Cardiac Surgery Biennial Report 2018-2019

Department of Cardiothoracic Surgery

瑪麗醫院
Queen Mary Hospital

醫院管理局
HOSPITAL AUTHORITY

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Abbreviations List

Abbreviations

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
LAA	Left Atrial Appendage
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
LVOT	Left Ventricular Outflow Tract
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
PDA	Patent ductus arteriosus
PFO	Patent Foramen Ovale
PVR	Pulmonic Valve Replacement
QMH	Queen Mary Hospital
RAA	Right Atrial Appendage
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

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Foreword

I feel much privileged in writing this Foreword for the Biennial Report 2018-19. As the Hospital Chief Executive of Queen Mary Hospital overseeing the service operations and planning of the whole of the Hong Kong West Cluster, service development of Cardiothoracic Surgery as a specialty has always been one of the attention areas.

Over the years, and as reflected in the data and charts so presented in the report, we can see a steady increase in the volume and complexity of cardiac surgery cases. All these have been achieved with a relatively high quality standard and performance outcome. As shown by benchmarking with data published by the Society for Cardiothoracic Surgery in Great Britain and Ireland, we have a high workload percentage of Adult Congenital Heart Surgery, Aortic Surgery, and Heart Transplantation (21.1% in QMH vs 3.2% in UK), and of Valvular Surgery (48% in QMH vs 23% in UK).

In terms of the survival rate for heart transplant patients, our rates at 5, 10 and 20 years stand at 80.1%, 67.6% and 40.4% respectively as compared to 72.2%, 56.5% and 24.06%, according to the International Society for Heart and Lung Transplantation (ISHLT), which is a global registry. For lung transplantation, the survival rates at 5, 10 and 20 years are 65.2%, 55.2%, 46.0% and are also higher than the rate as reported in ISHLT registry, being 55.7%, 34.1% and 11.8% respectively. Attainment of these figures is, by any measurement, not easy but requires sheer dedication and commitment on the part of our professional clinical team under the leadership of the Chief of Service. So congratulations to YOU all.

Having said that, I understand that the clinical team would not be complacent with the foregoing strong performance but would strive with every bit of their professionalism and expertise to achieve the highest quality service for patients. Indeed, this has been proven by a number of milestones the department has achieved over the year. For instance, we are the first centre in Asia to introduce cutting edge advanced technology with NeoChord for mitral valve repair. This together with the J Valve Transcatheter Aortic Valve Replacement (TAVR) system, itself a revolutionary next generation heart valve implantation system, has made the achievement even more commendable. And, on the heart transplantation front, there was the introduction of *the Organ Care System* in 2019 which helped to improve the success rate of transplantation for even marginal donor hearts.

All in all, I would like to express my utmost gratitude to colleagues of the department in maintaining the highest possible standard of care for our patients.

Dr. Theresa Li
Cluster Chief Executive, HKWC
& Hospital Chief Executive , QMH/TYH

Introduction

It is indeed a remarkable honor for me to introduce our 2018-2019 report which marks the 10th anniversary of our relentless data collection endeavor. Comprehensive data collection is essential for monitoring outcomes and service improvement. This would enable us to deliver world-class public medical services to the people of Hong Kong. It provides clear information to the administrators, service planners and patients. 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://hkwc.home/webapps/Dept/ctsd/report.html.

Our databases, data collection methodology and validation remain the same as in the previous reports. Our databases now contain collected data of 4057 adult cardiac surgeries and 2157 congenital 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. Our adult cardiac surgery data 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/). The book is currently being updated and the previous version has been taken down, therefore, our 2018-2019 data was compared to the UK data of 2015. We benchmark our performance against international standards, a powerful tool for continued improvement in services to patients. This report clearly documents the provision of high quality procedures comparable with the international standards in cardiac care.

While clinical excellence has always been our goal, we are continuously looking for the best way to evolve and change over time, using innovative technologies and finding ways to make these available to our patients. Each iteration of this report has the addition of newly introduced techniques. We are the first center in Asia to introduce cutting edge advanced technology with NeoChord for mitral valve repair. The J Valve Transcatheter Aortic Valve Replacement (TAVR) system, a revolutionary next generation heart valve implantation system was also introduced. In 2019, we implanted the 100th implantable Left Ventricular Assist Device (LVAD), which treats patients who are in end-stage heart-failure. We strive to provide our patients access to the latest technologies, including the HeartMate III LVAD.

With the remarkable repository of collected data we have built up a solid foundation to provide quality cardiac care for the people of Hong Kong. This cannot be achieved without the meticulous data collection effort of each and every of our team members.

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

Part 1: Adult cardiac surgery

Database Overview

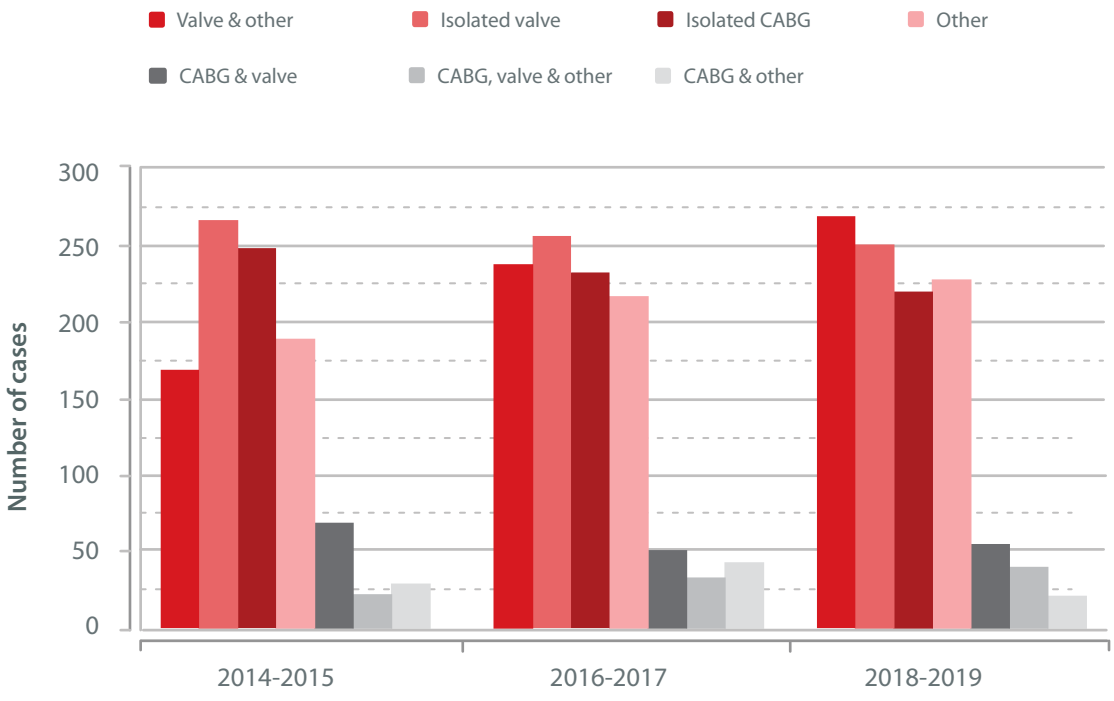
Database overview: Adult cardiac surgery

The overall workload at QMH, Hong Kong for the calendar years 2018-2019

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 1082 Adult Cardiac Surgeries in patients older than 18 years.
- During the last four years, QMH's adult cardiac surgery has been largely static. During this time, there has been an increase in less invasive therapy .
- 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. Isolated CABG surgeries represent 20% 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 46% (2016-2017) to 48%.
- The proportion of our valve surgeries was higher than in the UK (48% 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 : 2014-2019

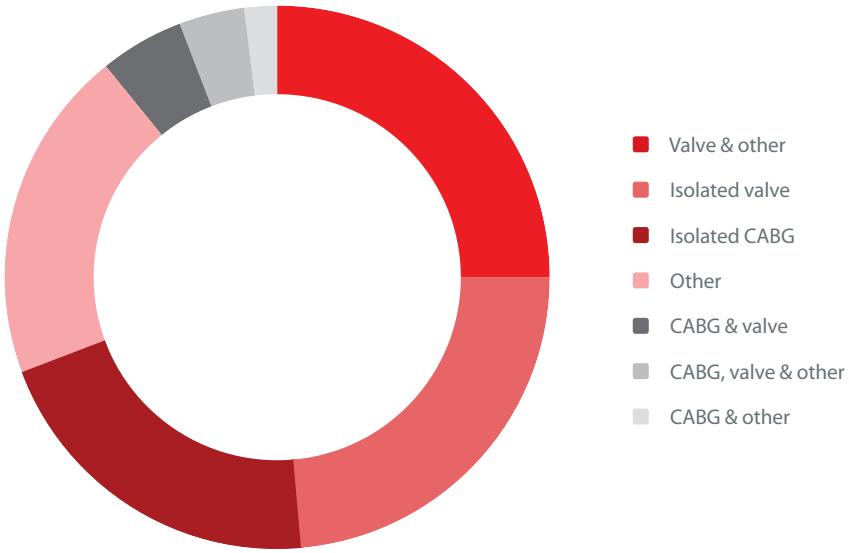


Overall workload at Queen Mary Hospital, Hong Kong: calendar years 2018-2019

		Data		
		Count	Proportion	Proportion in the UK *
Procedure grouping	Valve & other	270	25.0%	4.5%
	Isolated valve	251	23.2%	18.9%
	Other	228	21.1%	3.2%
	Isolated CABG	220	20.3%	58.3%
	CABG & valve	54	5.0%	11.5%
	CABG, valve & other	39	3.6%	1.6%
	CABG & other	20	1.8%	2.0%
	All	**1082**		

* 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, 2018-2019 (n=1082)



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 198 Isolated CABG surgeries, a figure which was higher than the UK data (90% 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	2	0	20	5	0	20	0	**47**
		2 grafts	20	0	11	5	0	10	0	**44**
		3 grafts	177	0	20	9	0	8	0	**213**
		4 grafts	20	0	3	1	0	1	0	**25**
		>4 grafts	1	0	0	0	0	0	0	**4**
	Valve surgery	Aortic alone	0	73	28	0	91	22	0	**214**
		Mitral alone	0	64	17	0	54	9	0	**144**
		Tricuspid alone	0	10	0	0	21	0	0	**31**
		Pulmonary alone	0	19	0	0	10	0	0	**29**
		Aortic & mitral	0	20	6	0	11	1	0	**38**
		Mitral & tricuspid	0	38	1	0	51	5	0	**95**
		other valve combinations	0	27	2	0	32	2	0	**63**

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 the earlier reports, surgery on the aorta remained static (184 in 2016-2017 vs 180 in 2018-2019) as in the last two years there has been an increase in minimally invasive, Thoracic Endovascular Aortic / Aneurysm Repair (TEVAR).
- Another area of case-volume growth compared to the previous reports is ventricular assist device (VAD) and extracorporeal membrane oxygenation (ECMO). Indications for ECMO in this report are not limited to cardiac support but also include pulmonary and eCPR (including ECMO support for trauma).
- 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 TEVAR.

Other procedures performed

		Data	
		Count	Proportion
Other procedures	No other procedures	525	48.5%
	All operations with an *other* component	557	51.5%
	Surgery on the aorta	180	16.6%
	Ablation surgery for atrial fibrillation	134	12.4%
	ECMO	67	6.2%
	Adult congenital surgery	53	4.9%
	Ventricular assist device	48	4.4%
	ASD	36	3.3%
	Cardiac transplant	23	2.1%
	Pulmonary transplant	14	1.3%
	Atrial myxoma	12	1.1%
	Pulmonary embolectomy	9	0.8%
	Pericardiectomy	5	0.5%
	LV restoration surgery	3	0.3%
	Acquired VSD	3	0.3%
	Other procedure not listed above	82	7.6%
	All	**1082**	

Previous cardiac surgery

- The proportion of Isolated CABG with previous cardiac surgery was 0.9% and remains unchanged compared to our preceding report. The proportion was 1.6% in UK.
- 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 29.1% in QMH while 'Valve & other' surgery with previous cardiac surgery was 20% and and was consistent with our previous report.
- Overall 18% of our Adult Cardiac Surgery patients had previous cardiac surgery performed and remains consistent with our preceding reports.

Previous surgery

		Previous cardiac surgery		
		No	Yes	Proportion prior surgery
Procedure grouping	Isolated CABG	218	2	0.9%
	Valve & other	216	54	20.0%
	Isolated valve	178	73	29.1%
	Other	166	62	27.2%
	CABG & valve	53	1	1.9%
	CABG & other	20	0	0.0%
	CABG,valve & other	38	1	2.6%
	All	**889**	**193**	**17.8%**

Operative mortality

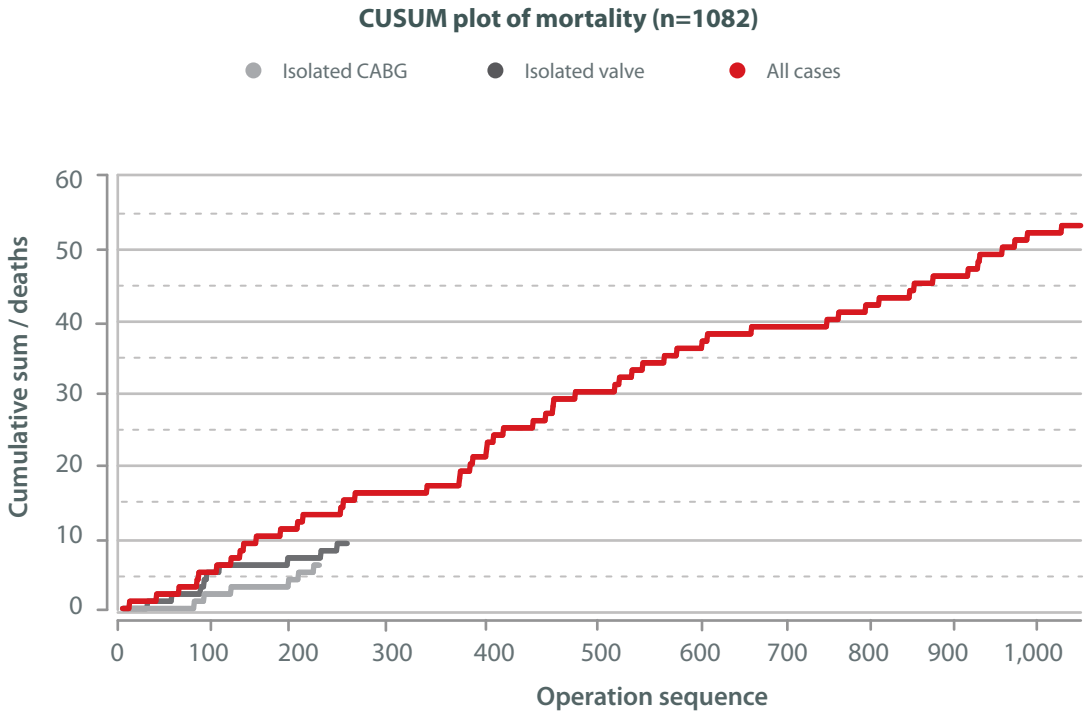
- Operative mortality defined as (1) all deaths, regardless of cause, occurring during the hospitalization in which the operation was performed, even if after 30 days (including patients transferred to other acute care facilities); and (2) all deaths, regardless of cause, occurring after discharge from the hospital but before the end of the 30th postoperative day.
- 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 and valves combined with other surgeries was at par with 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. '*CABG, valve & other*' mortality was lower than UK data and EACTS database.
- The mortality rate for combined CABG with valve & other, CABG with other surgery is higher than isolated CABG. Combined procedures involve more than one procedure during surgery and are generally more complex than isolated procedures.
- The mortality in the 'Other category' was mainly in ventricular assist devices and ECMO procedures. Only the ECMOs inserted for postcardiotomy cardiogenic shock were included in mortality calculation.

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

		Mortality data					
		Died	QMH			United Kingdom NACSD	EACTS database
			2018/19	2016/17	2014/15	2008	2006/08
Procedure grouping	Isolated CABG	6	2.70% (220; 1.1-6.1%)	1.30% (233; 0.3-4.0%)	2.00% (249; 0.7-4.9%)	1.50% (22,808; 1.3-1.6%)	2.20% (219,053; 2.2-2.3%)
	Isolated valve	9	3.60% (251; 1.7-6.9%)	3.10% (257; 1.5-6.4%)	3.30% (267; 1.7-6.7%)	3.50% (7,379; 3.1-4.0%)	3.40% (75,247; 3.3-3.5%)
	CABG & valve	2	3.70% (54; 0.6-13.8%)	2.00% (50; 0.1-12.0 %)	8.80% (68; 4.0-20%)	6.10% (4,508; 5.4-6.8%)	6.20% (37,721; 6.0-6.5%)
	CABG & other	3	15.00% (20; 3.9-38.8%)	9.50% (42; 3.0-23.5%)	14.20% (28; 5.4-38.1%)	7.80% (766; 6.1-10.0%)	7.00% (4,327; 6.3-7.8%)
	Valve & other	13	4.80% (270; 2.6-8.2%)	4.20% (238; 2.0-8.1%)	2.90% (169; 1.1-7.3%)	5.50% (1,780; 4.5-6.7%)	4.90% (12,883; 4.5-5.3%)
	CABG, valve & other	2	5.10% (39; 0.8-18.6%)	12.50% (32; 4.0-30.0%)	14.20% (21; 4.4-42.2%)	11.50% (617; 9.2-14.4%)	11.30% (3,097; 10.2-12.5%)
	Other	18	8.50% (213; 5.2-13.2%)	10.10% (217; 6.6-15.1%)	6.80% (189; 4.1-12.5%)	7.90% (1,271; 6.5-9.5%)	7.70% (11,562; 7.2-8.2%)

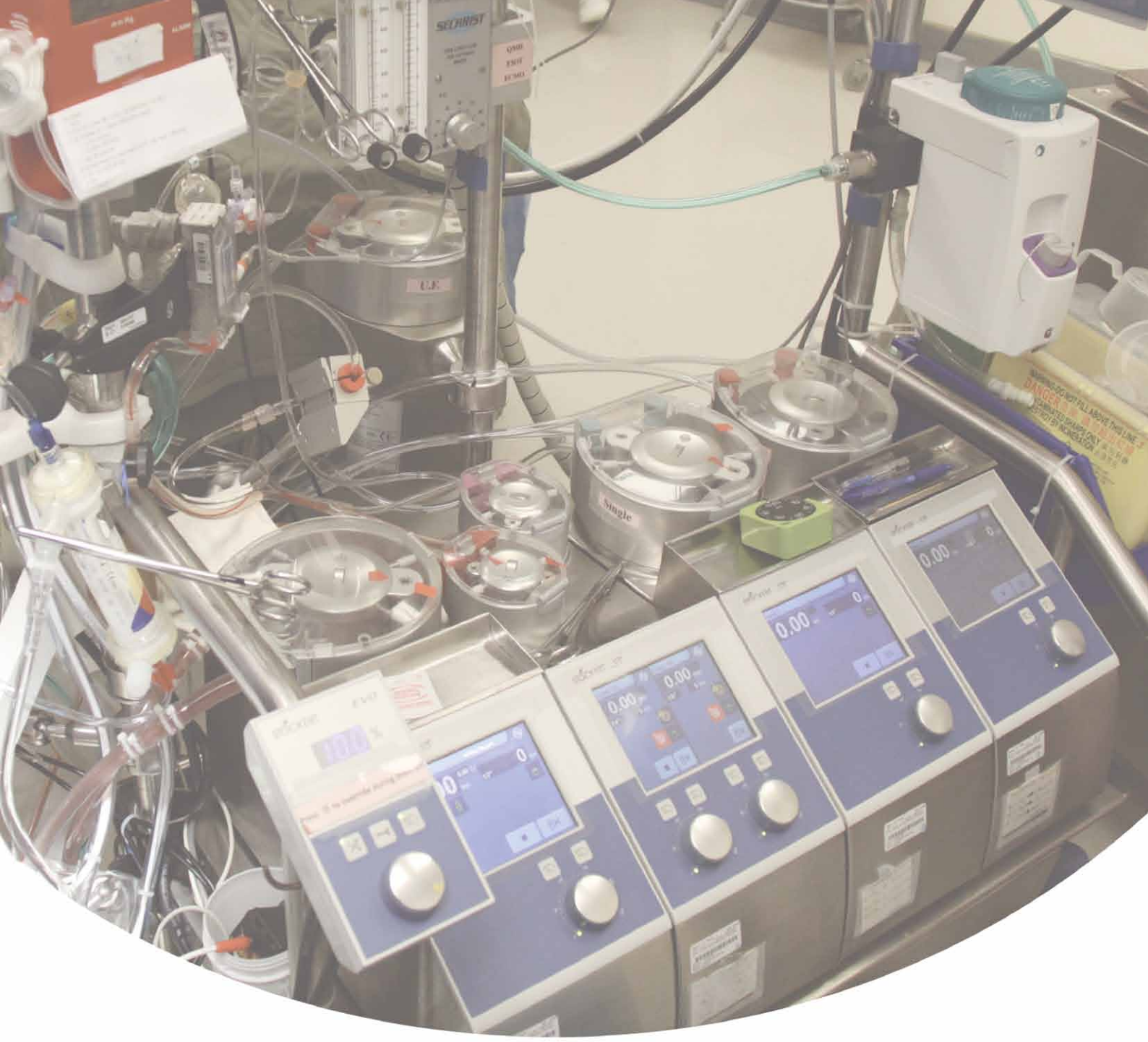
CUSUM plots of in-hospital mortality

- 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, 2018-2019

- 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.
- The total number of records used for mortality calculation was 1067 after excluding the ECMO's inserted for reasons other than post cardiotomy cardiogenic shock.
- Overall hospital mortality in this cohort was 4.9% (4.8% in 2016-2017). 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 10.8%. The average Logistic EuroSCORE in UK was 7.42% in 2015. The O/E ratio at QMH was 0.45.
- The average EuroSCORE-II predicted a mortality of 6.4% resulting in O/E ratio of 0.76 in our cohort.



