ANZSCTS
Cardiac Surgery
Database Program

Annual Report

2020

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

Annual Report

2020

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Abbreviations

ANZSCTS	Australian and New Zealand Society of Cardiac and Thoracic Surgeons
AoV	Aortic valve
AVR	Aortic valve replacement
BITA	Bilateral internal thoracic artery
BMI	Body mass index
CABG	Coronary artery bypass graft
CPB	Cardiopulmonary bypass
dNRI	Derived new renal insufficiency
DSWI	Deep sternal wound infection
eGFR	Estimated glomerular filtration rate
GEPA	Gastroepiploic artery
GM	Geometric mean
ICU	Intensive care unit
KPI	Key performance indicator
LITA	Left internal thoracic artery
LVD	Left ventricular dysfunction
LVEF	Left ventricular ejection fraction
LVF	Left ventricular function
MI	Myocardial infarction
MV	Mitral valve
MVR	Mitral valve replacement
NCA	New cardiac arrhythmia
NICOR	National Institute for Cardiovascular Outcomes Research
NRBC	Non-red blood cell
NSTEMI	Non-ST elevation myocardial infarction
OM	Operative mortality
PLOS	Procedural length of stay
RA-dNRI	Risk-adjusted dNRI
RA-OM	Risk-adjusted OM
RAC	Radial artery conduit
RBC	Red blood cell
RITA	Right internal thoracic artery
RTT	Return to theatre
STEMI	ST elevation myocardial infarction
STS	Society of Thoracic Surgeons
SV	Saphenous vein
SWEDEHEART	Swedish Web-system for Enhancement and Development of Evidence-based Care in Heart Disease Evaluated According to Recommended Therapies
Tri/Pulm	Tricuspid or pulmonary
TAVR	Transcatheter aortic valve replacement
TMVR	Transcatheter mitral valve replacement

Acknowledgements

The Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS) Cardiac Surgery 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 private and public units.

The ANZSCTS Cardiac Surgery Database Steering Committee reviews the statistical data, oversees the management of outliers, reviews data definitions and guides the management of the Database. The ANZSCTS Cardiac Surgery Database Research Committee evaluates applications for research involving the Database and ensures the probity and quality of ensuing publications. The ANZSCTS Cardiac Surgery Database Data Custodian – Professor Chris Reid, and the Chairman of the Steering Committee and Clinical Lead – Mr Gil Shardey, guide and oversee the entire Program.

The Data Management and Analysis Centre 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 Mr Alex Janssan) are responsible for the critical tasks required for the day-to-day operation of the Database including cleaning the submitted data, and running analyses that help inform the Committees. Without their contributions, the Committees would be unable to function.

The work of the ANZSCTS Database relies on the continuing interest and efforts of surgeons, Data Managers, and other relevant hospital staff who contribute data.

Photograph by Mark Lucas 2018 ©

Foreword

For the past fourteen years, the Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS) Cardiac Surgery Database Program has published an Annual Report. There were 55 units enrolled in the Program in 2020. Regrettably, three units were unable to submit the proportion of cases required for analysis and thirteen units started contributing mid-year (July 2020), therefore are not included, so that this report describes the data from surgery performed in 39 public and private hospital cardiac surgical units.

Data presented in this report provide unit comparisons for surgery performed in the 2020 calendar year. Thirty-day follow-up dictates that surgical outcomes are collected to the end of January 2021. Information is also presented as pooled (four or five year) and annual (five years) data.

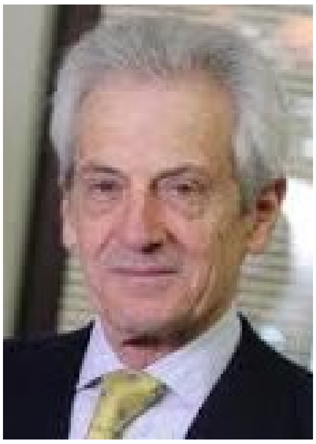
Units are de-identified by random coding. The report demonstrates unit performance compared to other contributing units, and the group average.

The Society's purpose is to ensure that high standards are maintained in all units performing cardiac surgery in Australia and New Zealand and where necessary, assist units to achieve that standard. The Program therefore has an important quality assurance function, where unit outcomes are compared against a set of performance indicators. Directors of Cardiothoracic Surgery Units are notified of potential outlying status in accordance with the ANZSCTS Database's *Special Cause Variation Management Policy*.

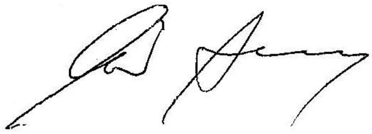
Overall, in the five-year period, although there is variation in practice, most participating cardiac surgical units had satisfactory outcomes for key performance indicators (mortality and complications).

This is the first Annual Report that includes risk-adjustment for derived new renal insufficiency as well as an updated model for operative mortality for isolated coronary artery bypass grafts (CABG), aortic valve replacement (AVR) and for combined AVR with CABG (detailed in Appendix A, pg. 86). These two new models permit for more accurate comparison between hospitals.

This year's theme documents the effect of COVID-19 on cardiac surgery throughout Australia and New Zealand in 2020, as presented in Section 2. It includes first-hand accounts of the clinical environment from surgeons and other medical staff and offers insight regarding the differences between the states and countries.



Mr Gil Shardey



Chairman
ANZSCTS Database Program
Steering Committee

Introduction

The ANZSCTS Cardiac Surgery Database Program 2020 Annual Report presents data on patient characteristics, operative details and unit outcomes for a range of key performance indicators (KPIs), including post-operative complications and mortality. This year, the effect of COVID-19 on cardiothoracic surgery in Australia and New Zealand was explored as an additional theme. The report is presented as follows:

- Section 1: Isolated Coronary Artery Bypass Graft (CABG) Surgery
- Section 2: Effect of COVID-19 on Cardiac Surgery
- Section 3: Isolated Valve Surgery
- Section 4: Combined Valve and CABG Surgery
- Section 5: Other Cardiac Surgery

Key performance indicators

The Database collects and analyses data for a range of clinically relevant surgical outcomes, from which the following key performance indicators (KPIs) are applied to monitor the performance of units:

- Operative mortality (OM; unadjusted and/or risk-adjusted)
- Permanent stroke
- Derived new renal insufficiency (dNRI; unadjusted and/or risk-adjusted)
- Deep sternal wound infection (DSWI)
- Return to theatre (RTT) for bleeding

The KPIs are defined in detail in Appendix B (pg. 87). Units that fall outside the upper 99.7% control limit for any of these KPIs are managed according to the Database *Special Cause Variation Management Policy*.

The additional outcomes presented in this report are:

- New cardiac arrhythmia (NCA)
- Duration of intensive care unit (ICU) stay
- Duration of ventilation
- Red blood cell (RBC) transfusions
- Non-red blood cell (NRBC) transfusions
- Pre- and post- procedural length of stay (PLOS)

These metrics may be used by units to compare their performance against all contributing units in Australia and New Zealand. It should be noted that in 2020, many cardiac surgery services were affected by the COVID-19 pandemic, which is reflected in case numbers and case mix for some units.

Data completeness

Of the cases submitted in 2020, 98.3% were flagged as complete. Incomplete cases miss one or more variables for a variety of reasons. The tables presented in this report include all available data. Accordingly, there are small variations in the total number of cases in each table due to the differing amount of missing data for each variable.

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. It then expanded to include Aotearoa New Zealand in 2019 with the addition of Auckland City Hospital and reached full public hospital coverage of cardiothoracic surgery in Australia in 2020. An additional thirteen units joined the Database in 2020, however, have only been contributing since July, therefore are not included in the report.

The 2020 report delivers a detailed analysis of data, providing an overview of annual trends and outcome measures based on KPIs. The data includes reported cardiac surgery performed in the 2020 calendar year, with 30-day follow-up, from 39 public and private cardiac units. The 2020 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 of data preparation and key variable definitions are presented in Appendix C (pg. 89).

The cardiac units listed in Table 1 contributed data to this report. Some units joined the Program more recently, therefore have not provided data over the full five years. Only units that submitted greater than 75% of their expected caseload in 2020 are included in Sections 1, 3, 4 and 5 of the report.

Table 1. Hospital participation

Contributing Hospitals	Hospital Type	2016	2017	2018	2019	2020
VICTORIA						
Alfred Hospital	Public	●	●	●	●	●
Austin Hospital	Public	●	●	●	●	●
Cabrini Private Hospital	Private	●	●	●	●	●
Epworth Eastern	Private	●	●	●	●	●
Epworth Richmond	Private	●	●	●	●	●
University Hospital Geelong	Public	●	●	●	●	●
Jessie McPherson Private Hospital	Private	●	●	●	●	●
Knox Private Hospital	Private					○
Melbourne Private Hospital	Private					○
Monash Medical Centre	Public	●	●	●	●	●
Peninsula Private Hospital	Private	●	●	●	●	●
Royal Melbourne Hospital	Public	●	●	●	●	●
St Vincent's Hospital (Melbourne)	Public	●	●	●	●	●
St Vincent's Private Hospital (Melbourne)	Private					○
Warringal Private Hospital	Private		○	●	●	●
NEW SOUTH WALES						
John Hunter Hospital	Public	●	●	●	●	●
Lake Macquarie Private Hospital	Private	●	●	●	●	●
Liverpool Hospital	Public	●	●	●	●	●
Newcastle Private Hospital	Private					○
Northern Beaches Hospital	Private					○
North Shore Private Hospital	Private		○	†	†	-
Norwest Private Hospital	Private					○
Prince of Wales Hospital	Public	●	●	●	●	†
Prince of Wales Private Hospital	Private					○
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	●	●	●	●	●
National Capital Private Hospital	Private					○
QUEENSLAND						
Gold Coast Private Hospital	Private					○
Gold Coast University Hospital	Public	●	●	●	●	●
Greenslopes Private Hospital	Private			○	●	●
St Vincent's Private Hospital Northside	Private	●	●	●	●	●
John Flynn Private Hospital	Private			○	●	●
Mater Hospital	Private	●	●	●	●	●
Prince Charles Hospital	Public	●	●	●	●	●
Princess Alexandra Hospital	Public	●	●	●	●	●
The Wesley Hospital	Private					○
Townsville Hospital	Public	●	●	●	●	●
Sunshine Coast University Private Hospital	Private				●	●

● Hospital engaged and contributing
○ New hospital that contributed <9 months of data
† Hospital engaged but contributed insufficient data (<75% of expected caseload)

Table 1. Hospital participation cont.

Contributing Hospitals	Hospital Type	2016	2017	2018	2019	2020
SOUTH AUSTRALIA						
Ashford Hospital	Private					○
Flinders Medical Centre	Public	●	●	●	●	●
Flinders Private Hospital	Private					○
Royal Adelaide Hospital	Public	●	●	●	●	●
WESTERN AUSTRALIA						
Fiona Stanley Hospital	Public	○	●	●	●	●
Sir Charles Gairdner Hospital	Public	●	●	●	●	●
St John of God Subiaco Hospital	Private	●	●	●	●	●
The Mount Hospital	Private					○
TASMANIA						
Royal Hobart Hospital	Public					●
NEW ZEALAND						
Auckland City Hospital	Public				●	●

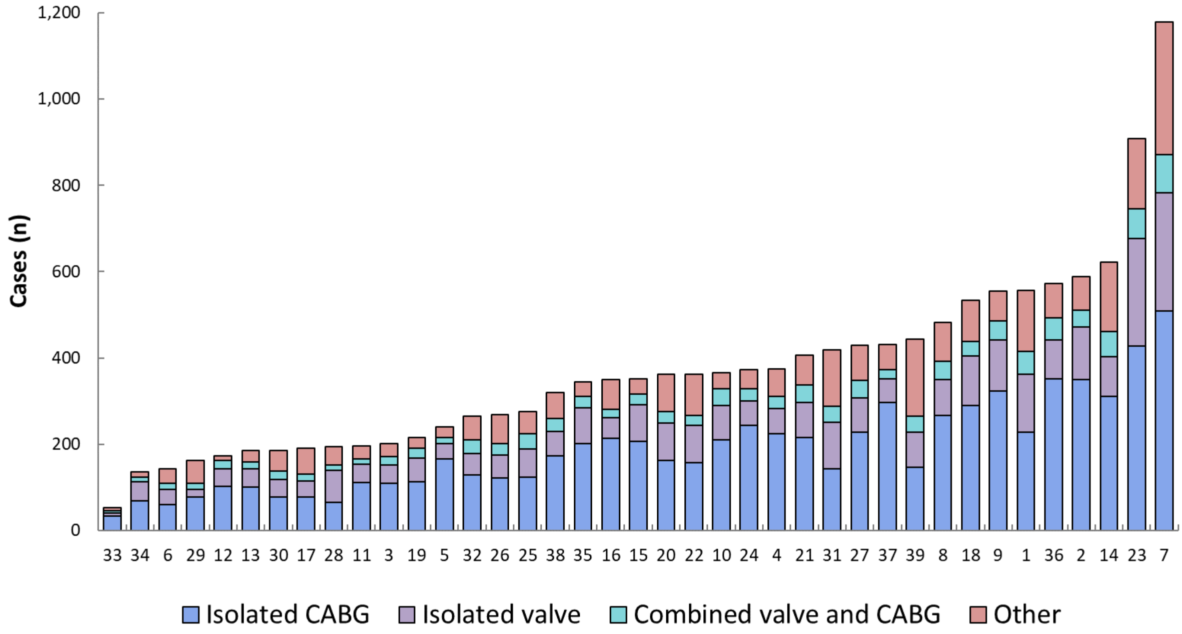
● Hospital engaged and contributing
○ New hospital that contributed <9 months of data
† Hospital engaged but contributed insufficient data (<75% of expected caseload)

Overview of surgical groups

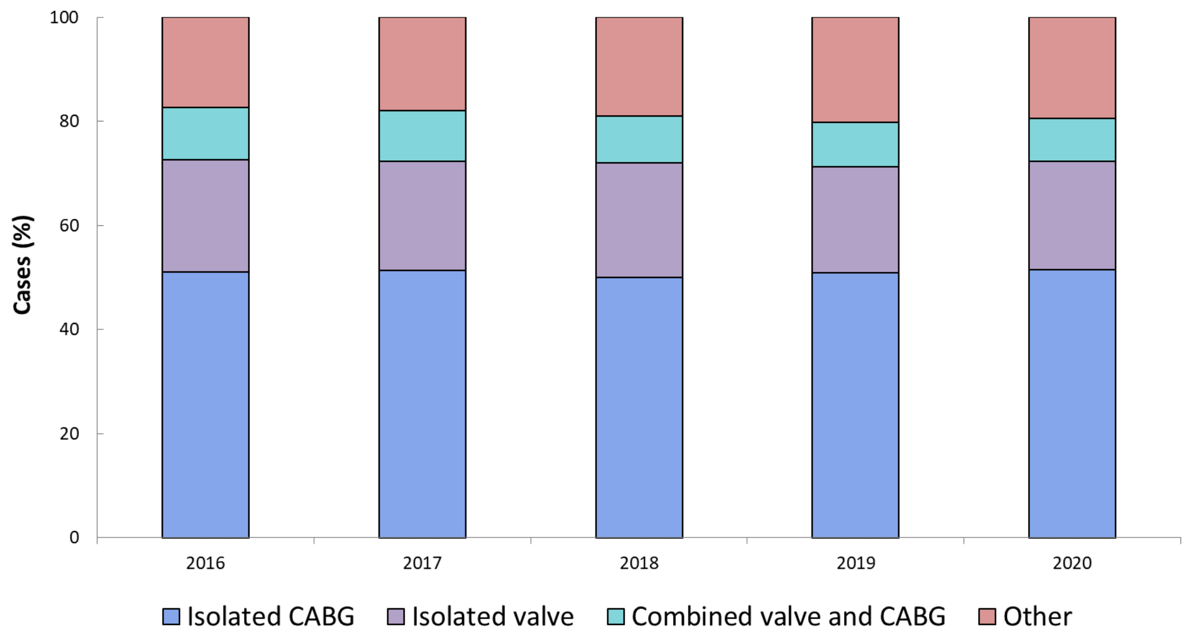
In 2020, 14,408 cardiothoracic operations were performed by 39 units. The proportion of cardiac surgery groups remained consistent across the majority of units, with isolated CABG surgery being the most common operation performed (Figure 1a), accounting for 51.5% of the surgeries in 2020 (Figure 1b).

Figure 1. Cardiac surgery groups

a. Units in 2020

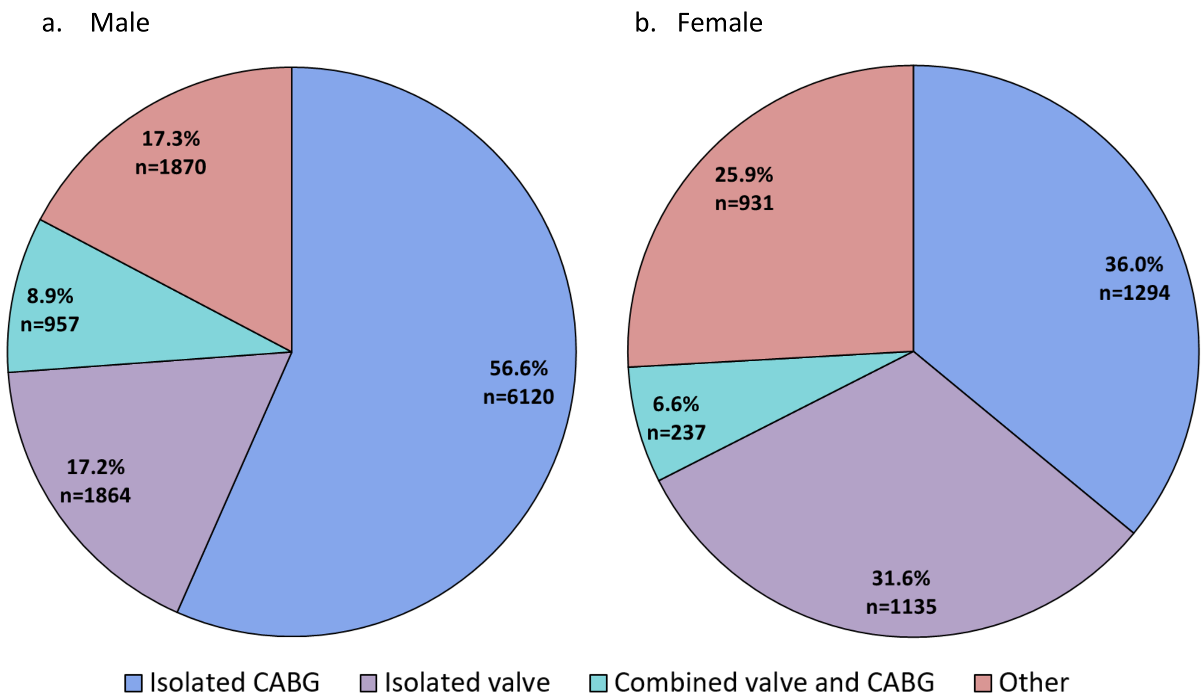


b. Year



The distribution of surgical groups differed between males and females (Figure 2). Over half of all males having cardiothoracic surgery in 2020 had an isolated CABG operation (56.6%), compared to approximately a third of females (36.0%). Interestingly, isolated valve operations accounted for approximately another third of female operations (31.6%), whereas for men, it was less than one fifth (17.2%).

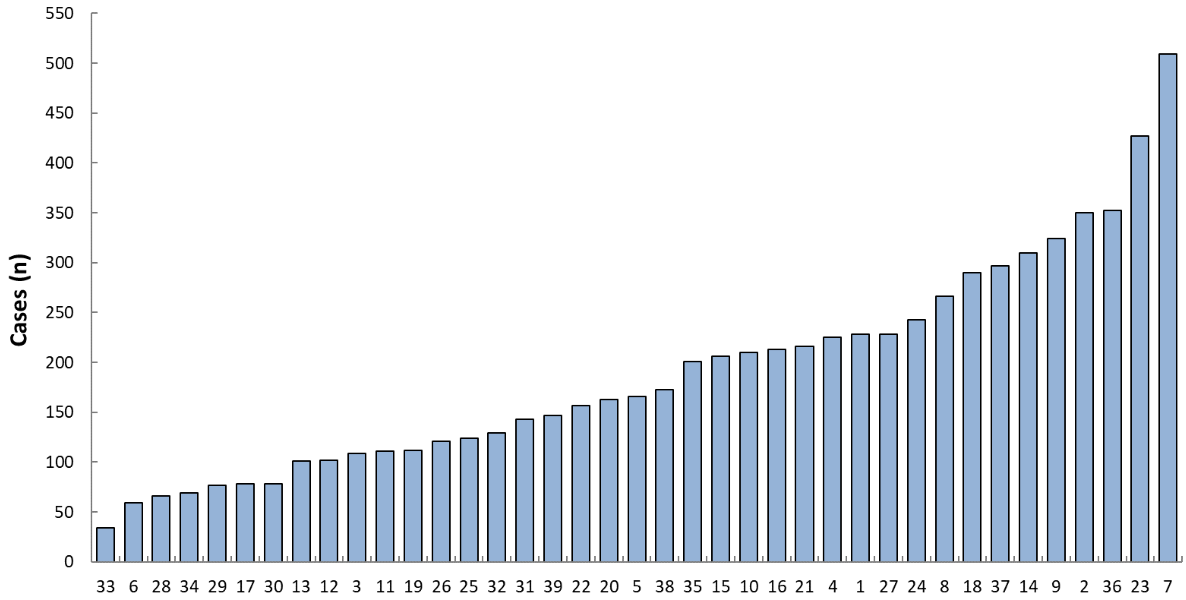
Figure 2. Cardiac surgery groups by sex, 2020



1. Isolated CABG Surgery

Due to the differences in overall caseload between units, the number of isolated CABG operations performed varied, ranging from 34 to 509 (Figure 3). The total number of operations performed in 2020 by the 39 units included in this report was 7,414.

Figure 3. Isolated CABG surgery performed by unit, 2020



1.1 Patient characteristics

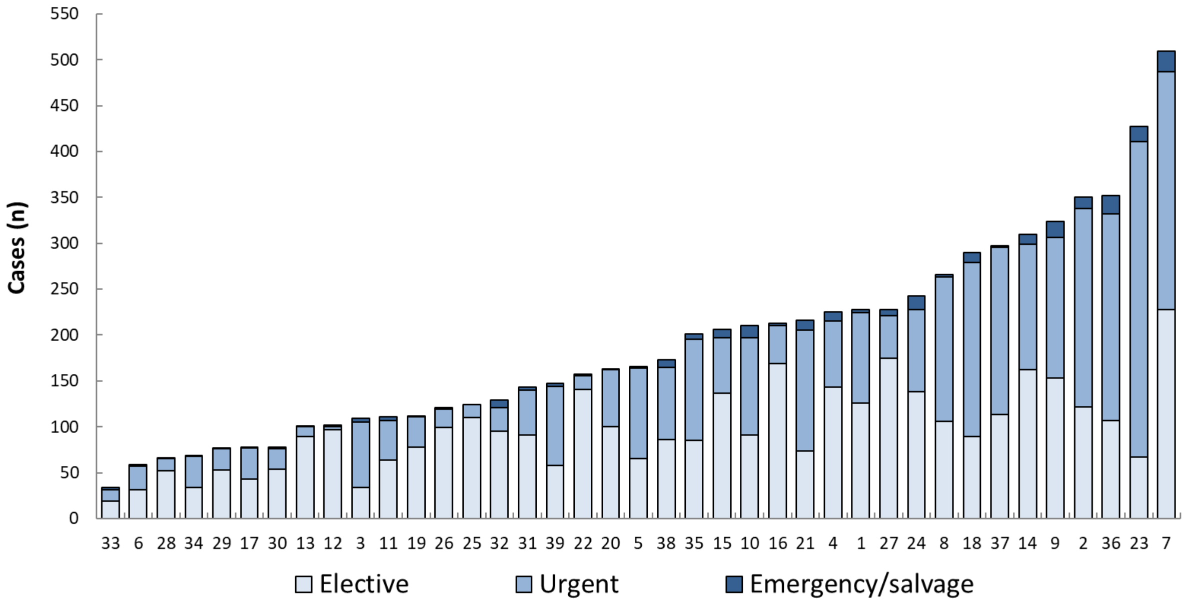
Key patient characteristics that influence the outcomes of surgery include clinical status, sex, age and comorbidities such as left ventricular dysfunction (LVD), previous myocardial infarction (MI), and previous coronary surgery. The frequency of these factors in the Australian and New Zealand cardiac surgery patient population are explored in the following sections.

1.1.1 Clinical status

The clinical status of isolated CABG patients varied considerably between units with urgent cases ranging from 2.9%-80.6% of the total caseload (Figure 4a). The overall proportion of elective cases continued to decrease in 2020, accounting for 51.0% compared to 55.3% in 2019 (Figure 4b). This aligned with a proportional increase in urgent cases, which may be a direct result of decreased elective surgery performed during the COVID-19 pandemic. Refer to Section 2 for more information about how the pandemic affected cardiothoracic surgery in 2020. It should be noted that clinical status is a reported variable, therefore variation can occur due to the interpretation of the Database's data definitions (Appendix C, pg. 89).

Figure 4. Clinical status of isolated CABG patients

a. Units in 2020



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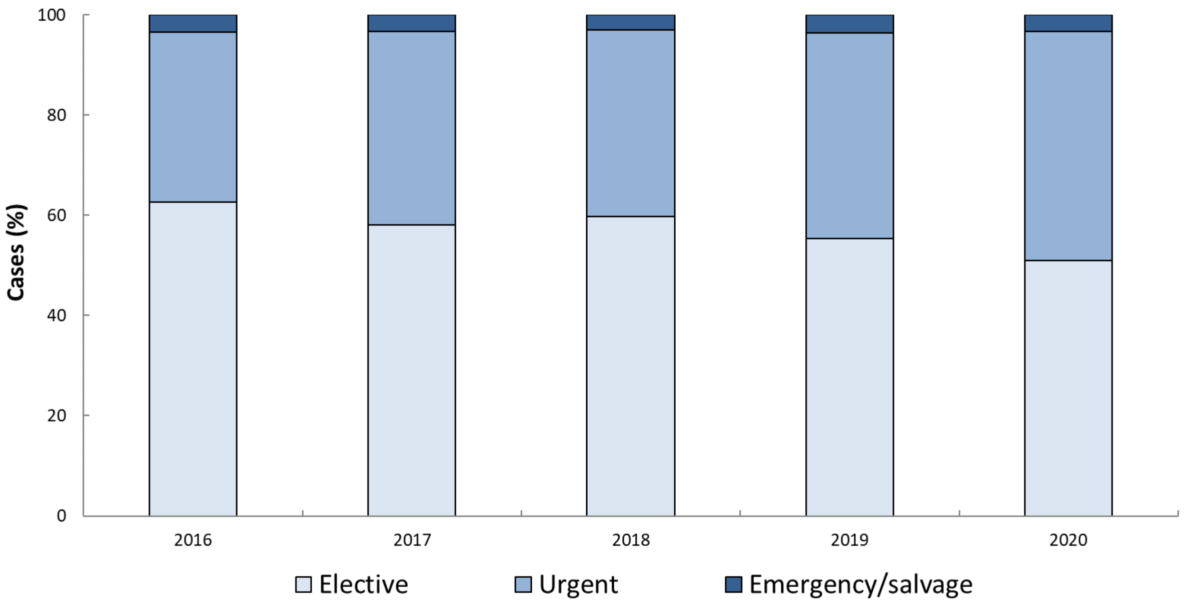
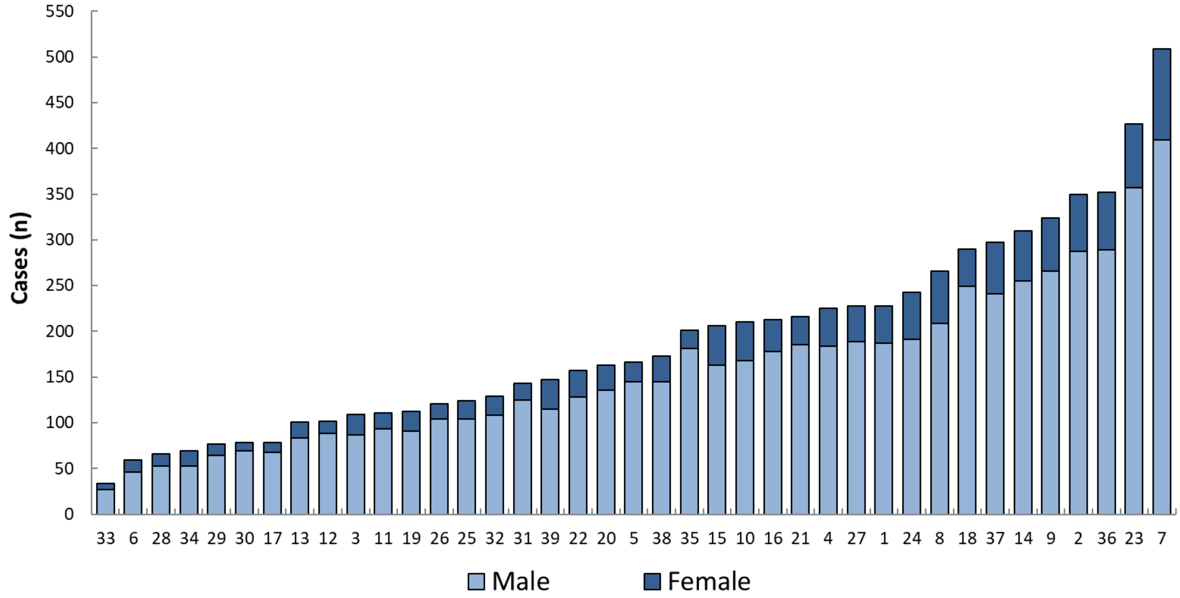


1.1.2 Sex and age

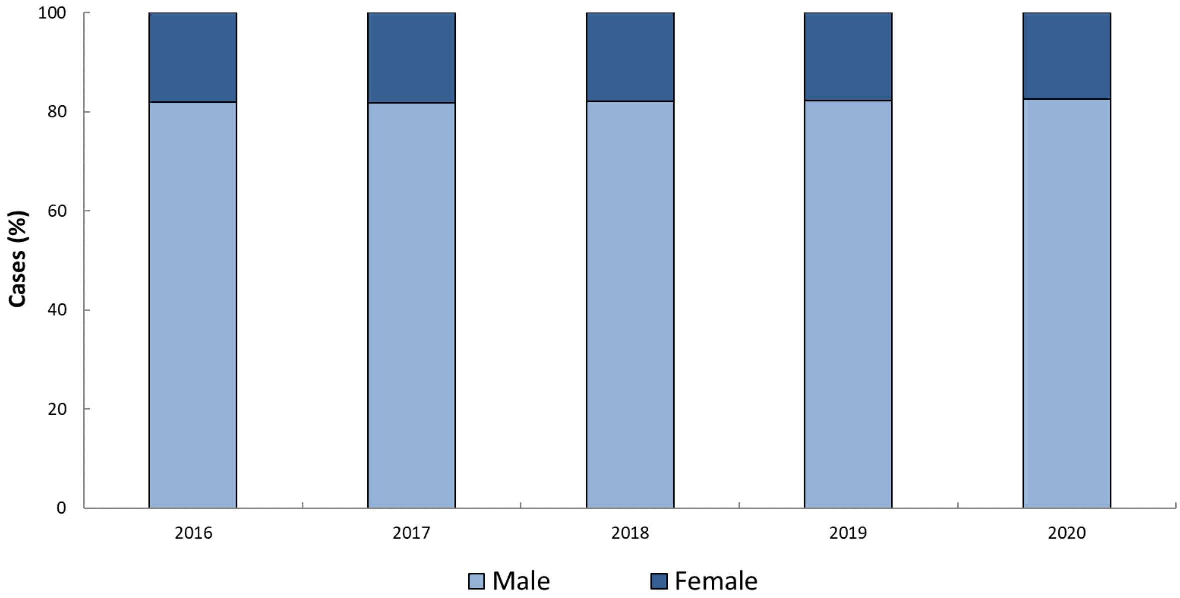
The proportion of males receiving isolated CABG surgery remains consistent across all units in 2020 and the preceding four years (Figures 5a and 5b). Males comprised 82.5% of all isolated CABG operations in 2020 and 82.1% during 2016-2020.

Figure 5. Sex of isolated CABG patients

a. Units in 2020

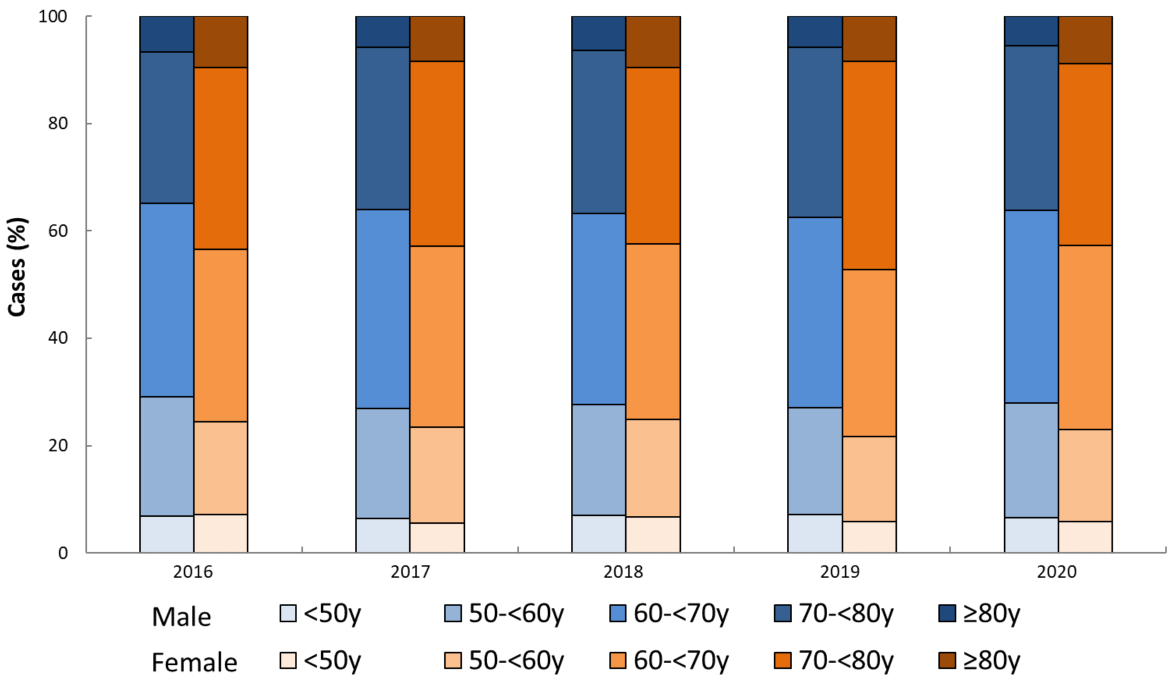


b. Year



The distribution of age groups between males and females also remains consistent over the past five years (Figure 6). Males aged between 60-69 years constitute the highest proportion to receive isolated CABG surgery in 2020 and in the preceding four years (between 35.5-36.9%). For females in 2020, the 60-69 and 70-79 age groups were equally high (≈34%). However, over the past five years, females in the 70-79 age group represented the largest proportions. This is consistent with the literature in that females generally have isolated CABG operations later in life(1).

Figure 6. Age groupings for male and female isolated CABG patients, 2016-2020



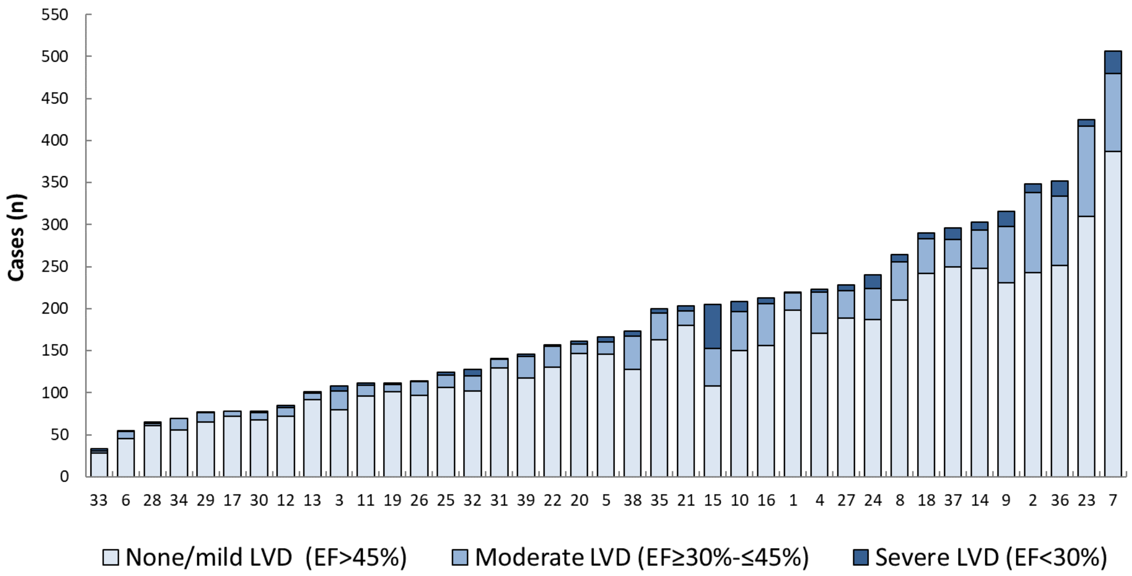
1.1.3 Left ventricular function

The majority of patients (79.4%) presenting for isolated CABG operations in 2020 had no or mild LVD (Figure 7a). The proportions of patients with moderate LVD (left ventricular ejection fraction [LVEF] between 30-45%) varied from 3.1-27.3% between units. Severe LVD was present in a very small proportion of patients (3.9%) across all units except unit 15 (25.4%). The proportion of none or mild, moderate, and severe LVD remain consistent over the 2016-2020 period (Figure 7b).

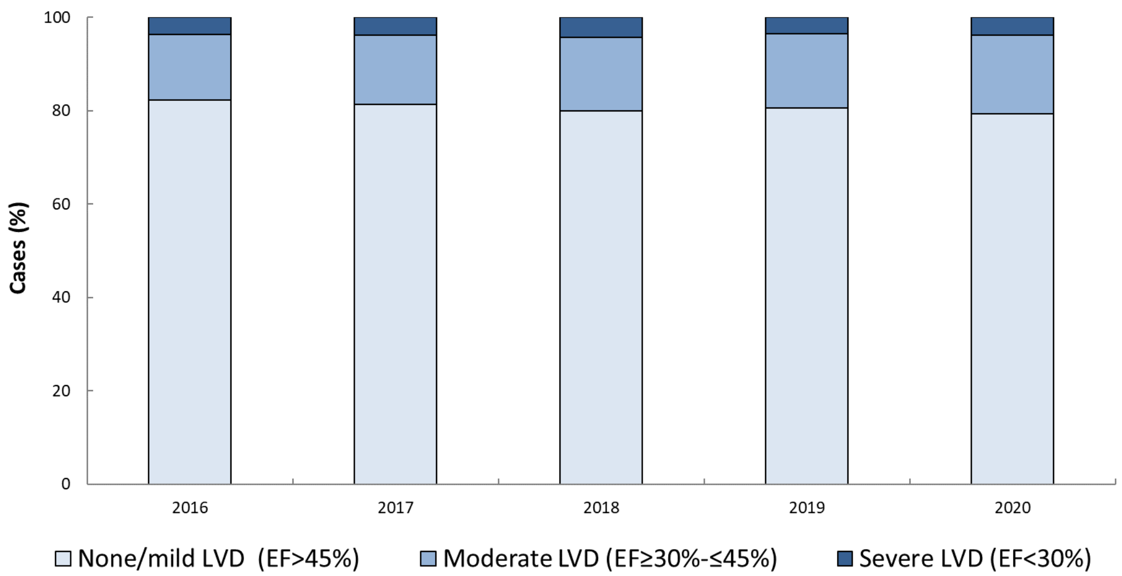
For the LVEF values that determine presence of LVD in the ANZSCTS Database, please refer to the figure legends or Appendix C (pg. 89).

