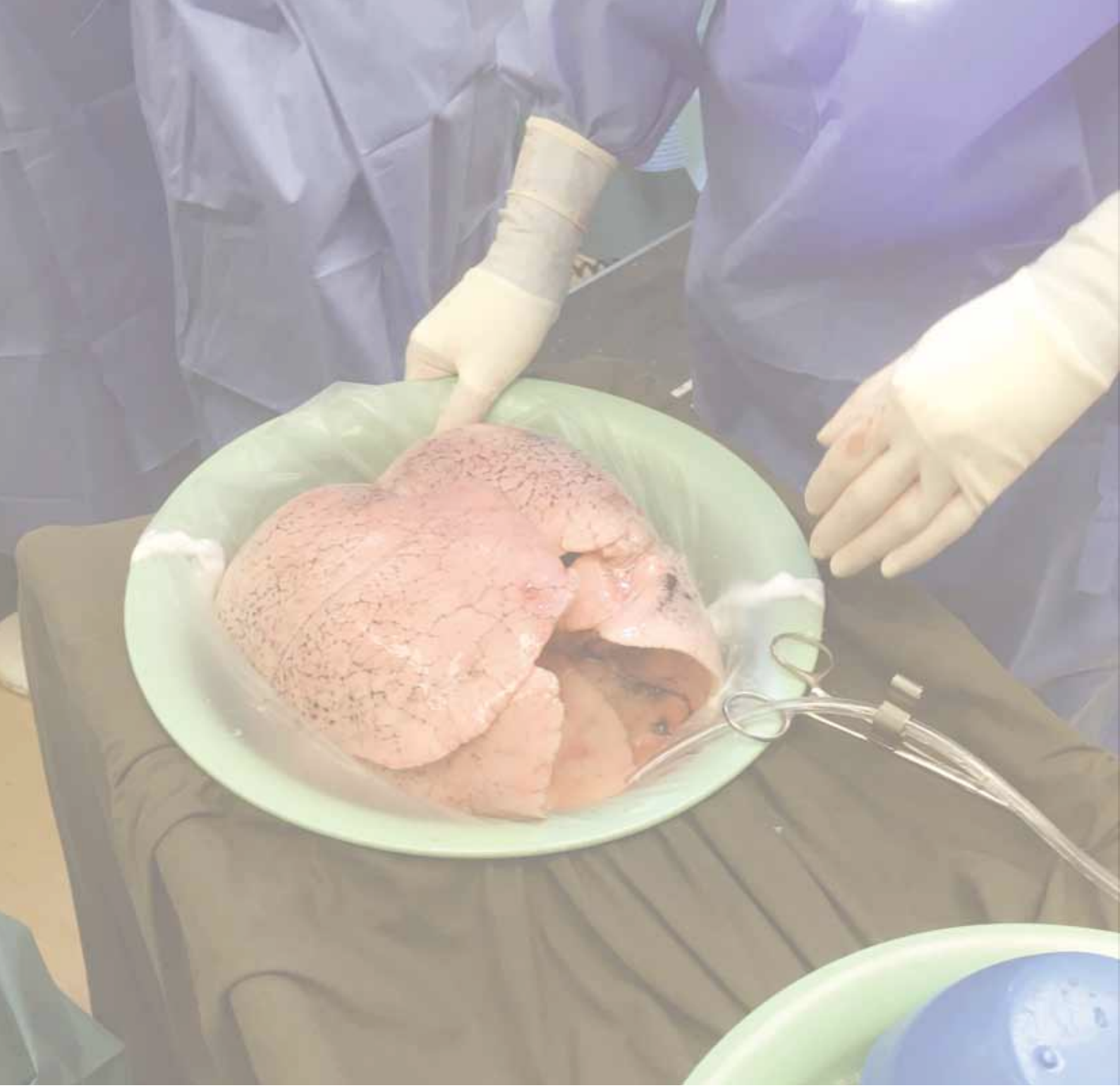
		Data	
		Count	Proportion
Other procedures	ASD closure	7	43.8%
	VSD closure	4	25.0%
	Surgery on the aorta	2	12.5%
	ASD closure, PAPVC repair	1	6.3%
	ASD closure, Atrial myxoma	1	6.3%
	LV aneurysmectomy	1	6.3%
	Total	**16**	**100%**

Surgical outcome: MICS

- The in-hospital mortality in this group of patients was 1.24%. The major complications in this group were, 7 patients (4.3%) had re-operation due to bleeding and 1 patient had stroke (0.6%).

Surgical outcomes: MICS versus open surgery

		Data
		MICS
Surgical outcome	Observed mortality	1.24%
	Predicted mortality: Logistic EuroSCORE, O/E ratio	6.42%, 0.19
	Predicted mortality: EuroSCORE II, O/E ratio	2.54%, 0.49
	Complications	
	Reoperation for bleeding rate	4.30%
	Post-operative stroke rate	0.60%
	Post-operative dialysis rate	1.86%

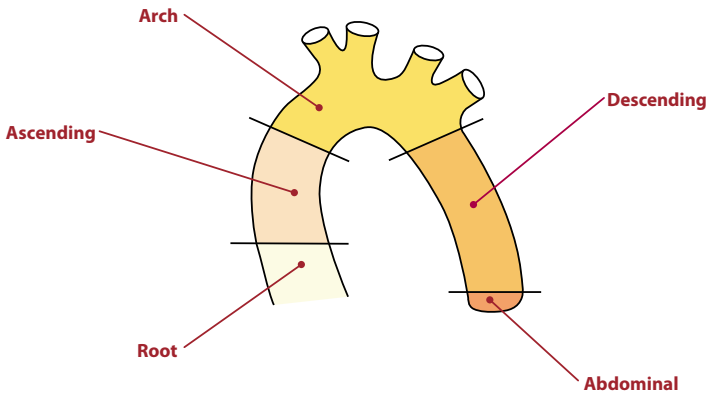


Surgery on the aorta and Other cardiac procedures

Surgery on the aorta and other cardiac procedures

Surgery on the aorta

- There has been a steady increase in the number of aortic surgeries from 96 (2012-2013) , 131 in (2014-2015) to 184 (2016-2017).
- Between 2016-2017 there were 85 (46.1%) patients who had aortic surgery at more than one location compared to 50 (38.1%) in 2014-2015 .
- Aortic surgery at one location constituted half (53.8%) of the aortic surgery caseload.
- The ascending aorta was the most common site for aortic surgery (39.6%).
- Involvement of ascending aorta frequently occurs with the involvement of other parts of the aorta too (44.5%)



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	0	15	3	2	**20**
		Ascending	3	28	2	40	**73**
		Arch	0	0	0	0	**0**
		Descending	0	0	0	6	**6**
	2	Root & ascending	2	34	10	12	**58**
		Descending & arch	0	0	0	2	**2**
		Ascending & arch	0	0	0	2	**2**
		Descending & abdominal	0	0	0	1	**1**
	3	Root, ascending & arch	0	0	0	0	**0**
		Ascending, arch & descending	2	2	1	14	**19**
	4	Root, ascending, arch & descending	1	1	0	0	**2**
		Root, ascending, arch & descending & abdominal	0	0	0	1	**1**
		All	**8**	**80**	**16**	**80**	**184**

Pathology and Surgical technique

- The most common pathology that affected the aorta was aneurysm with dissection. Aneurysms may affect any part of the aorta. Operations for thoracic aortic dissection constituted the main workload 88/184 (47.8%) followed by surgery for a non-dissected thoracic aneurysm 61/184 (33.1%).
- The most common aortic root procedure performed was Bentall 42/76 (root replacement with composite graft and coronary re-implantation), 17/76 underwent root replacement with preservation of valve and 17/76 underwent aortic root enlargement.

Surgery on the aorta: pathophysiology

		Count
Pathophysiology	Aneurysm	61
	Aneurysm with dissection	
	Acute	76
	Chronic	10
	Subacute	2
	Aortic valve stenosis	21
	Infection	8
	Congenital	4
	Iatrogenic	2
	Patient count	**184**

Surgery on the aorta: root

	Count
Bentall	42
Valve-sparing	17
Aortic root enlargement	
Nick's (Post.) procedure	12
Konno (Ant.) procedure	4
Manouguian (Post.)procedure	1
Sinus of Valsalva aneurysm repair	2
Aortic root abscess	2
Aortic root augmentation	1
Patient count	81

- Ascending aorta and Axillary/subclavian cannulation for arterial inflow were the most commonly used cannulation strategies in QMH (147/184).
- Femoral cannulation is particularly useful in emergency situations with haemodynamically unstable patients (25/184).
- Antegrade cerebral perfusion was used in 65 patients.

Surgery on the aorta: cerebral perfusion

		Count
Cerebral perfusion	None	59
	Antegrade	65
	Retrograde	1
	All	**125**

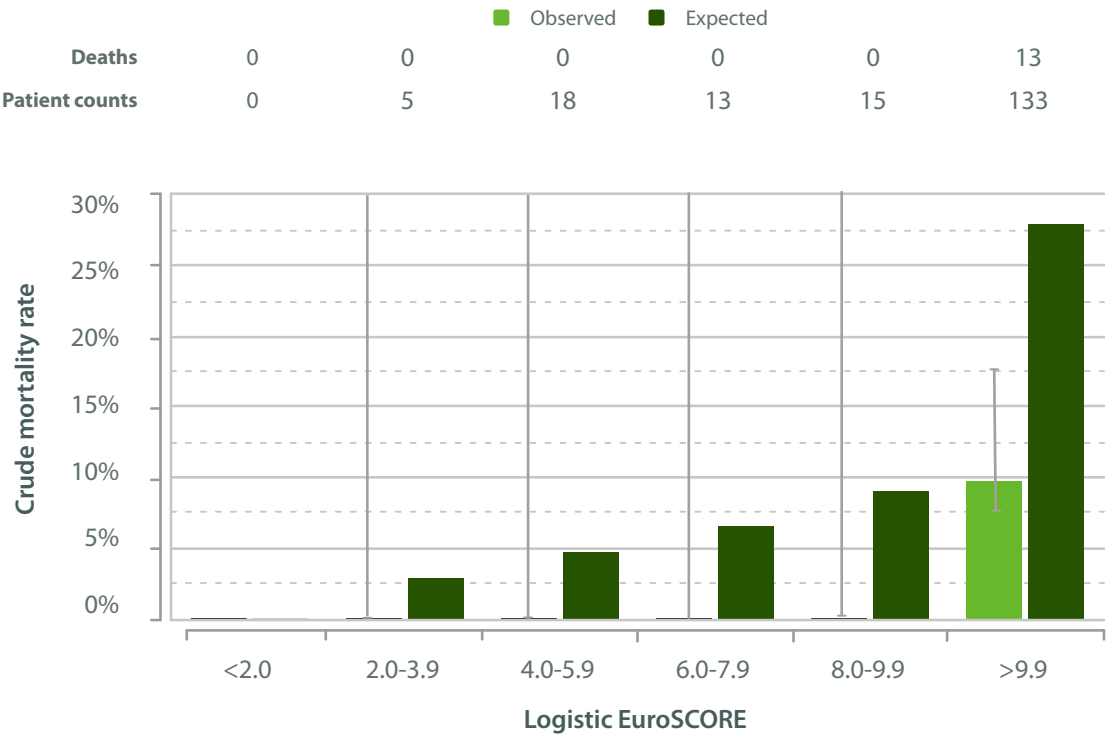
Surgery on the aorta: cannulation

		Count
Arterial cannulation	Ascending aorta	74
	Axillary/subclavian	73
	Femoral	25
	Arch	7
	Other	5
	Patient count	**184**

Mortality and morbidity

- Overall observed and expected mortality for aortic surgery was 7.06% and 21.9% respectively with O/E ratio of 0.310 indicating better than expected performance.
- Highest mortality was observed in the high-risk Logistic EuroSCORE group (>9.9). This group had the most challenging patients. 40% of surgeries in this group were emergency, 15% were urgent and 5.2% were performed as salvage procedures. 9/13 deaths in this group were emergency, urgent and salvage procedures.
- Inspite of these high-risk group procedures being particularly challenging, QMH observed mortality rate (9.7%) in this group was less than the expected mortality rate(27.9%).

Surgery on the aorta: Logistic EuroSCORE and mortality (n=184)



Other cardiac procedures

Other procedures

- 'Other procedures for congenital condition' performed included mainly Pulmonary valve replacement with pulmonary arterioplasty and reconstruction (11/37) and VSD repair (9/37).
- VAD are used in patients with heart failure. Most of the implantable VAD (HeartMate & HeartWare, 24/39) were performed for the intention of bridging to heart transplantation. 4 had pump exchange in 2016-2017.
- External VAD (11/39) were used until myocardial recovery or as a bridge to candidacy for transplant.
- The number of lung transplants increased from 17 to 22 and the number of cardiac transplants were 24.
- The number of atrial ablations performed remained almost same as the previous report, (108 in 2014-2015).