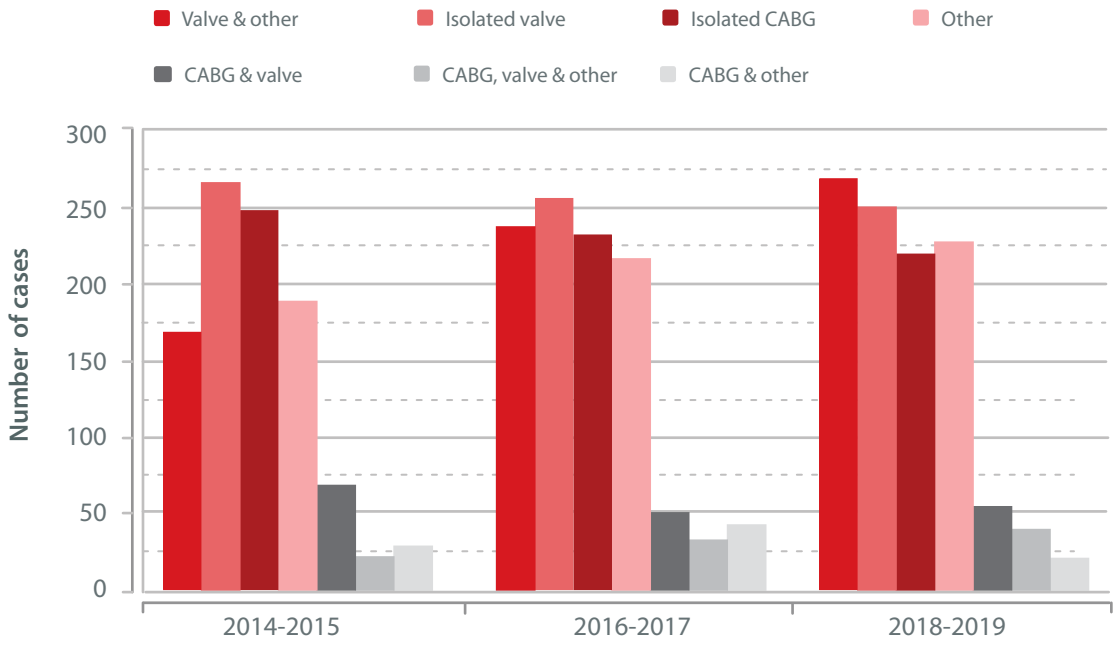
CABG surgery

CABG surgery

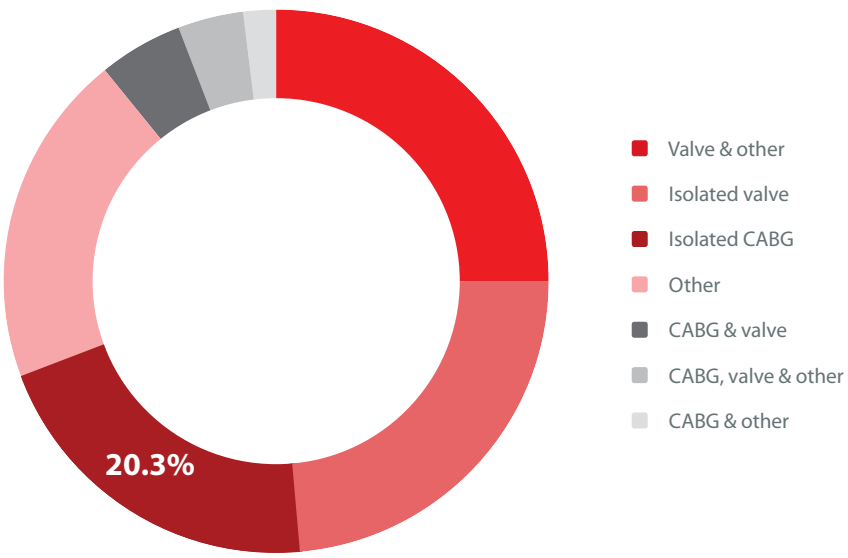
Isolated CABG in the context of overall workload

- Total 220 patients had isolated CABG in the year 2018 to 2019.
- Isolated coronary surgery contributed to 20.3% 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 : 2014-2019



Workload overview, 2018-2019 (n=1082)

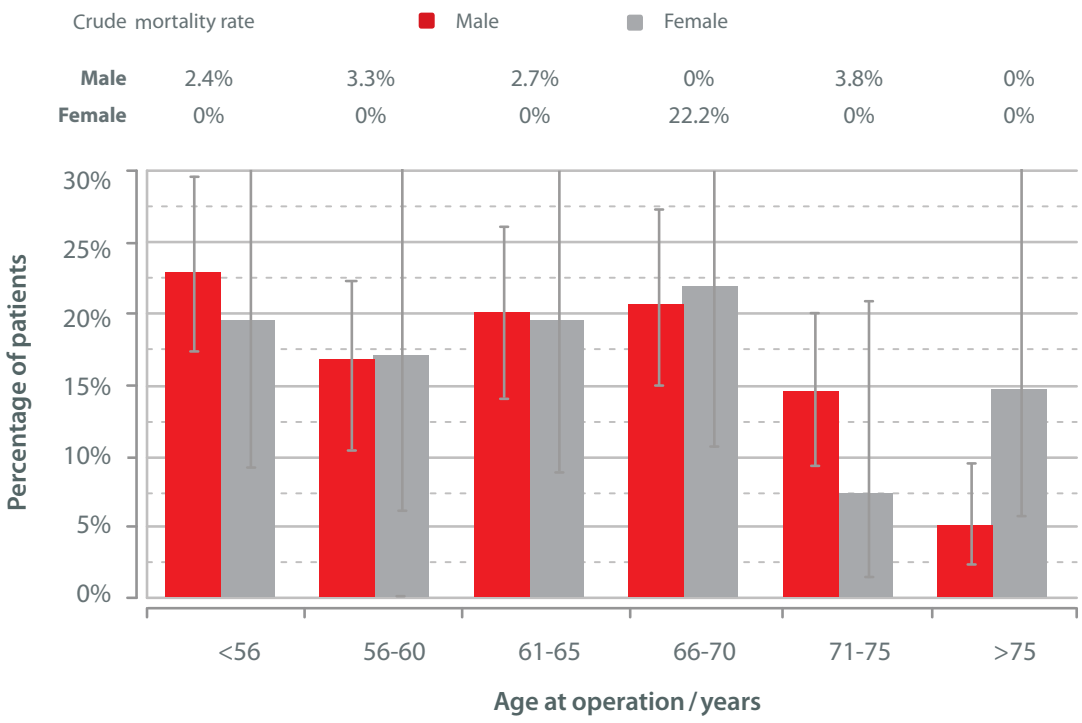


Pre-operative risk factors

Age and gender

- Higher proportion of male patients, 81.3% (179) underwent CABG compared to female patients, 18.6% (41). There was no significant change in this ratio over the previous years. 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. It is understood that women present with acute coronary syndrome later in life compared to their male counterparts.

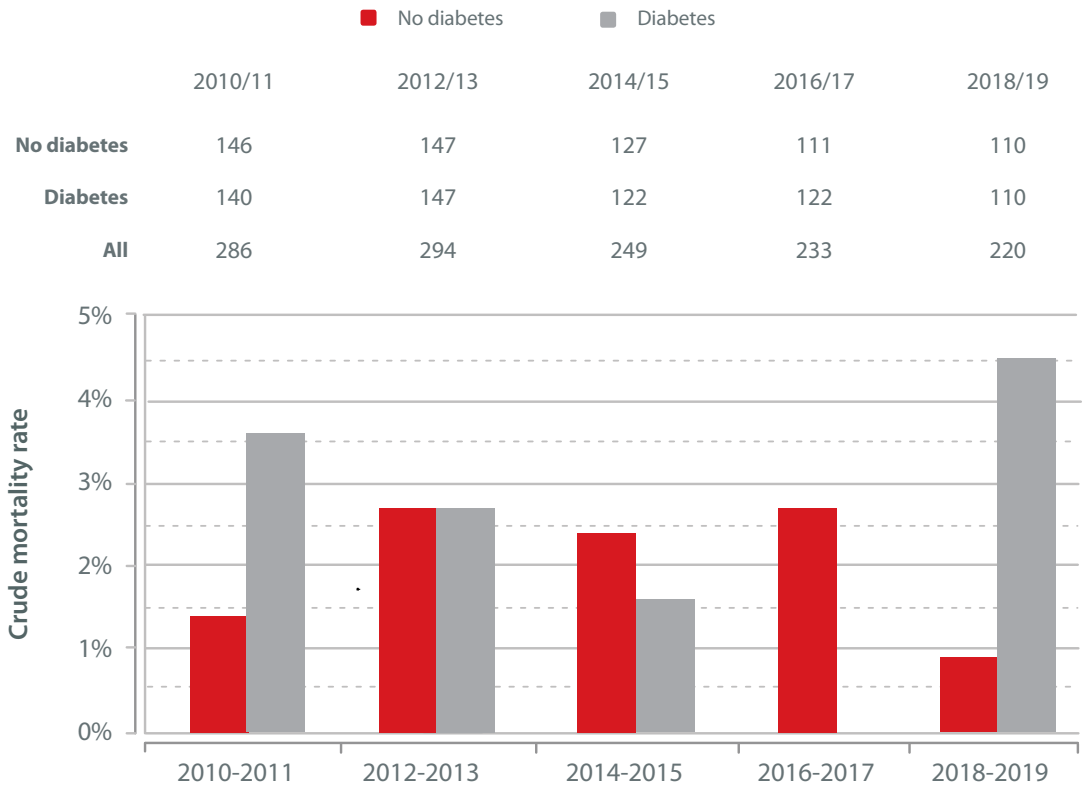
Isolated CABG: Age, gender and crude mortality (n=220)



Diabetes

- Individuals with diabetes who undergo CABG have a higher incidence of post-operative complications.
- The prevalence of diabetes among patients undergoing isolated CABG in our cohort has been approximately 50% .
- This percentage refers to diabetics who require some type of treatment.
- In 2018-2019 cohort, most (52.7%) took oral anti-diabetics, 33.6% were insulin-dependent diabetics, and 13.6% controlled their condition with diet.

Isolated CABG: Diabetes and crude mortality

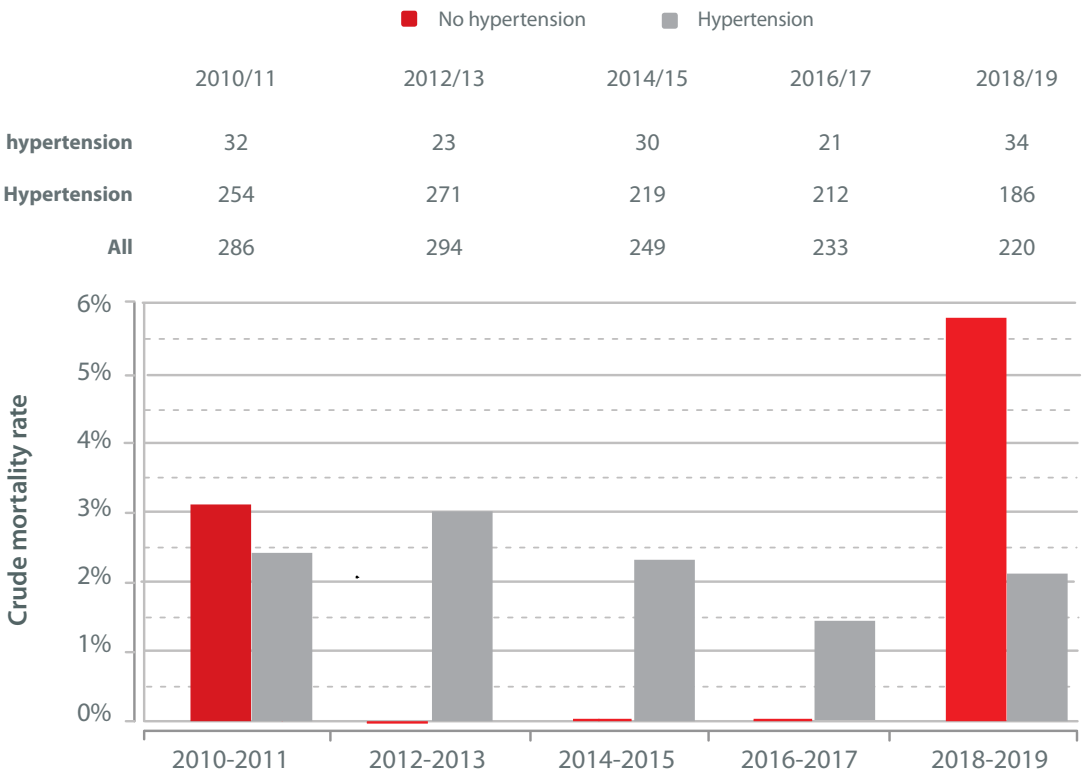


	2010/11	2012/13	2014/15	2016/17	2018/19
No diabetes	146	147	127	111	110
Diabetes	140	147	122	122	110
All	286	294	249	233	220

Hypertension

- Hypertension, defined as receiving antihypertensive medications at the time of surgery or BP greater than 140/90 on >1 occasion prior to admission.
- Pre-operative hypertension influences the overall risk of death and major adverse cardiac, cerebral and other vascular events after CABG.
- The prevalence of hypertension among patients undergoing isolated CABG in our cohort has been between 84-90% .
- The prevalence of hypertension among patients undergoing isolated CABG in 2018-2019 cohort was 84%.

Isolated CABG: Hypertension and crude mortality



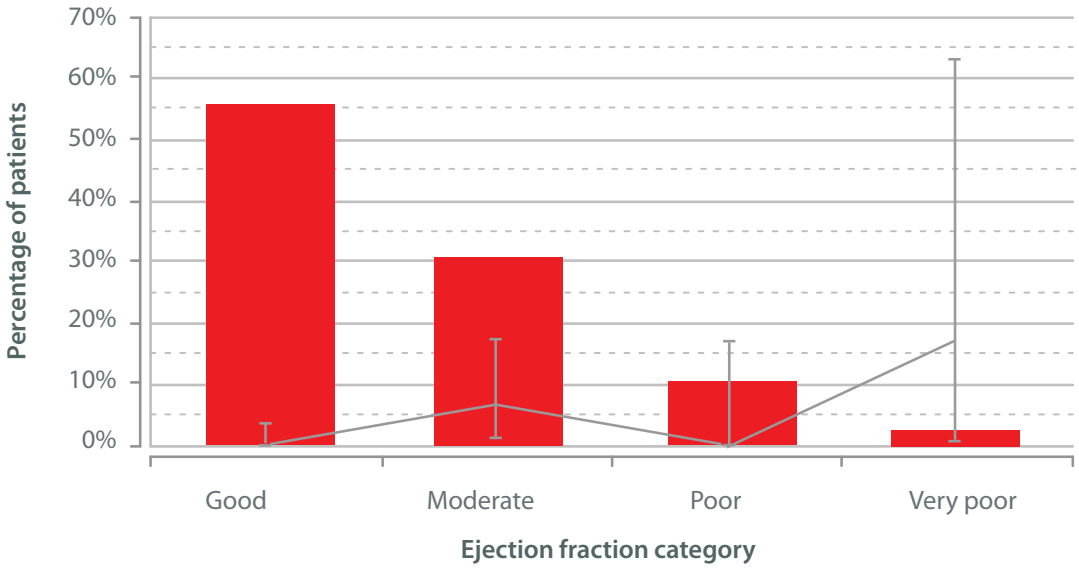
	2010/11	2012/13	2014/15	2016/17	2018/19
No hypertension	32	23	30	21	34
Hypertension	254	271	219	212	186
All	286	294	249	233	220

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 56% .
- There were 2.7% patients with very poor ejection fraction and only 10.5% with poor ejection fraction in this cohort.

Isolated CABG: Ejection fraction and crude mortality (n=220)

	Good	Moderate	Poor	Very poor
Patient counts	123	68	23	6
Deaths	0	5	0	1
Crude mortality rate	0	7.3%	0	16.6%

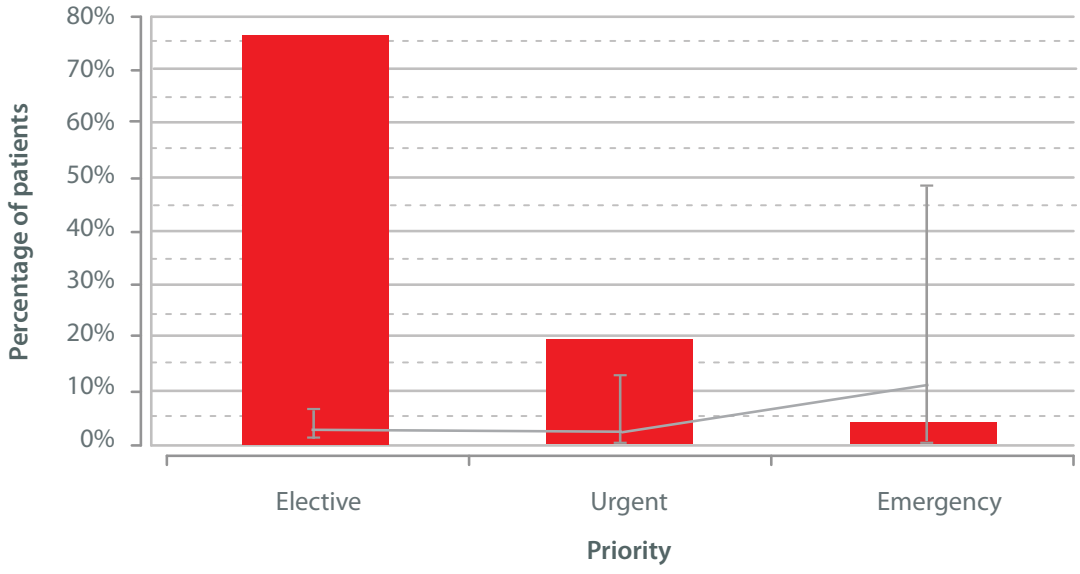


Priority distribution and mortality

- Most of the patients underwent CABG on an elective basis (76.3%). 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 20% and 4% of all coronary operations respectively and is lower than our previous report of 2016-2017, 34.8% and 5.2% respectively.
- We performed 20% 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 and urgent CABG a mortality of 2.3% was higher than the mortality of 0.58% and 1.26% respectively for elective CABG reported in UK in 2015.

Isolated CABG: Priority and crude mortality (n=220)

	Elective	Urgent	Emergency
Patient counts	168	43	9
Deaths	4	1	1
Crude mortality rate	2.3%	2.3%	11%



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 diabetes, hypertension and extra cardiac arteriopathy in isolated CABG was 50.0%, 83.6% and 6.8% respectively.
- The risk factors for coronary artery surgery in this cohort are previous cardiac surgery, diabetes, hypertension and presence of extra-cardiac arteriopathy.
- Among all the risk factors, the mortality rate for previous cardiac surgery is the highest, 50%.

Isolated CABG surgery: Post-operative mortality rates for various risk factors

			Mortality		
			Alive	Dead	Rate
Risk factors	Gender	Male	175	4	2.2%
		Female	39	2	4.9%
	Body mass index	≥25 kg m^{-2}	97	2	2.0%
		<25 kg m^{-2}	117	4	3.3%
	Left main stem disease	No	127	3	2.3%
		Yes	87	3	3.3%
	Previous cardiac surgery	No	213	5	2.3%
		Yes	1	1	50.0%
	Diabetes	No	109	1	0.9%
		Yes	105	5	4.5%
	Hypertension	No	32	2	5.8%
		Yes	182	4	2.1%
	Extra-cardiac arteriopathy	No	201	4	1.9%
		Yes	13	2	13.3%
	Previous CVA	No	213	6	2.7%
		Yes	1	0	0.0%
	Pre-op IABP insertion	No	212	6	2.7%
		Yes	2	0	0.0%
	Renal failure requiring dialysis	No	200	5	2.4%
		Yes	14	1	6.6%

The grafting process

Arterial grafting

Total number of grafts = 659 in 220 patients.

Average number of grafts= 2.99

Patients with LIMA graft= 209/ 220 (95%)

Patients with LIMA and Radial Artery graft = 30/ 220 (13.6%)

Arterial grafting

- There were 659 distal anastomoses made in 220 patients. On average, each patient received 2.99 grafts in isolated CABG. This has remained constant over last six 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 95.0% of 220 isolated CABG. 209 patients had the LIMA grafted to the Left Anterior Descending (LAD) artery in isolated CABG. *STS Adult Cardiac Surgery Database reported internal mammary artery (IMA) grafts use of 95% in 2010.
- 3 grafts or more were performed in 198 Isolated CABG surgeries which was higher than the UK data (90.0 % 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 (30/220).

*Squiers JJ, Mack MJ. Coronary artery bypass grafting-fifty years of quality initiatives since Favaloro. Annals of Cardiothoracic Surgery. 2018;7(4):516-520. doi:10.21037/acs.2018.05.13

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 91.8% for vein graft harvest.

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

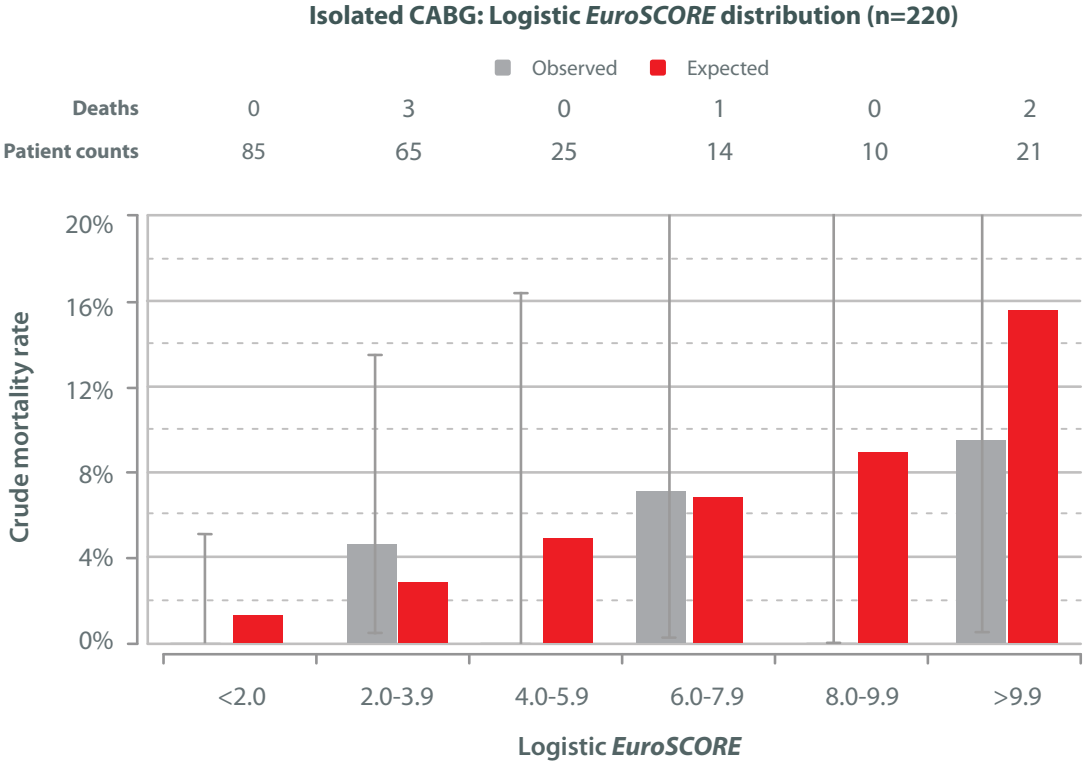
		Endoscopic harvest of the names conduit		
		No	Yes	Endoscopic harvest rate
Conduit	Radial artery used	0	30	100.0%
	Vein used	18	202	91.8%

Isolated CABG surgery: Radial artery graft usage at each of the coronary artery sites treated (n=31 grafts)

		Data	
		Count	Proportion
Coronary site	OM1	23	74.2%
	OM2	5	16.1%
	Diag 1	2	6.5%
	Distal LAD	1	3.2%
	All	**31**	

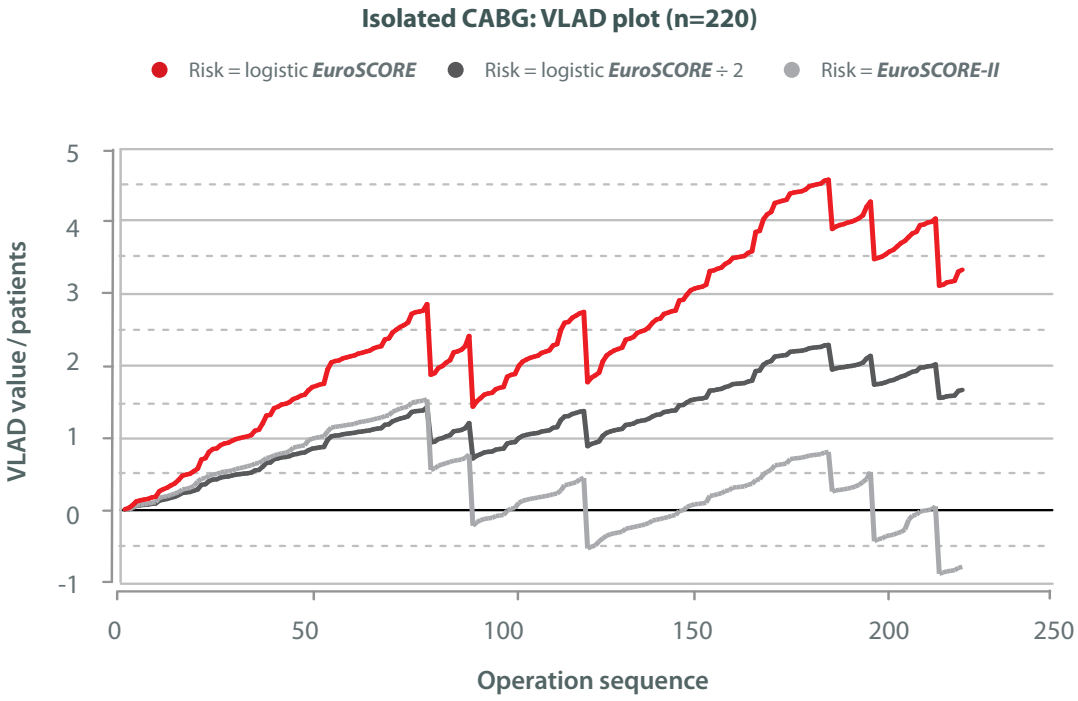
Logistic *EuroSCORE, EuroSCORE II* and mortality

- 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, a Logistic EuroSCORE higher than 9.9 contributes 9.5% of patients.
- The overall expected mortality in isolated CABG group of patients was 4.2% (9 patients). While the Observed mortality was 2.7% (6 patients). Thus, the observed *versus* expected mortality ratio was 0.64 for isolated CABG. In 2016-2017 we reported observed *versus* expected mortality ratio of 0.17.
- 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 2.4% (5 patients) and the O/E ratio was 1.1.



