Queensland Health

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Queensland Cardiac Clinical Network

Queensland Cardiac Outcomes Registry

2021 Annual Report

Cardiac Surgery Audit

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Queensland Government

Queensland Cardiac Outcomes Registry
2021 Annual Report

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1 Message from the QCCN Chair

Evolution and growth have seen QCOR become far more than a clinical quality registry and fulfil many more roles and functions than traditional registries. In compiling this seventh QCOR Annual Report we can reflect on the key deliverables and impact that the Registry has across many domains of healthcare and the health system in Queensland.

Despite declines in measures of burden of disease, cardiovascular disease and coronary heart disease are conditions with the highest burden of disease and mortality rates for Queenslanders. With the relatively contemporary nature of many of the interventions used to treat cardiovascular disease many analyses, risk scores and quality assurance frameworks exist, allowing the treatment of cardiac disease to be closely monitored. This data rich environment sets it apart from many other medical fields.

In its seventh publication year, this wide-reaching quality and safety program now comprises of cumulative analysis of over 250,000 patient interactions with the Queensland public health system for cardiac disease.

As the program develops and grows, we are frequently asked what is exceptional about QCOR? The answers are compelling and far-reaching. It is the broadest cardiac clinical quality registry of its kind in Australia. It is underpinned by point of care clinical systems and applications that allow clinicians to perform their role at the highest level, knowing their daily activities are supported by quality improvement opportunities. It is a clinical quality program that offers tools, insights, benchmarking and clinical excellence initiatives. It offers the means to enact multimillion-dollar consumables savings programs allowing healthcare money to be reinvested into patient care. But most importantly it is a tool that offers transparent, meaningful clinician-led solutions that aim to improve the health outcomes for all Queenslanders.

In the third year of the global coronavirus pandemic, healthcare providers have faced new and continuing challenges that demand innovative solutions to support the provision of first-class healthcare. The current report confirms that those involved in managing heart and lung disease have delivered volumes of work similar to, or, exceeding those observed in the pre-pandemic era. More importantly, despite unprecedented system stress, the Queensland cardiac community has rallied to maintain high standards of care that are demonstrated in the 2021 outcomes analysis.

Looking forward, we keenly await the delivery of a contemporary statewide cardiovascular information system for diagnostic and interventional cardiology and echocardiography. Investment in such a forward-thinking, all-encompassing solution would not be possible without the collegiality and cooperation of cardiac clinicians throughout the state. Such collaboration is enabled by the platform laid by QCOR and its focus on clinician engagement, supported by our colleagues at eHealth Queensland.

For the public and healthcare consumers, this report provides confidence that the quality and consistency of cardiac procedural care is routinely reported to providers, supporting continuous service improvement.

As the 2021 QCOR Annual Report is finalised, all that is left is to commend the tireless work of the collegiate network of healthcare professionals that continue to uphold the highest clinical standards. We express a sincere wish that the scope of QCOR's activities will be expanded for the benefit of more Queenslanders over many years to come.

Dr Rohan Poulter and Dr Peter Stewart
Co-chairs, Queensland Cardiac Clinical Network

2 Acknowledgements

This collaborative report was produced by the SCCIU, audit lead for QCOR for and on behalf of the Queensland Cardiac Clinical Network. This would not be possible without the tireless work of clinicians in contributing quality data and providing quality patient care, while the contributions of QCOR committee members and others who had provided writing or other assistance with this year's Annual Report is also gratefully acknowledged.

QCOR Interventional Cardiology Committee

- Dr Sugeet Baveja, The Townsville Hospital
- Dr Yohan Chacko, Ipswich Hospital
- Dr Christopher Hammett, Royal Brisbane & Women's Hospital
- Dr Dale Murdoch, The Prince Charles Hospital
- A/Prof Atifur Rahman, Gold Coast University Hospital
- Dr Sam Sidharta, Rockhampton Hospital
- Dr Yash Singbal, Princess Alexandra Hospital
- Dr Gregory Starmer, Cairns Hospital
- Dr Michael Zhang, Mackay Base Hospital
- Dr Rohan Poulter, Sunshine Coast University Hospital (Chair)