Procedure detail

		Procedure grouping								
		CABG alone	Valve alone	CABG & valve	CABG & other	Valve & other	CABG, valve & other	Other	All	All (2014-2015)
Other cardiac procedures	None	233	257	50	6	69	11	71	**697**	**699**
	LV aneurysmectomy	0	0	0	11	1	1	2	**15**	**9**
	Acquired VSD	0	0	0	1	0	1	1	**3**	**3**
	Atrial myxoma	0	0	0	2	0	0	4	**6**	**10**
	Pulmonary embolectomy	0	0	0	0	0	0	9	**9**	**7**
	Cardiac transplant	0	0	0	1	0	0	23	**24**	**22**
	Pulmonary transplant	0	0	0	0	5	0	17	**22**	**17**
	Cardiac trauma	0	0	0	0	0	0	0	**0**	**0**
	Epicardial pacemaker	0	0	0	0	0	0	1	**1**	**5**
	Pericardiectomy	0	0	0	1	0	0	3	**4**	**1**
	ASD closure	0	0	0	1	19	0	15	**35**	**35**
	Other procedure for congenital condition	0	0	0	0	22	0	15	**37**	**46**
	Atrial Ablation	0	0	0	4	89	9	3	**105**	**108**
	Other procedure not listed above	0	0	0	16	47	10	26	**99**	**47**
	ECMO	0	0	0	3	7	3	30	**43**	**13**
	Ventricular assist device	0	0	0	0	7	0	32	**39**	**33**
	Patient count	233	257	50	42	238	32	217	**1069**	**991**

TAVI (Transcatheter Aortic Valve Implantation)

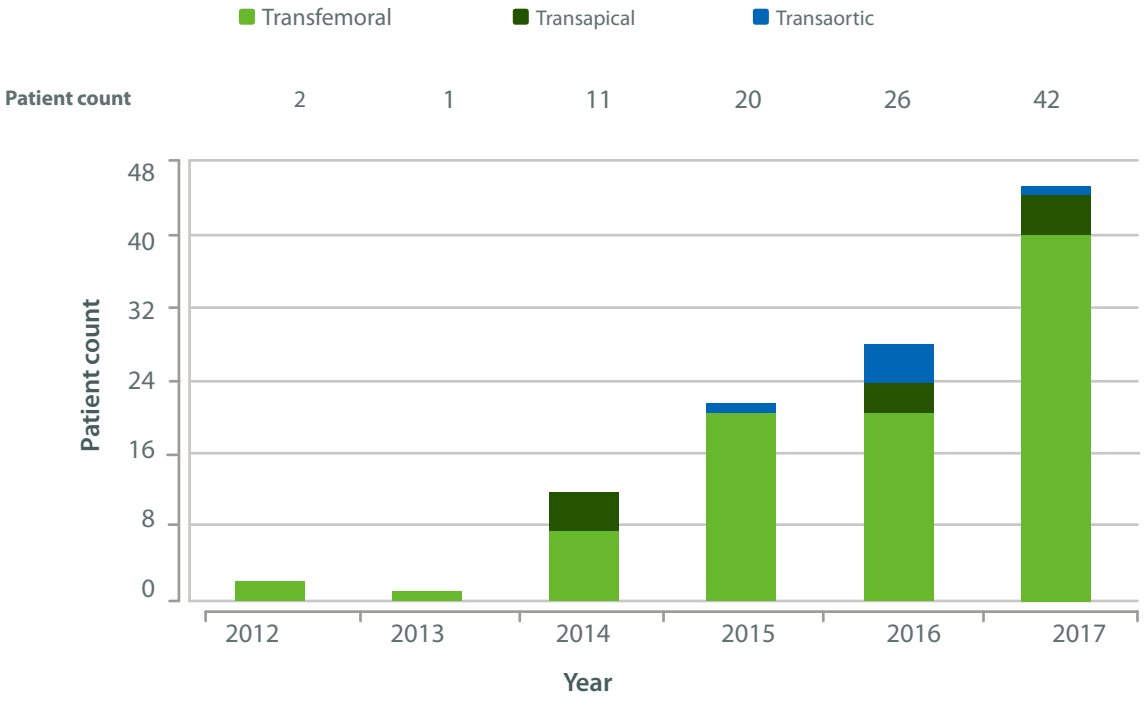
Overview

- TAVI is part of a growing trend in the field of minimally-invasive surgeries.
- TAVI program continues to grow and deliver excellent outcomes.
- TAVI is restricted to those patients who can't tolerate the traditional approach or they are deemed to be at high risk of suffering serious complications from open-heart surgery.
- Recovery time is much faster for TAVI patients.
- The high cost of TAVI valves still remain an issue.
- TAVI was a relatively new procedure during the time period in question. We began performing the procedure during 2012. We are continuously expanding minimally invasive approaches to care. Compared to our previous report of 2014-2015 (31) we have performed more TAVI cases in 2016-2017 (68).

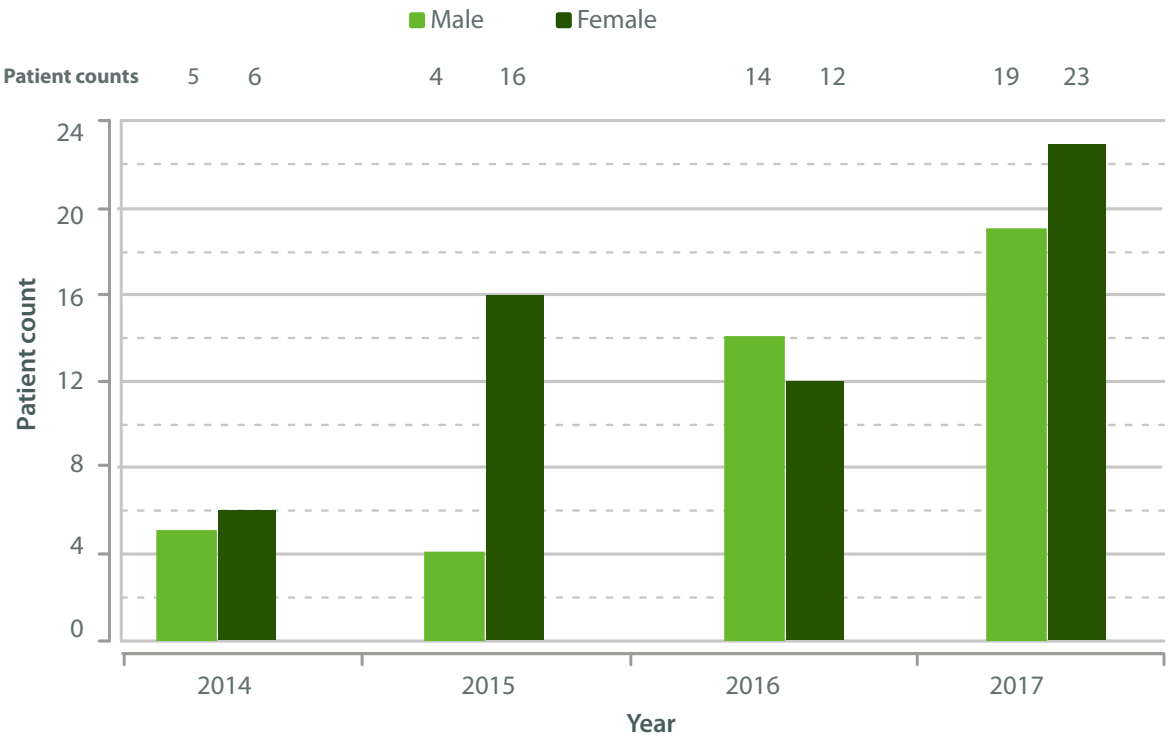
Number of TAVI procedures, per access type and year

- The transfemoral access route is the predominant choice .
- Alternative (non-femoral) access routes include transapical, subclavian, and transaortic access.

Number of TAVI procedures, *per* access type and year (n=102)



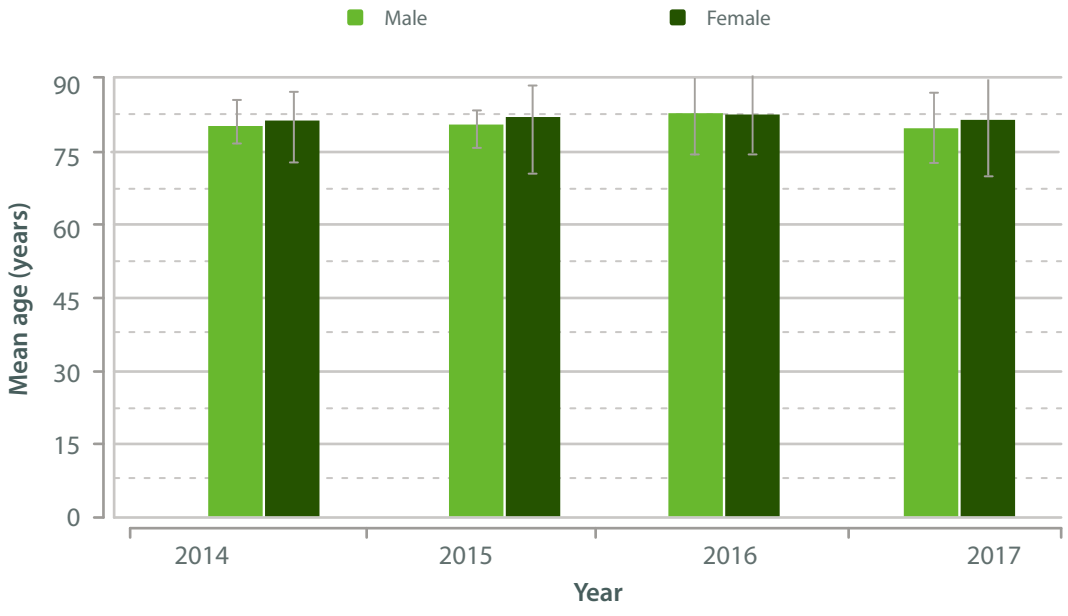
Patient count, *per* year, 2016–2017 (n=68)



Mean age of patients, per year, 2016–2017

- The mean age of the patients is over 80 years, with no major change over four years.
- This indicates that there has been no major change in the selection of patients between TAVI and surgical aortic valve replacement.

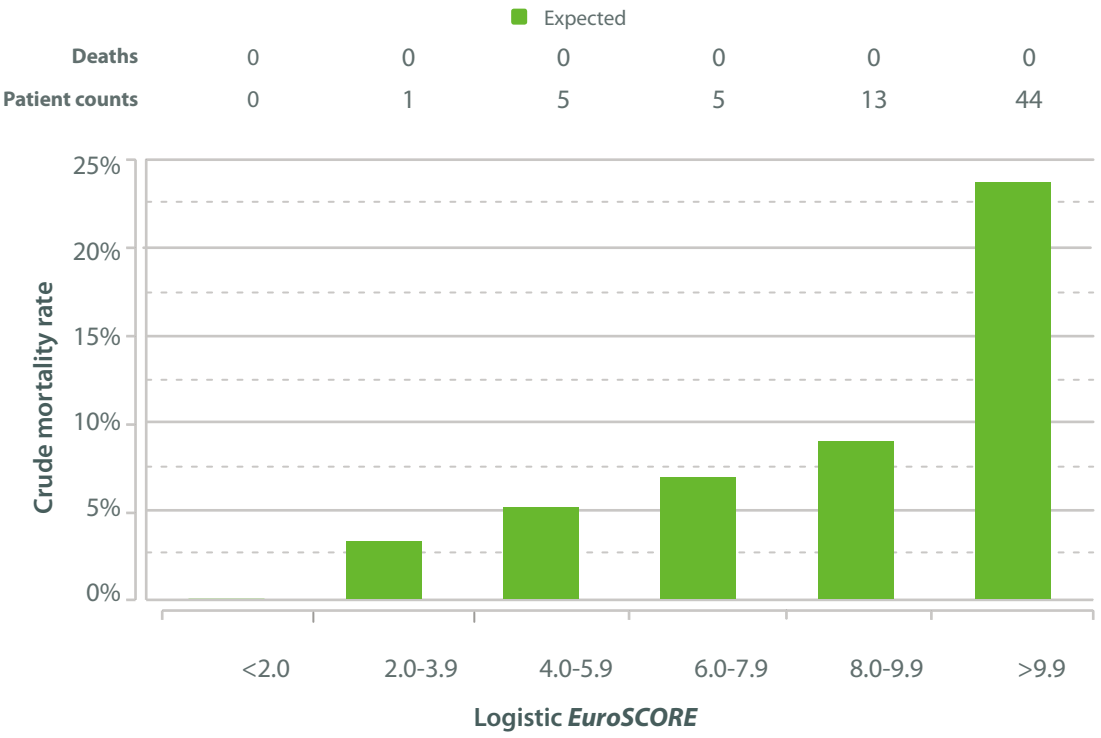
Mean age of patients, *per* year



Mortality and morbidity

- Logistic EuroSCORE is high in a greater proportion of patients.
- This implies that among aortic stenosis patients, TAVI is offered mostly to high-risk patients, whereas the lower risk patients are still treated surgically.
- The rate of cerebrovascular accident was 1.4% (1/68).)
- Overall mean Logistic EuroSCORE for this group was 18.05 ± 13.5.
- There was no in-hospital mortality observed in 2016-2017 cohort.