VLAD plot for isolated CABG

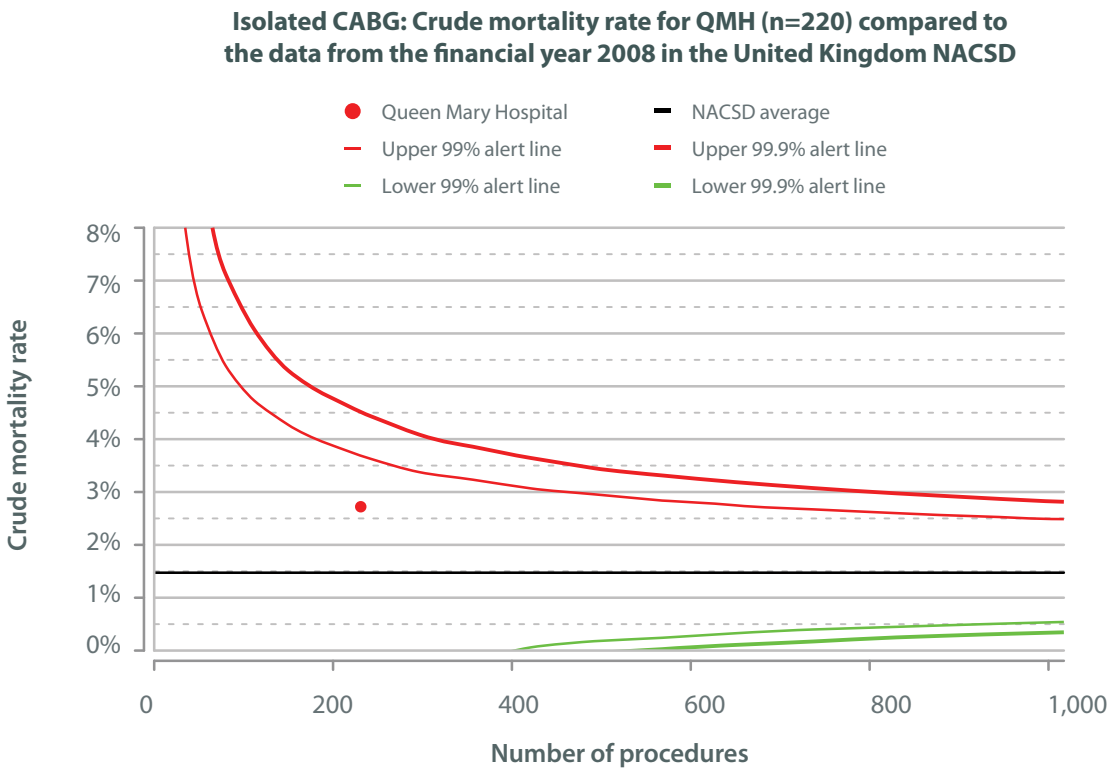
- The following Variable Life-Adjusted Display (VLAD) graph covers all risk-scored isolated CABG procedures performed during 2018 and 2019.
- The plot is risk adjusted and performance as predicted should run approximately around the horizontal zero line (the heavy black line).
- The plotted line goes 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 3 extra lives had been saved at Queen Mary Hospital.
- A Logistic EuroSCORE divided by 2 is also shown in the graph.



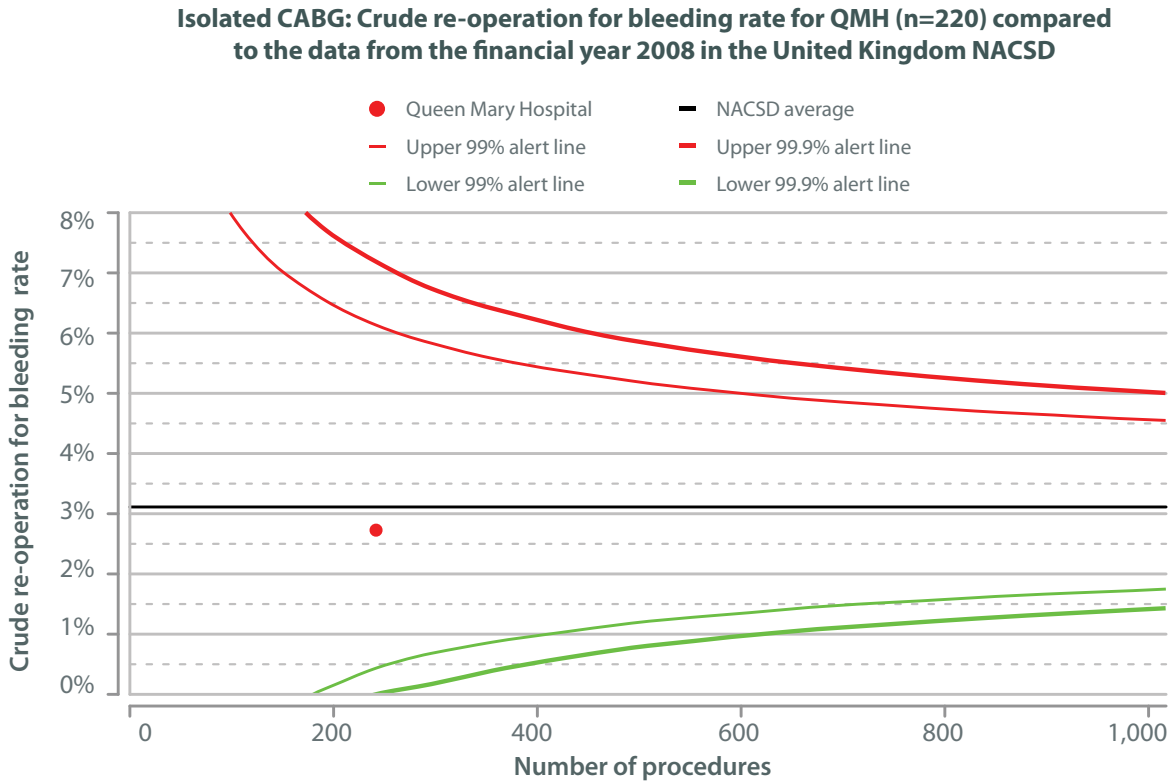
International benchmarking of results

- 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 crude mortality for isolated CABG at Queen Mary Hospital rate (2.7%) fell well within the alert lines.
- The re-operation for bleeding rate for isolated CABG at Queen Mary Hospital was 2.7% and this also fell well within the alert lines.
- The crude stroke rate and the proportion of patients that need haemofiltration / dialysis for acute renal failure; were 2.27% and 2.72% respectively. The stroke rate and the dialysis rate at Queen Mary Hospital fell well within the funnel plot alert lines.
- The dark horizontal line on the charts represents the average of the data from the financial year 2008 in the United Kingdom NACSD.
- 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.

Post-operative mortality

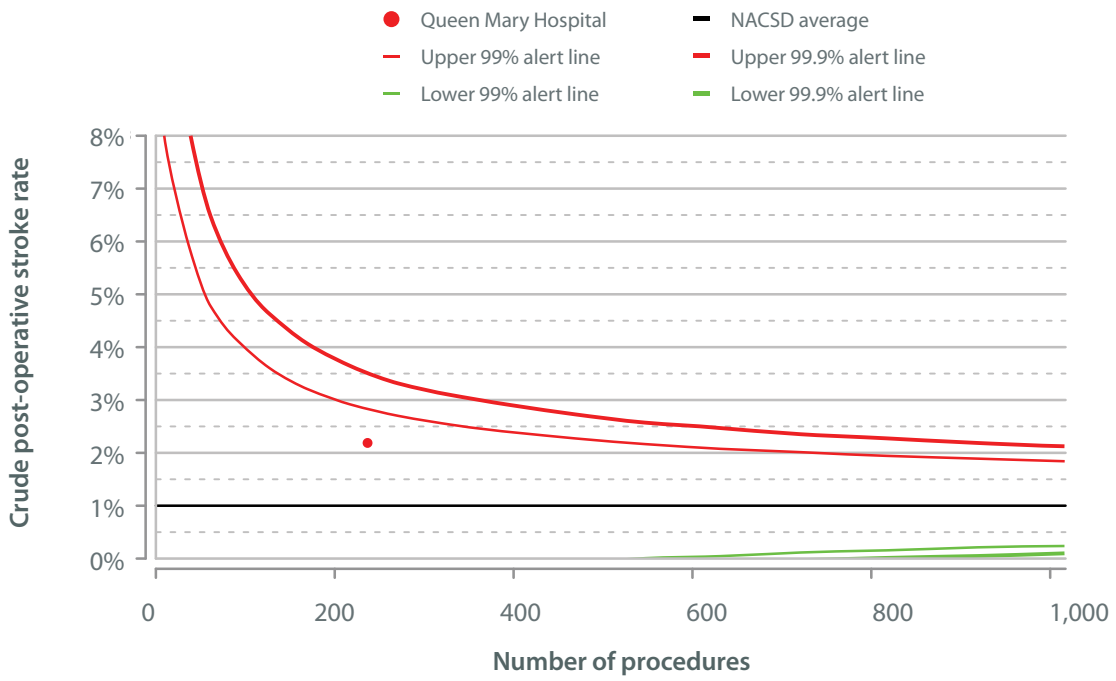


Re-operation for bleeding



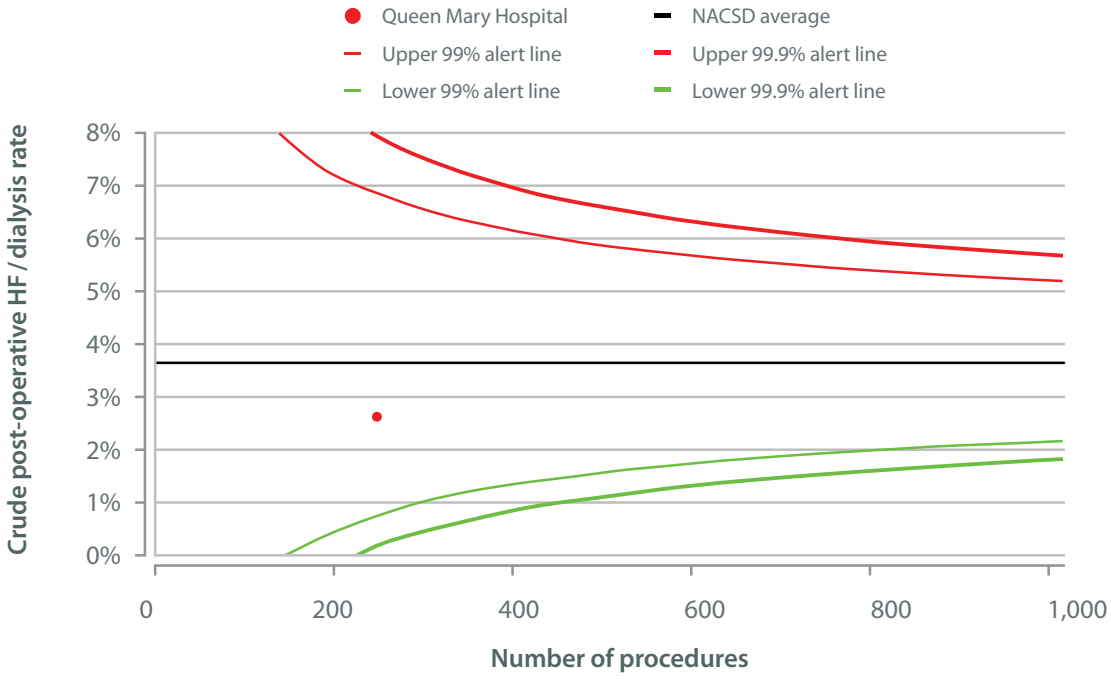
Post-operative stroke

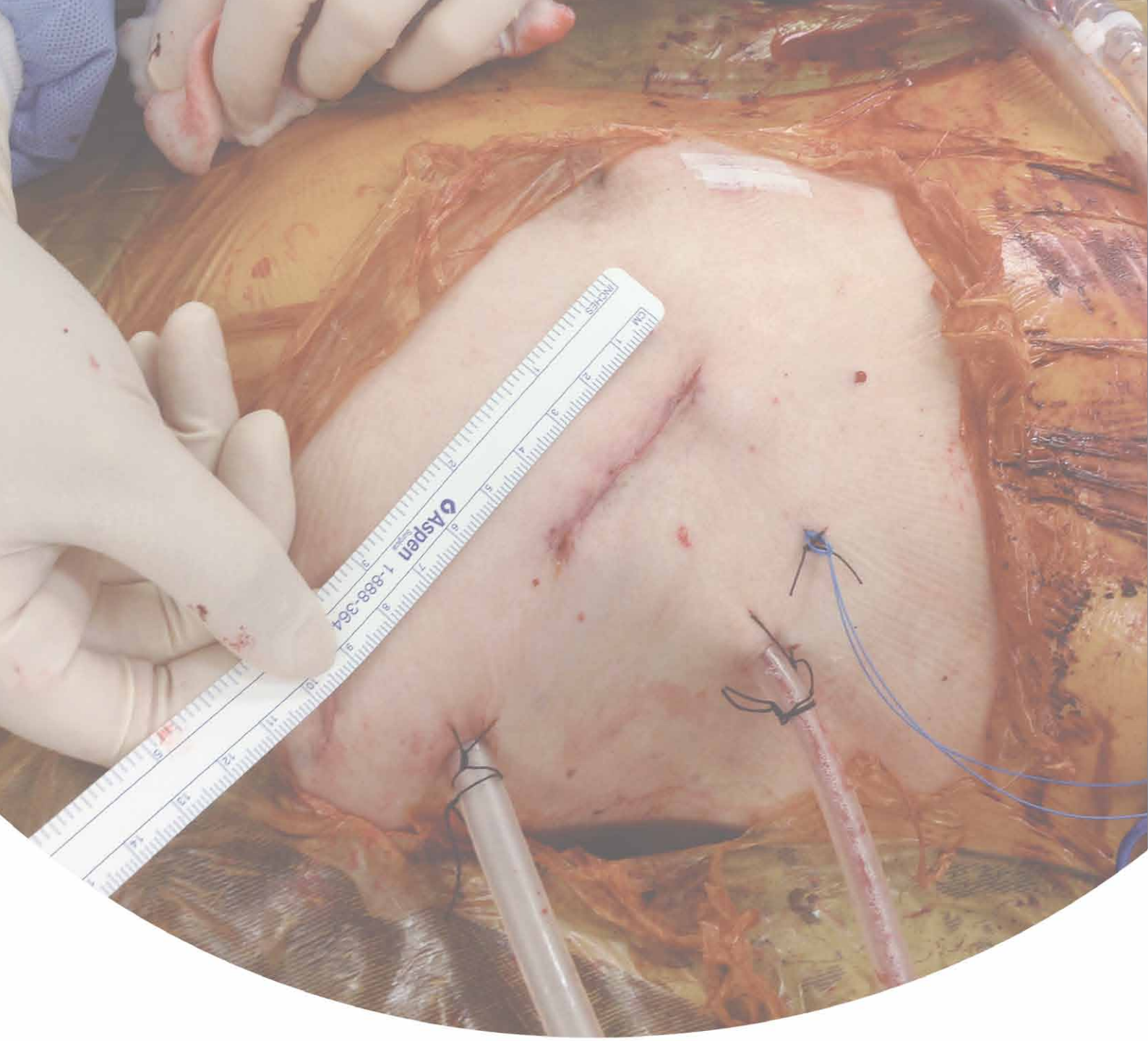
Isolated CABG: Crude post-operative stroke rate for QMH (n=220) compared to the data from the financial year 2008 in the United Kingdom NACSD

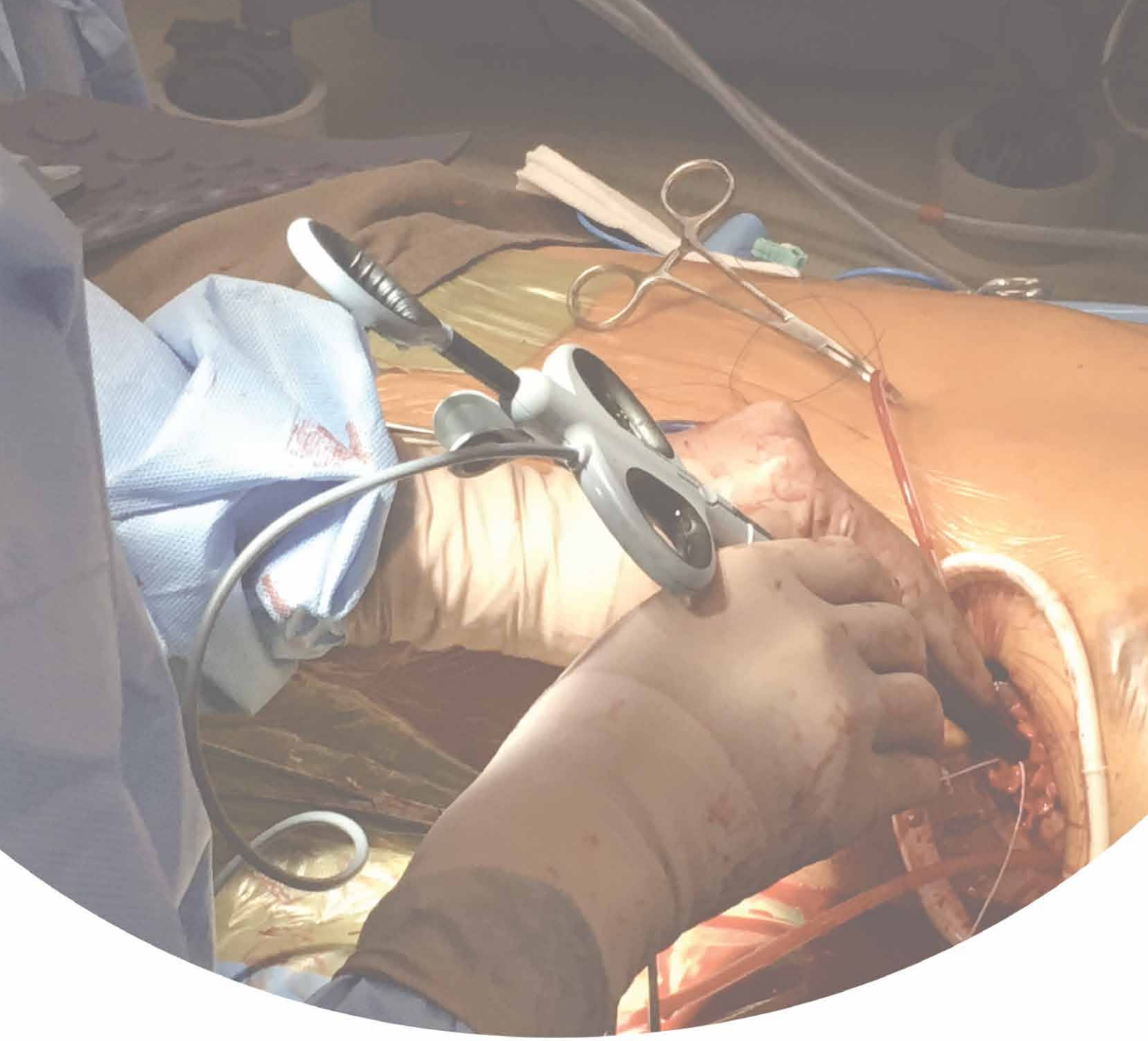


Post-operative HF / dialysis

Isolated CABG: Crude post-operative HF / dialysis rate for QMH (n=220) compared to the data from the financial year 2008 in the UK NACSD




Aspen
1-888-364



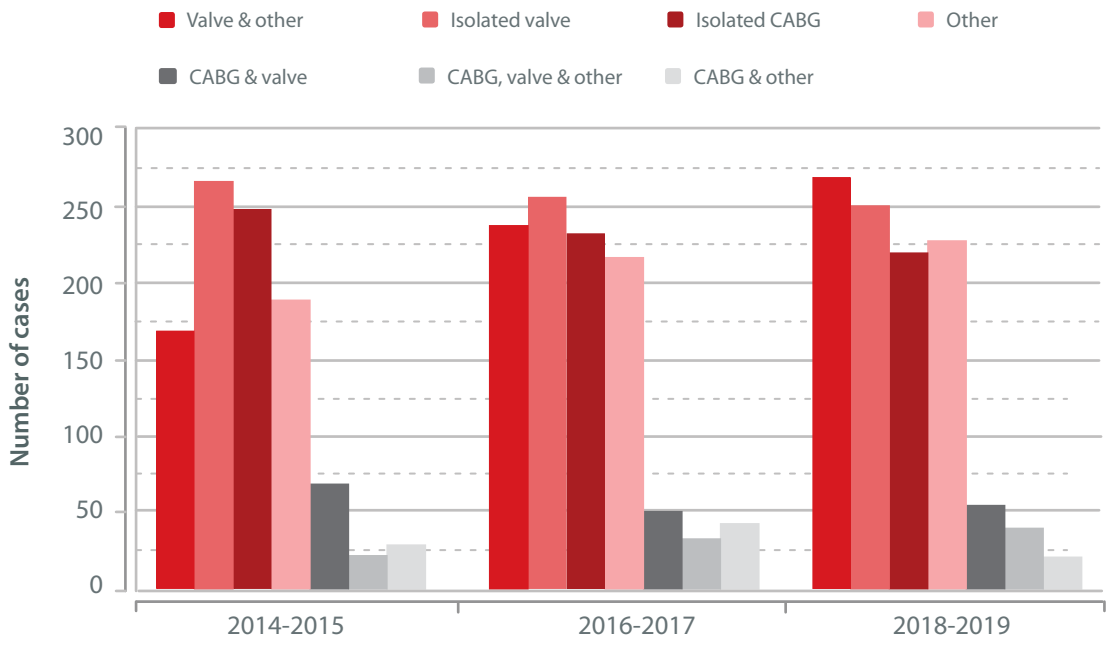
Valve surgery

Valve surgery

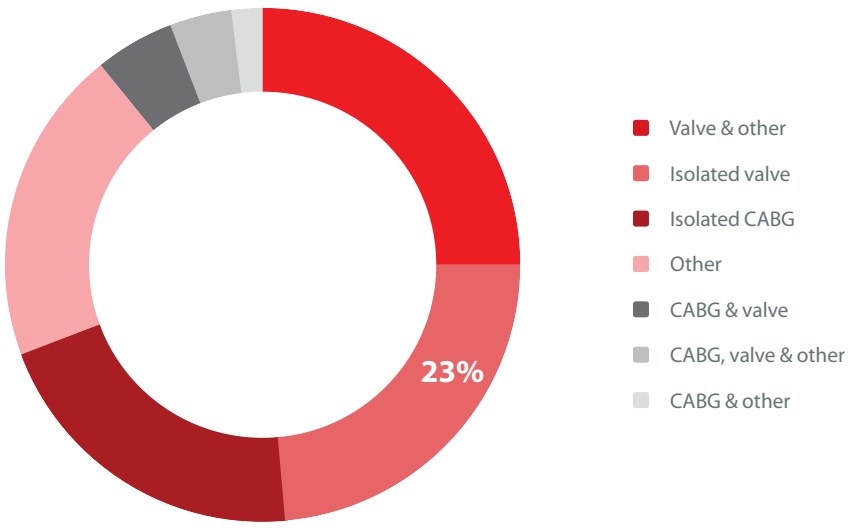
Isolated valve surgery in the context of overall workload

- During the year 2018 & 2019, there were 251 isolated valve operations performed at Queen Mary Hospital, contributing to 23% 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 363 (34%) valvular operations performed in combination with the other procedures like CABG, radiofrequency atrial ablation, aortic surgery, septal defect repair, *etc.* There has been a consistent increase in this group over the last ten years (20.8% in 2010-2011).

