ANZSCTS
Cardiac Surgery
Database Program

National Annual Report

2017

The Australian and New Zealand Society of Cardiac and Thoracic Surgeons Cardiac Surgery Database Program

National Annual Report

2017

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Abbreviations

ANZSCTS	Australian and New Zealand Society of Cardiac and Thoracic Surgeons
AVR	Aortic valve replacement
BITA	Bilateral internal thoracic artery
BMI	Body mass index
BSA	Body surface area
CABG	Coronary artery bypass graft
CL	Control limit
CPB	Cardiopulmonary bypass
CVA	Cerebrovascular accident
DNRI	Derived new renal insufficiency
DSWI	Deep sternal wound infection
eGFR	Estimated glomerular filtration rate
FFP	Fresh frozen plasma
GM	Geometric mean
ITD	Intrathoracic drain
ICU	Intensive care unit
ITA	Internal thoracic artery
KPIs	Key performance indicators
LITA	Left internal thoracic artery
LVD	Left ventricular dysfunction
LVF	Left ventricular function
MI	Myocardial infarction
MV	Mitral valve
MVR	Mitral valve replacement
NCA	New cardiac arrhythmia
NRBC	Non-red blood cell
NSTEMI	Non-ST elevation myocardial infarction
OM	Observed mortality
PBM	Patient blood management
RA	Radial artery
RAMR	Risk-adjusted mortality rate
RBC	Red blood cell
Re-op	Re-operation
RITA	Right internal thoracic artery
STEMI	ST elevation myocardial infarction
SVG	Saphenous vein graft
Tri/Pulm	Tricuspid or pulmonary
TAVR	Transcatheter aortic valve replacement
TMVR	Transcatheter mitral valve replacement
TXA	Tranexamic acid

Acknowledgements

The Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS) Database is funded by the Department of Health and Human Services, Victoria; the Clinical Excellence Commission, New South Wales; Queensland Health, Queensland; and through participation fees from contributing units.

We gratefully acknowledge contributions made by the ANZSCTS Cardiac Surgery Database Steering Committee, the ANZSCTS Cardiac Surgery Database Research Committee, the ANZSCTS Registry Data Custodian – Prof Chris Reid, and the Chairman of the Steering Committee and Clinical Lead – Mr Gil Shardey.

We also acknowledge the ANZSCTS Cardiac Surgery Database data and project management staff at the Centre for Cardiovascular Education in Therapeutics at Monash University (Dr Jenni Williams-Spence, Dr Lavinia Tran, Mr Noah Solman, Ms Jenna McLaren, Mrs Nicole Marrow, Mr Mark Lucas, and Ms Jill Edmonds).

During 2017, the Registry Data Custodian, Prof Chris Reid, was supported by a National Health and Medical Research Council Fellowship that provided salary support to contribute to initiatives such as the ANZSCTS Database.

The work of the ANZSCTS Database would not be possible without the efforts of the surgeons, data managers, and other relevant hospital staff who contribute data.

Photograph by Mark Lucas 2018 ©

Foreword

This is the eleventh National Annual Report of the ANZSCTS Database Program. It describes the data from surgery performed in 31 National public and private hospital cardiac surgical units.

Data presented in this report includes unit comparisons for procedures performed in the 2017 calendar year with procedural outcomes collected up to the end of January 2018. Data is also presented as pooled data (four or five year), and annual data (five years).

The report includes detailed analyses and summaries showing unit comparisons for key performance indicators. Heads of units are notified of outlying status in accordance with the ANZSCTS Database's outlier management procedure (Appendix A).

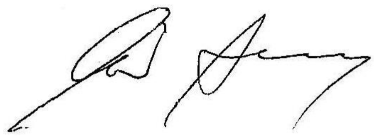
Units are de-identified by random coding. The report demonstrates unit performance compared to other contributing units, and the group average.

Overall, in the five-year period, although there is variation in practice, most participating Australian cardiac surgical units had satisfactory outcomes for key performance indicators (mortality and complications), as defined by being within the 95% control limit of the National average.

This year's report also examines the use of blood products in elective isolated coronary artery bypass graft (CABG) patients. This section discusses the trends in blood product use and post-operative blood loss over the last ten years. It identifies the marked differences between units in the frequency and nature of transfusions. While this analysis cannot elucidate the reasons for this variation, it is intended to inform units of that variation and prompt some to review their protocols.

As always, the Society will continue its mission to ensure that high standards are maintained in all units performing cardiac surgical procedures in Australia.

Mr Gil Shardey



Chairman
ANZSCTS Database Program
Steering Committee

Key Messages

- Nearly three times as many male patients underwent CABG procedures, compared to valve surgery; whereas, similar numbers of female patients underwent CABG or valve procedures.
- Of the 6,454 CABG procedures reported by contributing hospitals in 2017, more than 60% were elective and less than 4% were emergency.
- A higher proportion of female CABG and/or valve surgery patients are aged 70 years and over, compared to their male counterparts.
- The levels of left ventricular function have remained stable over the last five years in both CABG and valve with CABG surgery patients.
- Of the 3,398 patients who had a MI prior to CABG surgery in 2017, more than 72% were non-ST elevation myocardial infarction (NSTEMI), and 65% were more than seven days before surgery.
- Between 2013 and 2017, the proportion of redo CABG procedures has gradually decreased from 2.8% to 1.3%.
- In 2017, single or bilateral internal thoracic artery use was 94.2% for on-pump patients and 97.7% for off-pump patients, while the rate of radial artery use was 36.5% and 28.6% for on-pump and off-pump patients, respectively.
- Use of arterial and venous conduits has remained similar over time, with saphenous vein grafts accounting for 47% of anastomoses, and ITA grafts accounting for 37%.
- Advancing age or redo surgery; and patients with diabetes and/or prior renal impairment were generally associated with increased rates of post-operative complications.
- CABG patients with a pre-operative creatinine level ≥200 µmol/L had higher incidence of cerebrovascular accident, deep sternal wound infection and re-operation for bleeding, and a 9-fold increase in the incidence of derived new renal impairment.
- All units were within the 99.7% control limit for risk-adjusted mortality in CABG patients in 2017.
- Of the 2,608 isolated valve procedures reported to the ANZSCTS Database in 2017, 15% were redo, and 1,359 were single aortic operations.
- All units were within the 99.7% control limit for observed mortality for aortic valve replacements (AVR) and AVR with CABG patients in 2013-2017.
- There is significant variation between units for CABG, AVR, and CABG with AVR patients with respect to post-operative complications, particularly new cardiac arrhythmia, re-operation for bleeding, and readmission.

Since 2008 in elective isolated CABG patients:

- There has been a progressive decrease in the proportion of patients given red blood cell and non-red blood cell transfusions, albeit levelling off over the last three years.
- There has been a marked reduction in the use of fresh frozen plasma.
- There has been a persistent and continuing reduction in four hour intrathoracic drain fluid loss.
- There has been a marked increase in the number of patients continuing antiplatelet medication to within two days of surgery, and this is primarily driven by an increase in use of aspirin.
- While the proportion of patients exposed to blood transfusions has levelled off over the past three years, there remains wide variation between units in their rate of exposure of patients to red blood cells, ranging from 7% to nearly 50%.

Introduction

The ANZSCTS Cardiac Surgery Database Program 2017 National Annual Report presents data on patient characteristics and unit performance for a range of key performance indicators (KPIs), including post-operative complications and mortality. This year, the use of blood products in elective isolated CABG surgery has been explored as an additional theme. The data is organised by procedure type, as follows:

- Section 1: Isolated CABG
- Section 2: Blood Product Use in Elective Isolated CABG
- Section 3: Isolated Valve
- Section 4: Valve with CABG
- Section 5: Other Cardiac Surgery

Key Performance Indicators

The ANZSCTS Database collects data for a range of KPIs based on clinically relevant surgical outcomes; these are defined in detail in Appendix B.

The KPIs that are peer reviewed to benchmark and monitor the performance of units are:

- Mortality (risk-adjusted or observed)
- Permanent stroke
- Derived new renal impairment
- Deep sternal wound infection
- Re-operation for bleeding

Units that fall outside of the 99.7% control limit for any of these KPIs are managed according to the Database outlier escalation policy (Appendix A).

The additional KPIs which are presented in this report are:

- New cardiac arrhythmia
- Duration of ICU stay
- Duration of ventilation
- Red blood cell transfusions
- Non-red blood cell transfusions

These metrics may be used by units to benchmark their individual performance against other units at the National level.

Contributing units

In 2001, the ANZSCTS with the support of the Victorian Department of Health and Human Services developed a Program to collect and report data on cardiac surgery performed in Victorian hospitals. The Program expanded to National coverage, producing annual reports to inform its participants since 2002 for Victorian units, and since 2007 at a National level.

The 2017 report delivers a detailed analysis of data, providing an overview of annual trends and outcome measures based on KPIs. The data includes reported cardiac procedures performed in the 2017 calendar year, with follow up data to 31st January 2018, in 31 public and private cardiac units. The 2017 data is presented adjacent to pooled data for the preceding four years, and as part of average annual data over five years, to show trends in outcomes. Where the number of cases in the current year is low (sections 3 and 4), pooled data includes the current year.

Details on data preparation and key variable definitions are presented in Appendix C.

The following cardiac units contributed data to this report. Some units joined the Program more recently, therefore have not provided data over the full five years.

Table 1. Hospital Participation

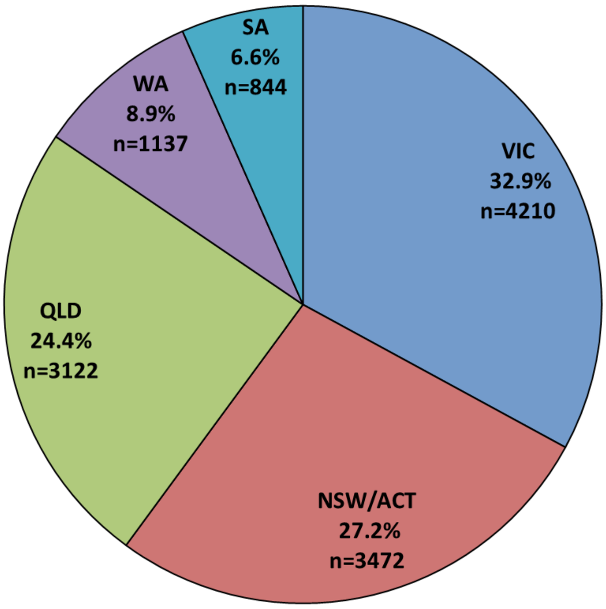
Contributing Hospitals	Hospital Type	2013	2014	2015	2016	2017
VICTORIA						
Alfred Hospital	Public	●	●	●	●	●
Austin Hospital	Public	●	●	●	●	●
Cabrini Private Hospital	Private	●	●	●	●	●
Epworth Hospital Eastern	Private	●	●	●	●	●
Epworth Hospital Richmond	Private	●	●	●	●	●
Jessie McPherson Private Hospital	Private	●	●	●	●	●
Monash Medical Centre	Public	●	●	●	●	●
Peninsula Private Hospital	Private	●	●	●	●	●
Royal Melbourne Hospital	Public	●	●	●	●	●
St Vincent's Hospital (Melbourne)	Public	●	●	●	●	●
University Hospital Geelong	Public	●	●	●	●	●
Warringal Private Hospital	Private					○
NEW SOUTH WALES						
John Hunter Hospital	Public	●	●	●	●	●
Lake Macquarie Private Hospital	Private	●	●	●	●	●
Liverpool Hospital	Public	●	●	●	●	●
North Shore Private Hospital	Private					○
Prince of Wales Hospital	Public	●	●	●	●	●
Royal Prince Alfred Hospital	Public	●	●	●	●	●
Royal North Shore Hospital	Public	†	●	●	†	†
St George Hospital	Public	●	†	●	●	●
St George Private Hospital	Private					○
Strathfield Private Hospital	Private					○
St Vincent's Hospital (Sydney)	Public	●	†	●	●	●
Westmead Hospital	Public	●	●	●	●	●
Westmead Private Hospital	Private					○
AUSTRALIAN CAPITAL TERRITORY						
Canberra Hospital	Public	●	†	●	●	●
QUEENSLAND						
Gold Coast University Hospital	Public			●	●	●
Greenslopes Private Hospital	Private					○
Holy Spirit Northside Hospital	Private	●	●	●	●	●
John Flynn Private Hospital	Private					○
Mater Hospital	Private	●	●	●	●	●
Prince Charles Hospital	Public			●	●	●
Princess Alexandra Hospital	Public			●	●	●
Townsville Hospital	Public	●	●	●	●	●
Sunshine Coast University Private Hospital	Private					
SOUTH AUSTRALIA						
Flinders Hospital	Public	●	●	●	●	●
Royal Adelaide Hospital	Public	●	●	●	●	●
WESTERN AUSTRALIA						
Fiona Stanley Hospital	Public			●	●	●
Sir Charles Gairdner Hospital	Public	●	●	●	●	●
St John of God Hospital	Private	●	●	●	●	●

● Hospital engaged and contributing
○ Hospital engaged but contributing <12 months
† Hospital engaged but contributed insufficient data (<66% of expected caseload)

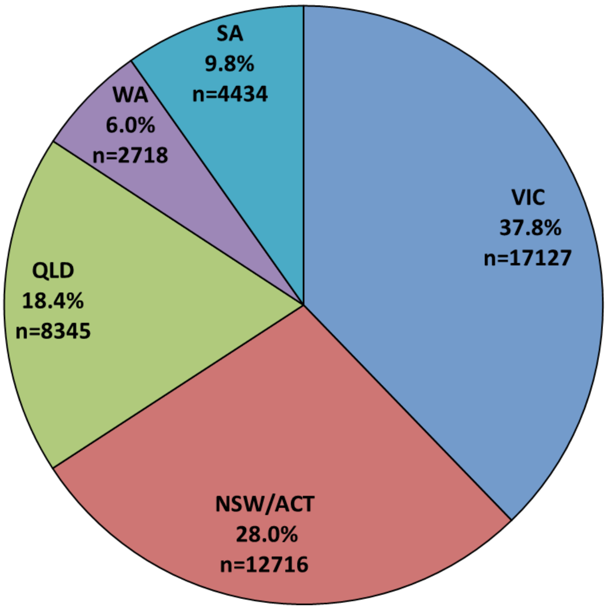
The proportion of total cardiac surgery procedures performed in participating Australian units is reported by jurisdiction (Figure 1).

Figure 1. Proportion of cardiac procedures reported by contributing units in each jurisdiction

a. 2017



b. 2013-2016

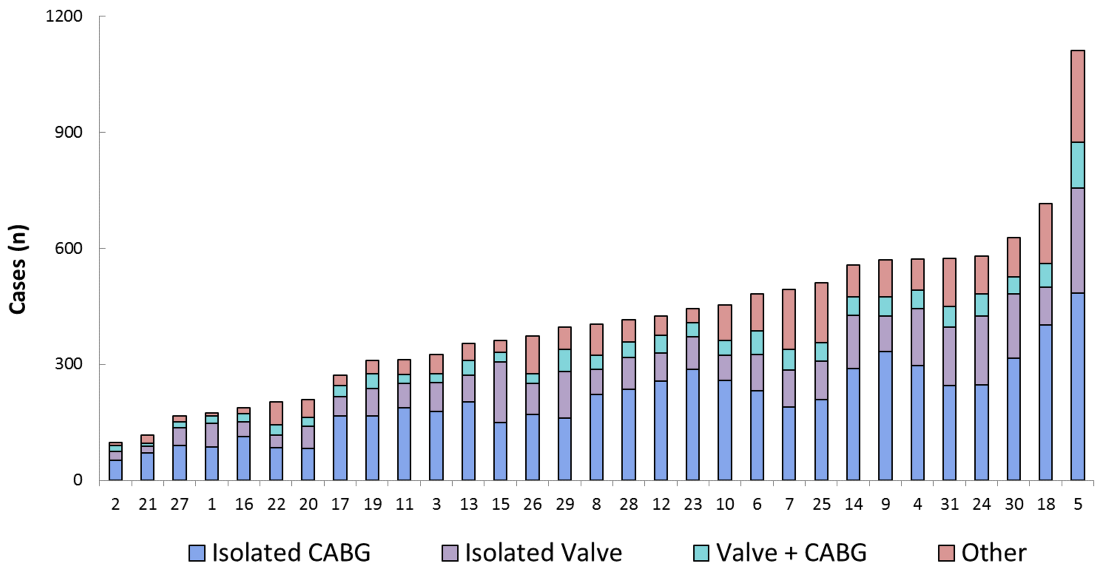


Overview of procedure types

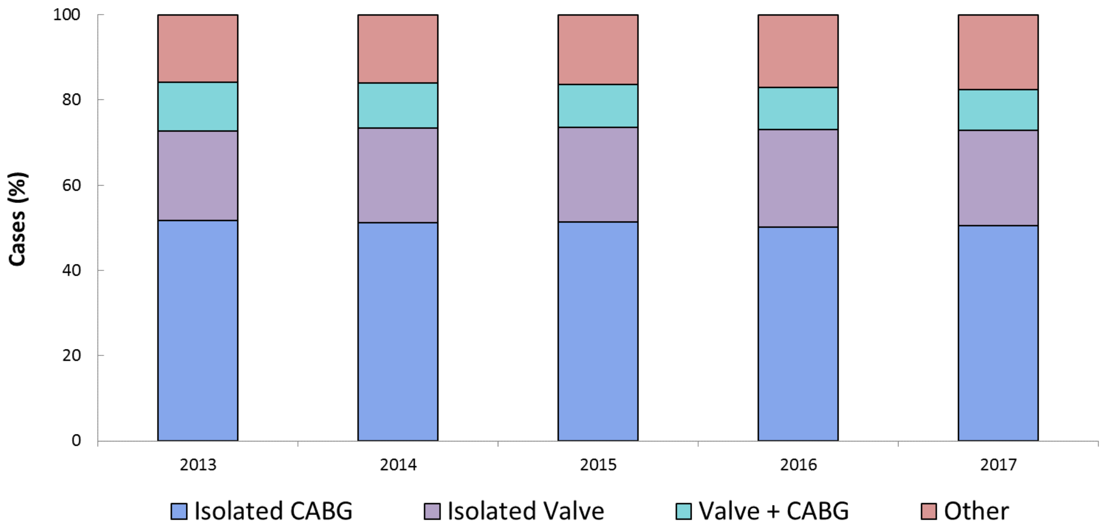
Isolated CABG was the most common major cardiac procedure performed in 2017, and annually since 2013, accounting for more than 50% of the cardiac procedures reported to the ANZSCTS Database (Figure 2).

Figure 2. Cardiac procedure types performed by a. unit in 2017 and b. year

a.

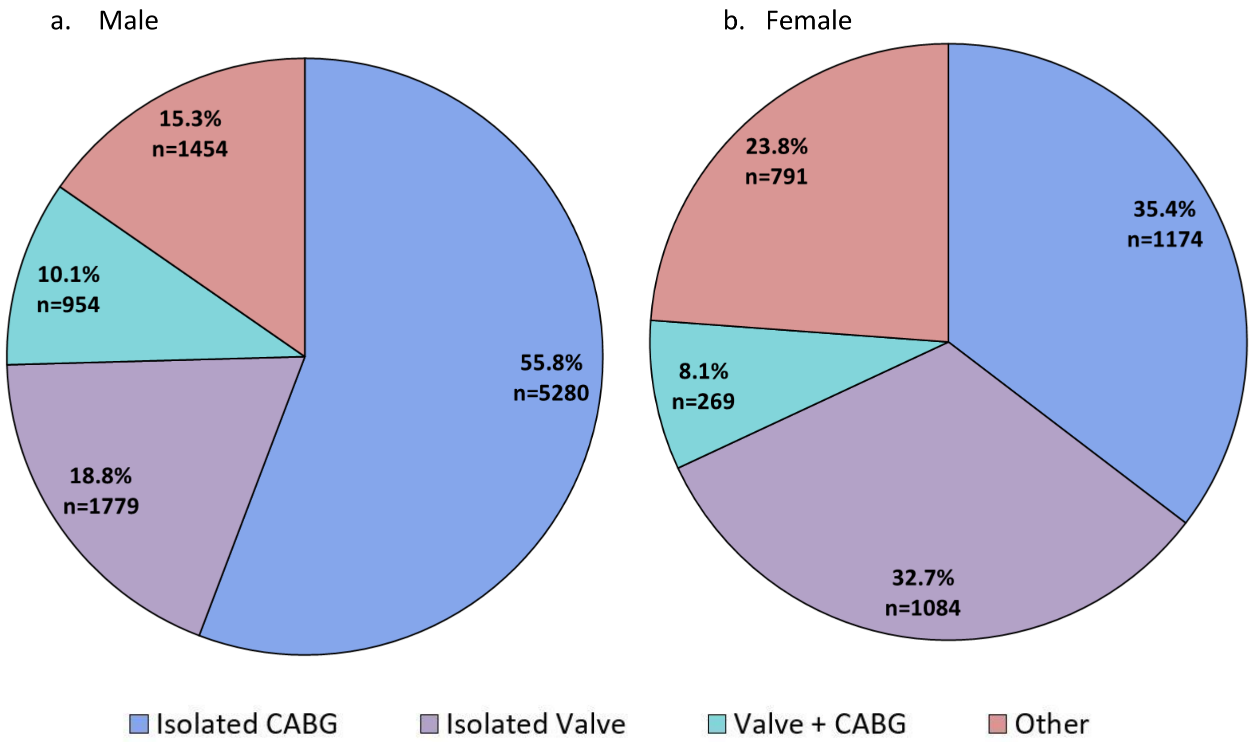


b.



There is a gender difference in the types of procedures performed. Male patients predominantly underwent isolated CABG procedures while women had more isolated valve and other types of cardiac surgery, proportionally.

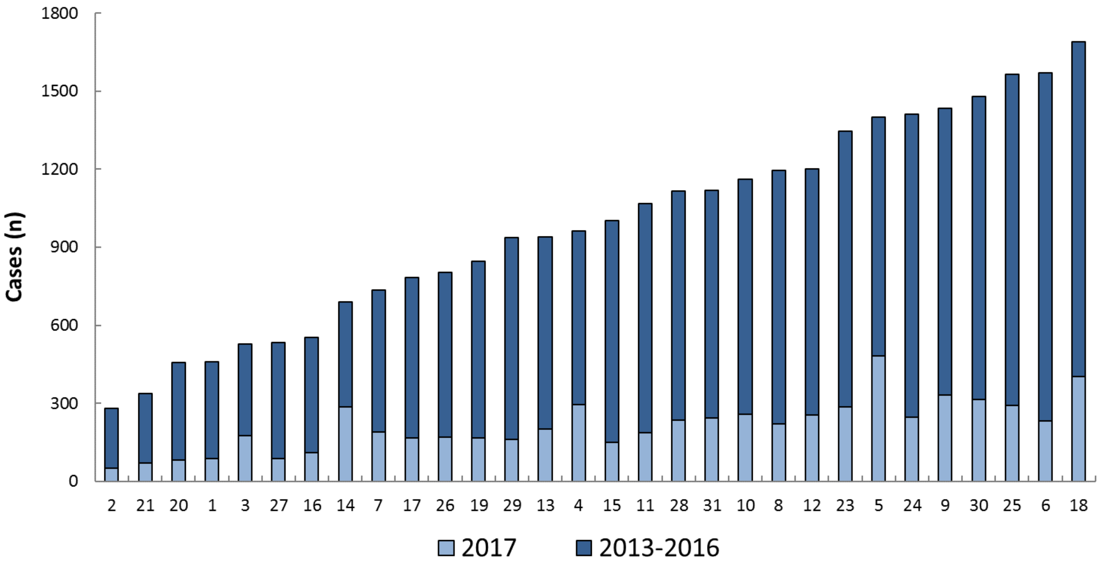
Figure 3. Cardiac procedure types performed in 2017 on a. males and b. females



1. Isolated CABG

In 2017, the number of isolated CABG procedures performed varied widely between units, ranging from 52 to 483 (Figure 4). Not all units contributed data for the entire 2013-2016 period; therefore, numerical comparisons cannot be made for the pooled data.

Figure 4. Isolated CABG procedures performed by unit, 2013-2017



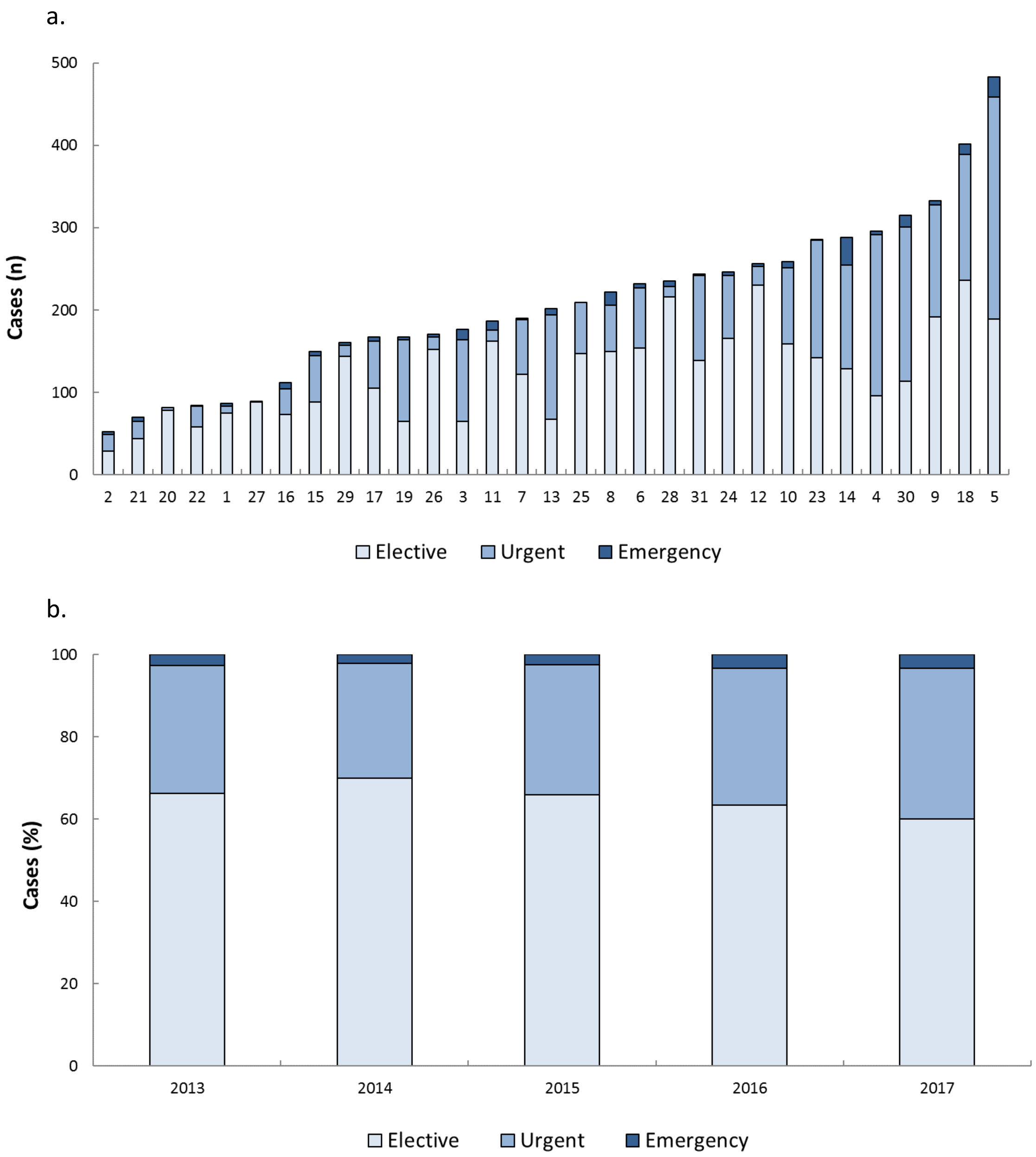
1.1 Patient characteristics

The risk profile of isolated CABG patients has changed significantly over the past few decades, with patients increasingly presenting later in life and with more comorbidities[1–4]. Key patient characteristics that influence the outcomes of surgery include clinical status, gender, age and comorbidities. The distributions of these factors in the Australian cardiac surgery patient population are explored in the following sections.

1.1.1 Clinical status

The pooled unit data consistently shows that the majority of patients are categorised as elective (>60%), and less than 4% as emergency (Figure 5b).

Figure 5. Clinical status of isolated CABG procedures by a. unit in 2017 and b. year

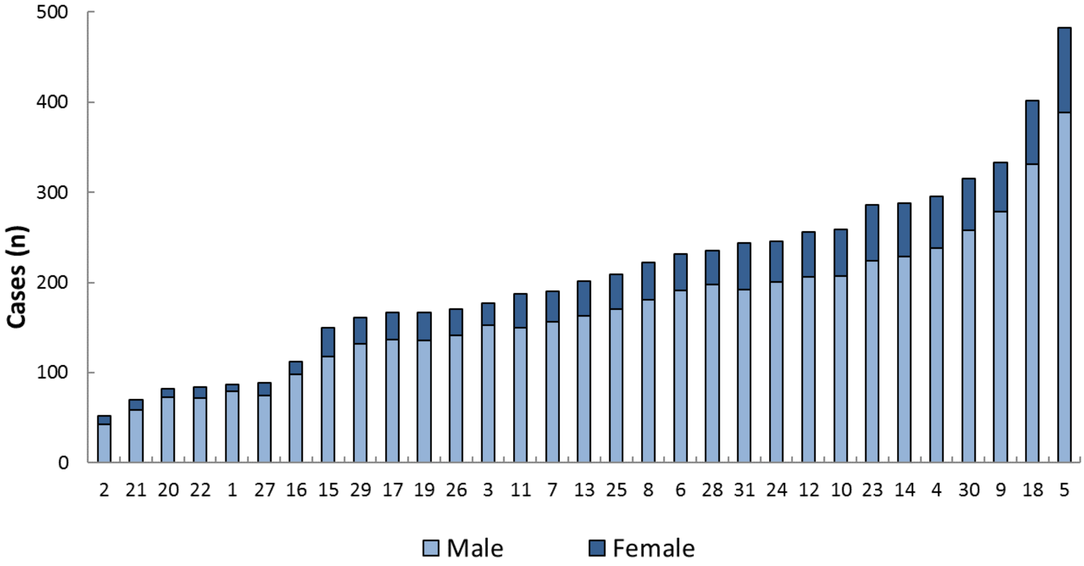


1.1.2 Gender and age

The ratio of male to female patients in 2017 was reasonably consistent between units (Figure 6a). Pooled unit data shows that over the last five years, approximately 80% of patients who had a CABG procedure were male (Figure 6b).

Figure 6. Gender of isolated CABG patients by a. unit in 2017 and b. year

a.