TAVI: Logistic EuroSCORE and mortality (n=68)



Atrial ablation

Patients and procedure

- In 2016-2017, 105 atrial ablation procedures were performed to treat atrial fibrillation.
- In all cases, the surgery included treatment for atrial fibrillation and another cardiac procedure.
- In 84.8% of atrial ablation procedures another cardiac procedure was valve surgery.
- Most of the patients undergoing this procedure were relatively young patients <65 years of age (60%).

Atrial ablation age and concomitant procedures

		Concomitant procedures					
		CABG & other	Valve & other	CABG, valve & other	Other	All	Percentage
Age at surgery / years	<56	0	29	1	3	33	31.4%
	56-60	1	14	3	0	18	17.1%
	61-65	0	12	0	0	12	11.4%
	66-70	1	19	3	0	23	21.9%
	71-75	2	13	2	0	17	16.2%
	>75	0	2	0	0	2	1.9%
	All	**4**	**89**	**9**	**3**	**105**	**100.0%**
	Percentage	**3.8%**	**84.8%**	**8.6%**	**2.9%**		

Part 2: Congenital cardiac surgery

Congenital cardiac surgery

Database overview: Congenital cardiac surgery

Database overview

- The paediatric and congenital cardiac surgical programme started in1967 in this unit. It is an important proportion of work at the Department of Cardiothoracic Surgery, Queen Mary Hospital now.
- We participate in the ECHSA database as we believe collecting, analyzing and reporting information is essential for service improvement.
- This 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.
- ECHSA contains data of 392 centres from 83 countries.
- It contains records of 267,425 operations performed on 232,089 patients.
- This report is based on our data submitted to the ECHSA database.
- Paediatric patients, age <= 18 years undergoing congenital cardiac surgery and adult cardiac surgery procedures those defined as performed for cardiac defect present from birth are included in this report.

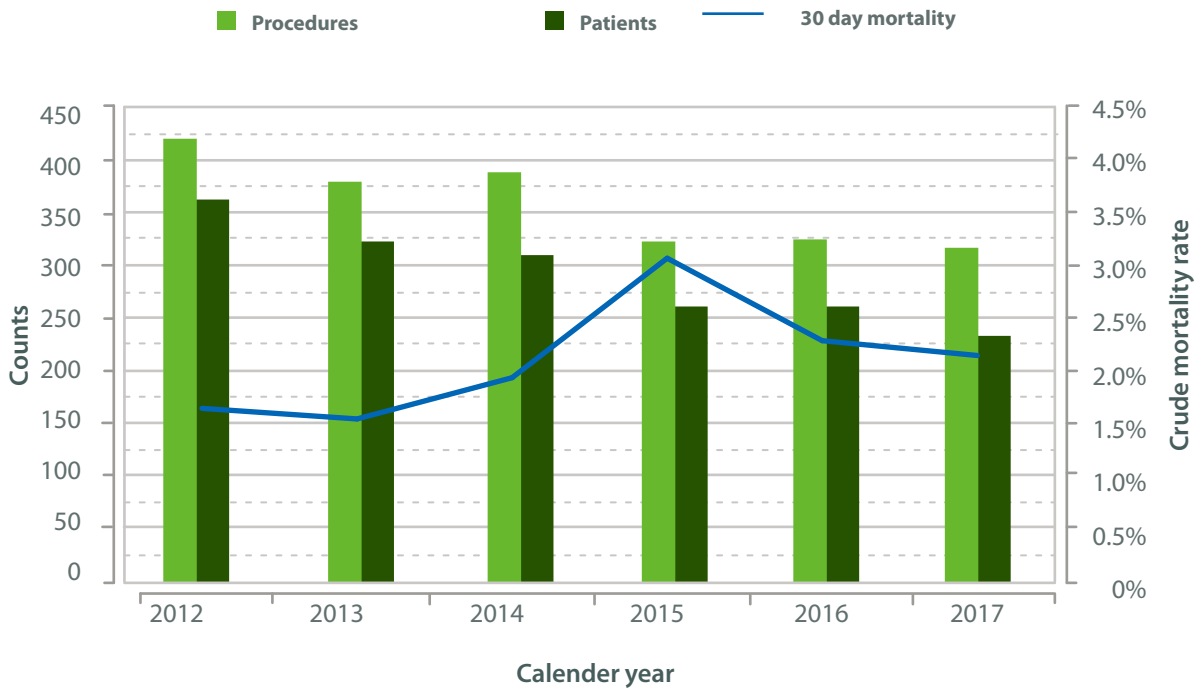
The Overall Workload

Workload by year

- Overall 642 procedures were performed on 484 patients in the year 2016 and 2017 at QMH with a mean 30-day mortality of 2.27%.
- Total volumes of congenital cardiac surgery steadily decreased by approximately 10% compared to the previous four years.
- This coincides with the ban imposed in 2013 on mainland chinese women giving birth in Hong Kong.

Overall workload : 2012 - 2017

Procedures	421	380	389	323	325	317
Patients	363	323	310	261	261	233
30 day mortality	1.65%	1.55%	1.94%	3.07%	2.29%	2.15%



Workload by procedure category

- Open heart surgery accounted for 60% of the workload in QMH. The proportion was lower than that in the ECHSA database.
- The proportion of closed heart surgery was higher than that in the ECHSA database.

Workload by procedure category

		Data		
		Count	Proportion	Proportion in the ECHSA Database
Procedure Category	Open heart surgery	383	59.6%	72.8%
	Closed heart surgery	218	33.9%	19.6%
	ECMO (post-cardiotomy)	24	3.7%	2.56%
	Thoracic	15	2.3%	2.07%
	VAD operation done with CPB	2	0.31%	0.06%
	All	**642**		

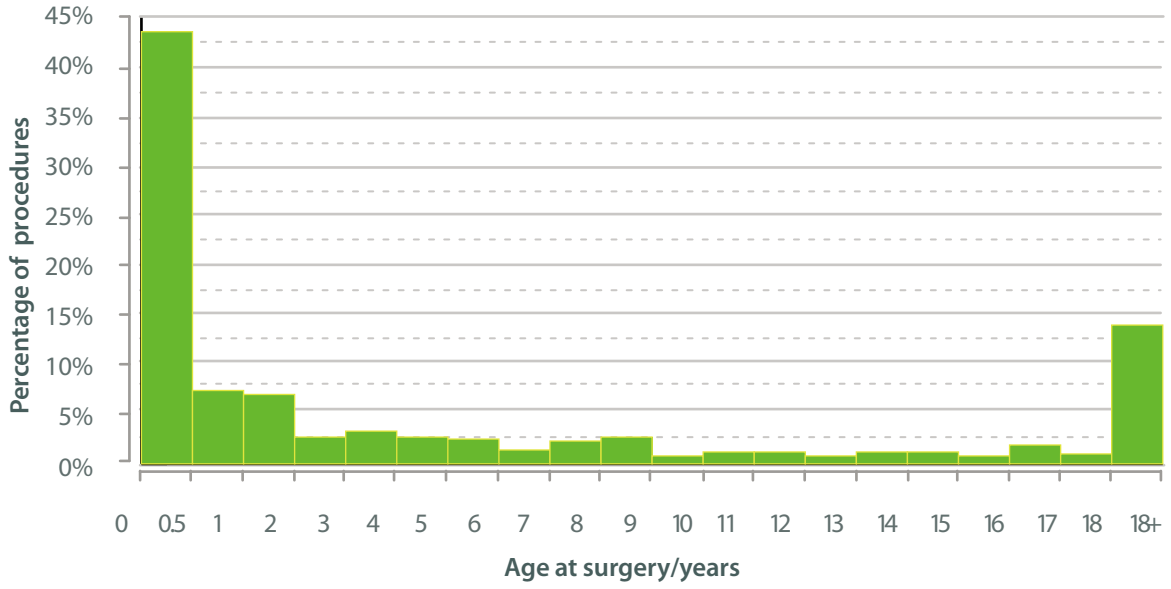
Workload by age group

- Patients with congenital heart disease from birth through adulthood are operated upon in QMH.
- Nearly 50% of the operations were performed on patients below 1 year of age.
- The proportion of the number of neonatal surgeries at QMH (26.3%) was higher than that in the ECHSA database (15.8%).
- Adult congenital heart surgery contributed a considerable proportion (10.9%) of the workload at QMH.

Workload By age group

		Data		
		Count	Proportion	Proportion in the ECHSA Database
Age group	Neonates (0-30 days)	169	26.3%	15.8%
	Infants (31-365 days)	199	31.0%	37.3%
	Children (1-18 years)	204	31.8%	37.3%
	Adults (>18 years)	70	10.9%	9.49%

Histogram of age at operation



Demographic and perioperative data

- In QMH, the average post-operative ventilation support time was 58 hours (2.4 days), which was much shorter than that in the ECHSA Database (70.65 hours or 2.9days).

Demographic and perioperative data and data by procedure category

		Overall	
		QMH	ECHSA
Mean value	Age at operation (months)	75.13	72.54
	Weight at operation (kg)	15.84	16.85
	Length of stay (days)	21.54	15.18
	Total CPB time (min)	114.9	104.26
	Total aortic cross-clamp time (min)	71.91	59.54

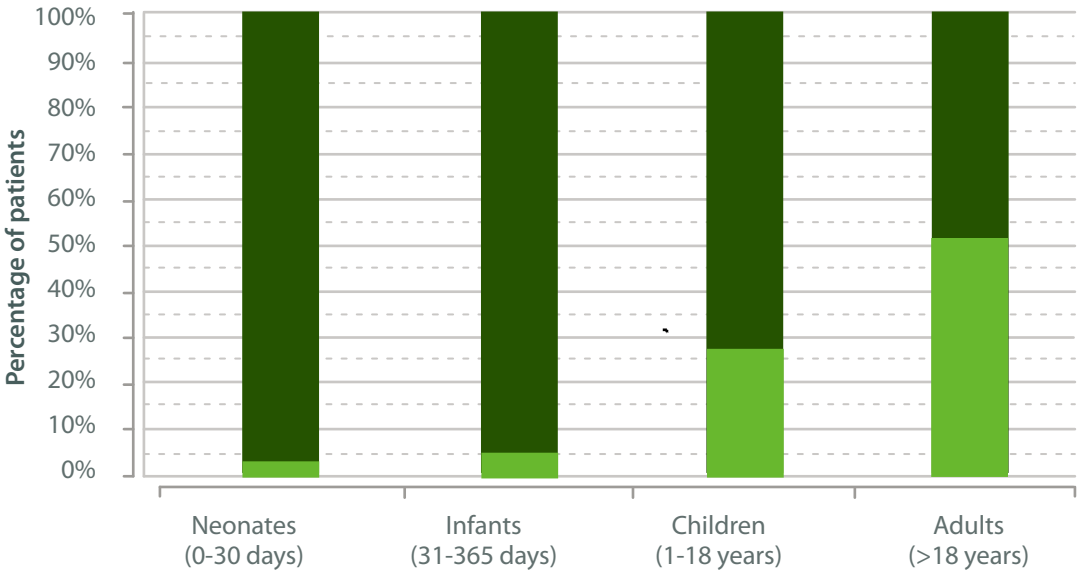
Previous cardiac surgery

Previous cardiac surgery within age groups

- Overall 16.6% of the patients had undergone previous cardiac surgery.
- In the under 1 year age group only 8% had previously undergone surgery compared to 11.6% between 2014-2015 and 26% between 2012-2013.
- In adult congenital heart surgery about 51.4% of the patients had previous cardiac surgery done signifying that most of the adult congenital heart surgeries are related to surgeries performed in early life.
- For children aged between 1 and 18 years, 27.4% had undergone at least one cardiac surgical procedure.
- There is no previous cardiac surgery data available from ECHSA for comparison.