Cardiac surgery activity in QMH : 2014-2019



Workload overview, 2018-2019 (n=1082)



Priority

- There were 166 isolated single valve operations performed during 2018-2019.
- 141 out of 166 (85%) isolated single valve operations were performed electively.
- The remaining 15% were urgent, emergency or salvage operations. This was an increase compared to our preceding report (8% in 2016-2017).

Isolated single valve surgery: operative urgency

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Priority	Elective	59	53	29
	Urgent	12	6	0
	Emergency	1	4	0
	Salvage	1	1	0
	All	**73**	**64**	**29**

Previous cardiac surgery

- Redo operations contributed a significant workload in the isolated valve operation group.
- The majority of isolated single valve procedures (71%) at QMH were first-time operations.
- Among all isolated single valve operations, 48 (29%) 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	60	56	2
	Previous cardiac surgery	13	8	27
	All	**73**	**64**	**29**

Haemodynamic pathology

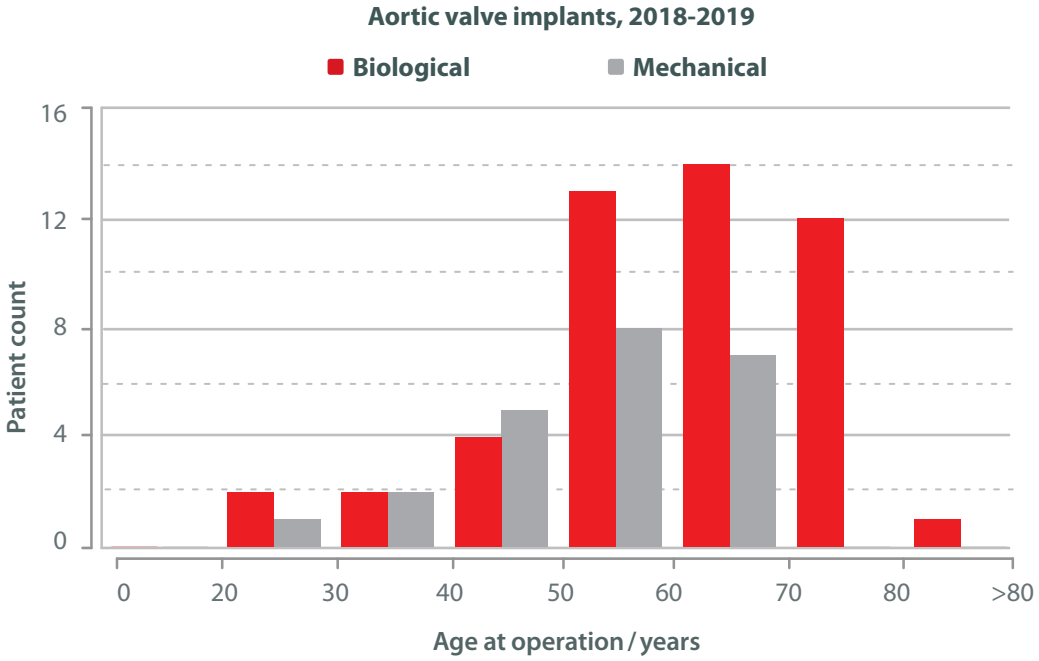
- Less than half of the isolated aortic valve operations, 34/73 (47%), were for patients with aortic stenosis.
- Among all patients who had isolated mitral valve surgery, 58/64 (91%) had mitral regurgitation.

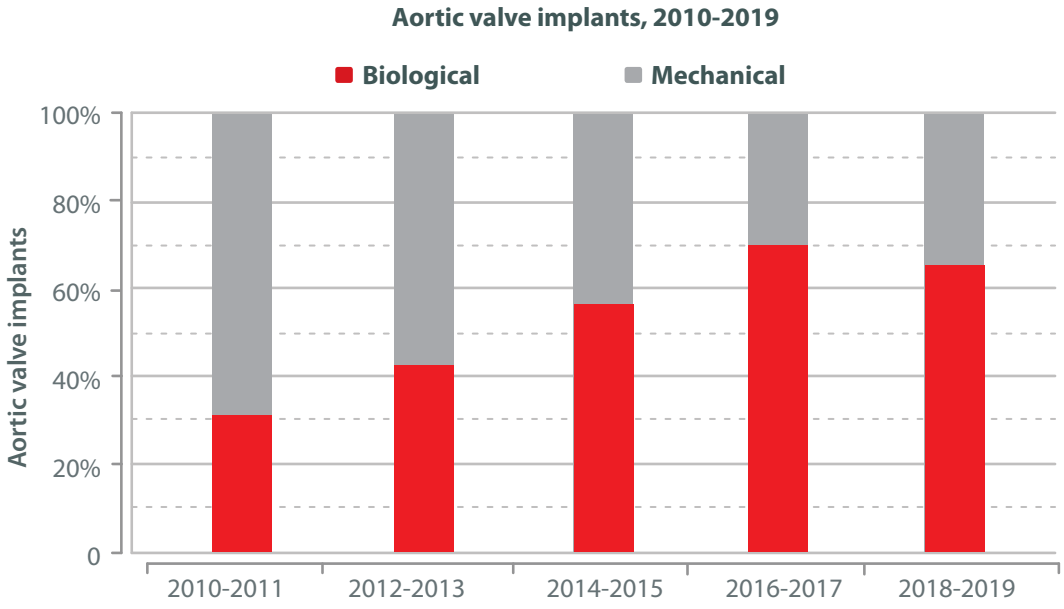
Isolated single valve surgery: haemodynamic pathology

		Valve treated		
		Aortic alone	Mitral alone	Other singles
Haemodynamic pathology	Stenosis	34	3	0
	Regurgitation	29	58	28
	Mixed	10	3	1
	All	**73**	**64**	**29**

Aortic valve surgery

- Most of the biological prostheses were implanted in patients above 65 years of age.
- A majority of the prostheses for all AVR were biological, 48 (66%) and 23 (32%) received mechanical prostheses. The remaining 2% underwent aortic valve repair. *Bioprosthesis made up 63.6% of aortic valve implants in USA between 2007 and 2011.
- 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.





*Harky A, Suen MMY, Wong CHM, Maaliki AR, Bashir M. Bioprosthetic Aortic Valve Replacement in <50 Years Old Patients - Where is the Evidence?. Brazilian Journal of Cardiovascular Surgery. 2020;34(6):729-738. Published 2020 Jan 1. doi:10.21470/1678-9741-2018-0374

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, 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	28	28	2
	Calcific degeneration	18	5	0
	Congenital	14	0	21
	Active infective endocarditis	8	7	0
	Rheumatic	5	7	2
	Other native valve pathology	4	5	2
	Previous infective endocarditis	4	8	0
	Annuloaortic ectasia	3	0	0
	Native valve not present	1	2	0
	Functional regurgitation	0	0	3
	Ischaemic	0	3	0

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 (47/67).
- Mitral valve replacement was most performed for mitral stenosis which was mainly of rheumatic aetiology (26/30). Replacement was also performed for mitral regurgitation due to degenerative pathology (11/24). Prosthesis failure, infective endocarditis, thrombus formation were the other important causes.
- 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	30	24	16
	Repair	0	66	1
	All	**30**	**90**	**17**

Type of mitral valve repair (*excluding NeoChord repair)

- Most of the isolated mitral valve repair operations were complex repairs, involving two or more repair procedures.
- Most (95.5%) 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)	64	95.5%
	Artificial chord	26	38.8%
	Leaflet resection	22	32.8%
	Other	6	8.9%
	Annuloplasty (suture)	5	7.4%
	Leaflet patch	4	5.9%
	Commisurotomy	3	4.4%

* Details of off pump beating heart mitral repair with NeoChord can be found in the section "The surgery on the Aorta and Other cardiac procedures".

Tricuspid valve surgery

Tricuspid valve repair in the context of all tricuspid valve surgeries

- 74/251, (30%) of all isolated valve(s) surgeries involved tricuspid valve procedures. This remains same as the preceding report.
- Isolated single valve tricuspid surgery was rare, only 10 patients during the year 2018-2019 had the isolated single valve tricuspid operation.
- Isolated single valve tricuspid repairs were mainly for regurgitation. Rheumatic disease, functional regurgitation and congenital disease were the pathology in isolated tricuspid valve surgery.

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**

isolated tricuspid valve surgery: details

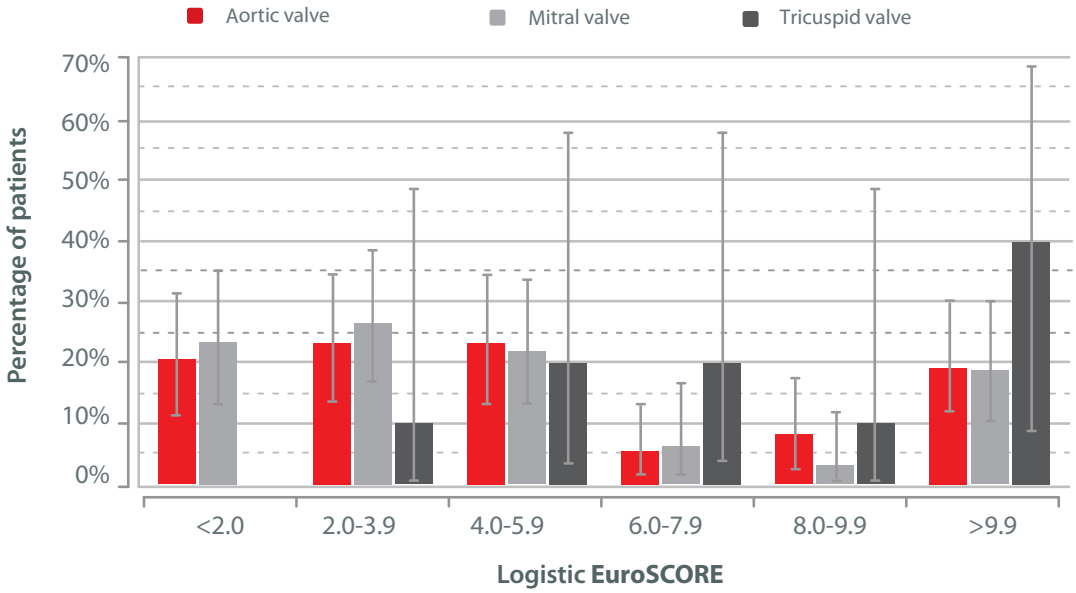
		Data	
		Count	Percentage
Haemodynamic pathology	Regurgitation	9	90.0%
	Stenosis (prosthesis failure)	0	-
	Mixed	1	10.0%
	All	10	
Previous cardiac surgery	No previous cardiac surgery	3	30.0%
	1 previous cardiac surgery	7	70.0%
	All	10	
Valve pathology	Rheumatic	3	30.0%
	Other	2	20.0%
	Congenital	2	20.0%
	Functional Regurgitation	2	20.0%
	Degenerative	1	10.0%
	All	10	

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 7.49% and 2.89% respectively.
- The expected mortality risk for isolated mitral valve surgery alone as predicted by Logistic EuroSCORE and EuroSCORE II was 8.89 % and 3.52% respectively.
- The expected mortality risk for isolated tricuspid valve surgery alone as predicted by Logistic EuroSCORE and EuroSCORE II was 10.31% and 5.65% respectively.

Isolated single valve surgery: Logistic EuroSCORE distribution (n=147)



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	73	3	0.041	0.074	0.55
	Mitral alone	64	2	0.031	0.089	0.34
	Tricuspid alone	10	0	0.000	1.031	0.00

Isolated single valve surgery: EuroSCORE II and mortality

		Count		Mortality		
		All	Deaths	Observed (O)	Expected(E)	O/E Ratio
Valve treated	Aortic alone	73	3	0.041	0.028	1.46
	Mitral alone	64	2	0.031	0.035	0.88
	Tricuspid alone	10	0	0.000	0.056	0.00

Isolated multiple valve surgery: Logistic EuroSCORE and mortality

		Count		Mortality		
		All	Deaths	Observed (O)	Expected(E)	O/E Ratio
Valve treated	Mitral & tricuspid	38	2	0.052	0.127	0.40
	Aortic & mitral	20	0	0.000	0.124	0.00
	Aortic, mitral and tricuspid	15	2	0.133	0.161	0.82

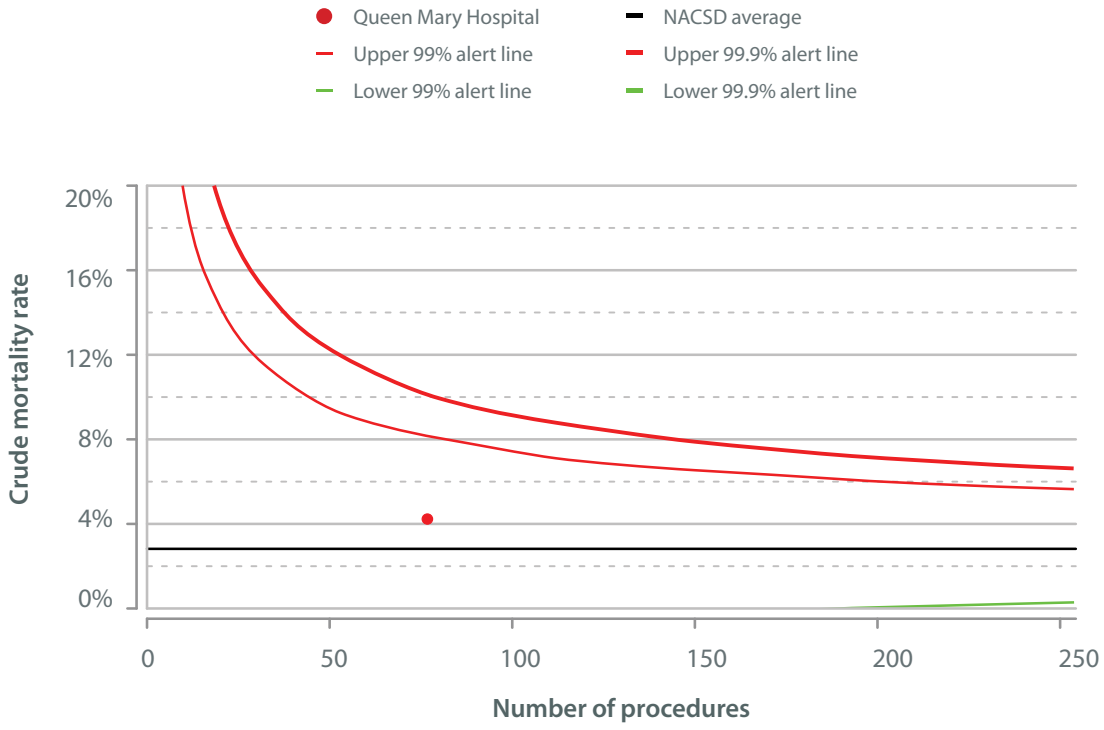
Isolated multiple valve surgery: EuroSCORE II and mortality

		Count		Mortality		
		All	Deaths	Observed (O)	Expected(E)	O/E Ratio
Valve treated	Mitral & tricuspid	38	2	0.052	0.044	1.18
	Aortic & mitral	20	0	0.000	0.052	0.00
	Aortic, mitral and tricuspid	15	2	0.133	0.070	1.90

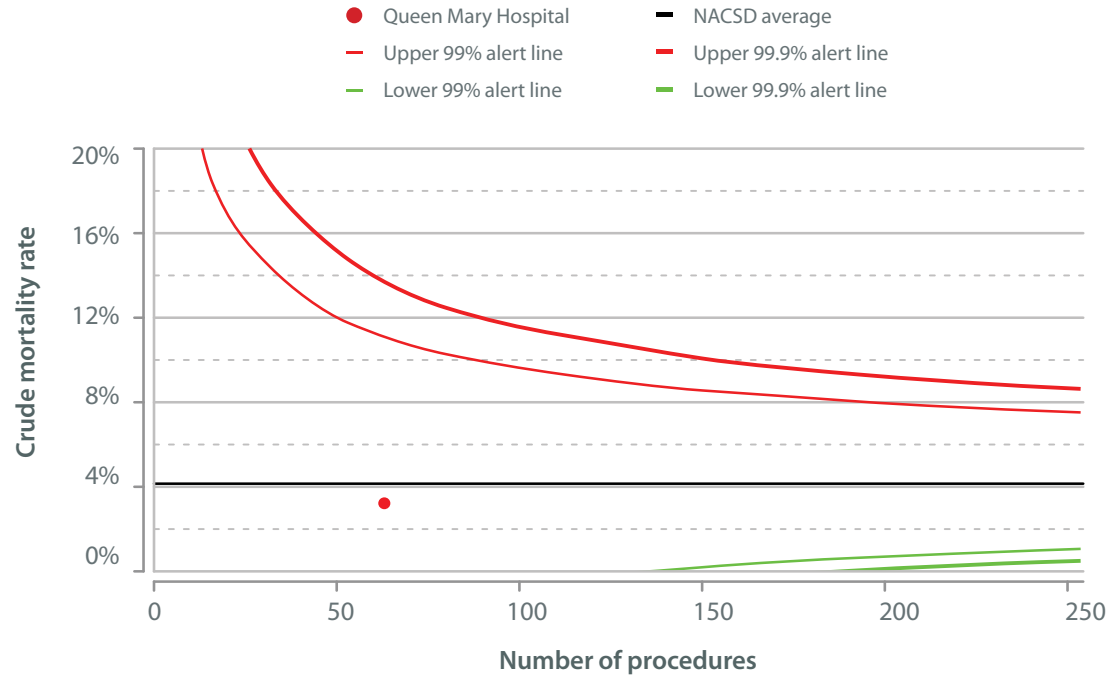
International benchmarking of mortality

- 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=73) 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=64) 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 2018-2019, about 11.5% (125/1082) of cardiac surgical procedures were performed using a minimally invasive approach, which is slightly less than in the preceding report since more of other minimally invasive mitral and aortic surgeries have been done, which are not included in this report.
- The most common minimally invasive approach was mini thoracotomy. This utilizes a four to six 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 11.8% in 2016-2017 to 22.4%.

MICS approach

		Data	
		Count	Proportion
Type of MICS approach	Mini-thoracotomy	71	56.80%
	Robot-assisted surgery	28	22.40%
	Hemi-sternotomy	26	20.80%
	Total	**125**	**100.0%**

Procedures performed using MICS

- A wide range of MICS procedures for heart conditions were performed.
- In 2018-2019, 26.2% (66/251) of isolated valve procedures were performed using a MICS technique. The proportion of valve with concomitant surgery and surgery other than valve have increased compared to the preceding report (26.1% & 9.9% respectively in 2016-2017).

Procedures performed using MICS

		Data	
		Count	Proportion
Procedure grouping	Valve alone	66	52.8%
	Valve and concomitant surgery	44	35.2%
	Surgery other than valve	15	12.0%
	Total	**125**	**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	34	70.8%
	ASD closure	4	8.3%
	PFO closure	3	6.3%
	LAA closure	3	6.3%
	LVOT myotomy and myectomy	2	4.2%
	LAA closure and RAA excision	1	2.1%
	Mediastinal lymph nose biopsy	1	2.1%
	Total	**48**	**100.0%**

Procedures other than valve surgery using MICS

		Data	
		Count	Proportion
Other procedures	ASD closure	11	68.8%
	Atrial myxoma	2	12.5%
	VSD closure	2	12.5%
	PFO closure	1	6.3%
	Total	**16**	**100.0%**

Surgical outcome: MICS

- The in-hospital mortality seen in this group of patients was 0.8% (1 patient). The major complications in this group were, 6 patients (4.8%) had re-operation due to bleeding and 1 patient required renal replacement therapy (0.8%).