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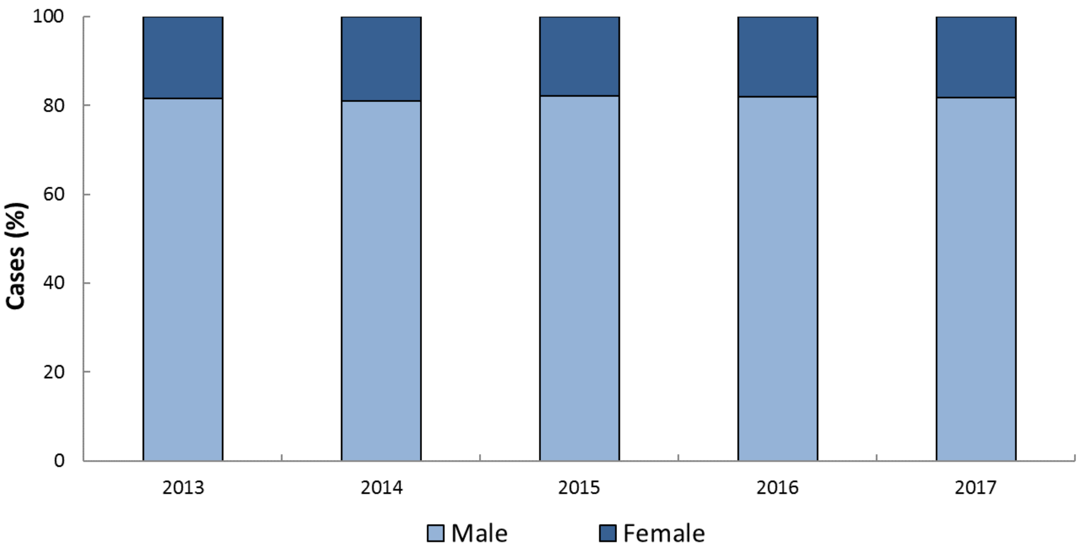
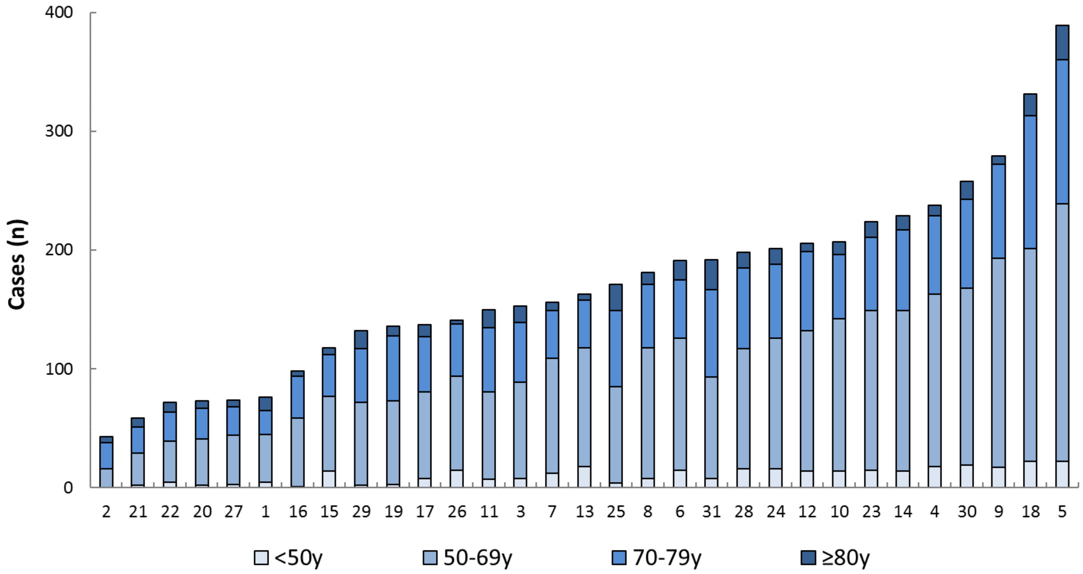


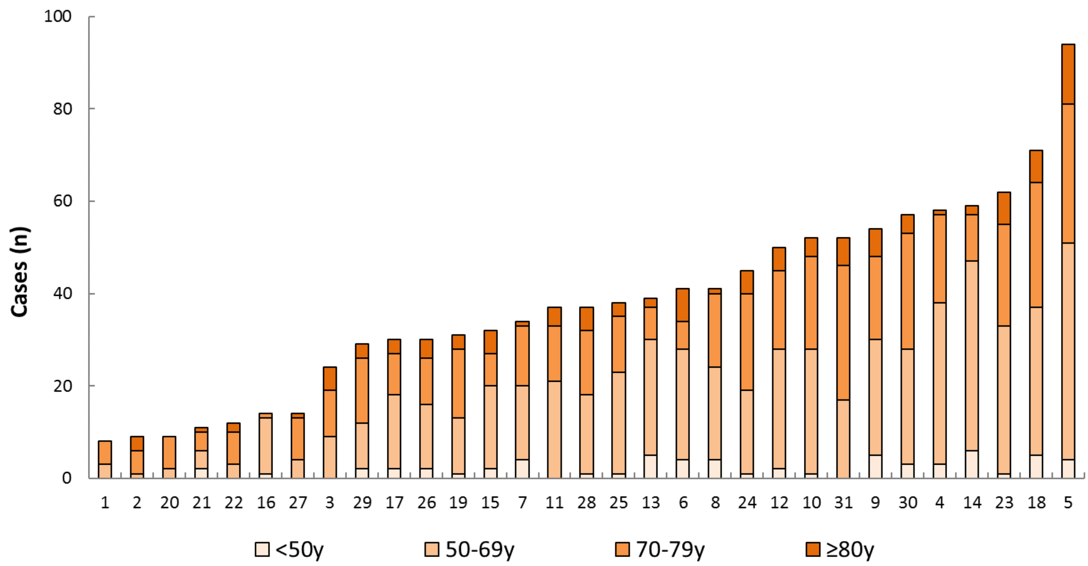
In 2017, the highest proportion of male patients who had a CABG were aged 50-69 years (Figure 7a). For women, the most common age group was less consistent, being 50-69 years for some units, and 70-79 years for other units (Figure 7b).

Figure 7. Number of 2017 isolated CABG cases by age group for a. males and b. females

a.

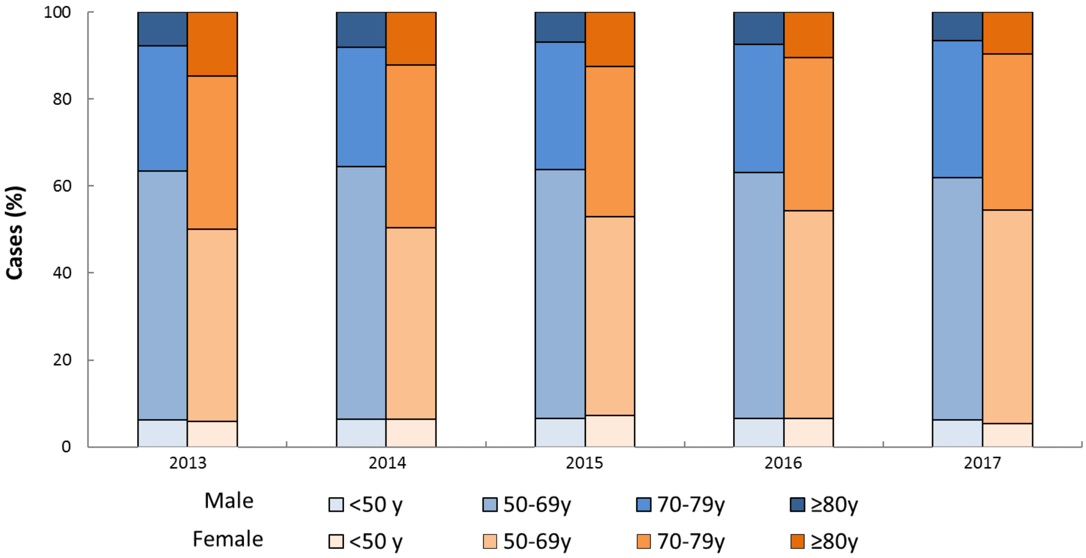


b.



It is understood that women often present with an acute coronary syndrome later in life and with more comorbidities than their male counterparts[5]. Figure 8 shows that for women undergoing isolated CABG procedures over the last five years, a markedly higher proportion have been aged 70 years and over, compared to their male counterparts. This gap between the genders has been gradually decreasing over the last five years.

Figure 8. Age groupings for male and female patients who had isolated CABG procedures, 2013-2017



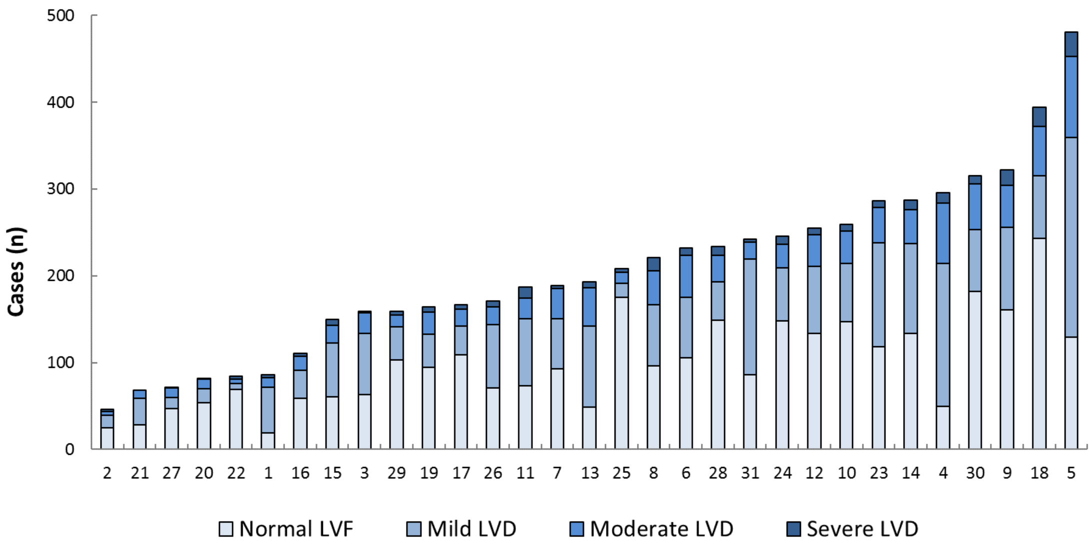
1.1.3 Left ventricular function

The ANZSCTS Database considers a normal left ventricular function (LVF) to be an ejection fraction (EF) greater than 60%. Patients with mild left ventricular dysfunction (LVD) have an EF between 46-60%, those with moderate LVD have an EF between 30-45%, and those with severe LVD have an EF of <30%.

Approximately 48% of patients in 2017 had normal LVF and this was consistent between most units (Figure 9a and b). Patients with mild LVD accounted for 33% of cases, while moderate LVD and severe LVD occurred in 15% and 4% of cases, respectively.

Figure 9. Isolated CABG procedures based on pre-procedure LVF by a. unit in 2017 and b. year

a.



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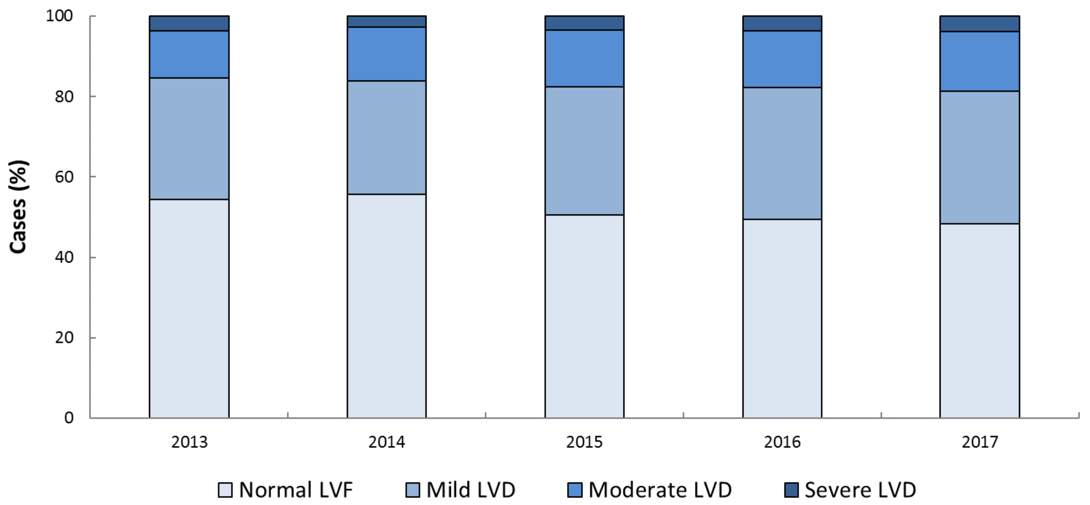
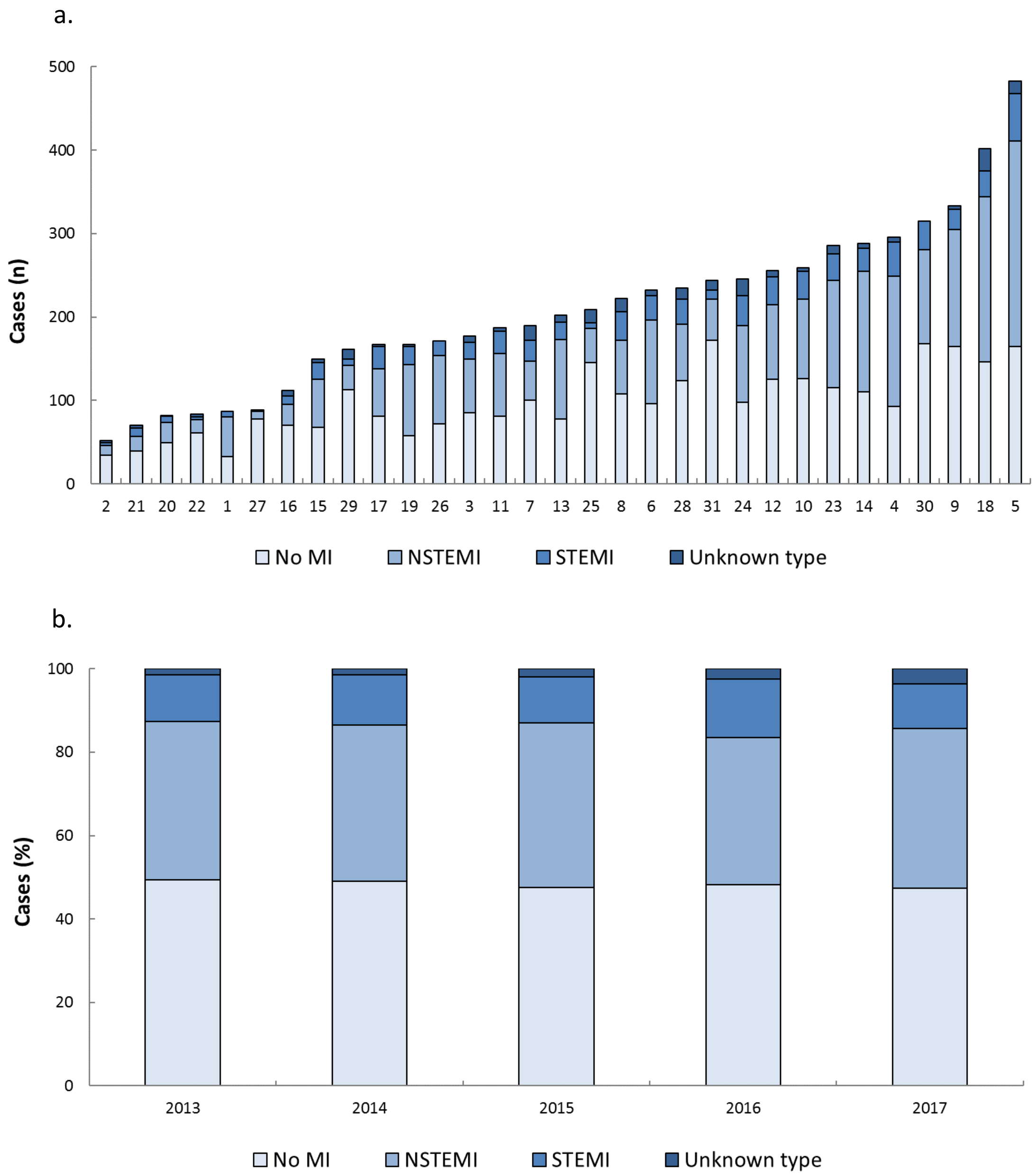


1.1.4 Previous myocardial infarction

The distribution of types of myocardial infarction (MI) was largely similar between all units (Figure 10a). Annual pooled unit data shows that since 2013, approximately 48% of all patients had no MI prior to CABG, 38% had non-ST-elevation MI (NSTEMI), and 12% ST-elevation MI (STEMI; Figure 10b). Approximately 2% of MI cases reported to the Database did not specify the type of MI.

Figure 10. Isolated CABG procedures based on prior MI by a. unit in 2017 and b. year

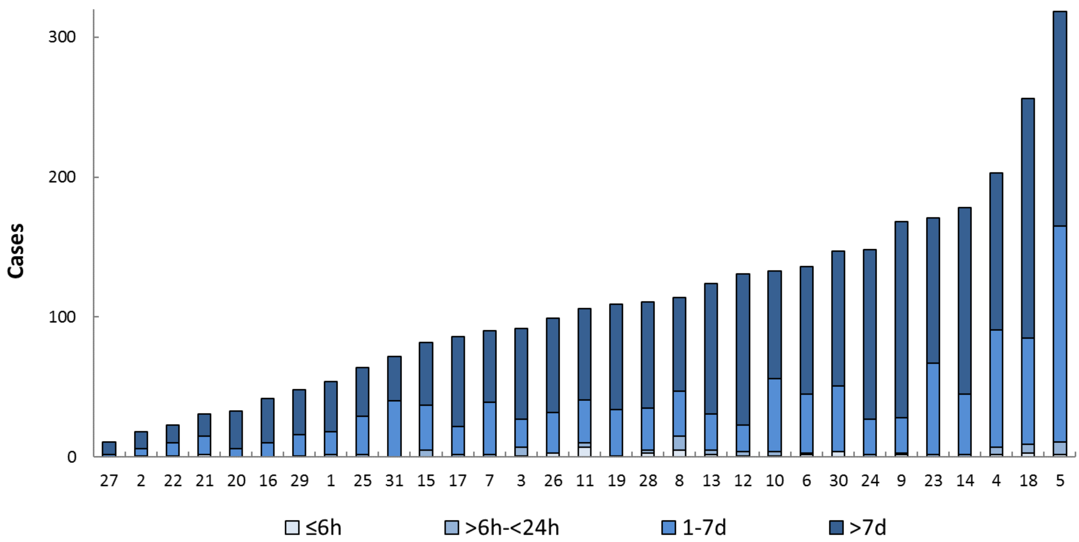


1.1.5 Timing of prior myocardial infarction

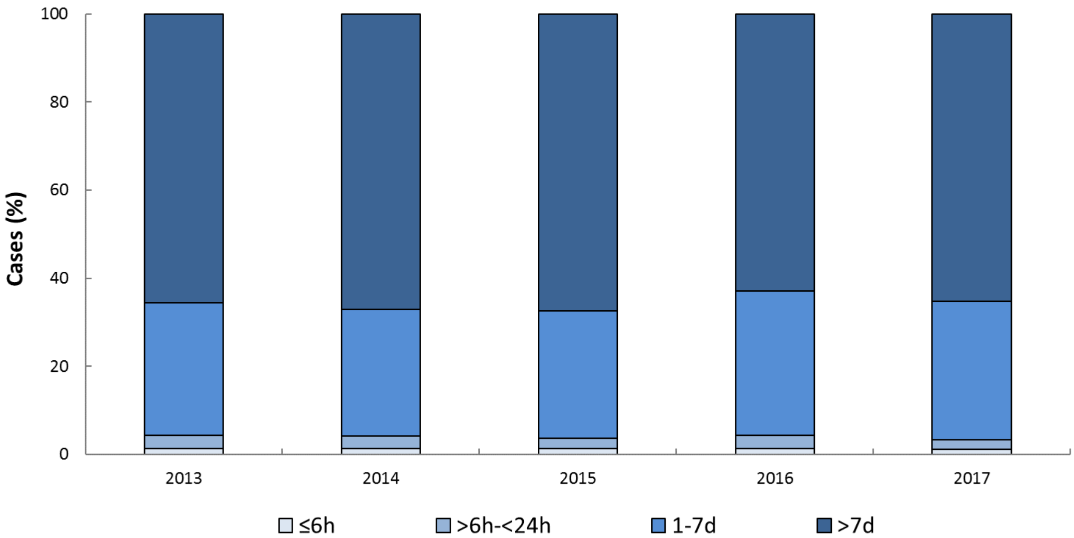
In all units, the majority of cases with a prior MI reported the incident as having occurred more than seven days before CABG surgery (Figure 11a). This is consistent with the pooled data over the last five years (Figure 11b). In 2017, 31% of patients had a MI 1-7 days pre-operatively, while MIs within 24 hours of surgery occurred in less than 4% of cases.

Figure 11. Isolated CABG procedures based on timing of pre-procedure MI by a. unit in 2017 and b. year

a.



b.



1.2 Previous surgery and use of cardiopulmonary bypass

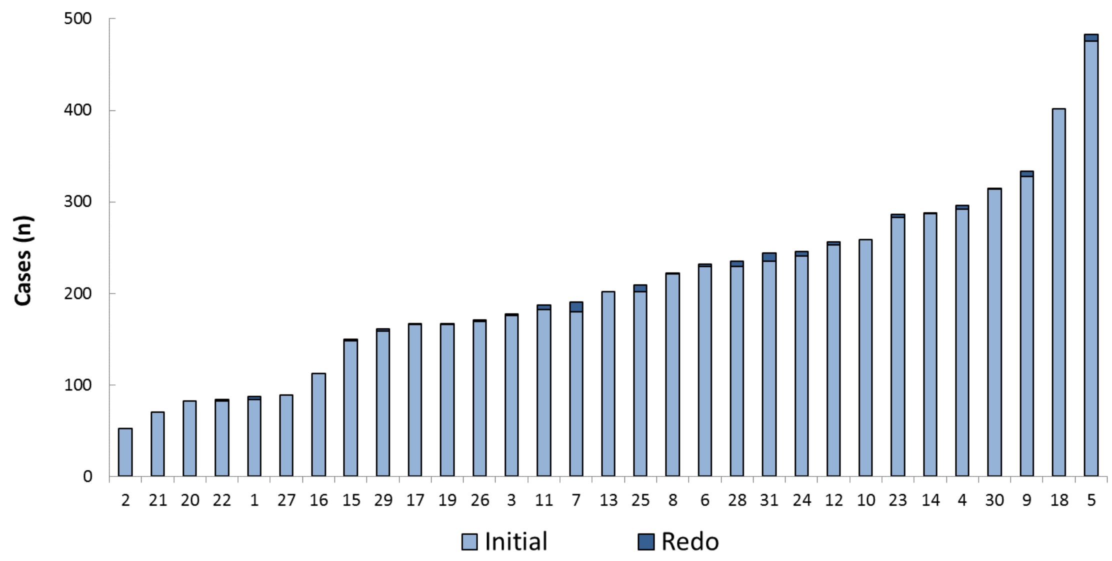
1.2.1 Initial versus redo procedures

In 2017, 98.7% of cases were initial procedures. This was consistent between units (Figure 12a). Since 2013, the frequency of redo procedures has decreased progressively (Figure 12b).

A procedure is considered a redo if the patient has had any prior cardiac surgery.

Figure 12. Initial versus redo isolated CABG by a. unit in 2017 and b. year

a.



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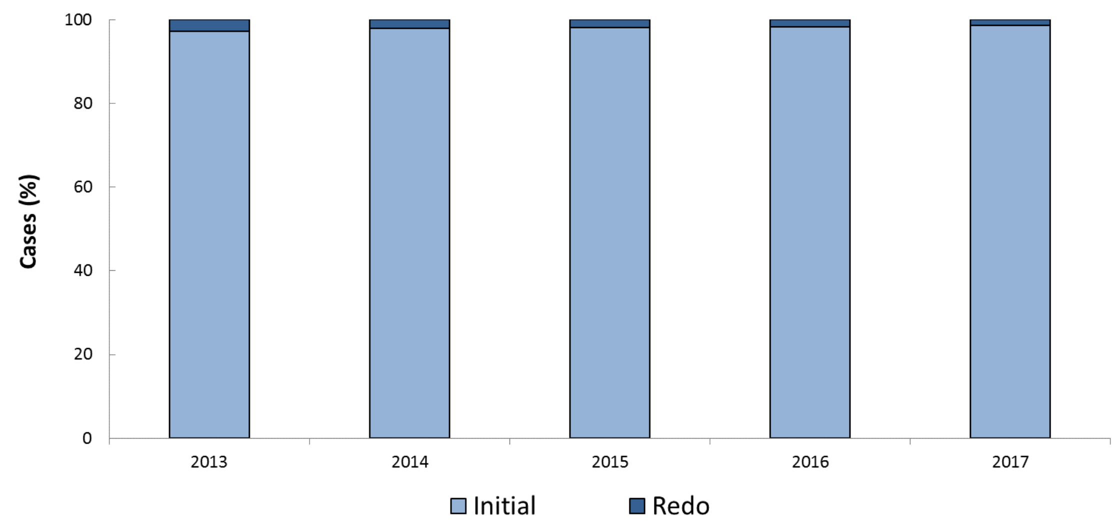
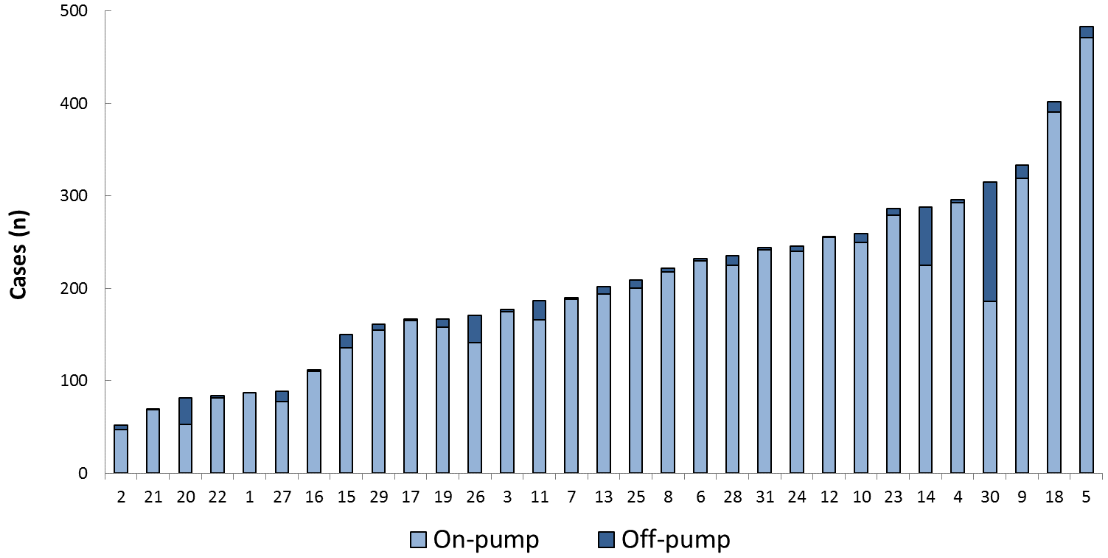


1.2.2 On-pump versus off-pump

There is variation between the units in the proportion of procedures performed off-pump. Four units performed a notably higher ratio of off-pump to on-pump operations (Figure 13a). In 2017, 93% of cases were performed using cardiopulmonary bypass (CPB), and this figure has stayed relatively consistent since 2015 (Figure 13b).

Figure 13. On-pump and off-pump isolated CABG by a. unit in 2017 and b. year

a.



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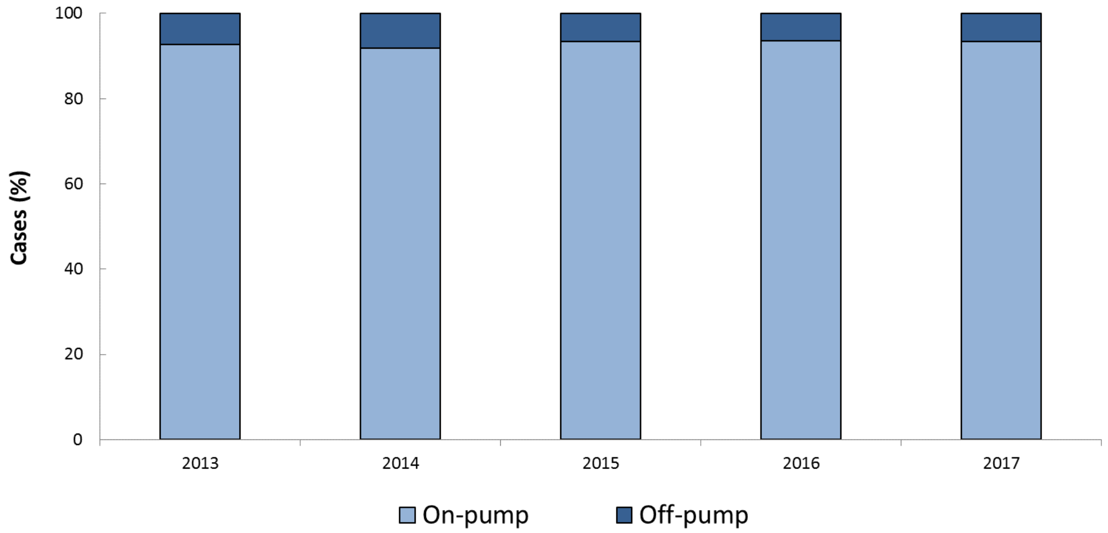


1.3 Conduits used and distal anastomoses performed

The use of conduits varied between on- and off-pump CABG procedures. Off-pump CABG procedures were associated with, on average, fewer grafts than on-pump procedures. A greater proportion of off-pump procedures involved total arterial revascularisation. These findings are consistent between the most recent 2017 data and the pooled 2013-2016 data (Table 2a).

Compared to on-pump, off-pump procedures more commonly use bilateral internal thoracic artery (ITA) and T and Y grafts (Table 2b). In 2017, the rate of single or bilateral ITA use was 94.2% for on-pump patients and 97.7% for off-pump, while the rate of radial artery (RA) use was 36.5% and 28.6% for on-pump and off-pump patients, respectively.

Table 2a. Summary of anastomoses and conduits for on-pump and off-pump isolated CABG

		On-pump	Off-pump
No. of patients	2017	6028	426
	2013-2016	21518	1640
Mean no. grafts	2017	3.1	2.4
	2013-2016	3.2	2.3
Only arterial grafts (%)	2017	20.7	61.7
	2013-2016	21.6	64.9
Arterial with SVG grafts* (%)	2017	79.3	38.3
	2013-2016	78.3	35.0

*Proportion of procedures in which at least one vein graft was used

Table 2b. Arterial conduits used for on-pump and off-pump isolated CABG (% of patients)

		On-pump	Off-pump
BITA	2017	7.9	24.2
	2013-2016	8.6	21.7
GEPA	2017	0.1	0.0
	2013-2016	0.4	0.4
LITA or RITA	2017	86.3	73.5
	2013-2016	85.6	76.4
RA (x1 or x2)	2017	36.5	28.6
	2013-2016	37.3	28.7
T or Y grafts*	2017	9.0	14.1
	2013-2016	9.2	21.0

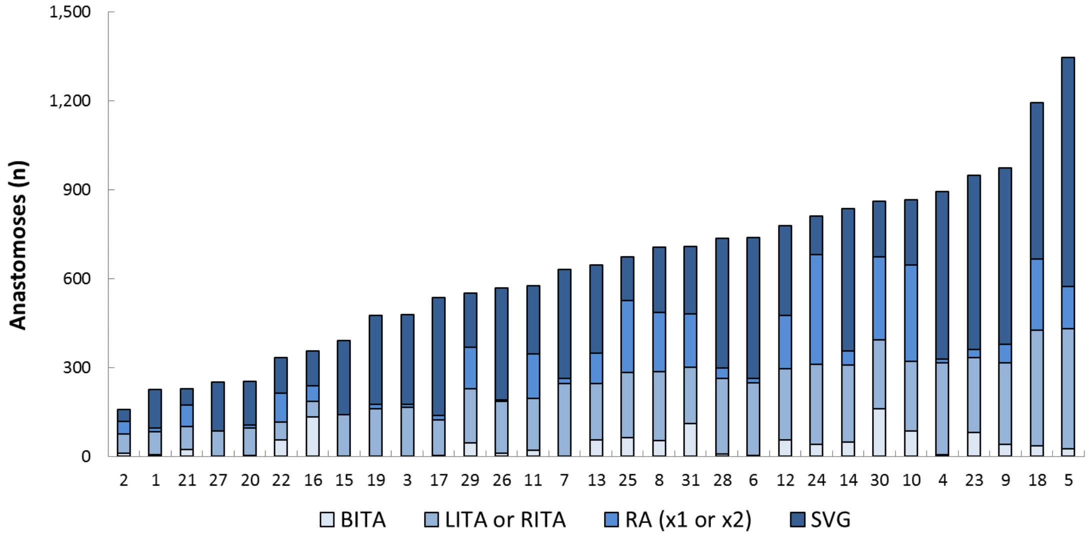
*Arterial only

1.4 Arterial and venous conduit usage

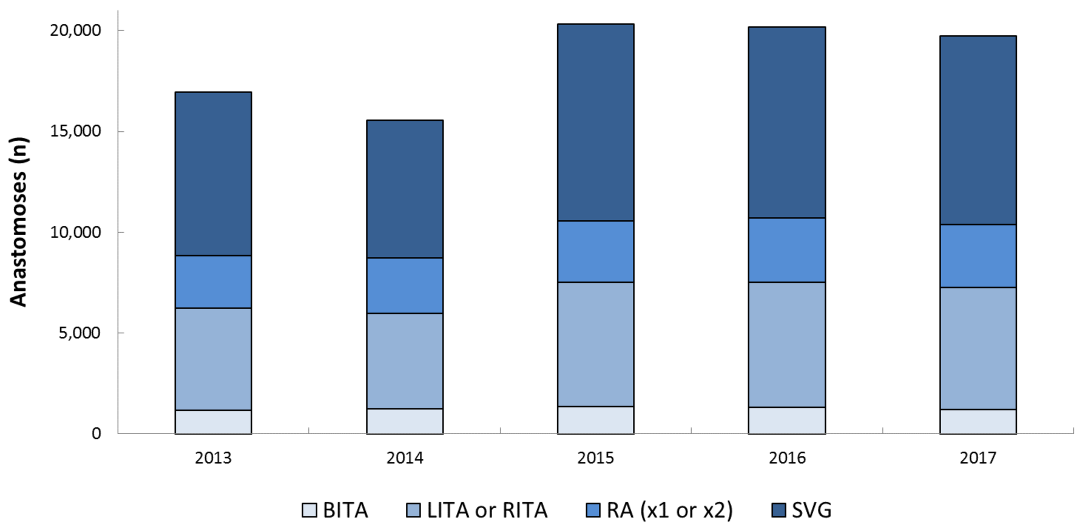
In 2017, there was some variation in the proportions of arterial and venous conduit usage between the cardiac surgical units (Figure 14a). Since 2013, the overall frequency of use of the arterial and venous conduit options has remained broadly similar, with saphenous vein grafts accounting for approximately 47% of anastomoses, ITA grafts accounting for 37%, and radial artery grafts for 16% (Figure 14b).