Previous cardiac surgery: Age groups

	Neonates (0-30 days)	Infants (31-365 days)	Children (1-18 years)	Adults (>18 years)
Previous surgery	5	10	56	36
Total procedures	169	199	204	70
Rate	2.9%	5.02%	27.4%	51.4%



List of primary diagnosis, primary procedures and complications in QMH, 2016-2017

Primary diagnosis

- The table lists the most frequent primary diagnoses with the number of cases and their proportion.
- The primary diagnosis is the most important diagnosis for specific patient.
- If the patient has several diagnoses, it's very important to order them correctly, so the most important diagnosis is on the top.
- The primary diagnosis has a tremendous impact on the reports, as it designates the relation between diagnoses and mortality.
- Consistent with the previous report Patent ductus arteriosus, VSD (Perimembranous) were the two most frequent congenital heart defects at QMH.

25 most frequent primary cardiac diagnosis in QMH , 2016-2017

Primary diagnosis	Count	Proportion
VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	68	14.05%
Patent ductus arteriosus	67	13.84%
TOF, Pulmonary stenosis	36	7.44%
ASD, Secundum	34	7.02%
VSD, Type 1 (Subarterial) (Supracristal) (Conal septal defect) (Infundibular)	26	5.37%
Pulmonary insufficiency	26	5.37%
Coarctation of aorta	25	5.17%
AVC (AVSD), Complete (CAVSD)	13	2.69%
Pulmonary atresia, VSD (Including TOF, PA)	12	2.48%
TGA, IVS	10	2.07%
Total anomalous pulmonary venous connection (TAPVC), Type 1 (supracardiac)	10	2.07%
Total anomalous pulmonary venous connection (TAPVC), Type 3 (infracardiac)	8	1.65%
TGA, VSD	6	1.24%
Pulmonary atresia, IVS	6	1.24%
Aortic stenosis, Valvar	6	1.24%
Mitral regurgitation	6	1.24%
Interrupted aortic arch + VSD	5	1.03%
Cardiac tumor	5	1.03%
Single ventricle, Tricuspid atresia	5	1.03%
DCRV	5	1.03%
Pulmonary atresia, VSD-MAPCA (pseudotruncus)	4	0.83%
AVC (AVSD), Partial (incomplete) (PAVSD) (ASD, primum)	4	0.83%
VSD, Type 4 (Muscular)	4	0.83%
Ebstein's anomaly	4	0.83%
Partial anomalous pulmonary venous connection (PAPVC)	4	0.83%

Primary procedures

- The following table lists the top 25 procedures by quantity undertaken for congenital heart disease between 2016-2017 and these accounted for 72% of the workload.
- It does not equate to the number of patients, as a proportion of patients will have had more than one procedure during this two year period.
- Primary procedure is the most important, the most significant procedure in specific operation. In most cases, it's the procedure with highest Basic Score.
- ECHSA report takes into account only one procedure *per* patient which is the primary procedure.
- VSD repair, and PDA closure remain the most frequent procedures consistently over past four years and the proportion remains relatively static over the past four years.

25 most frequent primary cardiac procedures in QMH , 2016-2017

Primary procedure	Count	Proportion	ABC score
VSD repair, Patch	92	14.33%	6.0
PDA closure, Surgical	72	11.21%	3.0
ASD repair, Patch	32	4.98%	3.0
Valve replacement, Pulmonic (PVR)	29	4.52%	6.5
Mediastinal exploration	22	3.43%	1.5
TOF repair, Ventriculotomy, Transanular patch	22	3.43%	8.0
Coarctation repair, End to end, Extended	21	3.27%	8.0
ECMO cannulation	19	2.96%	6.0
TAPVC repair	17	2.65%	9.0
Shunt, Systemic to pulmonary, Modified Blalock-Taussig Shunt (MBTS)	13	2.02%	6.3
PA banding (PAB)	12	1.87%	6.0
ECMO decannulation	11	1.71%	6.0
Arterial switch operation (ASO)	10	1.56%	10.0
Valvuloplasty, Mitral	10	1.56%	8.0
Fontan, TCPC, External conduit, Fenestrated	9	1.40%	9.0
Pulmonary atresia - VSD (including TOF, PA) repair	9	1.40%	9.0
Pacemaker implantation, Permanent	9	1.40%	3.0
Thoracic and/or mediastinal procedure, Other	8	1.25%	-
TOF repair, Ventriculotomy, Nontransanular patch	8	1.25%	7.3
Pericardial drainage procedure	8	1.25%	3.0
Arterial switch operation (ASO) and VSD repair	7	1.09%	3.0
Valvuloplasty, Aortic	7	1.09%	8.0
Interrupted aortic arch repair	6	0.93%	10.8
Coronary artery bypass	5	0.78%	7.5
Ebstein's repair	5	0.78%	10.0

Common post operative events/ major complications

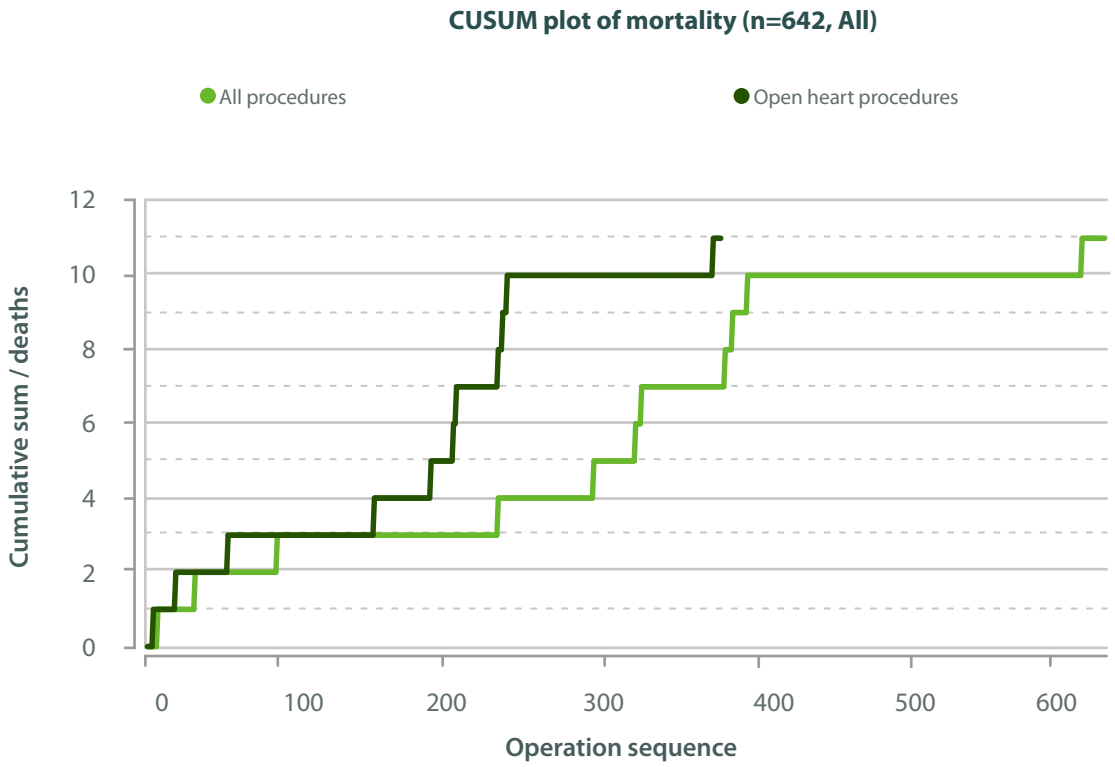
- The following table lists the common post-operative events and major complications.
- A total of 241 operations had complications. The most frequent complication was a sternum which was left open in 7.79% of the patients (n=50).
- There was marked improvement in the rate of acute renal failure requiring temporary dialysis from 10.2% in 2014-2015 to 3.5% in 2016-2017.
- Mechanical circulatory support, such as ECMO, is another vital component when attempting to reduce mortality in patients undergoing congenital heart surgery. In QMH 18 patients needed ECMO in the early post-operative period due to cardiac arrest or low cardiac output.

Postoperative event/complication details

		Data	
		Count	Proportion
Post operative event/major complication	Sternum left open, Planned	50	7.79%
	Acute renal failure requiring temporary dialysis	23	3.58%
	Postoperative/Postprocedural mechanical circulatory support (IABP, VAD, ECMO, or CPS)	18	2.80%
	Cardiac dysfunction resulting in low cardiac output	17	2.65%
	Arrhythmia requiring drug therapy	14	2.18%
	Sepsis	12	1.87%
	Arrhythmia necessitating pacemaker, Temporary pacemaker	11	1.71%
	Pneumothorax, Requiring intervention	9	1.40%
	Pleural effusion, Requiring drainage	9	1.40%
	Bleeding, Requiring reoperation	8	1.25%
	Pneumonia	8	1.25%
	Pulmonary hypertension	6	0.93%
	Unplanned interventional cardiovascular catheterization procedure during the postoperative or postprocedural time period	6	0.93%
	Arrhythmia	5	0.78%
	Pericardial effusion, Requiring drainage	5	0.78%
	Arrhythmia requiring electrical cardioversion or defibrillation	5	0.78%
	Postoperative/Postprocedural respiratory insufficiency requiring reintubation	5	0.78%

Cumulative sum(CUSUM) plot of 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 was no mortality seen in the closed heart procedures.
- There were no indications of odd results in the CUSUM plot for Queen Mary Hospital.



Risk stratification

Complexity score benchmarking

- ABC scores for each surgical procedure is based on the potential for mortality, the potential for morbidity, and surgical difficulty.
- The mean ABC score in QMH was lower than that in the ECHSA database; the overall mortality at QMH in eligible patients was also lower than that in the ECHSA database.
- We performed more complex surgeries in 2016-2017 as the score increased compared to 2014-2015 (5.9).

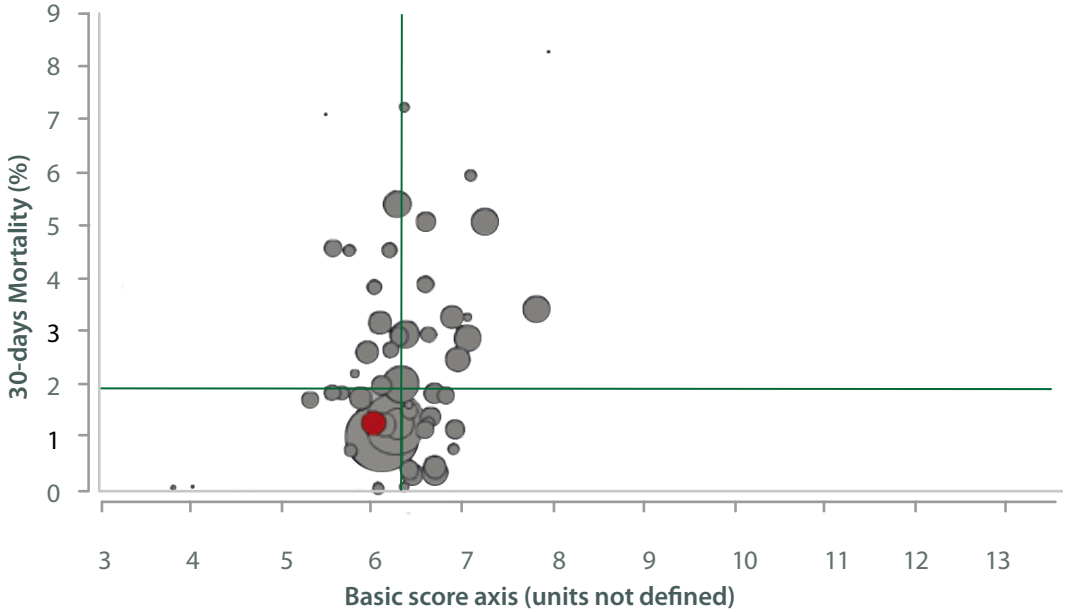
Complexity score and mortality 2016-2017

		Procedure count		Mortality		ABC score	
		All	Eligible*	QMH	ECHSA	QMH	ECHSA
Year	2016	325	286	2.29%	2.50%	6.58	6.98
	2017	317	266	2.15%	2.56%	6.43	6.91
	All	**642**	**552**	**2.27%**	**2.56%**	**6.51**	**6.95**

* Eligible procedures refer to the procedures with ABC scores.

- The bubble chart is a scatter chart showing a centre's performance in terms of mortality of the ECHSA 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 ECHSA database.
- The red bubbles relating to the QMH performances reveals that the QMH population has an below average mortality and patient and procedural complexity.

International comparison of mortality rate and complexity score



Observed versus expected (O/E) mortality

- O/E ratio tells us how well we are performing as compared to other hospitals by reporting whether our patient survival is better or worse than expected given how complex the patients are at QMH.
- The overall mortality O/E ratio in QMH, 2016-2017 was 0.68, indicating a better outcome than expected. There was an improvement in overall mortality compared to our previous report as O/E ratio was 0.80 in 2014-2015.
- Mortality among neonates, children and adults also improved as the O/E ratio was 1.19, 0.18 and 0 compared to 2, 0.40 and 0.32 respectively in 2014-2015.