Figure 7. Isolated CABG: pre-operative LVD

a. Units in 2020



b. Year

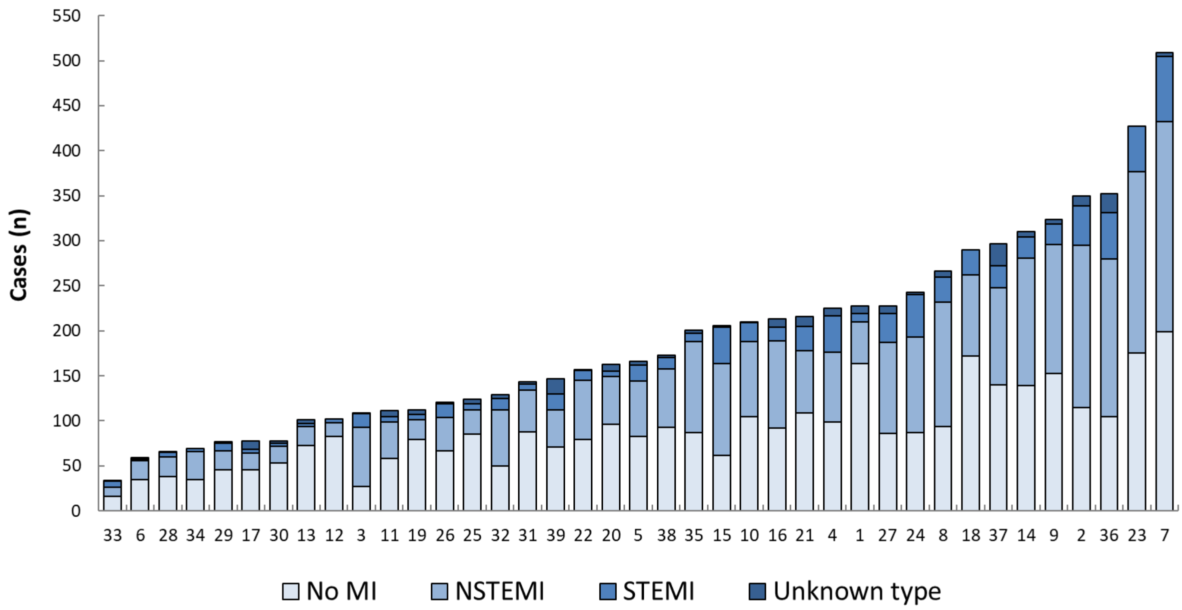


1.1.4 Previous myocardial infarction

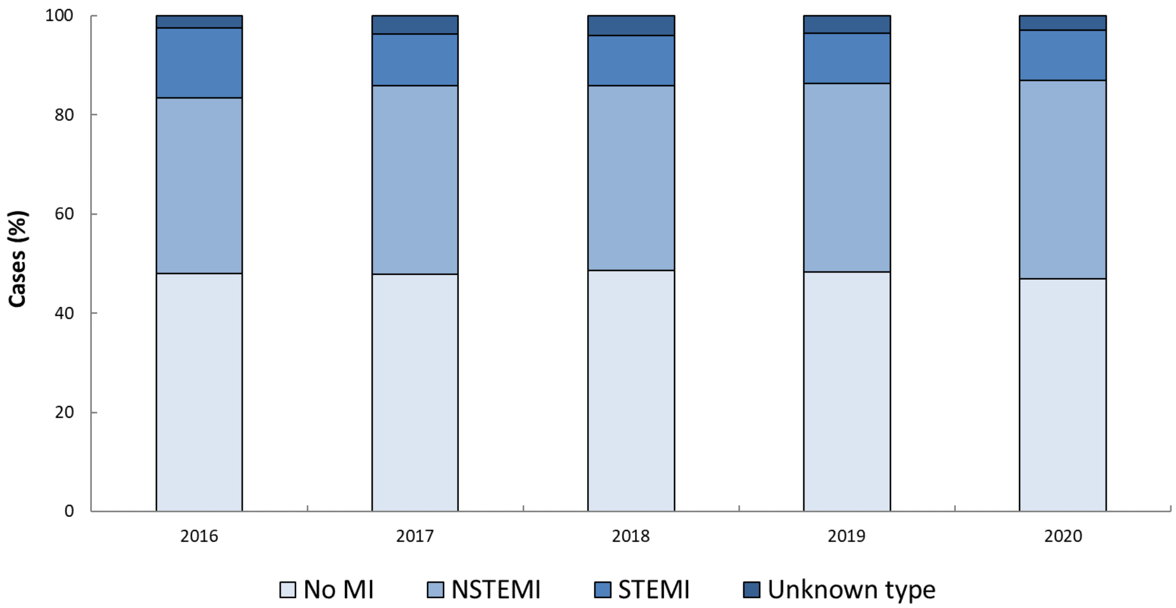
The proportions of patients with non-ST elevation myocardial infarction (NSTEMI) and ST elevation myocardial infarction (STEMI) prior to isolated CABG surgery were consistent between units for 2020 and in the preceding four years (Figures 8a and 8b). Similarly, the proportions of patients presenting with no previous MI, which is approximately 50%, or unknown MI type, have also remained consistent over the past five years (Figure 8b).

Figure 8 Isolated CABG: prior MI

a. Units in 2020



b. Year

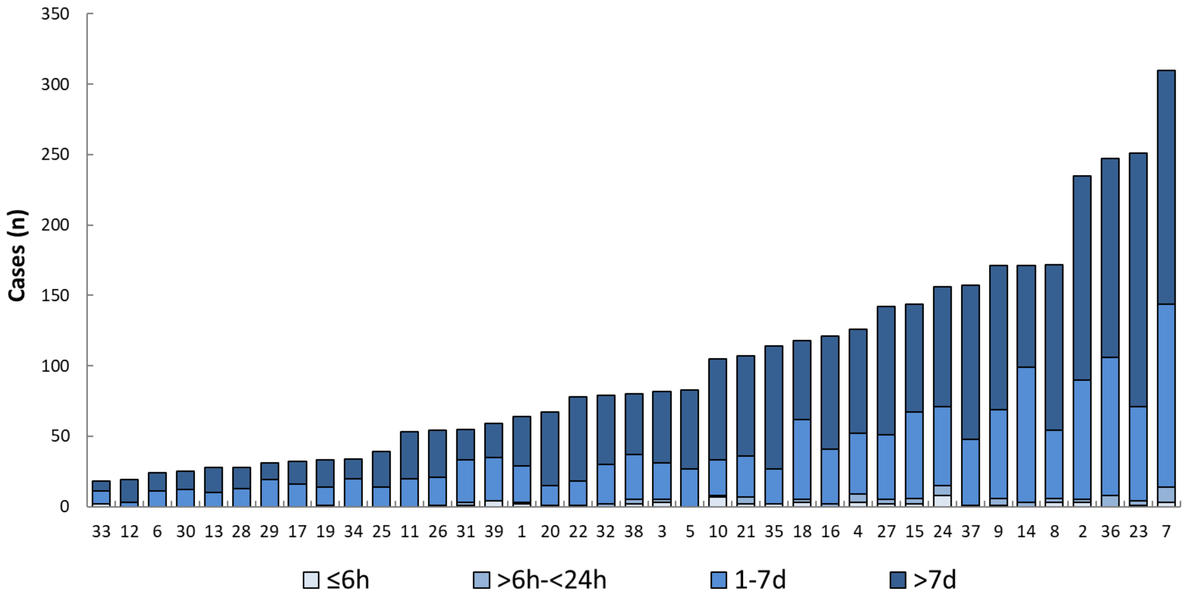


1.1.5 Timing of previous myocardial infarction

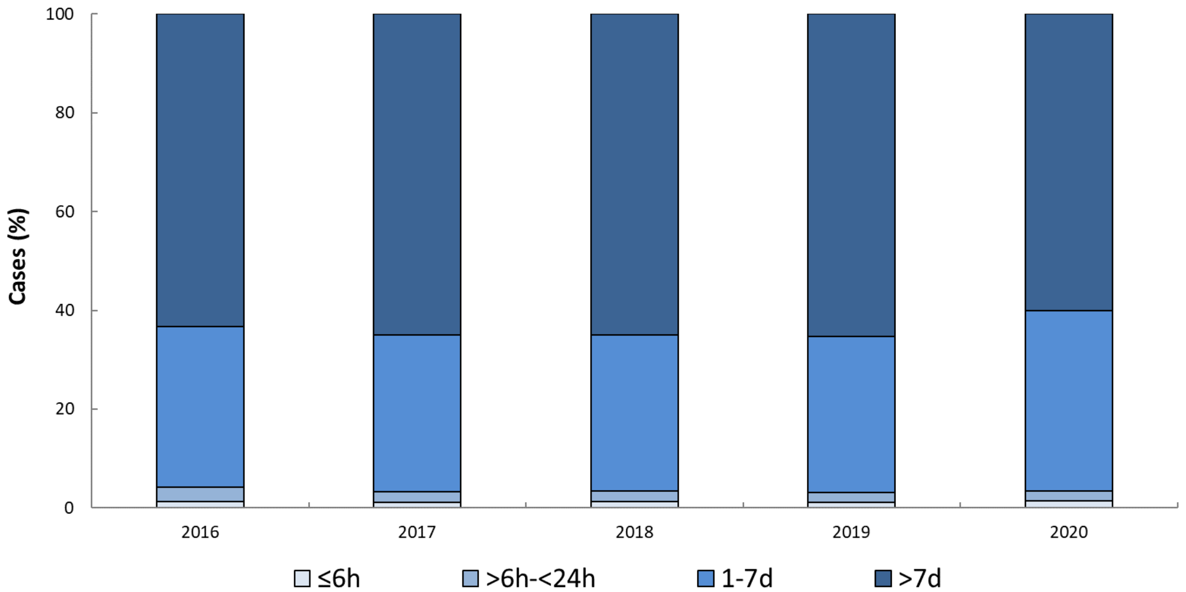
In 2020, a majority (60.1%) of patients who have had a previous MI had it occur more than seven days prior to their isolated CABG surgery, although there were a few units in which most patients had an MI 1-7 days prior to surgery (Figure 9a). Over the past five years, 32.9% of patients had an MI 1-7 days prior to surgery whilst 63.6% had an MI more than seven days prior to surgery (Figure 9b).

Figure 9. Isolated CABG: timing of pre-operative MI

a. Units in 2020



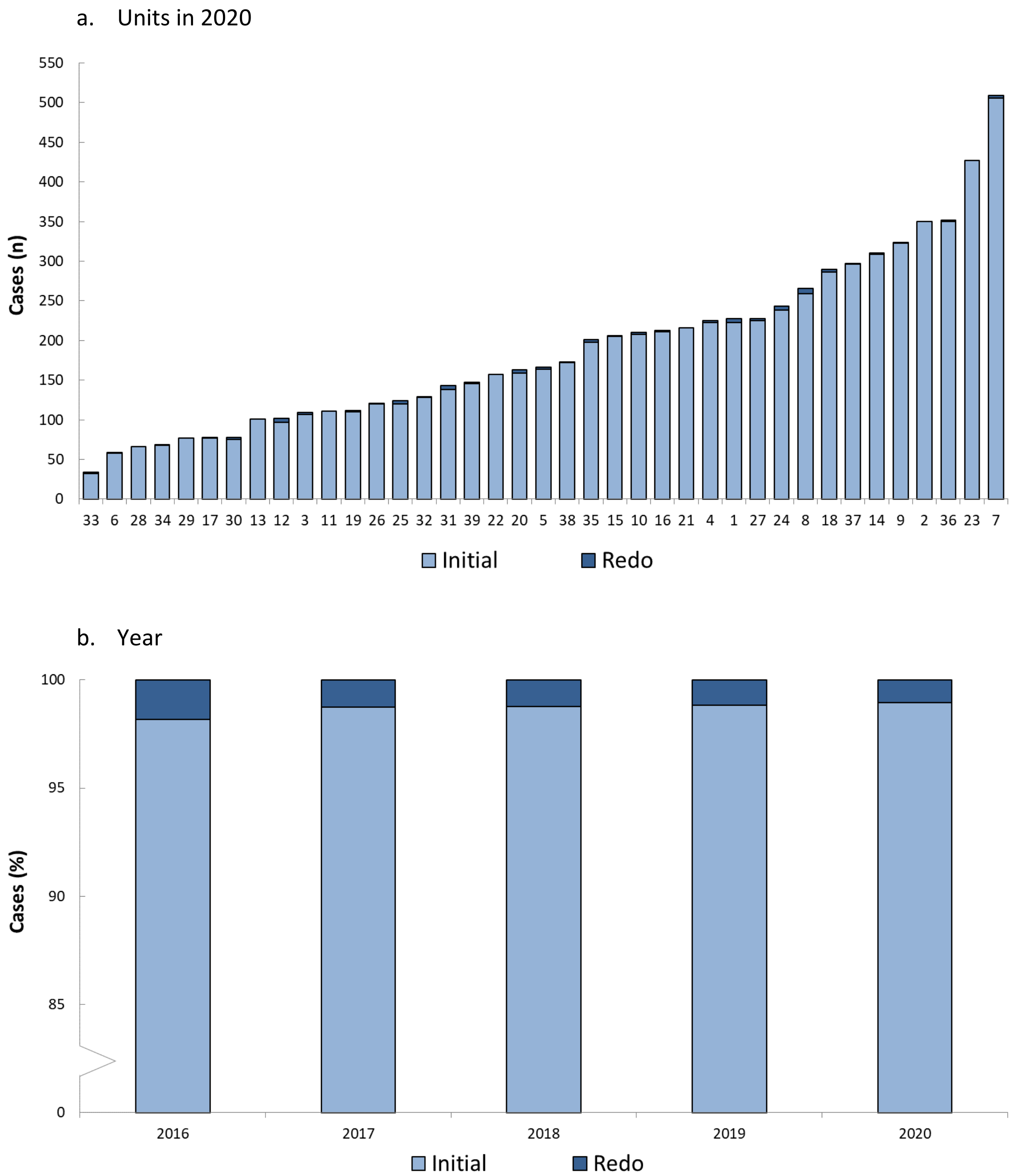
b. Year



1.2 Previous coronary surgery

A redo operation is defined as any previous cardiac surgery. In 2020, 1.1% of isolated CABG operations were redo operations (Figure 10a). The proportion of redo operations over the past five years is 1.3% (Figure 10b). This proportion is double that reported by the Swedish Web-system for Enhancement and Development of Evidence-based Care in Heart Disease Evaluated According to Recommended Therapies (SWEDEHEART) registry(2).

Figure 10. Isolated CABG: initial and redo surgery

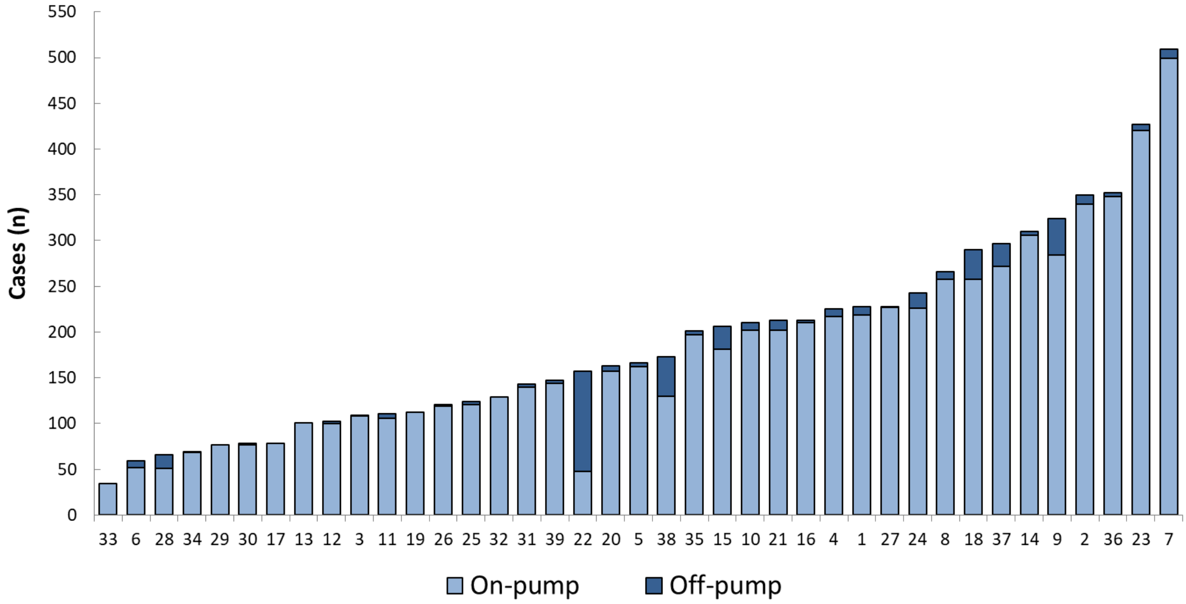


1.3 On-pump and off-pump coronary surgery

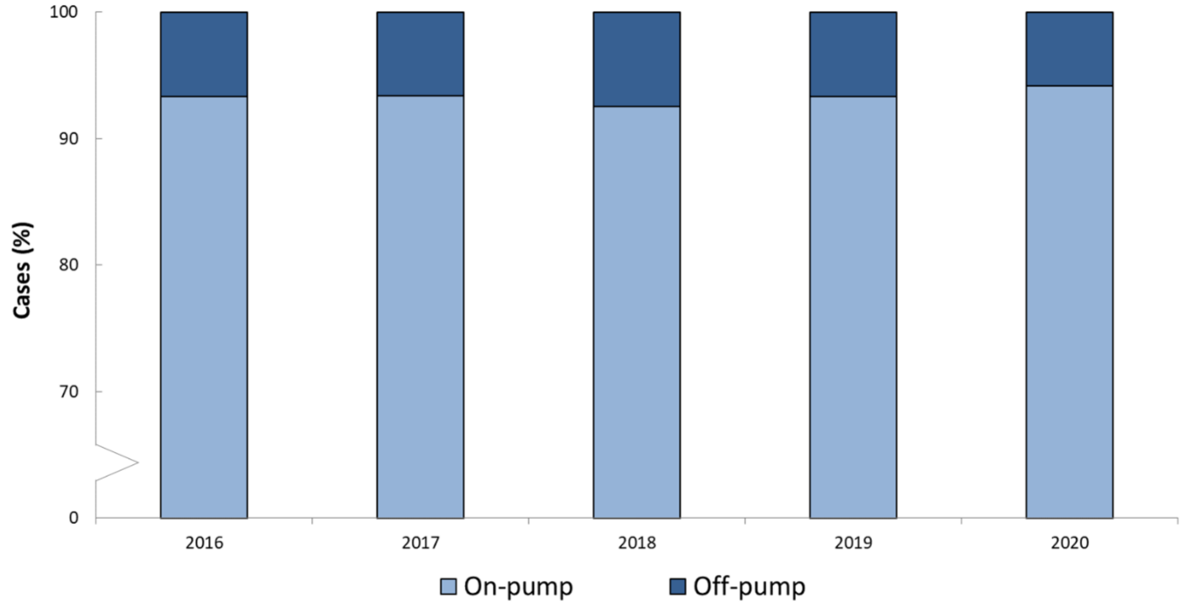
In 2020, 5.8% of isolated coronary operations were performed without cardiopulmonary bypass (CPB). However, units 22 and 38 performed 69.4% and 24.9% of their operations off-pump respectively (Figure 11a). Over the past five years, of 6.6% of isolated CABG operations were performed off-pump (Figure 11b).

Figure 11. On-pump and off-pump isolated CABG

a. Units in 2020



b. Year



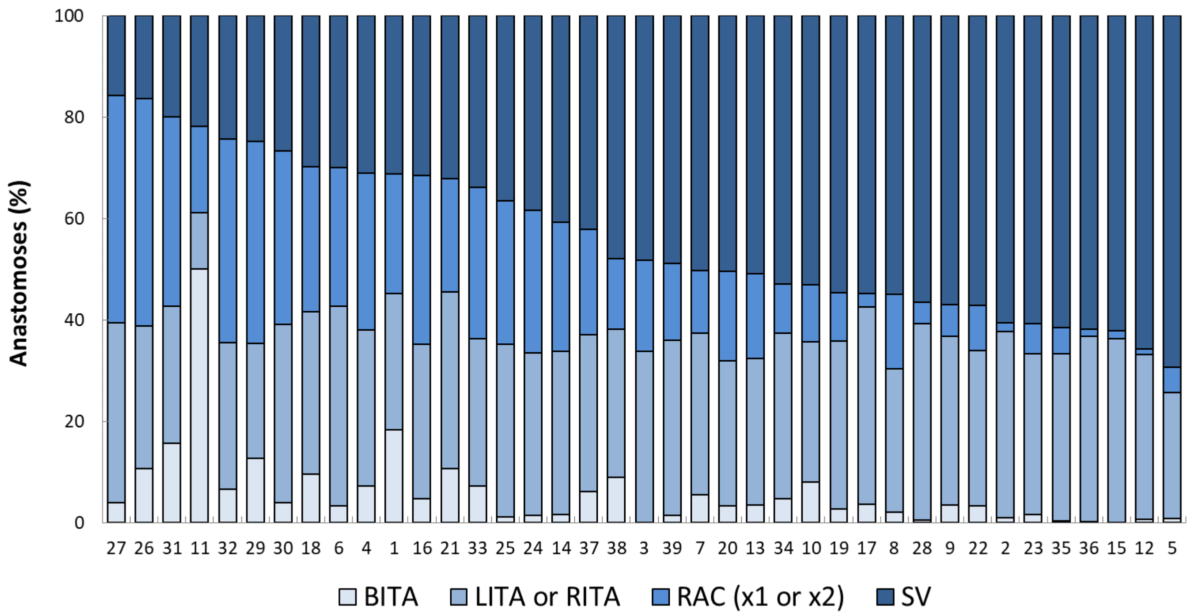
1.4 Conduit selection

1.4.1 Conduits used for anastomoses

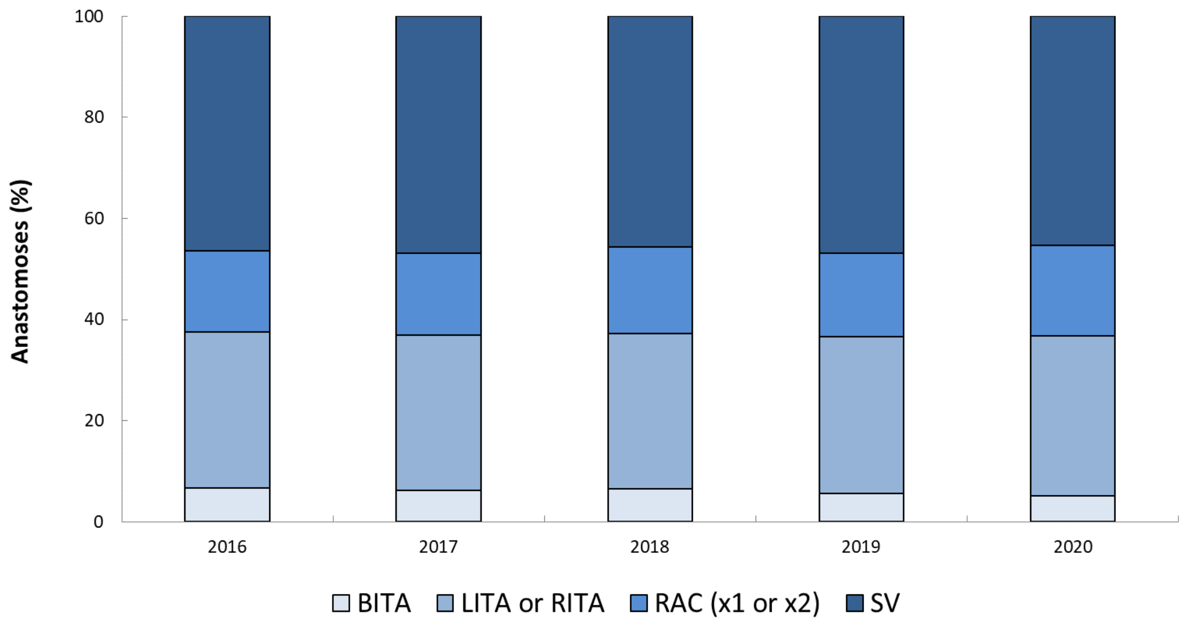
The choice of conduits used for isolated CABG operations in 2020 differed between the units. Figure 12a shows the variation. However, the majority (45.4%) of anastomoses performed were with saphenous vein (SV), 31.5% with the left or right internal thoracic artery (LITA or RITA), 17.9% with the radial artery conduit (RAC), and 5.2% with bilateral internal thoracic arteries (BITA). Those proportions were similar to the previous four years (Figure 12b).

Figure 12. Percentage of arterial and venous anastomoses performed in isolated CABG

a. Units in 2020



b. Year

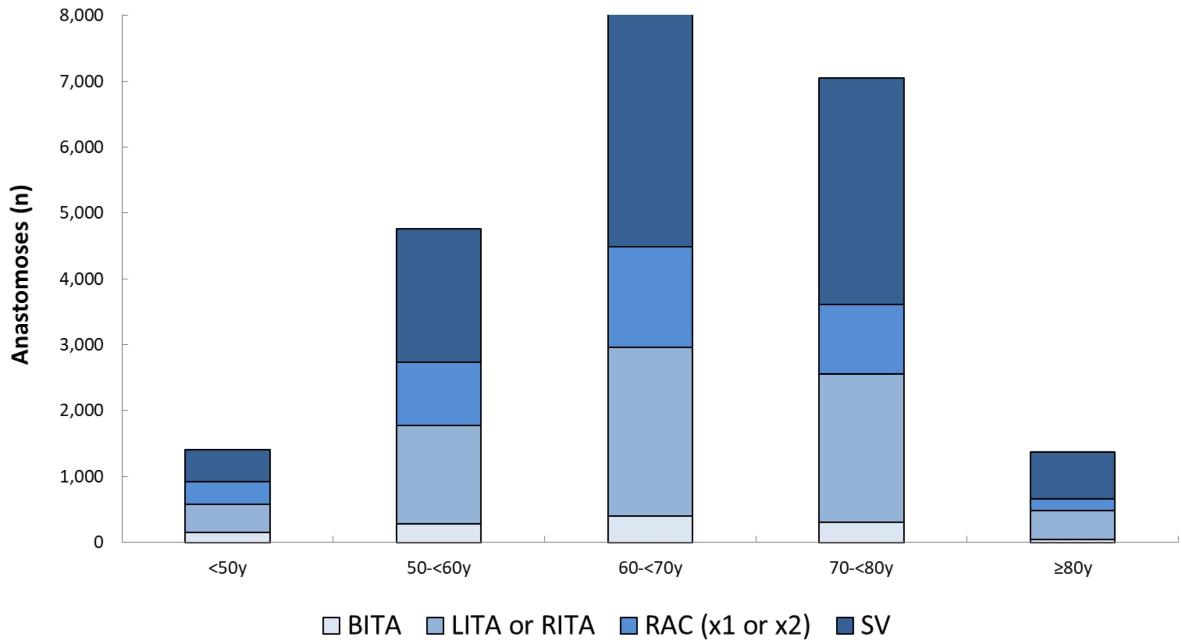


1.4.2 Conduits used for anastomoses by age

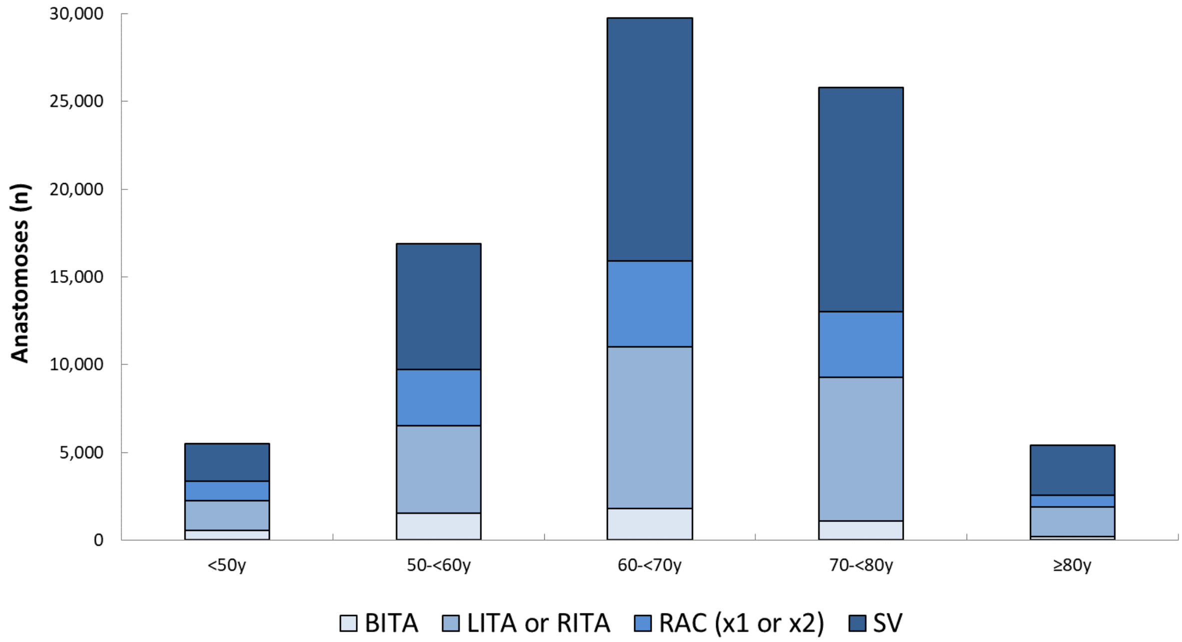
In 2020, the largest number of arterial and venous anastomoses was performed in patients that were between 60-70 years old followed by the 70-80 age group (Figure 13a). The proportion of the type of conduit used remained similar in 2020 compared to the preceding four years (Figure 13b).

Figure 13. Number of arterial and venous anastomoses performed in isolated CABG patients, by age

a. 2020



b. 2016-2019



1.4.3 Conduits used and distal anastomoses performed

Over the past five years, the all-arterial technique was used in approximately one fifth (22.1%) of on-pump operations but in more than half (52.7%) of off-pump operations (Table 2a). Off-pump isolated CABG operations involved a lower mean number of anastomoses.

In 2020, 88.6% and 82.1% of patients having an on- or off-pump isolated CABG operation, respectively, had a LITA or RITA conduit, with or without other arterial or vein conduits (Table 2b). RACs were used in 41.3% of on-pump, and 26.5% of off-pump operations. BITA conduits and T or Y grafts were less common, but used more frequently in off-pump surgery.

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

		On-pump	Off-pump
n	2020	6980	431
	2016-2019	25146	1852
Mean no. anastomoses	2020	3.1	2.5
	2016-2019	3.1	2.5
Only arterial conduits (%)	2020	22.1	52.7
	2016-2019	22.0	53.4
Arterial with saphenous vein conduits* (%)	2020	77.9	47.3
	2016-2019	78.0	46.5

*Proportion of operations in which at least one vein conduit was used

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

		On-pump	Off-pump
BITA	2020	6.8	14.8
	2016-2019	8.2	18.9
GEPA~	2020	0.1	0.2
	2016-2019	0.1	0.1
LITA or RITA	2020	88.6	82.1
	2016-2019	86.2	78.0
RAC (x1 or x2)	2020	41.3	26.5
	2016-2019	38.1	25.6
T or Y grafts*	2020	7.8	17.9
	2016-2019	8.7	15.7

~GEPA = gastroepiploic artery
*Arterial only

1.5 Influence of co-morbidities on complications

Post-operative complications considered in this section include permanent stroke, DSWI, NCA, and RTT for bleeding or tamponade. Data on the incidence of dNRI excludes patients with pre-operative renal impairment (refer to Appendix B, pg. 87, for the definition of dNRI). In the following section, these complications are evaluated in the context of comorbidities.

1.5.1 Pre-existing diabetes and renal impairment

The proportion of patients with insulin dependent diabetes in the isolated CABG cohort remained consistent over the last five years.

Patients with insulin dependent diabetes had a higher incidence of post-operative permanent stroke and DSWI (Table 3). The incidence of NCA and RTT for bleeding in 2020 was higher in those with high pre-operative creatinine (>200µmol/L) or low pre-operative eGFR (≤60mL/min/1.73m^2), but was not influenced by the presence of diabetes.

Table 3. Influence of pre-operative diabetes and of renal function on complications (%) for isolated CABG patients

		Insulin dependent diabetes		Pre-operative creatinine		Pre-operative eGFR	
		No	Yes	≤200 µmol/L	>200 µmol/L	>60mL /min/1.73m	≤60mL /min/1.73m
n	2020	6524	889	7203	211	6121	1291
	2016-2019	23554	3441	26232	766	21814	5178
Permanent stroke	2020	1.1	1.7	1.1	2.4	1.0	1.9
	2016-2019	0.8	1.7	0.9	2.6	0.7	1.8
DSWI	2020	0.9	2.4	1.0	2.9	1.1	1.0
	2016-2019	1.0	2.8	1.2	3.2	1.2	1.6
NCA	2020	26.9	24.2	26.5	31.6	25.8	30.5
	2016-2019	26.5	24.3	26.2	30.0	25.3	30.4
RTT for bleeding	2020	2.5	2.3	2.4	5.3	2.4	3.1
	2016-2019	2.3	2.5	2.3	4.6	2.1	3.1

1.5.2 Age

The incidence of permanent stroke, NCA, and RTT for bleeding increases with advancing age in 2020 (Table 4). Interestingly, there was a slight decrease in DSWI with advancing age in 2020, however the preceding four years showed that age did not influence DSWI. RTT for bleeding also showed no clear trend based on patient age over 2016-2019.

Table 4. Influence of patient age on complications (%) for isolated CABG patients

		Age				
		<50 y	50-59 y	60-69 y	70-79 y	≥80 y
n	2020	476	1532	2640	2312	454
	2016-2019	1831	5435	9542	8398	1792
Permanent stroke	2020	0.6	0.9	1.1	1.3	1.8
	2016-2019	0.5	0.7	0.8	1.3	1.2
DSWI	2020	1.5	1.2	1.1	1.0	0.7
	2016-2019	0.9	1.2	1.3	1.5	1.2
NCA	2020	10.1	18.9	27.3	32.3	36.9
	2016-2019	11.5	18.0	26.4	32.2	37.8
RTT for bleeding	2020	1.5	1.9	2.9	2.4	3.8
	2016-2019	2.8	2.2	2.1	2.5	2.6

1.5.3 Surgical history or use of cardiopulmonary bypass

The incidence of post-operative complications was similar between patients who did or did not have redo or off-pump surgery (Table 5). However, in 2020, redo surgery was associated with a zero incidence of DSWI and a higher incidence of RTT for bleeding.

Table 5. Influence of redo surgery or use of CPB on complications (%) for isolated CABG patients

		Surgery		CPB	
		Initial	Redo	On-pump	Off-pump
n	2020	7336	78	6980	431
	2016-2019	26629	369	25146	1852
Permanent stroke	2020	1.1	1.3	1.1	1.4
	2016-2019	1.0	1.4	1.0	0.9
DSWI	2020	1.1	0.0	1.1	0.7
	2016-2019	1.3	1.9	1.3	1.0
NCA	2020	26.6	24.4	26.7	25.1
	2016-2019	26.3	25.9	26.4	24.5
RTT for bleeding	2020	2.5	3.8	2.5	2.6
	2016-2019	2.3	3.0	2.3	2.4

1.5.4 Influence of comorbidities on derived new renal insufficiency

The incidence of post-operative unadjusted dNRI was generally higher in patients with diabetes and increasing age (Table 6). In 2020, patients with pre-operative creatinine >200 µmol/L or estimated glomerular filtration rate (eGFR) ≤60 mL/min/1.73m^2 had seven- and four-fold increases in the incidence of dNRI, respectively. These data exclude patients who had pre-operative dialysis.

Table 6. dNRI (%) for isolated CABG patients on the basis of diabetes, renal insufficiency, age, surgical history and use of CPB

	2020		2016-2019	
	n	dNRI (%)	n	dNRI (%)
Insulin dependent diabetes				
No	6446	2.2	23308	2.4
Yes	839	4.3	3210	4.2
Pre-operative creatinine				
≤200 µmol/L	7174	2.3	26171	2.4
>200 µmol/L	111	16.2	348	18.3
Pre-operative eGFR				
>60mL/min/1.73m^2	6100	1.6	21782	1.9
≤60mL/min/1.73m^2	1184	6.8	44733	5.9
Age				
<50y	460	2.8	1769	2.1
50-<60y	1490	1.5	5307	1.9
60-<70y	2608	2.4	9366	2.3
70-<80y	2278	2.7	8296	3.2
≥80y	449	4.7	1781	3.9
Previous surgery				
Initial	7209	2.5	26159	2.5
Redo	76	1.3	360	5.4
CPB				
On-pump	6862	2.4	24704	2.6
Off-pump	420	3.3	1815	1.9

1.6 Influence of patient characteristics on operative mortality

OM includes all mortalities that occur in-hospital or within 30 days of procedure. In 2020, the unadjusted OM increased with more exigent clinical status (Table 7). OM was greater in the female (1.6%) compared to the male cohort (1.1%). Over the preceding four years worsening LVD, previous STEMI or NSTEMI, decreased timing between previous MI and isolated CABG surgery, and redo surgery were also associated with increased OM. The same trends were seen in 2020 with the exception of LVD. It should be noted that OM is not risk-adjusted and does not account for differences in patient characteristics.