Figure 14. Number of arterial and venous anastomoses used in isolated CABG procedures by a. unit in 2017 and b. year

a.



b.



1.5 Effect of co-morbidities on complications

Post-operative complications considered in this report include any cerebrovascular accident (CVA), deep sternal wound infection (DSWI), new cardiac arrhythmia (NCA), and re-operation (re-op) for bleeding or tamponade. Data on the incidence of derived new renal impairment (DNRI) is presented separately, to allow for the exclusion of patients with pre-operative renal impairment. In the following section, these complications are evaluated in the context of key cardiac surgery patient comorbidities.

1.5.1 Pre-existing diabetes and renal impairment

This report compares two parameters of renal impairment: patients with a pre-operative creatinine level of ≥200 µmol/L or those with a pre-operative estimated glomerular filtration rate (eGFR) ≤60 mL/min/1.73m^2.

The data confirm that patients with diabetes and/or prior renal impairment have a higher incidence of some post-operative complications (Table 3).

Table 3. Complications (%) for isolated CABG patients based on pre-operative diabetes and renal function status

		Diabetes*^		Pre-op creatinine		Pre-op eGFR	
		No	Yes	<200 µmol/L	≥200 µmol/L	>60mL /min/1.73m2	≤60mL /min/1.73m2
n	2017	3909	2543	6269	185	5119	1335
	2013-2016	14392	8756	22550	609	17647	5512
Any CVA	2017	0.9	2.0	1.3	4.3	1.0	2.5
	2013-2016	1.1	1.5	1.2	2.5	0.9	2.1
DSWI	2017	1.1	2.2	1.5	3.8	1.4	2.1
	2013-2016	0.9	1.7	1.2	2.3	1.2	1.3
NCA	2017	26.2	26.4	26.0	33.9	24.7	32.1
	2013-2016	26.1	25.1	25.6	29.9	24.5	29.9
Re-op for bleeding	2017	2.4	2.5	2.3	5.4	2.3	3.0
	2013-2016	2.3	2.1	2.1	4.4	1.9	3.3

*Two and 11 missing cases in 2017 and 2013-2016, respectively
^Refers to all diabetes, regardless of type of therapy

1.5.2 Age

Advancing age was associated with higher incidence of any CVA and NCA; however, the incidence of DSWI appears to be independent of age (Table 4).

Table 4. Complications (%) for isolated CABG patients based on patient age

		Age			
		<50 y	50-69 y	70-79 y	≥80 y
n	2017	389	3519	2078	464
	2013-2016	1482	12769	6955	1951
Any CVA	2017	0.5	1.1	1.9	1.7
	2013-2016	0.8	0.9	1.6	2.1
DSWI	2017	1.5	1.3	1.9	1.1
	2013-2016	1.0	1.2	1.2	1.1
NCA	2017	11.1	22.5	33.4	35.6
	2013-2016	10.3	22.4	32.1	36.6
Re-op for bleeding	2017	4.4	2.2	2.3	3.4
	2013-2016	2.4	1.9	2.5	2.9

1.5.3 Surgical history or use of cardiopulmonary bypass

Redo CABG and procedures using CPB were associated with a higher incidence of some post-operative complications, compared to initial CABG and off-pump surgery (Table 5).

Table 5. Complications (%) for isolated CABG patients based on surgical history or use of CPB

		Surgery		CPB*	
		Initial	Redo	On-pump	Off-pump
n	2017	6370	84	6028	426
	2013-2016	22668	491	21518	1640
Any CVA	2017	1.4	0.0	1.3	1.4
	2013-2016	1.2	1.2	1.2	0.8
DSWI	2017	1.5	2.4	1.5	1.2
	2013-2016	1.2	1.6	1.2	0.6
NCA	2017	26.1	38.1	26.4	24.9
	2013-2016	25.7	27.9	25.8	24.7
Re-op for bleeding	2017	2.4	1.2	2.3	4.2
	2013-2016	2.2	2.9	2.2	2.1

*Five and 18 missing cases in 2017 and 2013-2016, respectively

1.5.4 Effect of comorbidities on derived new renal impairment

Patients with diabetes, pre-operative renal impairment, increasing age, or who underwent on-pump cardiac surgery had an increased incidence of DNRI (Table 6). In particular, patients in 2017 with pre-operative creatinine ≥200 µmol/L or eGFR ≤60 mL/min/1.73m^2 had 9- and 3-fold increases in the incidence of DNRI, respectively. This data excludes patients that received pre-operative dialysis.

Table 6. DNRI (%) for isolated CABG patients based on diabetes, renal impairment, age, surgical history and use of CPB

	2017		2013-2016	
	n	DNRI (%)	n	DNRI (%)
Diabetes*^				
No	3882	2.5	14293	2.4
Yes	2456	3.8	8500	4.0
Pre-op creatinine				
<200 µmol/L	6252	2.7	22494	2.8
≥200 µmol/L	88	23.9	310	15.2
Pre-op eGFR				
>60mL/min/1.73m2	5110	2.1	17612	2.3
≤60mL/min/1.73m2	1230	6.7	5192	5.3
Age†				
<50y	380	2.1	1441	2.2
50-69y	3443	2.5	12547	2.5
70-79y	2050	3.6	6878	3.2
≥80y	463	5.0	1936	5.4
Previous surgery				
Initial	6259	3.0	22328	2.9
Redo	81	2.5	476	4.6
Cardiopulmonary bypass~				
On-pump	5920	3.0	21185	3.0
Off-pump	420	2.6	1618	2.2

*Two and 11 missing cases in 2017 and 2013-2016, respectively
^Refers to all diabetes, regardless of type of therapy
†Four and two cases missing for 2017 and 2013-2016, respectively
~One case missing from 2013-2016

1.6 Influence of patient characteristics on mortality

In 2017, observed mortality (OM) did not always conform to the trends in the pooled data for the preceding four years. In particular, female patients aged 80 years and over had lower mortality, while male patients aged less than 50 years had higher mortality, compared to the other age groups and pooled data (Table 7). In addition, redo cases had a similar OM to initial cases for the 2017 data. It should be noted that observed mortality is not risk-adjusted and does not account for differences in patient characteristics.

Table 7. Observed mortality (%) for isolated CABG patients, based on patient characteristics

	2017		2013-2016	
	n	OM (%)	n	OM (%)
Clinical status				
Elective	3874	0.8	15317	0.8
Urgent	2366	1.2	7219	1.5
Emergency/salvage	214	6.5	623	7.9
Gender/age				
Male	5280	1.1	18942	1.1
<50y	327	1.2	1207	0.5
50-69y	2941	0.5	10848	0.8
70-79y	1657	1.8	5457	1.6
≥80y	351	2.8	1429	2.5
Female	1174	1.1	4217	1.5
<50y	62	0.0	275	0.4
50-69y	578	0.5	1921	0.9
70-79y	421	2.1	1498	1.9
≥80y	113	0.9	522	3.4
Left ventricular function^				
Normal LVF	3076	0.7	11925	0.8
Mild LVD	2103	0.7	7051	1.0
Moderate LVD	946	2.3	3057	2.1
Severe LVD	241	5.8	787	6.6
Previous MI				
No MI	3056	0.9	11228	0.6
NSTEMI	2469	1.2	8693	1.6
STEMI	690	1.9	2813	2.3
Unknown type	239	1.7	425	1.2
Timing of prior MI				
≤6h	42	9.5	160	12.5
>6h-<24h	73	6.8	328	7.0
1-7d	1065	1.0	3608	1.8
>7d	2218	1.2	7832	1.3
Previous surgery				
Initial	6370	1.1	22668	1.2
Redo	84	1.2	491	3.1
Cardiopulmonary bypass				
On-pump	6028	1.1	21518	1.2
Off-pump	426	1.2	1640	1.0

^88 and 339 cases missing from 2017 and 2013-2016, respectively

1.7 Unit outcomes – mortality, complications and resource utilisation

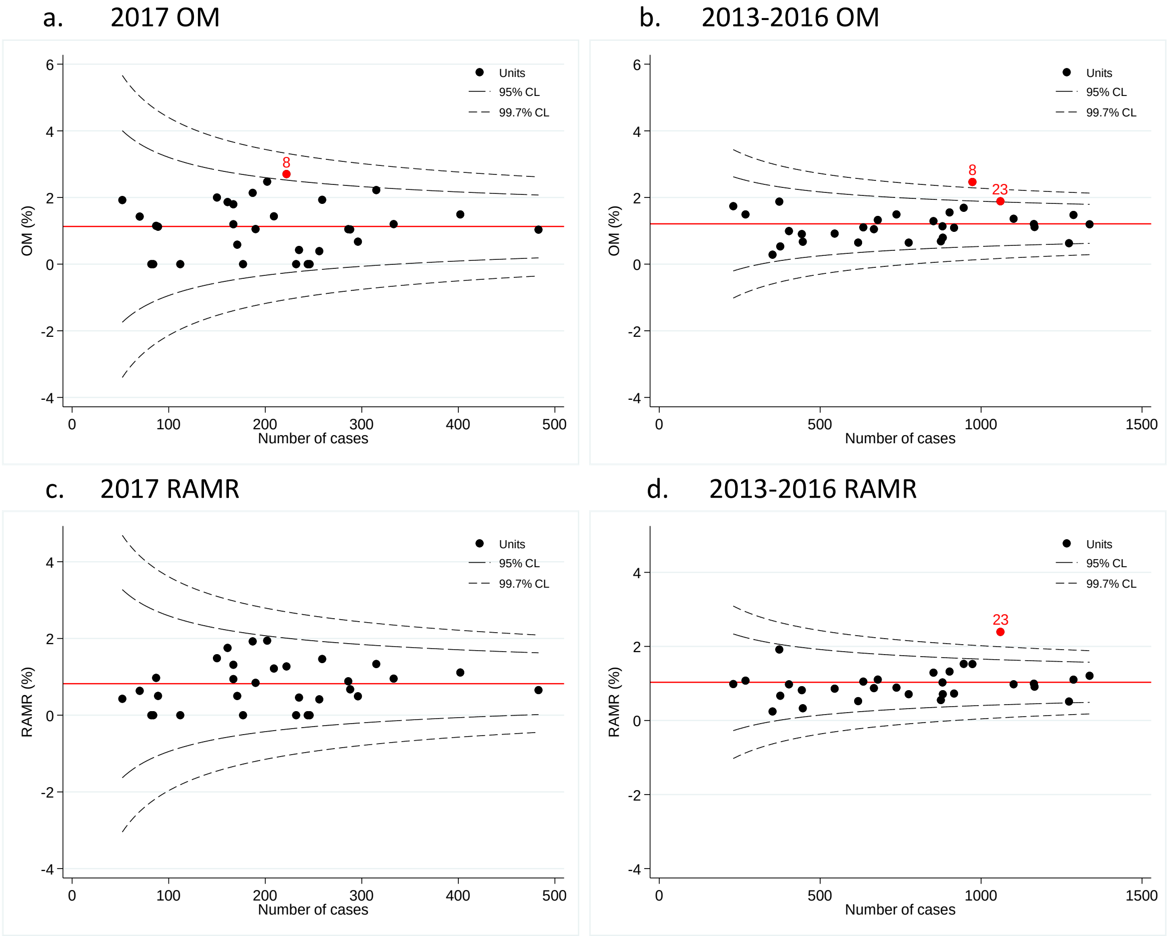
Unit outcomes for mortality and complications are presented in funnel plots, which are explained in detail in Appendix D. The solid line in each plot represents the average value. Units above the upper 99.7% control limit (CL) are notified and managed as outlined in Appendix A.

The complications explored in this section are any CVA, DNRI, DSWI, NCA, readmission, and re-op for bleeding. The resource utilisation variables include duration of intensive care unit (ICU) stay and ventilation; and red blood cell (RBC) and non-RBC transfusion (NRBC).

1.7.1 Mortality

Both the OM and risk-adjusted mortality rates (RAMR) were consistent between 2017 and the preceding four years (Figure 15). An explanation as to how RAMR is calculated is provided in Appendix E.

Figure 15. Mortality by unit following isolated CABG



1.7.2 Complications

The average rates of post-operative complications were largely similar between 2017 and the preceding four years (Figures 16-21). The exception is for DSWI, which was slightly higher in 2017, compared to the 2013-2016 pooled data (Figure 18). The data for rates of DNRI excludes patients who received pre-operative dialysis (Figure 17).

Figure 16. CVA by unit following isolated CABG

a. 2017 CVA b. 2013-2016 CVA

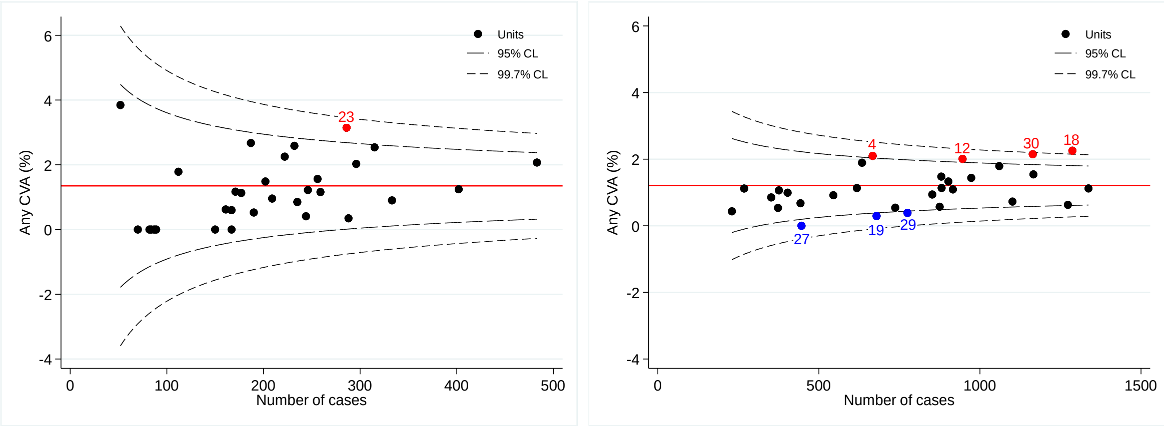


Figure 17. DNRI by unit following isolated CABG

a. 2017 DNRI b. 2013-2016 DNRI

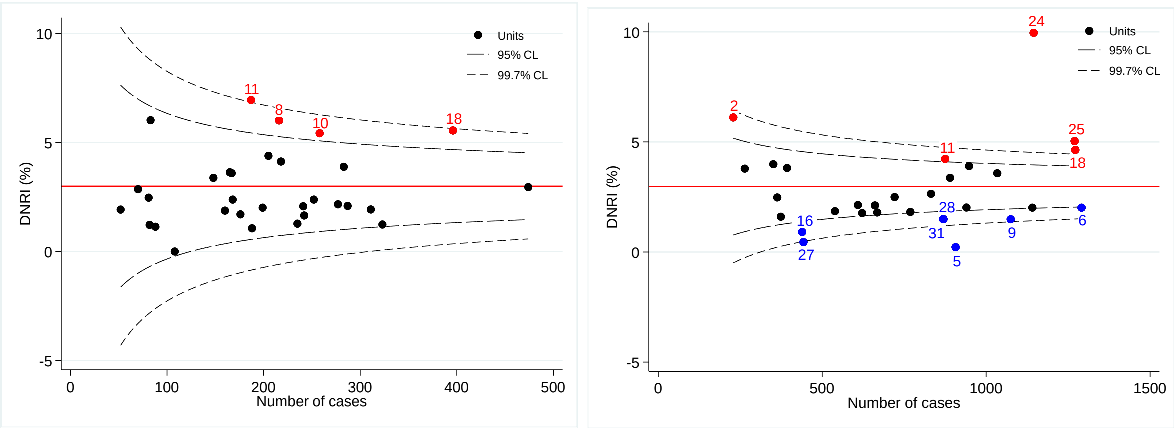


Figure 18. DSWI by unit following isolated CABG

a. 2017 DSWI | b. 2013-2016 DSWI

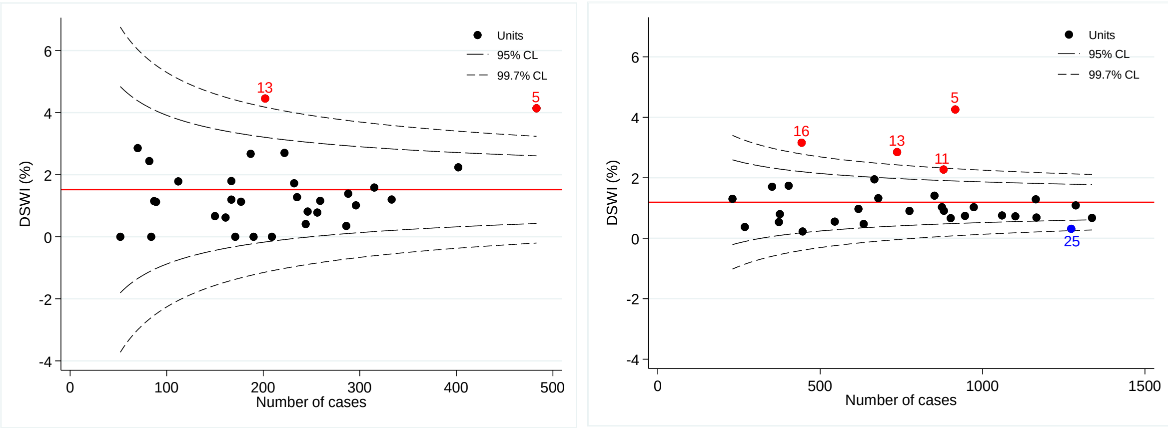


Figure 19. NCA by unit following isolated CABG

a. 2017 NCA | b. 2013-2016 NCA

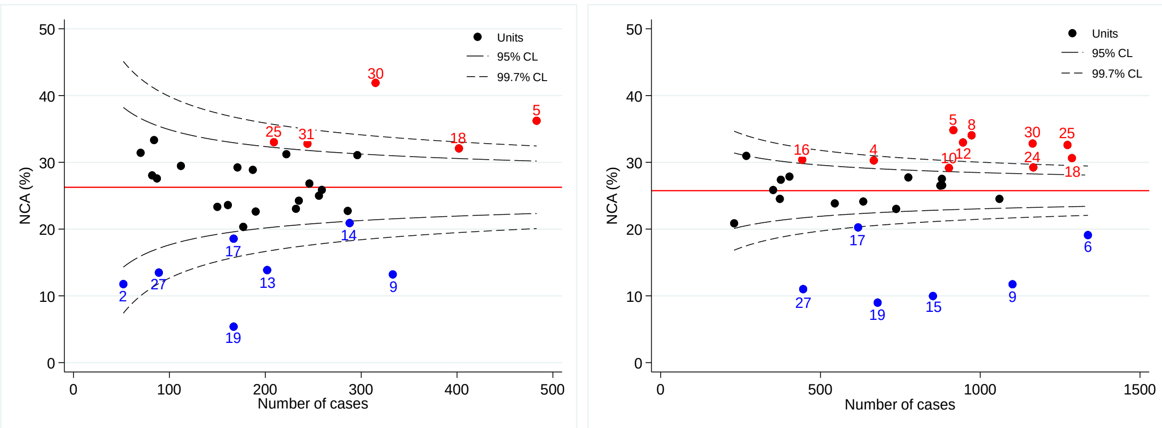


Figure 20. Re-operation for bleeding by unit following isolated CABG

a. 2017 Re-op for bleeding | b. 2013-2016 Re-op for bleeding

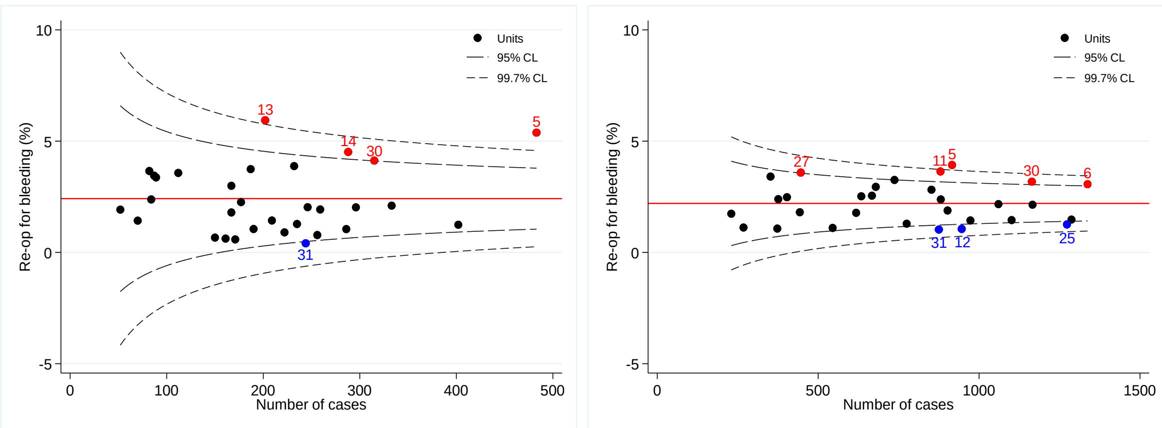
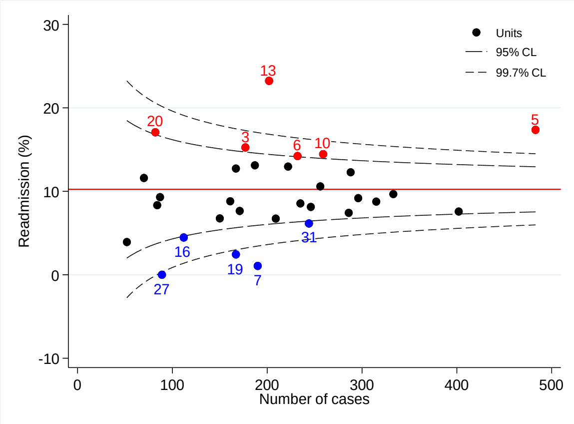
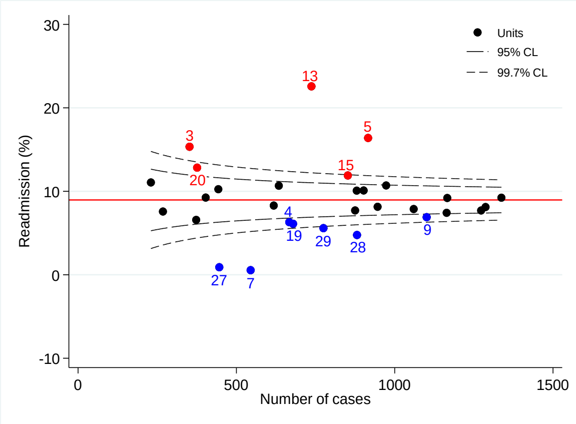


Figure 21. Readmission by unit following isolated CABG

a. 2017 Readmission



b. 2013-2016 Readmission



1.7.3 Resource utilisation

Due to the skewed distribution of the ICU length of stay and ventilation data, the geometric means (GM) are presented. The GM is defined as the nth root of a product of n numbers. It is useful to describe the central tendency of a set of skewed data, as it is less sensitive to outlying values.

In 2017 and the pooled data for the preceding four years, there was marked variation between units with respect to the time patients spent in the ICU, the duration of ventilation, and the percentage of patients who received RBC or NRBC transfusions (Tables 8 and 9).

Table 8. Resource utilisation by unit for isolated CABG patients in 2017

	2017			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	39.1	9.3	26.4	12.6
2	64.1	6.7	23.1	21.2
3	30.3	9.2	20.9	27.1
4	25.8	10.1	19.6	6.4
5	34.8	9.2	28.6	19.7
6	61.0	10.8	29.7	19.4
7	38.3	8.3	30.0	32.1
8	39.7	11.0	12.2	9.9
9	95.5	13.1	39.9	18.3
10	33.5	9.2	31.7	23.2
11	38.3	10.9	34.8	25.1
12	30.4	11.2	32.4	18.8
13	40.0	11.5	29.7	21.3
14	36.8	8.4	22.9	10.4
15	40.5	10.0	29.3	16.7
16	56.9	15.4	28.6	13.4
17	65.1	15.8	52.7	32.3
18	41.1	8.0	27.4	15.4
19	36.1	11.2	37.1	31.7
20	56.3	7.3	17.1	15.9
21	30.6	9.3	12.9	7.1
22	58.8	7.6	50.0	19.0
23	63.5	12.2	34.6	19.2
24	30.3	8.5	29.7	7.7
25	59.4	9.0	42.6	23.4
26	35.1	6.9	26.3	24.6
27	81.2	14.4	12.4	3.4
28	43.6	10.9	37.4	21.7
29	37.3	5.6	16.8	13.7
30	82.2	11.9	38.1	24.1
31	54.0	8.8	12.7	4.9
Total	44.3	9.9	29.3	18.2

Table 9. Resource utilisation by unit for isolated CABG patients, 2013-2016

	2013-2016			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	32.4	9.7	31.0	11.3
2	62.7	6.5	14.3	5.2
3	32.5	10.3	21.3	20.5
4	26.3	9.2	13.2	5.2
5	33.8	10.3	27.7	16.9
6	55.4	10.6	30.2	21.5
7	37.0	8.3	17.6	16.1
8	43.8	11.6	17.8	11.8
9	94.1	12.8	39.9	15.3
10	35.9	9.9	40.7	24.5
11	37.9	11.7	31.9	27.5
12	33.9	10.8	35.2	17.3
13	34.7	11.1	33.2	26.7
14	39.7	9.2	17.9	8.7
15	45.9	13.5	35.7	21.5
16	57.1	12.0	32.3	19.9
17	42.1	14.8	48.7	27.7
18	58.0	8.4	30.9	15.5
19	28.6	12.3	38.0	30.6
20	58.2	7.9	21.0	18.9
21	35.5	10.6	17.9	14.6
23	57.2	13.9	25.8	17.3
24	37.9	9.8	24.2	13.1
25	57.5	8.3	35.0	21.3
26	34.0	8.5	25.6	19.6
27	69.9	15.7	25.6	7.6
28	45.6	11.7	46.8	26.8
29	33.4	6.1	21.7	16.8
30	79.3	11.8	32.9	16.5
31	52.4	8.4	12.0	9.8
Total	45.8	10.4	29.6	18.2

2. Blood product use in patients having elective isolated CABG

There is cogent debate about the precise indications for the use of blood products in cardiac surgical patients. There is evidence that red blood cell transfusions are associated with adverse outcomes, including decreased short and long term survival, and increased incidence of multi-organ failure and length of stay[6–9]. This has prompted a move towards more restrictive transfusion policies.

The Australian Patient Blood Management (PBM) Guidelines were introduced in March, 2012 and include a specific perioperative module. How widely these guidelines have been adopted by cardiac surgical units across Australia is unclear.

Optimisation of blood product use is important for improving patient outcomes, as well as for reducing healthcare expenses and facilitating better resource utilisation. The following analyses examine the current trends in blood product use for patients undergoing elective isolated CABG.

Patients who were reported as having had a transfusion with zero units of blood product were excluded from the transfusion exposure data. Patients who received zero or greater than 50 units of any individual blood product were excluded from the volume analyses.

Part 1: Trend data 2008-2017

a. Transfusion

There was a steep decline in the frequency of red blood cell (RBC) transfusions between 2011 and 2014, then a more gradual decline over the last three years (Figure 22). It is interesting to note that the start of this decline preceded publication of the PBM guidelines. In 2017, approximately 26% of patients having elective CABG received RBC transfusions. The mean volume of RBC units transfused per patient has remained steady (Figure 23).

There was a similar decline in the frequency of transfusion of non-RBC (NRBC) products between 2011 and 2014, which has also levelled out in recent years (Figure 24). This reduction seems largely due to a decrease in the use of fresh frozen plasma (FFP) and, to a lesser extent, platelets (Figure 25). The NRBC products included in these analyses are platelets, FFP and cryoprecipitate (cryo).