Mortality O/E ratio by year

		Count			O/E ratio calculation			
		All procedures	Eligible procedures*	Eligible deaths**	Observed mortality	Expected mortality	O/E Ratio	O/E Ratio 2014-2015
Year	2016	325	286	6	2.29%	3.38%	0.67	-
	2017	317	266	5	2.15%	3.23%	0.66	-
	All	**642**	**552**	**11**	**2.27%**	**3.30%**	**0.68**	**0.80**

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

Mortality O/E ratio by age group

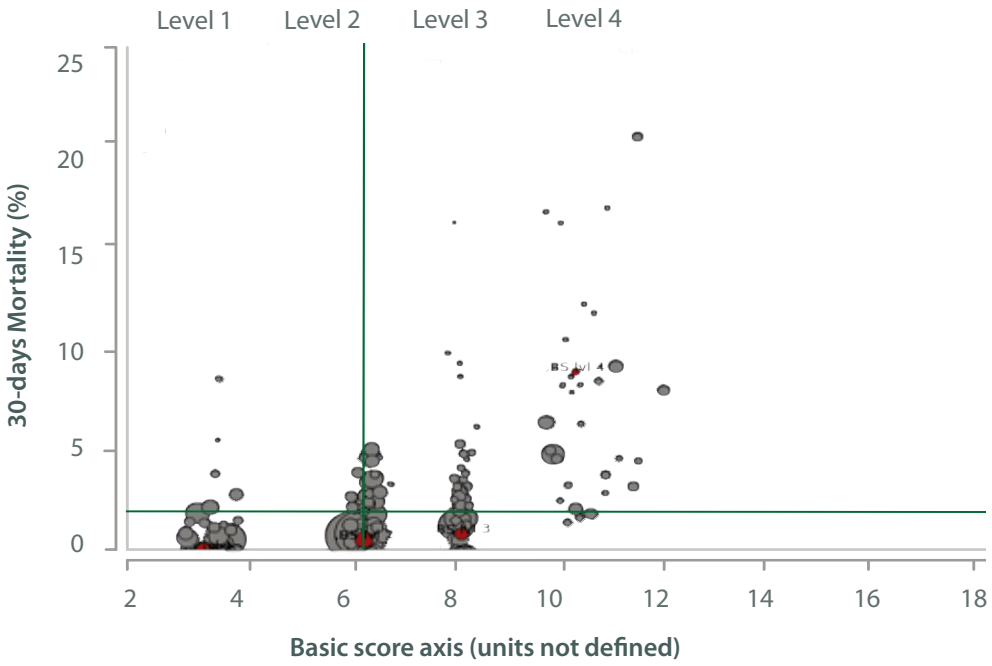
		Count			O/E ratio calculation			
		All procedures	Eligible procedures*	Eligible deaths**	Observed mortality	Expected mortality	O/E Ratio	O/E Ratio 2014-2015
Age group	Neonates (0-30 days)	169	128	5	4.81%	4.01%	1.19	2.0
	Infants (31-365 days)	199	181	5	3.14%	2.89%	1.08	0.74
	Children (1-18 years)	204	175	1	0.59%	3.25%	0.18	0.40
	Adults (>18 years)	70	68	0	-	3.26%	0	0.32

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

Risk adjusted mortality

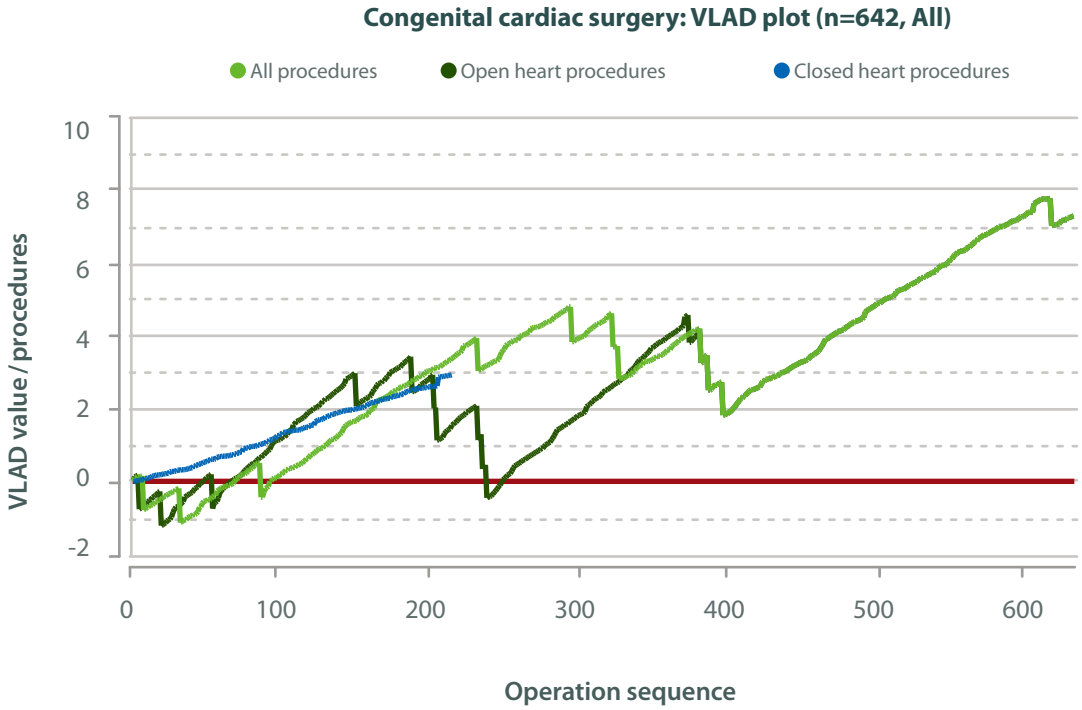
- This bubble chart shows the performances of the procedures with different risk levels according to the ABC scores.
- The ABC score allocates a basic score to each operation varying from 1.5-15, in addition each procedure is also assigned an ABC level, an integer from 1 to 4 .
- ABC level 1 and level 2 procedures contributed to 67% of congenital cardiac procedures at QMH.
- ABC level 3 and level 4 procedures contributed to 27% of congenital cardiac procedures at QMH.
- Procedures like heart transplantation, VAD implantation, re-exploration for bleeding *etc.* which formed 6.4% of the procedures could not be assigned ABC score and ABC level.
- At QMH the mortality rate for ABC levels 1,2,3 was well below the ECHSA mean mortality rate, whereas, the mortality rate for ABC level 4 was higher than the ECHSA mean rate.

International comparison of mortality rate and procedures by Basic Score Levels



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

- The following Variable Life-Adjusted Display (VLAD) graph covers all risk-scored procedures performed during 2016 and 2017.
- If the 30-day outcome is a survival then the VLAD plot goes up and if it is a death the VLAD plot goes down.
- A run of survivors will cause the VLAD plot to go up and a run of deaths will cause it to go down.
- Overall 7 extra lives had been saved at Queen Mary Hospital in 2016-2017 compared to 6 lives saved in 2014-2015.



Age group- Volume and Outcomes

Neonates (0-30 days)

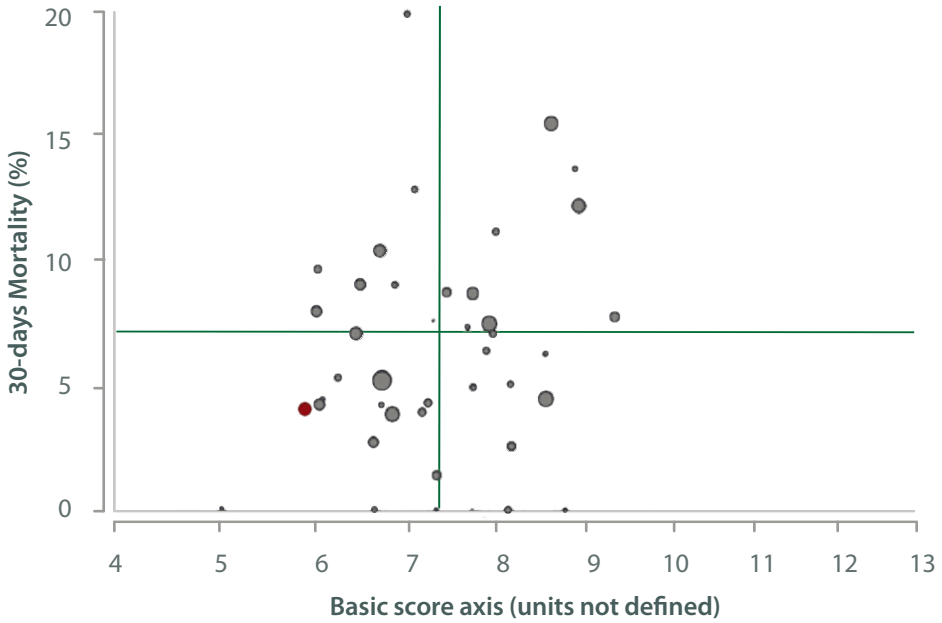
5 most frequent primary diagnosis in neonates

		Data	
		Count	Proportion
Diagnosis	Patent ductus arteriosus	26	25.0%
	Coarctation of aorta	17	16.3%
	Total anomalous pulmonary venous connection (TAPVC), Type 3 (supracardiac)	15	14.4%
	TGA, IVS/ VSD	14	13.4%
	Pulmonary atresia, IVS	5	4.8%

5 most frequent primary procedures in neonates

		Data		
		Count	Proportion	ABC score
Procedures	PDA closure, Surgical	30	17.7%	3.0
	Delayed sternal closure	28	16.5%	-
	Coarctation repair, End to end	18	10.6%	6.0
	TAPVC repair	15	8.8%	9.0
	Shunt, Systemic to pulmonary, Modified Blalock-Taussig Shunt (MBTS	11	6.5%	6.3

Mortality and complexity benchmarking in neonates



Infants (31-365 days)

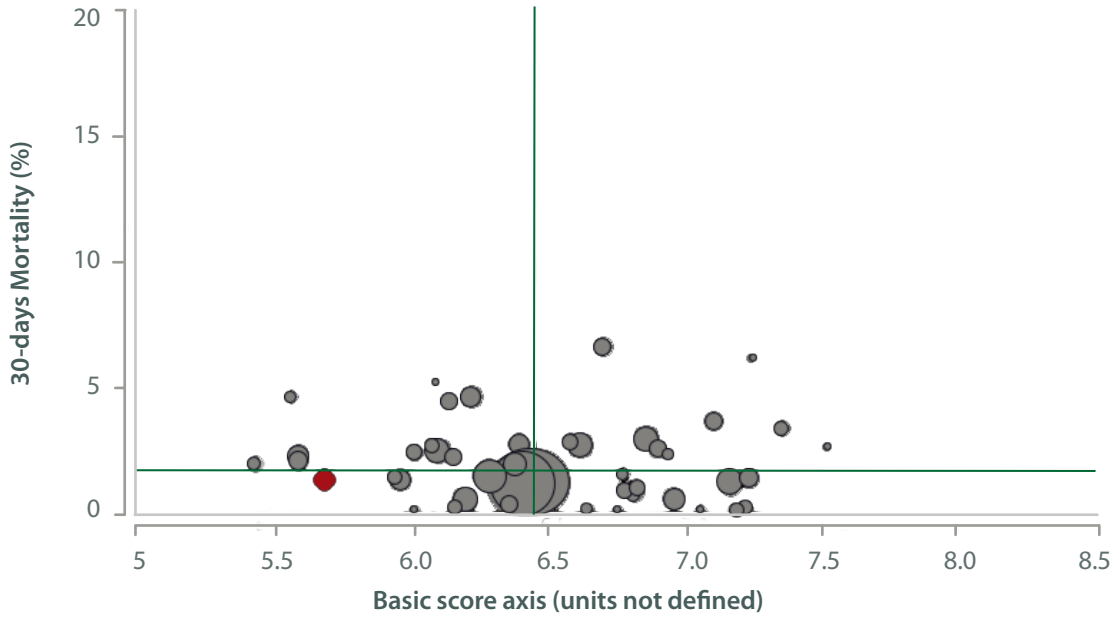
5 most frequent primary diagnosis in Infants

		Data	
		Count	Proportion
Diagnosis	VSD, Type 2 (Perimembranous) (Paramembranous)	47	29.5%
	Patent ductus arteriosus	41	25.7%
	TOF, Pulmonary stenosis	19	11.9%
	Coarctation of aorta	9	5.6%
	AVC (AVSD), Complete (CAVSD)	5	3.1%