Surgical outcomes: MICS versus open surgery

		Data
		MICS
Surgical outcome	Observed mortality	0.80%
	Predicted mortality: Logistic EuroSCORE, O/E ratio	3.40%, 0.23
	Predicted mortality: EuroSCORE II, O/E ratio	1.34%, 0.59
	Complications	
	Reoperation for bleeding rate	4.80%
	Post-operative dialysis rate	0.80%

Surgery on the aorta and Other cardiac procedures

Surgery on the aorta and other cardiac procedures

Surgery on the aorta

- Surgery on the thoracic aorta comprises 16.6% of our overall workload.
- The number of aortic surgeries remained steady, maintaining the increase of 2016-2017. We are performing increasing number of endovascular stenting with hybrid approaches since the last two years.
- Between 2018-2019 there were 98 (54.4%) patients who had aortic surgery at more than one segment compared to 85 (46.1%) in 2016-2017 .
- Isolated ascending aorta was the most common site for aortic surgery (32.7%).
- Replacement of the ascending aorta that includes any part of the aortic arch accounted for 25% of the workoad.
- The frozen elephant trunk technique has increasingly been used to treat the complex aortic pathology involving aortic arch and the proximal descending aorta. Frozen elephant trunk prosthesis was used in 32 patients and 17 of these were undertaken as emergency procedures.

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	1	12	2	0	**15**
		Ascending	2	29	6	22	**59**
		Arch	0	1	0	4	**5**
		Descending	0	1	0	2	**3**
	2	Root & ascending	0	42	8	6	**56**
		Ascending & arch	0	0	0	6	**6**
		Descending & abdominal	0	0	0	1	**1**
	3	Root, ascending & arch	0	0	1	1	**2**
		Ascending, arch & descending	1	5	0	17	**23**
		Root, ascending & descending	0	1	0	0	**1**
	4	Root, ascending, arch & descending	0	5	2	2	**9**
		All	**4**	**96**	**19**	**61**	**180**

Pathology and Surgical technique

- The most common pathology that affected the aorta was aneurysm . Aneurysms may affect any part of the aorta.
- The most common aortic root procedure performed was Bentall 52/83 (root replacement with composite graft and coronary re-implantation), 16/83 underwent root replacement with preservation of valve.

Surgery on the aorta: pathophysiology

		Count
Pathophysiology	Aneurysm	81
	Aneurysm with dissection	75
	Others	24
	Patient count	**180**

Surgery on the aorta: root

	Count
Bentall	52
Valve-sparing	16
Aortic root enlargement	
Nick's (Post.) procedure	9
Konno (Ant.) procedure	2
Sinus of Valsalva aneurysm repair	2
Aortic root abscess patch repair	2
Patient count	**83**

- Ascending aorta and Axillary/subclavian cannulation for arterial inflow were the most commonly used cannulation strategies in QMH (152/180).
- Femoral cannulation is particularly useful in emergency situations with haemodynamically unstable patients (21/180).
- Circulatory arrest with antegrade cerebral perfusion with was used in 86/87 patients.

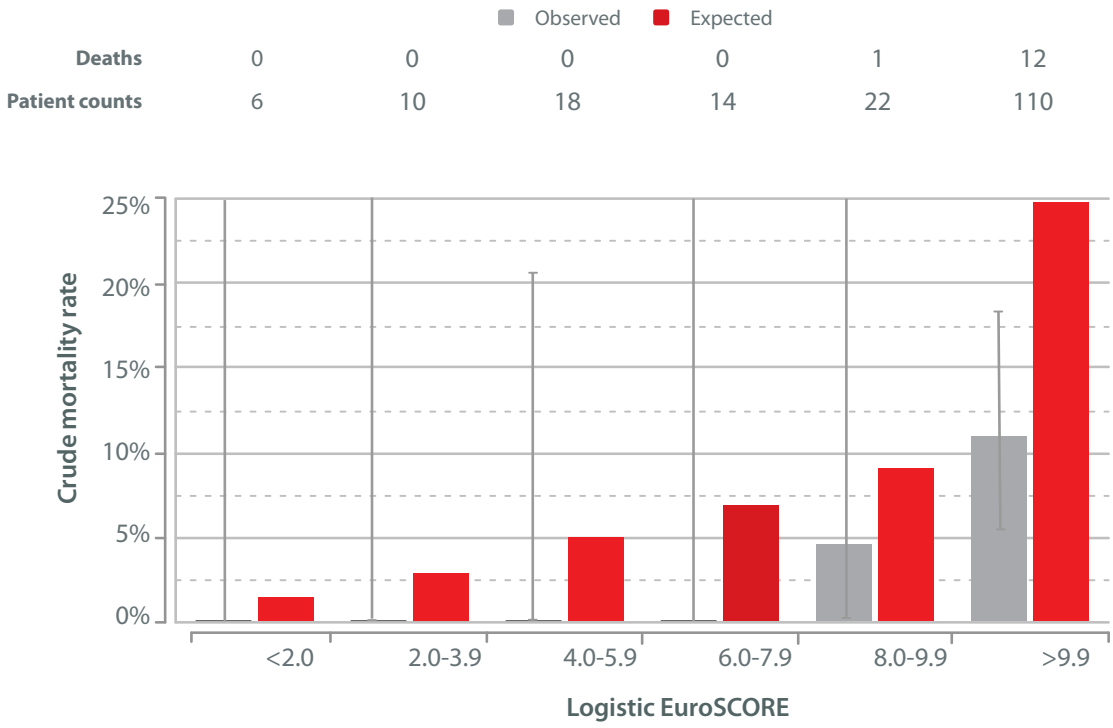
Surgery on the aorta: cannulation

		Count
Arterial cannulation	Ascending aorta	88
	Axillary/subclavian	64
	Femoral	21
	Arch	6
	Other	1
	Patient count	**180**

Mortality and morbidity

- Overall observed mortality was 7.2% . Logistic EuroSCORE predicted a mortality of 17.4%. The O/E ratio was 0.41.
- EuroSCORE II predicted an overall mortality of 9.5%.
- Highest mortality was observed in the high-risk Logistic EuroSCORE group (>9.9). 37% of surgeries in this group were emergency, 10% were urgent and 7% were salvage procedures.
- QMH observed mortality rate (10.9%) in this high-risk group was less than the expected mortality rate (24.7%).
- EuroSCORE II predicted a mortality of 13.4% for this high-risk group.
- Reoperation for bleeding/tamponade was required in 11.1% (20/180).
- New post operative transient/permanent stroke was seen in 9.4% (17/180).
- Post operative renal replacement therapy was required in 7.7% (14/180).

Surgery on the aorta: Logistic EuroSCORE and mortality (n=180)



Other cardiac procedures

Other procedures

- 'Other procedures for congenital condition' performed included mainly Pulmonary valve replacement with pulmonary arterioplasty and reconstruction, Fontan conversion and VSD repair .
- VADs are used in patients with heart failure. There has been an increase in the number of implantable VAD's in 2018-2019.
- External VAD were used until myocardial recovery or as a bridge to candidacy for transplant.
- ECMO was used for cardiac, pulmonary and eCPR support (including use in trauma) as opposed to our previous reports where only post cardiotomy ECMO were reported. (Paediatric ECMO is reported in a separate section)
- The number of lung transplants decreased from 22 to 14 and the number of cardiac transplants remained static.
- The number of atrial ablations performed increased compared to the previous report, (105 in 2016-2017).

Procedure detail

		Procedure grouping								
		CABG alone	Valve alone	CABG & valve	CABG & other	Valve & other	CABG, valve & other	Other	All	All (2016-2017)
Other cardiac procedures	None	220	251	54	2	77	15	59	**678**	**697**
	LV restoration surgery	0	0	0	0	1	2	0	**3**	**15**
	Acquired VSD	0	0	0	1	0	0	2	**3**	**3**
	Atrial myxoma	0	0	0	1	0	0	11	**12**	**6**
	Pulmonary embolectomy	0	0	0	0	1	0	8	**9**	**9**
	Cardiac transplant	0	0	0	1	0	0	22	**23**	**24**
	Pulmonary transplant	0	0	0	0	1	0	13	**14**	**22**
	Pericardiectomy	0	0	0	1	3	0	1	**5**	**4**
	ASD closure	0	0	0	0	18	1	17	**36**	**35**
	Other procedure for congenital condition	0	0	0	2	23	0	28	**53**	**37**
	Atrial Ablation	0	0	0	6	115	11	2	**134**	**105**
	Other procedure not listed above	0	0	0	3	50	9	20	**82**	**99**
	ECMO	0	0	0	3	5	1	30	**67**	**43**
	Ventricular assist device	0	0	0	0	9	0	39	**48**	**39**
	Patient count	220	251	54	20	270	39	212	**1082**	**1069**

TAVI (Transcatheter Aortic Valve Implantation) and J·Valve TAVI system

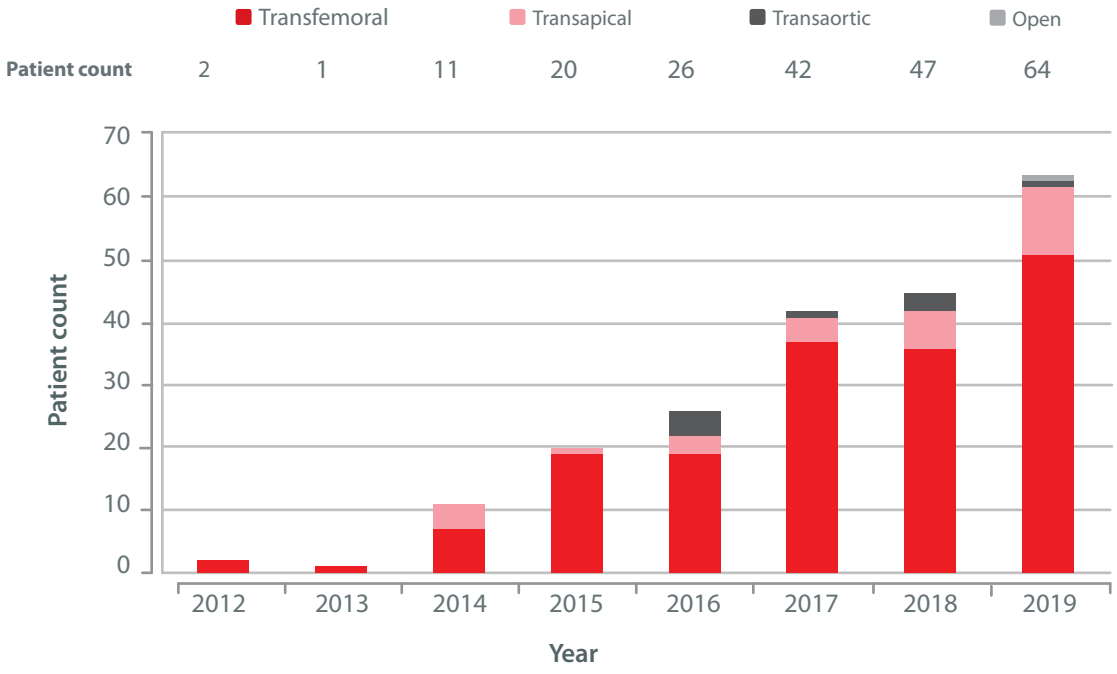
Overview

- TAVI program began at QMH in 2012 and continues to grow.
- Valve-in -valve procedures in mitral, pulmonic and tricuspid positions are also performed.
- Compared to our previous report of 2016-2017 (68) we have performed more TAVI cases in 2018-2019 (111).
- At QMH TAVI with the J-Valve device was introduced in 2019.
- J-Valve is designed for transapical implantation and is an effective treatment option for patients with pure/dominant aortic regrugitation.
- At QMH eight TAVI with the J-Valve device have been successfully performed.

Number of TAVI procedures, per access type and year

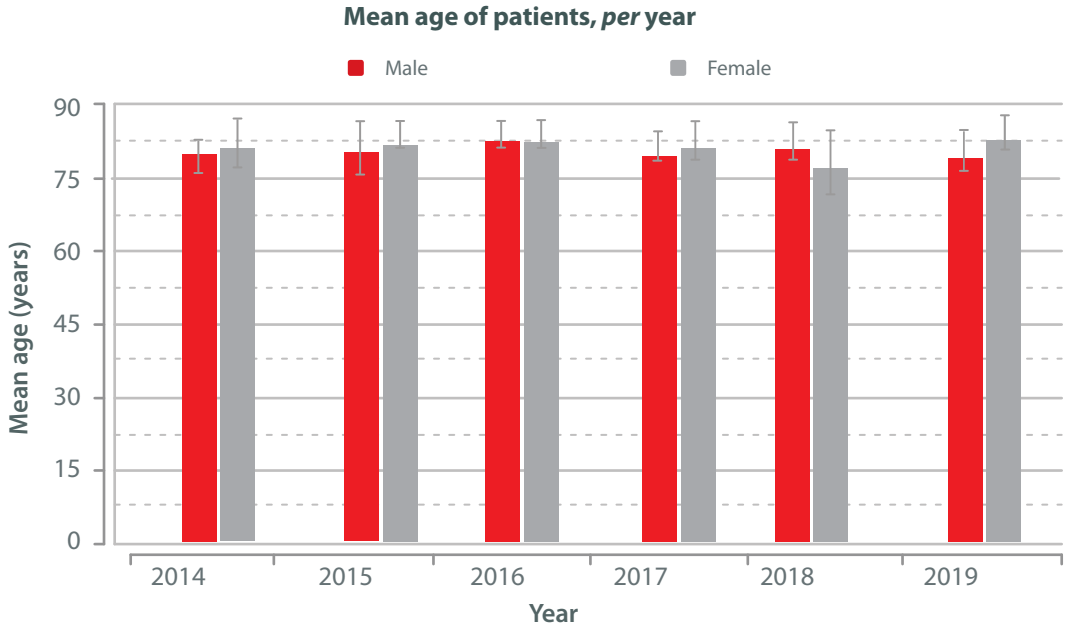
- The transfemoral access route is the predominant choice .
- Alternative (non-femoral) access routes include transapical, subclavian, and transaortic access.

Number of TAVI procedures, *per* access type and year (n=213)



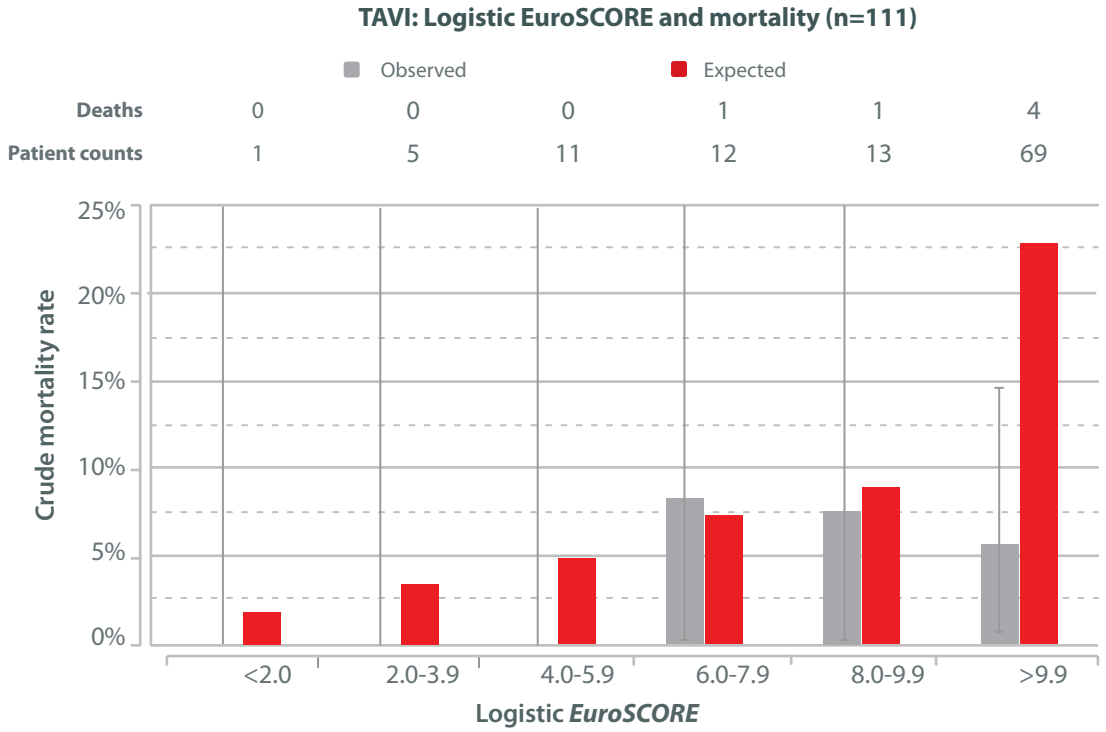
Mean age of patients, per year, 2018–2019

- The mean age of the patients is over 80 years, with no major change over six years.



Mortality and morbidity

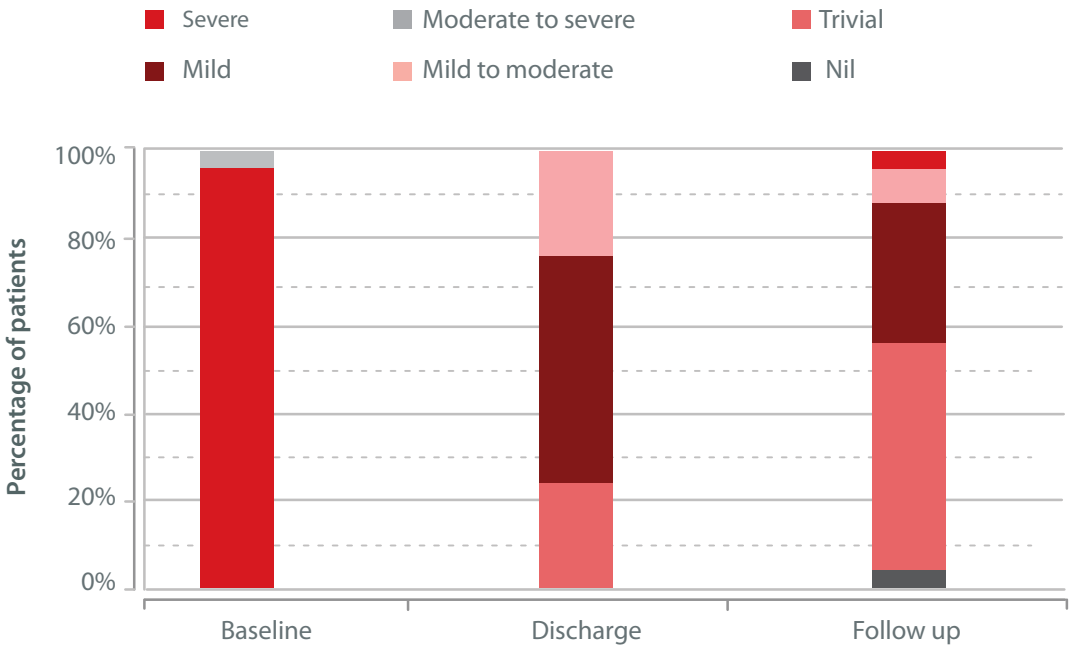
- Logistic EuroSCORE is high in a greater proportion of patients as TAVI is offered mostly to high-risk patients.
- Overall mean Logistic EuroSCORE for this group was 16.7% (1.83%-69.22%).
- The overall in-hospital mortality observed was 5.4%. The O/E ratio was 0.32.
- No strokes/myocardial infarction/renal replacement therapy was reported in this cohort. Permanent pacemaker was implanted in 5 patients (4.5%).



NeoChord Beating Heart Mitral Valve Repair

- The NeoChord procedure is an innovative approach used for beating heart mitral valve repair.
- It is a treatment option for patients with degenerative mitral valve regurgitation.
- It is a minimally invasive procedure and may be suited to patients who are deemed too high risk to withstand conventional surgery.
- QMH is the first center in Asia to successfully treat the patients with NeoChord procedure.
- It was introduced in QMH in 2018 and 25 patients have been treated with this procedure.
- Mean age of this group is 67.6 ±10 (Range, 49-89) years and the mean EuroSCORE II is 3.8 % (0.50%-49.4%).
- No mortality was seen in this group.

Mitral regurgitation grades at baseline, at discharge and at the latest follow-up (n=25)



Atrial ablation

Patients and procedure

- In 2018-2019, 134 atrial ablation procedures were performed to treat atrial fibrillation.
- In all cases, the surgery included treatment for atrial fibrillation and another cardiac procedure.
- In 85.8% 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 (67%).
- Sinus rhythm was restored in 67% of these patients at the latest follow up.

Atrial ablation age and concomitant procedures

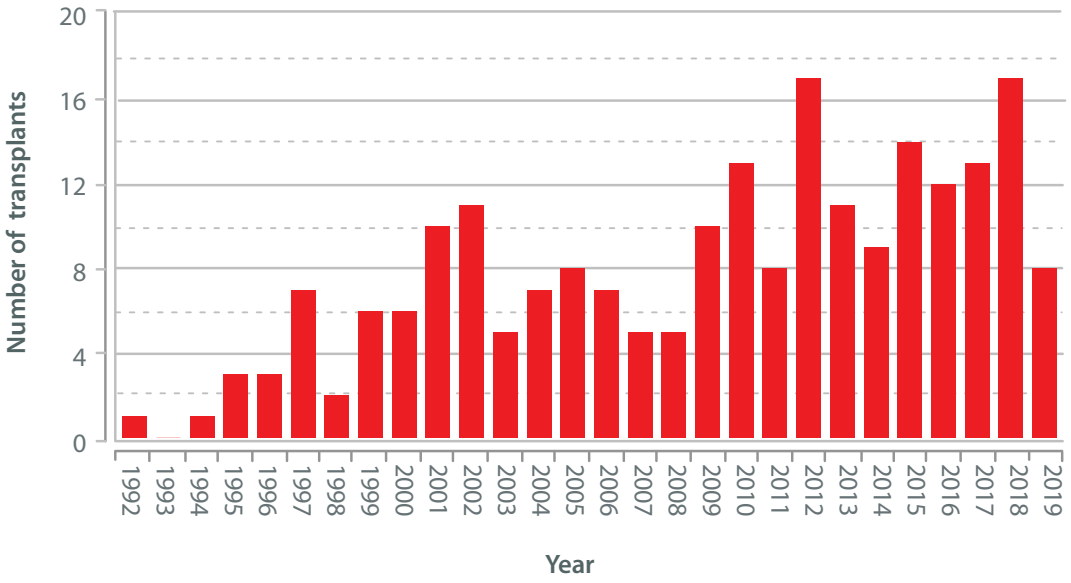
		Concomitant procedures					
		CABG & other	Valve & other	CABG, valve & other	Other	All	Percentage
Age at surgery / years	<56	1	41	0	2	44	32.8%
	56-60	1	14	2	0	17	12.7%
	61-65	0	26	3	0	29	21.6%
	66-70	2	20	3	0	25	18.7%
	71-75	2	12	3	0	17	12.7%
	>75	0	2	0	0	2	1.5%
	All	**6**	**115**	**11**	**2**	**134**	**100.0%**
	Percentage	**4.5%**	**85.8%**	**8.2%**	**1.5%**		

Thoracic Organ Transplant

Heart Transplant

- QMH is the sole provider of thoracic organ transplant services in Hong Kong.
- These services are provided to both adult and pediatric patients.
- Heart and lung transplant procedures are often performed as emergencies out of hours.
- Heart transplant is considered the gold standard therapy for end-stage heart failure refractory to medical treatment.
- A growing number of heart recipients have been implanted with ventricular assist devices as a bridge to transplant.
- Over the last decade, there has been a increase in the number of donors in Hong Kong. This is reflected in a corresponding rise in annual heart transplant activity.
- The Organ Care System for marginal donor hearts was introduced in 2019.