Figure 22. Percentage of patients who received a RBC transfusion

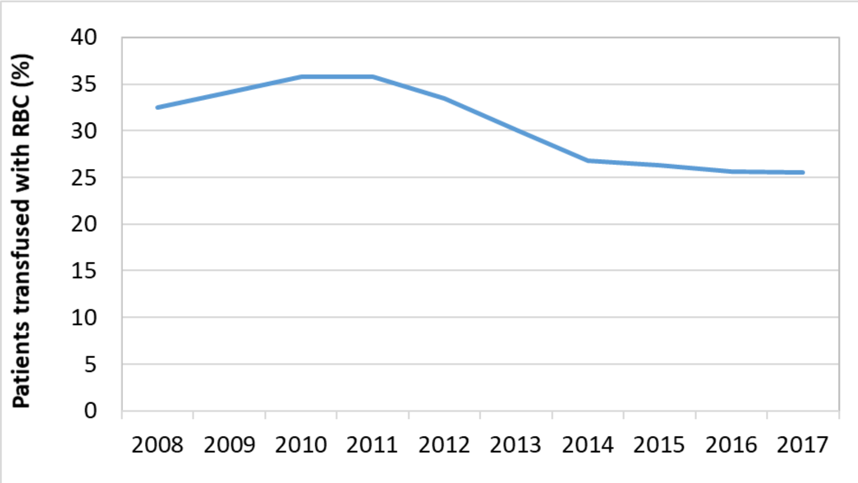


Figure 23. Mean volume (units) of RBCs used per transfused patient

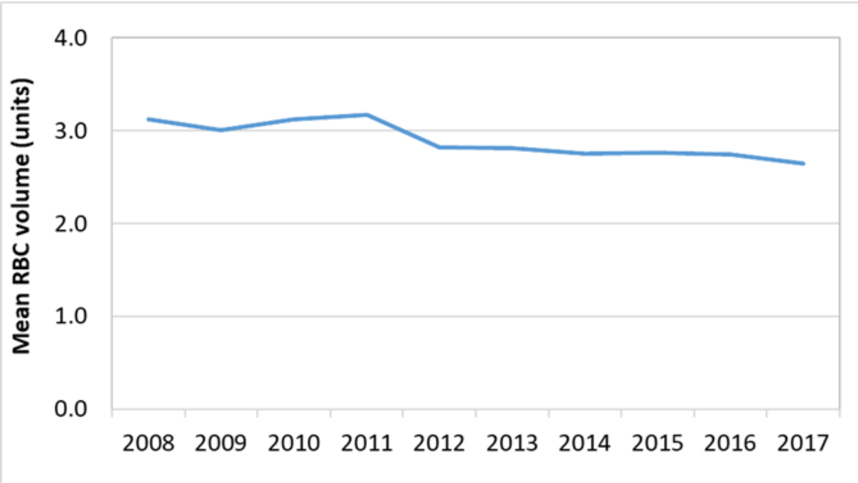


Figure 24. Percentage of patients who received NRBC transfusions

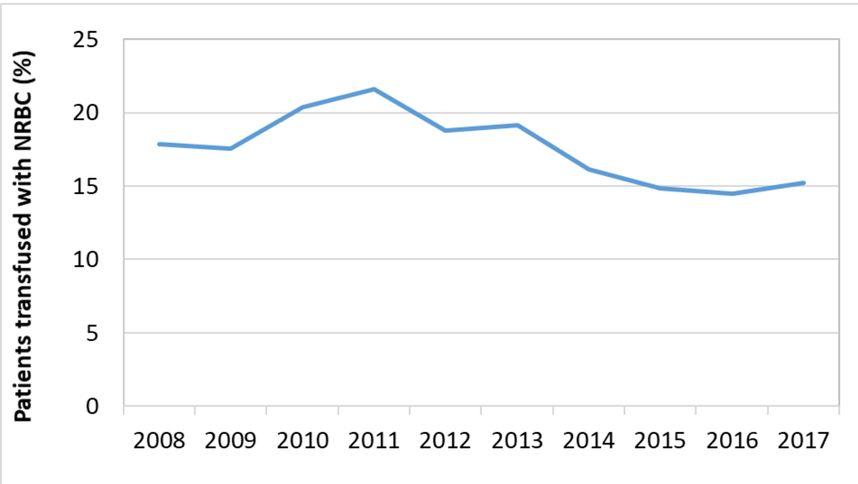
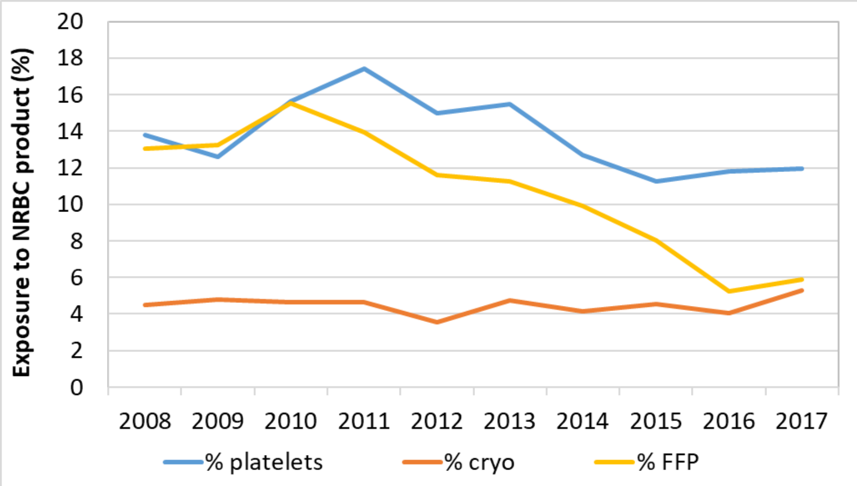


Figure 25. Percentage of patients that received platelets, FFP, and/or cryoprecipitate



b. Post-operative blood loss

There has been a general trend towards lower four-hour post-operative intrathoracic drain (ITD) fluid loss in recent years (Figure 26). This decline has continued during the period of stabilised RBC transfusions shown in Figure 22. Despite the reduction in RBC transfusions, NRBC transfusions, and ITD loss, the rate of re-operation for bleeding has remained steady since 2008 (Figure 27).

Figure 26. Mean four-hour post-operative ITD loss

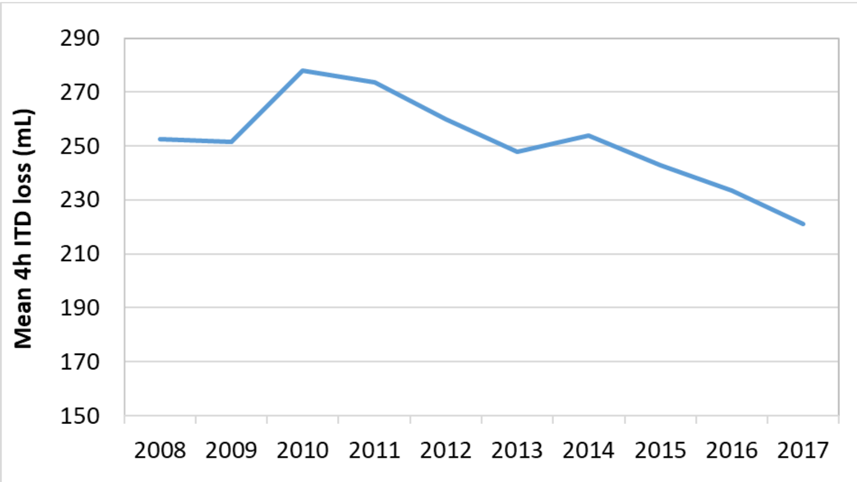
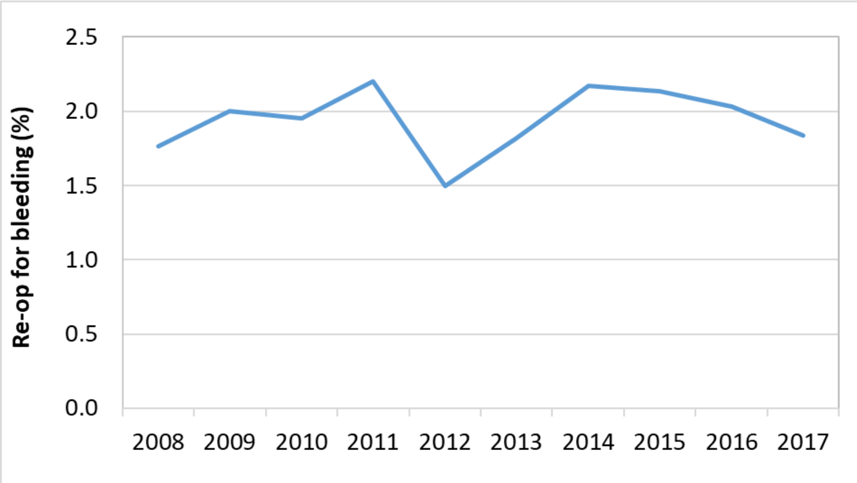


Figure 27. Percentage of patients returned to theatre for bleeding or tamponade



c. Review of factors that may influence transfusion and blood loss

Since 2008, there has been a steady increase in the proportion of patients taking antiplatelet medication within two days of surgery (Figure 28). This corresponds to a steady decrease in the proportion of patients not taking any antiplatelet medication peri-operatively, and to a smaller reduction in the number of patients who ceased treatment more than two days prior to surgery. In this analysis, antiplatelet therapy includes treatment with aspirin, thienopyridine, ticagrelor, aggrastat, abciximab and other agents.

The increased frequency of antiplatelet use within two days of surgery is primarily due to the increased use of aspirin (Figure 29). Less than 2% of patients use solely non-aspirin antiplatelet therapies in the pre-operative period, and this rate has been steady since 2008 (Figure 30).

Figure 28. Percentage of patients on any pre-operative antiplatelet therapy

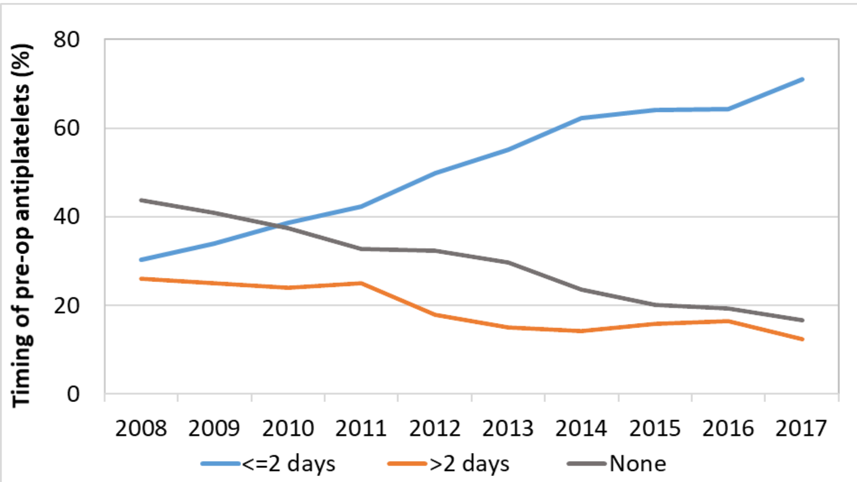


Figure 29. Percentage of patients on pre-operative aspirin (+/- other antiplatelet therapy)

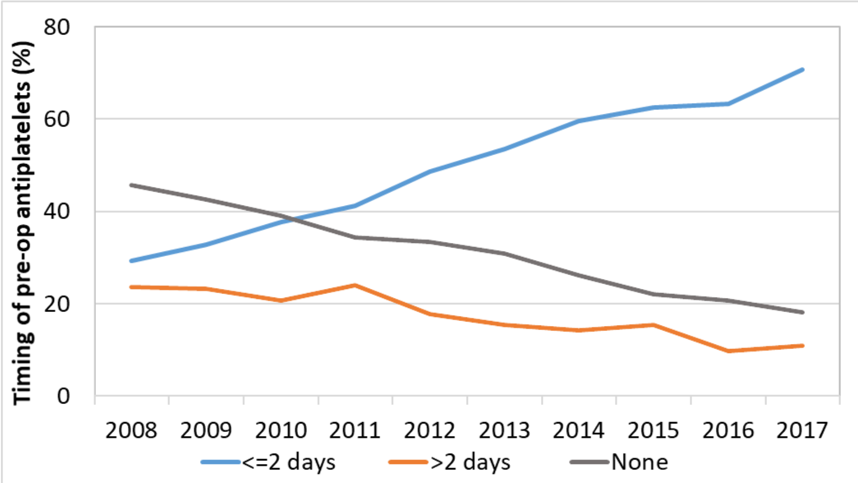
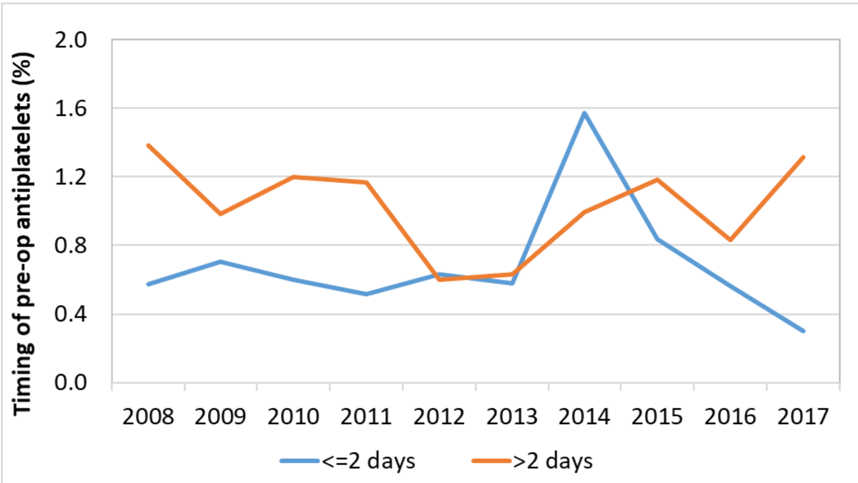


Figure 30. Percentage of patients solely on non-aspirin antiplatelet therapy pre-operatively



The frequency of both RBC and NRBC transfusions are consistently higher in patients taking aspirin, with or without other antiplatelet medications, within two days of surgery (Figure 31a and b). Transfusion rates for patients that cease antiplatelet medications more than two days before surgery are similar to patients that do not take any antiplatelet medications. The reduction in RBC transfusions has affected all patients, irrespective of antiplatelet use.

Over the last ten years, there has been a steady reduction in the mean level of ITD fluid loss within four hours of surgery for patients taking aspirin. In fact, over the past three years, aspirin taken within two days of surgery appears not to have affected blood loss (Figure 32). This has mirrored the reduction in the proportion of patients receiving RBC and NRBC transfusions. The volume of ITD loss for patients not taking aspirin within two days of surgery fluctuated from 2008-2014, but has since also shown a gradual decline (Figure 32).

Therefore, the observed reduction in four hour blood loss is related to factors other than pre-operative antiplatelet therapy.

Figure 31. Proportion of patients transfused by pre-operative aspirin (+/- other antiplatelet therapy) use

a. RBC b. NRBC

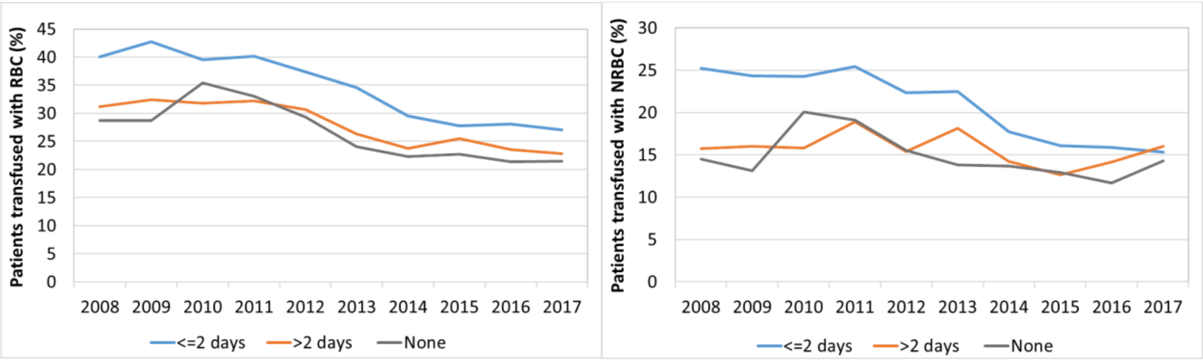
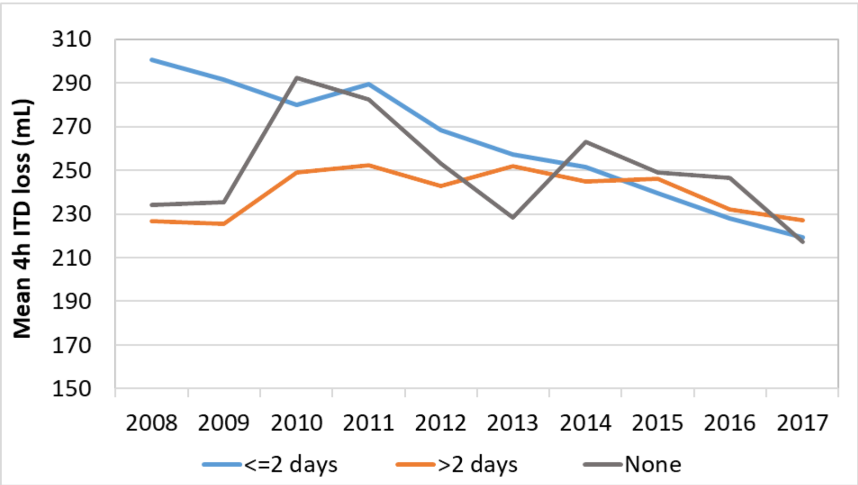


Figure 32. Four-hour ITD loss by pre-operative aspirin (+/- other antiplatelet therapy) use



The proportions of patients who received RBC and NRBC transfusions were reasonably similar between those that did or did not receive intra-operative tranexamic acid (TXA; Figure 33). However, since 2013 there has been a decline in the rate of transfusions amongst patients who did not receive TXA, while the frequency of transfusions in patients who receive TXA has remained stable. Intra-operative TXA use has steadily increased since 2012 (Figure 34).

Four-hour ITD loss is consistently less in patients who receive TXA. There has been a greater reduction in blood loss since the 2010 peak, in patients who did not receive TXA. However, blood loss in those who did, has remained steady, albeit with a gradual reduction since 2014 (Figure 35).

Figure 33. Proportion of patients transfused by pre-operative administration of TXA

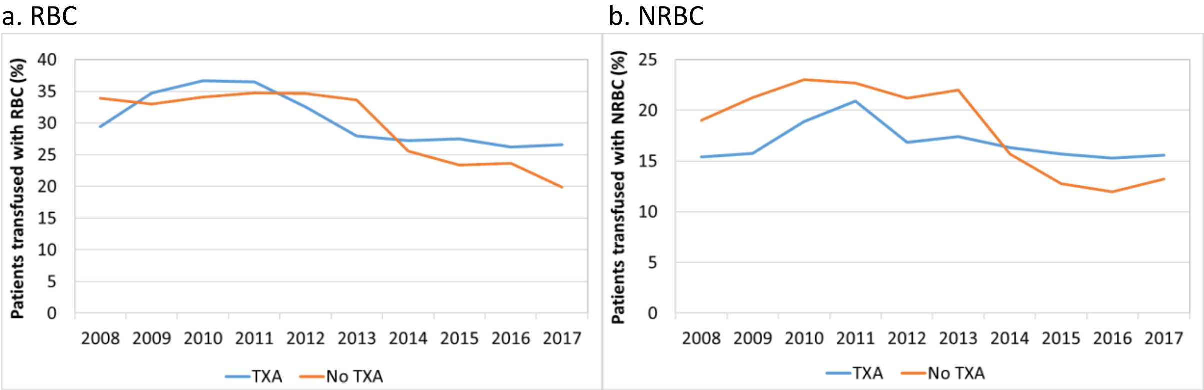


Figure 34. Use of intra-operative TXA infusion

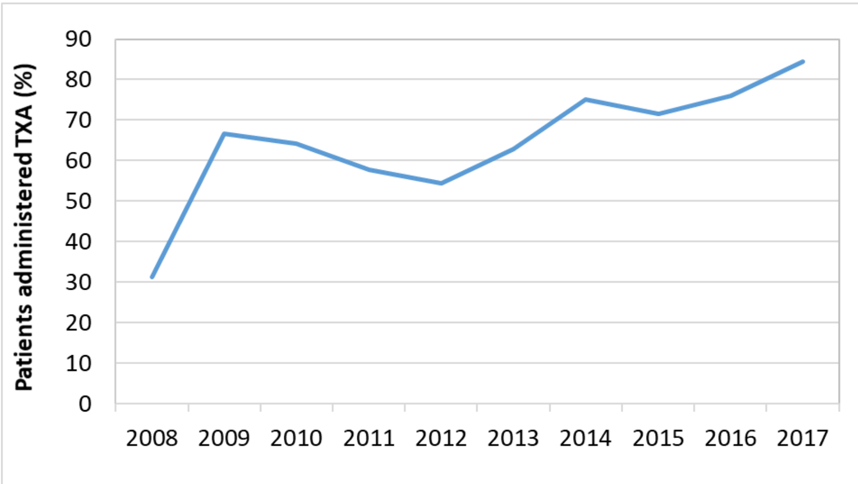
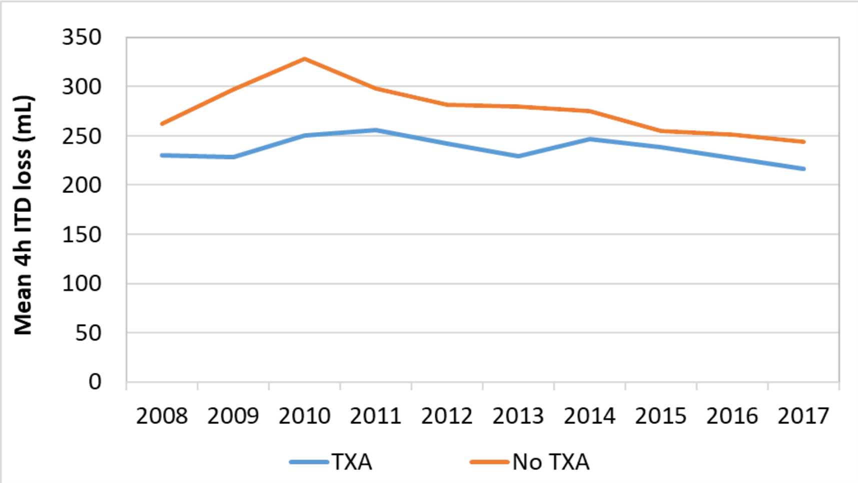


Figure 35. Four hour ITD loss by use of intra-operative TXA infusion

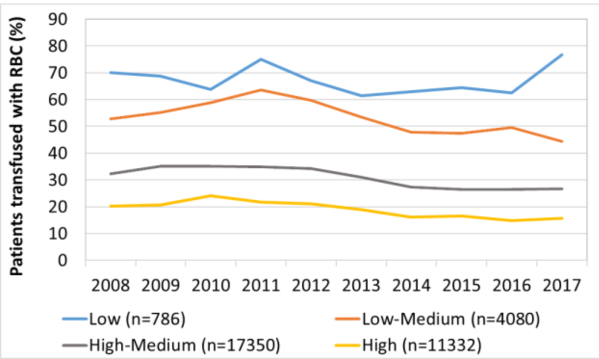


Body surface area (BSA) and body mass index (BMI) are two indicators of body size. Patients with lower BSA were more likely to receive transfusions and showed higher levels of four-hour ITD loss (Figures 36 and 37). This is consistent with the obesity paradox discussed in the literature, which documents lower blood loss and transfusion rates in patients with overweight or obese BMIs[10,11].

Patients in the low, low-medium, high-medium and high categories had BSAs corresponding to <1.5 m^2, ≥1.5 - <1.7 m^2, ≥1.7 - <2.0 m^2, and ≥2.0 m^2, respectively.

Figure 36. Proportion of patients transfused by BSA

a. RBC



b. NRBC

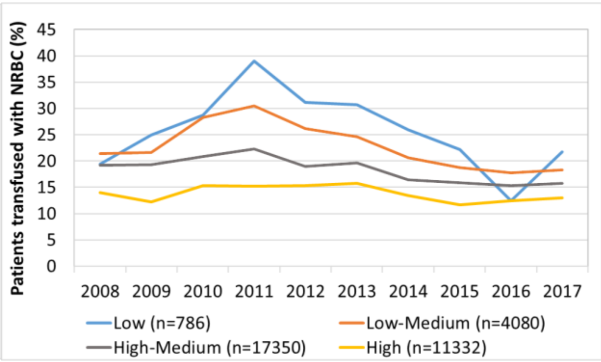
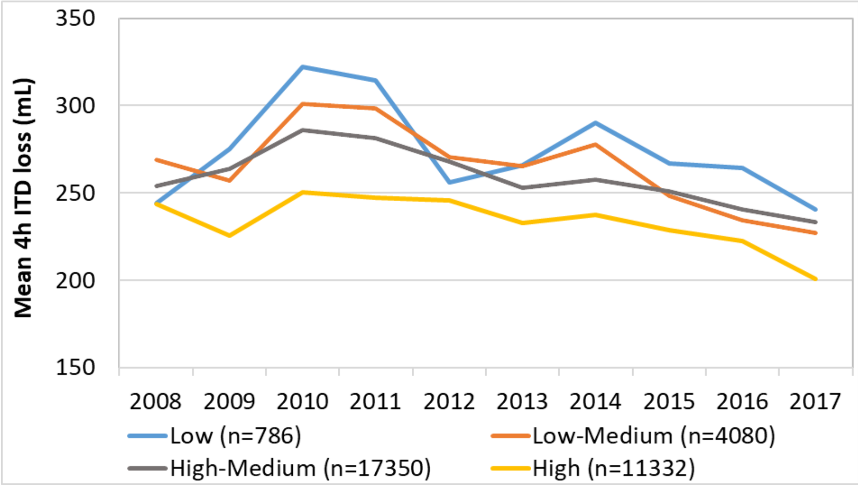


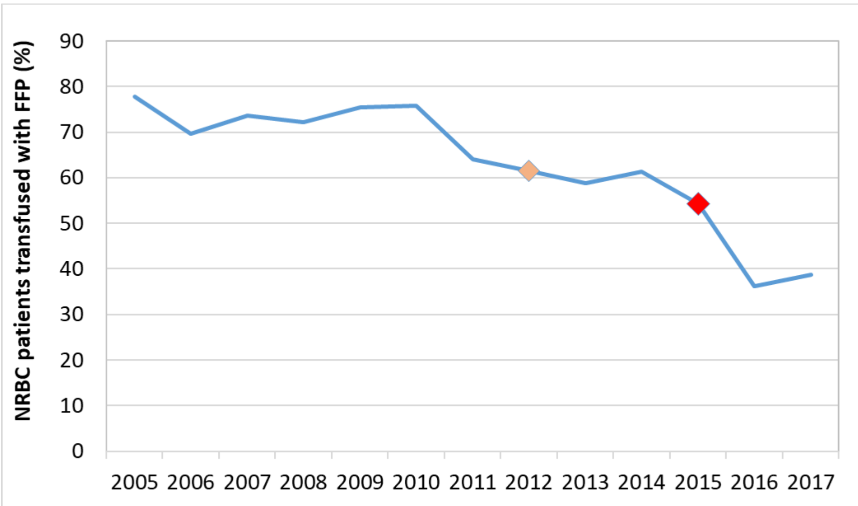
Figure 37. Four-hour ITD loss by BSA



Between 2005 and 2010, more than 70% of NRBC transfusions included FFP (Figure 38). The proportion of NRBC transfusions including FFP has since steadily declined to less than 40%, with a particularly steep decline between 2014 and 2016. This reduction indicates there has been an increase in the use of other NRBC products. In addition to fewer patients receiving FFP, the patients who do receive FFP receive lower volumes, compared to levels pre-2011 (Figure 39). Again, there was a sharp reduction in FFP volume use between 2014 and 2016, which has since levelled off.

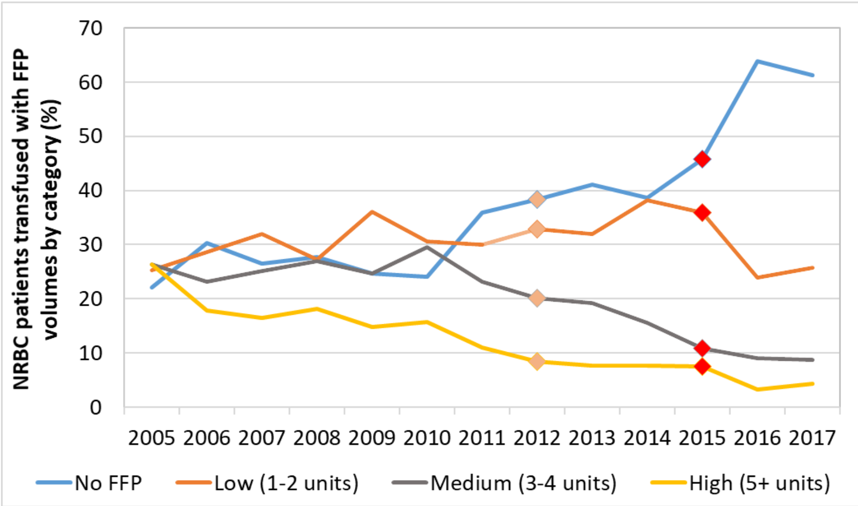
It is interesting to note that the PBM guidelines published in 2012 and a Cochrane review published in 2015 concluded there was no evidence for the efficacy of prophylactic administration of FFP for preventing bleeding in cardiac surgery (represented by the diamonds in Figures 38 and 39)[12,13]. It is unclear whether these reviews may have influenced the overall use of FFP in cardiac surgery.

Figure 38. Proportion of NRBC-transfused patients that received FFP



Diamonds represent release of PBM (2012) and Cochrane review (2015) regarding FFP use

Figure 39. Volume of FFP used in NRBC-transfused patients



Diamonds represent release of PBM (2012) and Cochrane review (2015) regarding FFP use

Part 2: Unit comparisons

Only units that consistently provided complete caseload data for 2015-2017, inclusive, are included in the following analyses. All the following analyses are presented for the pooled 2015-2017 period.

Table 10. Transfusion rates (%) for RBC and NRBC products by unit

Unit	Cases	RBCs transfused		NRBCs transfused			
		% RBC	Mean volume per transfusion (units)	% NRBC	% Platelets	% Cryo	% FFP
1	279	25.81	2.22	10.07	7.86	2.50	5.00
2	99	19.19	2.84	14.14	13.13	1.01	4.04
3	253	19.76	2.86	20.95	17.39	13.04	0.00
4	417	10.07	2.38	2.64	1.92	1.44	0.48
5	550	25.09	3.98	15.88	14.96	4.93	0.73
6	556	23.92	2.63	16.91	14.39	5.40	7.91
7	280	20.36	2.18	22.94	21.15	7.17	1.79
8	368	12.77	2.66	7.61	5.71	1.36	4.08
9	474	31.22	2.72	10.97	7.81	6.75	6.75
10	449	32.52	2.52	25.61	22.49	11.36	6.68
11	503	31.01	2.98	23.46	17.89	5.57	11.33
12	648	31.33	2.45	13.12	9.72	1.85	9.26
13	230	23.48	2.57	17.83	14.78	7.39	0.00
14	410	16.83	2.12	9.27	8.05	3.90	2.20
15	361	32.69	2.55	16.16	13.93	2.51	7.24
16	177	25.99	2.72	13.56	12.99	5.09	2.83
17	395	48.61	2.74	24.56	16.71	7.85	15.70
18	560	23.93	2.70	11.61	7.32	0.54	7.50
19	216	28.70	3.53	27.32	13.43	10.65	25.00
20	286	18.18	2.58	16.08	13.29	5.25	4.90
21	114	14.91	2.88	5.26	5.26	1.75	1.75
23	596	28.36	2.73	14.65	8.92	5.39	9.60
24	496	23.59	2.50	8.67	7.66	1.82	2.02
26	467	24.63	2.94	20.56	16.70	3.21	13.70
27	306	17.32	2.43	4.25	2.61	2.29	3.27
28	621	40.58	2.82	20.65	15.65	6.13	7.58
29	501	15.97	3.19	13.37	10.58	1.20	7.19
30	539	34.14	2.64	13.17	8.91	5.94	6.68
31	409	6.85	3.07	4.65	3.42	0.98	1.22
Total	**11560**	**25.55**	**2.74**	**14.78**	**11.50**	**4.50**	**6.46**

There is marked variation in the proportion of isolated CABG patients who receive RBC and/or NRBC transfusions between cardiac surgical units (Figures 40 and 41). This is consistent with a previous study using ANZSCTS Database data, which found variation in transfusion frequency between hospitals even after accounting for relevant patient and procedure characteristics[14]. This variation could not be attributed to hospital-specific factors such as the state or territory, private or public units, or teaching versus non-teaching units.