5 most frequent primary procedures in Infants

		Data		
		Count	Proportion	ABC score
Procedures	VSD repair, Patch	50	25.1%	6.0
	PDA closure, Surgical	42	21.1%	3.0
	TOF repair, Ventriculotomy, Transanular patch	15	7.5%	8.0
	Delayed sternal closure	12	6.0%	-
	PA banding (PAB)	8	4.0%	6.0

Mortality and complexity benchmarking in infants



Children (1-18 years)

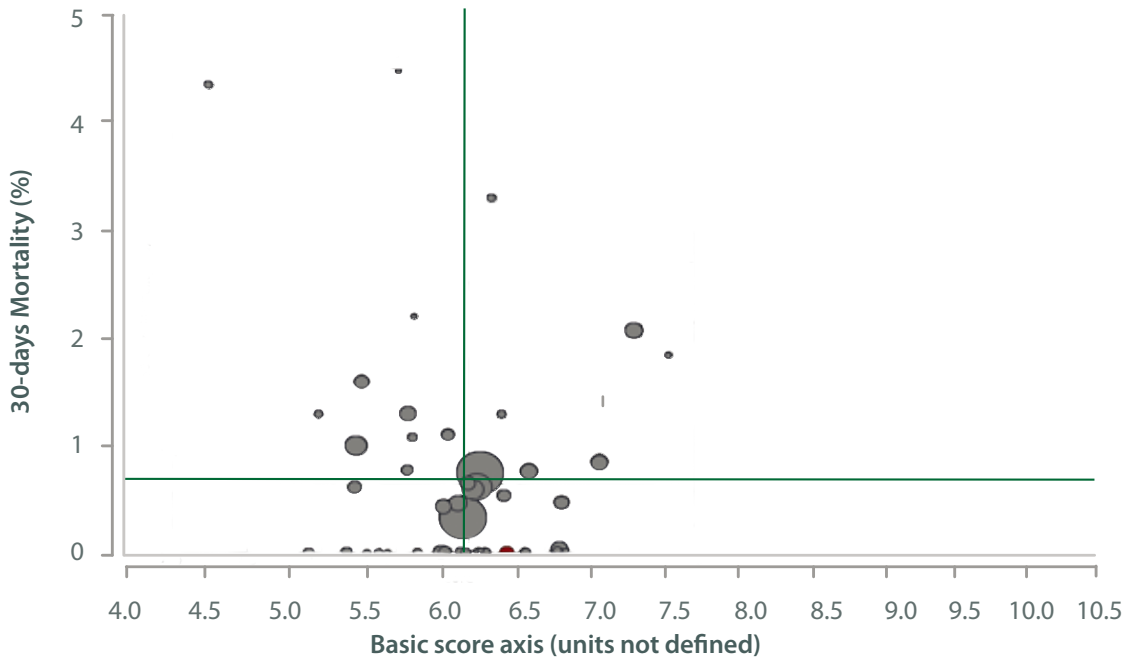
5 most frequent primary diagnosis in Children

		Data	
		Count	Proportion
Diagnosis	ASD, Secundum	23	13.6%
	VSD, Type 1 (Subarterial) (Supracristal) (Conal septal defect) (Infundibular)	20	11.8%
	VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	17	10.0%
	TOF, Pulmonary stenosis	14	8.2%
	Pulmonary atresia, VSD (Including TOF, PA)	8	4.7%

5 most frequent primary procedures in Children

		Data		
		Count	Proportion	ABC score
Procedure	VSD repair, Patch	31	15.1%	6.0
	ASD repair, Patch	21	10.2%	3.0
	Fontan, TCPC, External conduit, Fenestrated	9	4.4%	9.0
	Valvuloplasty, Mitral	8	3.9%	8.0
	Pulmonary atresia - VSD (including TOF, PA) repair	8	3.9%	9.0

Mortality and complexity benchmarking in children



Adults (18 years or above)

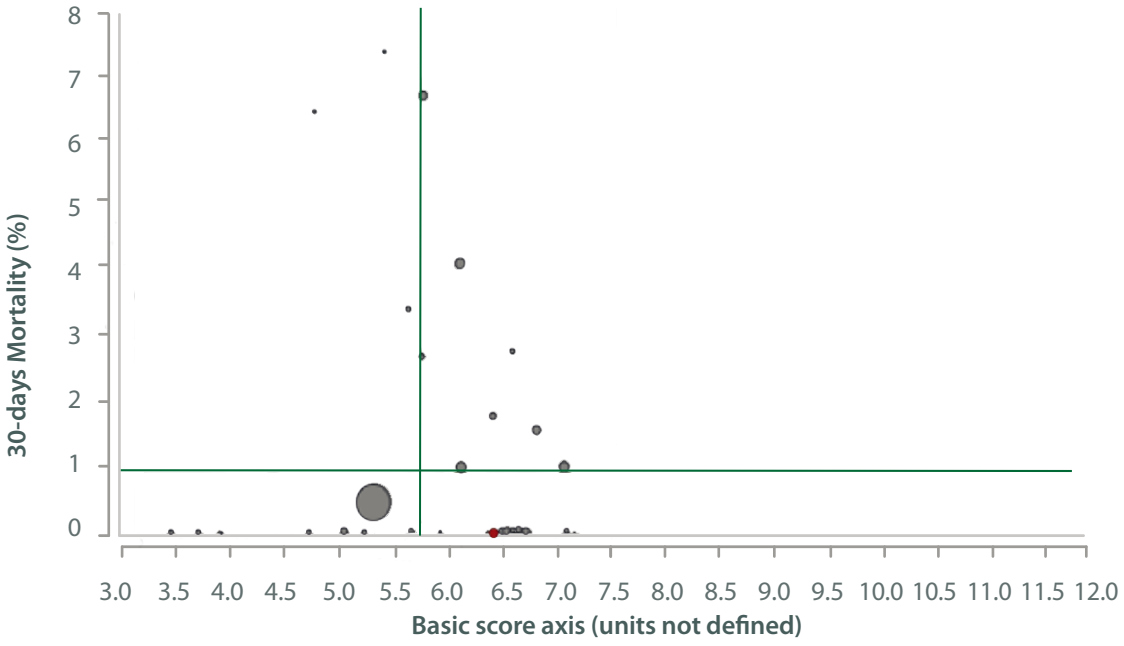
5 most frequent primary diagnosis in adults

		Data	
		Count	Proportion
Diagnosis	Pulmonary insufficiency	27	39.7%
	ASD, Secundum	9	13.2%
	VSD, Type 1 (Subarterial) (Supracristal) (Conal septal defect) (	5	7.3%
	Cardiac tumor	3	4.4%
	VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	2	2.9%

5 most frequent primary procedures in adults

		Data		
		Count	Proportion	ABC score
Procedure	Valve replacement, Pulmonic (PVR)	27	38.5%	6.5
	ASD repair, Patch	10	14.2%	3.0
	VSD repair, Patch	7	10.0%	6.0
	Cardiac tumor resection	3	4.2%	8.0
	Fontan revision or conversion (Re-do Fontan)	2	2.8%	12.5

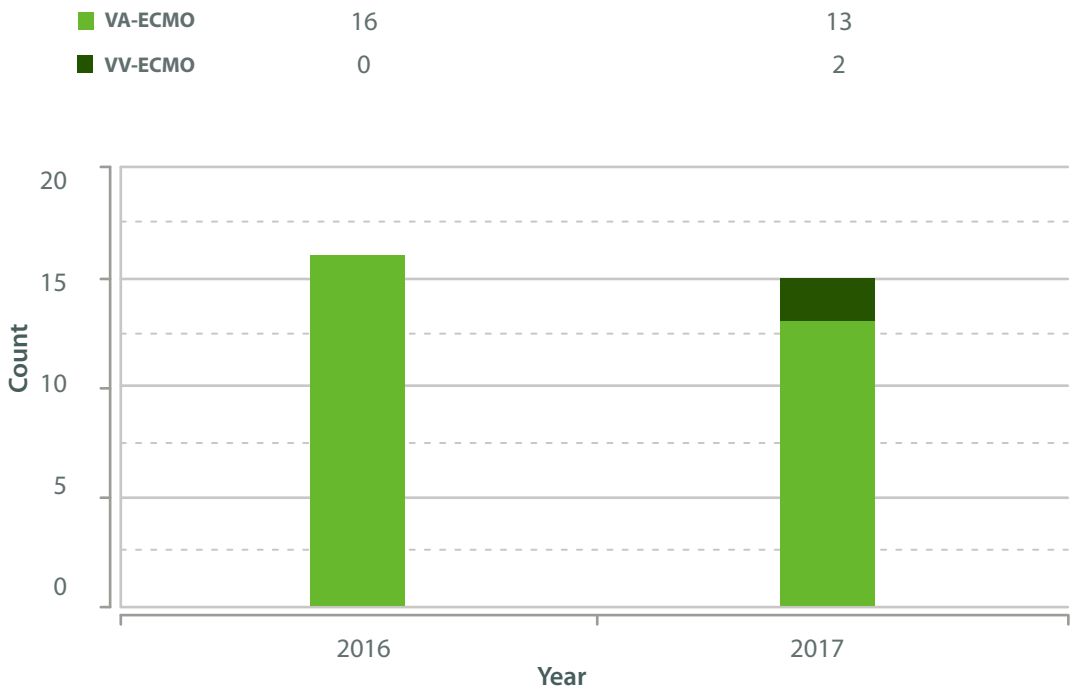
Mortality and complexity benchmarking in adults



Paediatric Extracorporeal membrane oxygenation program in QMH

- ECMO has been developed for use in patients with respiratory or cardiac failure.
- ECMO program started with treating post-cardiotomy, low cardiac output patients in 2000 at Grantham Hospital.
- In line with provision of ECMO becoming standard for centres performing paediatric cardiac surgery, use of ECMO in this cardiac surgical population has increased in QMH.
- Paediatric ECMO program includes patients <=18 yrs of age supported with extracorporeal membrane oxygenation.
- During 2016-2017, 38 ECMO runs were provided. to 31 children with a goal of bridging these children to recovery or to other implantable device or heart transplantation.
- Severe respiratory failure due to respiratory infection were supported with venovenous ECMO (VV-ECMO)(2/31) except for 1 case of pneumonia with septic shock which was supported with venoarterial ECMO (VA-ECMO).
- Failure to wean off Cardiopulmonary Bypass (CPB), VA-ECMO support under Extracorporeal Cardiopulmonary Resuscitation (eCPR) were the main indications for VA-ECMO (29/31) support.

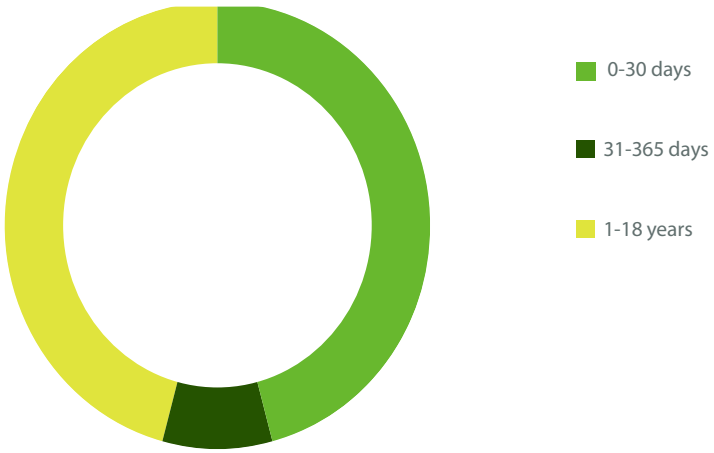
ECMO mode and count by year



Age distribution

- 38.7% (12/31) of the paediatric cases supported with ECMO were between 1-18 years.
- Cardiogenic shock (5/12), severe respiratory failure due to pneumonia (3/12), failure to wean off CPB (2/12), post cardiotomy hemodynamic instability (1/12) and as VA-ECMO support under eCPR (1/12) were the main etiologies for VA-ECMO (10/12)and VV-ECMO (2/12) support in this group.
- 38.7% (12/31) were neonates and all received VA-ECMO support.
- The indications for ECMO in neonates were, as VA-ECMO support under eCPR (5/12), failure to wean off CPB(4/12), post cardiotomy hemodynamic instability(2/12) and respiratory failure (1/12).
- 22.6% (7/31) were infants and all received VA-ECMO support.
- The main indications in infants were, failure to wean off CPB (3/7), as VA-ECMO support under eCPR (2/7) and cardiogenic shock (2/7).