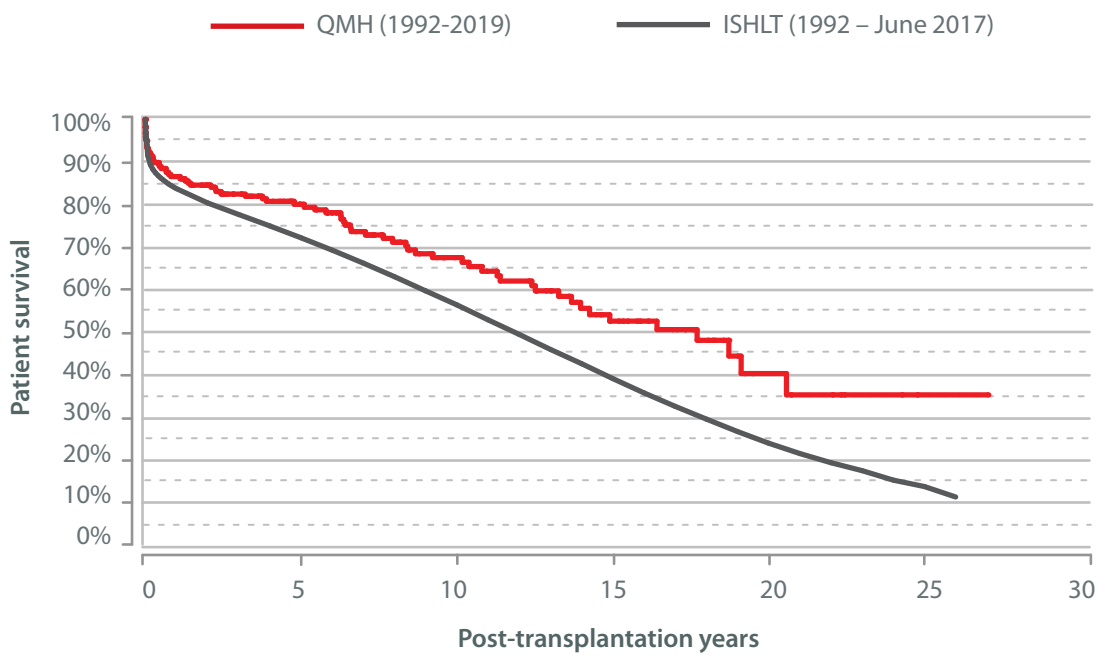
Annual adult and paediatric heart transplant activity in Hong Kong 1992-2019



Heart Transplant outcomes

- Heart transplant survival comparisons have been made with ISHLT, The International Society for Heart and Lung Transplantation , a global registry , which has a data of 114,783 heart transplants between January 1992 – June 2017.
- In Hong Kong, 219 heart transplants including 10 in patients <18 years and 1 re-transplant have been done.
- Heart transplant in QMH shows comparable with or even better results compared with ISHLT registry data.
- In Hong Kong, the survival rates at 5 ,10 and 20 years are 80.1%, 67.6% and 40.4% compared to 72.2% , 56.5% and 24.06% respectively, reported in ISHLT registry.

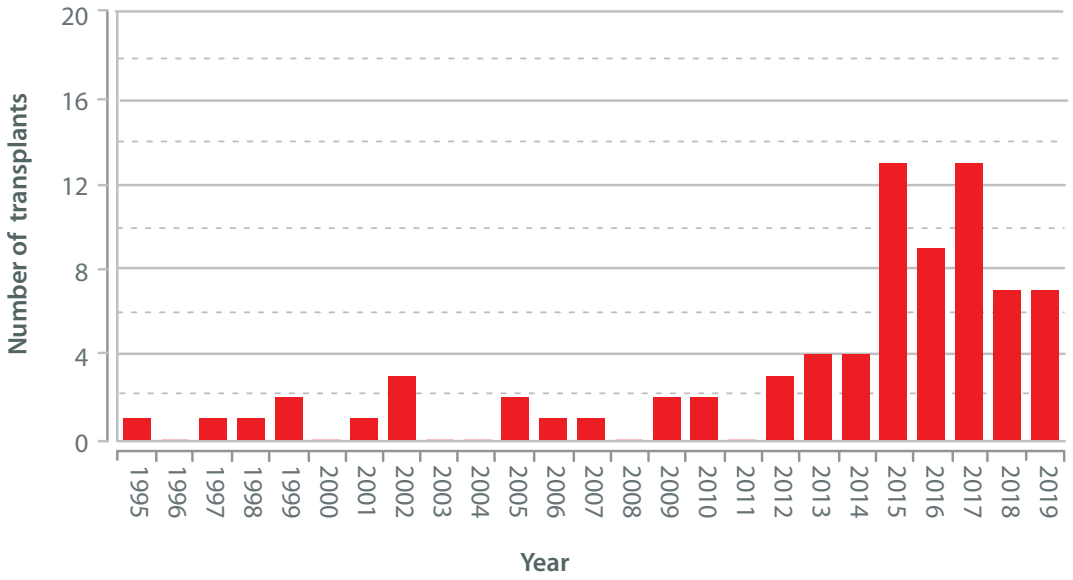
Actuarial survival rate of adult and paediatric heart transplants



Lung Transplant

- Bilateral sequential lung transplant has become the standard of care for most end-stage lung conditions.
- Clinical lung transplant was first performed in Hong Kong in 1995.
- In the early years, the volume of activity was very low.
- There has been a clear trend of increasing volume in the past few years.
- With the increasing acceptance of organ donation by the Hong Kong general public, as well as an increase in the number of patients being referred for consideration for lung transplant, there has been a marked increase in lung transplant since 2014.
- The ex vivo lung perfusion (EVLP) was introduced in 2018. EVLP increases utilization of marginal donor lungs without compromising early lung transplant outcomes.

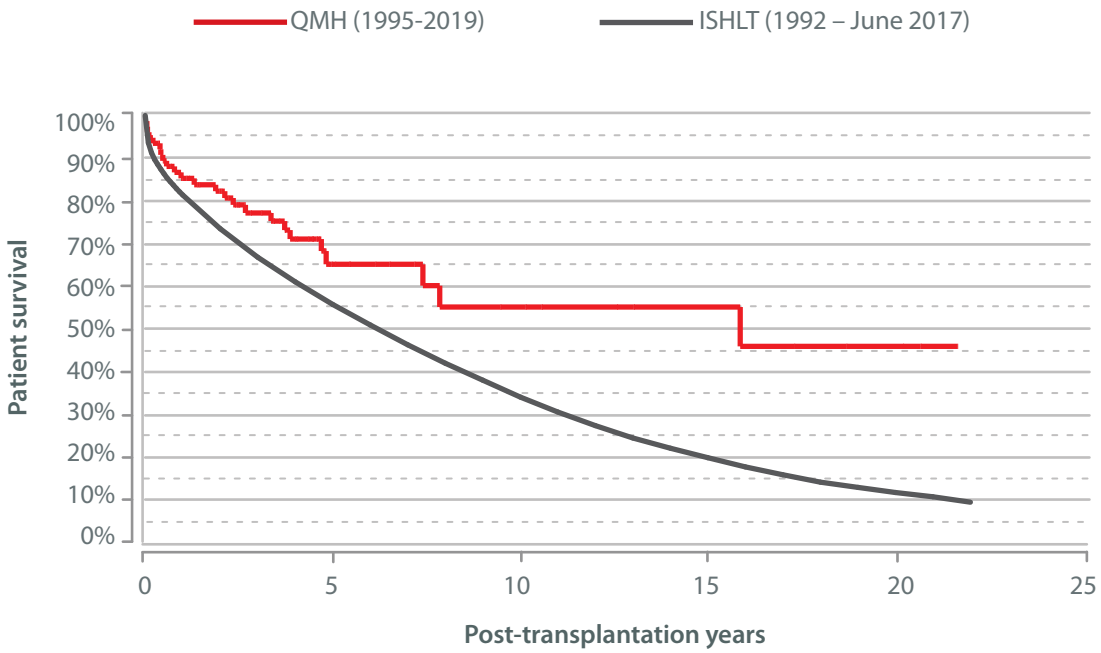
Annual lung transplant activity in Hong Kong 1995-2019



Lung Transplant outcomes

- Lung transplant survival comparisons have been made with ISHLT, The International Society for Heart and Lung Transplantation , a global registry , which has a data of 63,410 adult patients between January 1992 – June 2017.
- In Hong Kong 77 lung transplants have been done.
- Lung transplant in QMH compare quite favorably with the ISHLT Registry .
- In Hong Kong, the survival rates at 5 , 10 and 20 years are 65.2%, 55.2%, 46.0% compared to 55.7% , 34.1% and 11.8% reported in ISHLT registry.

Actuarial survival rate of adult lung transplants

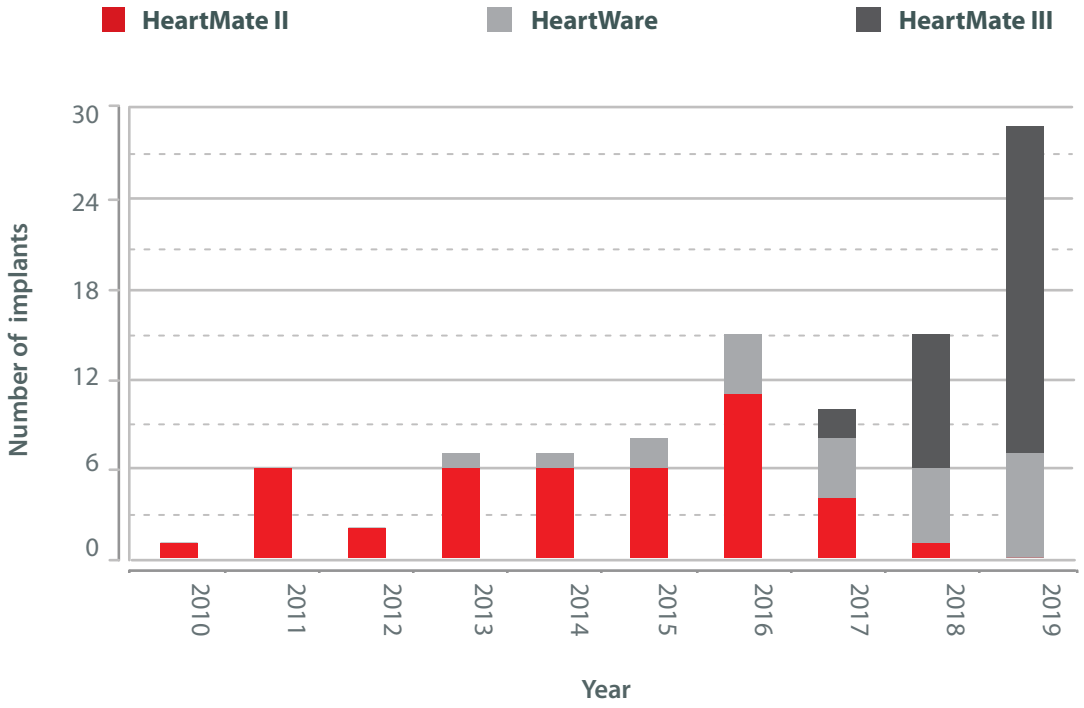


Ventricular Assist Devices (VAD)

Implantable Left Ventricular Assist Devices (LVAD)

- A left ventricular assist device (LVAD) is a pump that used for end-stage heart failure patients. It is surgically implanted, a battery-operated, mechanical pump, which then helps the left ventricle pump blood to the rest of the body.
- LVAD program was launched in Hong Kong in 2010 in QMH. Since then 100 LVADs have been implanted.
- LVADs are offered to both adult and pediatric patients.
- HeartMate and HeartWare are the two LVAD devices offered in this program. In QMH, 76 HeartMate and 24 HeartWare devices have been implanted.
- In QMH, LVAD has been used as a bridge-to-transplant and destination therapy.
- VAD's are a demanding area of the service and the number of patients is likely to continue to increase in the face of donor shortage.

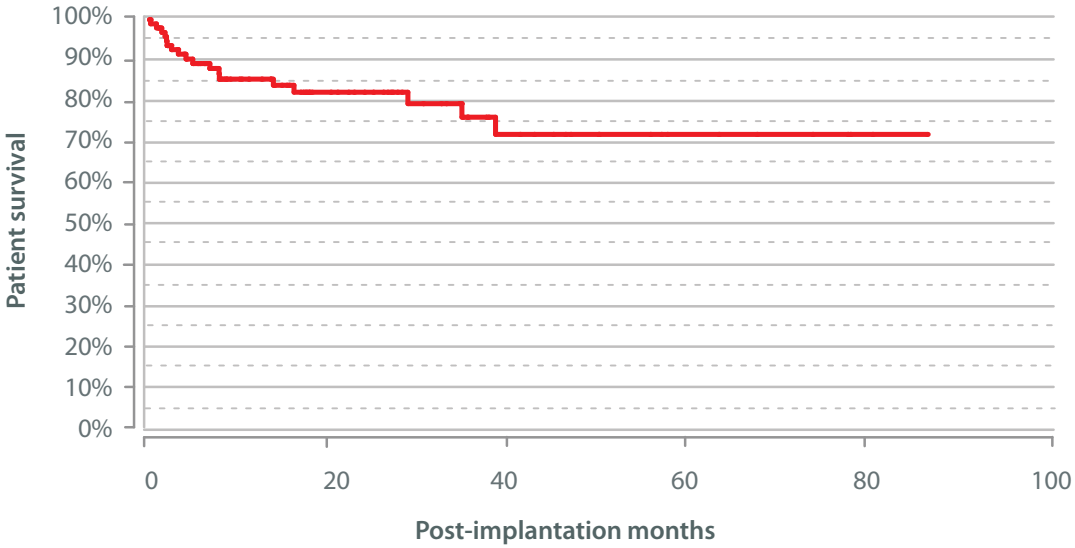
Annual Left ventricular assist device activity in Hong Kong , 2010-2019



LVAD Outcomes

- The International Society for Heart and Lung Transplantation Registry for Mechanically Assisted Circulatory Support (IMACS) is an international registry intended to enroll and follow patients who receive durable mechanically assisted circulatory support devices (MCSD).
- The IMACS Registry compiles and analyzes worldwide data from patients undergoing implantation of durable left ventricular assist devices.
- In its Third Annual Report, the IMACS focused on an outcome analysis of 16,286 patients who underwent isolated CF-LVADs.
- One and 3 year survival rates for isolated LVAD reported by IMACS are 82.9% and 64.5% respectively. At QMH,1 and 3 year survival rates for isolated LVAD are 86% and 76.2% respectively.
- In Hong Kong 100 LVADs have been implanted . Twenty five patients were bridged to transplant and 57 are alive on the device.

Actuarial survival rate of implantable LVAD 2010-2019



Part 2: Congenital cardiac surgery

Congenital cardiac surgery

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 401 centres from 85 countries.
- It contains records of 308,783 operations performed on 246,139 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.

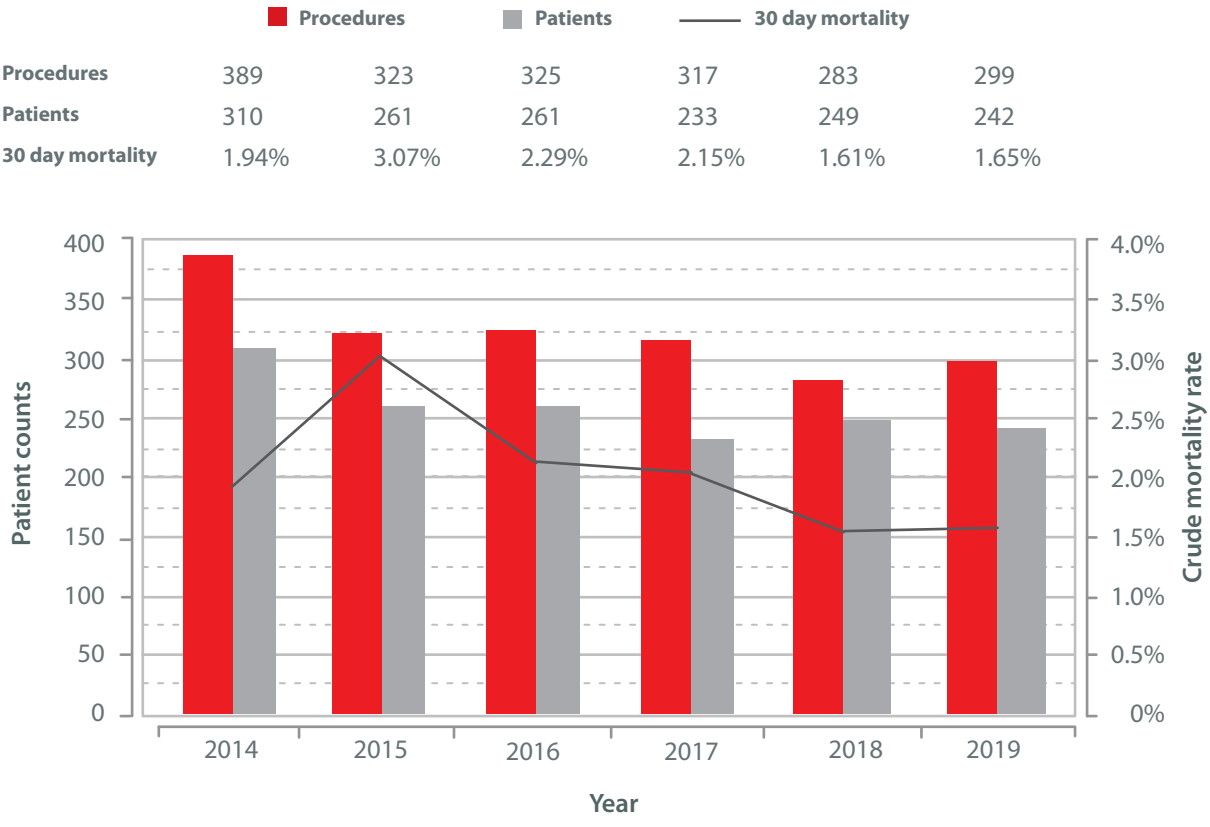
The Overall Workload

Workload by year

- Overall 582 procedures were performed on 475 patients in the year 2018 and 2019 at QMH with a mean 30-day mortality of 1.68%.
- Surgery for congenital heart disease accounts for 35% of the total cardiac surgical workload in QMH.
- Total volumes of congenital cardiac surgery has remained static over last three years.

Congenital cardiac surgery activity in QMH 2014-2019

Procedures	389	323	325	317	283	299
Patients	310	261	261	233	249	242
30 day mortality	1.94%	3.07%	2.29%	2.15%	1.61%	1.65%



Workload by procedure category

- Open heart surgery accounted for 70% 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. It has remained higher since the last 5 years.

Workload by procedure category

		Data		
		Count	Proportion	Proportion in the ECHSA Database
Procedure Category	Open heart surgery	410	70.4%	76.1%
	Closed heart surgery	122	21.0%	14.5%
	Thoracic	27	4.6%	1.5%
	VAD pump change done without CPB	9	1.5%	0.2%
	VAD operation done with CPB	7	1.2%	0.1%
	ECMO (post-cardiotomy)	6	1.0%	2.1%
	Other	1	0.2%	1.3%
	All	**582**		

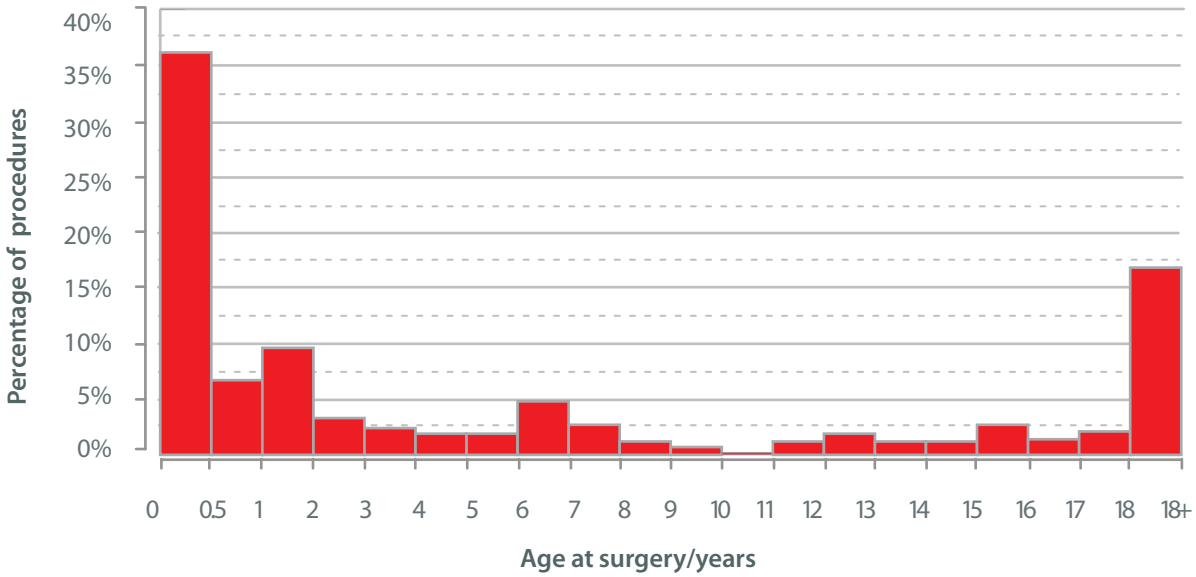
Workload by age group

- Patients with congenital heart disease from birth through adulthood are operated upon in QMH.
- Approximately 43% of the congenital workload is in performed on patients below one year of age.
- The proportion of the number of adult surgeries at QMH (16.2%) was higher than that in the ECHSA database (11.2%).
- Adult congenital heart surgery increased compared to our previous report (16.2% vs 10.9%).

Workload by age group

		Data		
		Count	Proportion	Proportion in the ECHSA Database
Age group	Neonates (0-30 days)	90	15.5%	13.7%
	Infants (31-365 days)	159	27.3%	35.2%
	Children (1-18 years)	239	41.0%	39.9%
	Adults (>18 years)	94	16.2%	11.2%

Histogram of age at operation



Demographic and perioperative data

- In QMH, the average age was 111.2 months , which was higher than that in the ECHSA Database (81.8 months).