Figure 40. Transfusion frequency by unit

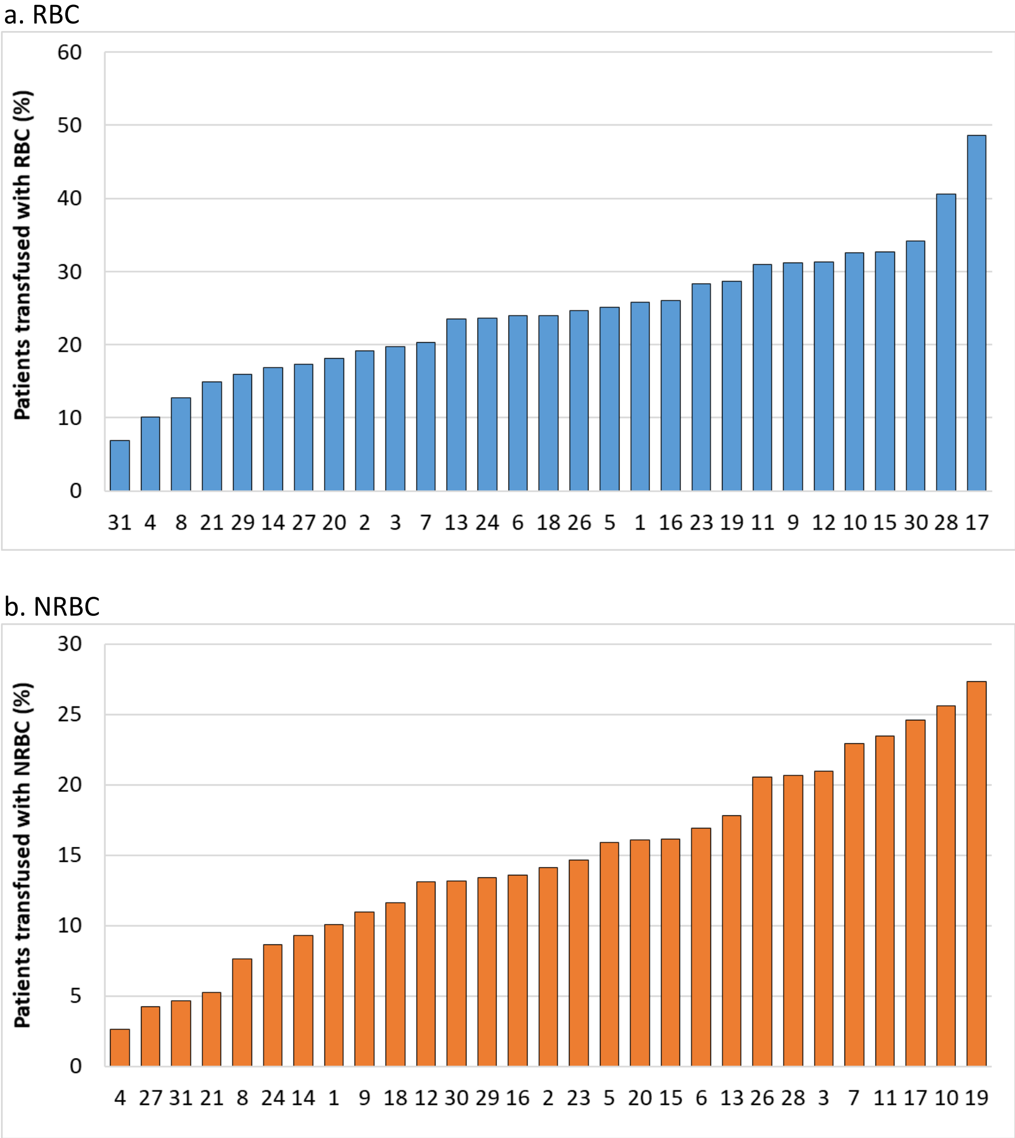
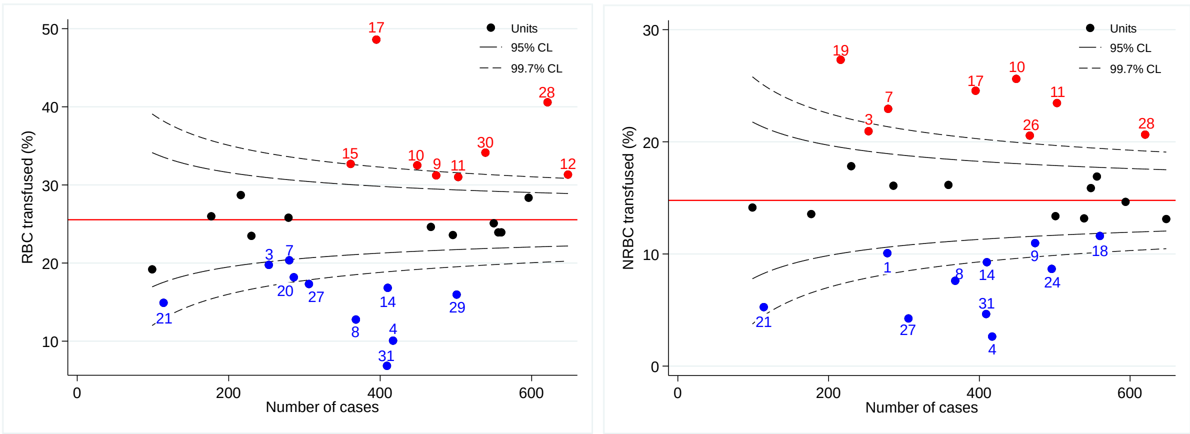


Figure 41. Unit comparisons of frequency of a. RBC transfusion and b. NRBC transfusion

a. RBC b. NRBC



Despite an overall reduction in FFP usage by ANZSCTS participating sites, several individual units have not shown a decrease in the proportion of patients receiving FFP between 2015 and 2017 (Figure 42). The majority of units have mostly transfused low volumes of FFP per patient (Figure 43). Please note that units with no columns did not report any FFP transfusions for the corresponding period.

Figure 42: Unit comparison of frequency of FFP use in NRBC-transfused patients

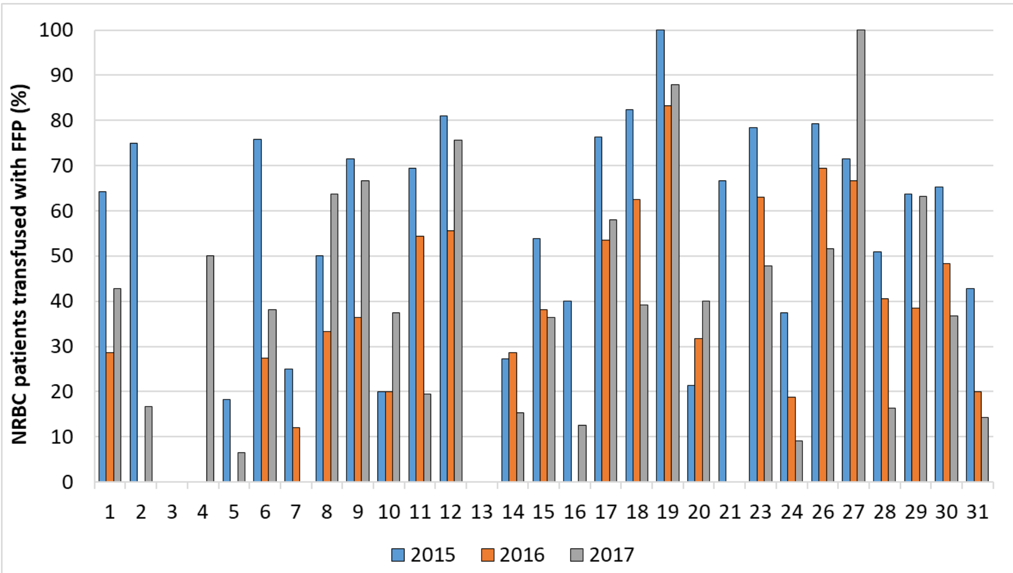
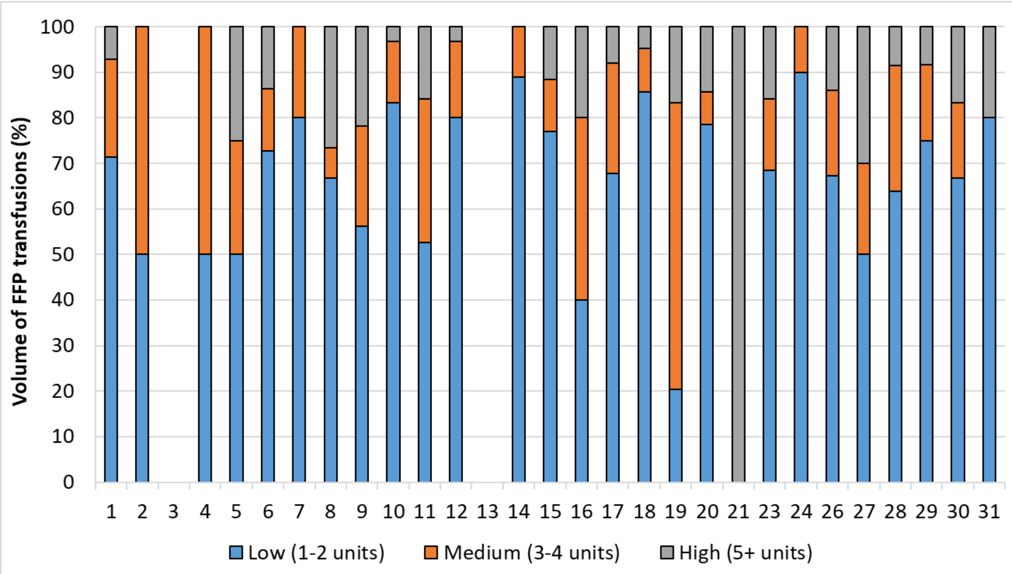


Figure 43. Unit comparison of volume of FFP transfusion in patients transfused with FFP



Conclusions

Overall, over the past ten years:

- There was a progressive decrease in the proportion of patients given RBC and NRBC transfusions, albeit levelling off over the last three years.
- The most marked reduction was seen in FFP use, with a reduction in both the proportion of patients transfused, and the number of units used per transfusion.
- There was a persistent and continuing reduction in four hour ITD fluid loss, yet the return to theatre rate for bleeding or tamponade has not changed significantly.
- There has been a marked increase in the number of patients taking antiplatelet therapies within two days of surgery, and this has been primarily driven by an increase in use of aspirin.
- While the rate of RBC and NRBC transfusions are consistently higher in patients taking aspirin, with or without other antiplatelet medications, there has been a reduction in the mean level of ITD fluid loss for this patient group.
- Although tranexamic acid was used with increasing frequency, there is no consistent relationship between its use and transfusion frequency or four hour ITD fluid loss.

The implication of this data is that some factor(s) other than continuing aspirin till surgery, intra-operative use of TXA, or reduction of the frequency and volume of FFP transfusions is responsible for the observed reduction of blood loss after isolated CABG.

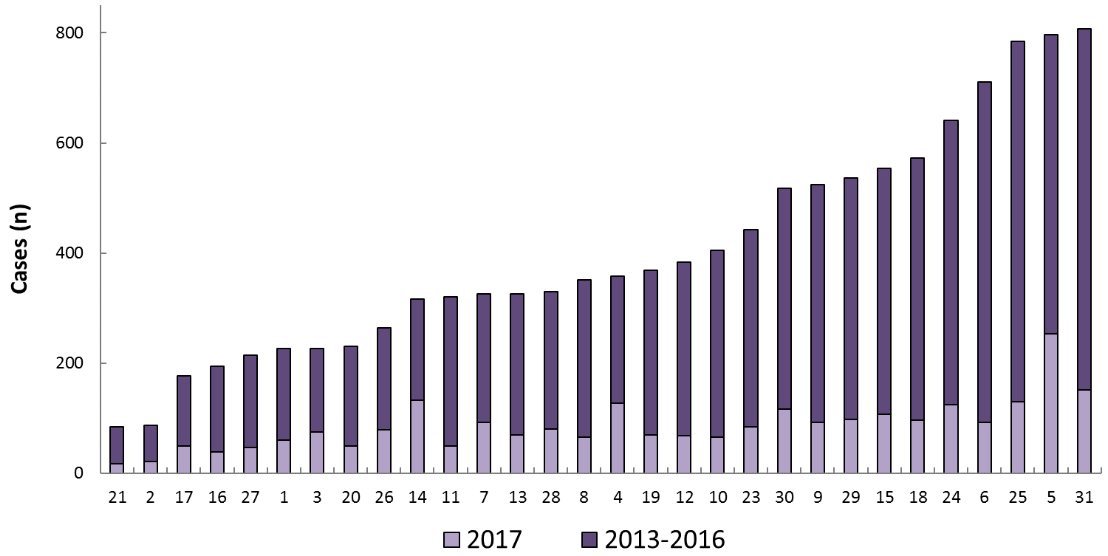
Over the past three years, when there was some levelling of the frequency and volumes of transfusions, there remains a wide variation between units in the frequency and nature of transfusions. This report cannot elucidate the reasons for this variation. Rather, it is intended to inform units of that variation and prompt some to review their protocols.

3. Isolated Valve

This section explores the patient population and outcomes for isolated surgical valve procedures. Transcatheter aortic or mitral valve replacements (TAVR and TMVR) are not included in the following grouped analyses.

In 2017, the number of isolated valve procedures performed varied widely between units, ranging from 18 to 273 (Figure 44). Not all units contributed data for the entire 2013-2016 period; therefore, numerical comparisons cannot be made for the pooled data.

Figure 44. Isolated valve procedures performed by unit, 2013-2017



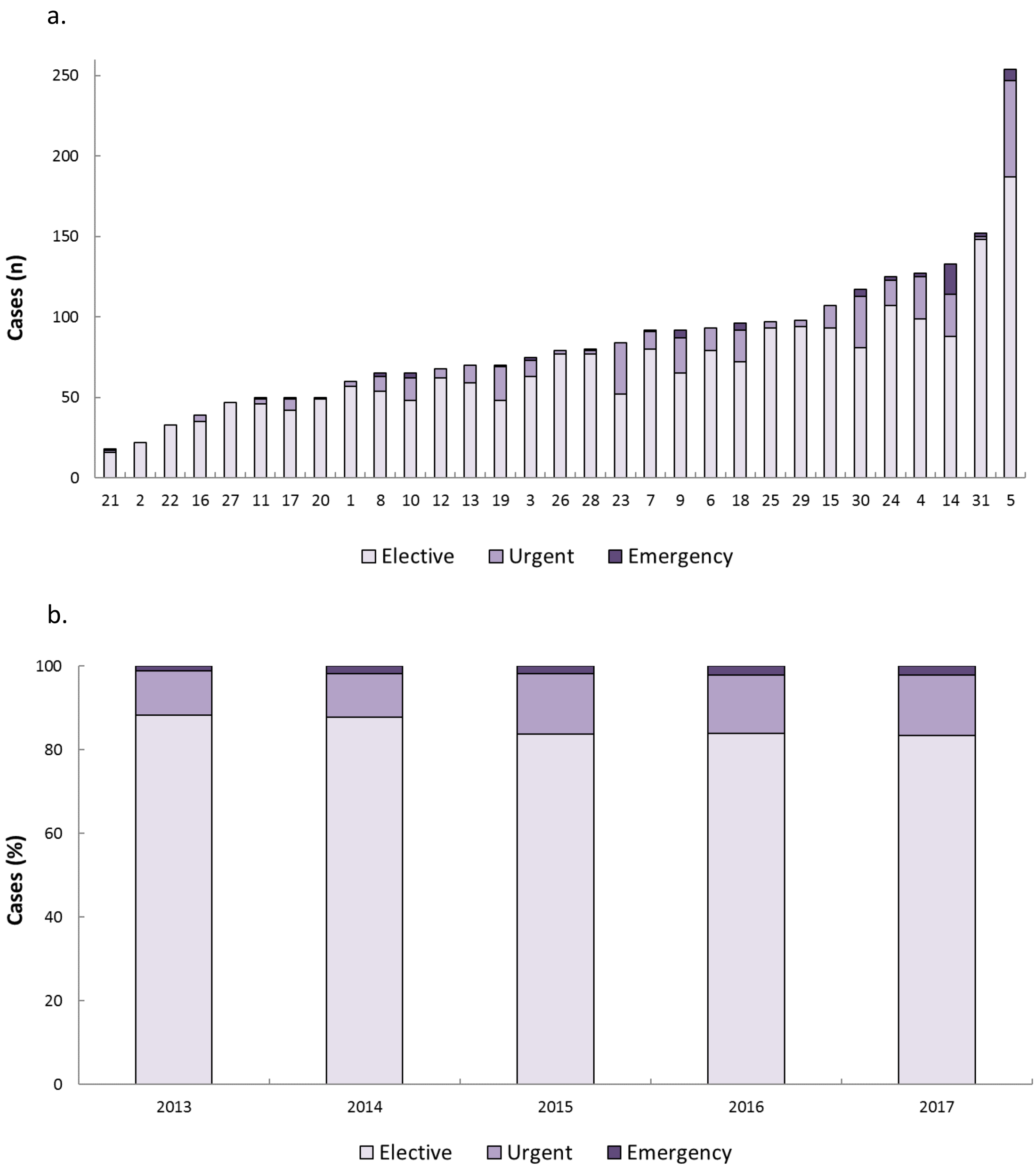
3.1 Patient characteristics

Key patient characteristics that influence the outcomes of surgery include clinical status, gender, age and comorbidities. The distributions of these factors in the Australian isolated valve surgery patient population are explored in the following sections.

3.1.1 Clinical status

The pooled unit data consistently shows that the majority of isolated valve surgery patients are categorised as elective (>83%), and less than 3% as emergency (Figure 45b).

Figure 45. Clinical status of isolated valve procedures by a. unit in 2017 and b. year

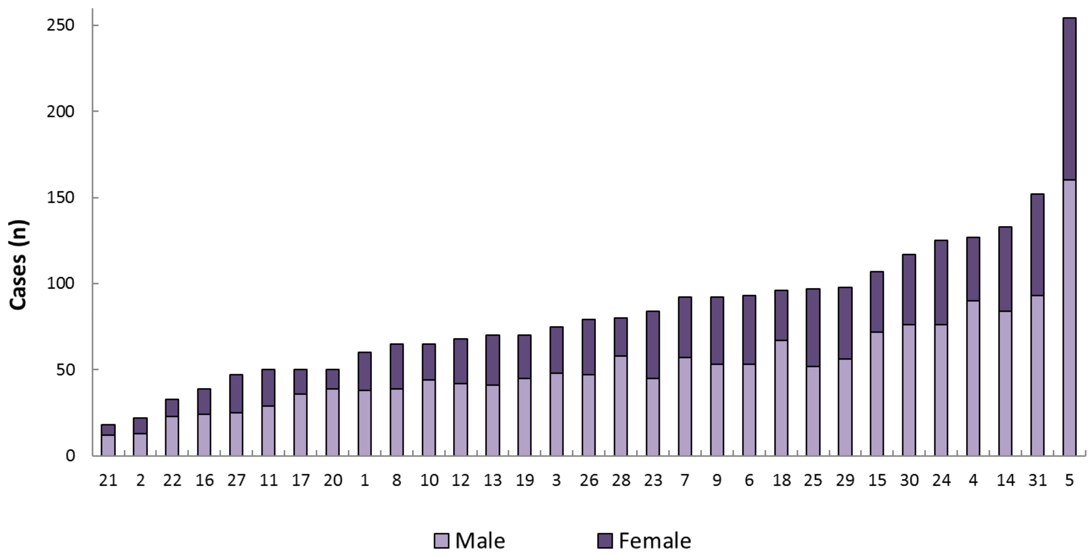


3.1.2 Gender and age

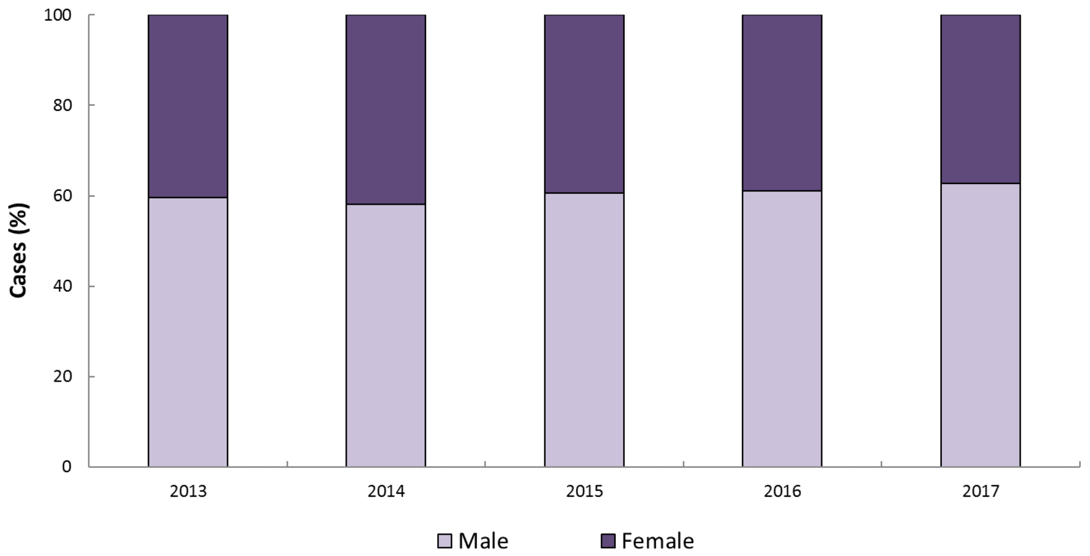
The ratio of male to female patients in 2017 was reasonably consistent between units (Figure 46a). Pooled unit data shows that over the last five years, approximately 60% of patients who had an isolated valve procedure were male (Figure 46b).

Figure 46. Gender of isolated valve surgery patients by a. unit in 2017 and b. year

a.



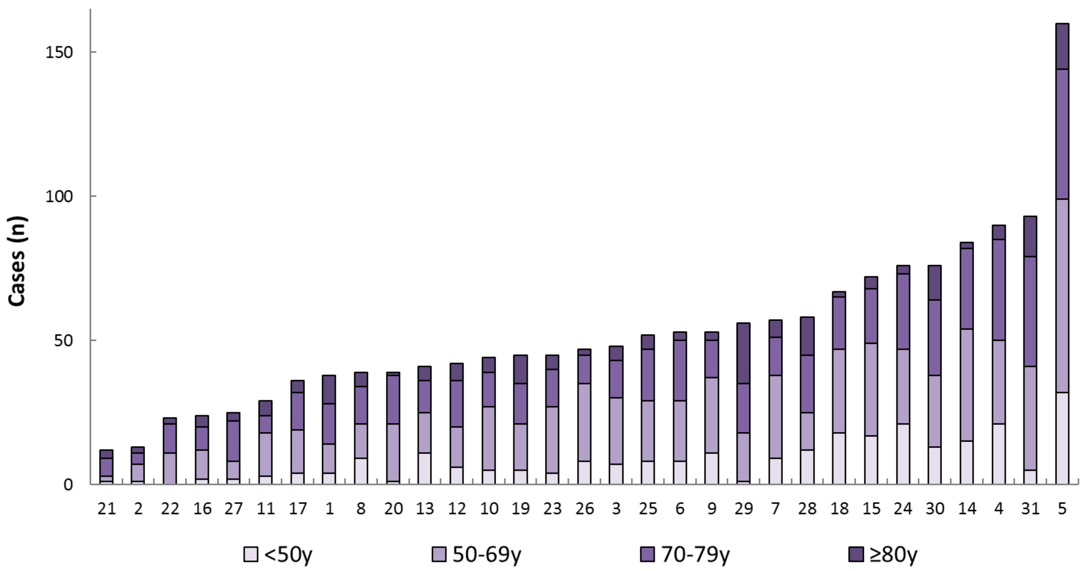
b.



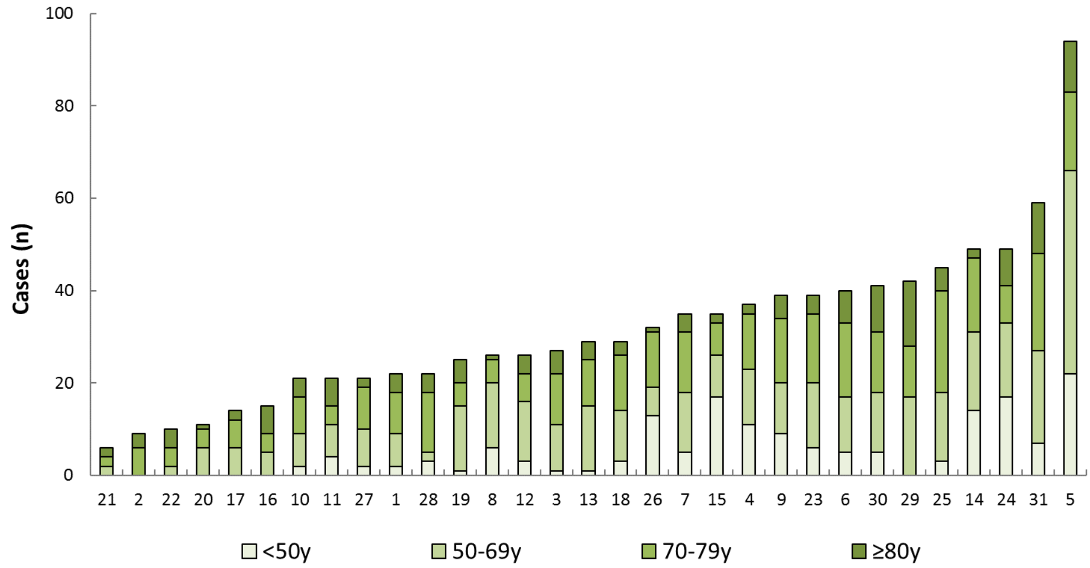
In 2017, the majority of patients who underwent isolated valve surgery were aged between 50 and 79 years. Figure 47a and b show the proportions of cases by gender. There was notable variation between the units in the proportion of procedures performed in patients aged 80 years and over.

Figure 47. Number of isolated valve cases in 2017 by age group for a. males and b. females

a.

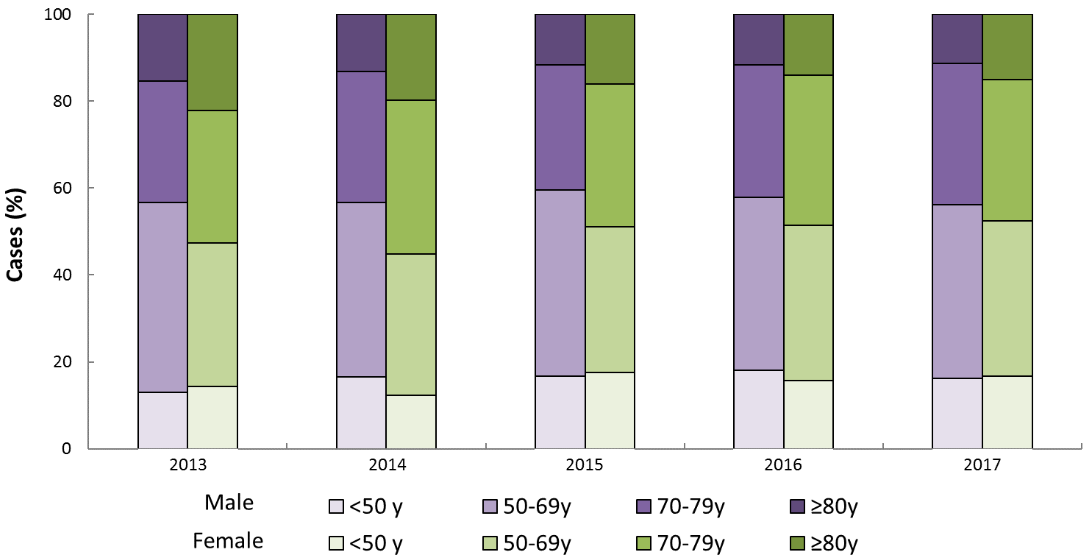


b.



As was the case with isolated CABG procedures, a higher proportion of women undergoing isolated valve procedures over the last five years have been aged 70 years and over, compared to their male counterparts. This gap between the genders has been gradually decreasing over the last five years (Figure 48).

Figure 48. Age groupings for male and female patients that had isolated valve procedures in 2013-2017

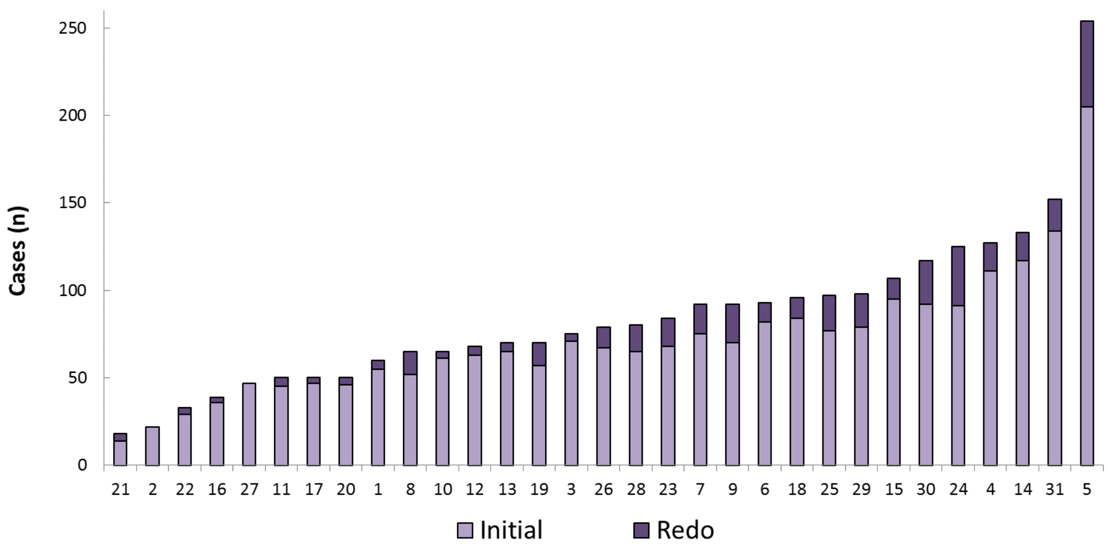


3.2 Previous surgery

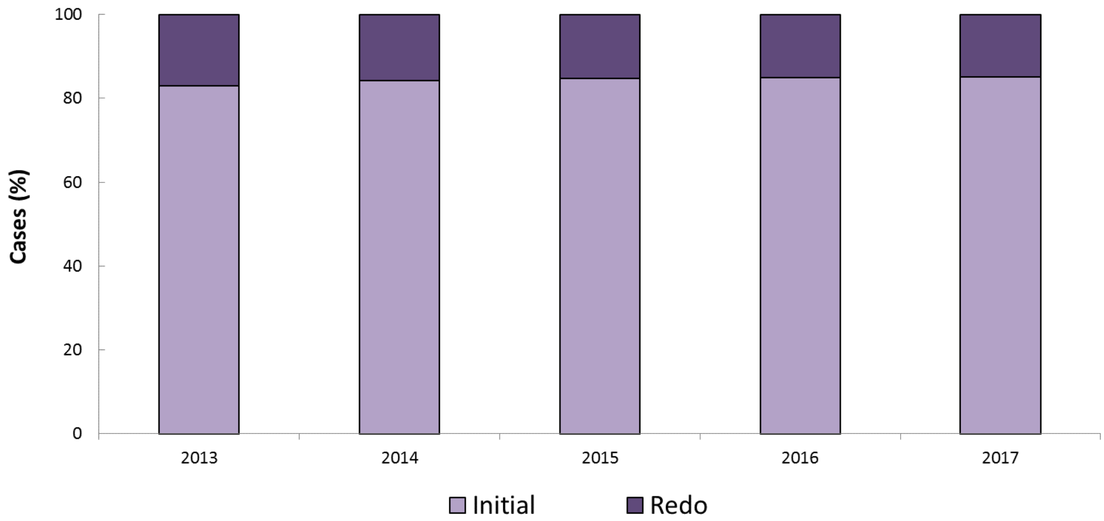
The proportion of initial and redo isolated valve procedures is reasonably consistent between units (Figure 49a). A procedure is considered a redo if the patient has had any prior cardiac surgery. Since 2013, redo procedures have consistently accounted for approximately 15% of isolated valve procedures (Figure 49b).

Figure 49. Initial and redo isolated valve procedures by a. unit in 2017 and b. year

a.



b.



3.3 Overview of all valve procedures

Case numbers and observed mortality rates for single and multi-valve procedures are detailed in Table 11. Where these procedures have been performed with CABG, they are presented separately, in Section 4 (Table 15). A full list of valve procedures is available in the ANZSCTS Database Data Definitions Manual.

Aortic root reconstructions and transcatheter aortic valve replacements (TAVR) are reported in Table 12. The case numbers presented in this table are for procedures performed in isolation, or with other valve surgery. Where these procedures have been performed in conjunction with any other cardiac surgery, they are reported in Section 5 (Table 23).

The ANZSCTS Database released a specific TAVR module in September of 2016 and, as a result, has seen a significant increase in the number of TAVR cases reported.

The most common isolated valve procedures performed in 2017 and in the preceding four years were single aortic, followed by single mitral procedures (Table 11).