Table 7. Influence of patient characteristics on OM (%) for isolated CABG surgery, 2020 and 2016-2019

	2020		2016-2019	
	n	OM (%)	n	OM (%)
Clinical status				
Elective	3778	0.8	15870	0.7
Urgent	3393	1.2	10233	1.3
Emergency/salvage	243	8.2	895	6.7
Sex/age				
Male	6120	1.1	22145	1.0
<50y	400	1.0	1526	0.8
50-<60y	1311	0.7	4597	0.4
60-<70y	2196	0.7	7971	0.8
70-<80y	1874	1.7	6695	1.3
≥80y	339	2.9	1356	2.2
Female	1294	1.6	4853	1.7
<50y	76	1.3	305	0.0
50-<60y	221	1.8	838	1.2
60-<70y	444	0.5	1571	1.0
70-<80y	438	1.8	1703	2.5
≥80y	115	5.2	436	2.8
LVD				
None/mild LVD (EF>45%)	5812	0.9	21610	0.7
Moderate LVD (EF≥30%-≤45%)	1226	2.6	4044	2.1
Severe LVD (EF<30%)	283	2.5	1022	5.3
Previous MI				
No MI	3484	0.9	13014	0.7
NSTEMI	2958	1.4	10059	1.4
STEMI	757	2.1	2994	1.9
Unknown type	215	0.9	931	1.0
Timing of prior MI				
≤6h	56	14.3	166	8.4
>6h-<24h	78	5.1	326	6.4
1-7d	1426	2.0	4456	1.6
>7d	2352	0.9	9034	1.1
Previous surgery				
Initial	7336	1.2	26629	1.0
Redo	78	2.6	369	3.8
CPB				
On-pump	6980	1.2	25146	1.1
Off-pump	431	2.1	1852	1.2
Dialysis				
No	7285	1.1	26519	1.0
Yes	128	10.2	476	6.3
Pre-operative creatinine				
≤200 µmol/L	7203	1.0	26232	0.9
>200 µmol/L	211	9.0	766	5.9

1.7 Unit outcomes – mortality, complications and resource utilisation

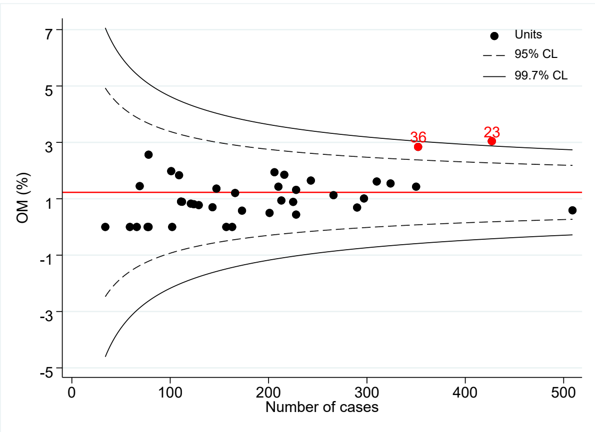
Unit outcomes for operative mortality and complications are presented in funnel plots, which are explained in Appendix D-I (pg. 91). Units above the upper 99.7% control limit for KPIs are notified and managed in accordance with the ANZSCTS Database's *Special Cause Variation Management Policy*. Definitions for KPIs are outlined in Appendix B (pg. 87). The complications explored in this section are permanent stroke, dNRI, DSWI, NCA, readmission, and RTT for bleeding. The resource utilisation variables include duration of (ICU) stay and ventilation, RBC and NRBC transfusion, and pre- and post-PLOS. Cases with missing outcome data are excluded from the analyses.

1.7.1 Operative mortality

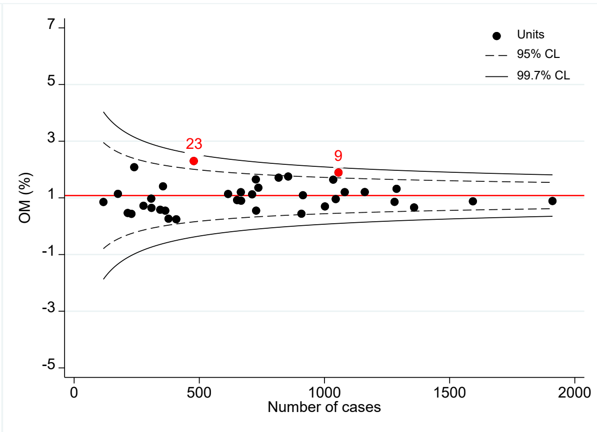
Unadjusted OM was 1.2% in 2020 and 1.1% in 2016-2019 for all isolated CABG operations in the ANZSCTS Database (Figures 14a and b). In comparison, New Zealand reported 2.2% in-hospital mortality in 2017; the National Institute for Cardiovascular Outcomes Research (NICOR) National Adult Cardiac Surgery 2019 Summary Report reported 1.0.% mortality in non-emergency isolated CABG patients in 2017/18; the Society of Thoracic Surgeons (STS) published an operative mortality rate of 2.2% for the 2016 calendar year; and the SWEDEHEART registry had a 30-day mortality rate of 0.7% for 2019(2-5). The risk-adjusted OM (RA-OM) was 1.1% in 2020 and 0.9% for 2016-2019 (Figures 14c and d). Refer to Appendix A (pg. 86) for further information regarding how the Database determines the RA-OM rate.

Figure 14. Mortality by unit following isolated CABG

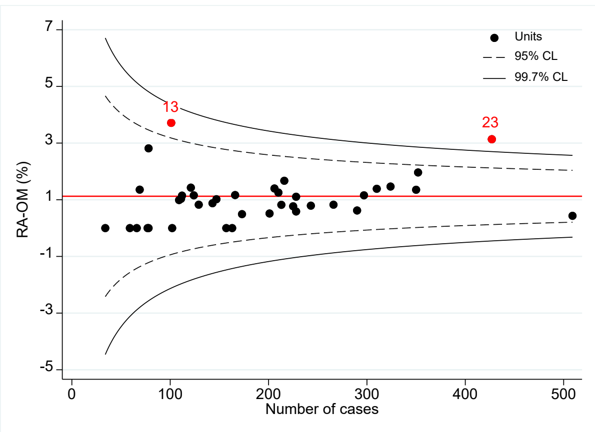
a. 2020 OM



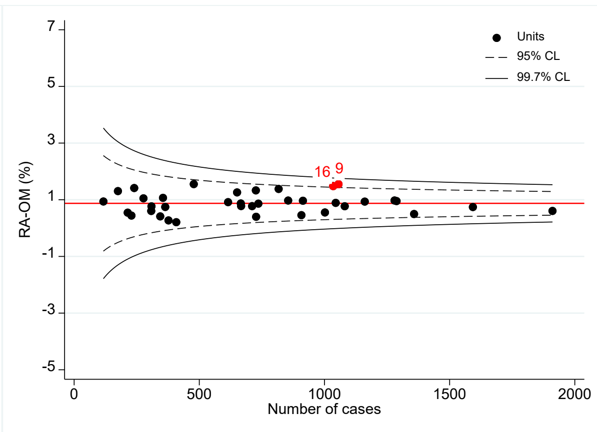
b. 2016-2019 OM



c. 2020 RA-OM



d. 2016-2019 RA-OM



1.7.2 Complications

In 2020, the incidence of unadjusted dNRI was 2.5% and the risk-adjusted dNRI (RA-dNRI) rate was 2.1% (Figures 15a and c). One unit remained outside the upper 99.7% control limit after risk-adjustment. For the 2016-2019 period, unadjusted dNRI incidence was 2.6% (Figure 15b). After risk-adjustment, the RA-dNRI rate was 2.3% (Figure 15d) and one unit remained outside the upper 99.7% control limit. Comparatively, New Zealand reported a slightly higher incidence of 3.3% for new renal failure in a recent 2018 report(6).

Permanent stroke incidence was 1.1% in 2020 and 1.0% over 2016-2019 (Figures 16a and b) which is higher than the New Zealand reported rate of 0.8% in 2018(6). DSWI remained low in 2020 (1.1%) and was slightly lower than in the preceding four years of 1.3% (Figures 17a and b). Comparatively, New Zealand reported DSWI incidence of just 0.4% in 2018 which may be attributed to the coordinated national effort through the Health Quality and Safety Commission cardiac surgical site infections programme(6). NCA incidence in 2020 was 26.6%, which remained consistent with the 2016-2019 average of 26.3% (Figures 18a and b), and RTT for bleeding also remained consistent with a rate of 2.5% in 2020 compared to the 2016-2019 rate of 2.3% (Figures 19a and b). Incidence of all-cause readmission was also consistent with a rate of 9.8% in 2020 compared to the 2016-2019 rate of 10.0% (Figures 20a and b).

Figure 15. dNRI by unit following isolated CABG

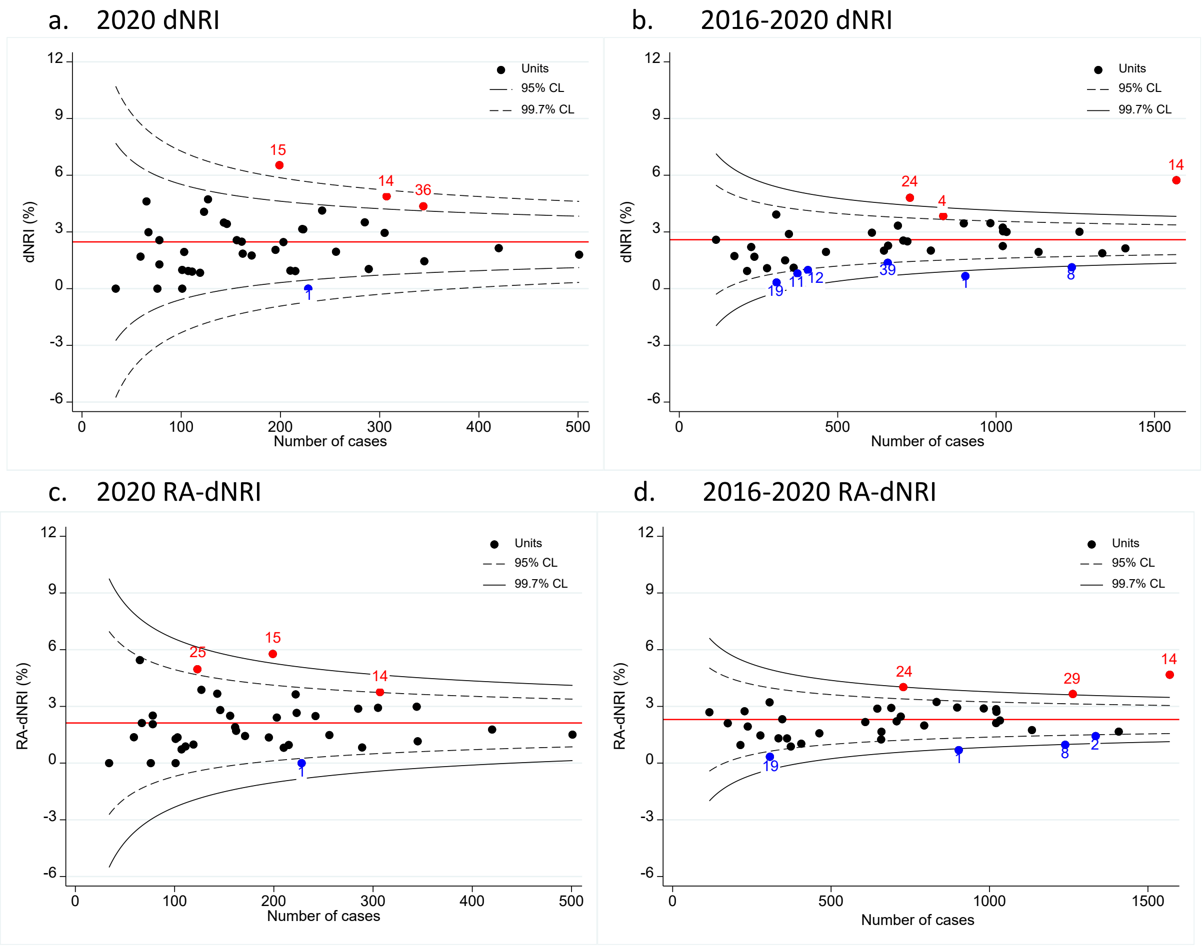


Figure 16. Permanent stroke by unit following isolated CABG

a. 2020 Permanent stroke b. 2016-2019 Permanent stroke

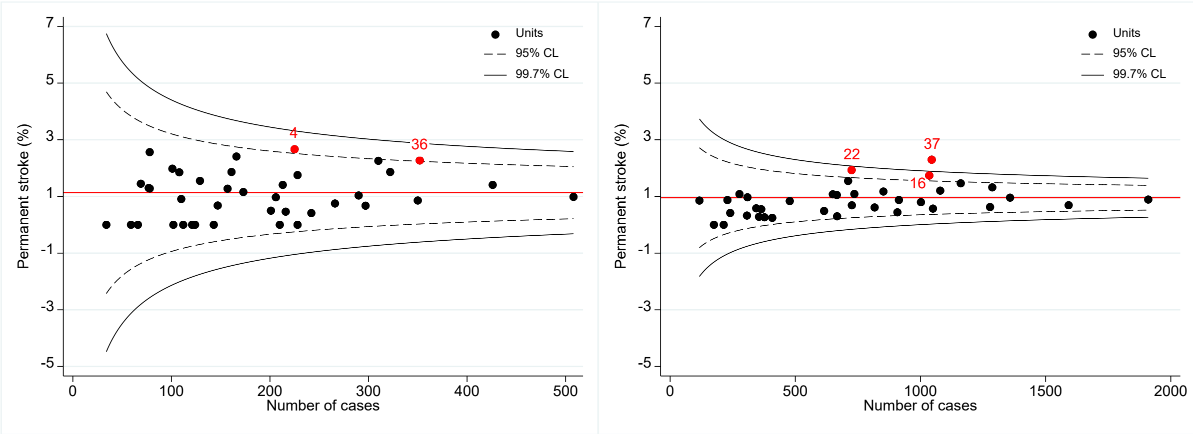


Figure 17. DSWI by unit following isolated CABG

a. 2020 DSWI b. 2016-2019 DSWI

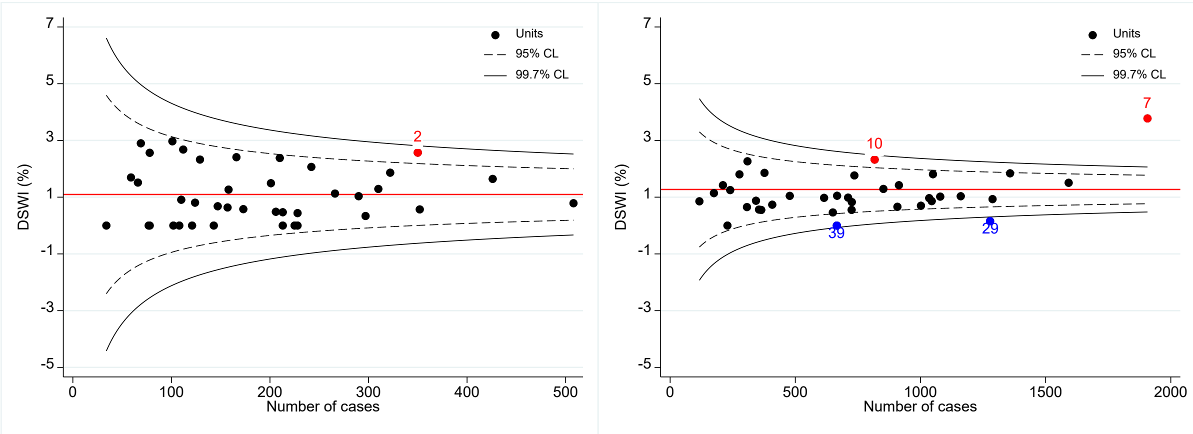


Figure 18. NCA by unit following isolated CABG

a. 2020 NCA b. 2016-2019 NCA

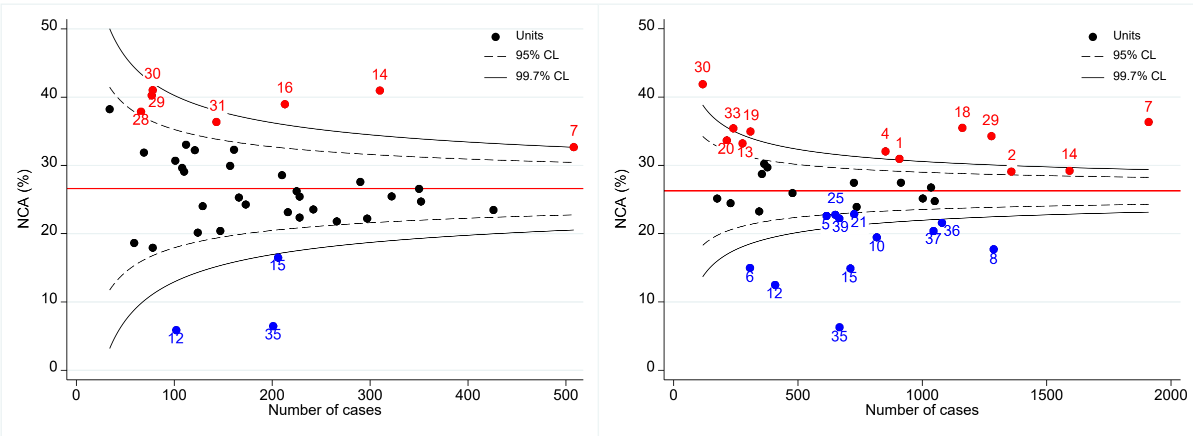
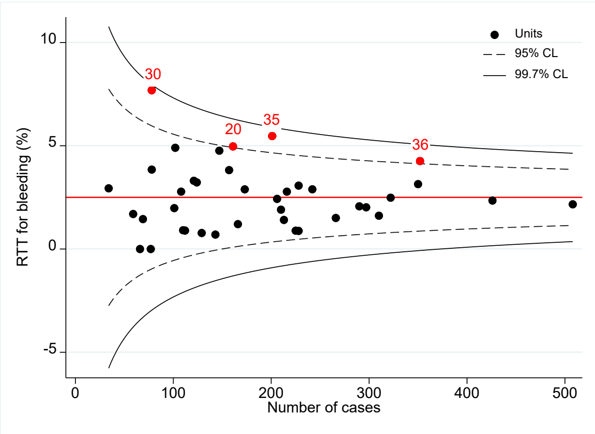


Figure 19. RTT for bleeding by unit following isolated CABG

a. 2020 RTT for bleeding



b. 2016-2019 RTT for bleeding

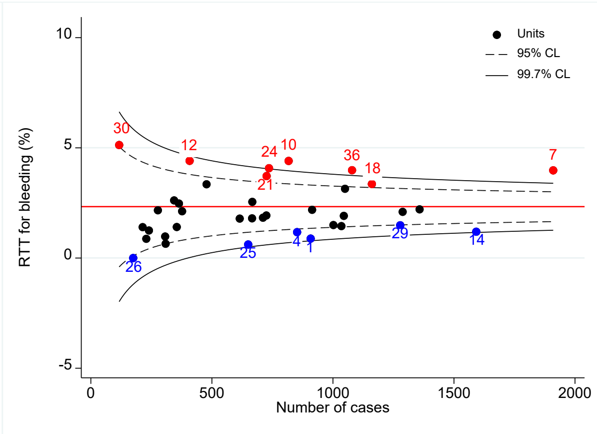
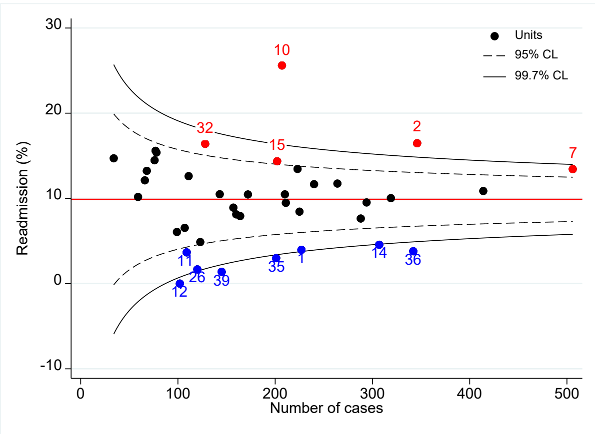
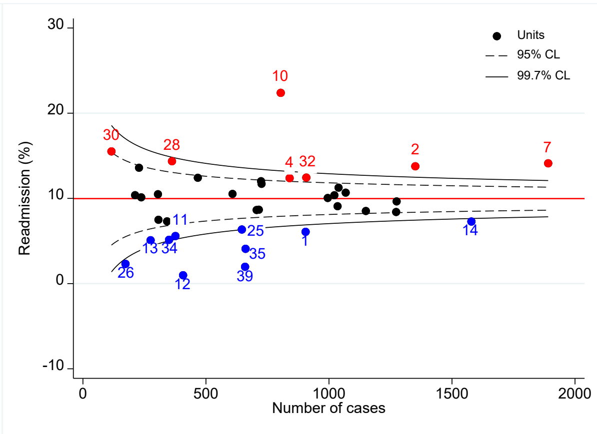


Figure 20. Readmission by unit following isolated CABG

a. 2020 Readmission



b. 2016-2019 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 used. The GM is defined as the nth root of a product of n numbers. It is less sensitive to outlying values, so describes the central tendency of a set of skewed data more accurately.

There was wide variation between units in the time patients spent in the ICU, duration of ventilation, and the proportions of patients receiving RBC or NBRC transfusion in 2020, however the mean for each resource remained consistent with the preceding four years (Tables 8 and 9).

Table 8. Resource utilisation by unit for isolated CABG patients, 2020

	2020			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	53.0	9.3	14.5	11.8
2	26.7	9.4	17.7	7.7
3	44.4	13.3	27.5	9.2
4	41.3	9.4	16.9	12.9
5	76.4	13.8	52.4	34.9
6	60.2	6.8	39.0	20.3
7	34.8	8.5	20.4	23.4
8	108.3	11.0	47.4	28.9
9	46.5	7.6	25.6	17.3
10	36.3	11.5	24.3	12.9
11	59.3	9.2	27.0	16.2
12	85.0	12.0	13.7	10.8
13	63.1	15.2	31.7	45.5
14	43.9	10.7	23.9	15.5
15	46.8	10.9	29.6	12.6
16	32.9	10.9	34.3	17.8
17	33.0	6.3	14.1	41.0
18	82.6	7.4	35.9	21.7
19	76.2	13.1	12.5	4.5
20	66.0	7.6	29.8	30.4
21	31.7	10.1	22.7	15.7
22	45.4	7.1	24.8	17.2
23	38.2	10.3	30.2	15.2
24	43.8	11.2	32.9	19.8
25	37.4	6.2	24.2	25.0
26	50.4	7.6	40.5	39.7
27	32.7	8.4	35.5	10.1
28	60.3	7.3	16.7	22.7
29	66.7	7.3	48.1	23.4
30	60.8	7.6	23.1	16.7
31	58.9	9.7	28.7	14.7
32	36.1	9.3	34.9	24.0
33	32.9	7.4	14.7	23.5
34	39.3	7.0	14.5	5.8
35	41.5	11.8	20.9	29.9
36	58.4	9.7	28.1	23.6
37	65.8	12.7	31.3	15.8
38	71.8	10.7	26.0	13.3
39	46.3	9.2	32.7	33.3
Total	**47.8**	**9.6**	**27.6**	**19.2**

Table 9. Resource utilisation by unit for isolated CABG patients, 2016-2019

	2016-2019			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	53.1	9.2	10.7	5.9
2	26.5	9.6	16.1	6.9
4	40.5	10.2	13.7	6.5
5	64.6	14.5	47.3	32.4
6	59.6	6.9	25.0	15.6
7	33.6	8.7	27.0	19.9
8	101.9	12.3	41.5	21.8
9	39.7	8.1	21.5	11.9
10	40.4	11.9	25.9	16.3
11	56.4	13.6	24.7	15.6
12	80.1	14.7	14.7	4.7
13	60.6	14.1	28.9	40.8
14	43.8	8.7	25.3	12.7
15	46.0	12.1	31.4	17.6
16	31.2	11.4	33.5	17.5
17	35.2	5.8	22.3	38.0
18	82.6	9.5	36.3	21.0
19	75.1	14.0	14.2	4.2
20	68.6	7.9	23.4	33.2
21	32.3	10.1	24.2	25.0
22	40.9	7.9	25.9	20.4
23	35.3	10.8	39.7	15.9
24	38.8	11.1	33.7	26.8
25	36.0	5.7	18.6	16.9
26	46.7	7.3	23.4	19.4
27	32.7	9.0	31.0	9.8
28	56.5	7.3	17.3	20.3
29	60.0	9.1	38.9	19.1
30	74.6	7.8	29.9	12.8
32	36.5	9.6	32.1	23.5
33	32.8	9.2	12.5	8.3
34	38.0	8.5	23.4	5.9
35	38.1	11.0	26.5	23.1
36	58.3	9.8	31.5	23.6
37	63.8	12.4	31.5	17.9
38	71.3	11.7	27.6	17.7
39	37.8	8.2	24.3	29.6
Total	**46.0**	**9.8**	**27.6**	**17.7**

The median is used instead of the GM in this section to present data for pre- and post-PLOS as we consider '0' days as valid data (whereas the GM excludes '0'). In 2020 and the preceding four years, there was variability between units in the pre- and post-PLOS data (Figures 21-24). In 2020, the medians ranged from 0-4 days for pre-PLOS and 5-9 days for post-PLOS. Refer to Appendix D-II (pg. 92) for an explanation as to how to interpret box plots.

Figure 21. Pre-PLOS for isolated CABG patients by unit, 2020

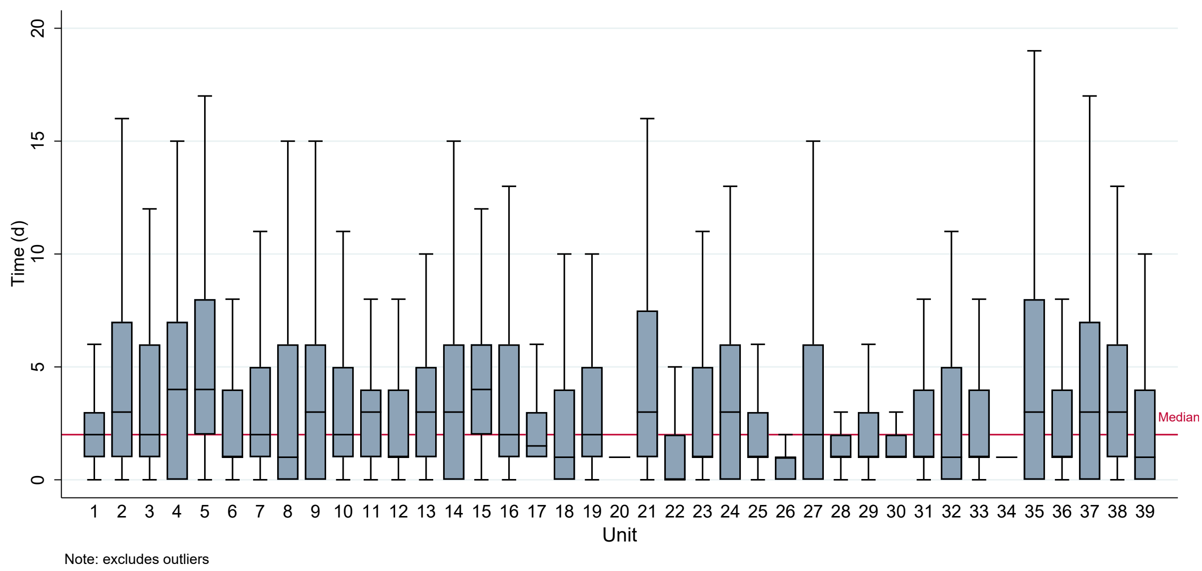


Figure 22. Pre-PLOS for isolated CABG patients by unit, 2016-2019

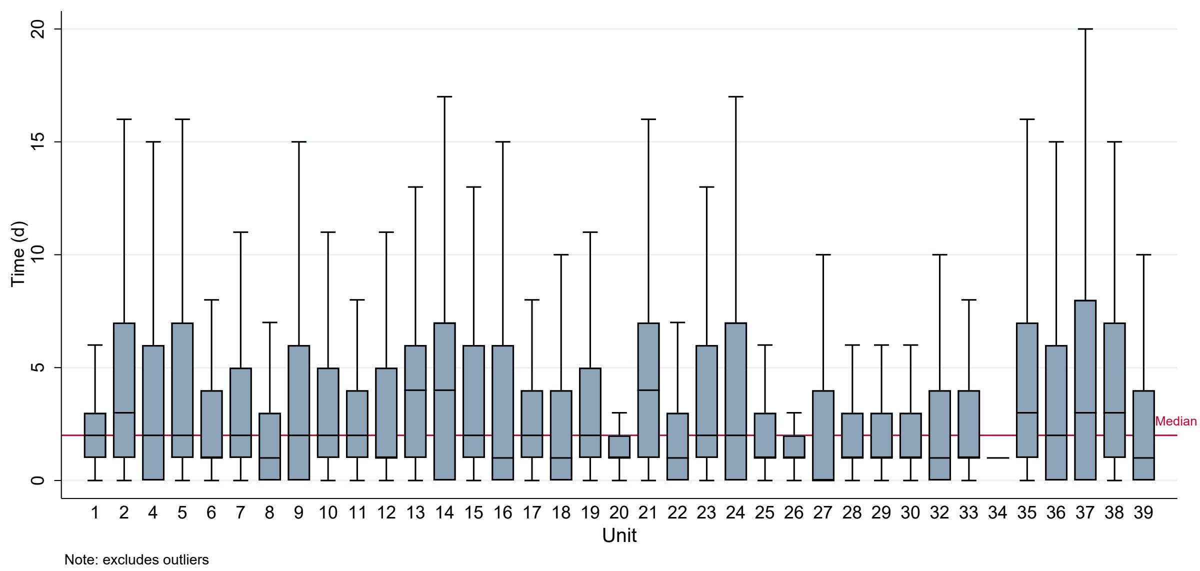
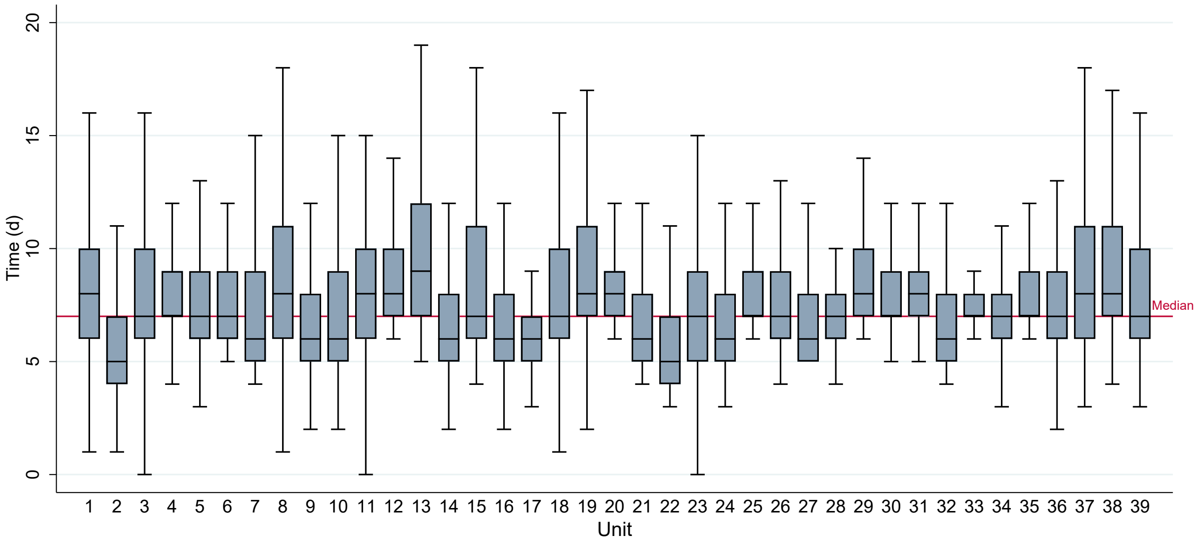
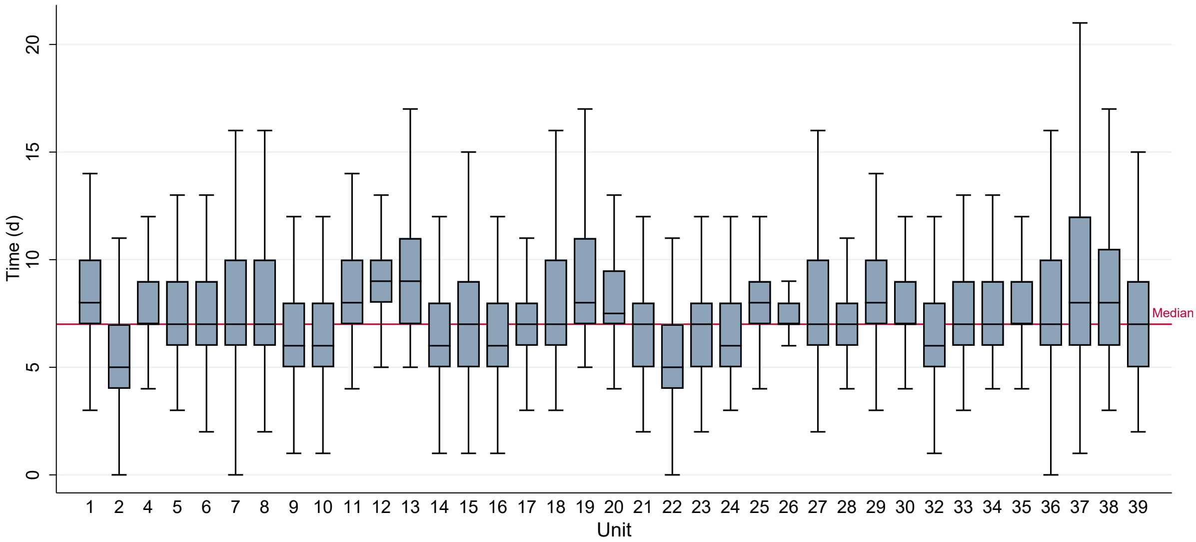


Figure 23. Post-PLOS for isolated CABG patients by unit, 2020



Note: excludes outliers

Figure 24. Post-PLOS for isolated CABG patients by unit, 2016-2019



Note: excludes outliers

2. Effect of COVID-19 on Cardiac Surgery

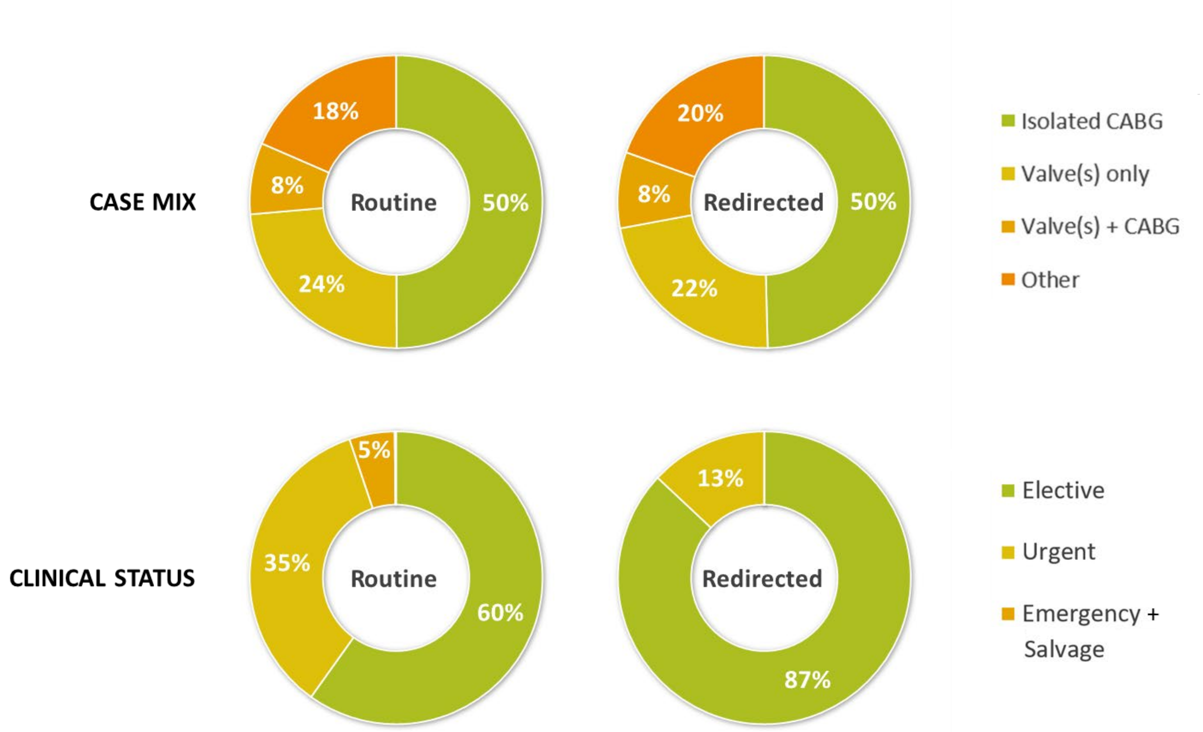
ANZSCTS Database pandemic response

In early April 2020, during the first lockdown in Victoria, the Database convened a working group to determine whether data related to the pandemic should be included in the dataset. At that time, there was limited information available regarding the outcomes for cardiac surgery patients with pre- or post-operative COVID-19 diagnoses. It was also unclear what the trajectory of the pandemic would be in Australia and worldwide, making it challenging to anticipate what data may be beneficial for future research.

Following consultation with the ANZSCTS, and in line with other leading international registries such as the STS Adult Cardiac Surgery Database in the United States and the SWEDEHEART registry in Sweden, the working group elected to collect data on peri-operative COVID-19 diagnoses in patients. The new variables were split into diagnoses that were confirmed preoperatively (pre- and post-admission) and post-operatively (pre-and post-discharge).

In addition, repeated restrictions on elective surgery at hospitals instituted by the state governments resulted in cases being redirected from public hospitals to private hospitals from the point of admission. The overlap in surgeons, anaesthetists, perfusionists and intensivists and the location of late post-operative patient care varied significantly between hospital partnerships. This presented a challenge for the quality assurance activities of the Database Program, which are based on hospital-level outcomes. The Database implemented a 'redirection' variable to distinguish these cases from the routine hospital caseload to facilitate analyses. Information regarding the differences in case mix and clinical status of redirected patients in comparison to all other patients is presented in Figure 25.

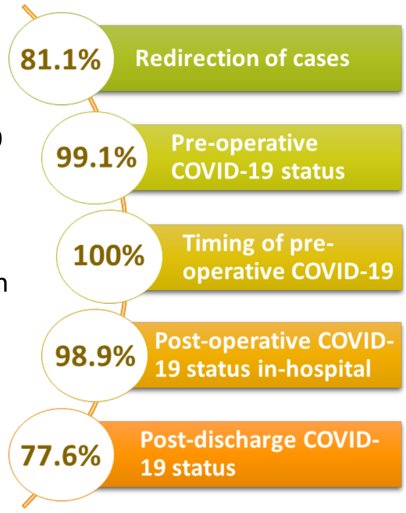
Figure 25. Proportions of procedure type and clinical status separated by patient redirection status

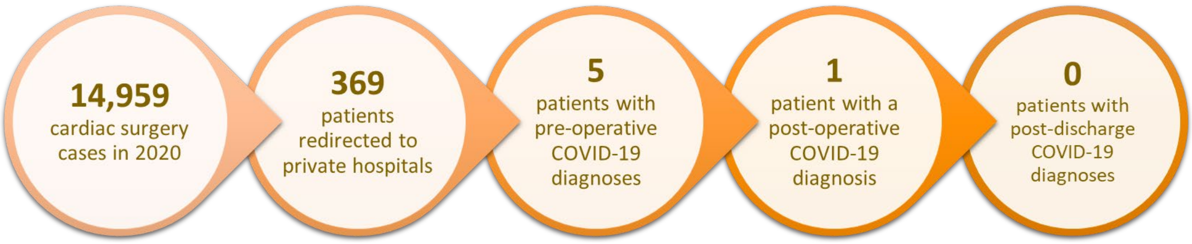


The changes to the data entry web-system were implemented in May of 2020 and were applied retroactively to all cases from the start of January. The Data Management and Analysis Centre worked closely with all site Data Managers to facilitate backdated data submission and attain a high level of completeness for these variables. The exception was for COVID-19 diagnoses collected via the 30-day patient follow-up, which were not amended for cases that were already complete.

Almost 15,000 cases were submitted to the Database in 2020, with five reported as having a pre-operative diagnosis of COVID-19 and one with an in-hospital post-operative diagnosis. There were 369 cases redirected from public to private hospitals and all of these were located in Victoria and New South Wales. However, additional public cases were redirected to units that do not contribute to the Database.