ECMO: Age distribution



Indication for ECMO support

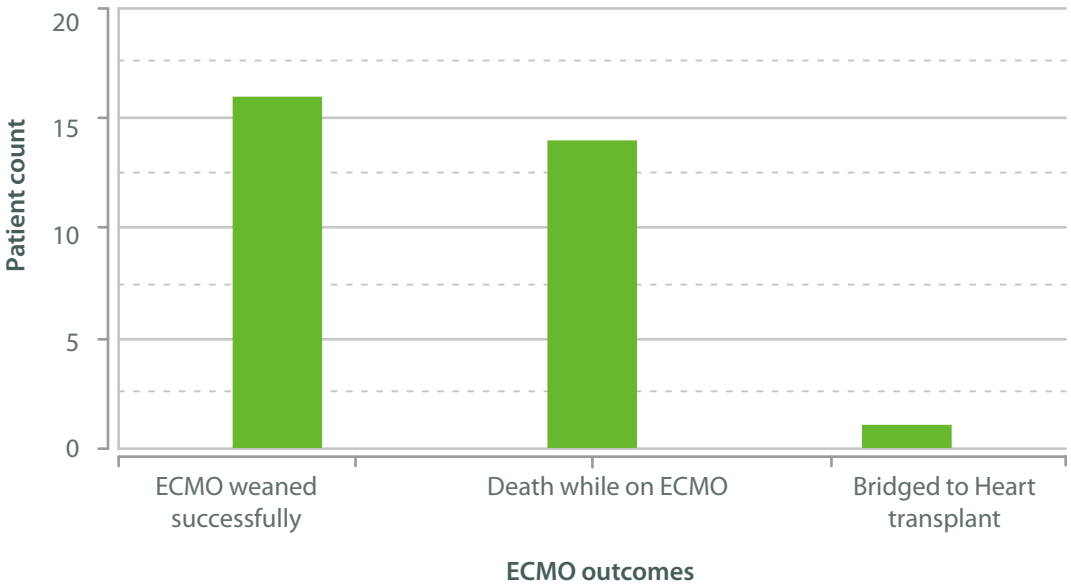
- ECMO was used for children in QMH for wide spectrum of different etiologies.

	Indication for ECMO	Data		
		Count	Proportion	Mortality
Indication	Post-cardiotomy	12	38.7%	33.3%
	Failure weaning from cardiopulmonary bypass	9		
	Hemodynamic instability	3		
	VA-ECMO support under eCPR	9	29.0%	55.5%
	Myocarditis	3	9.7%	66.6%
	Respiratory failure due to Pneumonia	2	6.5%	50.0%
	Septic shock	2	6.5%	0%
	Pulmonary complication of congenital heart disease	2	6.5%	100%
	Dilated cardiomyopathy	1	3.2%	0%

ECMO outcomes

- Overall survival to discharge rate for Paediatric ECMO was 48.3% (15/31).
- Overall 17 (54.8%) were successfully weaned off ECMO.
- One (3.2%) was successfully bridged to heart transplant.
- Overall sixteen patients died (51.6%), 14 died while on ECMO and 2 died after successful weaning off ECMO.
- Post cardiotomy requiring ECMO support showed a mortality of 12.9% (4/31)
- VA-ECMO support under eCPR showed a mortality of 16.1%(5/31).
- Myocarditis had a mortality of 6.5% (2/31).
- Pulmonary complication of congenital heart disease showed 6.5% (2/31) mortality.
- Viral pneumonia associated respiratory failure requiring ECMO showed a mortality of 3.2% (1/31).

ECMO outcome (n=31)