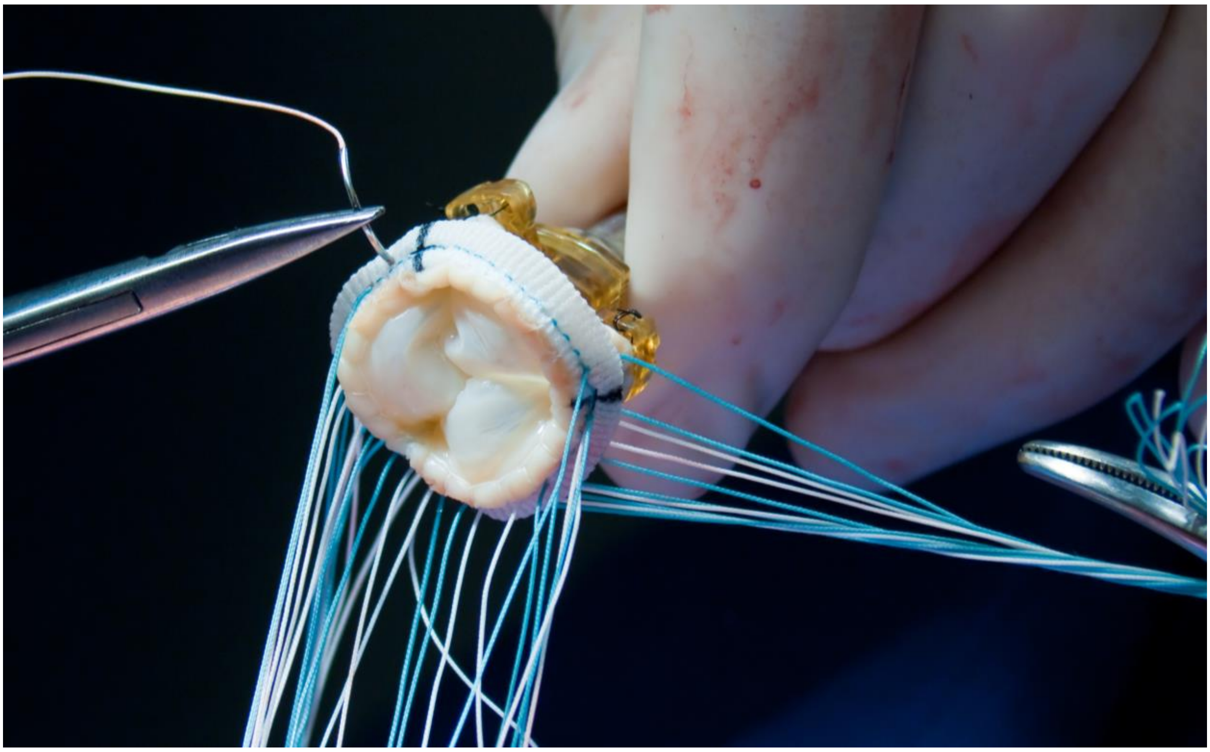


Table 11. Observed mortality (%) for valve procedures performed in 2017 and 2013-2016

Valve Procedure	Year	n	OM (%)
Single aortic[#]	2017	1359	1.6
	2013-2016	5270	1.9
AVR	2017	1312	1.6
	2013-2016	5033	1.9
Other aortic	2017	47	2.1
	2013-2016	236	2.5
Single mitral*	2017	762	2.6
	2013-2016	2573	1.5
Replacement	2017	338	4.1
	2013-2016	1109	3.0
Repair	2017	405	1.0
	2013-2016	1450	0.3
Single tricuspid	2017	76	6.6
	2013-2016	167	7.8
Single pulmonary	2017	40	2.5
	2013-2016	124	0.8
Aortic and mitral	2017	155	6.5
	2013-2016	596	5.7
Aortic and tricuspid	2017	16	0.0
	2013-2016	58	5.2
Mitral and tricuspid	2017	150	2.0
	2013-2016	490	5.1
Other double	2017	10	0.0
	2013-2016	40	2.5
Triple	2017	39	7.7
	2013-2016	152	11.2
Quadruple	2017	1	0.0
	2013-2016	2	0.0
Total valve procedures^	2017	**2608**	**2.5**
	2013-2016	**9472**	**2.5**

[#]Aortic valve procedures exclude TAVR
*Mitral valve procedures exclude TMVR
^Three cases excluded due to missing data

Table 12. Observed mortality (%) for other valve procedures performed in 2017 and 2013-2016

Valve Procedure	Year	n	OM (%)
Aortic root replacement with valve conduit	**2017**	31	6.5
	2013-2016	149	1.3
Pulmonary autograft aortic root replacement (Ross)	**2017**	12	0.0
	2013-2016	50	0.0
Root reconstruction with valve sparing (David)	**2017**	7	0.0
	2013-2016	27	0.0
TAVR	**2017**	247	2.4
	2013-2016	494	1.8
Transapical^	**2017**	23	4.3
Transfemoral^	**2017**	167	2.4
Transaortic^	**2017**	12	0.0
Transsubclavian^	**2017**	13	7.7
Total other valve procedures	**2017**	**297**	**2.7**
	2013-2016	**720**	**1.5**

^33 cases were not included due to missing access route data

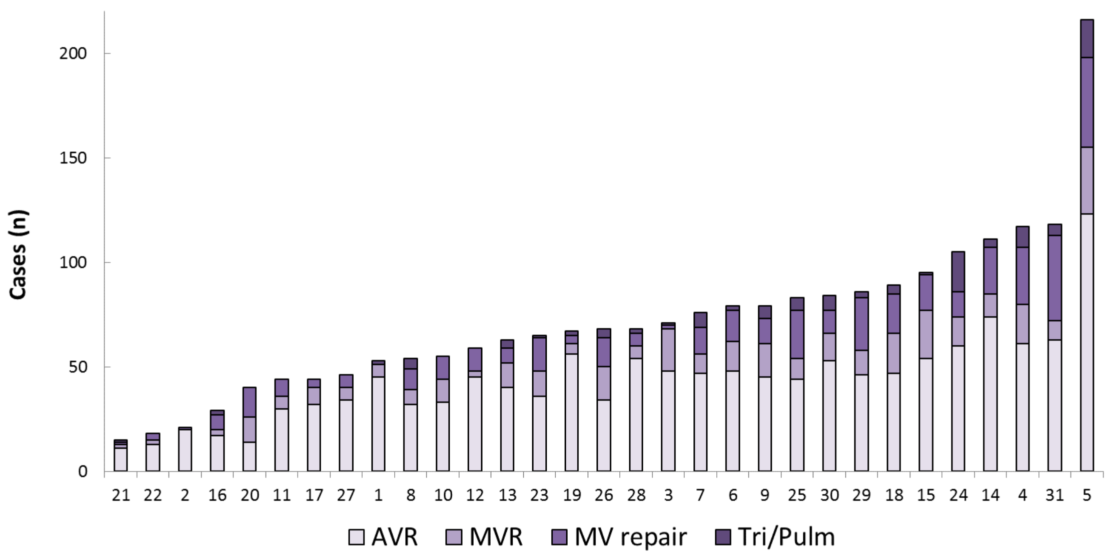
3.4 Single valve procedures

3.4.1 Type of procedure

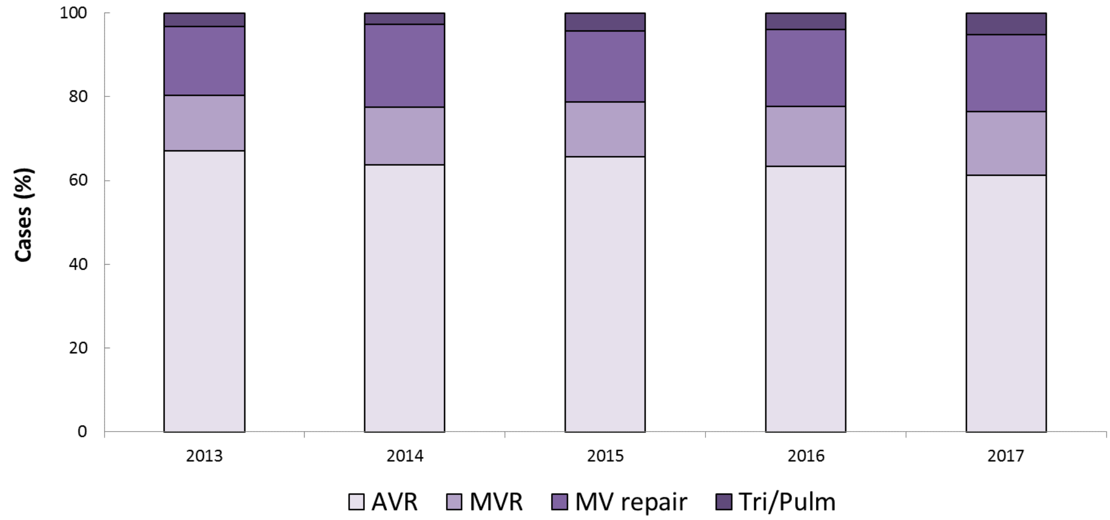
The proportions of the types of single valve surgery performed were consistent over the last five years and between units (Figure 50a and b). More than 60% of isolated single valve procedures performed in each of the last five years were AVRs (Figure 50b).

Figure 50. Type of isolated single valve procedures performed by a. unit in 2017 and b. year

a.



b.



3.4.2 Influence of patient characteristics on mortality

As expected, observed mortality was higher for patients who had urgent or redo procedures (Table 13). The relationship between mortality and age, LVF, and previous MI was less consistent which, for some categories, may be related to lower case numbers. It should be noted that observed mortality is not risk-adjusted and therefore does not account for differences in patient characteristics.

The table below refers to surgical valve replacements. Non-invasive percutaneous valve replacements such as TAVR and TMVR have been excluded.

Table 13. Observed mortality (%) based on patient characteristics for the three most common isolated single valve procedure types, 2013-2017

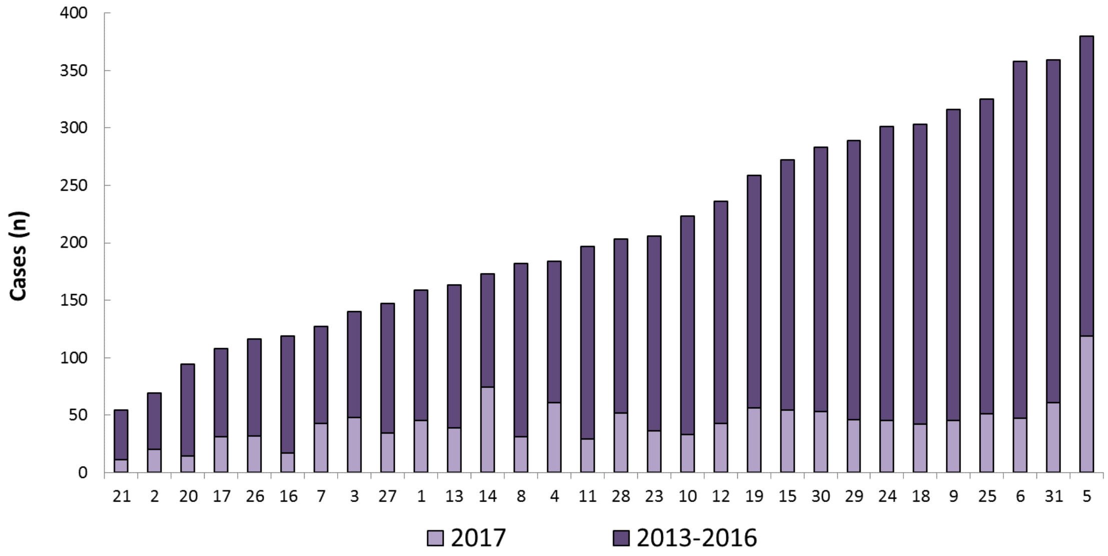
	AVR		MVR		MV repair	
	n	OM (%)	n	OM (%)	n	OM (%)
Clinical status						
Elective	5523	1.4	1145	2.6	1685	0.5
Urgent	738	3.9	245	4.9	153	0.7
Emergency/salvage	84	13.1	57	8.8	17	0.0
Gender/age						
Male	4029	1.7	724	2.9	1268	0.2
<50y	435	0.7	130	3.1	242	0.0
50-69y	1561	1.3	300	1.7	694	0.3
70-79y	1428	1.9	217	4.1	248	0.1
≥80y	602	2.8	77	3.9	84	0.0
Female*	2316	2.1	723	3.6	587	1.0
<50y	127	3.1	173	2.3	113	0.0
50-69y	741	0.5	263	4.2	277	1.1
70-79y	909	2.1	201	5.5	143	0.7
≥80y	537	4.1	84	0.0	54	3.7
Left ventricular function^						
Normal LVF	3960	1.4	857	3.4	1157	0.4
Mild LVD	1551	2.1	383	4.2	538	0.7
Moderate LVD	515	2.9	157	1.3	125	0.0
Severe LVD	168	6.5	20	0.0	14	0.0
Previous MI						
No MI	5874	1.7	1324	3.0	1799	0.4
NSTEMI	336	3.9	70	8.6	32	3.1
STEMI	85	1.2	39	0.0	15	6.7
Unknown type	50	8.0	14	7.1	9	0.0
Previous surgery						
Initial	5605	1.4	1077	3.2	1785	0.5
Redo	740	5.0	370	3.5	70	0.0

*Two cases missing for MVR female age group
^151, 30 and 21 cases missing for AVR, MVR and MV repair, respectively

3.5 Aortic valve replacement

The number of AVRs performed by each unit in 2017 ranged from 11 to 119 (Figure 51). Not all units contributed data for the entire 2013-2016 period; therefore, numerical comparisons cannot be made for the pooled data.

Figure 51. AVR procedures performed by unit, 2013-2017



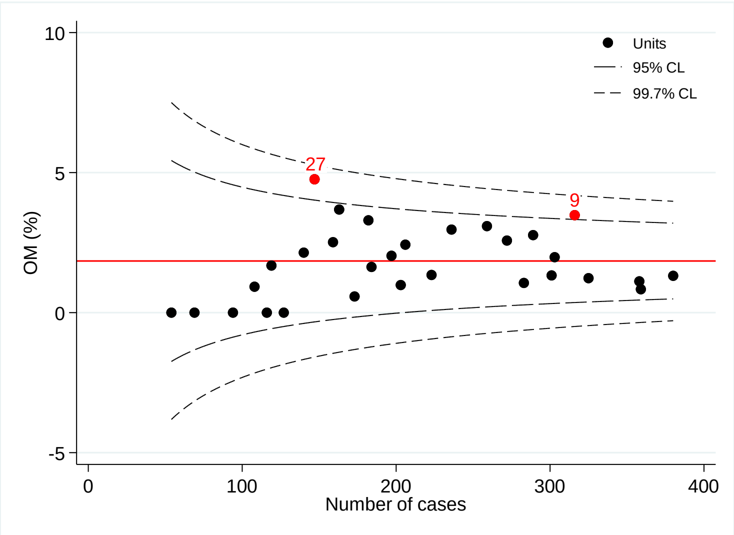
3.5.1 Unit outcomes – mortality, complications and resource utilisation

Unit outcomes are reported for isolated AVR procedures only, because these are the most commonly performed valve procedures. Due to low procedure numbers, the unit outcome data for AVRs is presented for the pooled 2013-2017 period.

3.5.1.1 Mortality

All units were within the upper 99.7% control limit for observed mortality (OM) in the 2013-2017 period (Figure 52).

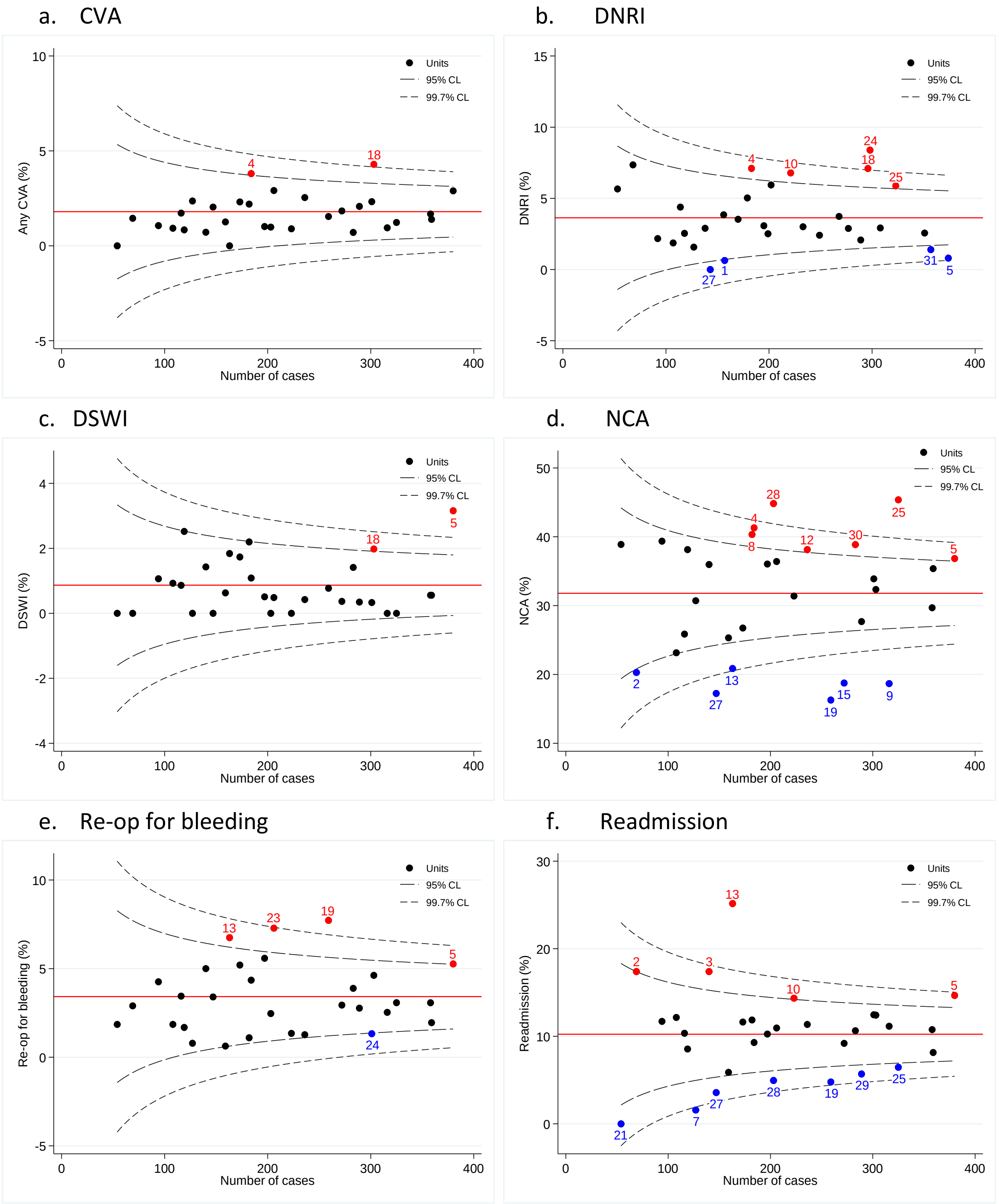
Figure 52. Observed mortality by unit following AVR, 2013-2017



3.5.1.2 Complications

While the rates of cerebrovascular accident (CVA) and deep sternal wound infection (DSWI) were similar for most units, there was notable variation in the rates of derived new renal impairment (DNRI), new cardiac arrhythmia (NCA), re-operation for bleeding, and readmission (Figure 53). The data for rates of DNRI excludes patients who received pre-operative dialysis (Figure 53b).

Figure 53. Complications by unit following AVR, 2013-2017



3.5.1.3 Resource utilisation

Due to the skewed distribution of the ICU length of stay and ventilation data, the geometric means (GM) are presented. The GM is defined as the nth root of a product of n numbers. It is useful to describe the central tendency of a set of skewed data, as it is less sensitive to outlying values.

The pooled data shows marked variation between units with respect to the time patients spent in the intensive care unit (ICU), the duration of ventilation, and the percentage of patients who received red blood cell (RBC) or non-RBC (NRBC) transfusions (Table 14).

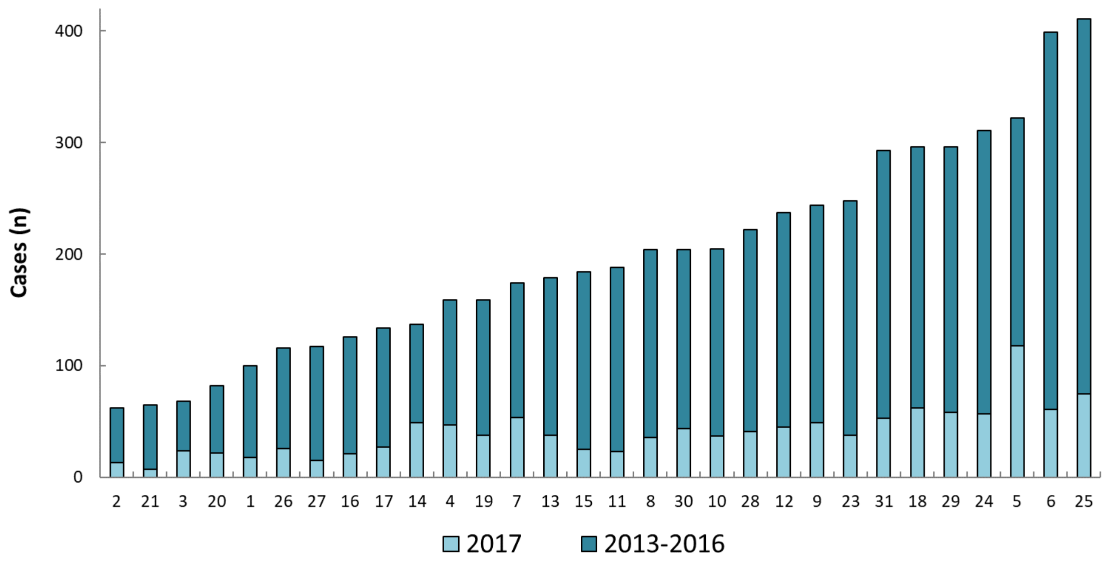
Table 14. Resource utilisation by unit for isolated AVR patients, 2013-2017

	2013-2017			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	31.5	9.2	20.3	13.3
2	63.3	5.7	29.0	11.6
3	34.2	10.9	24.3	25.7
4	24.9	8.5	16.3	5.4
5	31.9	9.4	28.7	20.3
6	59.7	11.1	29.4	20.2
7	36.1	7.6	15.7	20.5
8	40.4	9.8	19.2	9.9
9	100.5	13.1	38.3	21.2
10	38.1	9.3	40.4	25.1
11	33.2	10.1	28.9	31.0
12	33.6	10.3	32.2	16.5
13	37.6	10.8	28.8	25.2
14	39.7	8.2	26.0	13.3
15	48.8	14.8	30.9	17.6
16	59.2	12.3	35.3	19.3
17	48.3	14.6	53.7	45.4
18	58.7	8.8	30.4	25.1
19	36.1	14.9	45.6	46.3
20	56.7	8.1	26.6	28.7
21	35.8	9.9	18.5	11.1
23	68.0	14.2	32.5	23.8
24	33.4	9.3	24.7	12.0
25	53.8	8.4	37.5	21.5
26	34.9	8.1	27.6	24.1
27	77.4	16.6	25.9	12.2
28	44.1	11.8	39.9	25.6
29	37.3	6.3	31.5	22.8
30	76.8	10.8	33.2	18.7
31	52.8	8.4	11.7	7.8
Total	**45.9**	**10.1**	**29.8**	**20.6**

4. Valve with CABG

In 2017, the number of valve with CABG procedures performed varied between units, ranging from 7 to 118 (Figure 54). Not all units contributed data for the entire 2013-2016 period; therefore, numerical comparisons cannot be made for the pooled data.

Figure 54. Valve with CABG procedures performed by unit, 2013-2017



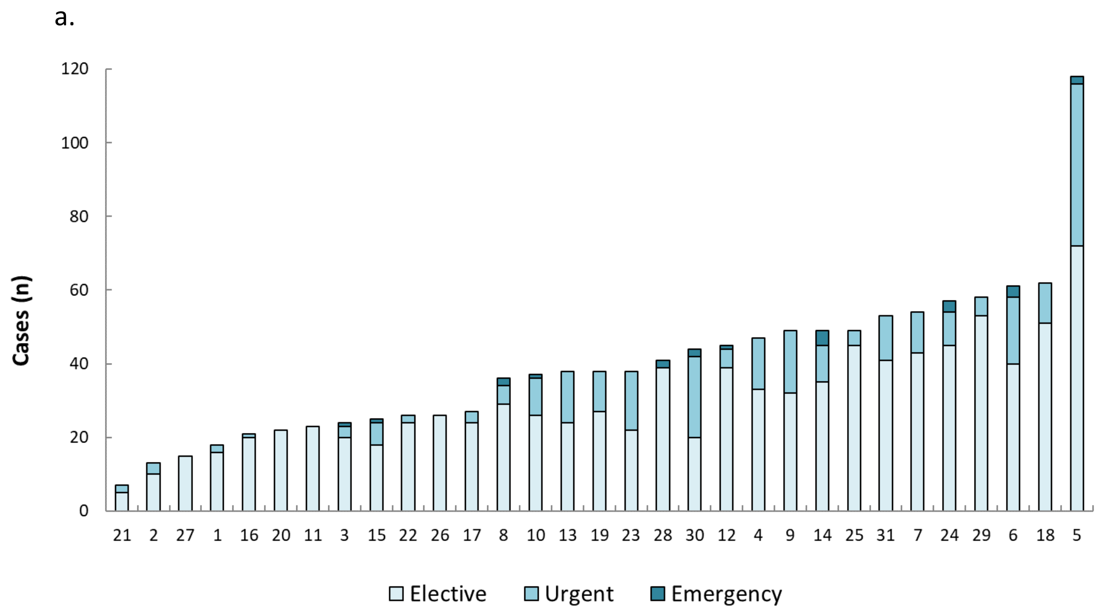
4.1 Patient characteristics

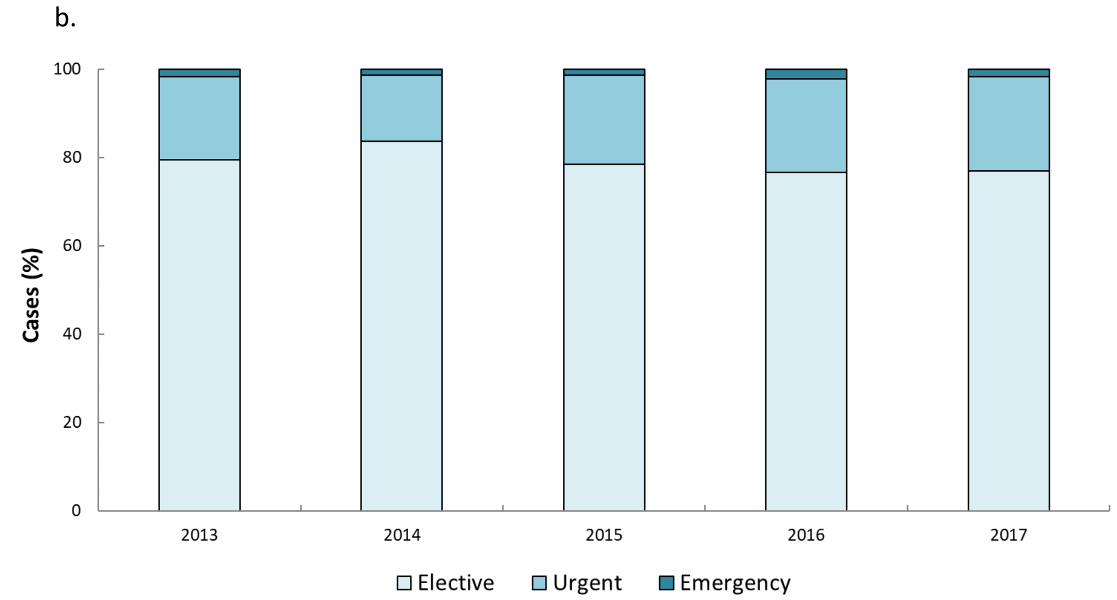
Key patient characteristics that influence the outcomes of surgery include clinical status, gender, age and comorbidities. The distributions of these factors in the Australian cardiac surgery patient population are explored in the following sections.

4.1.1 Clinical status

In 2017, over three quarters of valve with CABG procedures were elective, and less than 2% were reported as emergency (Figure 55).

Figure 55. Clinical status of valve with CABG procedures by a. unit in 2017 and b. year

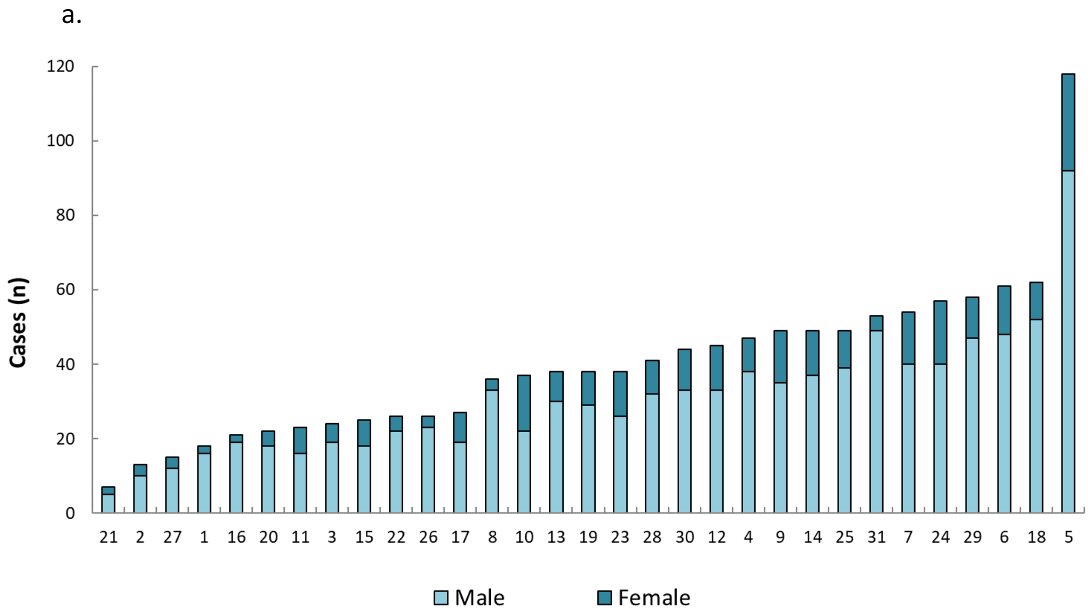


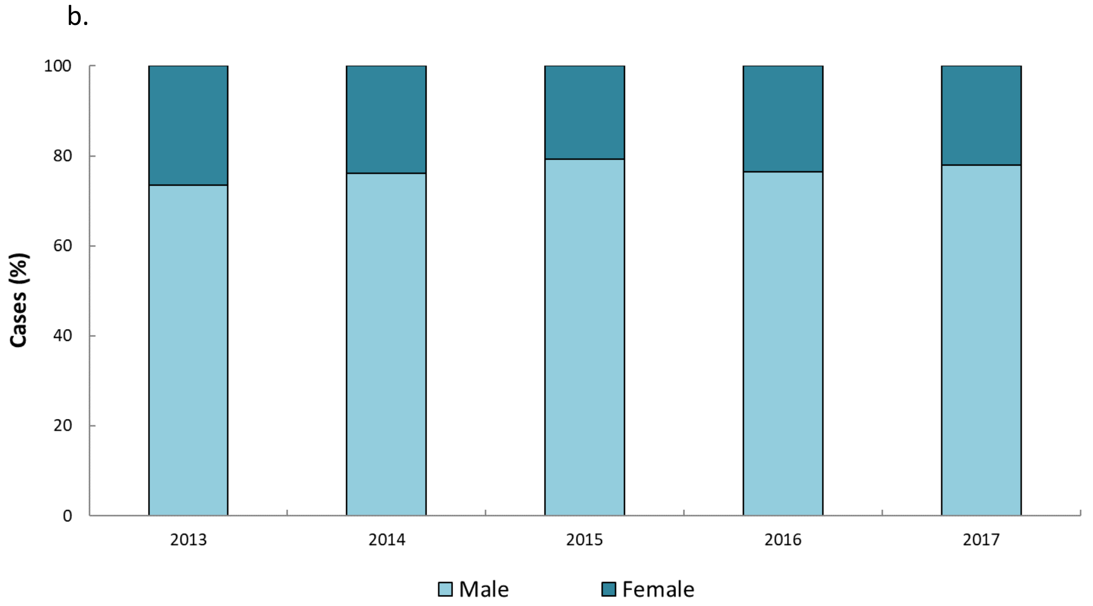


4.1.2 Gender and age

The ratio of male to female patients in 2017 was reasonably consistent between units (Figure 56a). Over the last five years, approximately 77% of valve with CABG patients have been male (Figure 56b).