Completeness of pandemic variables





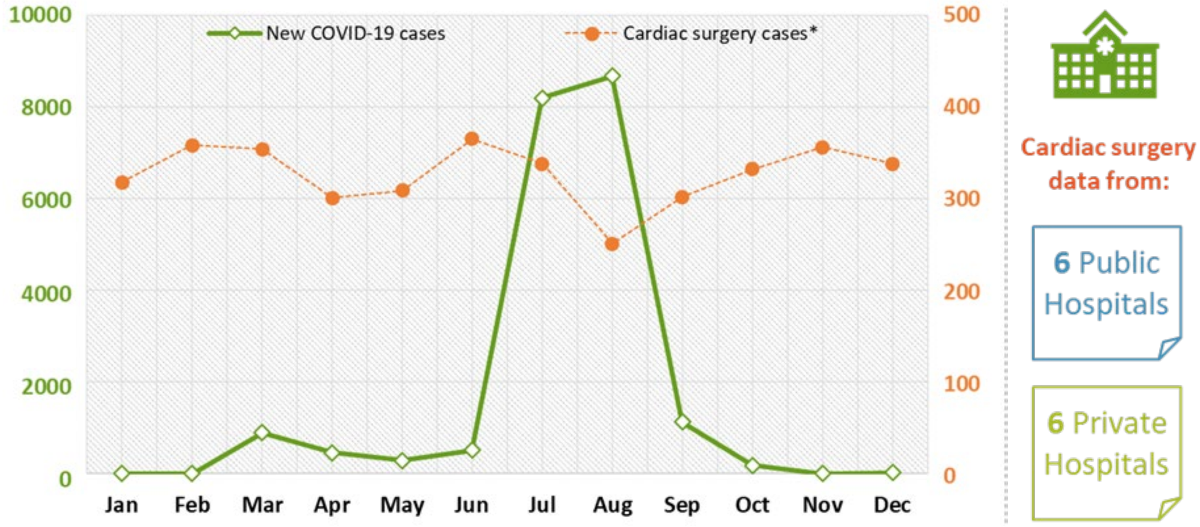
In 2020, there were significant differences in the burden and government responses to the pandemic between the states and territories in Australia and between Australia and New Zealand. The following pages present summary data on the caseloads, patient outcomes and resource utilisation data in each region, compared to activity in 2017 – 2019, inclusive. The tabulated data and bar graphs include only units that have contributed for the full 2017 – 2020 period, to allow valid comparisons. The line charts and other summary data restricted to 2020 include all units that contributed for the entirety of 2020, with the exception of the Royal Hobart Hospital, which was the only contributing unit in Tasmania and joined in the second quarter of 2020.

A selection of experiences written in July 2021 from cardiac surgeons, perfusionists and intensivists accompany the data. Each region faced increased pressure and new challenges throughout 2021 with the introduction of the COVID-19 Delta strain and rollout of vaccination programs; however, these submissions relate mostly to the events of 2020. Some responses have had minor edits for length and clarity.

Melbourne, Australia - September 2020

VICTORIA

Figure 26. Monthly cardiac surgery cases and COVID-19 positive cases in Victoria for 2020



*Some public hospital cases were redirected to a non-contributing hospital
COVID-19 cases data source: covid19data.com.au

"The first wave of infections in the COVID-19 pandemic arrived in Australia in late Jan 2020 in a returned overseas traveller. The first wave of infections in Victoria occurred over March and April and was short-lived. The start of the pandemic did prompt a number of initiatives at the state and hospital level to attempt to minimise staff shortages, and maintain service provision. Victoria experienced a second wave of infections in July and this prompted one of the world's longest lockdowns, finally lifting in November.

There was also an initial cessation of elective surgery across the state due to uncertainty about what to expect. ***All outpatient contact changed to telehealth overnight. Patients were reluctant to come into hospital to have cardiac assessments. This led to many more patients having to be admitted via emergency departments, and having inpatient surgery.***

At St Vincent's Public Hospital, we had made provisions to split our cardiac and thoracic surgical teams into two separate units, with half of our work being able to transfer to the co-located St Vincent's Private Hospital campus. This change allowed us to maintain a good volume of work, as well as freeing up ICU space if needed.

Due to the state of emergency arrangements with private hospitals, they had decreased activity so theatres were available for use. Overall there were nearly 80 cardiac cases performed from 28 July until the 25 November. This allowed the development of other protocols to enable further collaboration between the two organisations. ***The ability for patients to receive healthcare has improved, but in 2021 it feels like we are still seeing the tail of those that were neglected last year, with an increase in acuity and severity of disease overall."***

Dr Andrew Newcomb
Director of Cardiothoracic Surgery
St Vincent's Public Melbourne, Victoria

"Monash Health was relatively spared with respect to the worst of the pandemic in Melbourne as compared with the hospitals in the northern and western suburbs. There was an excellent leadership structure in place and a co-ordinated organisational response after the first Australian case of COVID-19 presented to Monash Health on 24 January 2020. ***Our cardiac surgery ward became a dedicated COVID-19 management ward and the staff performed in a highly professional and outstanding fashion.*** *Elective cardiac surgery activity was significantly reduced and we were only admitting Category 1 and high Category 2a patients.*

We continued to operate upon in-patients in a normal fashion under established COVID-19 precautions. Fortunately, during this time there was only a modest increase in our cardiac surgery waiting list. ***Private cardiac surgery at the Jessie McPherson Private Hospital was halted during our second lockdown as the private cardiology/cardiac surgery ward was also a dedicated COVID-19 management ward.*** *Outpatient care was principally via telehealth.*

The health service is now slowly emerging from the pandemic and is providing a major public health service to the south-east of Melbourne. All staff and patients have been significantly impacted by the pandemic and this will be maintained to a variable extent until high levels of community vaccination are achieved."

Professor Julian Smith
Director of Cardiothoracic Surgery
Monash Medical Centre, Victoria

Figure 27. Proportion of elective cardiac surgery cases by quarter in Victoria, 2017-2019 and 2020

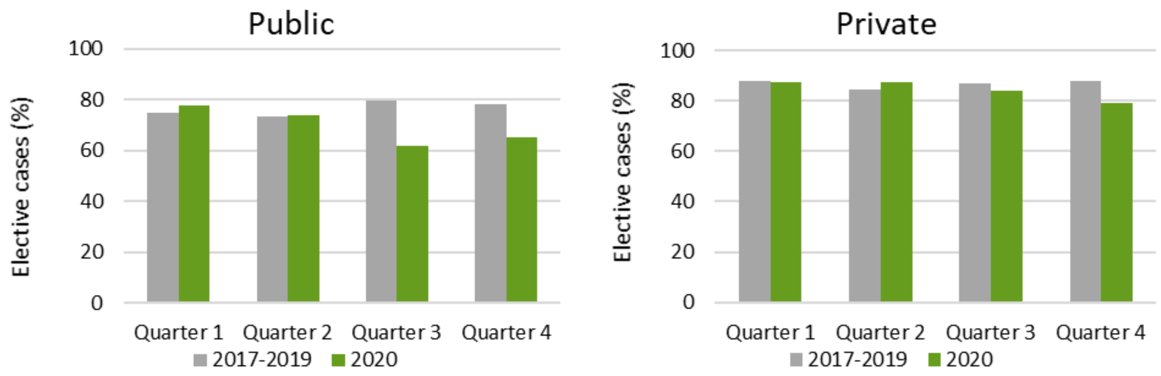


Figure 28. Proportion of urgent cardiac surgery cases by quarter in Victoria, 2017-2019 and 2020

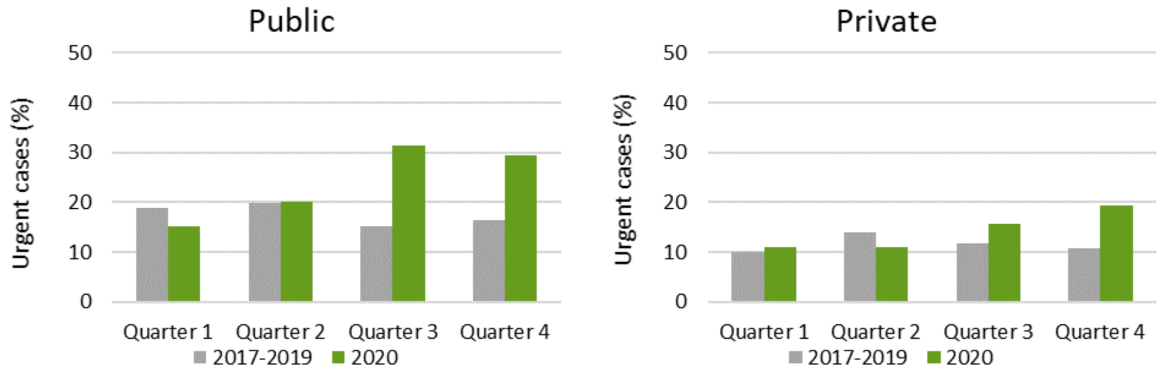
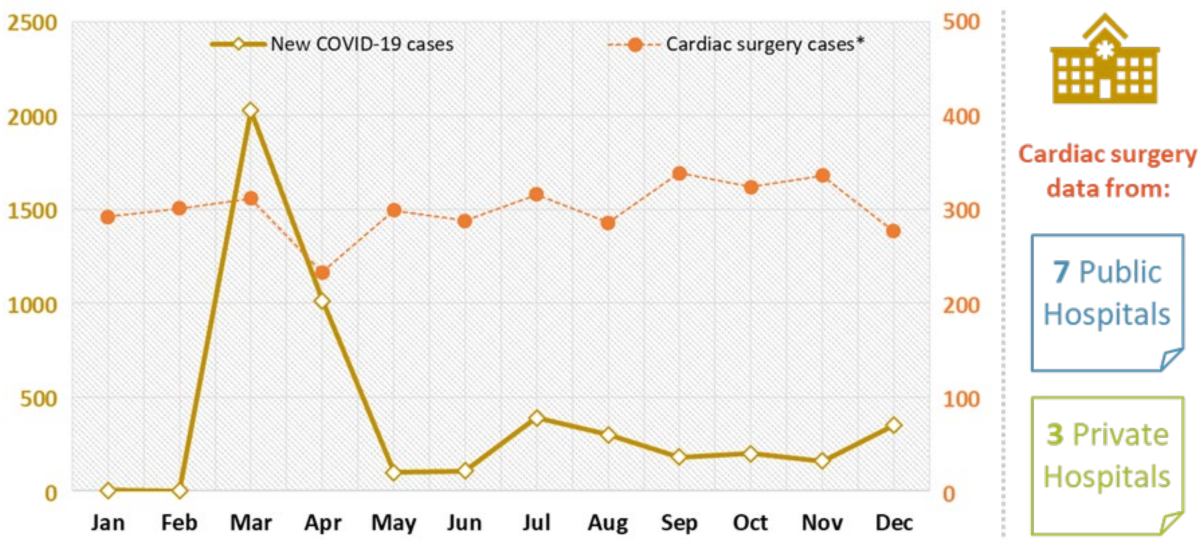


Table 10. Key outcomes and resource utilisation for cardiac surgery patients by quarter in Victoria, 2017-2019 and 2020

		Quarter 1		Quarter 2		Quarter 3		Quarter 4	
		2017-2019	2020	2017-2019	2020	2017-2019	2020	2017-2019	2020
Public	Total Procedures (n)	2086	694	2186	584	2243	571	2178	648
	Mortality (%)	3.0	2.5	2.8	3.1	3.0	2.3	1.9	1.9
	RTT for bleeding (%)	3.1	3.0	3.8	2.7	3.4	3.9	3.0	3.1
	dNRI (%)	6.0	5.1	7.5	5.4	6.7	6.5	6.1	7.7
	DSWI (%)	1.3	0.6	0.9	0.2	1.2	1.4	1.0	0.5
	Permanent stroke (%)	2.1	2.2	2.6	3.3	2.1	2.3	1.9	2.6
	ICU stay (GM, h)	41.2	42.5	43.7	46.0	41.8	47.3	42.7	47.8
	Ventilation time (GM, h)	11.6	11.6	12.1	12.2	11.3	12.7	11.3	12.7
Private	Total Procedures (n)	1091	336	1162	391	1204	320	1266	378
	Mortality (%)	1.4	0.9	1.5	1.0	1.6	1.3	1.4	1.6
	RTT for bleeding (%)	2.2	3.3	2.0	1.8	2.1	4.7	2.2	3.2
	dNRI (%)	2.8	2.1	3.7	2.6	3.8	5.4	2.7	2.9
	DSWI (%)	0.7	0.3	0.6	0.0	0.4	0.0	0.5	0.3
	Permanent stroke (%)	0.7	0.3	1.2	0.8	1.3	1.3	0.9	1.6
	ICU stay (GM, h)	50.3	56.4	51.0	55.0	54.0	61.7	51.5	57.0
	Ventilation time (GM, h)	8.5	8.9	8.6	7.9	8.7	8.9	7.9	8.1

NEW SOUTH WALES

Figure 29. Monthly cardiac surgery cases and COVID-19 positive cases in New South Wales for 2020



*Some public hospital cases in the second and third quarters were redirected to a non-contributing hospital
COVID-19 cases data source: covid19data.com.au

"Watched the outbreak and lockdown in Wuhan on Canadian media in Jan 2020. Recognised panic in the faces of colleagues with the early outbreak and fears concerning routine thoracic patients access to surgery.

Lost our Ward, some access to ICU but not our service. Even managed to cover each other so only one surgeon on site each day, a distinct first in our Unit. ***Continued to do a large amount of lung***

surgery before vaccination was available and was scared that I may take COVID home to my wife and grown up boys sheltering at home.

My first son has seen out the whole of COVID in central New York: weekly facetimes, long iso period, riding a bike down an empty Times Square, now mask free, 100% open and vaccinated (July 2021).

Felt the relief of finally being vaccinated more so my family now have great hope of life, love and travel re-emerging.

I am thankful for being able to work, provide for my family and live in a quiet safer city.

Mr Allen James
Cardiothoracic Surgeon
Lake Macquarie Private Hospital/John Hunter Hospital, NSW

Figure 30. Proportion of elective cardiac surgery cases by quarter in New South Wales, 2017-2019 and 2020

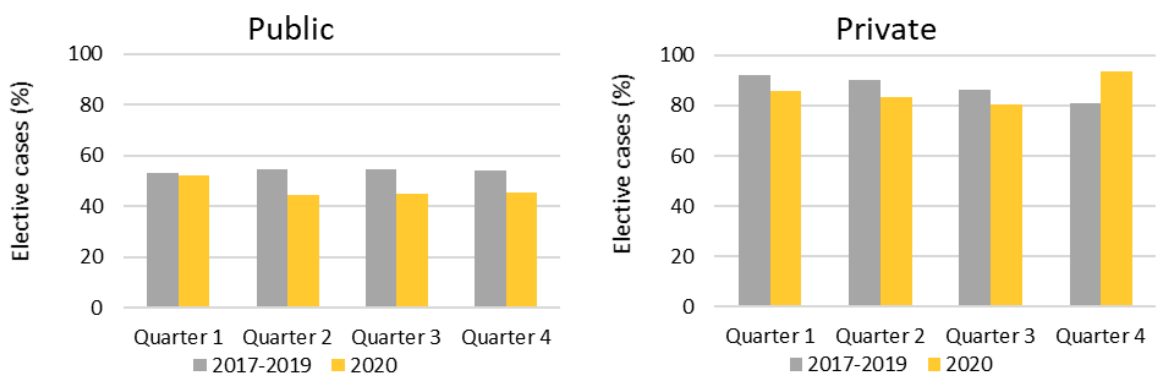


Figure 31. Proportion of urgent cardiac surgery cases by quarter in New South Wales, 2017-2019 and 2020

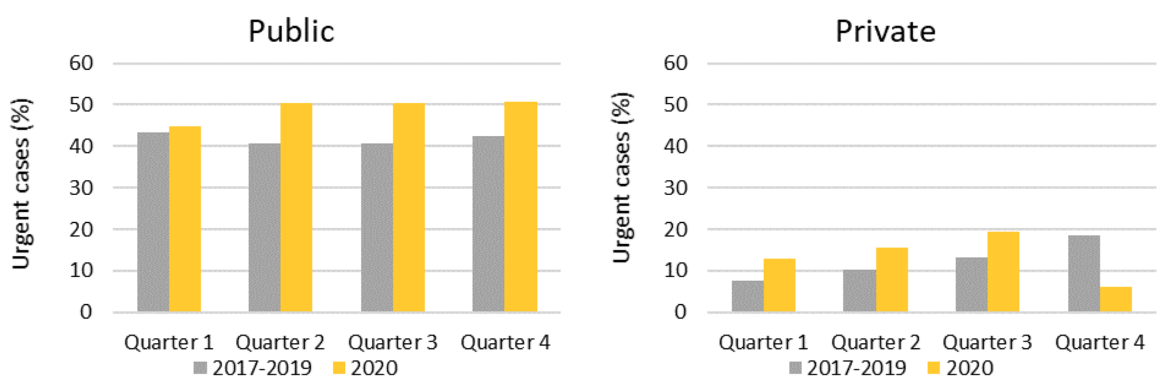
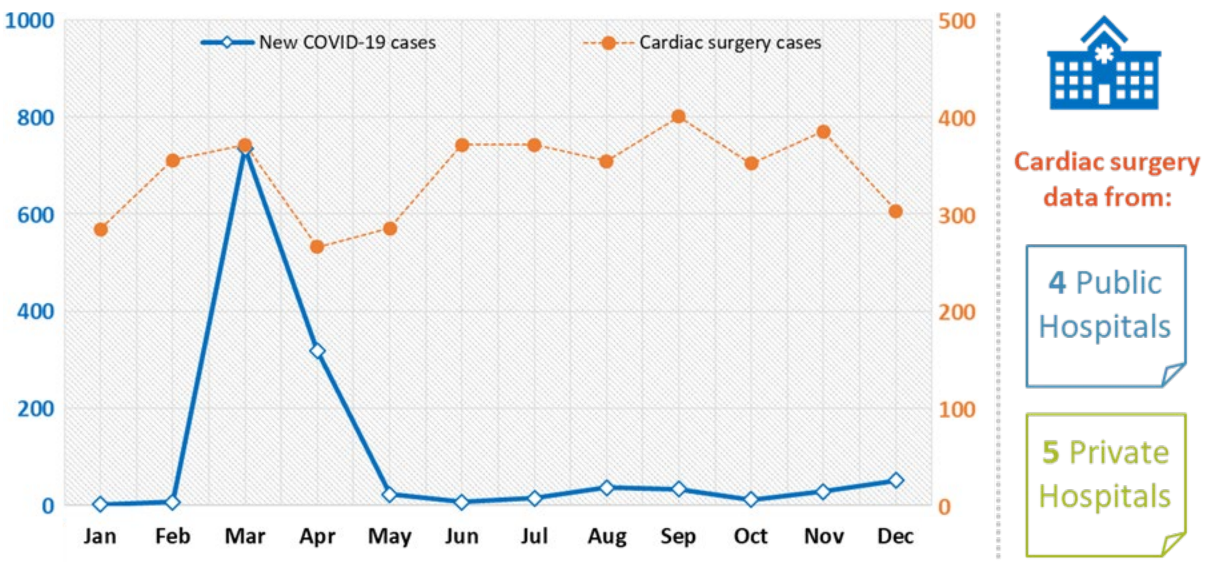


Table 11. Key outcomes and resource utilisation for cardiac surgery patients by quarter in New South Wales, 2017-2019 and 2020

		Quarter 1		Quarter 2		Quarter 3		Quarter 4	
		2017-2019	2020	2017-2019	2020	2017-2019	2020	2017-2019	2020
Public	Total Procedures (n)	1934	735	2162	634	2266	745	2208	769
	Mortality (%)	2.7	1.8	3.1	2.7	3.0	2.4	1.8	3.4
	RTT for bleeding (%)	4.1	3.4	3.5	5.1	4.3	6.3	4.1	5.2
	dNRI (%)	3.9	4.2	4.8	5.5	4.5	6.3	3.4	4.6
	DSWI (%)	1.0	1.2	0.8	0.5	1.0	0.7	0.5	0.8
	Permanent stroke (%)	2.0	1.8	2.0	2.4	2.7	1.1	1.6	2.1
	ICU stay (GM, h)	76.9	72.7	77.0	83.8	74.2	78.5	74.3	80.4
	Ventilation time (GM, h)	12.9	11.8	13.2	14.4	13.2	13.0	12.2	12.7
Private	Total Procedures (n)	301	170	358	186	437	196	459	168
	Mortality (%)	1.0	1.2	0.8	0.5	0.9	1.0	0.9	1.8
	RTT for bleeding (%)	2.0	5.3	3.6	4.3	3.7	4.6	2.4	4.8
	dNRI (%)	0.7	1.8	1.1	1.1	1.6	1.6	1.5	0.6
	DSWI (%)	1.3	1.2	1.7	1.1	1.1	0.5	0.9	1.2
	Permanent stroke (%)	0.0	1.8	1.1	0.5	1.4	2.1	0.7	1.2
	ICU stay (GM, h)	75.6	68.0	73.2	70.7	70.9	67.7	72.7	72.1
	Ventilation time (GM, h)	12.8	12.0	12.4	9.7	12.8	10.5	11.9	10.6

QUEENSLAND

Figure 32. Monthly cardiac surgery cases and COVID-19 positive cases in Queensland for 2020



COVID-19 cases data source: covid19data.com.au

*"**Apart from the illness and loss of life caused by COVID-19, the most marked initial effect was the psychological effect of the pandemic.** This was experienced in a particular way amongst frontline staff. News reports and personal accounts from colleagues overseas reinforced this anxiety. Practically, this anxiety resulted in a high degree of attention to workflow practices and the adaptation of hospital resources and theatre spaces for the intubation of COVID positive patients. Staff were reallocated, expecting an increase in the acutely unwell in intensive care and wards needing respiratory support. Surgical activity was paused as staff were rearranged and reskilled in*

intensive care. Thoughts were given to how to run triage teams, deciding between those who would benefit from therapy and those would instead be palliated.

The uncertainty in Cardiothoracic Surgery was how much we would have to be involved in the use of mechanical support, and whether we would be significantly affected as an ECMO retrieval service. In the initial phase of the pandemic, the degree to which ECMO would be needed was uncertain and the prospect of retrieving COVID-19 positive patients from around the State back to the larger centres in the South East corner of Queensland felt a real possibility.

Our hospital activity was put on hold as we anticipated large numbers of COVID patients, but the surge of patients did not eventuate, and we were able to return to regular levels of activity within a short period of time. This delayed treatment for Cardiac and Thoracic surgical patients in two ways, first by delaying time to surgery, but also by delaying time to outpatient clinics and listing for surgery. ***We were fortunate in that we did not see significantly worse outcomes for patients who we were treating at the time.*** *We employed a high frequency of Telehealth consultations, but acutely felt the absence of the face-to-face interaction with our patients.*

Undertaking Thoracic surgical operations, in full personal protective equipment, in isolated theatres certainly added to the difficulty of our day-to-day practice - and as every Thoracic surgical patient was assumed to be infectious in our hospital, it became a significant workload burden and an impediment to the smooth flow through of the operating theatre. ***As surgeons, we deal directly inside the human body with infectious diseases, but do not routinely feel the fear of contracting that infectious disease.*** *This was the first experience we had, in which team members felt that we could contract a disease that might be lethal within a short period of time, and this heightened the anxiety around the entire episode.*

We have been fortunate, to have not seen the high numbers of patients that we were anticipating, due to the well-co-ordinated Public Health efforts in Australia. Although the uptake of the COVID vaccine has been slow (as of July 2021), it appears that we weathered the worst of the storm, primarily by avoiding it. The public health measures though affect our patients by inflicting them with isolation whilst they recover from significant surgery. They suffer from the isolation they feel when they do not have their loved ones with them when they are recovering in hospital, and as a surgeon doing rounds on isolated patients who cannot have visitors, I have spent a large amount of my time being psychological and emotional support for patients for whom sometimes, myself and the nursing staff are their only human contact."

Dr Chris Cole
Cardiothoracic Surgeon
Public and Private units, QLD

Noosa Heads, Queensland
'Exercise Only' Beach Report, 2020

Figure 33. Proportion of elective cardiac surgery cases by quarter in Queensland, 2017-2019 and 2020

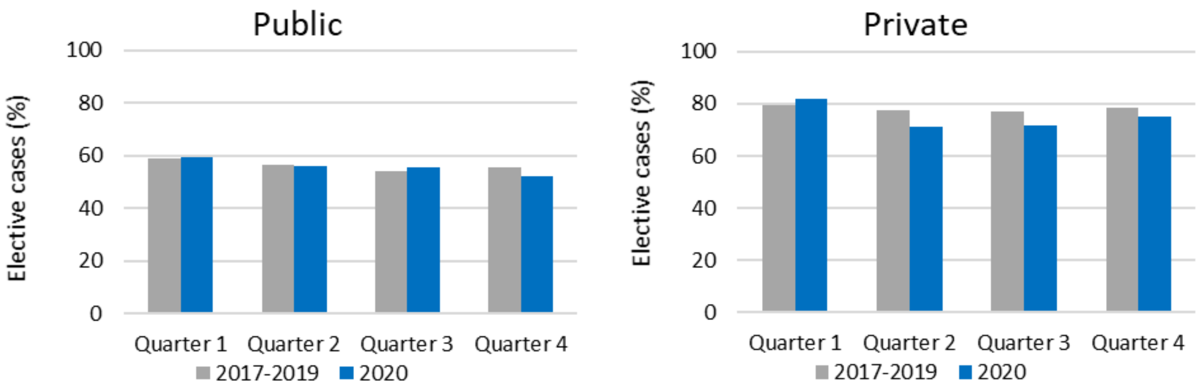


Figure 34. Proportion of urgent cardiac surgery cases by quarter in Queensland, 2017-2019 and 2020

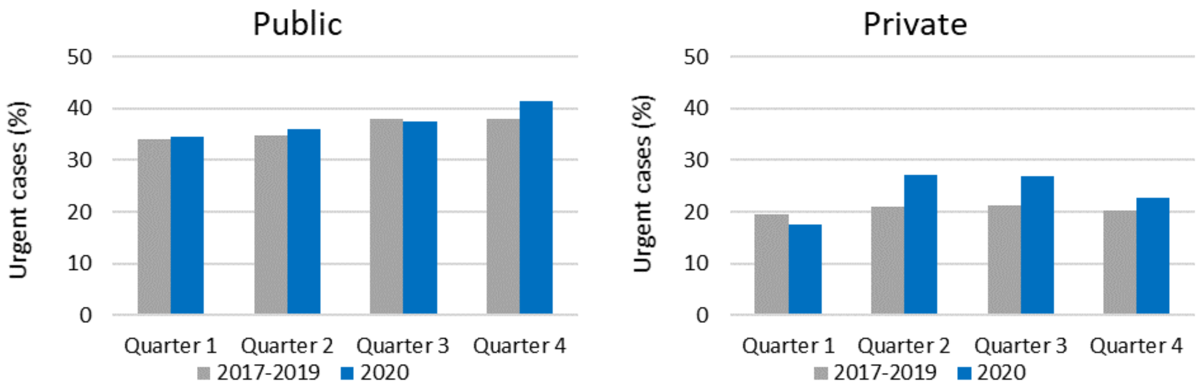
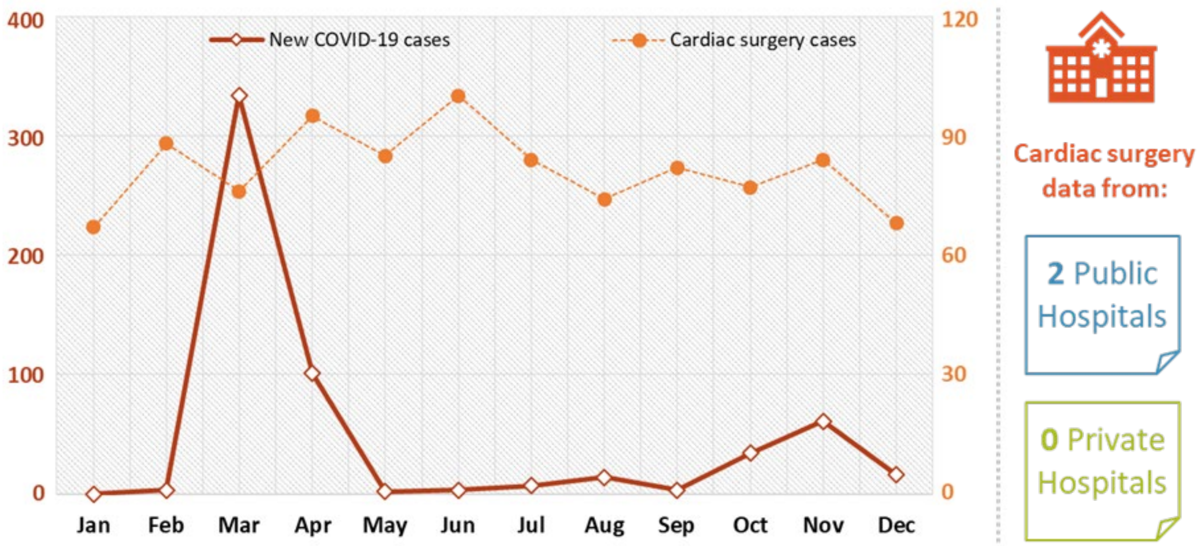


Table 12. Key outcomes and resource utilisation for cardiac surgery patients by quarter in Queensland, 2017-2019 and 2020

		Quarter 1		Quarter 2		Quarter 3		Quarter 4	
		2017-2019	2020	2017-2019	2020	2017-2019	2020	2017-2019	2020
Public	Total Procedures (n)	1753	638	1842	607	1897	736	1848	663
	Mortality (%)	2.2	1.6	2.3	3.1	2.7	1.5	2.0	2.6
	RTT for bleeding (%)	6.0	5.8	4.4	3.8	5.1	3.0	4.5	3.8
	dNRI (%)	4.8	4.8	4.2	4.2	4.2	4.0	4.1	4.4
	DSWI (%)	1.7	1.9	2.1	1.8	1.5	1.1	1.4	0.9
	Permanent stroke (%)	1.0	1.6	1.4	1.0	1.5	1.4	1.3	1.7
	ICU stay (GM, h)	37.2	39.3	36.1	37.2	35.7	39.8	36.2	36.1
	Ventilation time (GM, h)	10.8	11.3	11.1	11.2	10.4	11.1	10.6	10.7
Private	Total Procedures (n)	738	327	776	269	955	337	943	335
	Mortality (%)	1.2	1.2	1.3	0.4	0.7	1.2	1.0	0.9
	RTT for bleeding (%)	3.1	2.8	2.2	3.0	2.9	4.2	1.9	0.6
	dNRI (%)	1.2	0.9	2.9	1.9	3.4	1.2	1.7	2.1
	DSWI (%)	0.8	0.0	1.0	0.7	0.6	0.6	1.0	0.6
	Permanent stroke (%)	1.2	1.2	0.6	0.7	1.7	1.8	1.2	1.8
	ICU stay (GM, h)	60.3	51.2	57.0	55.5	58.8	54.5	56.4	55.3
	Ventilation time (GM, h)	10.4	5.7	8.6	6.0	9.2	6.0	8.4	6.5

SOUTH AUSTRALIA

Figure 35. Monthly cardiac surgery cases and COVID-19 positive cases in South Australia for 2020



COVID-19 cases data source: covid19data.com.au

"The first wave of reported COVID-19 infections in South Australia occurred in early March through April and resulted in a state of emergency being declared and a state-wide lockdown being issued from 22 March 2020. COVID-19 numbers remained low for the rest of 2020. There was an initial suspension of elective surgery across the South Australian Health Networks with outpatient consultations changing to telehealth and WebEx appointments, and no face to face pre-admission clinics in service. The state directive to suspend elective surgeries was lifted on the 12th May 2020.

The Royal Adelaide Hospital is the designated COVID-19 hospital in South Australia and as a result of capacity preservation some of the overflow was directed to Flinders Medical Centre, and some cases outsourced to private hospitals. At Flinders provisions were made to minimise the impact upon services with the unit opting to split into two teams, with skeleton staff onsite to ensure emergency surgery would not be affected by staff COVID exposure. ***Postponed elective surgery patients were followed-up daily to assess their health and advised to present to ED if symptoms present or worsen, allowing these patients to be treated surgically as inpatients.***

Due to the varying border restrictions and COVID-19 testing requirements in SA, Northern Territory patients were impacted. ***No commercial flight access resulted in increased use of care flights, and dispensing with a travelling personal carer/support.*** *This had a flow on effect resulting in longer postoperative stays than usual, increased bed block in the ICU/ward and CTSU patient overflow into non-dedicated cardiothoracic wards.*

After the resumption of elective surgery, the backlog of elective patients was able to be cleared relatively quickly, within 1-2 months, with the processes like WebEx and telehealth consults for rural patients and COVID screening over telehealth remaining after the initial outbreak.*"*

Professor Robert Baker
Director of Perfusion, Cardiac and Thoracic Surgery Unit,
Flinders Medical Centre, SA

Figure 36. Proportion of elective (left) and urgent (right) cardiac surgery cases by quarter in South Australia, 2017-2019 and 2020

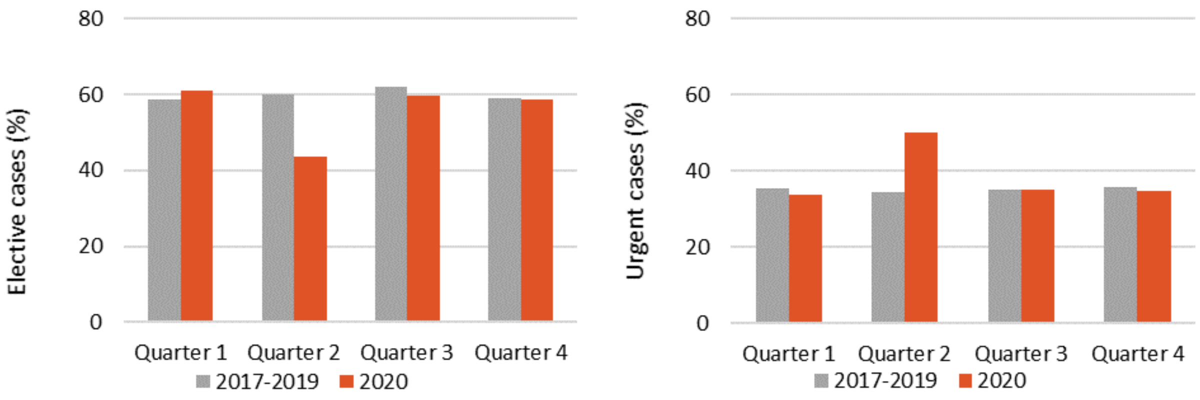
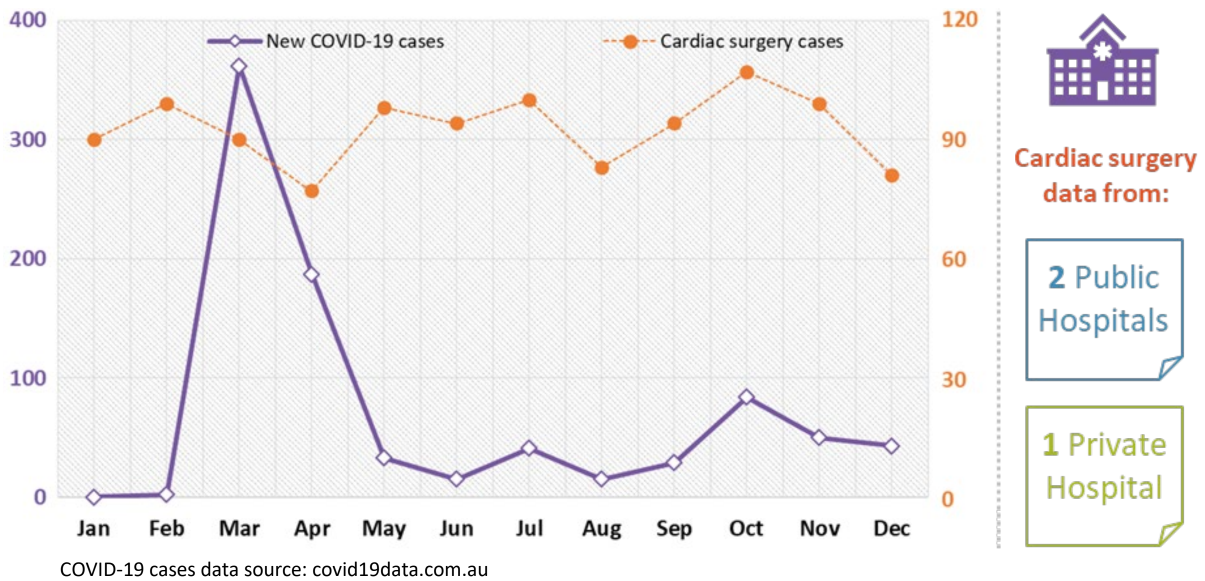


Table 13. Key outcomes and resource utilisation for cardiac surgery patients by quarter in South Australia, 2017-2019 and 2020

		Quarter 1		Quarter 2		Quarter 3		Quarter 4	
		2017-2019	2020	2017-2019	2020	2017-2019	2020	2017-2019	2020
Public	Total Procedures (n)	653	231	720	280	686	240	709	229
	Mortality (%)	2.3	1.7	1.5	2.9	1.6	2.5	1.8	2.6
	RTT for bleeding (%)	5.8	3.9	3.9	3.2	3.5	4.6	4.5	3.1
	dNRI (%)	4.1	3.1	5.4	6.9	5.6	6.9	3.6	4.0
	DSWI (%)	1.2	0.4	0.8	0.4	0.9	0.4	0.7	0.9
	Permanent stroke (%)	1.4	3.0	2.5	1.4	2.0	1.7	1.7	1.8
	ICU stay (GM, h)	60.2	51.0	57.0	62.9	59.4	58.9	56.8	58.2
	Ventilation time (GM, h)	12.5	9.8	11.5	11.7	11.4	11.9	12.3	11.2

WESTERN AUSTRALIA

Figure 37. Monthly cardiac surgery cases and COVID-19 positive cases in Western Australia for 2020



*"**The COVID Pandemic has affected Western Australia in a very different way to almost anywhere in the developed world.** We are protected by physical distance from the rest of the world.*

We have utilised this by shutting our borders to international travel and to other states when COVID has been spreading there. We have had also zero community spread and very few cases admitted to hospital. The only admissions have been sailors on international ships which have harboured here. The health department has had a very conservative approach with lockdowns occurring when even 1 case has been identified.

Despite the minimal effect on admissions to our hospitals, the health department has mandated ceasing all but urgent surgery during the lockdowns. This has had a significant effect on many surgical and interventional units in our hospital with severe disruption to lists and to patients and their families.

***We as a Cardiothoracic unit have maintained that our patients cannot be cancelled and have continued to operate throughout this period.** There were some issues with provision of ICU beds as half our beds were set aside for COVID emergencies (this did not occur on the last lockdown).*

We were involved in one case where a patient with angina had his stress test cancelled due to COVID and then presented a few days later with an out of hospital cardiac arrest. He required ECMO CPR and emergency stenting and suffered severe hypoxic cerebral injury. This would probably been prevented in normal circumstances if he had undergone the stress test."