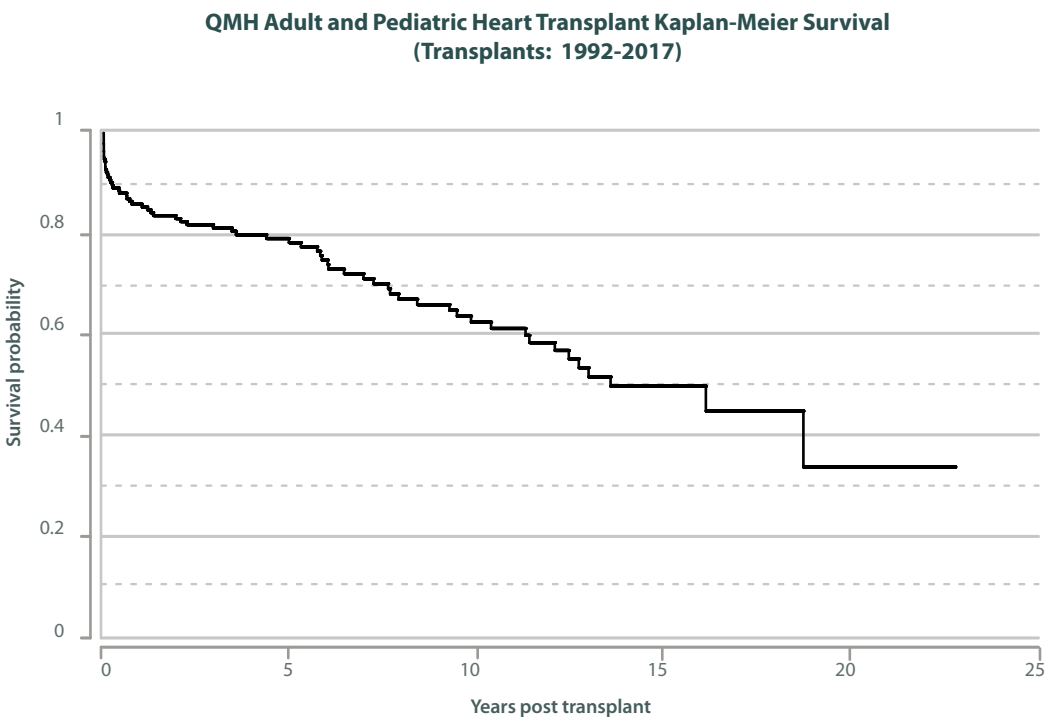

Standby

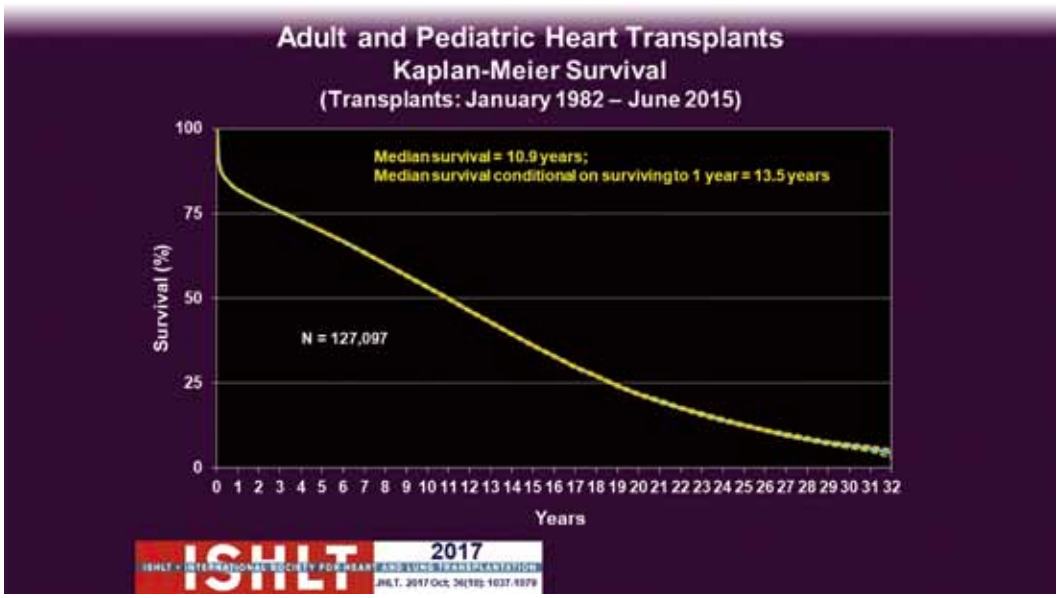
Appendices

Appendices

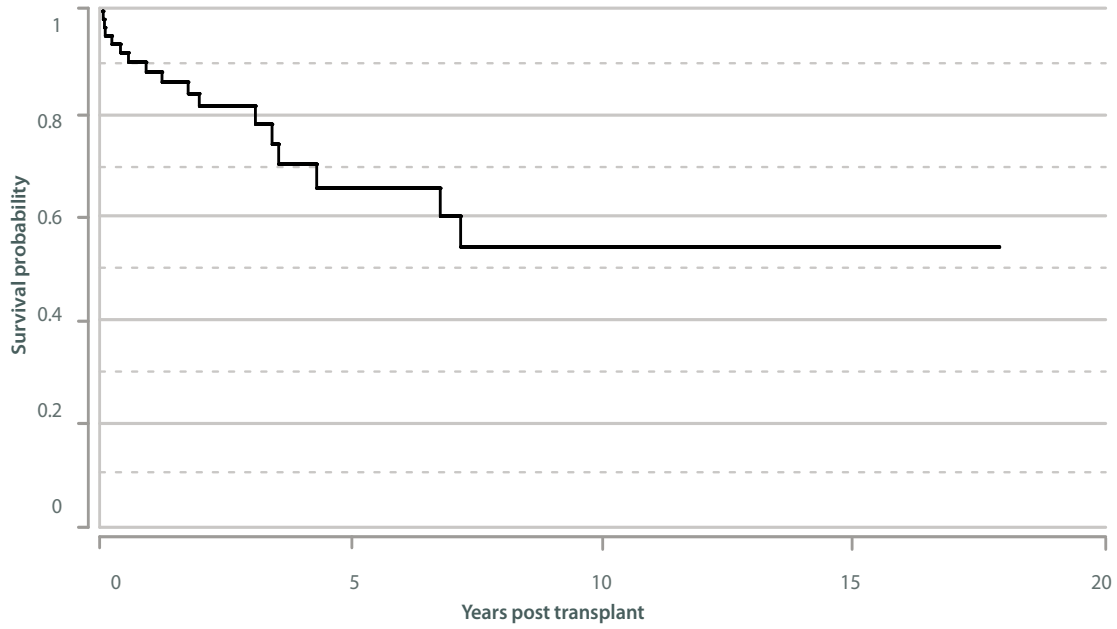
Appendix 1

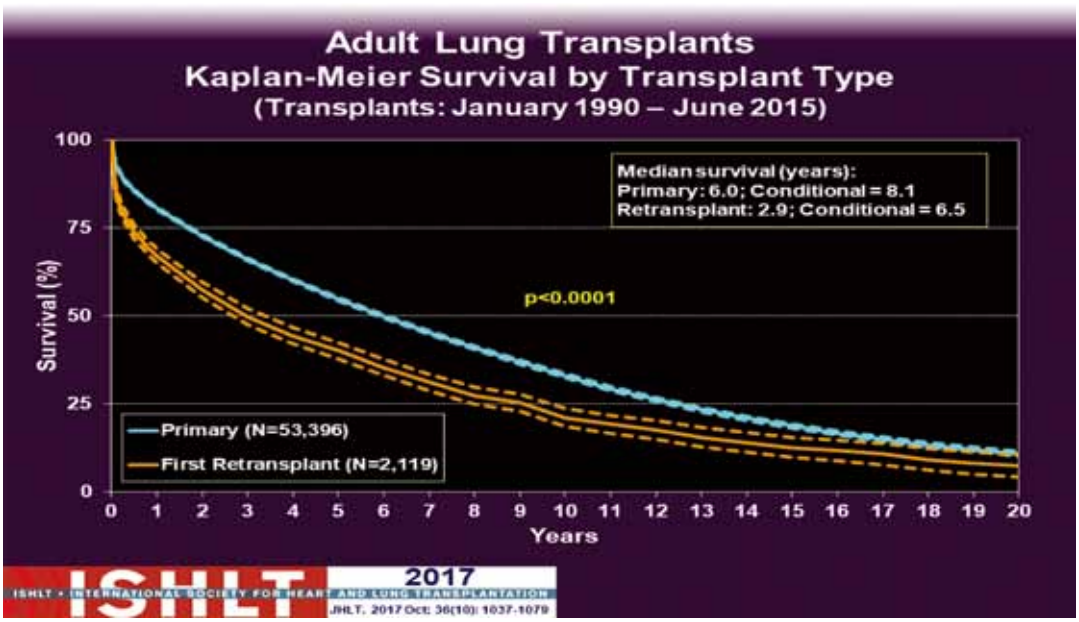
ISHLT Transplant Registry Report



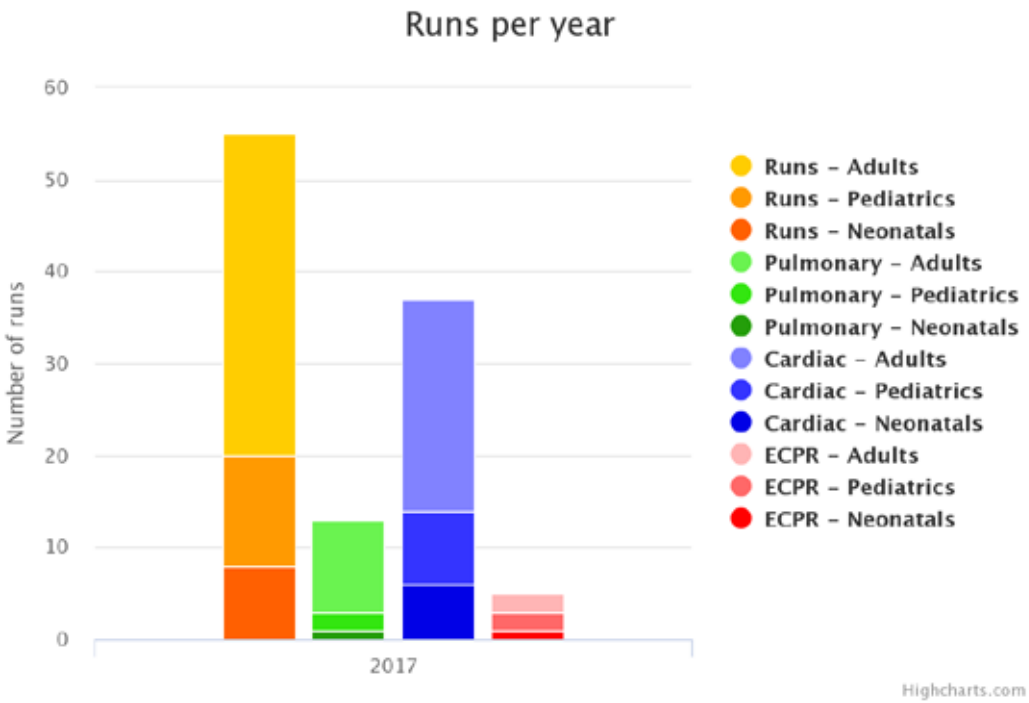


QMH Adult Lung Transplant Kaplan-Meier Survival
(Transplants: 1995-2017)





ELSO Registry Report



ECLS Registry Report

Extracorporeal Life Support Organization
2800 Plymouth Road
Building 300, Room 303
Ann Arbor, MI 48109

Center Benchmarking Summary
February, 2018
Department of Cardiothoracic Surgery, Queen Mary Hospital (620)

My Center's Last 10 Years ECLS Outcomes

		Total Runs	*Survived ECLS*		*Survived to DC or Transfer*	
Neonatal						
	Pulmonary	2	0	0%	0	0%
	Cardiac	6	4	66%	3	50%
Pediatric						
	Pulmonary	3	2	66%	2	66%
	Cardiac	8	6	75%	5	62%
	ECPR	1	1	100%	1	100%
Adult						
	Pulmonary	10	8	80%	3	30%
	Cardiac	24	15	62%	9	37%
	ECPR	1	0	0%	0	0%
Total		55	36	65%	23	41%

ELSO Registry Report

My Center's Last 10 Years Outcomes vs other ELSO Centers, Stratified by Center Volume

n, % Survived to DC or Transfer

	My Center		*<= 5 runs/year*		*6-20 runs/year*		*>20 runs/year*		*Total ELSO Registry*	
Neonatal										
Pulmonary	2	0%	568	69%	2,596	68%	4,204	67%	7,368	67%
Cardiac	6	50%	335	42%	1,310	45%	2,108	47%	3,753	46%
ECPR	0	%	53	24%	333	43%	800	42%	1,186	42%
Pediatric										
Pulmonary	3	66%	366	58%	1,264	56%	2,848	63%	4,478	60%
Cardiac	8	62%	590	57%	1,694	56%	3,131	58%	5,415	57%
ECPR	1	100%	158	36%	849	46%	1,913	42%	2,920	43%
Adult										
Pulmonary	10	30%	1,667	55%	3,520	57%	8,560	61%	13,747	60%
Cardiac	24	37%	1,624	43%	3,955	41%	8,131	42%	13,710	42%
ECPR	1	0%	473	30%	1,168	26%	2,641	30%	4,282	29%
Total	55	41%	5,834	50%	16,689	51%	34,336	52%	56,859	52%

IMACS Data Quality Report

IMACS registry provides monthly data quality reports and annual benchmarking reports. Next benchmarking report will be available in June.

IMACS
ISHLT REGISTRY FOR MECHANICALLY ASSISTED CIRCULATORY SUPPORT

Data Quality Report
2018-05-01
Queen Mary Hospital
Implant and event dates: March 13, 2013 to May 1, 2018

05/01/2018

Prepared by:

The Data and Clinical Coordinating Center
University of Alabama at Birmingham

James K. Kirklin, MD
Craig Collum, MPH
Nick Timkovich
Maceo Cleggett III

CONFIDENTIAL: This information is only intended for:
Queen Mary Hospital

IMACS DATA QUALITY REPORT (2018-05)
COVERAGE: March 13, 2013 - May 1, 2018
SITE: Queen Mary Hospital

I. Introduction and Methods

I.A. Purposes of this Report

Data quality is always a concern in a clinical registry. The purpose of this report is to provide each hospital an up to date snapshot of key data they have entered into IMACS and to provide lists of inconsistencies and improbable values that occur in the data. By addressing and correcting these data quality issues, the quality of the IMACS Registry and the resultant analyses will be improved.

I.B. Source of Data and Limitations

The data in this report are based on implants entered into the IMACS web-based data application through May 1, 2018. Patient enrollment in IMACS began on March 13, 2013. Your institution may have joined IMACS at a later date and therefore your patient enrollment may have begun at a later date.

IMACS is a registry that strives to meet the data quality standards of a prospective clinical trial. Many of the steps employed to increase the quality of the data (e.g. auditing, inconsistency resolution, etc.) are described in the IMACS protocol which can be found at www.ishlt.org. IMACS is an on-going registry and therefore data quality efforts will always have an associated lag time.

As you review the data from your hospital that are contained in this report, you may find some information that appears incorrect or inconsistent. Please remember that this report is a direct function of the data that has been entered at your hospital. Therefore, please check any data issues with your online submitted data. The only caveat to this is that any corrections that you have made to your data since May 1, 2018 will not appear in this report. They will appear in the next quarterly report.

I.C. Patient Coverage

This Data Quality Report contains information from ALL IMACS patients at your institution. This includes patients receiving primary, subsequent, and retrospective devices.

IMACS DATA QUALITY REPORT (2018-05)
COVERAGE: March 13, 2013 - May 1, 2018
SITE: Queen Mary Hospital

II. Data Quality Tables

Exhibit 1a: Implants by Year and Device Type

The following table summarizes the number of all device types implanted at your site by year. This includes all primary, subsequent, retrospective devices, and pediatric patients.

This table does not count devices in transfer patients that were implanted at other sites.

Implant Year	Device Type	
	LVAD	All
	N	N
2011	6	6
2012	2	2
2013	7	7
2014	7	7
2015	7	7
2016	15	15
2017	10	10
All	54	54

Exhibit 1b: Total Patients Receiving Implants and Implant Operations

The following table lists the total number of patients enrolled at your site and the total number of implant operations.

Information from patients that have transferred to your institution is not listed in this table.

Patients Implanted	Implant Operations
54	54

Appendix 2

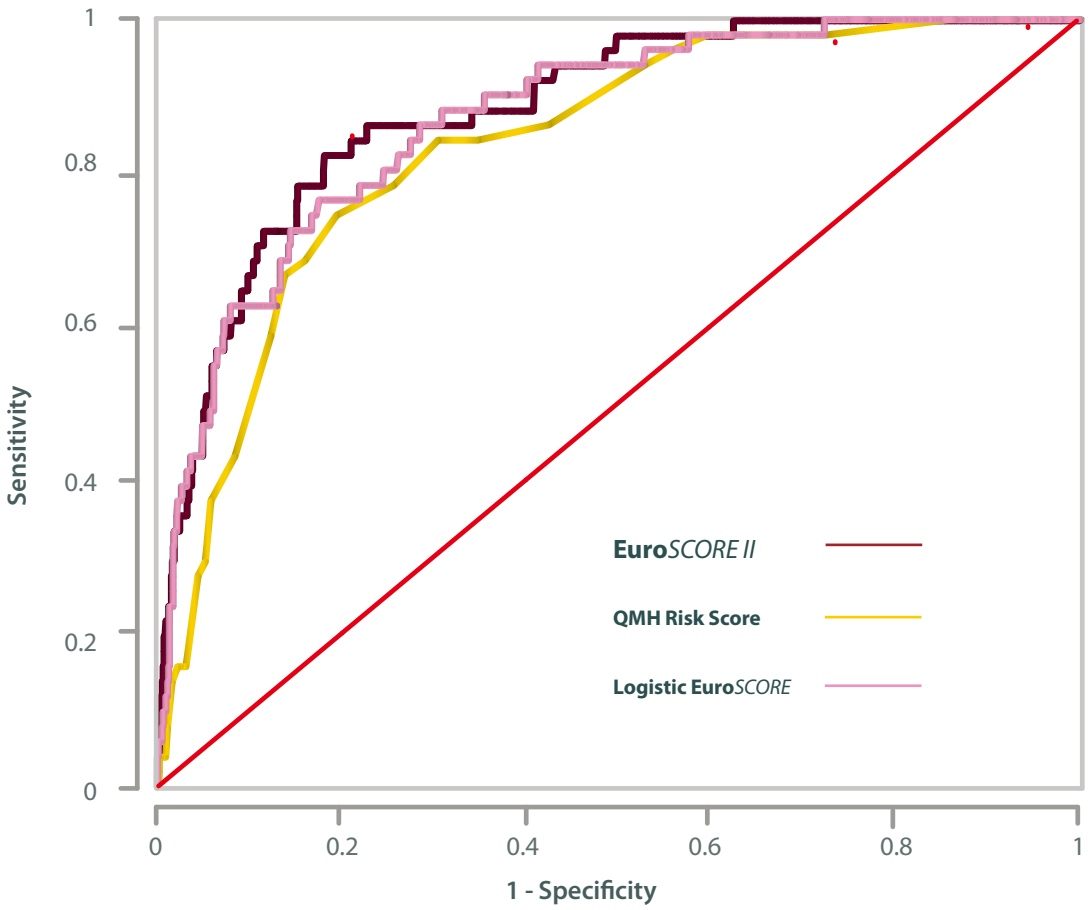
QMH Risk Score for Adult CABG and Valve surgery (since 2010)

- Significant geographic and demographic differences between European and Asian patients.
- QMH Risk Score was developed to predict in-hospital morality for patients undergoing CABG and valve surgery in Hong Kong.
- Between Nov 1999 and May 2006, 3156 adults undergoing CABG and valves surgery cases were prospectively collected.
- Age <18, congenital abnormalities, aortic surgery were excluded.
- Multivariate logistic regression analysis: 11 risk factors identified.
- Area under ROC curve = 0.756.
- Hosmer-Lemeshow goodness-of-fit test = p > 0.05.

QMH risk calculator

		Score
Risk Factors	Age (years)	
	<60	0
	60-64	2
	65-69	2.5
	70-74	3
	≥ 75	4
	Renal failure	4
	EF<30%	3
	Pre-operative Cardiac Conditions	2
	Transmyocardial infarction <48hrs	3.5
	Congestive cardiac failure	1.5
	Endocarditis	2.5
	Pulmonary hypertension	2.5
	Redo operation	2
	Emergency surgery	2
	Valves & CABG	2

Comparing EuroSCORE II , QM Score and Logistic EuroSCORE ROC for adult cardiac surgery, 2016-2017



		Area under the curve	Asymptotic 95% Confidence Interval		Hosmer-Lemeshow statistics (P-valve)
			Lower Bound	Upper Bound	
Risk stratification model	EuroSCORE II	0.885	0.843	0.928	0.119
	QMH Risk Score	0.837	0.787	0.888	0.355
	Logistic EuroSCORE	0.872	0.825	0.918	0.653

		Predicted mortality rate % (95%CI)	Observed/predicted ratio
Risk stratification model	EuroSCORE-II	7.59 (2.7-6.3)	0.64
	QMH Risk Score	4.35 (2.6-6.1)	1.1
	Logistic Euro*SCORE*	13.67 (7.1-12.1)	0.35

Appendix 3

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 level1

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.

Publications 2016-2017

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5. Hsin, M. K., & Au, T. W. K. (2017). Extracorporeal membrane oxygenation: A bridge too far… no more. *The Journal of Thoracic and Cardiovascular Surgery*, 154(6), e129-e130. doi: 10.1016/j.jtcvs.2017.08.098. Epub 2017 Sep 5.
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