Demographic and perioperative data and data by procedure category

		Overall	
		QMH	ECHSA
Mean value (range)	Total CPB time (min)	117.4 (10-495)	104.9 (2-999)
	Age at operation (months)	111.2 (0-818)	81.8 (0-1020)
	Total aortic cross-clamp time (min)	74.8 (8-282)	60.7 (1-479)
	Weight at operation (kg)	22.7 (0.75-101)	18.2 (0.5-199)
	Length of stay (days)	20.9 (0-288)	14.1(0-469)

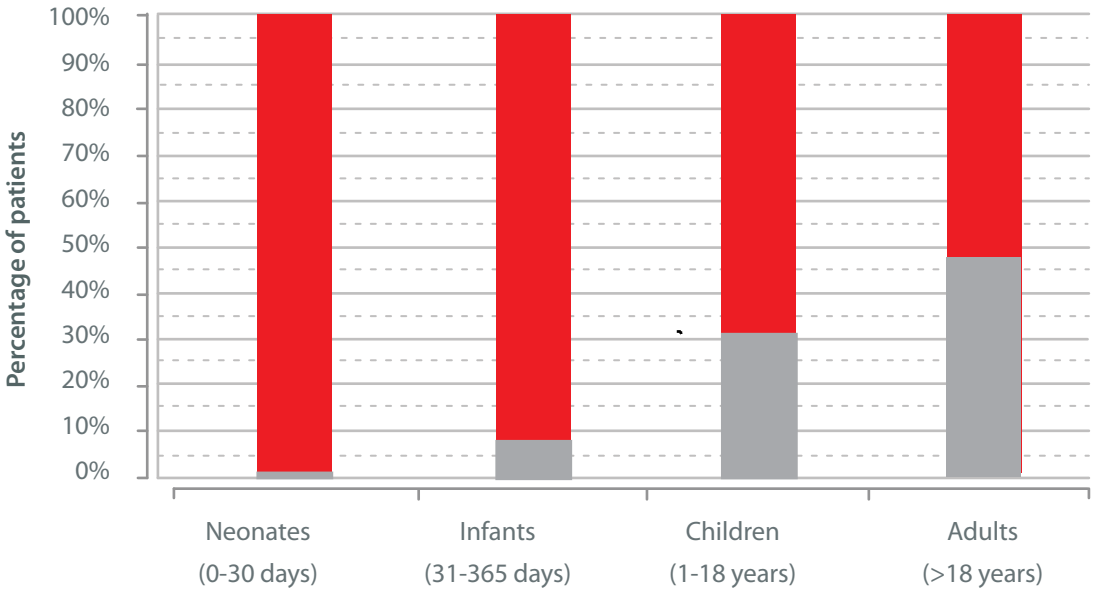
Previous cardiac surgery

Previous cardiac surgery within age groups

- Overall 23% of the procedures performed were redo surgeries.
- In the under one year age group only 9.2% had previously undergone surgery.
- In adult congenital heart surgery about 47.8% 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, 31.3% 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	1	13	75	45
Total procedures	90	159	239	94
Rate	1.1%	8.1%	31.3%	47.8%



List of primary diagnosis, primary procedures and complications in QMH, 2018-2019

Primary diagnosis

- 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.
- Latest randomized evidence showed that PDA ligation did not improve the outcomes and possibly increased the risk for sepsis and mortality, therefore, there has been a recent decline in the referrals for PDA.
- Consistent with the previous report, VSD (Perimembranous) remained the most frequent congenital heart defect at QMH.

25 most frequent primary cardiac diagnosis in QMH , 2018-2019

Primary diagnosis	Count	Proportion
VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	82	17.3%
TOF, Pulmonary stenosis	48	10.1%
ASD, Secundum	40	8.4%
Patent ductus arteriosus (PDA)	35	7.4%
VSD, Type 1 (Subarterial) (Supracristal) (Conal septal defect) (Infundibular)	28	5.9%
Cardiomyopathy (including dilated, restrictive, and hypertrophic)	26	5.5%
TGA, IVS	16	3.4%
Pulmonary insufficiency	15	3.2%
Coarctation of aorta	15	3.2%
AVC (AVSD), Complete (CAVSD)	14	2.9%
TGA, VSD	13	2.7%
Pulmonary atresia, IVS	12	2.5%
Pulmonary stenosis, Valvar	11	2.3%
Pulmonary atresia, VSD (Including TOF, PA)	11	2.3%
AVC (AVSD), Partial (incomplete) (PAVSD) (ASD, primum)	11	2.3%
Ebstein's anomaly	10	2.1%
DORV, TOF type	10	2.1%
DCRV	10	2.1%
Interrupted aortic arch + VSD	9	1.9%
Total anomalous pulmonary venous connection (TAPVC), Type 1 (supracardiac)	9	1.9%
Total anomalous pulmonary venous connection (TAPVC), Type 3 (infracardiac)	9	1.9%
Hypoplastic left heart syndrome (HLHS)	9	1.9%
Aortic stenosis, Valvar	7	1.5%
Aortic aneurysm (including pseudoaneurysm)	6	1.3%
Pectus	6	1.3%

Primary procedures

- The following table lists the top 25 procedures by quantity undertaken for congenital heart disease between 2018-2019.
- 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 remains the most frequent procedures consistently over past six years and the proportion has slightly increased compared to 2016-2017 report (14.33%).

25 most frequent primary cardiac procedures in QMH , 2018-2019

Primary procedure	Count	Proportion	ABC score
VSD repair, Patch	103	17.7%	6.0
ASD repair, Patch	36	6.2%	3.0
PDA closure, Surgical	36	6.2%	3.0
Valve replacement, Pulmonic (PVR)	31	5.3%	6.5
TOF repair, Ventriculotomy, Nontransanular patch	14	2.4%	7.5
Fontan revision or conversion (Re-do Fontan)	13	2.2%	12.5
Shunt, Systemic to pulmonary, Modified Blalock-Taussig Shunt (MBTS)	12	2.1%	6.3
AVC (AVSD) repair, Partial (Incomplete) (PAVSD)	10	1.7%	4.0
VSD repair, Primary closure	9	1.5%	6.0
DCRV repair	9	1.5%	7.0
Diaphragm plication	9	1.5%	4.0
TOF repair, Ventriculotomy, Transanular patch	9	1.5%	8.0
Right/left heart assist device procedure	9	1.5%	7.0
Valvuloplasty, Pulmonic	8	1.4%	5.6
Pacemaker implantation, Permanent	8	1.4%	3.0
ECMO decannulation	8	1.4%	4.0
VAD implantation	8	1.4%	7.0
Mediastinal exploration	8	1.4%	1.5
Coarctation repair, End to end, Extended	8	1.4%	8.0
Aortic root replacement, Mechanical	7	1.2%	8.8
ASD repair, Primary closure	7	1.2%	3.0
Arterial switch operation (ASO)	7	1.2%	10.0
ECMO cannulation	6	1.0%	5.0
Interrupted aortic arch repair	6	1.0%	10.8
Pectus repair	6	1.0%	5.3

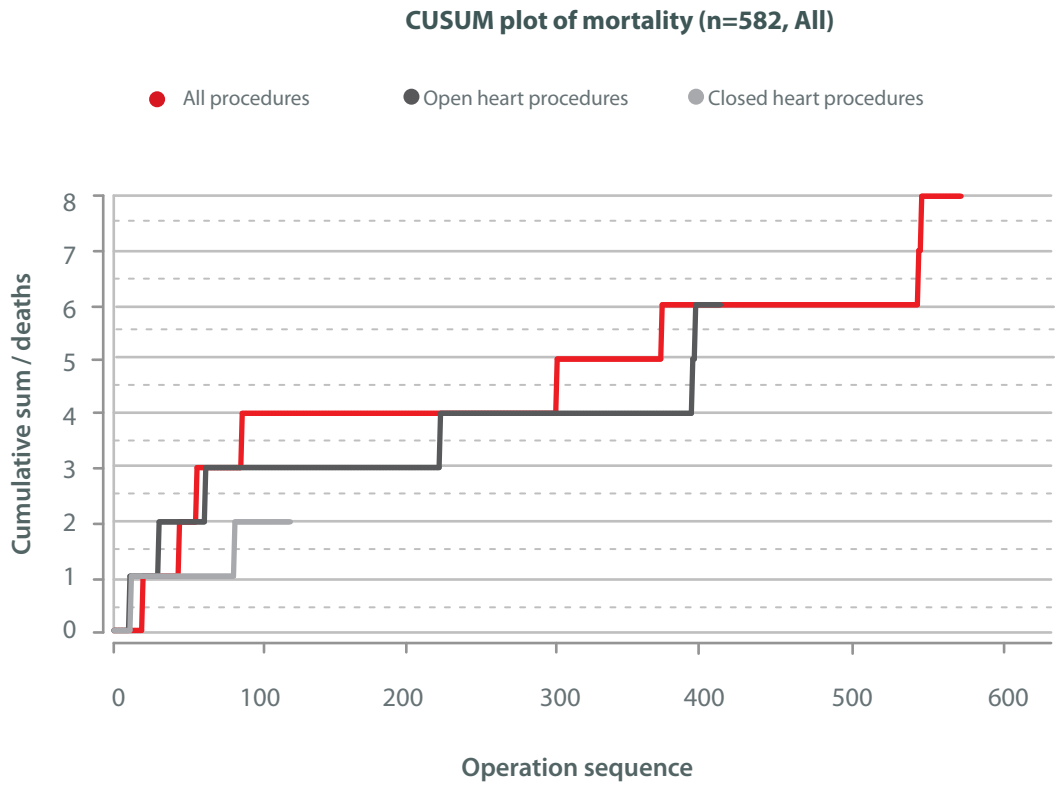
Common post operative events/ major complications

- The following table lists the common post-operative events and major complications.
- The most frequent complication was a sternum which was left open in 3.9% of the patients.
- There has been marked improvement in the rate of acute renal failure requiring temporary dialysis over last six years (10.2% in 2014-2015 , 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. Patients needing ECMO in the early post-operative period due to cardiac arrest or low cardiac output decreased compared to 2016-2017 report (18).

	Postoperative event/complication details	Data		
		Count	Proportion 2018-2019	Proportion 2016-2017
Post operative event/major complication	Sternum left open, Planned	23	3.90%	7.79%
	Renal failure - acute renal failure, requiring temporary dialysis with the need for dialysis not present at hospital discharge	15	2.60%	3.58%
	Pneumothorax, Requiring intervention	12	2.00%	1.40%
	Cardiac dysfunction resulting in low cardiac output	10	1.70%	2.65%
	Cardiac arrest, Timing = Cardiac arrest (MI) during or following procedure	10	1.70%	0.62%
	Paralyzed diaphragm requiring intervention	10	1.70%	0.31%
	Arrhythmia requiring drug therapy	9	1.60%	2.18%
	Pleural effusion, Requiring drainage	8	1.40%	1.40%
	Pneumonia	8	1.40%	1.25%
	Bleeding, Requiring reoperation	8	1.40%	1.25%
	Postoperative/Postprocedural respiratory insufficiency requiring reintubation	6	1.00%	0.78%
	Pulmonary hypertensive crisis (PA pressure > systemic pressure)	5	0.90%	0.31%
	Postoperative/Postprocedural mechanical circulatory support (IABP, VAD, ECMO, or CPS)	4	0.70%	2.80%
	Arrhythmia necessitating pacemaker, Permanent pacemaker	4	0.70%	0.16%
	Unplanned cardiac reoperation during the postoperative or postprocedural time period, exclusive of reoperation for bleeding	3	0.50%	0.47%
	Arrhythmia requiring electrical cardioversion or defibrillation	3	0.50%	0.78%
	Neurological deficit, Neurological deficit persisting at discharge	3	0.50%	0.47%

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 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. (Refer to the appendix for details about ABC score)
- 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.
- The complexity of surgeries performed remain nearly same as in 2016-2017 (6.58).

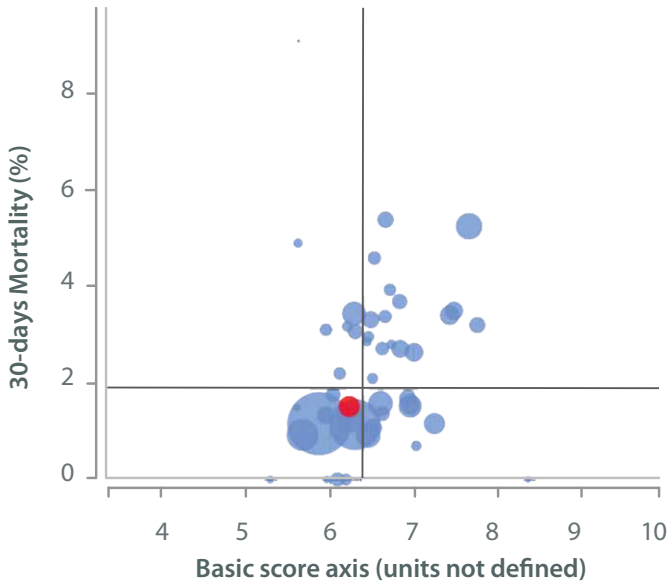
Complexity score and mortality 2018-2019

		Procedure count		Mortality		ABC score	
		All	Eligible*	QMH	ECHSA	QMH	ECHSA
Year	2018	283	251	1.61%	2.50%	6.52	6.86
	2019	299	253	1.65%	2.19%	6.82	6.80
	All	**582**	**504**	**1.68%**	**2.29%**	**6.67**	**6.84**

* Eligible procedures refer to the procedures with ABC scores.

- The quality of care chart shows the comparative results of the centers that are a part of that database
- Every bubble represents one centre, with larger bubbles indicating a larger volume of the centre.
- The lines show the mean values in the ECHSA database and the red bubble relates to QMH .
- Both the complexity level and the mortality of our patients was lower than the ECHSA average.

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, 2018-2019 was 0.47, indicating a better outcome than expected. There was an improvement in overall mortality compared to our previous reports.
- Mortality among neonates, children and adults also improved compared to our preceding report.

Mortality O/E ratio by year

		Count			O/E ratio calculation			
		All procedures	Eligible procedures*	Eligible deaths**	Observed mortality	Expected mortality	O/E Ratio 2018/19	O/E Ratio 2016/17
Year	2018	283	251	4	1.61%	3.40%	0.47	0.67
	2019	299	253	4	1.65%	3.72%	0.44	0.66
	All	**582**	**504**	**8**	**1.68%**	**3.56%**	**0.47**	**0.68**

* 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

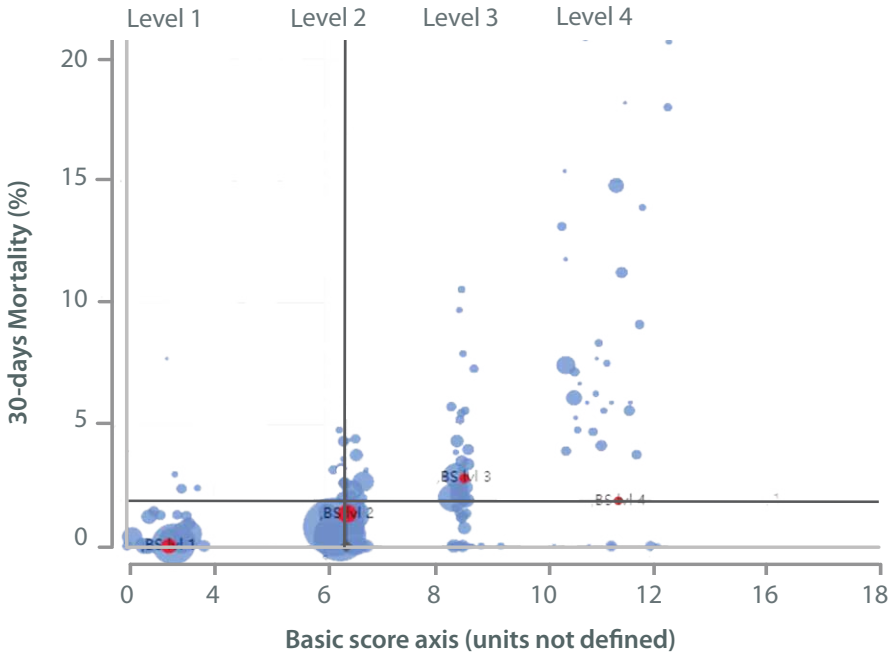
		Count			O/E ratio calculation			
		All procedures	Eligible procedures*	Eligible deaths**	Observed mortality	Expected mortality	O/E Ratio 2018/19	O/E Ratio 2016/17
Age group	Neonates (0-30 days)	90	71	3	4.84%	5.24%	0.92	1.19
	Infants (31-365 days)	159	147	4	2.76%	2.65%	1.04	1.08
	Children (1-18 years)	239	199	1	0.50%	3.72%	0.13	0.18
	Adults (>18 years)	94	87	1	1.16%	3.37%	0.34	0.00

*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 70% of congenital cardiac procedures at QMH.
- ABC level 3 and level 4 procedures contributed to 21.7% of congenital cardiac procedures at QMH.
- Procedures like heart VAD implantation, re-exploration for bleeding *etc.* which formed 8.8% of the procedures could not be assigned ABC score and ABC level.
- At QMH the mortality rate for ABC levels 1 & 2 were well below the ECHSA mean mortality rate, whereas, the mortality rate for ABC level 3 & 4 were higher than the ECHSA mean rate.

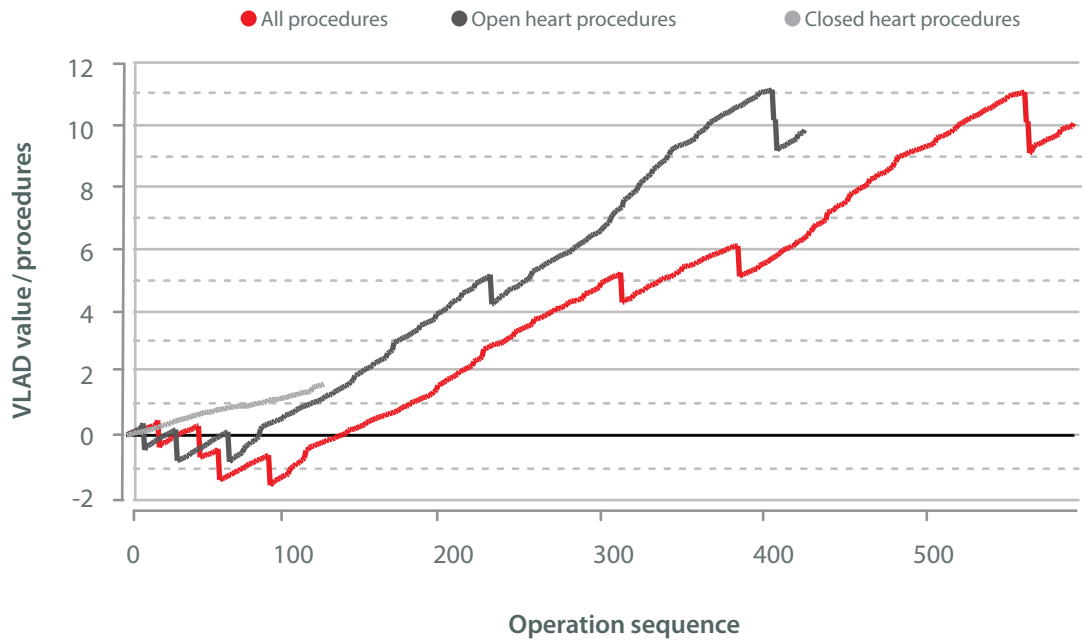
International comparison of mortality rate and procedures by Basic Score Levels



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 2018 and 2019.
- 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 10 extra lives had been saved at Queen Mary Hospital in 2018-2019 compared to 7 lives saved in 2016-2017.

Congenital cardiac surgery: VLAD plot (n=582, All)



Age group- Volume and Outcomes

Neonates (0-30 days)

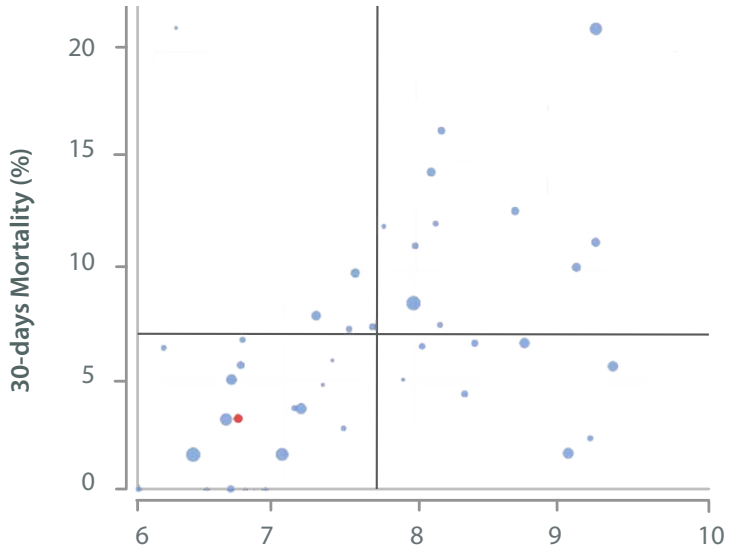
5 most frequent primary diagnosis in neonates

		Data	
		Count	Proportion
Diagnosis	TGA, IVS	8	12.9%
	Coarctation of aorta	8	12.9%
	Patent ductus arteriosus	8	12.9%
	TGA, VSD	6	9.6%
	Total anomalous pulmonary venous connection (TAPVC), Type 1 (supracardiac)	4	6.5%

5 most frequent primary procedures in neonates

		Data		
		Count	Proportion	ABC score
Procedures	PDA closure, Surgical	10	11.1%	3.0
	Shunt, Systemic to pulmonary, Modified Blalock-Taussig Shunt (MBTS)	10	11.1%	6.3
	Arterial switch operation (ASO)	7	7.8%	10.0
	Arterial switch operation (ASO) and VSD repair	6	6.7%	11.0
	Interrupted aortic arch repair	5	5.6%	10.8

Mortality and complexity benchmarking in neonates



Infants (31-365 days)

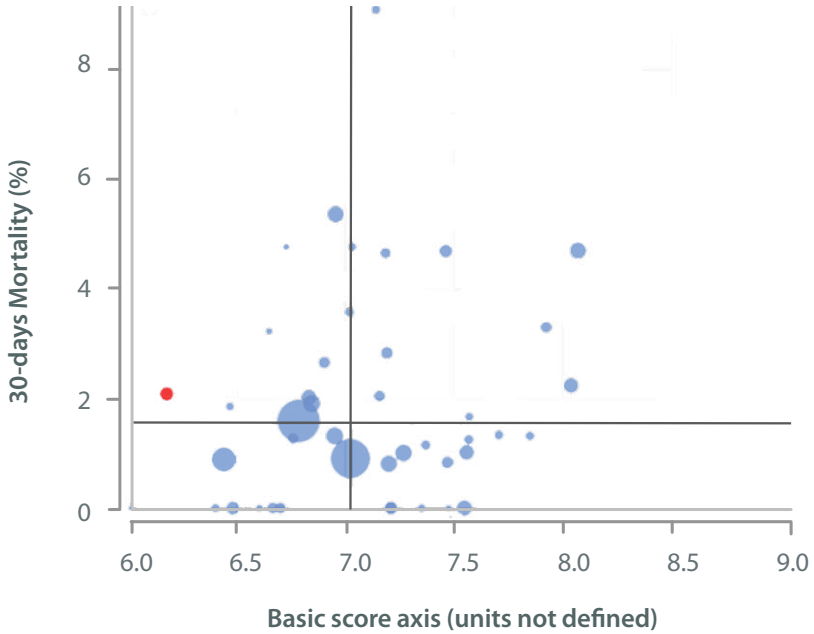
5 most frequent primary diagnosis in infants