Clinical Professor Mark Newman
Director of Cardiothoracic Surgery
Sir Charles Gairdner Hospital, WA

Figure 38. Proportion of elective cardiac surgery cases by quarter in Western Australia, 2017-2019 and 2020

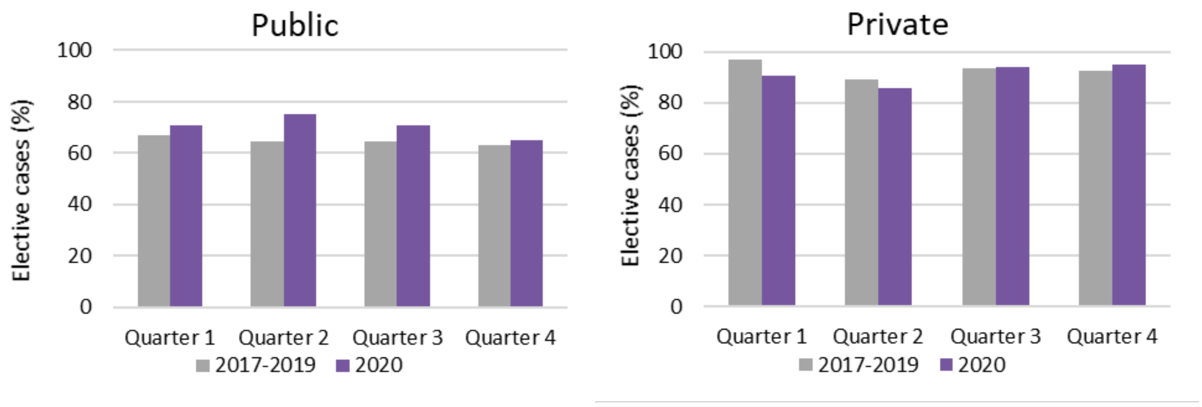


Figure 39. Proportion of urgent cardiac surgery cases by quarter in Western Australia, 2017-2019 and 2020

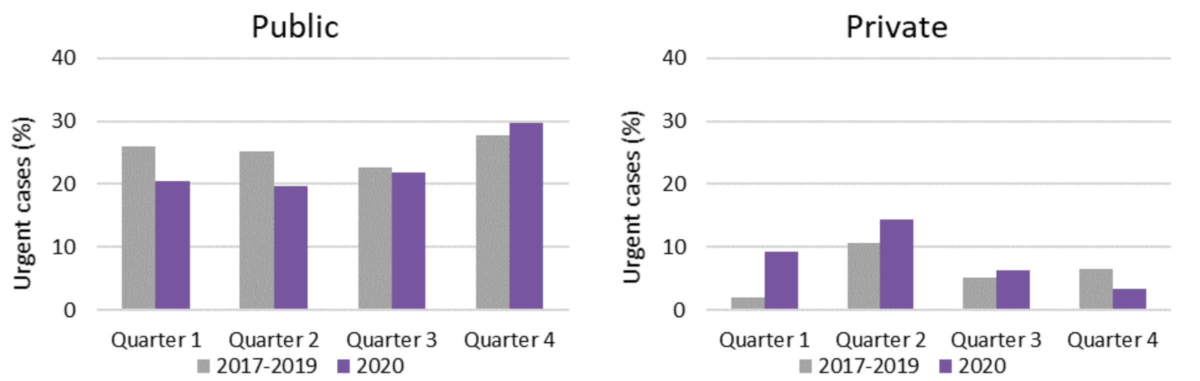
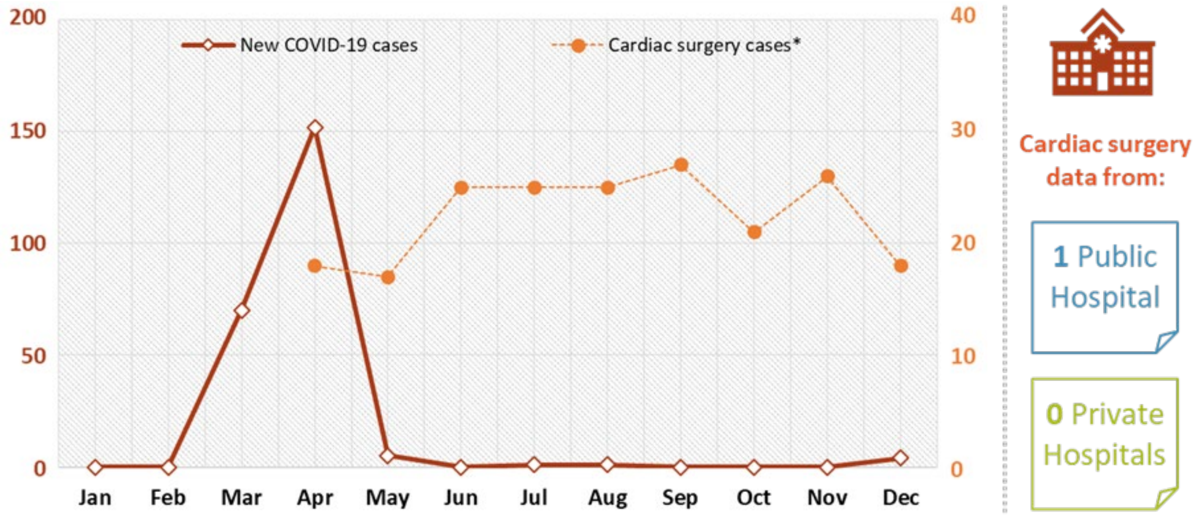


Table 14. Key outcomes and resource utilisation for cardiac surgery patients by quarter in Western Australia, 2017-2019 and 2020

		Quarter 1		Quarter 2		Quarter 3		Quarter 4	
		2017-2019	2020	2017-2019	2020	2017-2019	2020	2017-2019	2020
Public	Total Procedures (n)	687	225	672	234	624	229	646	229
	Mortality (%)	2.3	2.2	3.1	0.9	4.0	1.3	1.9	3.5
	RTT for bleeding (%)	3.1	1.3	4.4	4.3	3.2	5.7	3.4	5.7
	dNRI (%)	5.1	2.3	4.3	4.9	4.8	3.6	5.5	5.9
	DSWI (%)	0.6	0.4	1.4	1.3	0.2	0.9	2.0	1.3
	Permanent stroke (%)	2.5	2.2	1.8	0.9	2.4	1.8	2.6	2.6
	ICU stay (GM, h)	42.2	48.0	44.4	45.6	44.8	56.2	46.7	52.1
	Ventilation time (GM, h)	9.3	8.7	9.0	8.2	8.9	8.9	9.1	9.1
Private	Total Procedures (n)	160	54	168	35	156	48	185	58
	Mortality (%)	0.0	1.9	1.8	0.0	1.3	0.0	0.0	0.0
	RTT for bleeding (%)	1.3	1.9	3.0	2.9	4.5	0.0	3.2	1.7
	dNRI (%)	1.9	5.6	1.2	0.0	5.1	2.3	0.5	3.4
	DSWI (%)	0.6	3.7	0.6	0.0	0.0	0.0	0.0	0.0
	Permanent stroke (%)	1.3	0.0	1.2	2.9	1.3	0.0	0.5	0.0
	ICU stay (GM, h)	56.0	58.6	58.1	58.2	62.3	66.5	54.7	64.5
	Ventilation time (GM, h)	7.6	6.6	8.1	6.9	8.1	7.0	7.4	8.3

TASMANIA

Figure 40. Monthly cardiac surgery cases and COVID-19 positive cases in Tasmania for 2020



*Royal Hobart Hospital began contributing to the Database in quarter two of 2020
COVID-19 cases data source: covid19data.com.au

*"**What I should say is "Covid – what's Covid?"**. Tasmania has been extremely fortunate in that apart from the initial lock down last year in February of the whole state and then the 6-week lockdown of the North West Region when they had the break out in the hospital (all due to the Ruby Princess travellers) we have had no further lockdowns or restrictions. We move around outside maskless, we have full opening of restaurants, bars and retail. Events are running, granted with reduced capacity but still being held.*

Regarding the work in our unit, we have had to operate on one patient that we had to treat as COVID positive very early on as she was an emergency case without testing, who came to us from the North West Region during their lockdown and was in the emergency room of the hospital for seven hours prior to being transported. We employed the full COVID protocol and all went well with a successful outcome for the patient and negative result on her COVID test reported the following day.

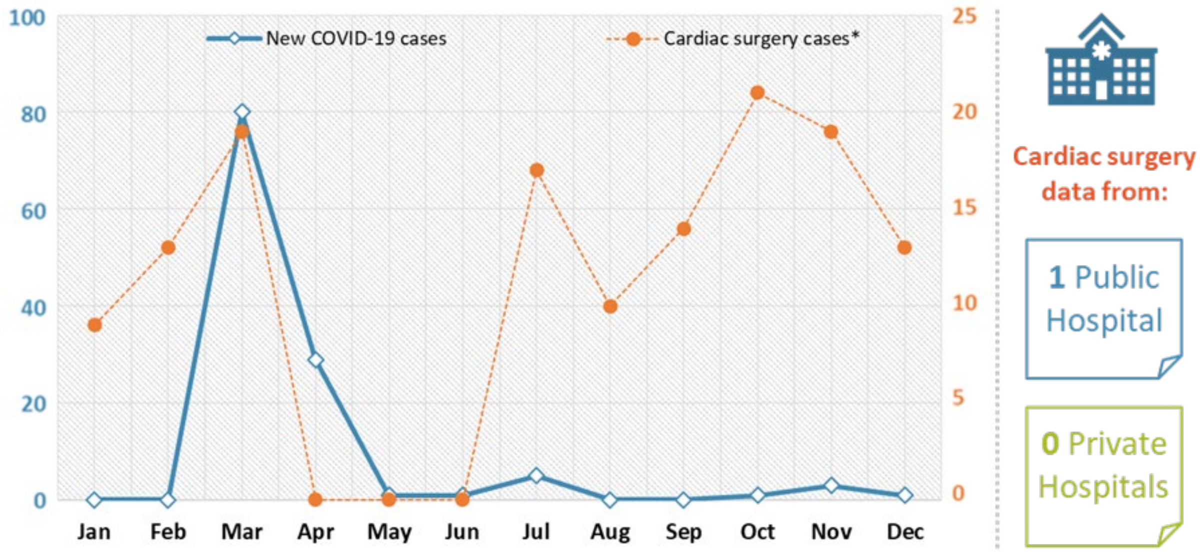
*We have all the necessary protocols in place within the hospital for managing COVID and most of us feel it is a case of not if but when it comes! **We originally had our ICU divided into two separate areas with plans for overflow into the recovery of theatre if ICU became full. This divider was taken down in the middle of 2020 and the ICU reopened and returned to its normal operation mode.***

We now all have to wear masks inside the hospital at all times, which again for those of us who work in theatre it is not that much of change from our normal day. We are enduring nothing like what our colleagues are at present having to work through."

Carmel Fenton
Head of Clinical Perfusion
Royal Hobart Hospital

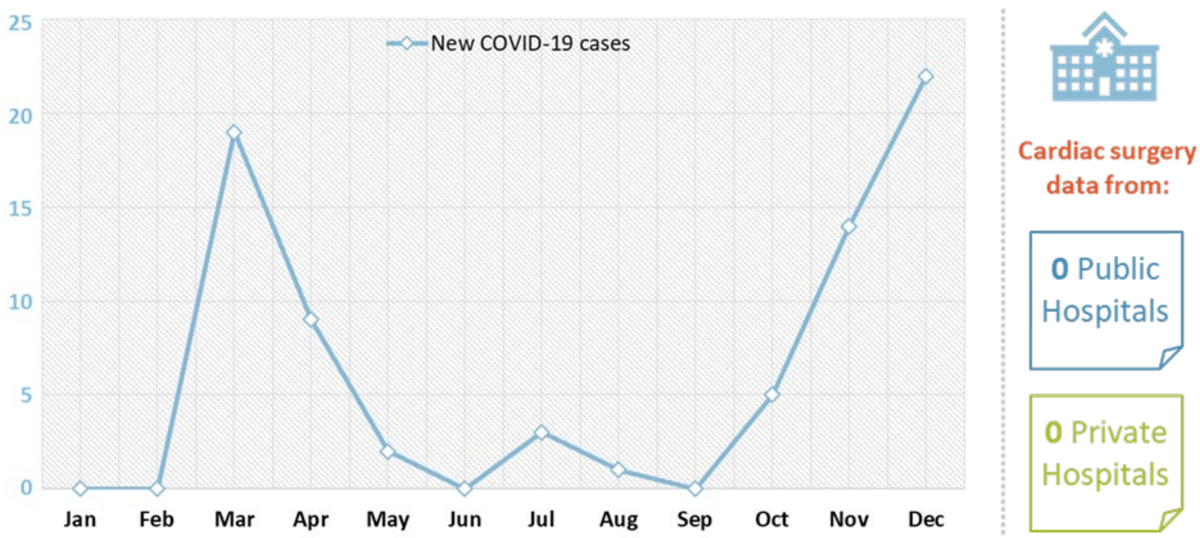
AUSTRALIAN CAPITAL TERRITORY AND NORTHERN TERRITORY

Figure 41. Monthly cardiac surgery cases in Canberra Hospital and COVID-19 positive cases in the Australian Capital Territory for 2020



*April-June cases were redirected to a non-contributing private hospital
COVID-19 cases data source: covid19data.com.au

Figure 42. Monthly COVID-19 positive cases in the Northern Territory for 2020

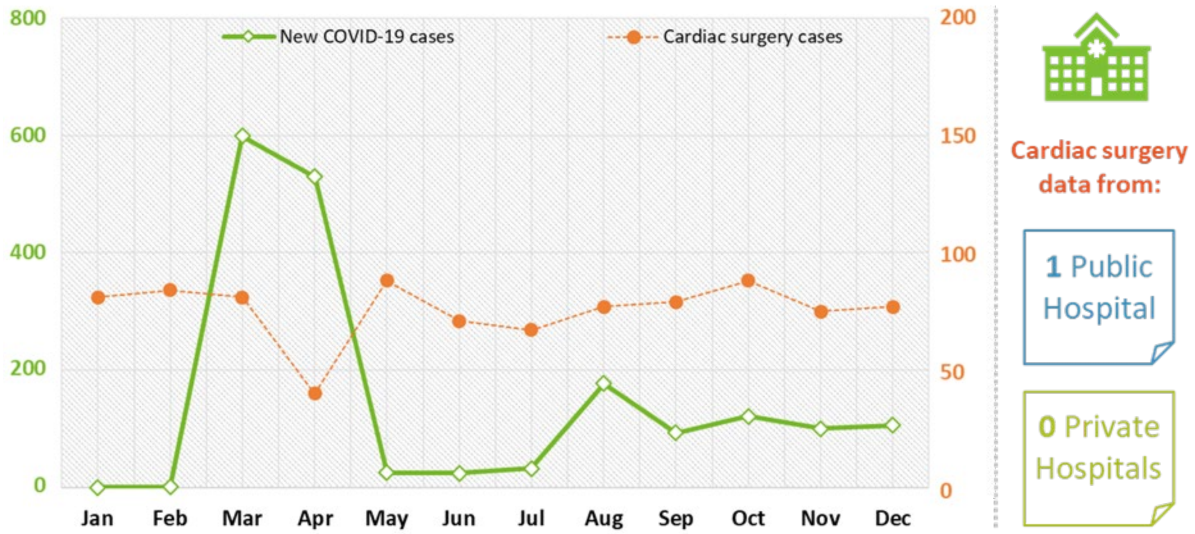


COVID-19 cases data source: covid19data.com.au

In 2020, there was one hospital in the Australian territories that performed cardiac surgery and contributed to the ANZSCTS Database, which was Canberra Hospital. The Northern Territory does not have dedicated cardiac surgery services, therefore most Northern Territory patients rely on care in South Australia. As noted in Professor Baker's recollection, the challenges in provision of care in South Australia during the pandemic extended to patients in the Northern Territory.

AOTEAROA NEW ZEALAND

Figure 43. Monthly cardiac surgery cases in Auckland City Hospital and COVID-19 positive cases in New Zealand for 2020



COVID-19 cases data source: https://covid19.who.int/

"It was the intention to continue to provide all cardiac surgery and thoracic surgery for malignancy. ***It rapidly became evident that patients through fear did not want to have surgery during the lockdown period even though NZ had very few COVID cases even in the first wave in any intensive care unit let alone hospital.***

After lockdown there was a slow build back up in cardiac surgery wait lists now exacerbated by national nursing shortages due to the reduction in immigration and hiring freeze to meet budget blow outs. This affected private suppliers of cardiac services as well. Massive back log in cardiac investigations reflect not just COVID but the systemic failure to invest/hire staff resources.

Patient's confusion over what part of our job reflected aerosolising procedures created fear/ confusion with staff especially anaesthesia and otorhinolaryngology colleagues. We have agreed that operating with full PPE gear to be worn by surgeon not practicable and fortunately probably not necessary.

The initial fear bordering on terror as it became clear the emergency planning was slow, cumbersome and overly cautious. I began making decisions. PPE gear lacking. Messaging changed on needs. In fact, NZ missed big case numbers of COVID nor did we see the normal rates of winter flu. Few intensive care beds added to already low rate by any measure. NZ will be forced to have very conservative strategy in an outbreak as to who can access a ventilator – maybe no one over 75.

Staff are low level exhausted. Few are taking their stipulated annual leave as travel curtailed, conferences ceased and the employer refusing business leave to travel. *Add nursing shortages, wage freeze, rising inflation – very unhappy workforce.*

Reinforced that clinicians are needed in crisis team not because we know the answers but because we have to live with uncertainty day to day and managers/bureaucrats find that very very difficult – so few decisions are made, take time and often lack decisive nature."

Dr Peter Alison
Director of Cardiothoracic Surgery
Auckland City Hospital, New Zealand

"New Zealand went into a national Level 4 lockdown on the 23 March 2020 and came out of it on 13 May 2020. In NZ Level 4 is the highest level of lockdown with all businesses and educational facilities closed (except essential services) and the population required to stay in their bubbles at home.

There are five public cardiac surgery units in NZ (Auckland, Waikato, Wellington, Christchurch & Dunedin). During the lockdown there was variation between the units in terms of the effect of the lockdown on cardiac surgery. ***Most units had some decrease in purely elective cases. A couple of the units had a marked decreased in overall caseload over the course of the lockdown with a consequent increase in waiting list numbers and the other units were able to almost carry on with business as usual and in fact were able to operate on more patients due to increased ICU bed availability and the use of private healthcare facilities during the lockdown.***

No COVID positive patients have had cardiac surgery and no patients have been infected with COVID post-operatively.

Fortunately, as of July 2021, since the initial lockdown NZ has had very little community COVID-19 and the cardiac surgery in public hospitals has returned to normal levels with waiting lists back to a similar state as pre-lockdown or being adversely affected by factors other than COVID."

Dr Alastair McGeorge
Cardiac Anaesthetist & Intensivist
Auckland City Hospital, New Zealand

Auckland, New Zealand
Level three lockdown, 2020

CHAIRMAN’S SUMMARY

This study reviewed four aspects of the effect of the COVID-19 pandemic on cardiac surgery in Australia and Aotearoa New Zealand.

Patients redirected from public to private hospitals
Captured redirected cases occurred only in Victoria and NSW. The case-mix of redirected patients was identical to those who were not. However, the clinical status of those patients differed in that considerably more were elective and none were considered to be emergencies.

Number of cardiac surgical operations compared to the previous three-year average
State government directives were associated with generally temporary, yet clear reductions of cardiac surgical throughput in all jurisdictions except South Australia, the decreases lagging peak COVID-19 case numbers by approximately one month.

When compared to the preceding three-year averages, the overall effect in 2020 was a reduction of cases in Victoria (12.3% being 550 patients), contrasting with an increase in NSW (6.8% being 228 patients, largely due to increased throughput in the private sector), Queensland (9.2% being 328 cases), South Australia (6.2% being 57 cases) and essentially no change in Western Australia.

Clinical status of patients operated on during 2020
There was a trend to a higher proportion of urgent cases in the quarters following peak COVID-19 case diagnoses in private and public hospitals in all States, that trend being somewhat attenuated in the Queensland public sector.

Key outcomes for cardiac surgery during 2020
Tables comparing those outcomes in 2020 to the average of the previous three years in public and private hospitals by quarter, whilst it makes interesting reading, does not reveal a consistent pattern. Overall, the outcomes of cardiac surgery in Australia and New Zealand were not notably changed by the conditions prevailing.

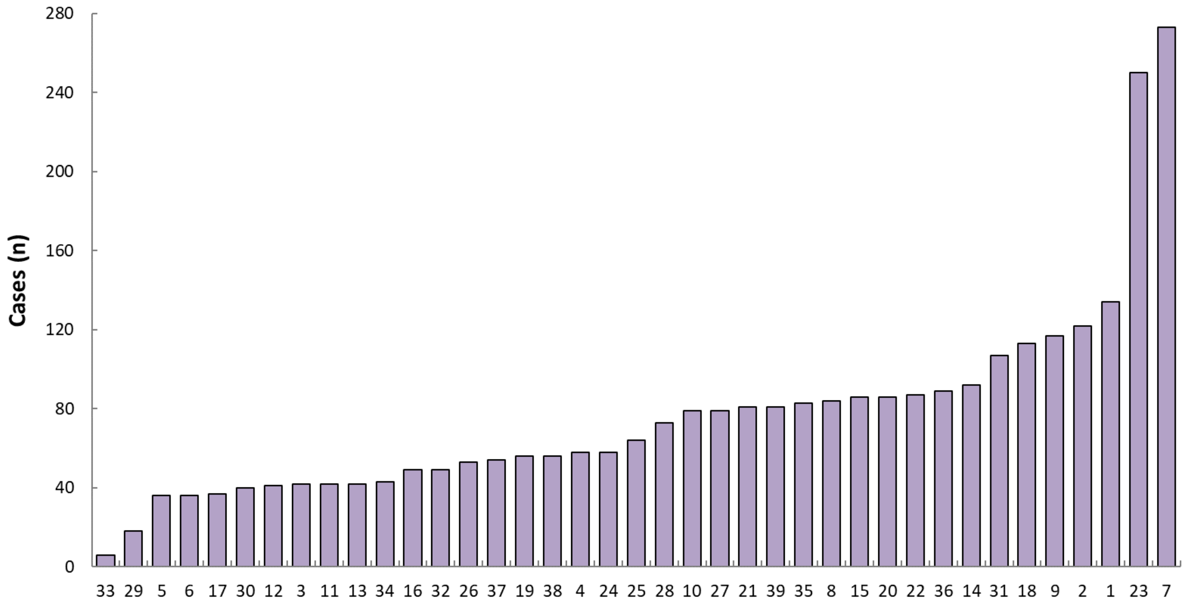
Mr Gil Shardey
Chairman, ANZSCTS Database Steering Committee

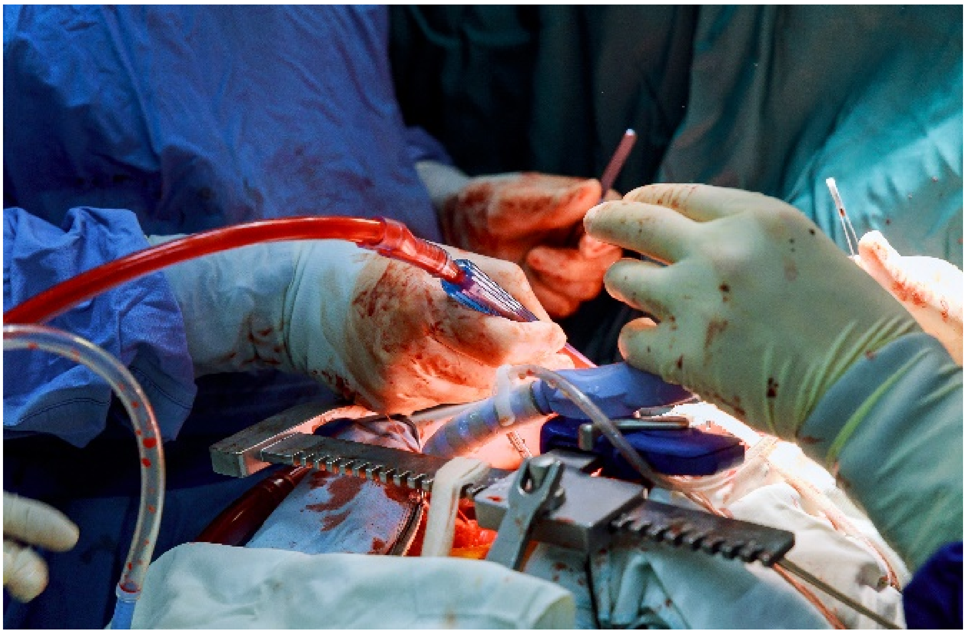
3. Isolated Valve Surgery

This section explores the patient population and outcomes for isolated valve surgery. Transcatheter aortic valve replacements (TAVR), transcatheter mitral valve replacements (TMVR) and MitraClip insertions are not included in the following grouped analyses.

In 2020, the number of isolated valve operations performed at units ranged from 6-273 (Figure 44).

Figure 44. Isolated valve surgery performed by unit, 2020





3.1 Patient characteristics

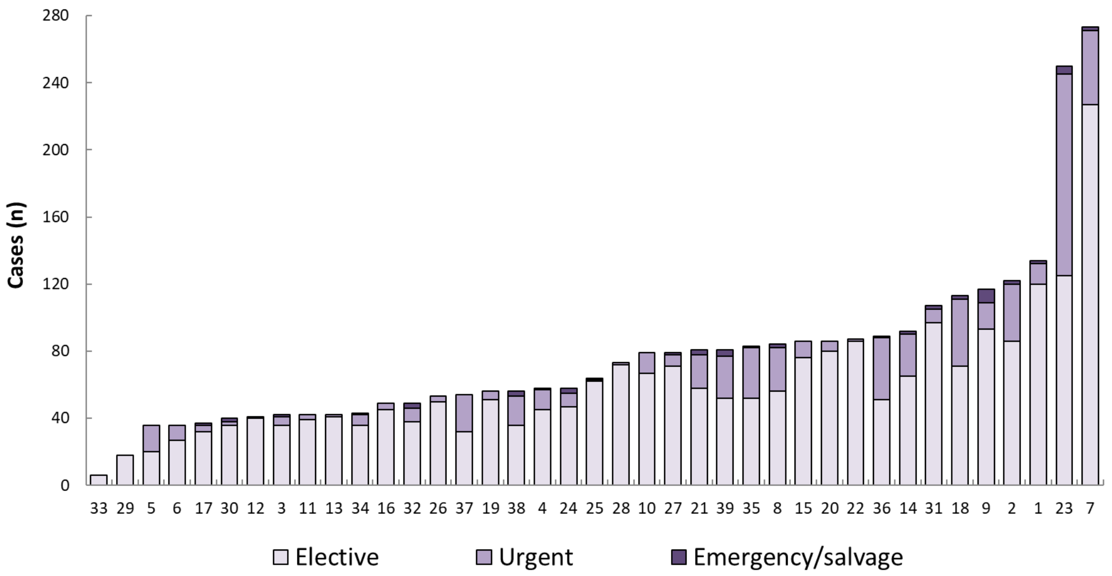
Since patient characteristics such as clinical status at presentation, age, sex, and other comorbidities can influence outcomes in the isolated valve surgery patient population, the distribution of those factors is explored in the following sections.

3.1.1 Clinical status

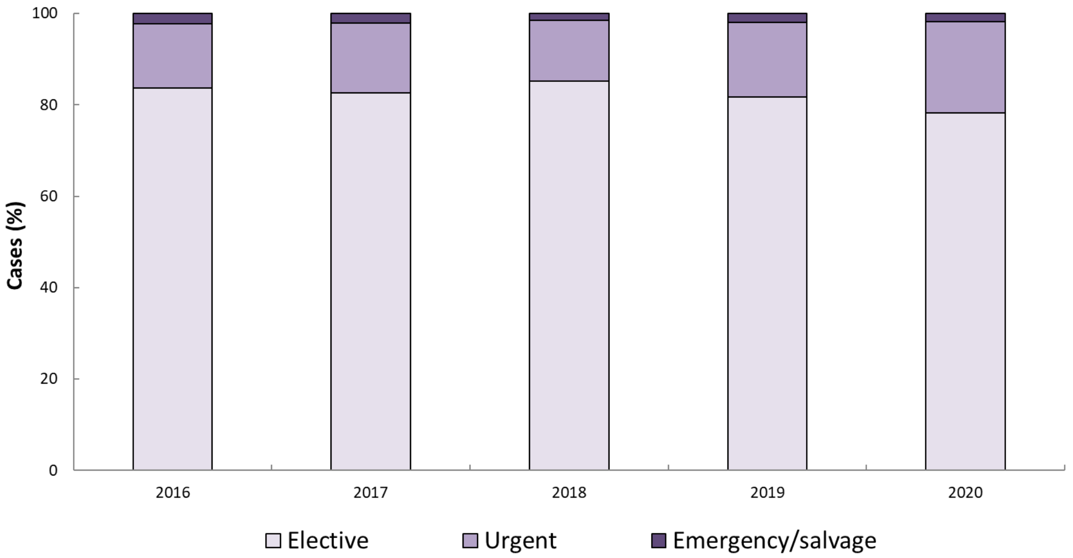
The proportion of reported urgent and emergency or salvage isolated valve operations in 2020 varied between units (Figure 45a). In 2020, the proportion of urgent isolated valve surgery was higher than the preceding four years, accounting for approximately 20% of cases (Figure 45b).

Figure 45. Clinical status of isolated valve patients

a. Units in 2020



b. Year

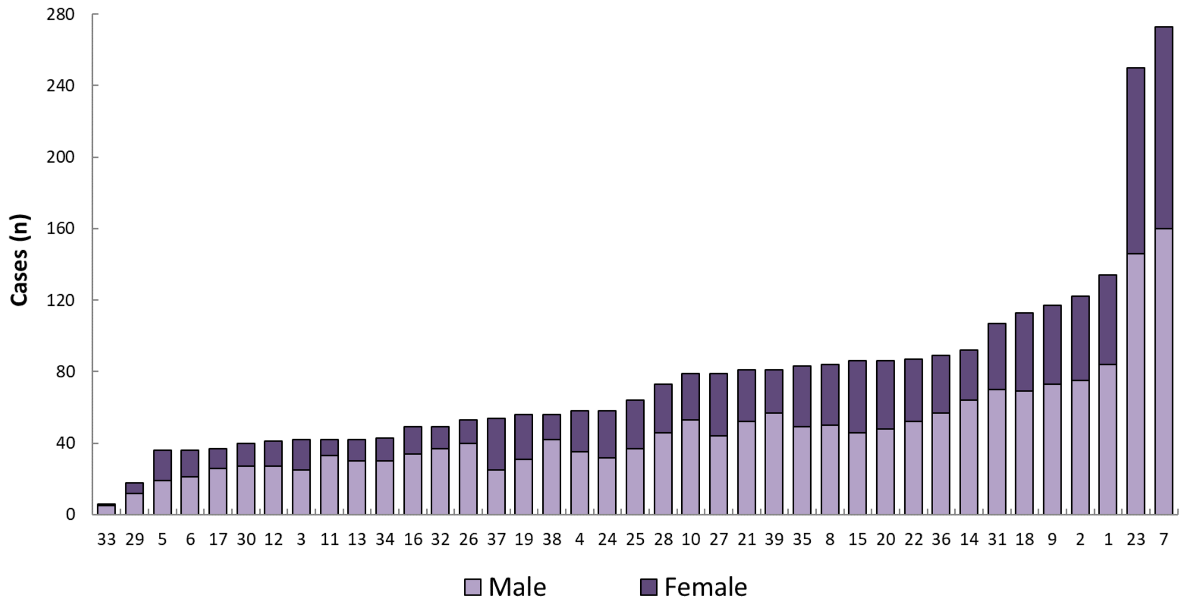


3.1.2 Sex and age

The ratio of male to female patients remained unchanged over the past five years, with males representing approximately 62.2% of the isolated valve patient cohort (Figure 46b).

Figure 46. Sex of isolated valve patients

a. Units in 2020



b. Year

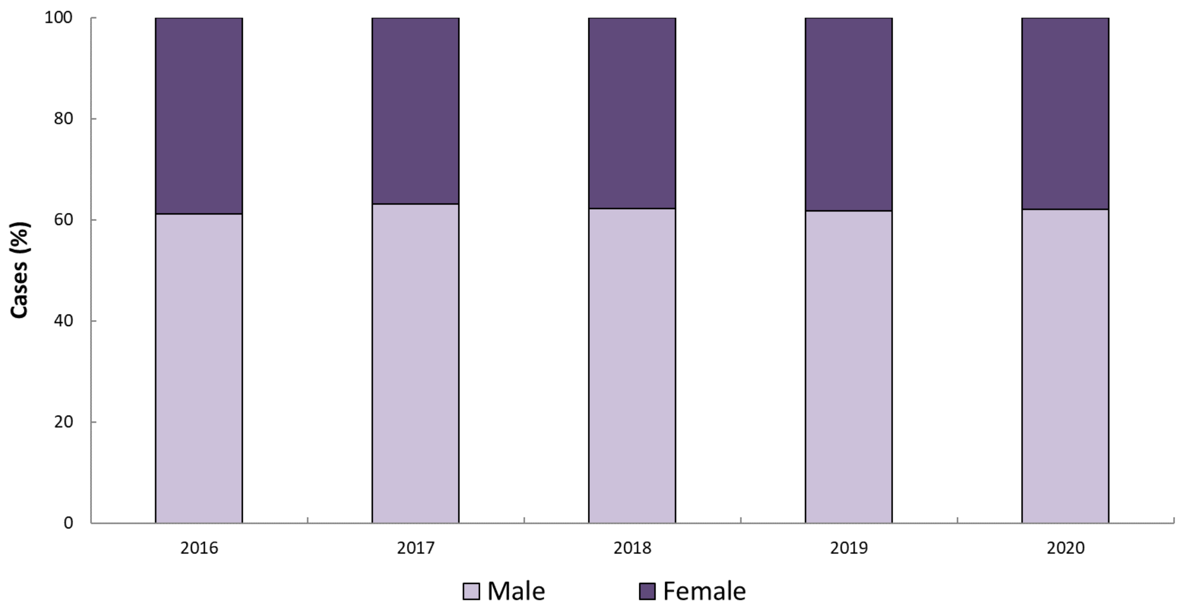
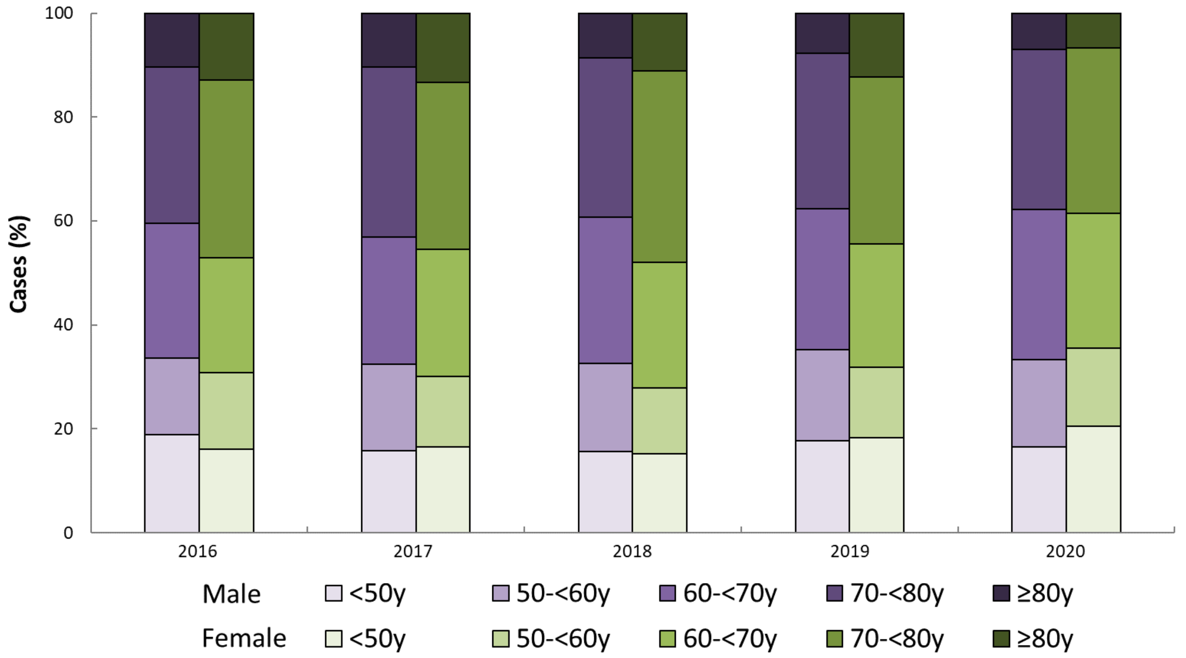


Figure 47 shows that by age group, the proportion of male and female isolated valve surgery patients were similar in 2020.

Figure 47. Age groupings for male and female isolated valve patients, 2016-2020

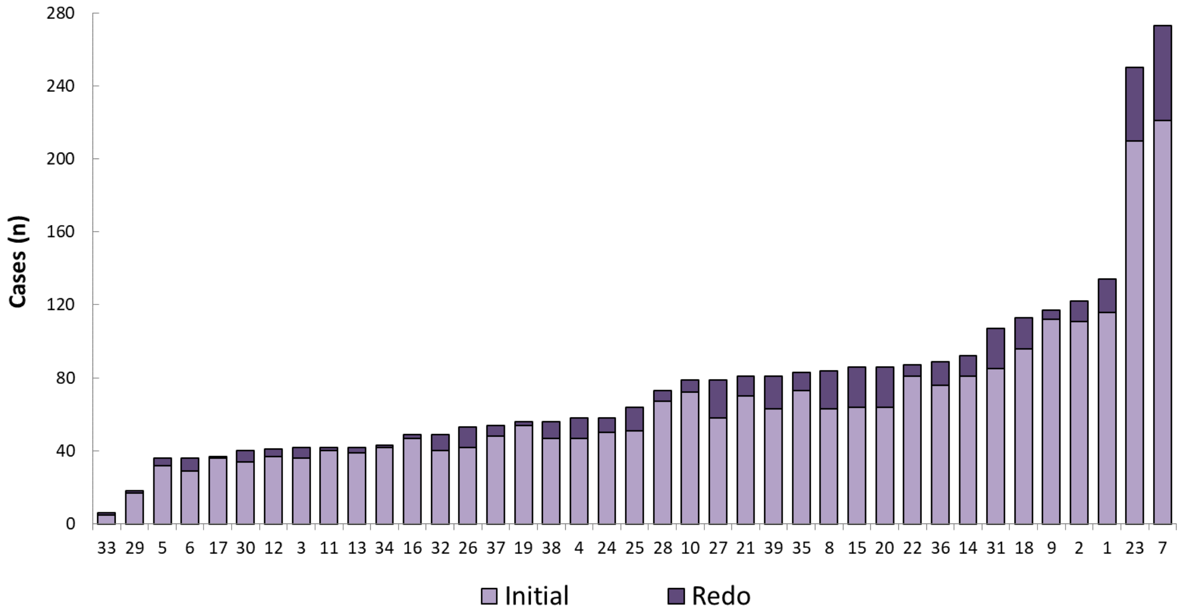


3.2 Previous surgery

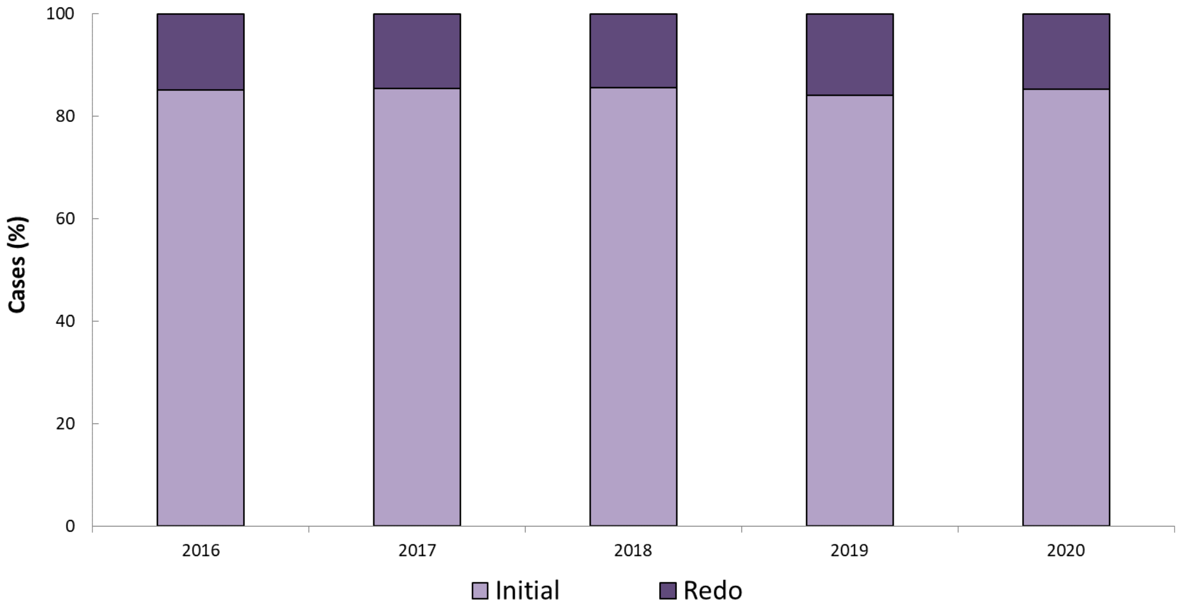
An operation is considered a redo if the patient had any prior cardiac surgery. In 2020, the proportion of isolated valve surgery patients who had previous cardiac surgery varied between units from 2.3-26.6% (Figure 48a). The overall proportion of cases in 2020 that had redo surgery remained similar to previous years at 14.7% (Figure 48b).