Figure 56. Gender of valve with CABG patients by a. unit in 2017 and b. year

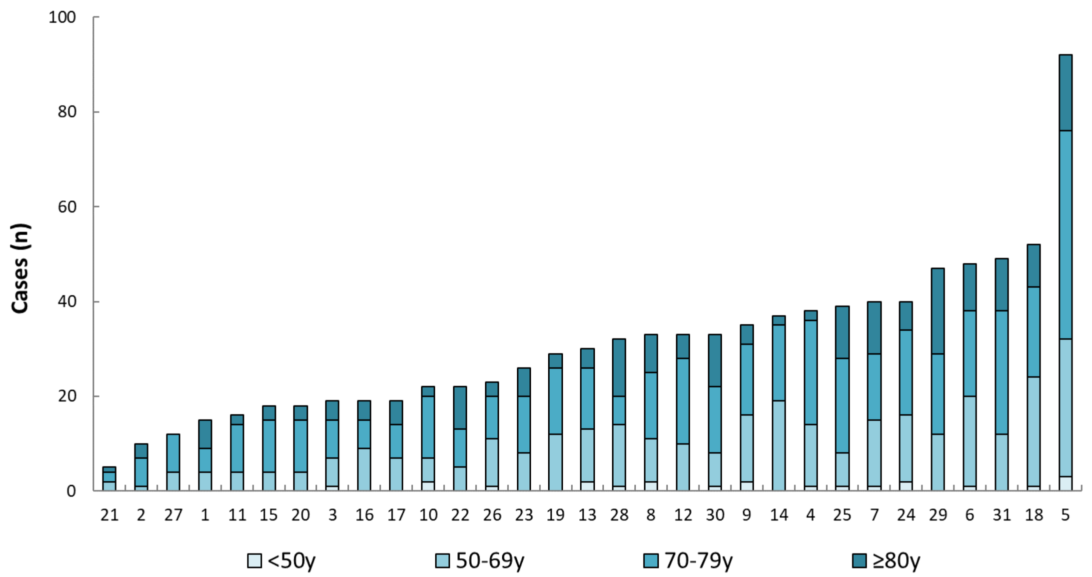




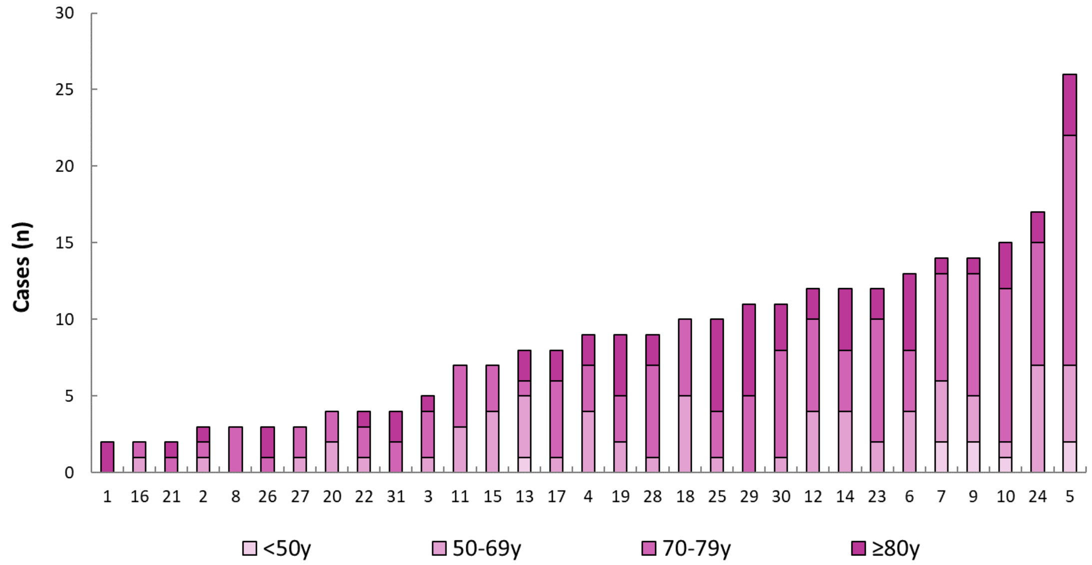
In 2017, the most common age group for both male and female patients who had a valve with CABG procedure was 70-79 years (Figure 57a and b). Valve with CABG procedures were rare in people aged under 50 years.

Figure 57. Number of 2017 valve with CABG cases by age group for a. males and b. females

a.

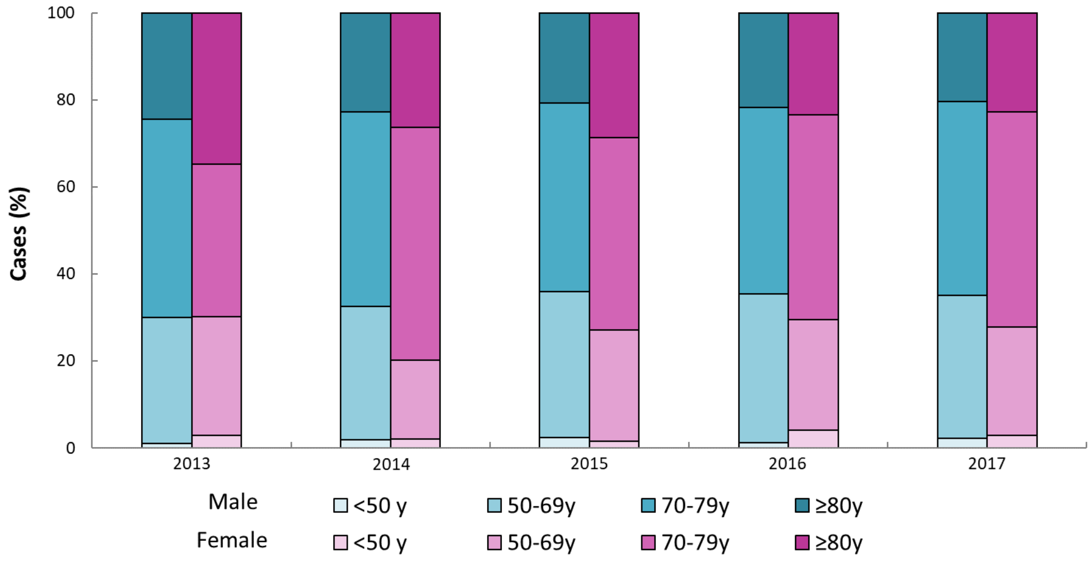


b.



Since 2014, there has been a slightly higher proportion of women aged 70 years and over undergoing valve with CABG procedures, compared to their male counterparts. This gap between the genders has slightly lessened over the last three years (Figure 58).

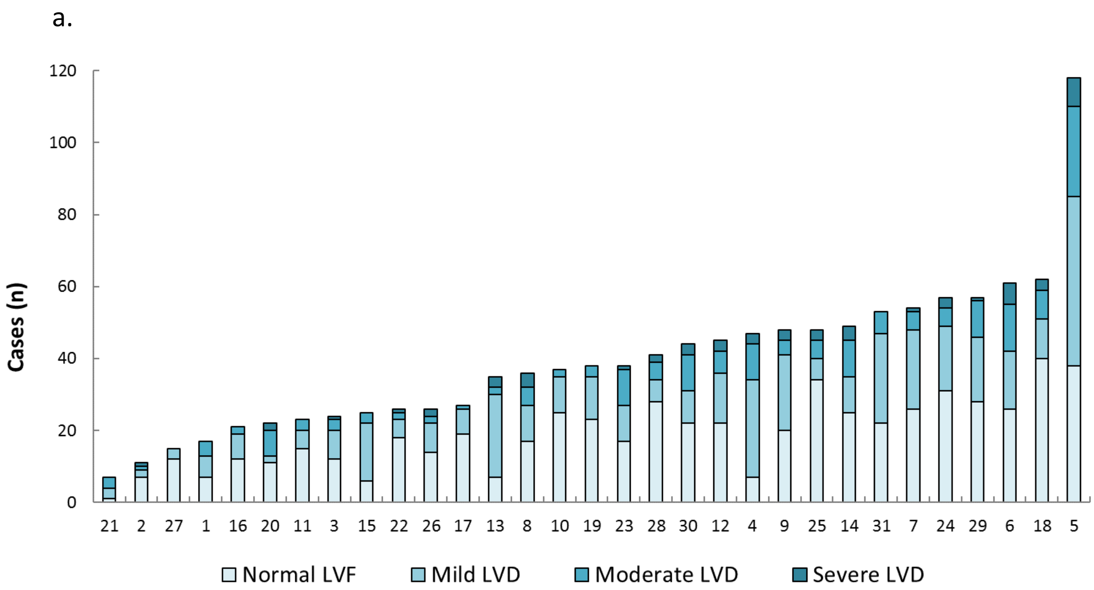
Figure 58. Age groupings for male and female patients that had valve with CABG procedures, 2013-2017

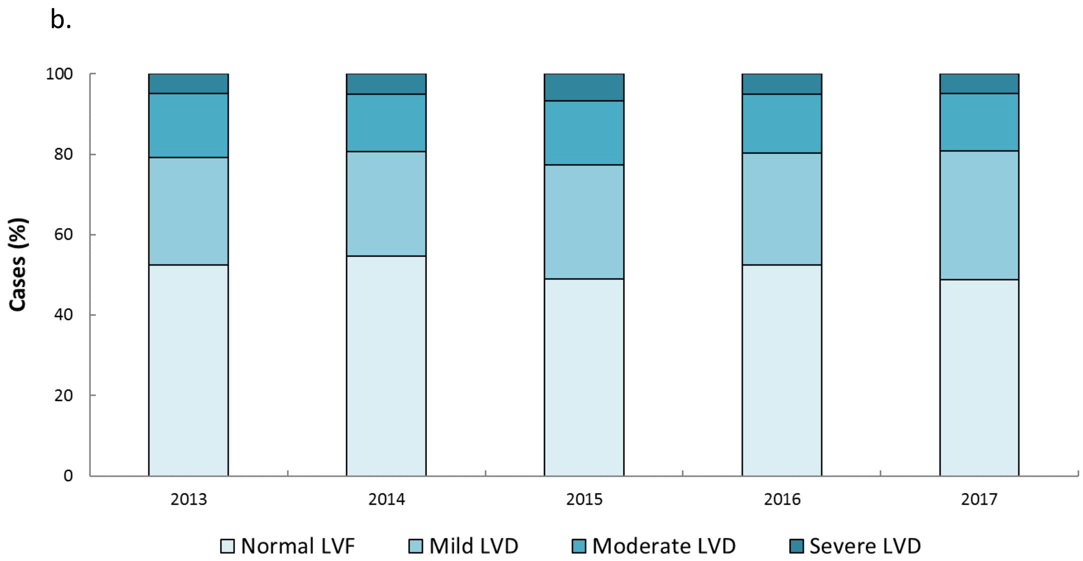


4.1.3 Left ventricular function

Just under half of the patients undergoing valve with CABG procedures in 2017 had normal left ventricular function (LVF; Figure 59a and b). There was variation between units, with some showing a higher proportion of patients with mild left ventricular dysfunction (LVD; Figure 59a). Patients with moderate LVD and severe LVD accounted for 14% and 5% of cases, respectively (Figure 59b).

Figure 59. Valve with CABG procedures based on pre-procedure LVF by a. unit in 2017 and b. year

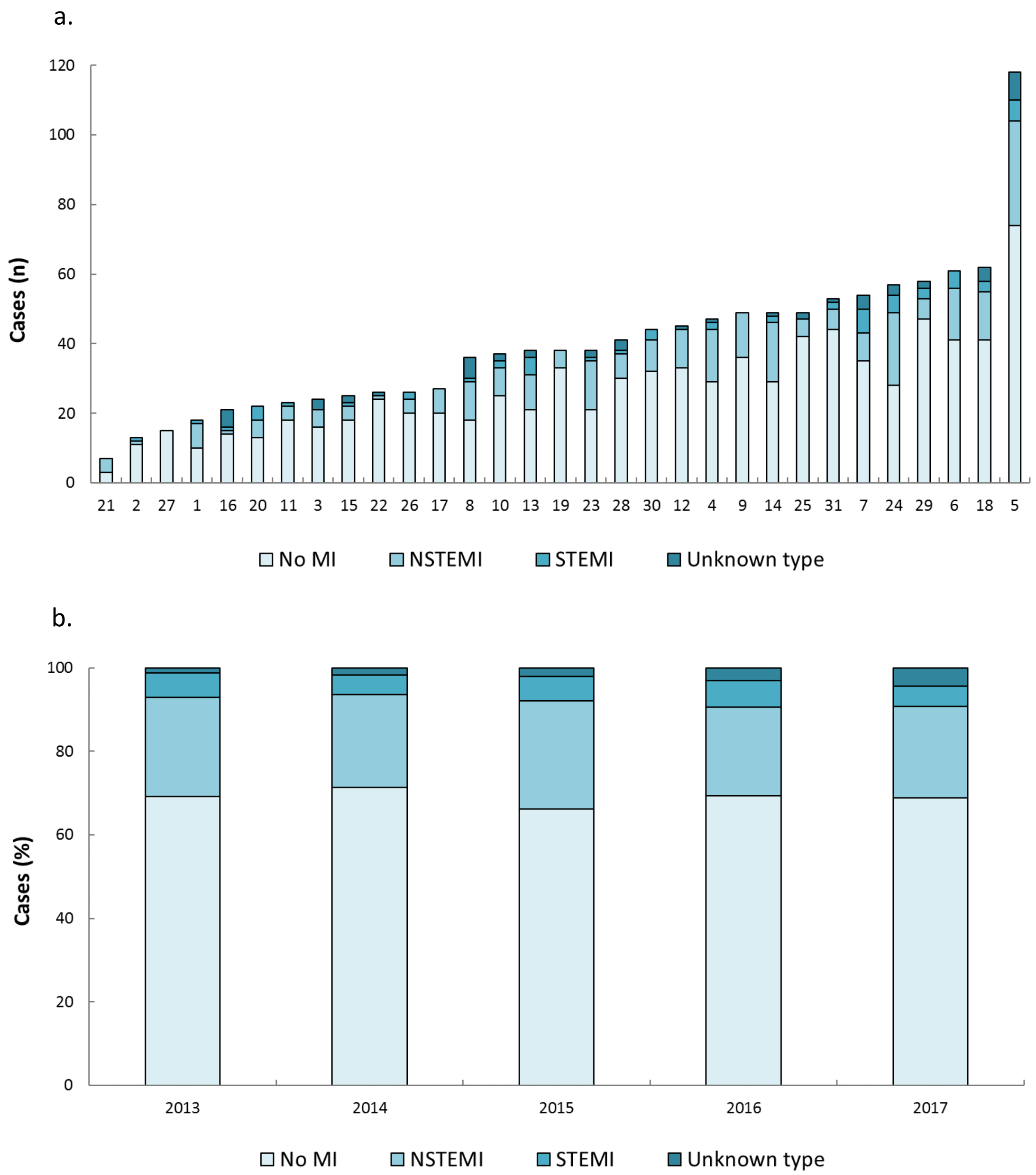




4.1.4 Previous myocardial infarction

The distribution of types of MI was largely similar between 2013 and 2017 and between units (Figure 60a and b).The pooled unit data shows that in 2017, approximately 69% of all patients had no MI prior to valve with CABG, 22% had a NSTEMI, 5% had a STEMI, and approximately 4% of MI cases reported to the Database did not specify the type of MI (Figure 60b).

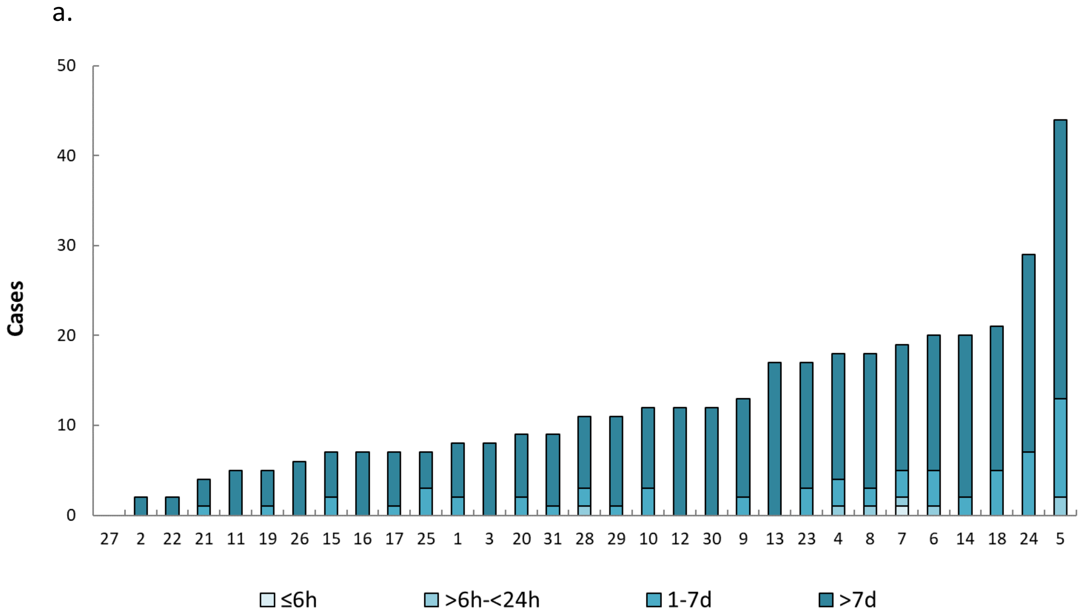
Figure 60. Valve with CABG procedures based on prior MI by a. unit in 2017 and b. year

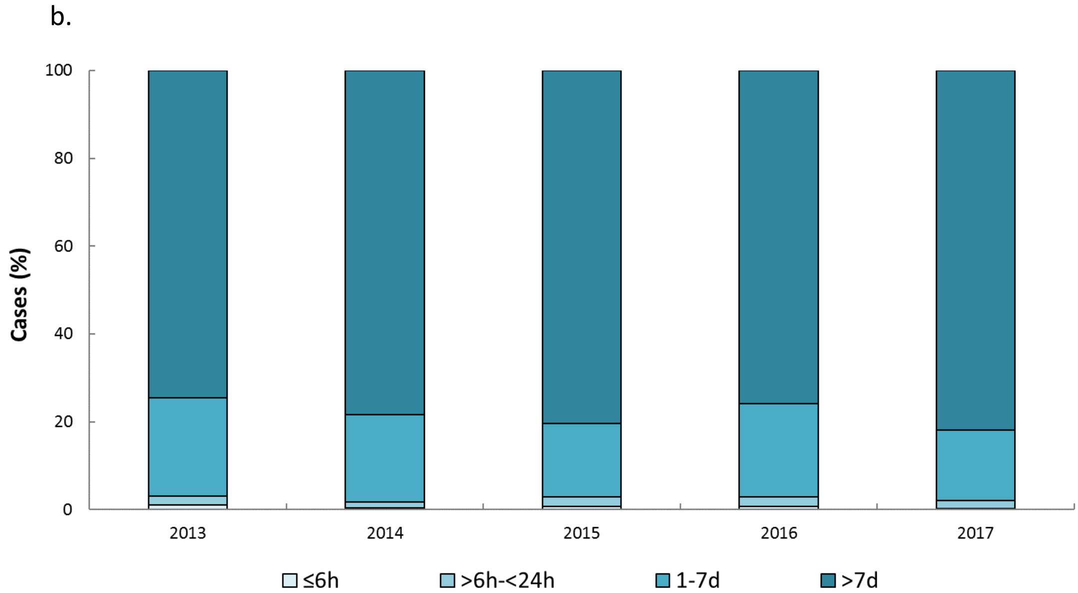


4.1.5 Timing of prior myocardial infarction

In all units, the majority of cases with a prior MI reported the incident as having occurred more than seven days before valve with CABG surgery (Figure 61a). This is consistent with the pooled data over the last five years (Figure 61b). In 2017, just over 2% of cases involved a MI within 24 hours of surgery (Figure 61b).

Figure 61. Valve with CABG procedures based on timing of pre-procedure MI by a. unit in 2017 and b. year



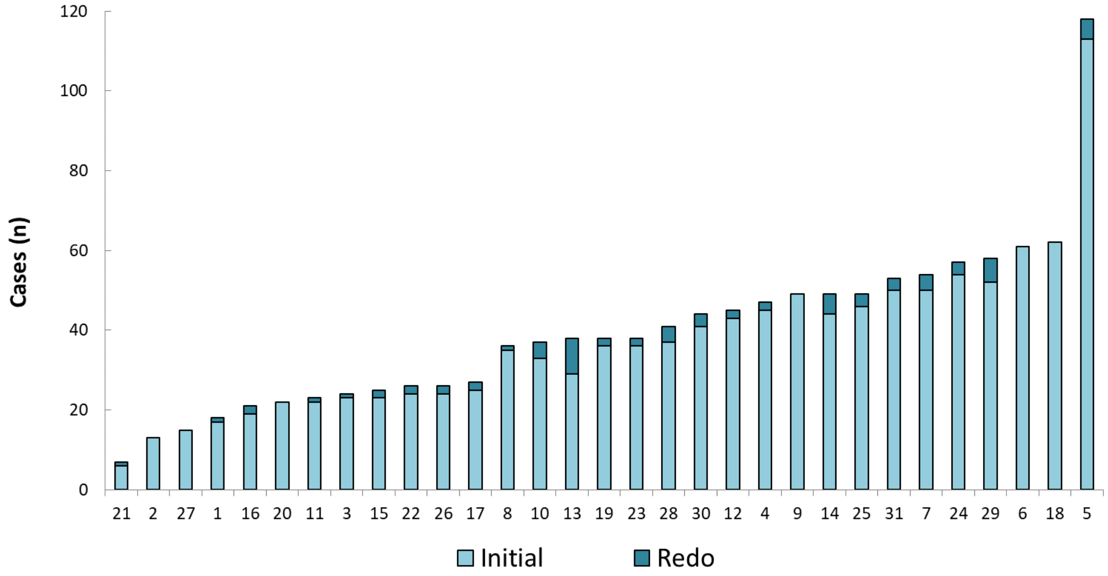


4.2 Previous surgery

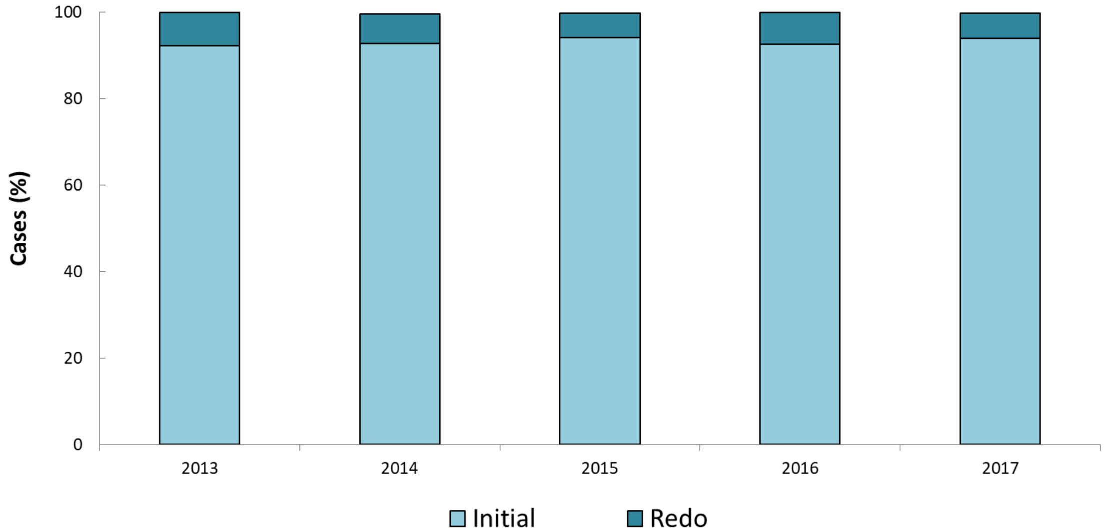
Approximately 6% of valve with CABG procedures performed in 2017 were redo procedures. A procedure is considered a redo if the patient has had any prior cardiac surgery. This figure has remained consistent since 2013, and is similar between units (Figure 62a and b).

Figure 62. Initial versus redo valve with CABG by a. unit in 2017 and b. year

a.



b.

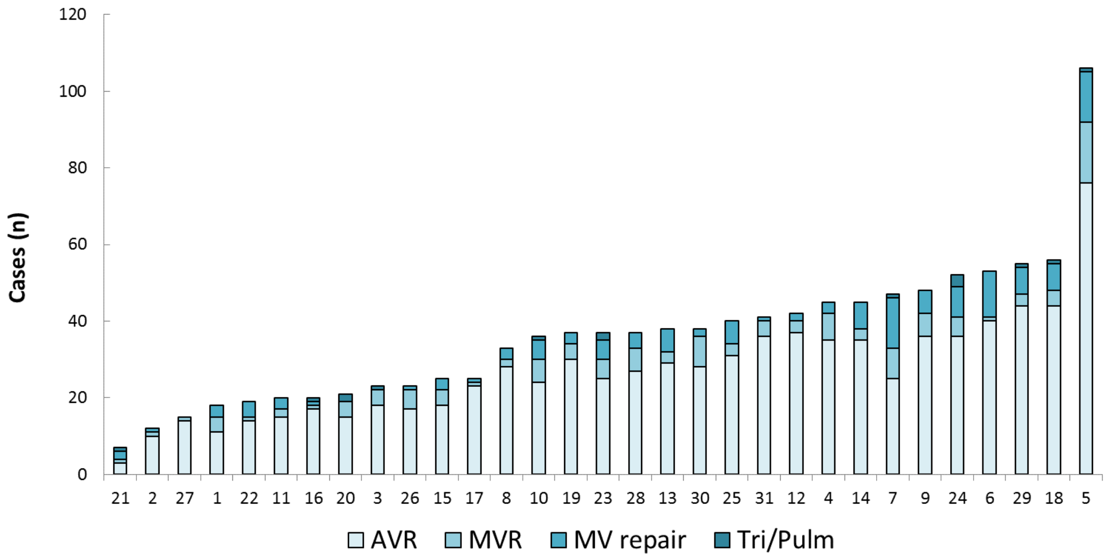


4.3 Valve procedure types with CABG

AVR with CABG procedures made up three quarters of the total valve with CABG procedures in 2017. MV replacements (MVR) and MV repairs each accounted for approximately 12% of total valve with CABG cases, and procedures involving the tricuspid or pulmonary (Tri/Pulm) were less than 2%. These patterns were similar between units and across the preceding four years (Figure 63a and b).

Figure 63. Type of valve procedures performed with CABG by a. unit in 2017 and b. year

a.



b.

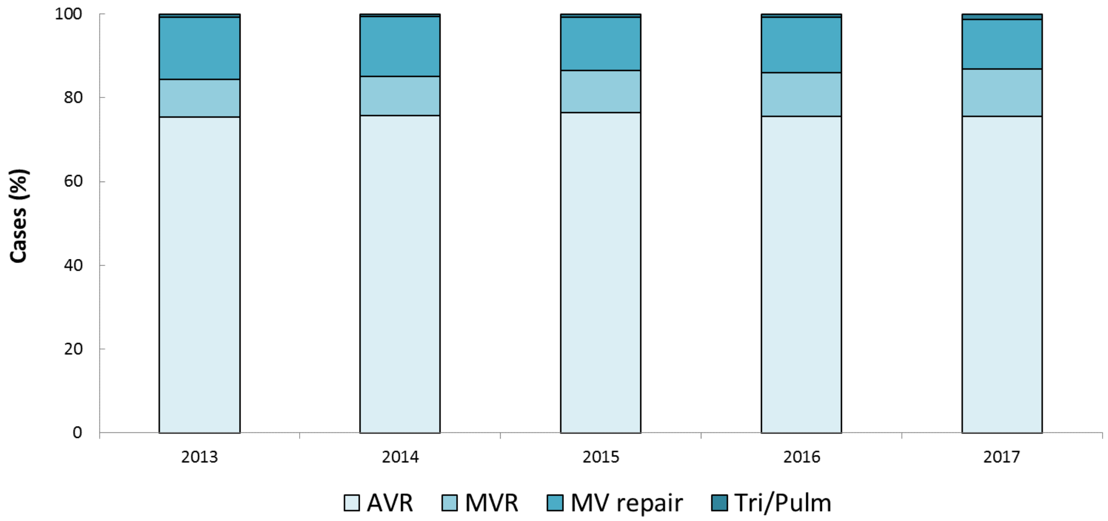


Table 15 shows the case numbers and observed mortality rates for the most common single and multi-valve procedures performed in conjunction with CABG.

Table 15. Observed mortality (%) for valve procedures with CABG performed in 2017 and 2013-2016

Valve Procedure	Year	n	OM (%)
Single aortic	2017	841	2.3
	2013-2016	3284	3.2
AVR	2017	832	2.3
	2013-2016	3231	3.1
Other aortic	2017	9	0.0
	2013-2016	53	5.7
Single mitral	2017	259	4.6
	2013-2016	1022	6.3
Replacement	2017	126	7.9
	2013-2016	422	9.2
Repair	2017	132	1.5
	2013-2016	595	4.0
Single tricuspid	2017	14	14.3
	2013-2016	29	6.9
Single pulmonary	2017	1	0.0
	2013-2016	2	50.0
Aortic and mitral	2017	63	4.8
	2013-2016	199	8.5
Aortic and tricuspid	2017	3	33.3
	2013-2016	24	8.3
Mitral and tricuspid	2017	34	2.9
	2013-2016	114	11.4
Other double	2017	1	0.0
	2013-2016	3	0.0
Triple	2017	4	0.0
	2013-2016	37	18.9
Quadruple	2017	0	-
	2013-2016	0	-
Total valve procedures^	2017	**1220**	**3.1**
	2013-2016	**4714**	**4.5**

^One case was not included due to missing data

4.4 Influence of patient characteristics on mortality

For all valve with CABG procedures, higher rates of observed mortality (OM) were reported with increasing urgency of the procedure or impairment of LVF, occurrence of pre-operative MI, and redo procedures (Table 16).