		Data	
		Count	Proportion
Diagnosis	VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	62	42.8%
	Patent ductus arteriosus	25	17.2%
	TOF, Pulmonary stenosis	12	8.3%
	AVC (AVSD), Complete (CAVSD)	6	4.1%
	DORV, TOF type	3	2.1%

5 most frequent primary procedures in infants

		Data		
		Count	Proportion	ABC score
Procedures	VSD repair, Patch	62	39.0%	6.0
	PDA closure, Surgical	24	15.1%	3.0
	VSD repair, Primary closure	6	3.8%	6.0
	TOF repair, Ventriculotomy, Nontransanular patch	6	3.8%	7.5
	TOF repair, Ventriculotomy, Transanular patch	5	3.1%	8.0

Mortality and complexity benchmarking in infants



Children (1-18 years)

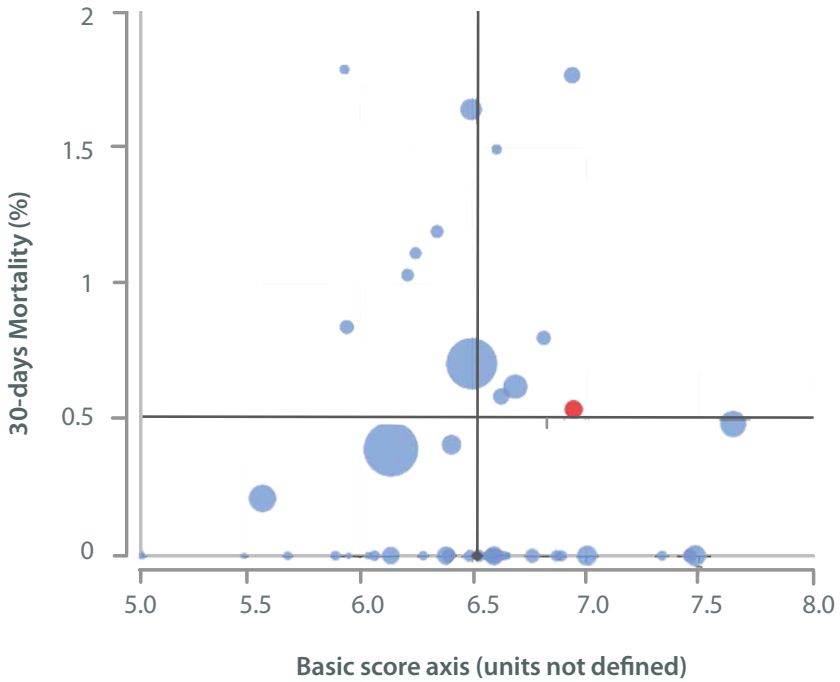
5 most frequent primary diagnosis in children

		Data	
		Count	Proportion
Diagnosis	ASD, Secundum	28	14.0%
	VSD, Type 1 (Subarterial) (Supracristal) (Conal septal defect) (Infundibular)	18	9.0%
	TOF, Pulmonary stenosis	17	8.5%
	VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	10	5.0%
	AVC (AVSD), Partial (incomplete) (PAVSD) (ASD, primum)	7	3.5%

5 most frequent primary procedures in children

		Data		
		Count	Proportion	ABC score
Procedure	VSD repair, Patch	31	13.0%	6.0
	ASD repair, Patch	24	10.0%	3.0
	Fontan revision or conversion (Re-do Fontan)	10	4.2%	12.5
	Right/left heart assist device procedure	9	3.8%	7.0
	VAD implantation	8	3.3%	7.0

Mortality and complexity benchmarking in children



Adults (18 years or above)

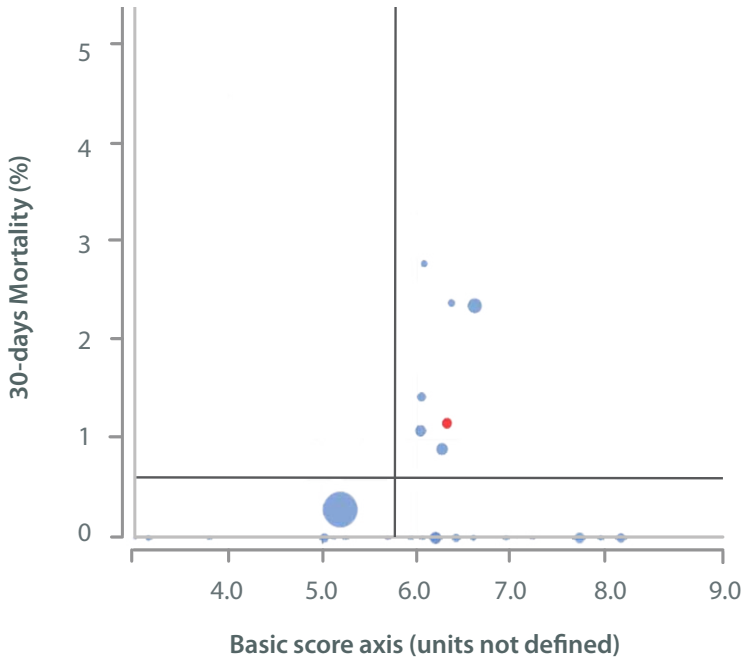
5 most frequent primary diagnosis in adults

		Data	
		Count	Proportion
Diagnosis	Pulmonary insufficiency	14	16.3%
	TOF, Pulmonary stenosis	12	14.0%
	ASD, Secundum	10	11.6%
	VSD, Type 2 (Perimembranous) (Paramembranous) (Conoventricular)	7	8.1%
	VSD, Type 1 (Subarterial) (Supracristal) (Conal septal defect) (Infundibular)	5	5.8%

5 most frequent primary procedures in adults

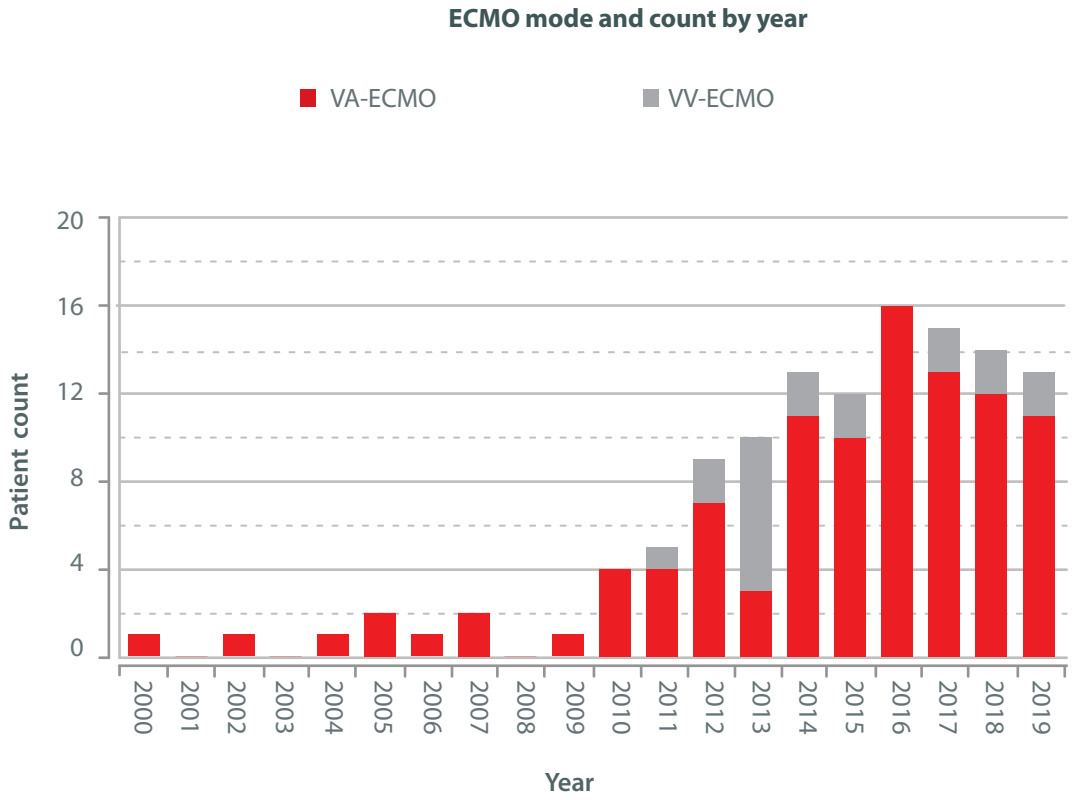
		Data		
		Count	Proportion	ABC score
Procedure	Valve replacement, Pulmonic (PVR)	28	29.8%	6.5
	ASD repair, Patch	11	11.7%	3.0
	VSD repair, Patch	8	8.5%	6.0
	DCRV repair	4	4.3%	7.0
	Fontan revision or conversion (Re-do Fontan)	3	3.2%	12.5

Mortality and complexity benchmarking in adults



Paediatric Extracorporeal membrane oxygenation (ECMO) program in QMH

- Since its establishment in 2000, the ECMO Program has supported more than 100 children.
- 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.
- Our program is a member of Extracorporeal Life Support Organization (ELSO) data registry for national and international ECMO Centers.
- During 2018-2019, 32 ECMO runs were provided to 27 children with a goal of bridging these children to recovery or to other implantable device or heart transplantation.
- At QMH majority of ECMO placements were VA-ECMO.



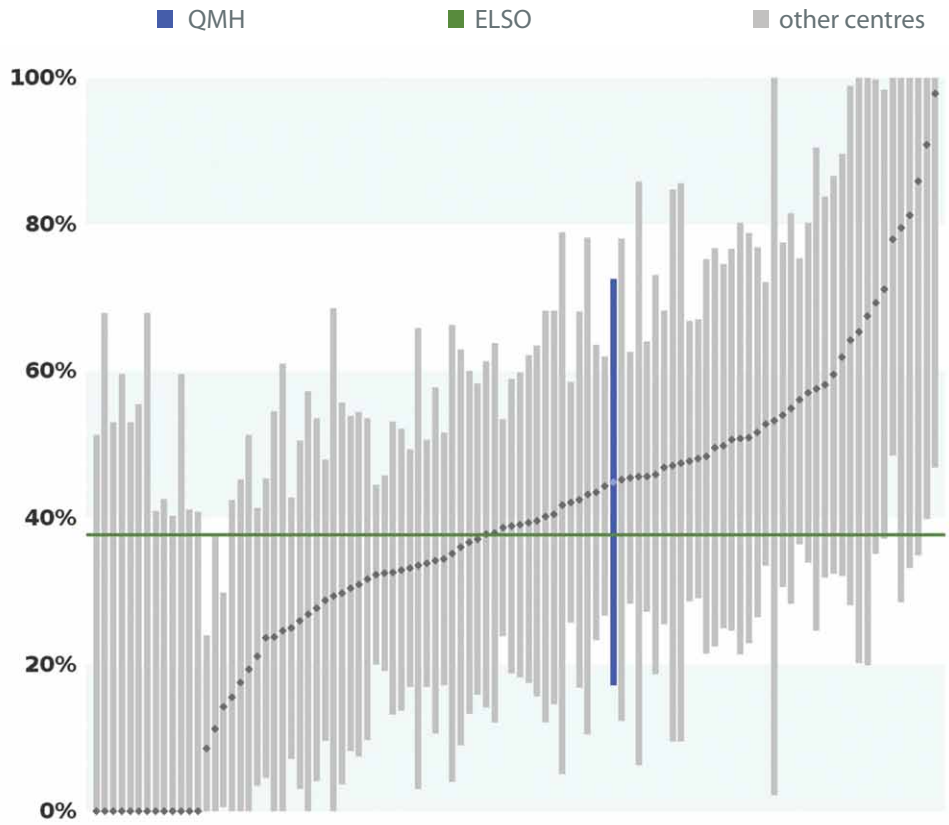
ECMO support stratified by age and indication: Benchmarking

- 40.7% (11/27) of the cases supported with ECMO were neonates and 64% of these were a day old. VA-ECMO support was provided to 91% (10/11).
- Children >30 days to18 years made up 59.2% (16/27) of the patients receiving ECMO support and 81.5% (13/16) of them received VA-ECMO.
- ECMO was used to support patients with cardiac, respiratory and, eCPR indications.
- In both the neonatal and paediatric groups, most of the patients were supported for cardiac indication.
- The mortality rate of neonatal patients undergoing ECMO at QMH is higher than reported in the ELSO registry, whereas the mortality rate in paediatric patients was much lower than reported in the registry.

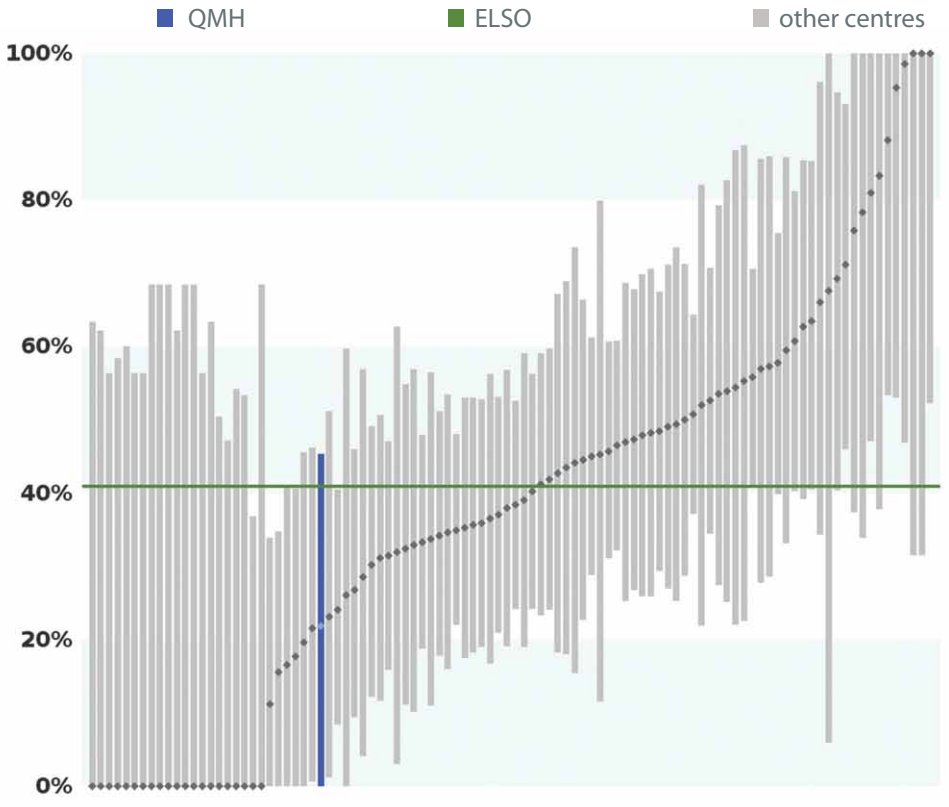
Benchmarking ECMO mortality

	QMH			ELSO registry	
	Count	Mortality (CI)	O/E Ratio	Count	Mortality (CI)
Neonatal (0-30 days)	11	44.9% (17.1%-72.6%)	1.07	2820	37.6% (35.8%-39.5%)
Paediatric (>30days)	16	21.9% (0%-45.3%)	0.5	4389	40.9% (39.4%-42.3%)

ECMO neonatal patients: Risk adjusted mortality rate compared to the data from the year 2018-2019 in the ELSO registry

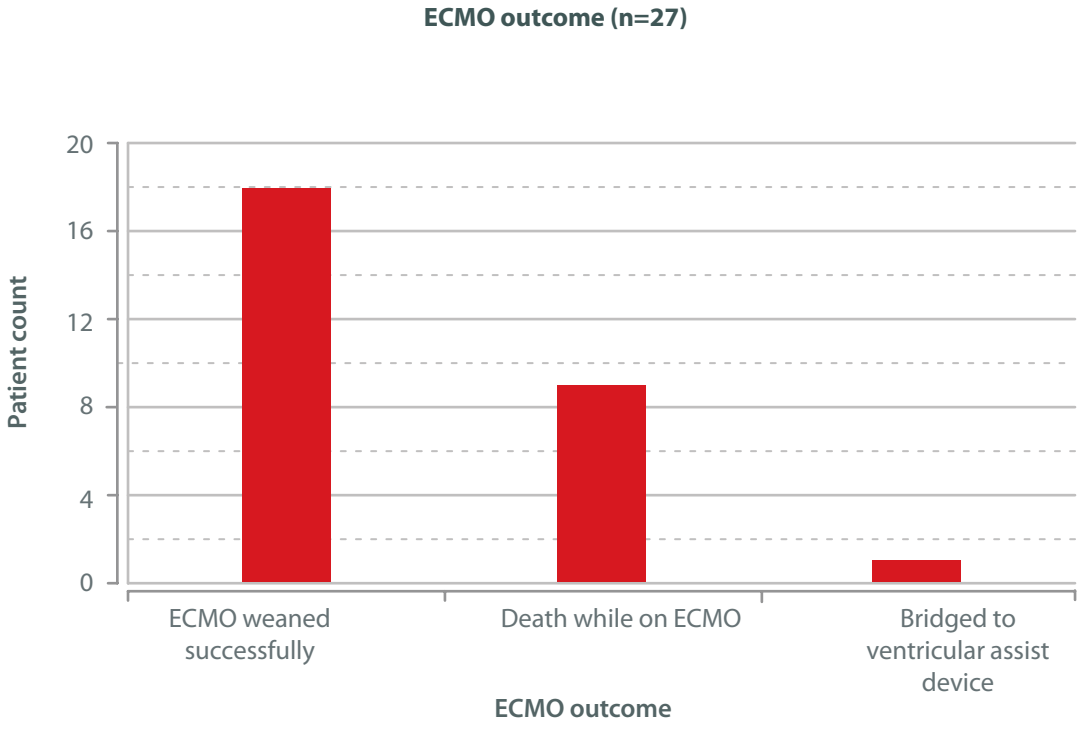


ECMO paediatric patients: Risk adjusted mortality rate compared to the data from the year 2018-2019 in the ELSO registry



ECMO outcomes: Neonatal and Paediatric

- Overall survival to discharge rate for Paediatric ECMO was 55.5% (15/27).
- Overall 66.6% (18/27) were successfully weaned off ECMO.
- One (3.7%) was successfully bridged to Berlin Heart biventricular device.
- Overall 12 patients died (44.4%), 9 died while on ECMO and 3 died after successful weaning off ECMO.

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Appendices

Appendices

Appendix 1

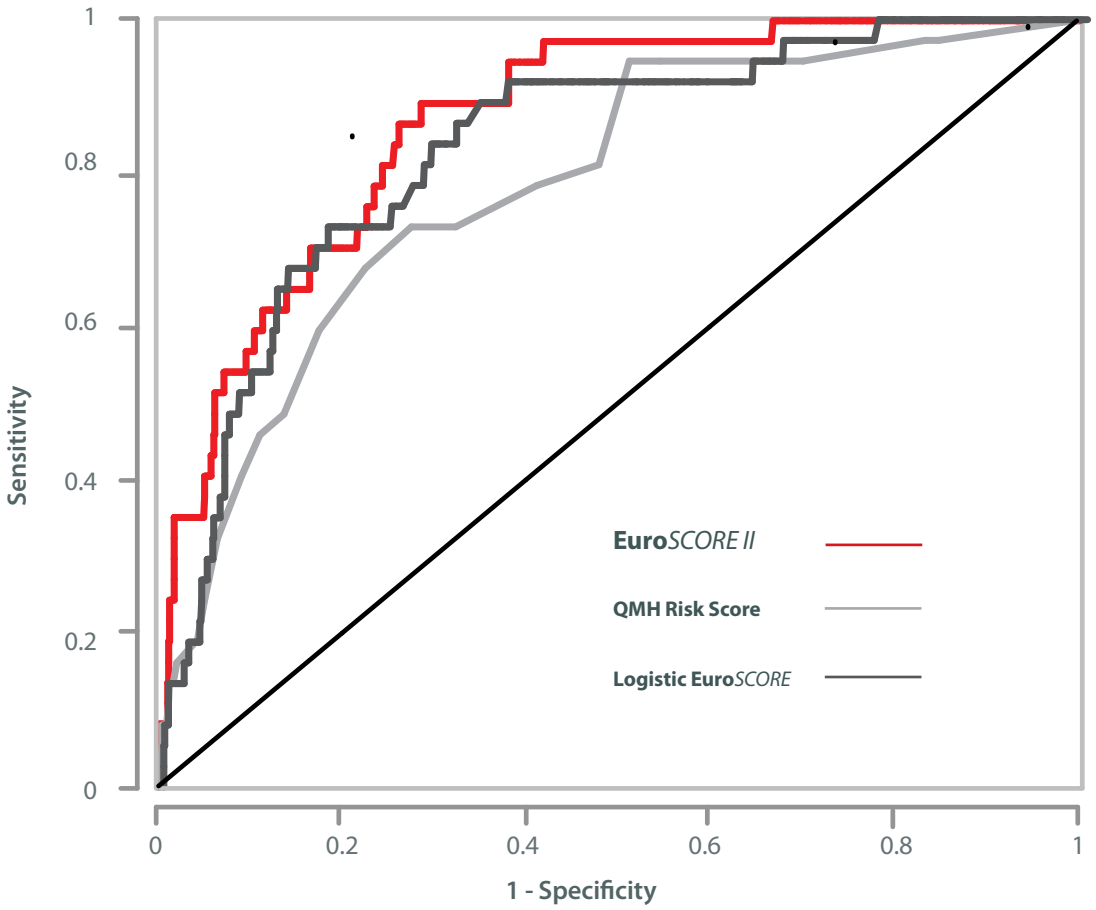
QMH Risk Score for Adult CABG and Valve surgery (since 2010)

- 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, 2018-2019



		Area under the curve	Asymptotic 95% Confidence Interval		Hosmer-Lemeshow statistics (P-valve)
			Lower Bound	Upper Bound	
Risk stratification model	EuroSCORE II	0.814	0.751	0.877	0.218
	QMH Risk Score	0.764	0.696	0.832	0.034
	Logistic EuroSCORE	0.783	0.714	0.852	0.425

		Predicted mortality rate % (95%CI)	Observed/predicted ratio
Risk stratification model	EuroSCORE-II	6.4 (5.8-7.0)	0.76
	QMH Risk Score	3.9 (3.8-4.1)	1.25
	Logistic Euro*SCORE*	10.8 (9.9-11.6)	0.45

Appendix 2

Congenital cardiac database

Nomenclature & Database

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

International Paediatric and Congenital Cardiac Code (IPCCC)

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

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 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 ECHSA Database.

Data validation and verification

- The ECHSA Database has intrinsic data validation rules 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 ECHSA 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 ECHSA 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 2018-2019

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醫院管理局
HOSPITAL AUTHORITY

瑪麗醫院
Queen Mary Hospital