Figure 48. Isolated valve: initial and redo surgery

a. Units in 2020



b. Year

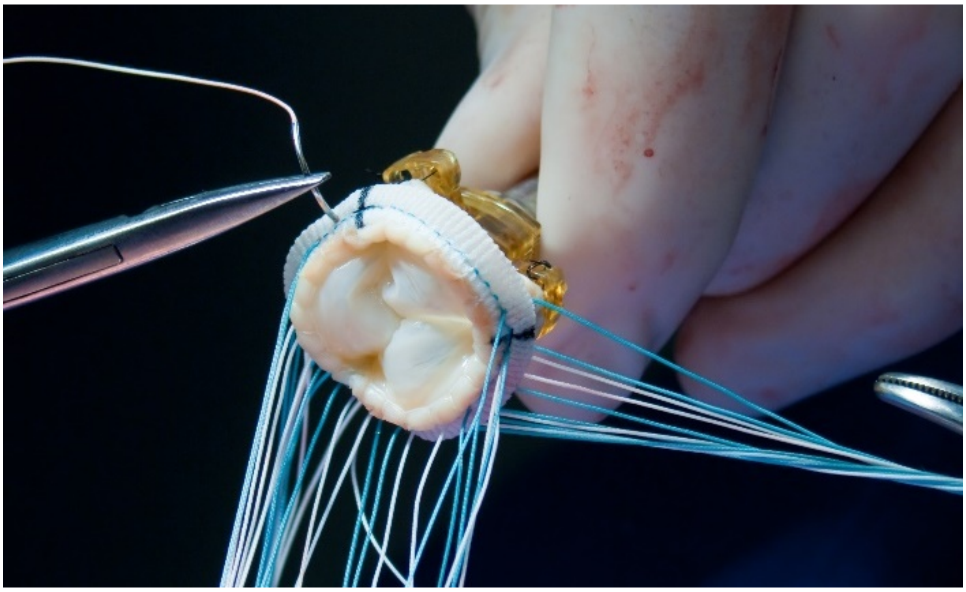


3.3 Overview of all valve surgery

Case numbers and unadjusted OM for single and multiple valve operations are detailed in Table 15. The OM is not risk-adjusted, therefore takes no account of clinical nor patient characteristics. Since annual incidence is generally low, apparently large differences between 2020 OM and 2016-2019 OM rates may not reflect significant changes in that outcome.

A full list of valve surgery included in the Database is available in the ANZSCTS Database Data Definitions Manual version 4 (available on request to the Data Management and Analysis Centre).

Combined valve and CABG surgery is presented in Section 4 (Table 19). TAVR cases are reported in Table 16. The ANZSCTS Database released a specific TAVR module in September 2016 and receive a small proportion of the TAVRs performed in Australia.



The most common isolated valve surgery performed in 2020 and in the preceding four years was single aortic, predominantly AVR, followed by single mitral. The OM for mitral valve (MV) repair was lower than for mitral valve replacement (MVR) in all years (Table 15).

Table 15. OM (%) for valve surgery, 2020 and 2016-2019

Valve surgery	Year	n	OM (%)
Single aortic[#]	2020	1428	1.0
	2016-2019	5865	1.5
AVR	2020	1373	1.0
	2016-2019	5635	1.5
Other aortic	2020	55	0.0
	2016-2019	230	1.7
Single mitral*	2020	983	1.3
	2016-2019	3311	1.6
MVR	2020	472	2.3
	2016-2019	1504	3.0
Repair	2020	506	0.4
	2016-2019	1790	0.4
Single tricuspid	2020	86	0.0
	2016-2019	264	5.3
Single pulmonary	2020	43	0.0
	2016-2019	158	0.6
Aortic and mitral	2020	182	6.6
	2016-2019	655	4.4
Aortic and tricuspid	2020	21	14.3
	2016-2019	80	6.3
Mitral and tricuspid	2020	186	0.5
	2016-2019	689	3.3
Other double	2020	17	0.0
	2016-2019	57	3.5
Triple	2020	50	0.0
	2016-2019	192	4.7
Quadruple	2020	0	-
	2016-2019	1	0.0
Total valve surgery	**2020**	**2996**	**1.4**
	2016-2019	**11272**	**2.0**

[#]aortic valve surgery excludes TAVR
*MV surgery excludes TMVR and insertion of MitraClip device

Table 16. OM (%) for TAVR, 2020 and 2016-2019

TAVR access route	Year	n	OM (%)
Transapical	2020	3	33.3
Transfemoral	2020	408	1.0
Transaortic	2020	6	0.0
Transsubclavian	2020	11	0.0
Unknown access route	2020	106	1.9
Total	2020	534	1.3
	2016-2019	1329	1.2

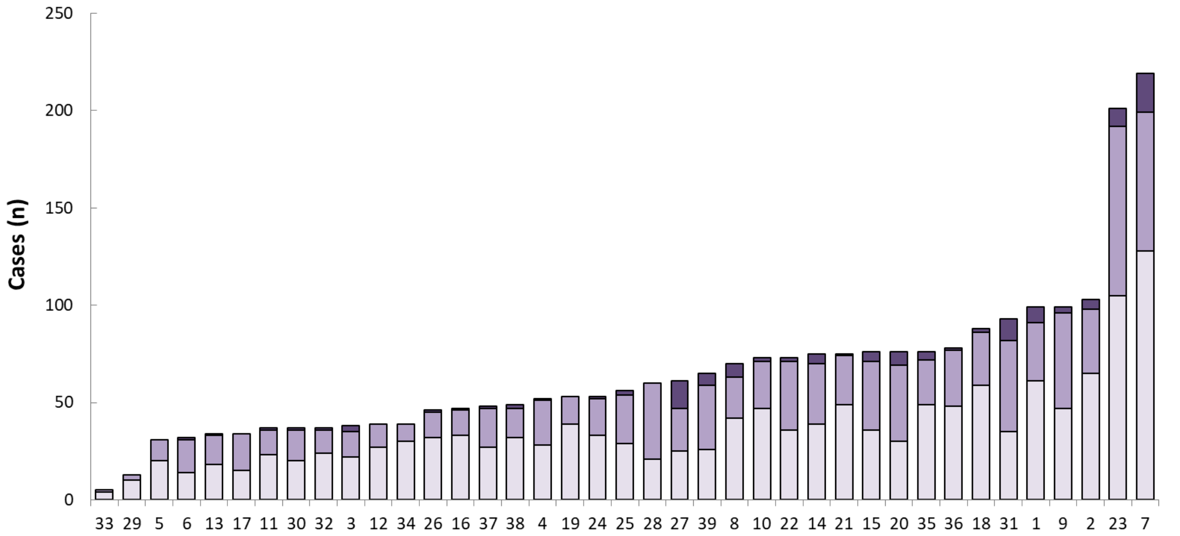
3.4 Single valve surgery

3.4.1 Type of surgery

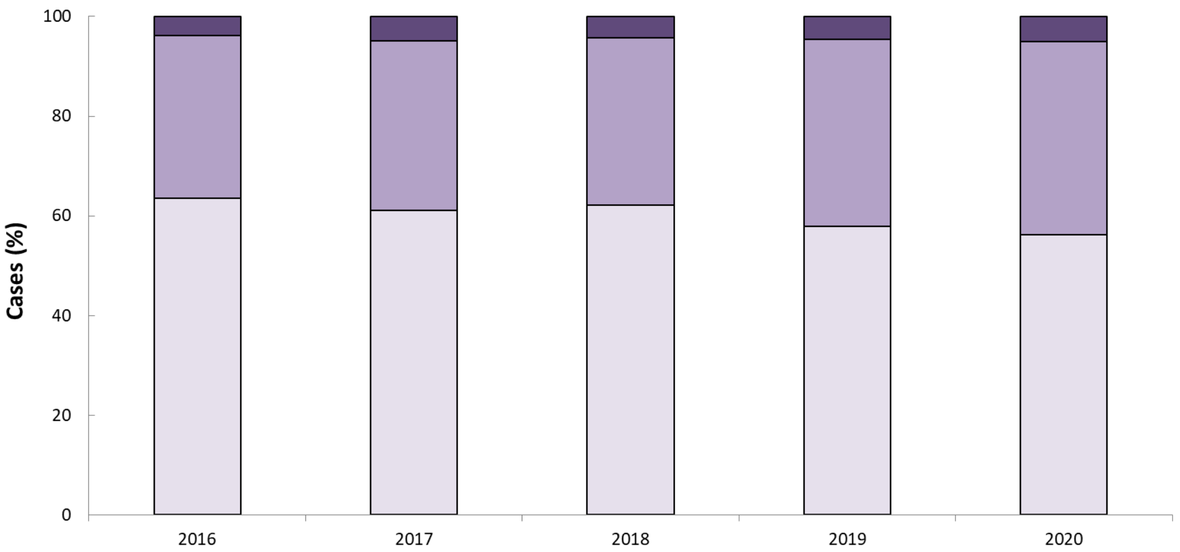
The relative proportions of the types of single valve surgery were consistent between units in 2020, apart from a small number of units that showed a larger proportion of single tricuspid or pulmonary valve surgery (tri/pulm; Figure 49a). In 2020, the proportion of patients having single aortic valve (AoV) surgery decreased to 56.2%, from 63.5% in 2016 (Figure 49b). Correspondingly, there was a proportionate increase in single MV surgery from 35.6% in 2016 to 38.7% in 2020, while isolated tri/pulm valve surgery reached 5.1% in 2020 (Figure 49b).

Figure 49. Type of isolated single valve surgery performed

a. Units in 2020



b. Year



3.4.2 Influence of patient characteristics on operative mortality

Generally, unadjusted OM was higher for patients with more exigent clinical status or redo operations (Table 17). The relationship between mortality and age, LVD, and previous MI was less consistent, particularly for MVR and MV repair, which may be related to lower case numbers. It should be noted that OM is not risk-adjusted and therefore does not account for differences in patient characteristics.

Table 17 refers to surgical valve replacement. Non-surgical percutaneous valve replacements such as TAVR and TMVR insertion have been excluded. Insertion of a MitraClip device has also been excluded.

Table 17. Influence of patient characteristics on OM (%) for the three most common isolated single valve operations, 2016-2020

	AVR		MVR		MV repair	
	n	OM (%)	n	OM (%)	n	OM (%)
Clinical status						
Elective	5915	1.0	1467	1.9	2040	0.3
Urgent	996	2.9	424	4.7	235	1.3
Emergency/salvage	97	11.3	85	9.4	21	0.0
Sex/age						
Male	4645	1.2	974	2.3	1581	0.2
<50y	489	0.2	185	3.2	340	0.0
50-<60y	654	0.9	173	1.7	391	0.0
60->70y	1334	1.1	245	2.0	446	0.2
70-<80y	1701	1.2	291	1.7	333	0.6
≥80y	467	2.8	80	3.8	71	0.0
Female	2363	1.8	1002	3.4	715	0.8
<50y	148	2.0	246	1.6	150	0.0
50-<60y	276	1.1	154	1.9	141	0.7
60->70y	672	0.9	206	4.4	188	0.5
70-<80y	953	2.3	280	5.7	190	1.1
≥80y	314	2.9	116	1.7	46	4.3
LVD						
None/mild LVD (EF>45%)	6038	1.2	1672	2.9	2131	0.4
Moderate LVD (EF≥30%-≤45%)	634	2.8	215	2.3	121	0.0
Severe LVD (EF<30%)	222	4.1	53	3.8	19	0.0
Previous MI						
No MI	6491	1.4	1810	2.7	2242	0.4
NSTEMI	340	2.1	85	5.9	29	3.4
STEMI	80	1.3	57	5.3	10	0.0
Unknown type	97	3.1	24	0.0	15	0.0
Previous surgery						
Initial	6261	1.2	1522	2.4	2221	0.4
Redo	747	3.2	454	4.4	75	0.0
Dialysis						
No	6904	1.3	1928	2.6	2286	0.4
Yes	104	8.7	48	12.5	10	0.0
Pre-operative creatinine						
≤200 µmol/L	6814	1.2	1896	2.6	2278	0.4
>200 µmol/L	194	8.2	80	8.8	18	5.6

3.5 Aortic Valve Replacement

Isolated AVR, being the largest group, is analysed in the following section. The number of AVRs performed by units in 2020 varied from 4-122 (Figure 50). Since 2016, the number of limited access operations has marginally increased from 7.9% to 9.6% in 2020 (Figure 51).

Figure 50. Isolated AVR performed by unit, 2020

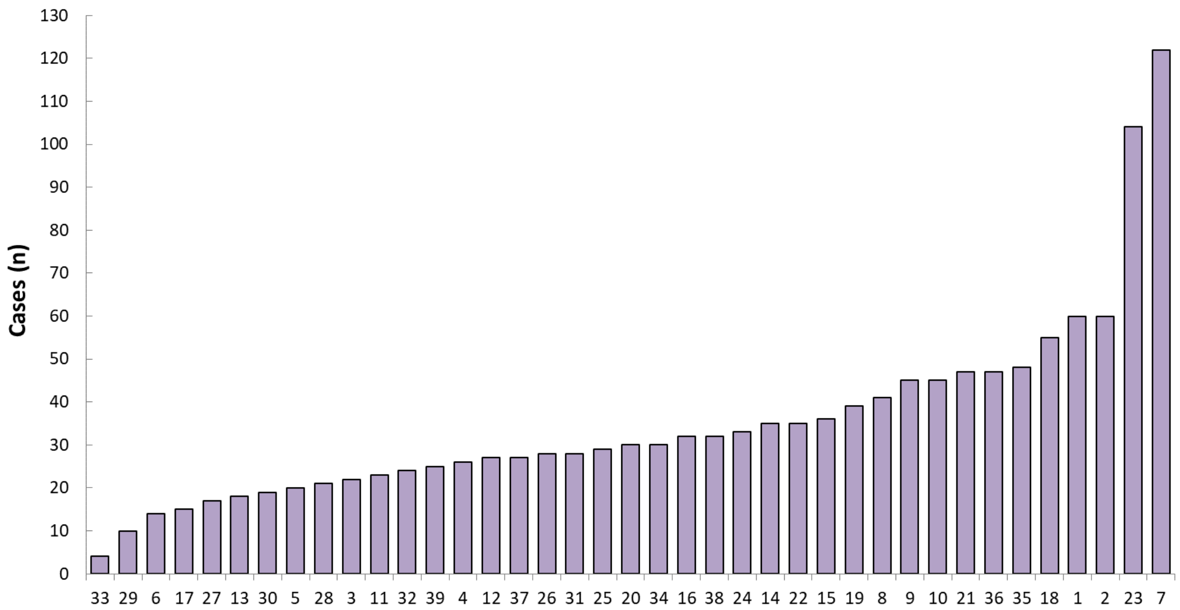
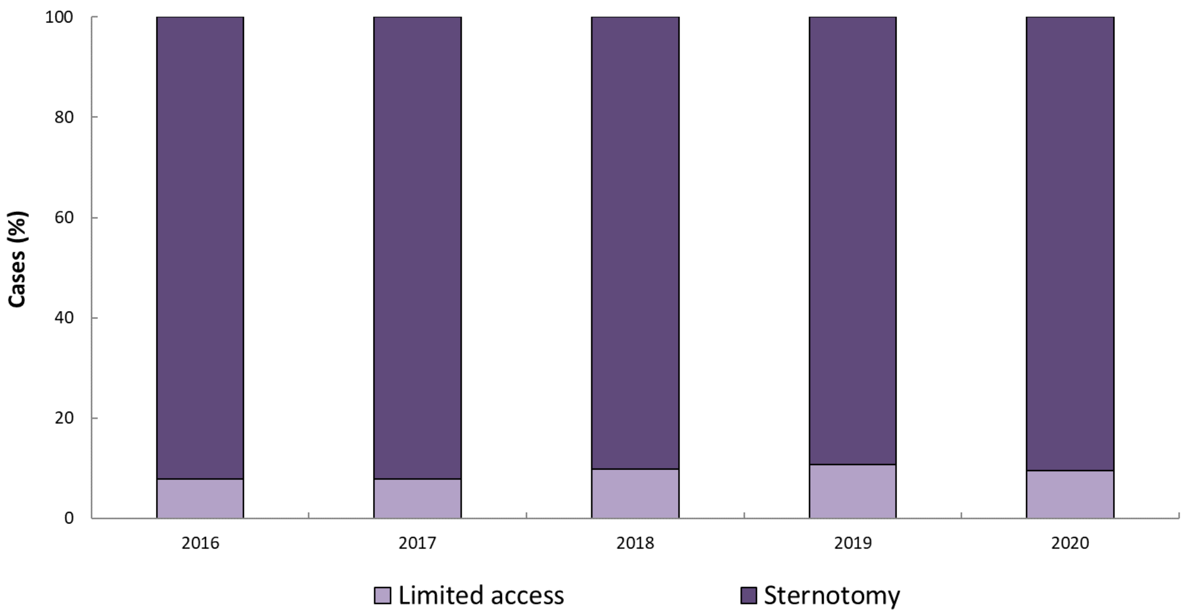


Figure 51. Surgical access for isolated AVR, 2016-2020



3.5.1 Unit outcomes – mortality, complications and resource utilisation

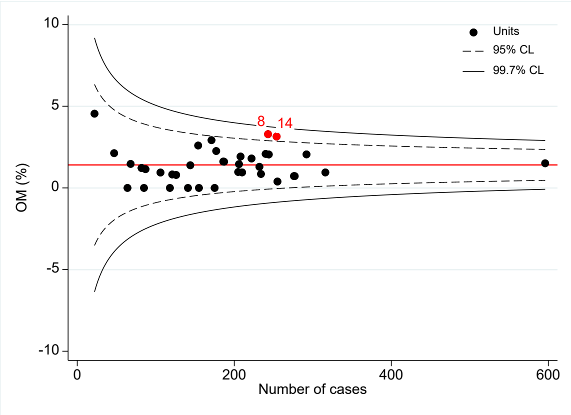
Unit outcomes are reported for the pooled 2016-2020 period for isolated AVR due to low surgical numbers making individual year outcome data difficult to interpret.

3.5.1.1 Operative mortality

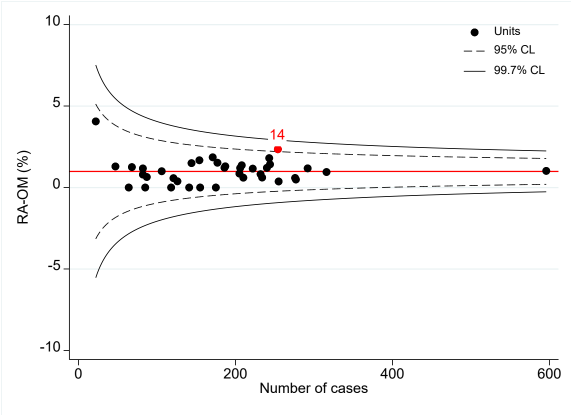
In the 2016-2020 period, the unadjusted OM for isolated AVR cases in the ANZSCTS Database was 1.4% (RA-OM of 1.0%), which was lower than the 1.6% reported in the 2019 ANZSCTS Database Annual Report(7). Comparatively, New Zealand reported OM of 0.9% in 2018(6). All units were within the upper 99.7% control limit for the five-year period (Figure 52).

Figure 52. Mortality by unit following AVR, 2016-2020

a. OM



b. RA-OM

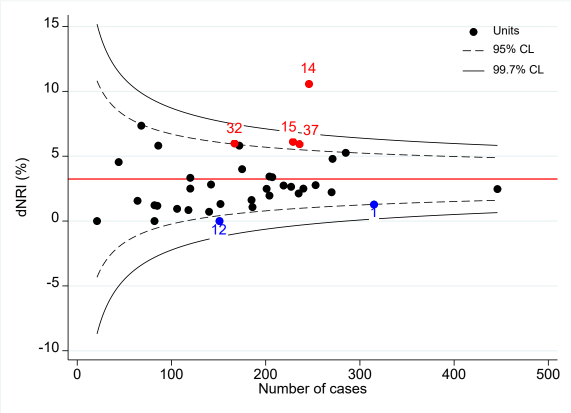


3.5.1.2 Complications

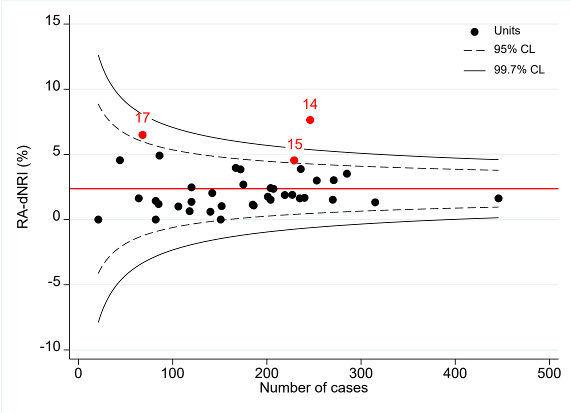
There was wide variation in dNRI incidence following AVR across the units. For the 2016-2020 period, dNRI incidence was 3.2% with one unit outside the upper 99.7% control limit. Upon risk-adjustment, the RA-dNRI was 2.5% and the same unit remained outside the upper 99.7% control limit (Figures 53a and b).

Figure 53. dNRI by unit following AVR, 2016-2020

a. dNRI



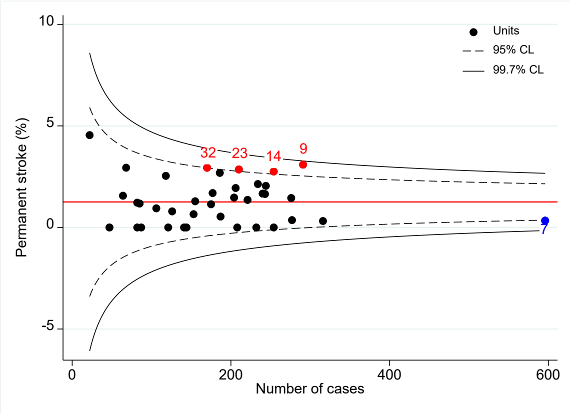
b. RA-dNRI



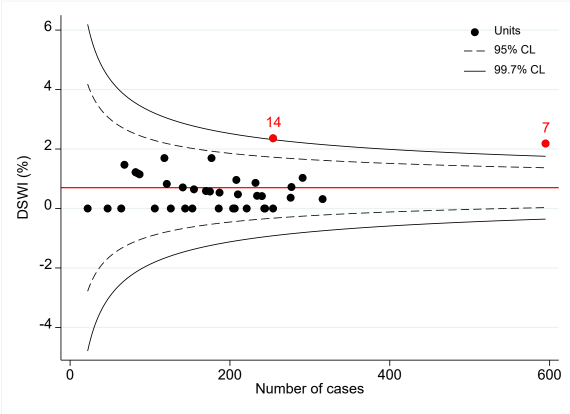
The mean incidences of permanent stroke (1.3%) and DSWI (0.7%) were similar for most units over the five-year period (Figures 54a and b), however NCA (32.3%), RTT for bleeding (3.8%) and readmission (10.3%) were largely varied across all the units (Figures 54c-e). These values remained consistent with those reported in previous ANZSCTS Database Annual Reports(7, 8).

Figure 54. Complications by unit following AVR, 2016-2020

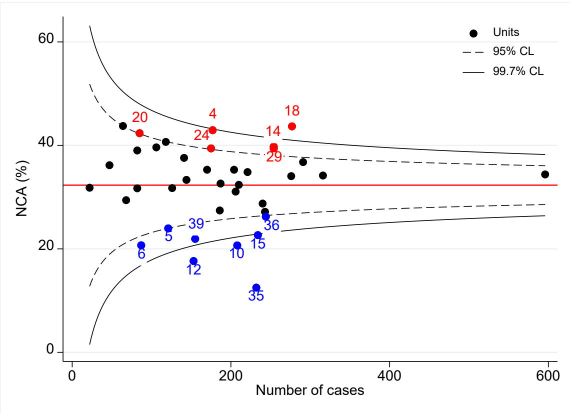
a. Permanent stroke



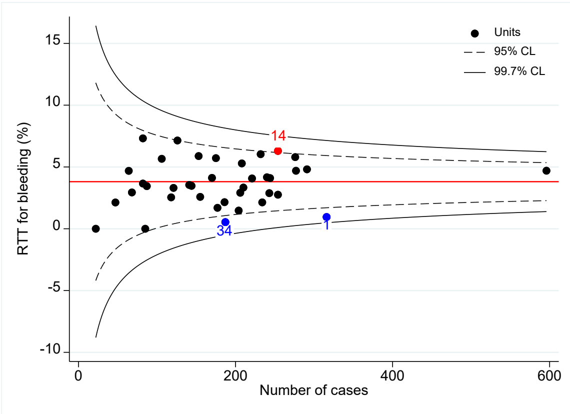
b. DSWI



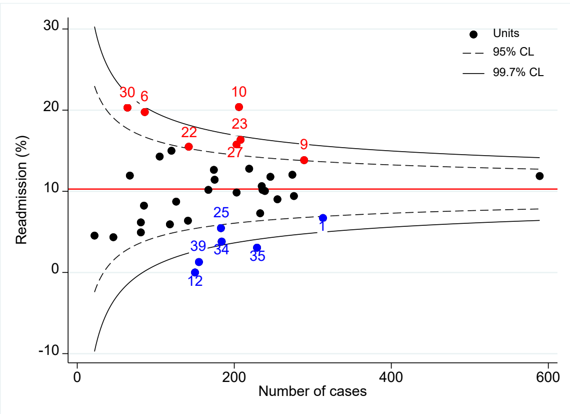
c. NCA



d. RTT for bleeding



e. Readmission



3.5.1.3 Resource utilisation

As for Section 1, due to the skewed distribution of the ICU length of stay and ventilation data, the GMs are presented. The GM is defined as the n^{th} root of a product of n numbers. It is less sensitive to outlying values, therefore describes the central tendency of a skewed dataset more precisely.

The five-year data shows marked variation between units for the time patients spent in the ICU, the duration of ventilation, and the percentage of patients who received RBC or NRBC transfusions (Table 18). The ICU length of stay and ventilation times were similar to those for isolated CABG cases, as were the proportion of cases involving transfusions.

Table 18. Resource utilisation by unit for isolated AVR patients, 2016-2020

	2016-2020			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	53.3	9.2	10.1	3.8
2	24.9	8.6	19.2	9.4
3	28.6	9.7	31.8	0.0
4	37.8	8.4	14.1	11.3
5	68.6	12.7	49.6	47.9
6	62.4	6.4	27.6	14.9
7	31.5	8.3	23.8	22.0
8	103.7	10.1	37.9	25.1
9	44.8	8.3	29.1	17.5
10	37.5	10.2	21.2	15.4
11	61.4	12.2	27.1	16.9
12	86.1	15.4	15.6	6.5
13	53.1	13.7	25.6	57.3
14	51.3	10.1	32.3	28.7
15	47.1	12.7	29.1	15.0
16	30.9	10.0	24.3	14.1
17	36.9	6.7	13.2	39.7
18	84.8	8.2	30.0	20.6
19	78.4	14.5	6.4	2.1
20	63.0	8.1	16.5	32.9
21	34.4	10.7	28.8	31.1
22	41.9	7.8	20.8	25.0
23	38.1	9.1	29.5	19.5
24	41.1	11.3	34.3	24.6
25	39.2	5.6	21.0	24.2
26	57.2	8.8	34.1	30.5
27	28.0	8.7	24.4	10.2
28	56.8	7.5	18.9	26.4
29	56.6	8.9	36.5	17.3
30	67.2	6.8	20.3	6.3
32	38.0	9.6	38.6	30.4
33	31.5	8.8	12.8	14.9
34	35.4	7.9	15.5	7.5
35	37.5	12.8	32.3	35.3
36	59.8	9.2	26.6	23.4
37	71.0	13.0	37.1	25.8
38	68.3	11.9	28.6	19.0
39	39.8	8.3	19.4	26.5
Total	**46.5**	**9.5**	**25.8**	**20.4**

As described in Section 1, the median is used for pre- and post-PLOS as GM excludes '0' values, which is a valid data point for these variables. In 2020 and the preceding four years, there was variability between units in the pre- and post-PLOS data (Figures 55 and 56). In 2020, the medians ranged from 0-1 days for pre-PLOS and 5-9 days for post-PLOS.

Figure 55. Pre-PLOS for isolated AVR patients by unit, 2016-2020

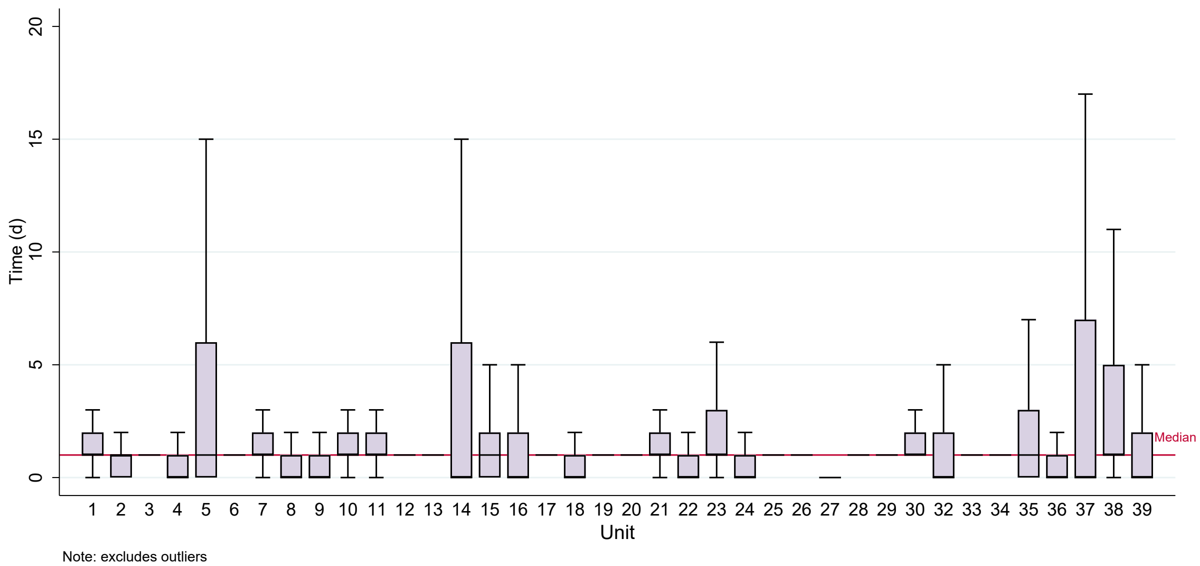
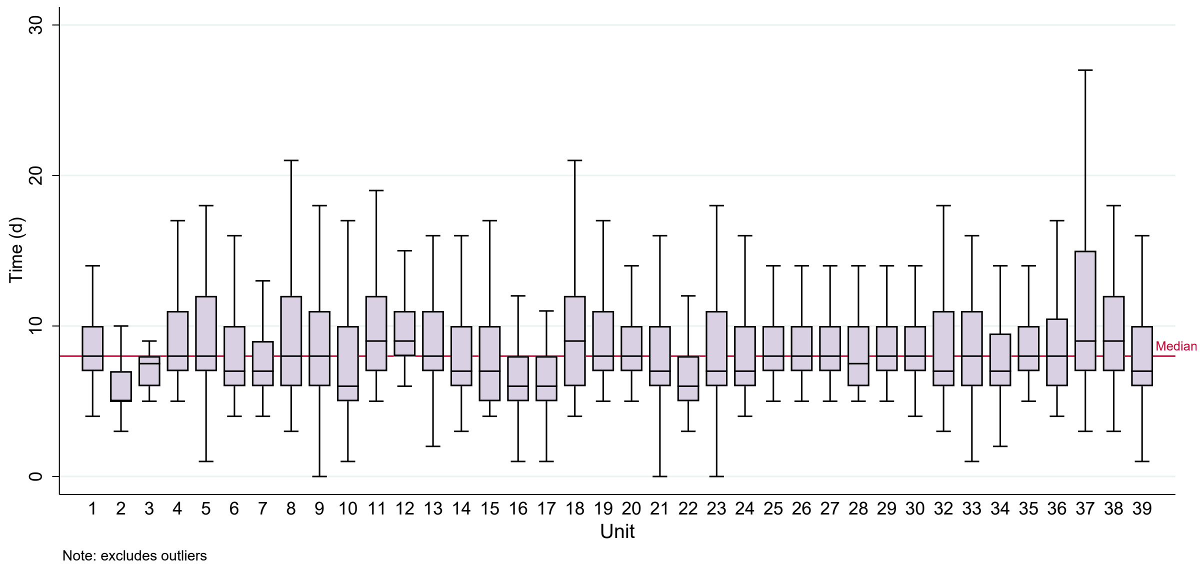


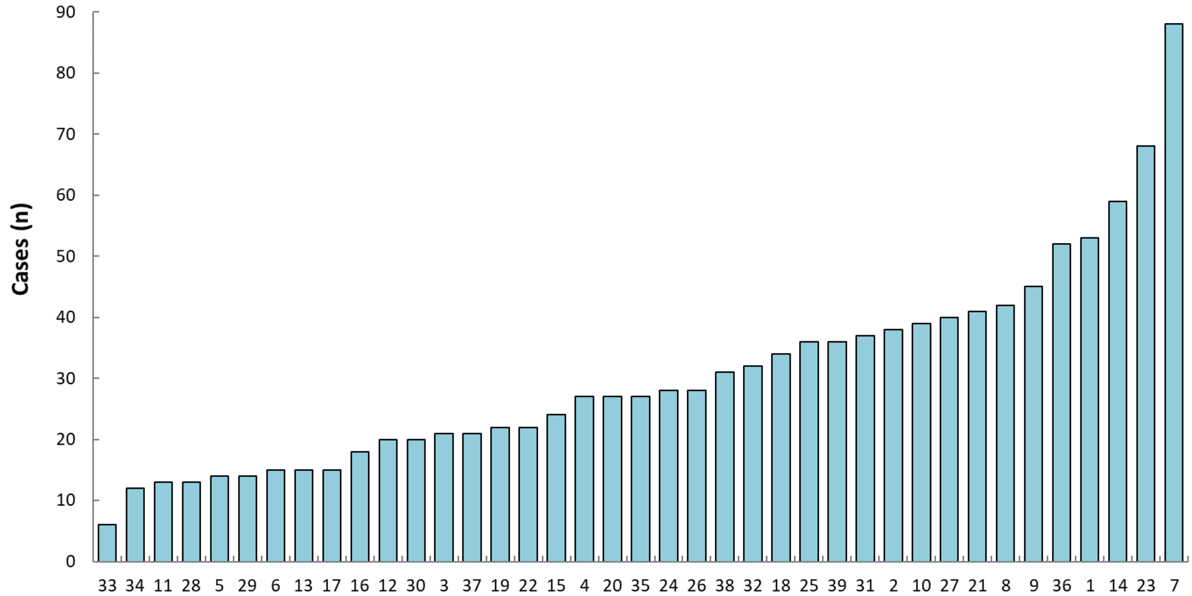
Figure 56. Post-PLOS for isolated AVR patients by unit, 2016-2020

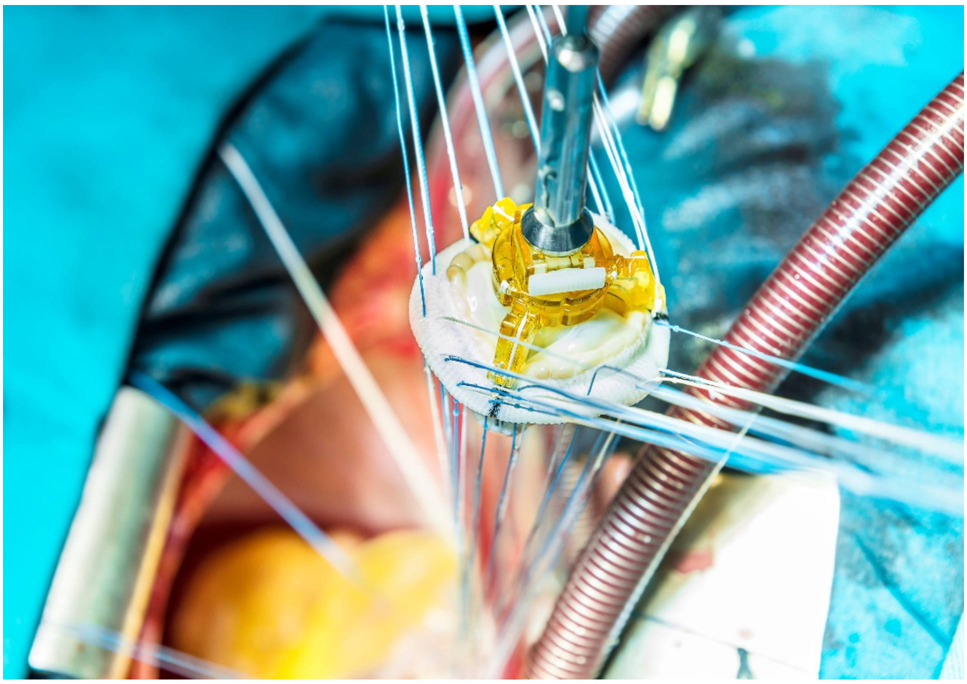


4. Combined Valve and CABG Surgery

Combined valve and CABG surgery is the smallest group analysed in this report, with 1,193 operations. The lowest number performed in a unit was six and the highest was 88 (Figure 57).