Table 16. Observed mortality (%) based on patient characteristics for AVR with CABG and all other valve with CABG, 2013-2017

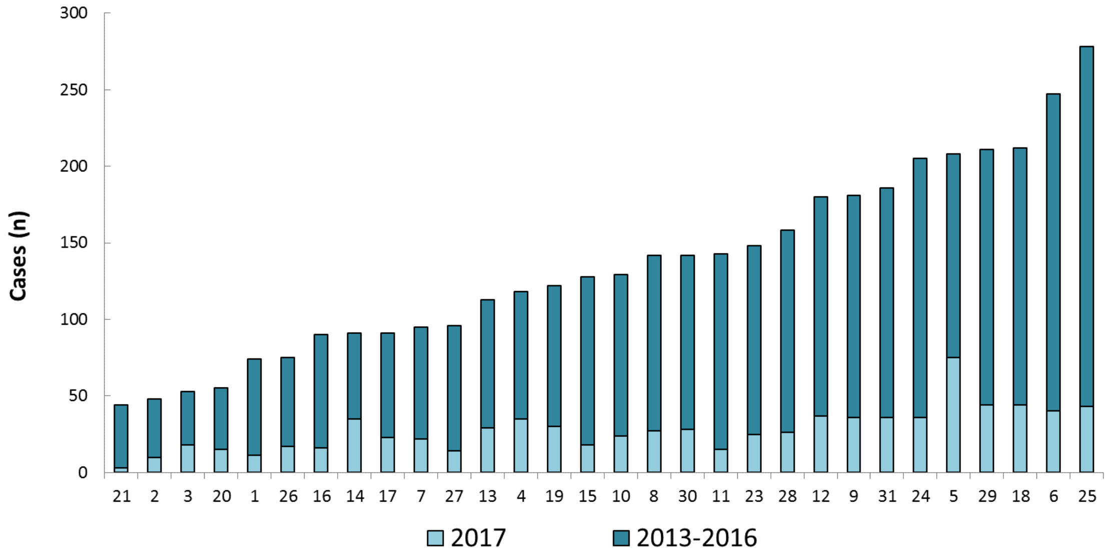
	AVR with CABG		All Other Valve with CABG	
	n	OM (%)	n	OM (%)
Clinical status				
Elective	3283	2.3	1400	4.8
Urgent	739	5.1	417	10.1
Emergency/salvage	41	14.6	62	30.6
Gender/age				
Male*	3186	2.7	1373	6.2
<50y	34	0.0	48	2.1
50-69y	890	2.0	573	5.9
70-79y	1498	2.3	517	6.2
≥80y	763	4.5	235	7.7
Female	877	3.9	506	8.5
<50y	11	0.0	27	11.1
50-69y	160	3.1	179	7.3
70-79y	422	4.0	206	7.3
≥80y	284	4.2	94	12.8
Left ventricular function^				
Normal LVF	2295	2.1	720	5.4
Mild LVD	1110	3.3	548	5.3
Moderate LVD	459	5.0	426	8.7
Severe LVD	140	7.9	170	12.4
Previous MI				
No MI	2911	2.2	1184	5.3
NSTEMI	898	4.8	470	7.4
STEMI	158	7.6	173	15.0
Unknown type	96	1.0	52	7.7
Timing of prior MI				
≤6h	8	0.0	4	75.0
>6h-<24h	12	8.3	23	13.0
1-7d	205	5.4	148	12.2
>7d	927	4.7	520	7.7
Previous surgery				
Initial	3845	2.9	1701	6.2
Redo	218	4.6	178	12.4

*One case missing from male age group for AVR + CABG
^59 and 16 cases missing from AVR + CABG and All other Valve + CABG, respectively

4.5 Aortic valve replacement with CABG

The number of AVR with CABG procedures performed in each unit in 2017 ranged from 3 to 75 (Figure 64). Not all units contributed data for the entire 2013-2016 period; therefore, numerical comparisons cannot be made for the pooled data.

Figure 64. AVR procedures with CABG performed by unit, 2013-2017



4.5.1 Effect of co-morbidities on complications

4.5.1.1 Pre-existing diabetes and renal impairment

This report compares two parameters of renal impairment: patients with a pre-operative creatinine level of ≥200 µmol/L or those with a pre-operative estimated glomerular filtration rate (eGFR) ≤60 mL/min/1.73m^2.

The data indicates that diabetes and prior renal impairment are associated with a higher incidence of post-operative cerebrovascular accident (CVA) following AVR with CABG (Table 17). Patients with pre-operative creatinine ≥200 µmol/L had a particularly increased incidence of CVA, and a higher rate of re-operation for bleeding.

Table 17. Complications (%) for AVR with CABG patients based on pre-operative diabetes and renal function status

		Diabetes*^		Pre-op creatinine		Pre-op eGFR	
		No	Yes	<200 µmol/L	≥200 µmol/L	>60mL /min/1.73m2	≤60mL /min/1.73m2
n	2017	541	290	797	35	542	290
	2013-2016	2051	1180	3115	116	1898	1333
Any CVA	2017	2.2	4.1	2.6	8.6	2.4	3.8
	2013-2016	2.2	3.4	2.6	4.3	2.2	3.3
DSWI	2017	1.3	1.0	1.3	0.0	1.7	0.3
	2013-2016	1.1	2.4	1.5	2.6	1.4	1.7
NCA	2017	37.5	37.2	36.6	57.1	35.1	42.0
	2013-2016	37.3	37.5	37.5	34.5	36.4	38.8
Re-op for bleeding	2017	3.9	2.4	3.3	5.7	3.9	2.4
	2013-2016	4.1	3.5	3.9	5.2	3.7	4.2

*One case missing in 2017
^Refers to all diabetes, regardless of type of therapy

4.5.1.2 Age

Advancing age was frequently, but not consistently, associated with higher rates of post-operative complications for patients undergoing AVR with CABG (Table 18).

Table 18. Complications (%) for AVR with CABG patients based on patient age

		Age*			
		<50 y	50-69 y	70-79 y	≥80 y
n	2017	14	231	402	184
	2013-2016	31	819	1518	863
Any CVA	2017	7.1	0.9	4.5	1.6
	2013-2016	0.0	2.3	2.6	3.2
DSWI	2017	0.0	2.2	0.7	1.1
	2013-2016	6.5	2.1	1.1	1.6
NCA	2017	14.3	31.6	42.1	36.1
	2013-2016	12.9	33.3	37.6	41.8
Re-op for bleeding	2017	14.3	3.0	3.0	3.8
	2013-2016	9.7	3.3	4.0	4.1

*One case missing in 2017

4.5.1.3 Surgical history

Redo AVR with CABG procedures were associated with a higher incidence of some post-operative complications, particularly deep sternal wound infection (DSWI) and re-operation for bleeding (Table 19).

Table 19. Complications (%) for AVR with CABG patients based on surgical history

		Surgery	
		Initial	Redo
n	2017	793	39
	2013-2016	3052	179
Any CVA	2017	2.5	10.3
	2013-2016	2.7	2.2
DSWI	2017	1.0	5.1
	2013-2016	1.5	2.2
NCA	2017	37.7	33.3
	2013-2016	37.3	38.2
Re-op for bleeding	2017	3.3	5.1
	2013-2016	3.8	5.6

4.5.1.4 Effect of comorbidities on derived new renal impairment

Patients with diabetes, pre-operative renal impairment, increasing age, or who underwent on-pump or redo cardiac surgery had an increased incidence of DNRI following AVR with CABG surgery (Table 20). In particular, patients in 2017 with pre-operative creatinine ≥200 µmol/L or eGFR ≤60 mL/min/1.73m^2 had 5- and 4-fold increases in the incidence of DNRI, respectively. This data excludes patients that received pre-operative dialysis.

Table 20. DNRI (%) for AVR with CABG patients based on diabetes, renal impairment, age, surgical history and use of CPB

	2017		2013-2016	
	n	DNRI (%)	n	DNRI (%)
Diabetes*^				
No	530	3.8	2013	4.8
Yes	287	7.0	1153	7.0
Pre-op creatinine				
<200 µmol/L	794	4.4	3104	5.1
≥200 µmol/L	24	20.8	62	29.0
Pre-op eGFR				
>60mL/min/1.73m2	540	2.4	1896	4.3
≤60mL/min/1.73m2	278	9.7	1270	7.5
Age†				
<50y	14	7.1	31	6.5
50-69y	226	4.0	788	5.1
70-79y	393	4.3	1491	5.0
≥80y	184	7.1	856	7.0
Previous surgery				
Initial	780	4.6	2992	5.5
Redo	38	10.5	174	6.9
Cardiopulmonary bypass				
On-pump	814	4.9	3163	5.6
Off-pump	4	0.0	3	0.0

*One case missing for 2017
^Refers to all diabetes, regardless of type of therapy
†One case missing for 2017

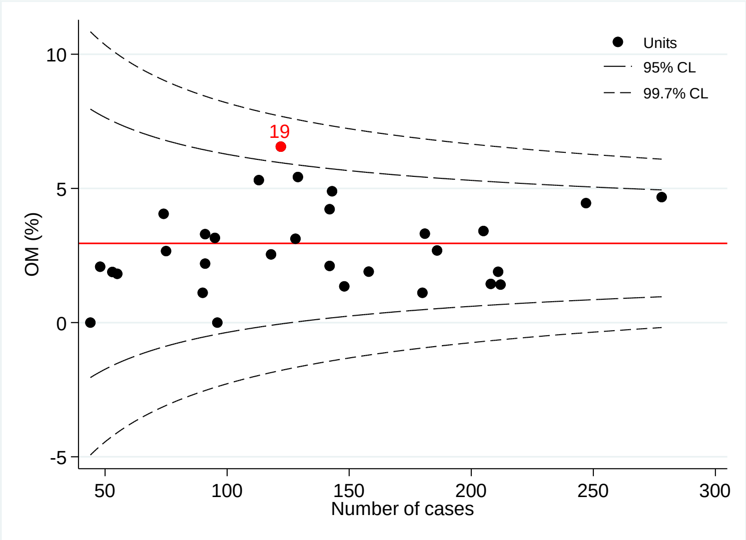
4.5.2 Unit outcomes – mortality, complications and resource utilisation

Due to low procedure numbers, the unit outcome data for AVR with CABG is presented for the pooled 2013-2017 period.

4.5.2.1 Mortality

All units were within the upper 99.7% control limit for OM in the 2013-2017 period (Figure 65).

Figure 65. Observed mortality by unit following AVR with CABG, 2013-2017

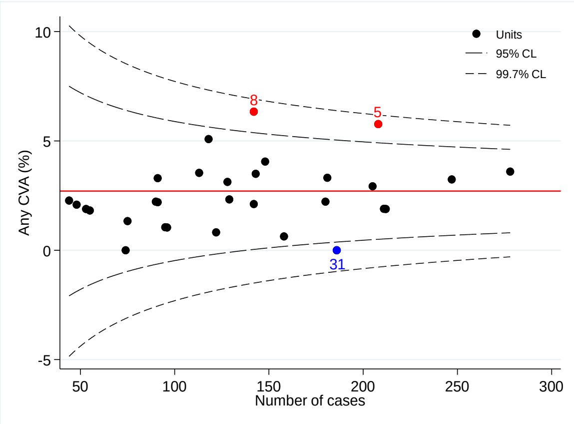


4.5.2.2 Complications

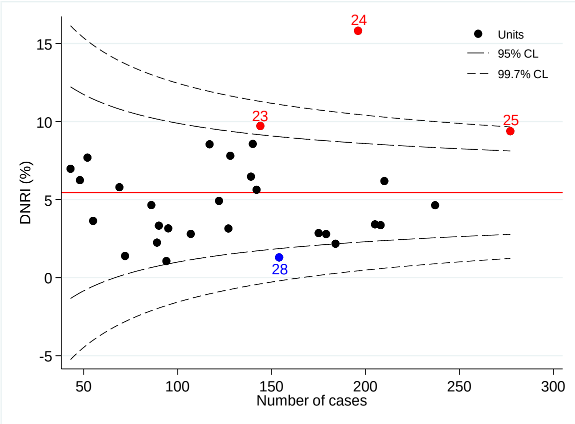
There was wide variation in the incidence of post-operative complications between units, particularly for NCA and readmission (Figure 66). The data for rates of DNRI excludes patients who received pre-operative dialysis (Figure 66b).

Figure 66. Complications by unit following AVR with CABG, 2013-2017

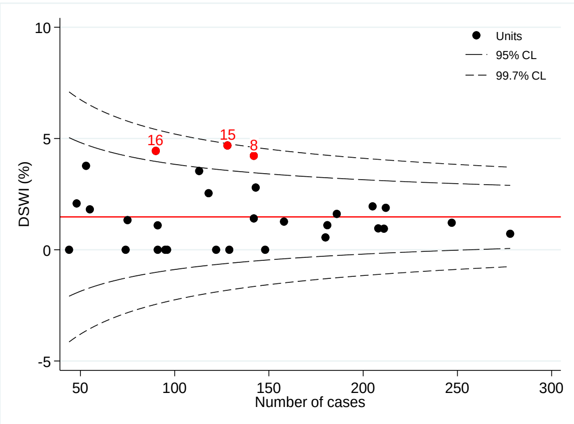
a. CVA



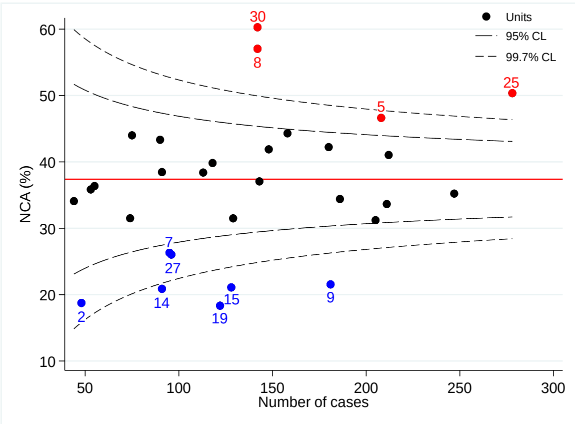
b. DNRI



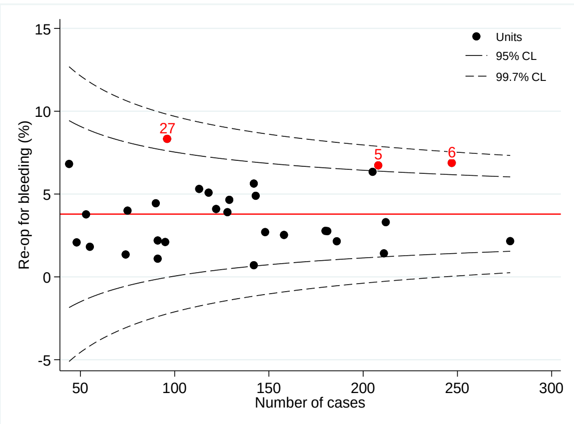
c. DSWI



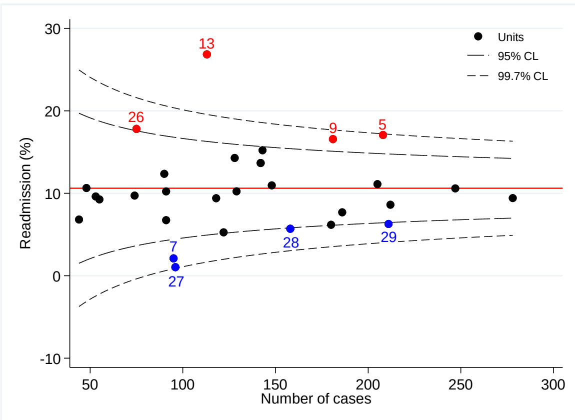
d. NCA



e. Re-op for bleeding



f. Readmission



4.5.2.3 Resource utilisation

Due to the skewed distribution of the ICU length of stay and ventilation data, the geometric means (GM) are presented. The GM is defined as the nth root of a product of n numbers. It is useful to describe the central tendency of a set of skewed data, as it is less sensitive to outlying values.

The pooled data shows marked variation between units with respect to the time patients spent in the ICU, the duration of ventilation, and the percentage of patients that received red blood cell (RBC) or non-RBC (NRBC) transfusions (Table 21).

Table 21. Resource utilisation by unit for AVR with CABG patients, 2013-2017

	2013-2017			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	35.6	11.1	43.8	20.5
2	66.0	5.7	27.1	14.6
3	42.6	14.2	45.3	43.4
4	28.3	10.9	16.9	11.9
5	41.3	11.6	43.8	30.3
6	77.3	14.2	47.8	34.8
7	40.0	10.1	34.7	28.4
8	53.7	14.6	31.0	22.5
9	120.8	16.7	59.7	39.8
10	53.9	13.8	66.7	46.5
11	47.5	15.4	52.4	42.7
12	38.4	14.0	55.0	31.1
13	46.7	19.5	52.7	40.2
14	44.7	9.6	36.3	19.8
15	61.1	17.1	44.5	28.9
16	65.2	15.1	54.4	30.0
17	59.1	18.5	86.8	65.9
18	71.3	10.3	56.1	31.6
19	34.3	14.0	54.9	46.7
20	65.5	10.7	41.8	32.7
21	48.8	13.9	31.8	15.9
23	83.7	17.0	47.3	28.4
24	43.0	11.9	45.9	28.8
25	67.8	10.8	60.1	39.2
26	37.9	10.0	44.0	36.0
27	91.8	17.7	31.3	10.4
28	56.5	13.9	65.8	39.9
29	42.1	8.1	45.5	35.5
30	95.2	15.6	58.5	35.9
31	56.9	10.4	27.4	16.1
Total	**55.7**	**12.8**	**48.5**	**32.5**

5. Other Cardiac Surgery

Table 22 reports the 2017 case numbers for all other cardiac procedures not covered in Sections 1, 3 or 4. Many of these procedures are not performed in isolation, therefore OM is not necessarily indicative of that specific procedure, and is not presented.

Table 22. Case numbers for other uncommon procedures performed in 2017

Surgery type (not mutually exclusive)	n
LV aneurysm	14
Acquired ventricular septal defect	26
Aortic replacement^	859
Ascending only	618
Ascending + arch	165
Arch only	37
Descending	13
Thoracic/abdominal only	3
Arch + descending	3
Ascending + arch + descending	13
Other	3
Aortic repair*	160
Endarterectomy	17
Patch repair	72
Endarterectomy + patch repair	3
Indication for aortic procedure	1043
Aneurysm	567
Dissection	265
Traumatic transection (<2 weeks)	2
Calcification	50
Other	159
Cardiac trauma	11
LV outflow tract myectomy	105
LV rupture repair	13
Pericardiectomy	27
Pulmonary thrombo-endarterectomy	26
Carotid endarterectomy	16
LV reconstruction	4
Pulmonary embolectomy	16
Cardiac tumour	67
Congenital	
Atrial septal defect	160
Other	133
Permanent LV epicardial lead	29
Atrial arrhythmia surgery	333
Left atrial appendage closure	242

^Four cases missing aortic procedure type data
*68 cases missing aortic repair type data

Table 23 provides case numbers for valve procedures that were performed in conjunction with other types of cardiac surgery.

Table 23. Case numbers for other valve procedures performed in 2017 and 2013-2016, without and with CABG

Valve Procedure (not mutually exclusive)		Without CABG	With CABG
Aortic root replacement with valve conduit	2017	220	33
	2013-2016	599	145
Pulmonary autograft aortic root replacement (Ross)	2017	14	-
	2013-2016	23	-
Root reconstruction with valve sparing (David)	2017	35	9
	2013-2016	128	26
Total other valve procedures	**2017**	**269**	**42**
	2013-2016	**750**	**172**

Table 24 presents case numbers and observed mortality (OM) for transplants performed without any concomitant procedures.

Table 24. Case numbers and observed mortality (%) for transplants performed in 2017

Surgery type (performed in isolation)	n	OM (%)
Cardiac transplant	73	4.1
Cardiopulmonary transplant	45	4.4

Concluding Remarks

The ANZSCTS Database has 95% data completeness for all reported KPIs, assuring minimal to no selection bias in analyses. Based on AIHW records (https://www.aihw.gov.au/reports/heart-stroke-vascular-disease/cardiovascular-health-compendium/data), approximately 60% of Australian cardiac procedures from 2017 were reported to the ANZSCTS Database. We strive toward the ideal of including all adult patients from every cardiac surgical unit so that the performance of all units and surgeons may be evaluated.

The significant changes made by the Program in 2017/2018 have been: to continually improve and update our Web System, including refining data definitions to reflect changes in clinical practice; recruitment of more hospital sites, reaching close to 100% coverage of the public hospitals in Australia and with the inclusion of the Royal Hobart Hospital in 2018 we will hit that target; and continuing the growth of our research program, with more than 25 projects in progress at the time of this report being published.

Our goals for the remainder of 2018 are to increase the scope of downloadable web reports showing comparative KPIs for all participating units; continue to enhance the Web System data entry portal for efficient data entry; bring on board our first site in New Zealand; and engage with further sites to work towards the achievement of total bi-National coverage.

Long-term goals for ANZSCTS Database will focus on extending the scope of the information collected through linkage of our data with other key external data sources; establishing a Cardiac Surgical Prosthesis Registry; evaluation of quality of life through collecting longitudinal Patient Reported Outcome Measures (PROMs); collecting twelve month follow-up data; and improving our reporting processes to health professionals and to the public.

We take this opportunity to thank contributors for their dedicated efforts with data collection and financial support, both of which are integral to our efforts.

Appendix A

Management of Unit Outliers – Review Timeline

Week 0: Identification of outlier during the Steering Committee (SC) quarterly review on funnel plot (outside the 99.7% control limit) for either the rolling 36-month period or two consecutive quarters.

Week 2: Unit contacted by the Chair of the SC and asked to undertake internal review of data. Data that may have an overall impact on KPI in question, is reviewed by unit and ANZSCTS Database team, within 8 weeks of notification.

Week 12: SC to review two independent reports from unit and ANZSCTS Database team. These reports are compared with most recent quarterly KPI data.

If the results have fallen back within control limits no further action is taken.

If the KPI still remains out of range the Chair of the SC will make a recommendation that the unit agrees to an external review of their data.

- The Peer Review and Quality Assurance Committee (PRQAC) will be activated and comprises members of ANZSCTS:
    - The President of the Society
    - The Vice-President of the Society
    - Royal Australian College of Surgeons Cardiothoracic Surgery Specialty-elected Councilor
    - The Chairman of the Board of Studies
    - The Chairman of the Science and Education Committee of The Society
    - The Chairman of the Board of The Australasian Cardiac Surgery Research Institution Ltd.
    - Ordinary or senior member of the Society, elected by ballot of all members of the Society.

Week 24: SC to review external audit report and monitor most recent (rolling 36 month and current quarter) KPI data.

- If sufficient data is available and results have fallen within control limits the unit will be informed along with the hospital administrative body that the review is finalised and no further action is required.
- If sufficient data is available and results still remain outside limits then the unit will be informed and a meeting will be arranged between the PRQAC, hospital administration and the Head of Unit.

Week 36: The SC will continue to monitor the unit's data if there is insufficient data for a statistical analysis. At 36 weeks the SC will review past 6 months of data and all data relating to KPI at the next quarterly review including:

    - The local audit report
    - The external audit report

- If the KPI still remains out of range the unit will be informed and a meeting will be arranged between PRQAC, hospital administration and the Head of Unit.

Appendix B

Key Performance Indicator Definitions

The KPIs presented in this report are based on the ANZSCTS Database Program Data Definitions Manual, as follows:

In-hospital and 30-day mortality or observed mortality

- *Observed mortality*
  Includes all in-hospital mortality and any post discharge mortalities that occurred within 30 days of the procedure.
- *Risk-adjusted mortality*
  Derived based on the ANZSCTS Database Program's risk model (Appendix E), and used to account for the degree of risk associated with the surgery and patient profile.

Re-operation for bleeding

Did the patient return to theatre for bleeding/tamponade?

Derived new renal impairment

Acute post-operative renal insufficiency is characterised by one of the following:

a. Increased serum creatinine to >0.2mmol/L (>200µmol/L) AND a doubling or greater increase in creatinine over the baseline pre-operative value AND the patient did not require pre-operative dialysis/haemofiltration, or
b. A new post-operative requirement for dialysis/haemofiltration (when the patient did not require this pre-operatively).

Deep sternal wound infection (DSWI)

Did the patient develop infection of sternal bone, muscle and/or mediastinum? The patient must have **wound debridement and** one of the following:

a. Positive cultures
b. Treatment with antibiotics

Includes all in-hospital DSWI events and any readmissions due to DSWI within 30 days of procedure.

Any cerebrovascular accident (CVA)

Any CVA is a combination of the following cerebrovascular endpoints:

a. Permanent stroke
   Did the patient experience a stroke or new central neurologic deficit (persisting for >72 hours) peri- or post-operatively?
b. Transient stroke
   Did the patient experience a new transient central neurologic deficit that was resolved completely within 72 hours (TIA/RIND)?
c. Coma
   Did the patient have post-operative coma of neurologic aetiology lasting at least 24 hours?
   Note: This excludes metabolic and drug related coma*

*This exclusion criteria did not apply prior to the change in the Data Definitions Manual on September 1st 2016.

New cardiac arrhythmia (NCA)

NCA is any new form of cardiac arrhythmia that occurred post-procedurally that required treatment. This includes:

a. Heart block requiring permanent pacemaker
b. New other bradyarrhythmia requiring permanent pacemaker
c. Cardiac arrest documented by one of the following:
    - Ventricular fibrillation OR
    - Rapid ventricular tachycardia with haemodynamic instability OR
    - Asystole OR
    - Pulseless electrical activity (PEA)*
d. New atrial arrhythmia (requiring treatment) - atrial fibrillation or flutter
e. New ventricular tachycardia

*This type of cardiac arrest was not specified prior to the change in the Data Definitions Manual on September 1st 2016.

Duration of ICU stay (initial stay only)

Number of hours spent by the patient in the ICU prior to transfer to the high dependency unit or general ward (does not include readmission to ICU). Calculated by subtracting the ICU admission date and time from ICU discharge date and time, where both values are available.

Duration of ventilation (initial post-operative ventilation only)

Number of hours post-operation for which the patient was ventilated. Calculated by subtracting ICU admission time from the ICU extubation time, where both values are available. If the patient was extubated on the operating table, duration of ventilation is zero. Delayed re-intubation time is not counted.

Red blood cell transfusions

Were allogeneic red blood cells transfused during the intra-operative or post-operative period? Does not include:

a. Pre-donated blood
b. Cell saver blood
c. Pump residual blood
d. Chest tube recirculated blood

Non-red blood cell transfusions

Were blood products other than RBC (e.g. FFP and Platelets) transfused during the intra-operative or post-operative period? Does not include albumin.

Appendix C
Data Preparation and Key Variable Definitions

Data preparation and presentation

Data includes operative details and outcomes of cardiac surgery performed in 31 participating units in 2017, and from 2013-2016 (sections 1 and 5) or 2013-2017 (sections 3 and 4) for pooled analyses.

Final data related to this report was received by the ANZSCTS Database Program Data Management Team in the Centre of Cardiovascular Research and Education in Therapeutics (CCRET) of the Department of Epidemiology and Preventive Medicine, Monash University, on March 2nd, 2018. Submitted data was checked for completeness and Data Managers in each unit were given opportunities to amend any errors. Any changes to the data after March 2nd, 2018 are not reflected in this report.

Variable definitions

All definitions are based on the ANZSCTS Database Data Definitions Manual. Version 3.0 applies to all patients with admission dates prior to September 1st, 2016 and version 4.0 applies to patients with admission dates on and after September 1st, 2016.

Key variables presented in this report are defined below.

- Clinical Status

Elective
The procedure could be deferred without risk of compromised cardiac outcome.

Urgent
a. Within 72 hours of angiography if initial operation was performed in the same admission as angiography ('same admission' includes where angiography was performed in another unit prior to direct transfer to unit where initial operation is performed); or
b. Within 72 hours of an unplanned admission (patient who had a previous angiogram and was scheduled for surgery but was admitted acutely); or
c. Procedure required during same hospitalisation in a clinically compromised patient in order to minimise chance of further clinical deterioration.^

^Additional criteria in version 4.0

Emergency*
Unscheduled surgery required in the next available theatre on the same day (as admission) due to refractory angina or haemodynamic compromise.

Salvage*
The patient underwent cardiopulmonary resuscitation *en route* to, or in the operating room, prior to surgical incision.

** Due to low number of cases, emergency and salvage patients are combined within the report, and labelled as emergency.*

- Readmission ≤ 30 day from surgery

Patient readmitted as an in-patient within 30 days from the date of surgery for ANY reason to general hospital; not emergency, short-stay wards or planned transfer to rehabilitation facility. Date of surgery counts as day zero.

- Redo operation

Operation performed on a patient who has undergone a prior cardiac surgery.

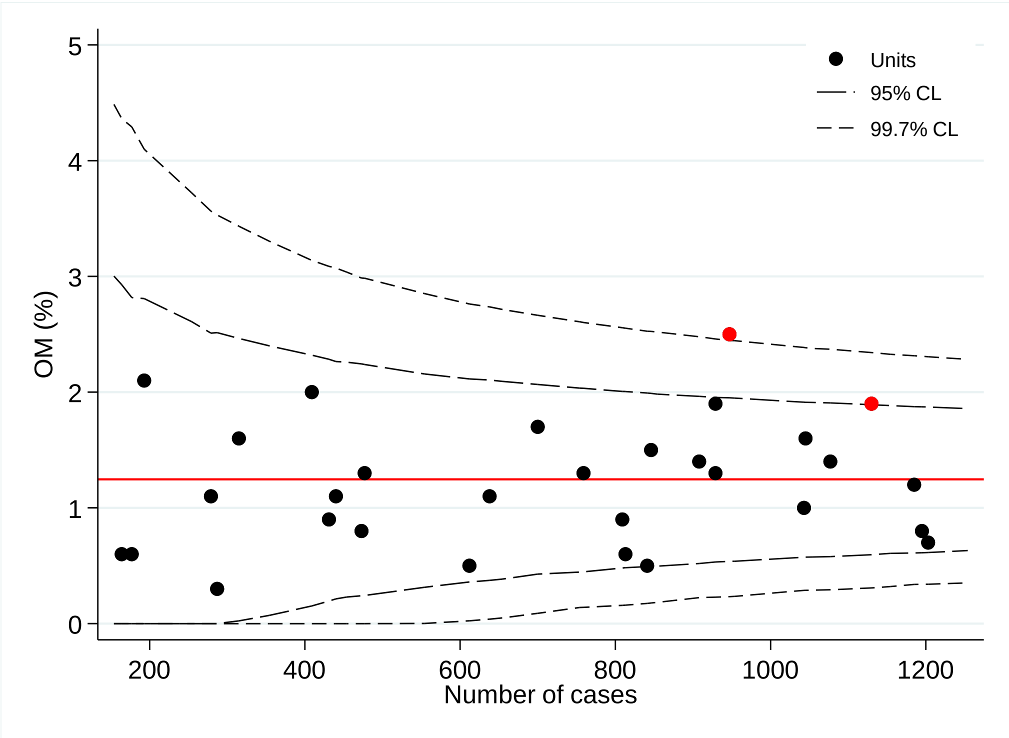
Appendix D

Interpretation of Funnel Plots

Funnel plots are an approach to compare performance standards of hospital units. They are especially useful in this situation as there is usually a difference in the numbers of procedures (sample size) included in the data plot. For example, the figure below illustrates the observed mortality (OM) after coronary artery bypass surgery in Australia between 2012 and 2015.

The solid line represents the average OM, the two-dotted lines are the 95% control limits (CL) and the two-dashed lines are the 99.7% CLs. The funnel plot allows the CLs to narrow as the number of procedures increases. This representation supports the 95% CL plot to illustrate the invalidity of ranking all of those units from “best” to “worst” as only two were worse than the majority, all of which had statistically similar outcomes.

Figure D-I. Observed mortality following CABG, by unit



Appendix E

All Procedures Risk Adjustment Model

The All Procedures Score (Billah, *et. al.*, 2010) is a validated pre-operative risk prediction model, used for risk-adjustment for 30-day mortality for all cardiac surgery, in Australia[15]. The model was developed based on a large number of procedures using standardised data collection methodology. Subsequent validation of the model showed that it is a good fit for Australian data and correctly classified the risk of a large number of procedures.

The Risk Adjusted Mortality Rate (RAMR) takes into account a number of risk factors listed in Table E-I. The ratio of the observed mortality (OM) rate to the predicted mortality rate indicates the relative performance adjusted for the severity of illness or risk. A ratio of 1 indicates results as expected, less than 1 indicates results better than expected, and greater than 1 indicates results worse than expected. This ratio is then multiplied by the Observed Average Mortality Rate to yield a RAMR which normalises the individual unit for its case mix.

RAMR is calculated as follows:

$$\text{RAMR} = \left(\frac{\text{OM Rate}}{\text{Predicted Mortality Rate}} \right) \times \text{Average OM Rate}$$

RAMR is therefore, a predictor of mortality for a given patient set which takes into account the risks for those patients.

Table E-I. Variables that define overall patient risk in the All Procedures Risk-Adjustment Model

Age	Gender	Clinical Status
Procedure type	Previous Cardiac Surgery	NYHA* class
EF Grade	Pre-operative Dialysis	Hypercholesterolaemia
Previous vascular disease	BMI>25kg/m^2	

* New York Heart Association functional classification for dyspnoea

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