Figure 57. Combined valve and CABG surgery performed by unit, 2020





4.1 Patient characteristics

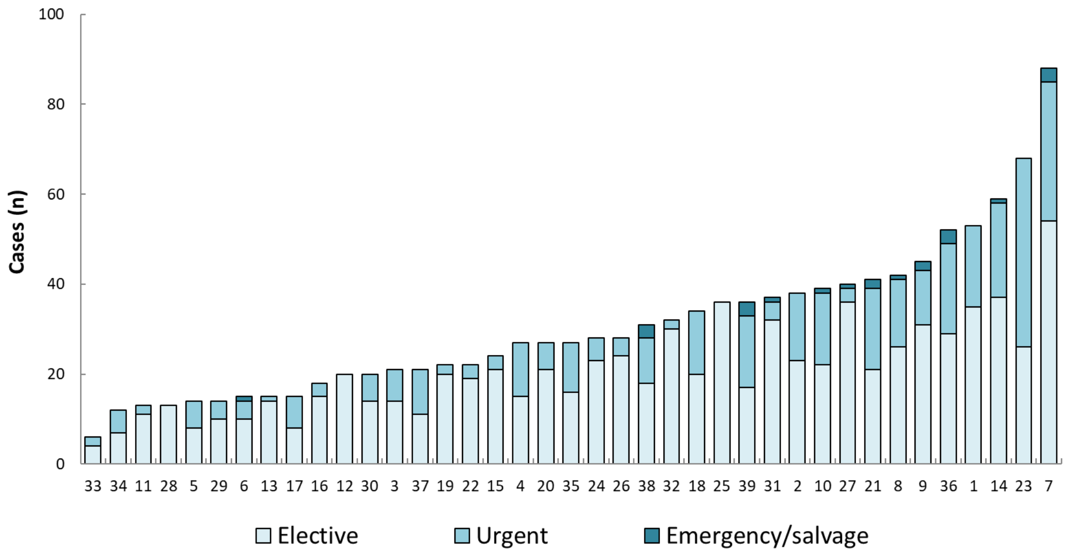
The patient characteristics that may affect the outcomes of surgery include clinical status, sex, age and comorbidities. These are explored in the following section.

4.1.1 Clinical status

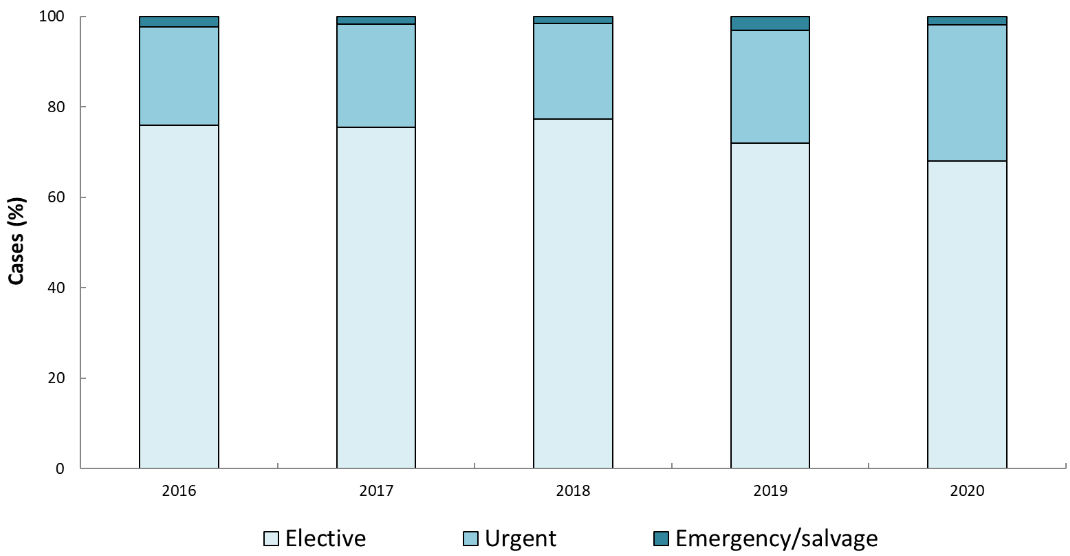
Similar to isolated CABG and isolated valve operations, the distribution of reported clinical status in each unit varied for combined valve plus CABG operations in 2020. Reported emergency and salvage cases comprised the smallest proportion (1.8%) with the majority of units reporting zero cases (Figure 58a). The largest proportion of cases was reported as elective, representing 68.0% of cases, followed by urgent cases (30.2%). The proportion of elective cases decreased in 2020 compared to 2019 and the proportion of reported urgent cases increased (Figure 58b).

Figure 58. Clinical status of combined valve and CABG patients

a. Units in 2020



b. Year

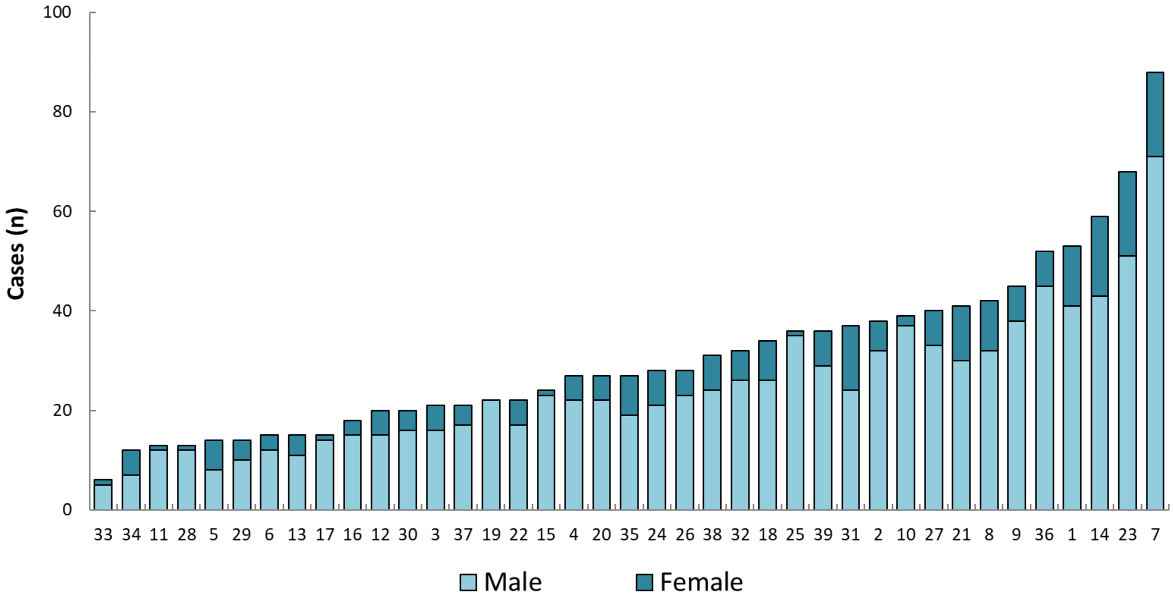


4.1.2 Sex and age

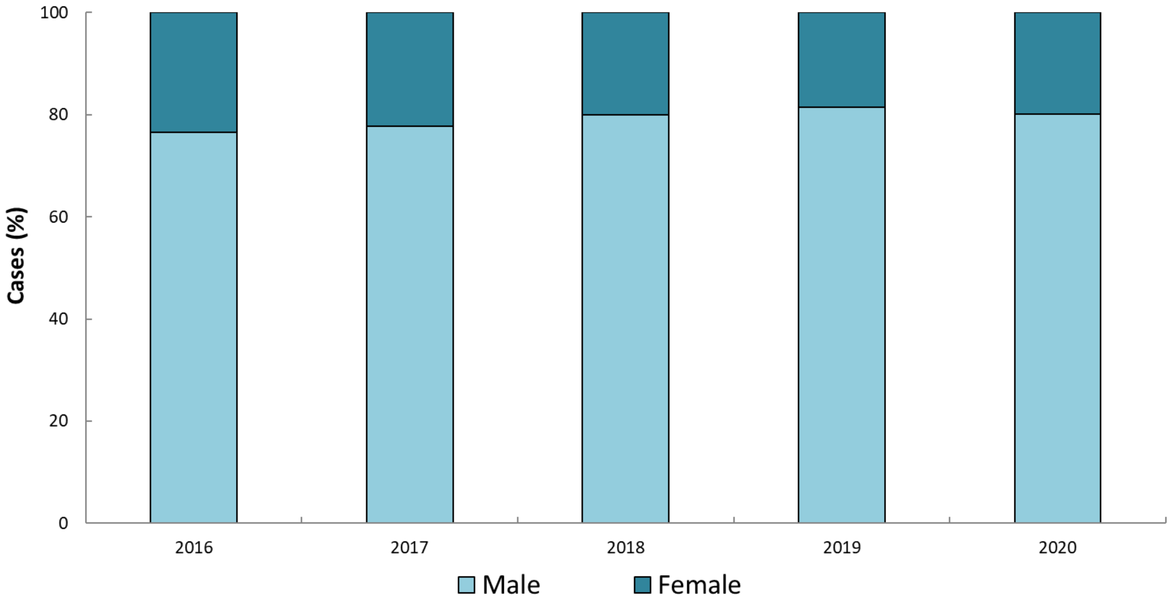
The ratio of male to female combined valve plus CABG patients was similar between units in 2020 with approximately 80.1% males and 19.9% females (Figure 59a). The proportion of males has gradually increased over the years from 76.5% in 2016 to 80.1% in 2020 (Figure 59b).

Figure 59. Sex of combined valve and CABG patients

a. Units in 2020

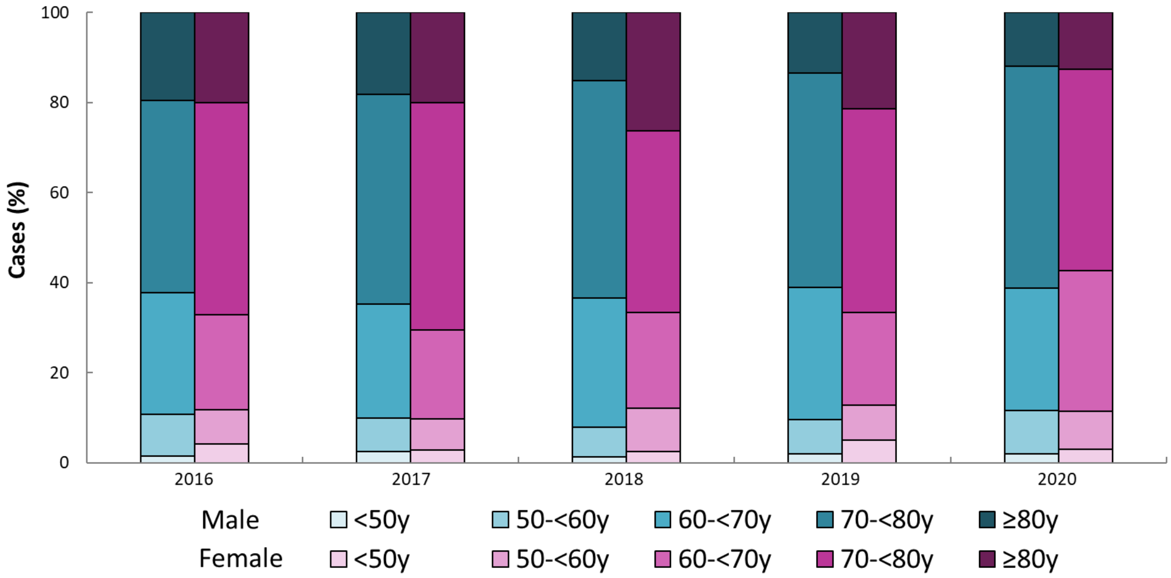


b. Year



In 2020, the proportion of female patients who had combined valve and CABG surgery aged 70 years and older was slightly lower (57.4%), compared to male patients (61.2%; Figure 60). Interestingly, this observation was not present in the preceding four years when the proportion of females over 70 was higher.

Figure 60. Age groupings for male and female combined valve and CABG patients, 2016-2020

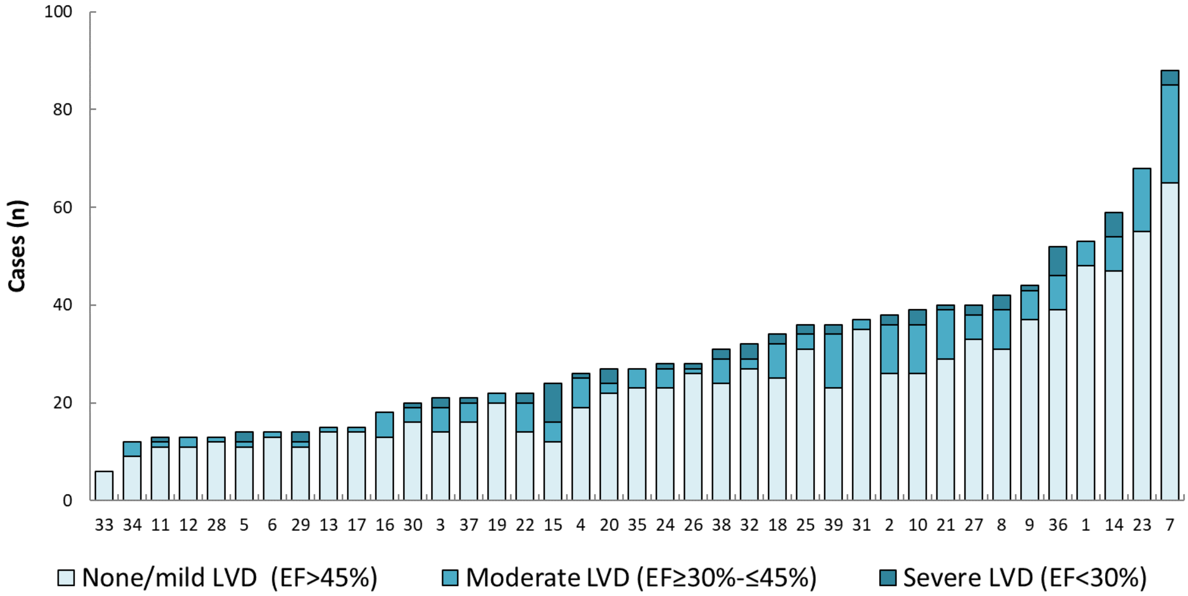


4.1.3 Left ventricular function

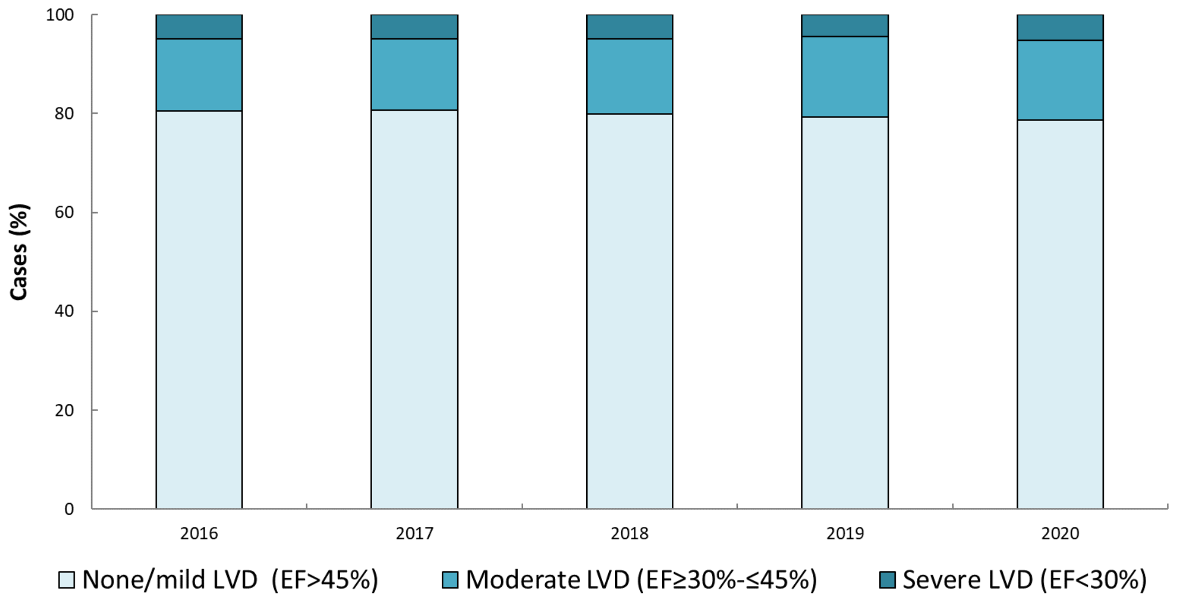
There was some variation between units for LVD in 2020 (Figure 61a). The majority (78.8%) of patients who received combined valve and CABG surgery at each unit had no or mild LVD (Figure 61b), which is a similar trend to that observed for isolated CABG. The proportions of patients with moderate and severe LVD in 2020 were 16.0% and 5.2%, respectively.

Figure 61. Combined valve and CABG: pre-operative LVD

a. Units in 2020



b. Year

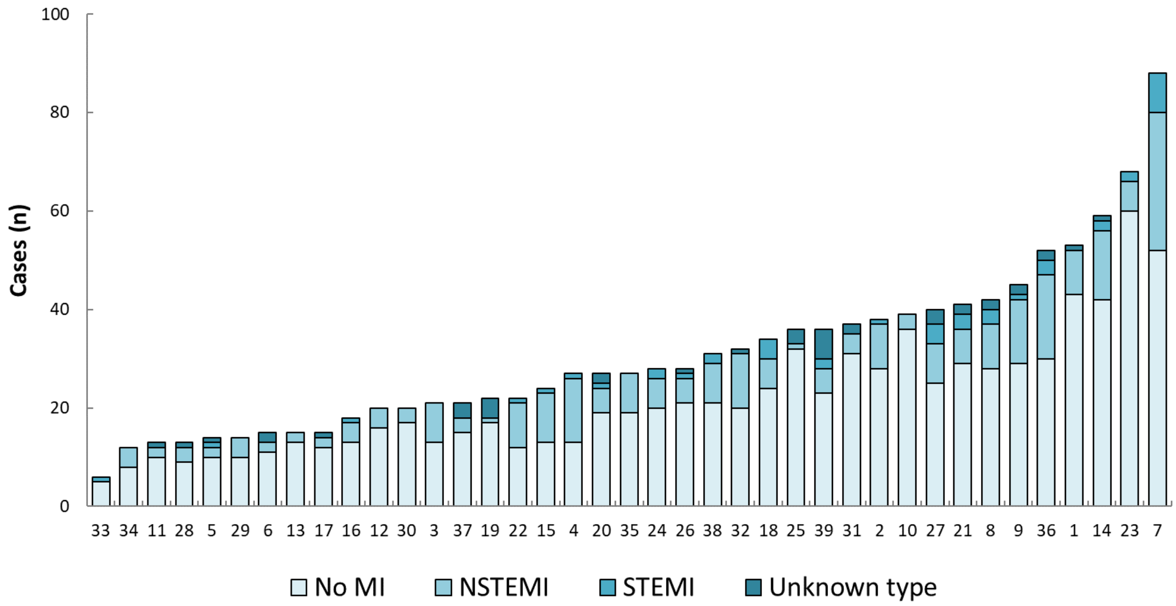


4.1.4 Previous myocardial infarction

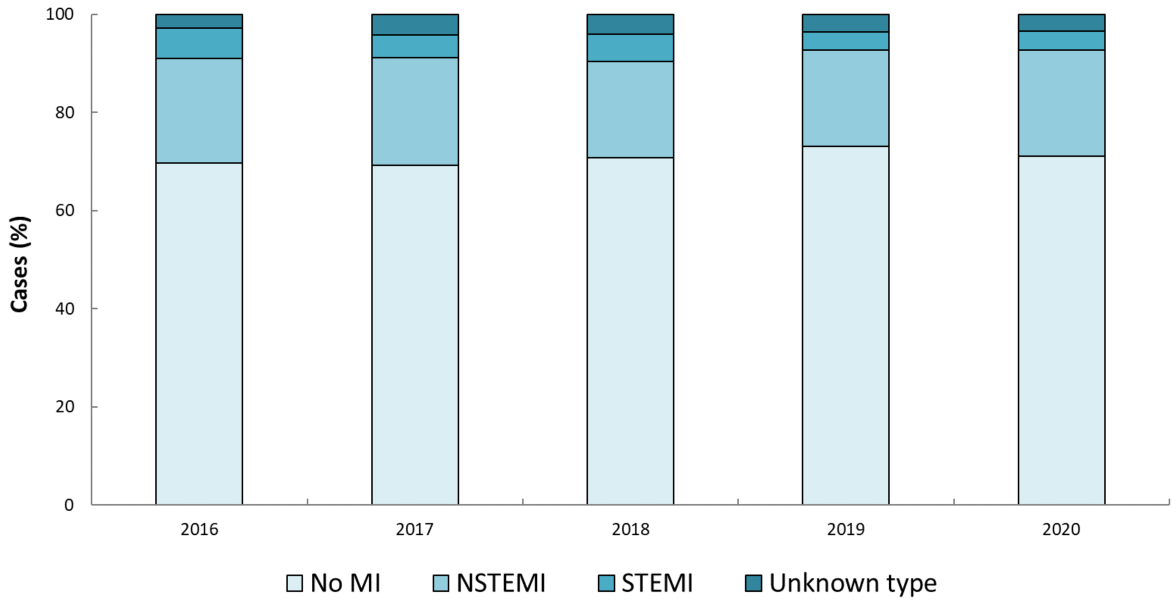
The majority of combined valve plus CABG patients (71.2%) did not have an MI prior to surgery in 2020 (Figure 62a), which is consistent with the preceding four years (Figure 62b).

Figure 62. Combined valve and CABG: prior MI

a. Units in 2020



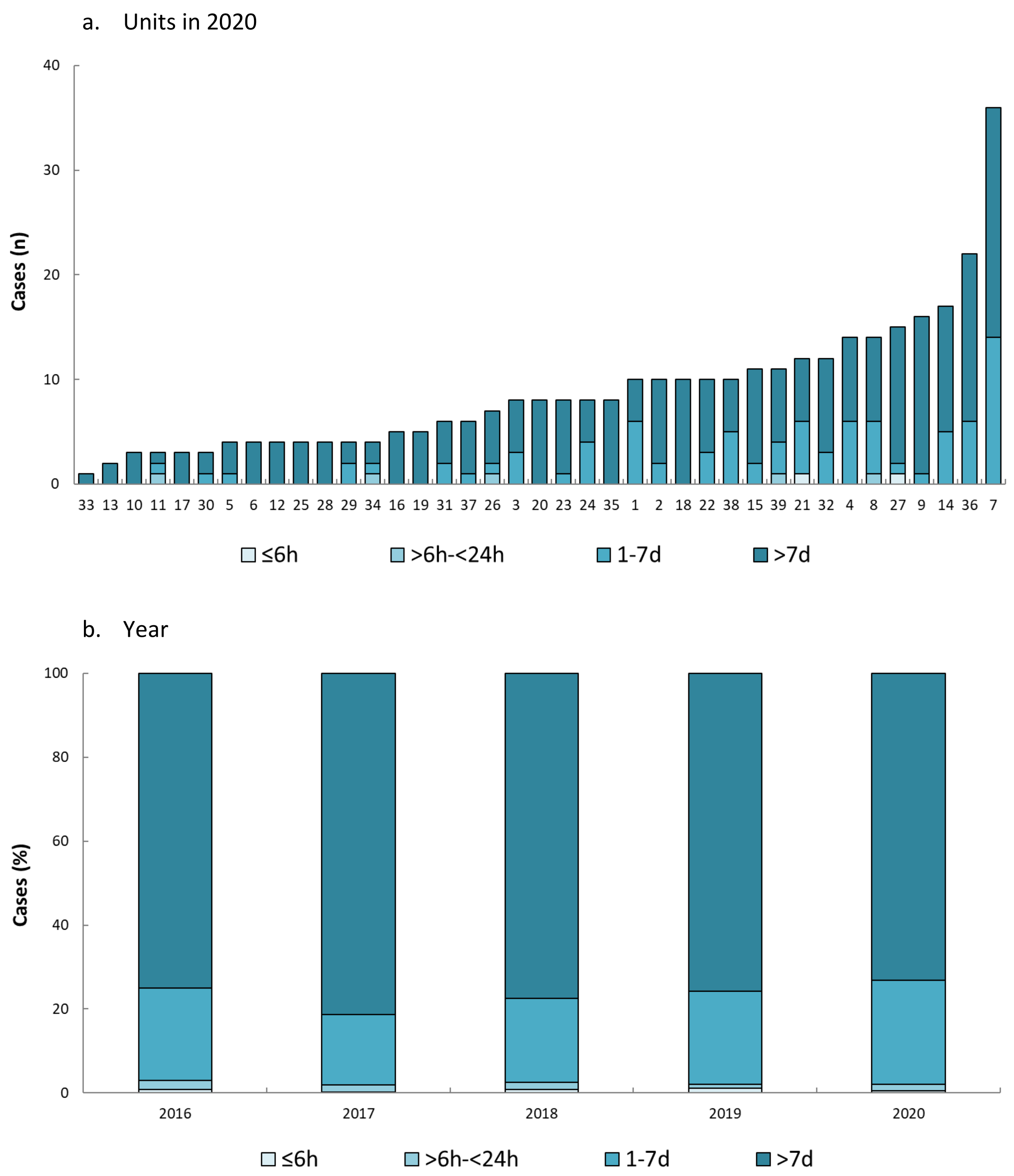
b. Year



4.1.5 Timing of pre-operative myocardial infarction

In 2020, the vast majority of patients who had combined valve and CABG surgery had an MI more than seven days prior to surgery (Figure 63a). This is consistent with the pooled data over the last five years, however the small proportion of patients who had an MI within six hours of surgery was halved in 2020 compared to 2019 (Figure 63b).

Figure 63. Combined valve and CABG: timing of pre-operative MI

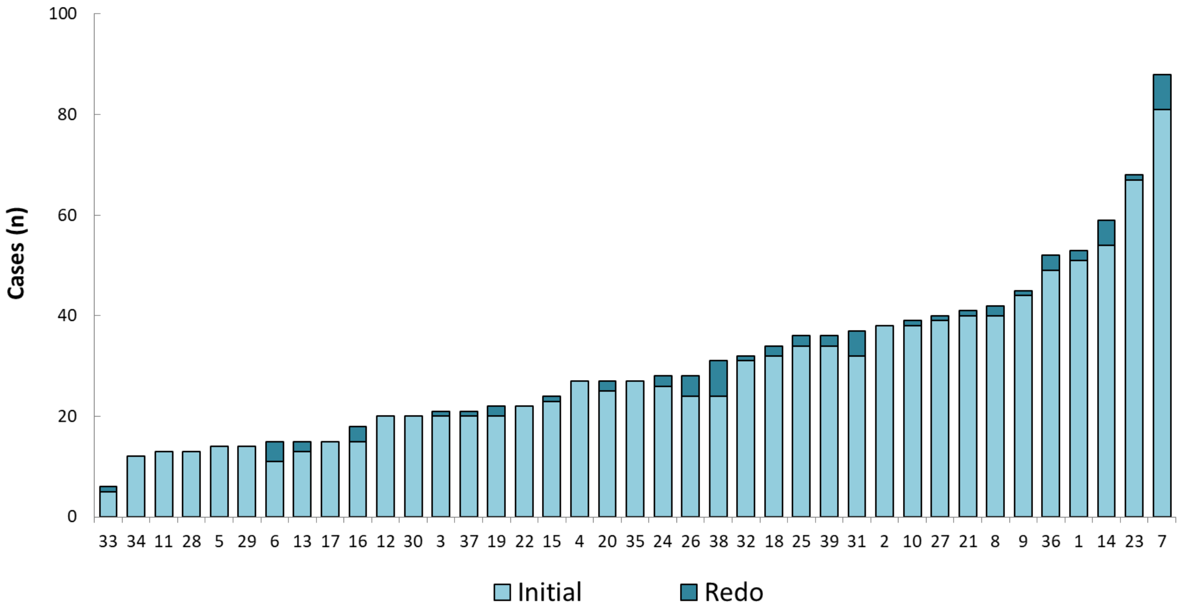


4.2 Previous surgery

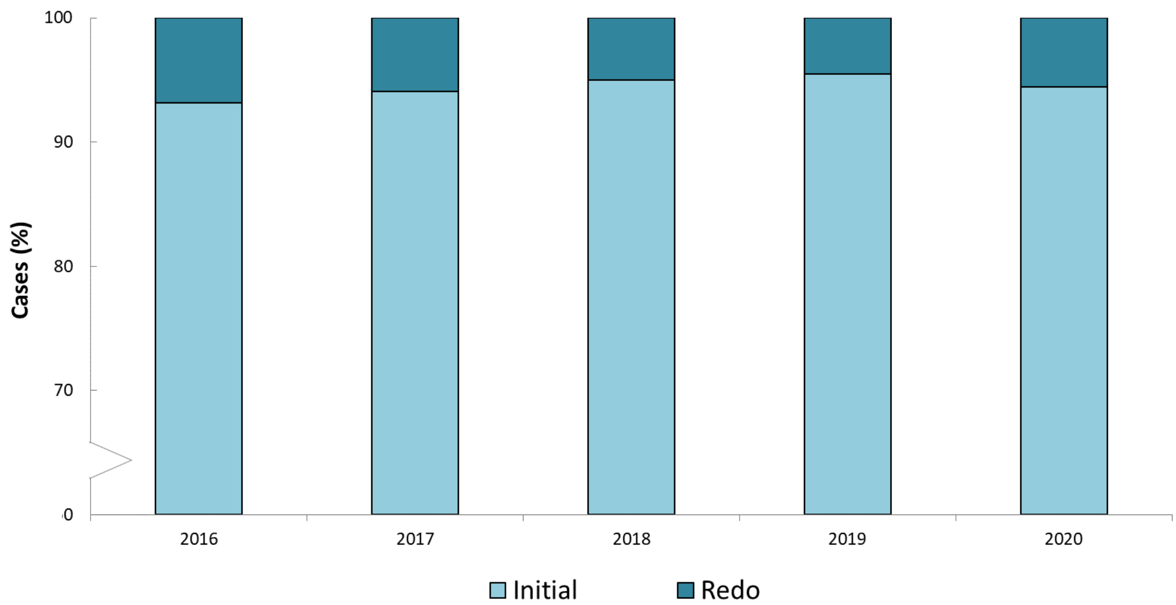
An operation is considered a redo if the patient had any prior cardiac surgery. The number of redo cases constitute a small and consistent proportion (≈5%) of combined valve and CABG surgery across the units in 2020 (Figure 64a). Despite a gradual decrease in the number of redo operations in the valve and CABG surgical group from 2016-2019, the proportion of redo operations increased to 5.5% in 2020 (Figure 64b).

Figure 64. Combined valve and CABG: initial and redo surgery

a. Unit in 2020



b. Year

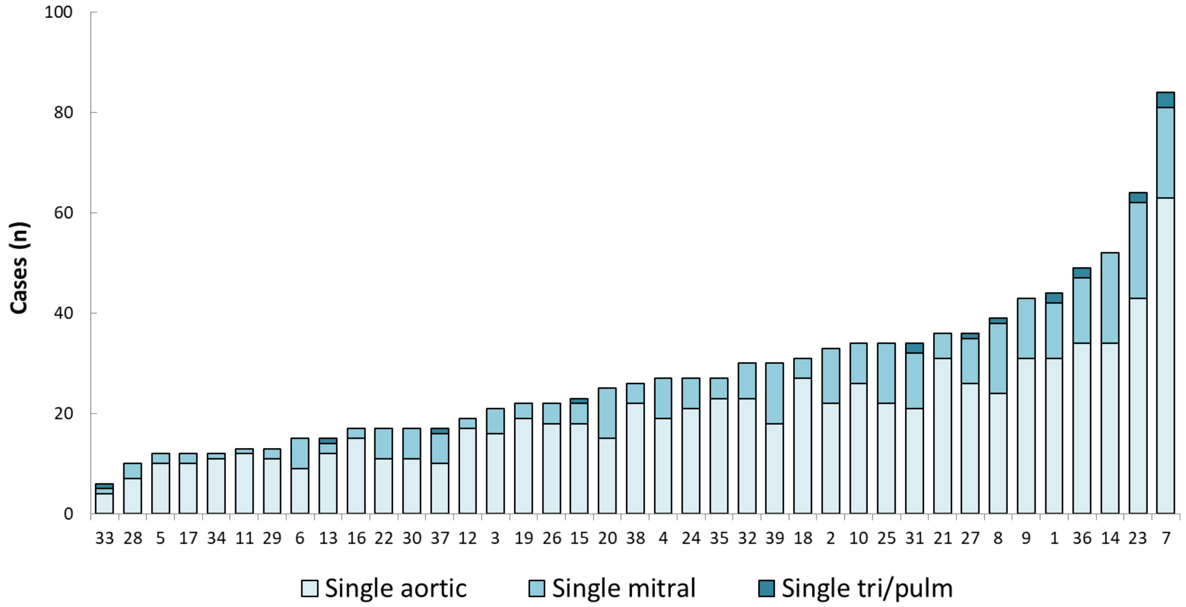


4.3 Single valve surgery combined with CABG

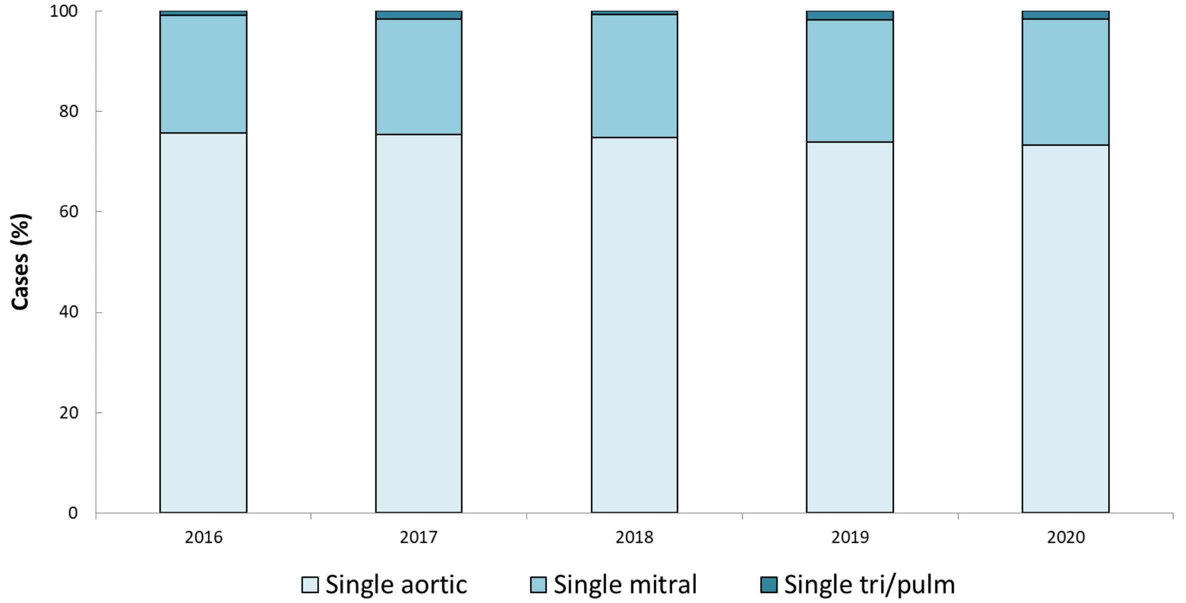
Single AoV and CABG is consistently the most commonly performed combined surgery, averaging 73.3% of all valve with CABG cases in 2020 (Figure 65a). One quarter of the cases were single mitral and CABG. The proportion of valve types remained consistent over the 2016-2020 period, although there is a very gradual decrease in single AoV and gradual increase in single mitral, combined with CABG (Figure 65b).

Figure 65. Type of single valve surgery combined with CABG

a. Units in 2020



b. Year



Of the three common valve and CABG combinations, MV repair and CABG had the lowest unadjusted OM in 2020 (1.6%) and combined AVR and CABG had the lowest OM for the preceding four years (2.6%; Table 19). In comparison, combined MVR and CABG had a consistently high OM in the preceding four years (7.5%), however was lower in 2020 (4.1%). The OM for other surgical groups was widely variable, as expected with low frequency data. The OM for all combined valve and CABG surgery was 3.1% in 2020, similar to 3.6% in 2016-2019.

Table 19. OM (%) for combined valve and CABG surgery, 2020 and 2016-2019

Valve surgery	Year	n	OM (%)
Single aortic	2020	797	3.0
	2016-2019	3367	2.6
AVR	2020	788	2.9
	2016-2019	3325	2.6
Other aortic	2020	9	11.1
	2016-2019	42	0.0
Single mitral	2020	274	2.9
	2016-2019	1069	4.8
MVR	2020	145	4.1
	2016-2019	530	7.5
Repair	2020	128	1.6
	2016-2019	536	2.1
Single tricuspid	2020	13	7.7
	2016-2019	51	5.9
Single pulmonary	2020	4	0.0
	2016-2019	5	0.0
Aortic and mitral	2020	62	4.8
	2016-2019	247	7.7
Aortic and tricuspid	2020	6	0.0
	2016-2019	20	20.0
Mitral and tricuspid	2020	32	0.0
	2016-2019	135	6.7
Other double	2020	0	-
	2016-2019	2	0.0
Triple	2020	5	20.0
	2016-2019	29	10.3
Quadruple	2020	0	-
	2016-2019	1	0.0
Total valve surgery	**2020**	**1193**	**3.1**
	2016-2019	**4926**	**3.6**

4.4 Influence of patient characteristics on operative mortality

Over the past five years, unadjusted OM for all combined valve and CABG surgery increased with reported urgency, severity of LVD, previous MI and redo surgery. The OM for MV repair and CABG was consistently lower than for MV replacement and CABG in all categories (except females 70-<80y) (Table 20).

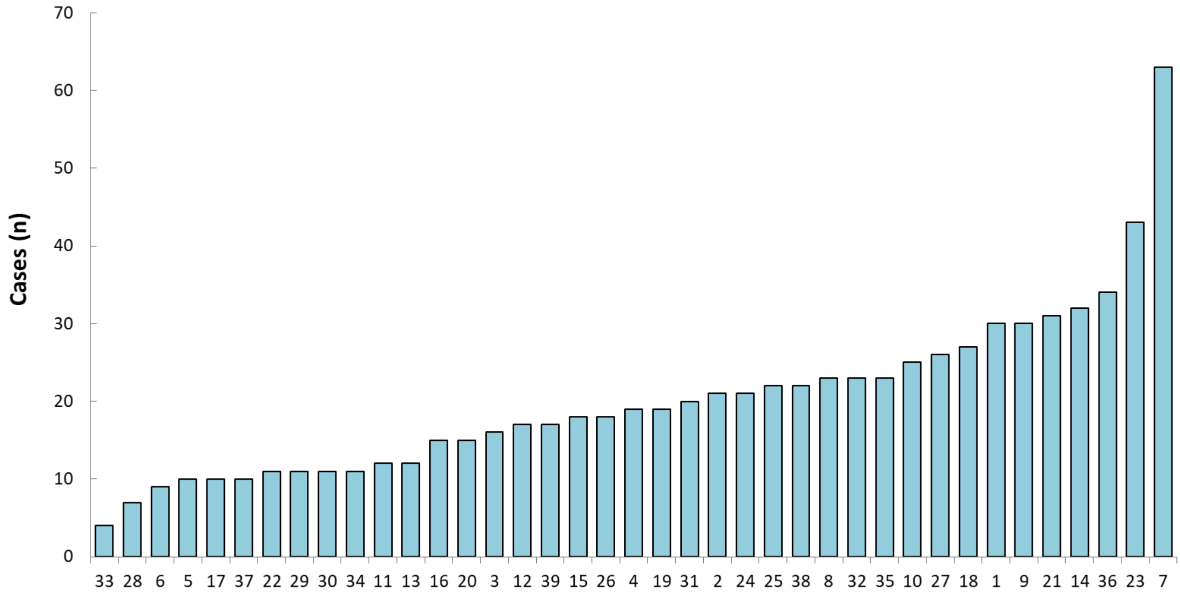
Table 20. Influence of patient characteristics on OM (%) for combined AVR and CABG, MVR and CABG and MV repair and CABG, 2016-2020

	AVR with CABG		MVR with CABG		MV repair with CABG	
	n	OM (%)	n	OM (%)	n	OM (%)
Clinical status						
Elective	3147	1.9	422	3.8	473	1.5
Urgent	910	4.6	228	11.0	167	1.8
Emergency/salvage	56	16.1	25	20.0	24	12.5
Sex/age						
Male	3332	2.3	467	7.3	551	1.6
<50y	34	0.0	18	5.6	26	0.0
50-<60y	204	1.5	58	6.9	82	2.4
60-<70y	869	1.5	143	6.3	181	2.2
70-<80y	1668	2.6	179	8.9	206	1.0
≥80y	557	3.4	69	5.8	56	1.8
Female	781	4.1	208	5.8	113	3.5
<50y	18	0.0	13	0.0	7	0.0
50-<60y	36	2.8	26	3.8	17	0.0
60-<70y	175	2.9	45	13.3	21	4.8
70-<80y	387	3.6	85	4.7	49	6.1
≥80y	165	7.3	39	2.6	19	0.0
LVD						
None/mild LVD (EF>45%)	3415	2.3	474	5.5	472	1.5
Moderate LVD (EF≥30%-≤45%)	515	4.5	139	8.6	136	3.7
Severe LVD (EF<30%)	142	4.9	53	13.2	51	2.0
Previous MI						
No MI	3012	1.9	418	4.1	420	1.2
NSTEMI	830	4.7	156	9.0	162	2.5
STEMI	135	7.4	74	17.6	57	7.0
Unknown type	136	2.9	27	7.4	25	0.0
Timing of prior MI						
≤6h	7	14.3	2	50.0	3	33.3
>6h-<24h	10	0.0	7	28.6	7	0.0
1-7d	224	5.8	61	16.4	56	3.6
>7d	860	4.5	186	8.6	177	2.8
Previous surgery						
Initial	3934	2.6	624	6.4	642	1.9
Redo	179	4.5	51	11.8	22	4.5
Dialysis						
No	4031	2.5	657	6.5	651	1.8
Yes	81	9.9	18	16.7	13	7.7
Pre-operative creatinine						
≤200 µmol/L	3993	2.5	633	5.5	643	2.0
>200 µmol/L	120	10.0	42	26.2	21	0.0

4.5 Combined AVR and CABG

There are notable differences in outcomes for the various valve categories. Combined AVR and CABG, being the largest group, is analysed separately in the following section. The lowest volume unit submitted four cases and the highest volume submitted 63 (Figure 66).

Figure 66. Combined AVR and CABG performed by unit, 2020



4.5.1 Influence of co-morbidities on complications

4.5.1.1 Diabetes or 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 eGFR ≤60 mL/min/1.73m^2.

Patients with insulin dependent diabetes had a high incidence of post-operative stroke and DSWI in 2020, whereas in the preceding four years, stroke, DSWI, NCA and RTT for bleeding were all increased with the presence of insulin dependent diabetes (Table 21). Similarly, patients with pre-operative creatinine >200µmol/L had higher incidence of post-operative complications in 2020, except for RTT for bleeding. Patients with pre-operative eGFR ≤60mL/min/1.73m^2 had higher incidences of all complications in 2020.

Table 21. Influence of pre-operative diabetes and of renal function on complications (%) for combined AVR and CABG patients

		Insulin dependent diabetes		Pre-operative creatinine		Pre-operative eGFR	
		No	Yes	≤200 µmol/L	>200 µmol/L	>60mL /min/1.73m	≤60mL /min/1.73m
n	2020	713	75	770	18	608	180
	2016-2019	3000	324	3223	102	2353	971
Permanent stroke	2020	2.1	4.0	2.2	5.6	2.0	3.3
	2016-2019	1.4	2.2	1.4	2.9	1.4	1.7
DSWI	2020	0.6	2.7	0.6	5.6	0.5	1.7
	2016-2019	1.1	1.2	1.2	1.0	1.2	1.0
NCA	2020	36.9	37.3	36.9	38.9	34.9	43.9
	2016-2019	37.2	39.3	37.4	38.2	36.6	39.4
RTT for bleeding	2020	5.6	4.0	5.6	0.0	5.4	5.6
	2016-2019	4.6	5.3	4.6	6.9	4.7	4.5

4.5.1.2 Age

Increasing age appears to be associated with increasing incidence of NCA and stroke with the exception of the <50-year group, though this should be interpreted with caution due to its low denominator (Table 22).

Table 22. Influence of patient age on complications (%) for combined AVR and CABG patients

		Age				
		<50 y	50-59 y	60-69 y	70-79 y	≥80 y
n	2020	10	57	228	389	104
	2016-2019	42	183	816	1666	618
Permanent stroke	2020	0.0	1.8	1.8	2.1	4.8
	2016-2019	2.4	0.0	1.0	1.7	1.8
DSWI	2020	10.0	0.0	0.9	0.5	1.0
	2016-2019	0.0	1.1	1.7	0.8	1.3
NCA	2020	0.0	21.1	34.2	39.8	44.2
	2016-2019	28.6	29.1	35.4	38.5	40.4
RTT for bleeding	2020	20.0	3.5	5.3	5.7	4.8
	2016-2019	9.5	5.5	4.4	4.6	4.5

4.5.1.3 Surgical history

Over the past five years, for AVR and CABG patients, redo surgery was associated with a higher incidence of DSWI, NCA and RTT for bleeding (Table 23).

Table 23. Influence of redo surgery on complications (%) for combined AVR and CABG patients

		Surgery	
		Initial	Redo
n	2020	753	35
	2016-2019	3181	144
Permanent stroke	2020	2.4	0.0
	2016-2019	1.4	2.1
DSWI	2020	0.8	0.0
	2016-2019	1.1	2.8
NCA	2020	37.5	25.7
	2016-2019	37.4	39.2
RTT for bleeding	2020	5.4	5.7
	2016-2019	4.7	4.9

4.5.1.4 Influence of comorbidities on derived new renal insufficiency

Over the past five years, patients with insulin dependent diabetes, high pre-operative creatinine (>200µmol/L) or low pre-operative eGFR (≤60mL/min/1.73m^2) had an increased incidence of unadjusted dNRI following combined AVR and CABG surgery, as did those having redo surgery (Table 24). Increasing age was less consistently associated with an increased incidence of dNRI. This data excludes patients who were on pre-operative dialysis.

Table 24. dNRI (%) for combined AVR and CABG patients on the basis of diabetes, renal insufficiency, age and surgical history

	2020		2016-2019	
	n	dNRI (%)	n	dNRI (%)
Insulin dependent				
No	704	2.7	2861	4.8
Yes	72	6.9	311	11.6
Pre-operative creatinine				
≤200 µmol/L	766	3.1	3128	5.0
>200 µmol/L	10	0.0	44	36.4
Pre-operative eGFR				
>60mL/min/1.73m^2	606	1.8	2288	3.6
≤60mL/min/1.73m^2	170	7.6	884	10.2
Age				
<50y	9	0.0	38	5.3
50-<60y	56	0.0	170	3.5
60->70y	223	3.6	775	5.5
70-<80y	386	3.6	1596	4.5
≥80y	102	2.0	593	8.4
Previous surgery				
Initial	741	3.2	3038	5.3
Redo	35	0.0	134	9.7

4.5.2 Unit outcomes – mortality, complications and resource utilisation

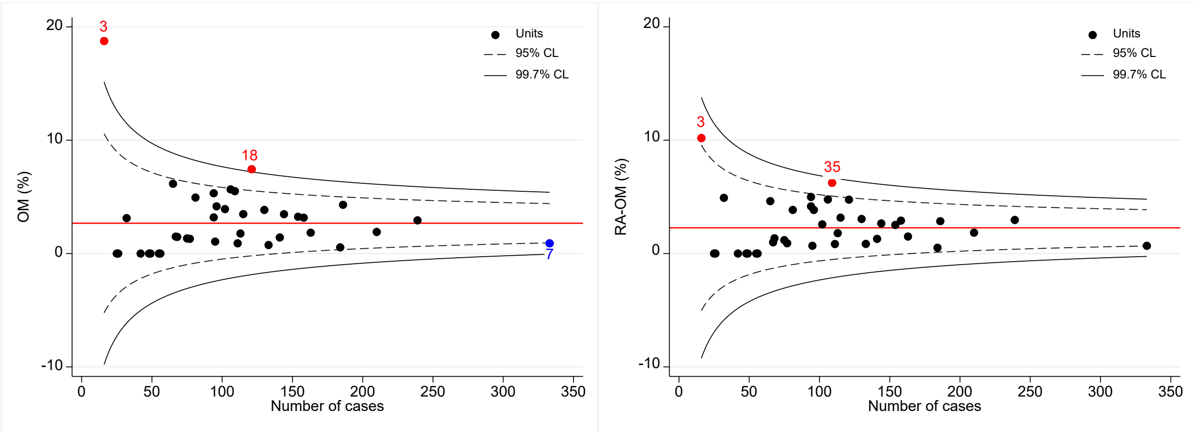
Due to low surgical numbers, the unit outcome data for combined AVR and CABG is presented for the pooled 2015-2019 period.

4.5.2.1 Operative mortality

The unadjusted OM for all units was 2.7% for combined AVR and CABG in the 2016-2020 five-year period (Figure 67a). The RA-OM was 2.2% and all units were within the 99.7% control limits (Figure 67b).

Figure 67. Mortality by unit following combined AVR and CABG, 2016-2020

a. OM b. RA-OM

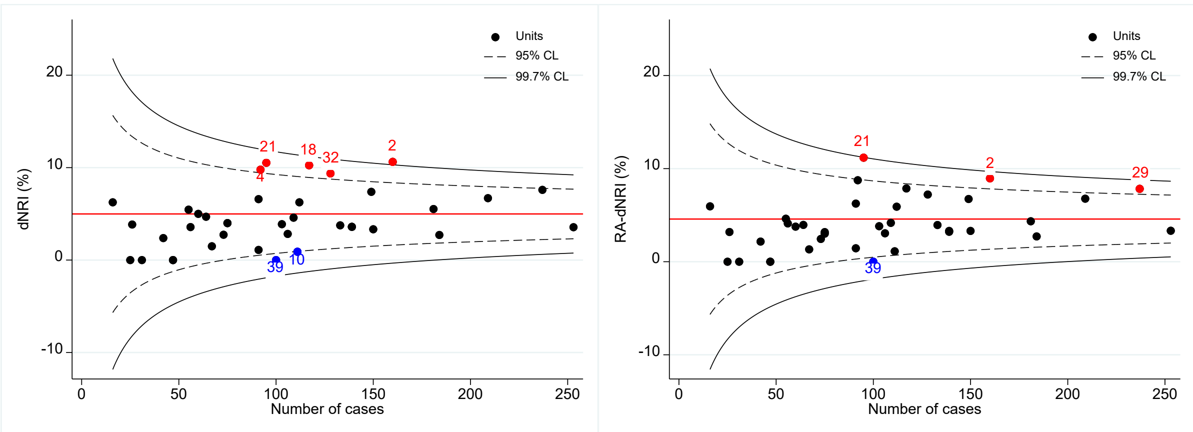


4.5.2.2 Complications

The unadjusted dNRI incidence for all units was 5.0% for combined AVR and CABG in the 2016-2020 five-year period (Figure 68a). The RA-dNRI was 4.7% and all units were within the 99.7% control limits (Figure 68b). Data for dNRI excludes patients who had pre-operative dialysis.

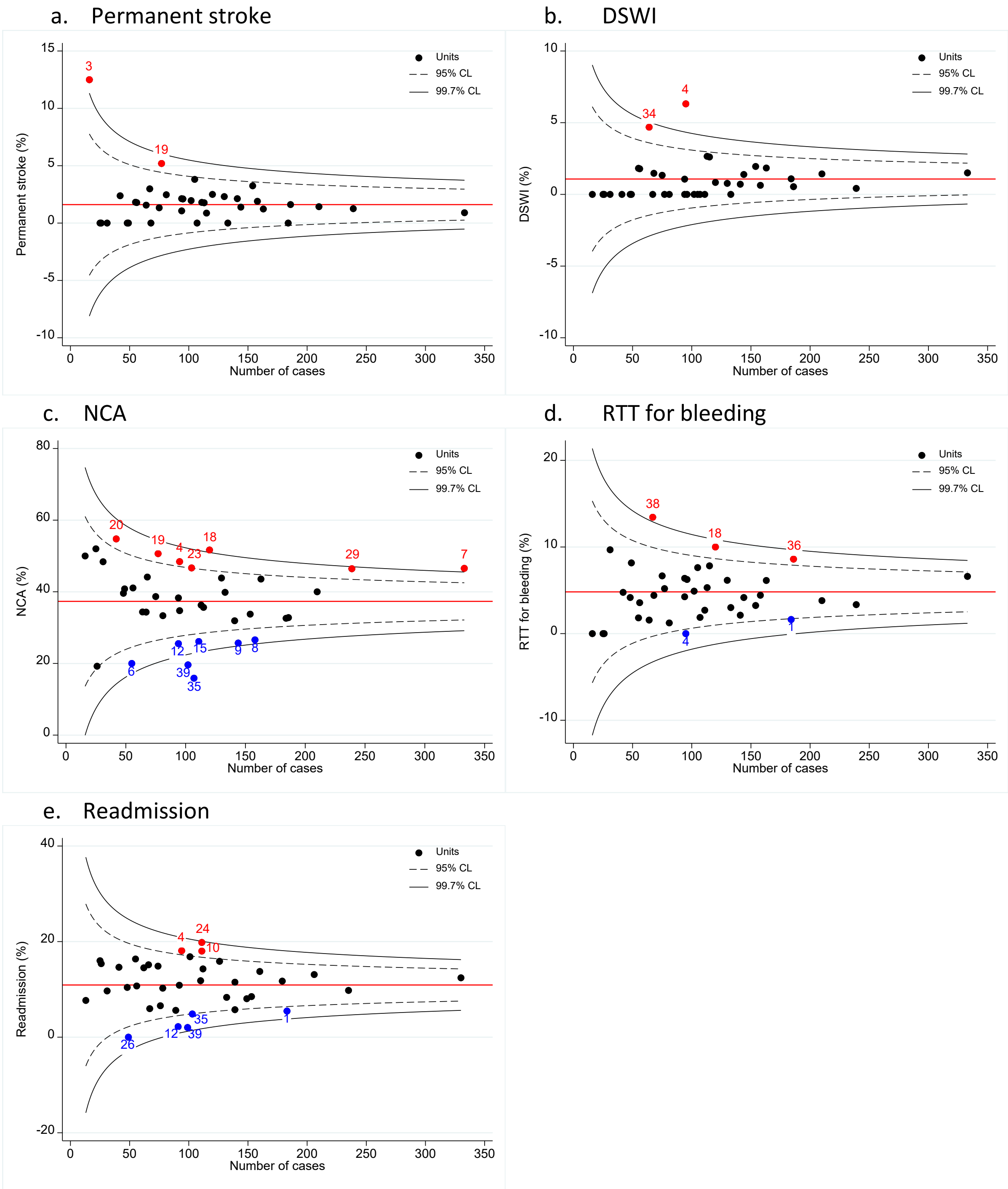
Figure 68. dNRI by unit following combined AVR and CABG, 2016-2020

a. dNRI b. RA-dNRI



Over the past five years, permanent stroke incidence was 1.6% (Figure 69a) and DSWI was 1.1% (Figure 69b). There was notable variation from the mean for NCA (37.3%; Figure 69c), RTT for bleeding (4.8%; Figure 69d), and readmission (10.9%; Figure 69e).

Figure 69. Complications by unit following combined AVR and CABG, 2016-2020



4.5.2.3 Resource utilisation

As for previous sections, ICU length of stay and ventilation data is presented as GM, which is defined as the nth root of a product of n numbers. It is less sensitive to outlying values, so portrays the central tendency of a set of skewed data more accurately.

Over the past five years, there was marked variation between units for the time patients spent in the ICU, the duration of ventilation, and the percentage of patients who received RBC or NRBC transfusions (Table 25). As expected, these times and rates are notably higher than for isolated CABG and isolated valve.

Table 25. Resource utilisation by unit for combined AVR and CABG patients, 2016-2020

	2016-2020			
Unit	ICU (GM, h)	Ventilation (GM, h)	RBC usage (%)	NRBC usage (%)
1	58.9	10.6	19.0	10.9
2	32.3	12.9	28.8	16.0
3	55.6	18.9	43.8	25.0
4	47.5	12.9	26.3	12.6
5	80.1	19.8	86.4	72.8
6	68.4	6.4	30.9	18.2
7	40.6	9.8	41.4	36.3
8	129.0	15.8	62.0	43.7
9	50.0	9.0	39.6	25.7
10	48.4	17.8	42.6	26.1
11	67.7	13.6	44.1	22.1
12	88.1	15.4	24.5	14.9
13	59.4	16.1	35.7	80.4
14	58.0	11.6	49.0	34.8
15	58.1	15.1	45.0	27.0
16	30.5	12.1	48.1	24.8
17	38.8	5.8	30.8	46.2
18	106.1	15.0	57.0	41.3
19	93.3	19.7	33.8	15.6
20	77.4	8.5	47.6	54.8
21	43.2	14.4	47.9	45.8
22	42.8	9.2	36.0	38.7
23	51.0	14.4	53.8	37.7
24	48.4	14.2	54.0	36.3
25	44.0	7.3	37.6	42.6
26	64.9	10.1	61.2	53.1
27	40.4	11.3	59.1	21.4
28	67.0	9.3	43.8	35.4
29	69.2	11.9	61.1	31.8
30	73.9	8.8	40.0	8.0
32	53.9	13.0	60.0	48.5
33	34.3	10.6	21.9	25.0
34	41.3	9.0	21.9	9.4
35	41.5	12.8	33.9	37.6
36	74.7	12.7	54.3	40.3
37	82.6	16.2	45.7	38.3
38	85.6	15.3	52.2	44.8
39	47.9	10.2	41.2	42.2
Total	55.9	12.1	45.1	33.2

As described in the other sections, the median is used for pre- and post-PLOS as GM excludes '0' values, which is a valid data point for these variables. In the 2016-2020 period, there was variability between units in the pre- and post-PLOS data for combined AVR and CABG cases (Figures 70 and 71). The medians ranged from 0-2 days for pre-PLOS and 6-10 days for post-PLOS.

Figure 70. Pre-PLOS for combined AVR and CABG patients by unit, 2016-2020

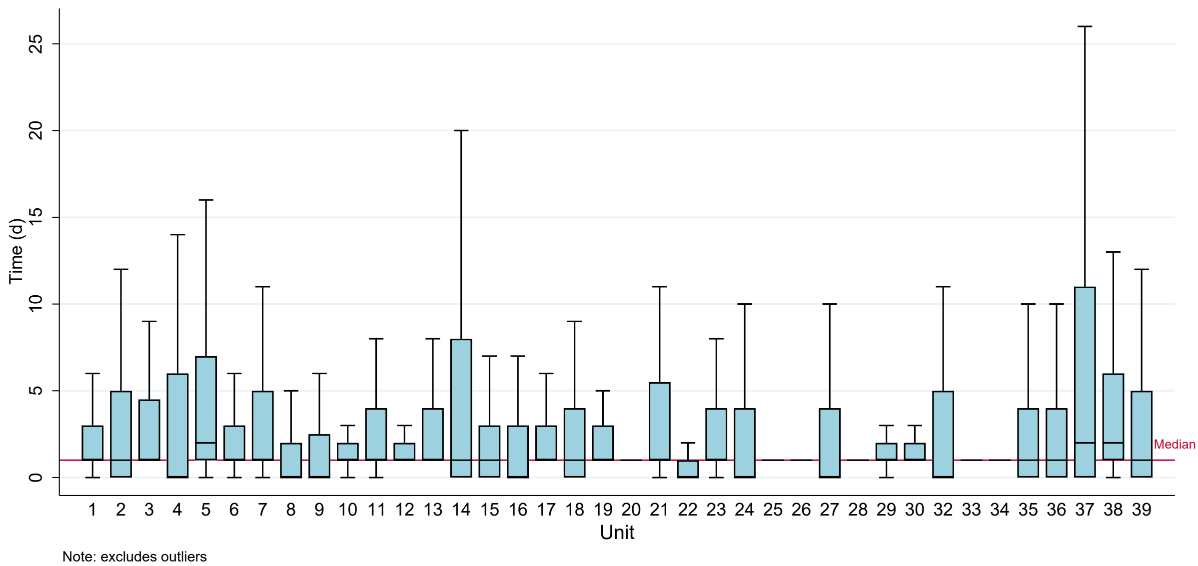
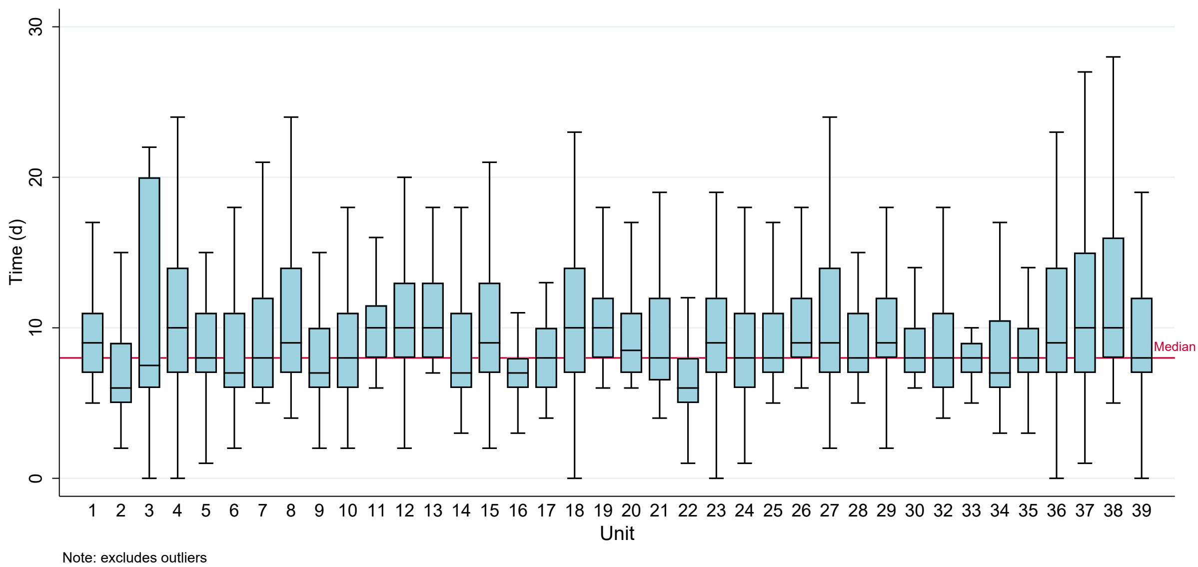


Figure 71. Post-PLOS for combined AVR and CABG patients by unit, 2016-2020



5. Other Cardiac Surgery

Table 26 lists the 2020 case numbers for cardiac surgery not covered in Sections 1, 3 or 4. Many of these cases are not performed in isolation, therefore OM is not necessarily indicative of that specific surgery, so is not presented.

Table 26. Case numbers for other uncommon cardiac surgery, 2020

Surgery type (not mutually exclusive)	n
LV aneurysm	21
Acquired ventricular septal defect	22
Aortic replacement	1181
Ascending only	874
Ascending + arch	224
Arch only	31
Descending	17
Thoraco-abdominal	4
Arch + descending	4
Descending + thoraco-abdominal	5
Ascending + arch + descending	9
Arch + descending + thoraco-abdominal	3
Other	9
Aortic repair	294
Endarterectomy	19
Patch repair	173
Endarterectomy + patch repair	4
Indication for aortic procedure	
Aneurysm	876
Dissection	313
Traumatic transection (<2 weeks)	1
Calcification	71
Other	183
Cardiac trauma	5
LV outflow tract myectomy	129
LV rupture repair	12
Pericardiectomy	33
Pulmonary thrombo-endarterectomy	27
Carotid endarterectomy	18
LV reconstruction	8
Pulmonary embolectomy	15
Cardiac tumour	98
Congenital	
Atrial septal defect	179
Other	170
Permanent LV epicardial lead	29
Atrial arrhythmia surgery	376
Left atrial appendage closure	379
Other	343

Table 27 provides case numbers for AoV valve surgery that was performed in isolation or in conjunction with other types of cardiac surgery.

Table 27. Case numbers for other AoV surgery performed without and with CABG, 2020 and 2016-2019

Valve surgery (not mutually exclusive)		Without CABG	With CABG
Aortic root replacement with valved conduit	2020	292	61
	2016-2019	1001	203
Pulmonary autograft aortic root replacement (Ross)	2020	38	2
	2016-2019	135	3
Root reconstruction with valve sparing (David)	2020	74	7
	2016-2019	226	29
Total other valve surgery	**2020**	**404**	**70**
	2016-2019	**1362**	**235**

Table 28 presents case numbers and OM for transplants performed without any concomitant surgery.

Table 28. Case numbers and OM (%) for transplants, 2020

Surgery type (performed in isolation)	n	OM (%)
Cardiac transplant	115	5.8
Cardiopulmonary transplant	35	1.3

Concluding Remarks

The participating sites in the ANZSCTS Database continue to submit high quality and complete data, allowing for accurate reporting with minimal to no selection bias in analyses. Routine data cleaning and validation activities demonstrate there is consistent accuracy in the data submitted and these measures will be supplemented in the future with the introduction of an audit program that caters to the spread of sites around Australia and New Zealand and the peri-pandemic era, both of which present challenges for on-site reviews.

Some of the significant activities for the Program in 2020-2021 have been to:

- create new risk-adjustment 'ANZSCORE' models to adjust OM and dNRI outcomes relative to case mix for isolated CABG, isolated AVR and AVR + CABG procedures;
- update the peer review process to incorporate the new risk-adjusted outcomes, refine the timeframes reviewed, provide supplementary data for sites, and introduce a new *Special Cause Variation Management Policy* to assist units identified as potential outliers;
- continually improve and update our web system, including the introduction of a 'Data Import' tool that allows sites that submit data in bulk to test and amend their data independently;
- further increase the coverage of the Database with the addition of three private hospitals in Australia and a further public hospital in New Zealand, bringing the total number of sites to 59;
- introduction of biannual bulletins to keep sites informed on Database activities.

The research program continues to provide access to data to a large number of post-graduate researchers and clinical staff with academic interests. In addition to 25 ongoing novel projects, linkage studies with the Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient Database and the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA) are in progress to address complex questions about patient pathways and long-term outcomes. In 2021, the process to apply for accessing non-identifiable data for research was updated and further information can be found on our website at https://anzscts.org/database/research/#research.

We strive toward the ideal of including all adult patients from every cardiac surgical unit so that the performance of all units may be evaluated and recruitment efforts will continue. Our other goals for the remainder of 2021 and early 2022 are to: finalise the development and implementation of a new risk-adjustment model for long-term mortality; pilot the inclusion of cumulative sum charts in the peer review process to provide feedback for lower volume procedures such as AVR and AVR + CABG; update the Data Definitions Manual, refining some definitions and adding new variables to reflect changes in clinical practice; and revising our audit program to reduce the reliance on site visits.

Long-term goals for the ANZSCTS Database will focus on extending the scope of the information collected through linkage of our data with other external administrative data sources; establishing a Cardiac Surgical Prosthesis Registry; exploring the use of data dashboards; and improving our reporting processes to health professionals and to the public.

Throughout the pandemic, the ANZSCTS Database continued to receive complete data from all contributing sites, including those in extended lockdowns or managing cases redirected from other hospitals. We extend our gratitude to all the dedicated surgeons, data managers and other administrative and clinical staff that made this 2020 report possible, as well as our integral financial supporters.

Appendix A

ANZSCORE OM and dNRI Models for isolated CABG Patients

The final ANZSCORE (OM; isolated CABG) model contains 20 variables. The model discrimination measured by the AUC (area under the receiver operating characteristic [ROC] curve) was 0.8235, indicating excellent discrimination. When validated on separate Australian and New Zealand data, the model also performs well.

The final ANZSCORE (dNRI; isolated CABG) model contains 21 individual variables. The model discrimination measured by the AUC (area under the ROC curve) was 0.7278, indicating that the model had acceptable discrimination.

Table D: Variables that define risk in the ANZSCORE isolated CABG models

ANZSCORE (RA-OM, isolated CABG) model variables	ANZSCORE (dNRI; isolated CABG) model variables
*Age^*	*Age^*
Timing of previous myocardial infarction	*Previous myocardial infarction*
Clinical status	*Clinical status*
*Estimated glomerular filtration rate^*	*Estimated glomerular filtration rate^*
NYHA class*	*NYHA* class*
Medicare	*Medicare*
Cerebrovascular disease	*Cerebrovascular disease*
Previous surgery	*Previous surgery with cardiopulmonary bypass*
Ejection fraction grade	*Ejection fraction grade*
Direct transfer from catheter lab/ICU to theatre	*Direct transfer from catheter lab/ICU to theatre*
Cardiogenic shock at the time of procedure	*Cardiogenic shock at the time of procedure*
IV nitrates at time of surgery	*IV nitrates at time of surgery*
Peripheral vascular disease	*Peripheral vascular disease*
Race	*Number of diseased vessels*
Pre-operative dialysis	*Body mass index^*
Resuscitation within 1 hour prior to operation	*Hypertension*
Lung disease	*Permanent pacemaker in situ*
Pre-operative arrhythmia	*History of diabetes*
Left main disease	*Congestive heart failure at the current admission*
Inotropes at time of surgery	*Sex*
	Previous catheterisation

*New York Heart Association
^data for continuous variables has an upper limit, any data that exceeds this upper limit for a case will not generate a risk score for that patient – the upper limits for age, eGFR and BMI are 130, 200mL/min/1.73m² and 60kg/m² respectively

Appendix B

Key Performance Indicator Definitions

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

In-hospital and 30-day mortality or operative mortality (OM)

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

Return to Theatre (RTT) for bleeding

Did the patient return to theatre for bleeding/tamponade?

Derived new renal insufficiency (dNRI)^

- *This indicator is derived from reported renal data*
  a. Acute post-operative renal insufficiency is characterised by one of the following: 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).
- *Risk-adjusted derived new renal insufficiency (RA-dNRI)*
  The observed outcome is adjusted based on the ANZSCTS Database Program's risk model (Appendix A), and used to account for the degree of risk associated with the surgery and patient profile.

^Where this measure is reported patients on dialysis pre-operatively are excluded from analysis.

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.

Permanent stroke

Did the patient experience a stroke or new central neurologic deficit (persisting for >72 hours) peri- or post-operatively?

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 (RBC) 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 (NRBC) 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 39 participating units in 2020, and from 2016-2019 (Sections 1 and 5) or 2016-2020 (Sections 3 and 4) for pooled analyses.

Final data related to this report was received by the ANZSCTS Database Program Data Management and Analysis Centre in the Centre of Cardiovascular Research and Education in Therapeutics (CCRET) of the Department of Epidemiology and Preventive Medicine, Monash University, on April 29th, 2021. 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 April 29th, 2021 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 Data Definitions Manual 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.*

- Left ventricular ejection fraction (LVEF)

Record the percentage of blood emptied from the left ventricle at the end of the contraction. Use the most recent determination prior to intervention. If unknown enter LVEF estimate.

This data gets converted to a measure of left ventricular function (LVF) or dysfunction (LVD) as follows;

EF (%)	Measure of function/dysfunction
LVEF > 60%	Normal LVF
LVEF 46-60%	Mild LVD
LVEF 30-45%	Moderate LVD
LVEF <30%	Severe LVD

- Readmission ≤ 30 days 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 any prior cardiac surgery.

Appendix D

Appendix D-I - Interpretation of Funnel Plots

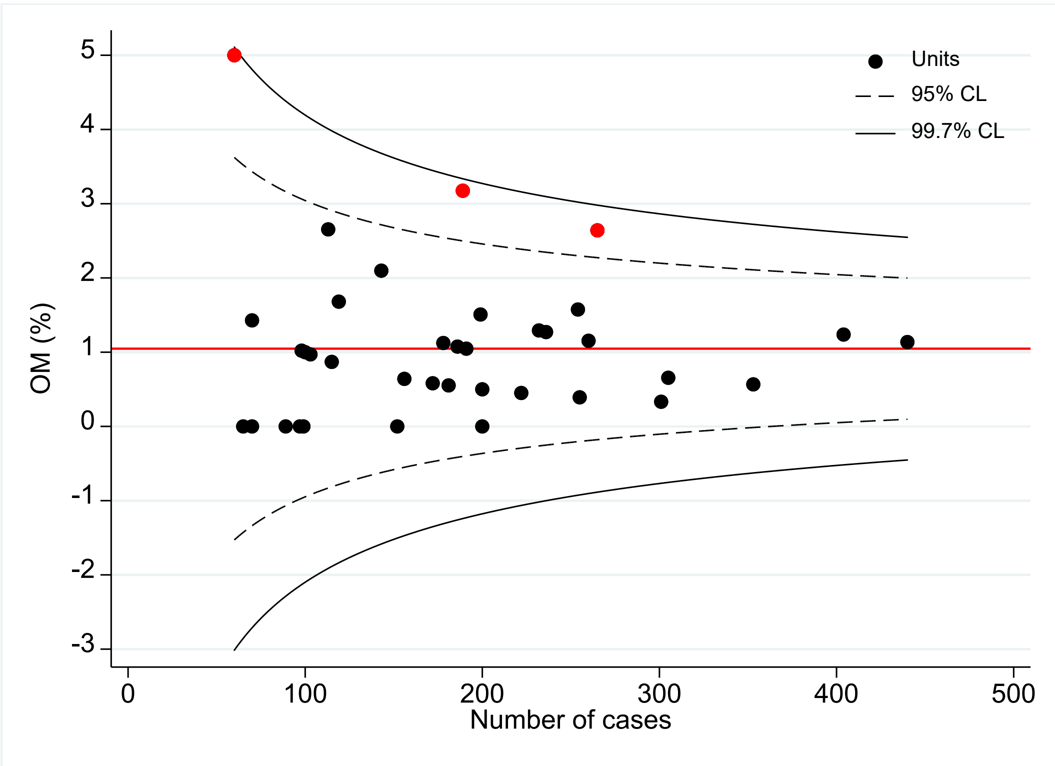
Funnel plots are an established benchmarking tool used to compare performance between healthcare providers. The plots include a single datapoint for each unit with the coordinates based on unit case number (x-axis) and aggregate outcome data (y-axis) for the specified time period.

The mean and standard deviation for all units, combined, are used to plot two sets of control limits (the 'funnels') which correspond to 95% (approximately two standard deviations) and 99.7% (approximately three standard deviations) from the mean. These cut-offs equate to the probability with which a unit performing at the expected level would be expected to fall within the control limits. Statistically, the selected limits impose a probability of false positive identification of an outlier of five or 0.3% for units outside the 95 or 99.7% control limits, respectively.

An advantage of funnel plots is that case number is factored into the control limits due to the reduced standard deviation for units with higher case volumes. This ensures that smaller volume units that are more susceptible to higher variation in outcomes are not evaluated using the lower thresholds associated with the larger volume units.

Figure C-I below illustrates operative mortality (OM) after isolated CABG in Australia in 2018. The solid red line represents the OM for all units, the two-dashed lines are the 95% control limits and the solid black lines are the 99.7% control limits. The funnel plot demonstrates how the control limits narrow as the number of cases increases. This representation illustrates the invalidity of ranking all of those units from "best" to "worst" as only three were worse than the majority, all of which had statistically similar outcomes.

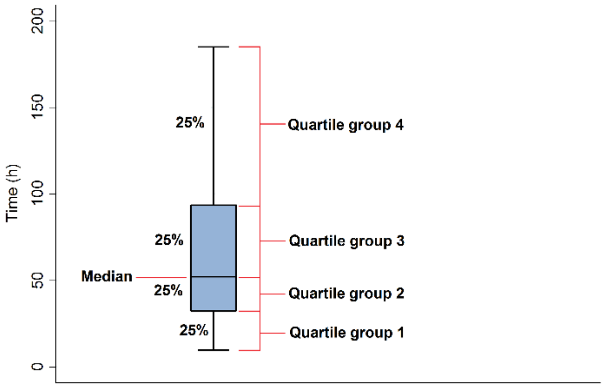
Figure D-I. OM following isolated CABG by unit



Appendix D-II - Interpretation of Box Plots

A Box Plot is a demonstration of statistical information that illustrates the maximum and minimum values (the upper and lower whiskers), the second and third quartiles (the lower and upper limits of the box, so that the box contains the middle half of the observations) and the median value (the line within the box), for a set of observations.

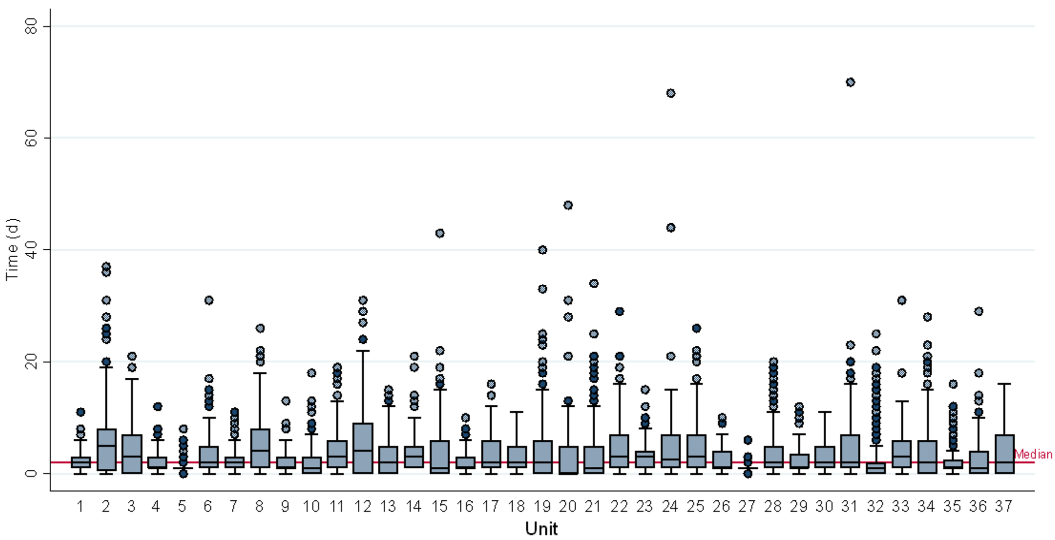
Figure D-II. Box plot example



The box plots presented in this report do not include observations that the statistical software package (Stata 15) has determined to be outliers (i.e. those that are 1.5 times greater than the upper limit of quartile group 3 or those 1.5 times lower than the lower limit of quartile group 2).

Where data is clustered particularly tightly, exclusion of outliers means the data may look compressed. For instance, in the length of stay data presented in Figure D-IIA, unit 27 has a number of outliers (represented by black circles) clustered around the median. When the outliers are removed, it looks as though all patients in unit 27 had a length of stay of one day, with no variation. Removing the outliers improves the readability of the graph, but does result in a small loss of information.

Figure D-IIA. Box plot example: length of stay data with outliers



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