QCOR Cardiothoracic Surgery Committee

- Dr Manish Mathew, Townsville University Hospital
- Dr Anil Prabhu, The Prince Charles Hospital
- Dr Morgan Windsor, Metro North Hospital and Health Service
- Dr Sylvio Provenzano, Gold Coast University Hospital
- Dr Christopher Cole, Princess Alexandra Hospital (Chair)

QCOR Cardiac Rehabilitation Committee

- Ms Michelle Aust, Sunshine Coast University Hospital
- Ms Maura Barnden, Metro North Hospital and Health Service
- Ms Wendy Fry, Cairns and Hinterland Hospital and Health Service
- Ms Emma Harmer, Metro South Hospital and Health Service
- Ms Helen Lester, Health Contact Centre – Self Management of Chronic Conditions Service
- Ms Rebecca Pich, Metro South Hospital and Health Service
- Ms Alexandra Samuels, Gold Coast Hospital and Health Service
- Ms Samara Phillips, Statewide Cardiac Rehabilitation Coordinator

Statewide Cardiac Clinical Informatics Unit

- Mr Michael Mallouhi
- Mr Marcus Prior
- Dr Ian Smith, PhD
- Mr William Vollbon

QCOR Electrophysiology and Pacing Committee

- Ms Simone Arthur, Toowoomba Hospital
- Vanessa Beattie, Gold Coast University Hospital
- Mr John Betts, The Prince Charles Hospital
- Mr Anthony Brown, Sunshine Coast University Hospital
- Mr Andrew Claughton, Princess Alexandra Hospital
- Dr Naresh Dayananda, Sunshine Coast University Hospital
- Dr Russell Denman, The Prince Charles Hospital
- Mr Braden Dinham, Gold Coast University Hospital
- Mr Nathan Engstrom, The Townsville Hospital
- A/Prof John Hill, Princess Alexandra Hospital
- Dr Paul Martin, Royal Brisbane & Women's Hospital
- Dr Caleb Mengel, Toowoomba Hospital
- Ms Sonya Naumann, Royal Brisbane & Women's Hospital
- Dr Sachin Nayyar, The Townsville Hospital
- Dr Kevin Ng, Cairns Hospital
- Dr Robert Park, Gold Coast University Hospital
- Mr Simon Townsend, The Prince Charles Hospital

QCOR Heart Failure Support Services Committee

- Mr Ben Shea, Redland Hospital
- Ms Angie Sutcliffe, Cairns Hospital
- Ms Deepali Gupta, Queen Elizabeth II Hospital
- Ms Helen Hannan, Rockhampton Hospital
- Ms Annabel Hickey, Statewide Heart Failure Services Coordinator
- Dr Rita Hwang, PhD, Princess Alexandra Hospital
- Ms Louvaine Wilson, Toowoomba Hospital
- Ms Melanie Burgess, Ipswich Hospital
- Ms Michelle Bertram, Gold Coast Hospital and Health Service
- Dr Wandy Chan, The Prince Charles Hospital
- Prof John Atherton, Royal Brisbane & Women's Hospital (Chair)

Queensland Ambulance Service

- Dr Tan Doan, PhD

3 Introduction

The Queensland Cardiac Outcomes Registry (QCOR) is an ever-evolving clinical registry and quality program established by the Queensland Cardiac Clinical Network (QCCN) in partnership with statewide cardiac clinicians and made possible through the funding and support of Clinical Excellence Queensland. QCOR provides access to quality, contextualised clinical and procedural data to inform and enhance patient care and support the drive for continual improvement of quality and safety initiatives across cardiac and cardiothoracic surgical services in Queensland.

QCOR is a clinician-led program, and the strength of the Registry would not be possible without this input. The Registry is governed by clinical committees providing direction and oversight over Registry activities for each cardiac and cardiothoracic specialty area, with each committee reporting to the QCCN and overarching QCOR Advisory Committee. Through the QCOR committees, clinicians are continually developing and shaping the scope of the Registry based on contemporary best practices and the unique requirements of each clinical domain.

Goals and mission

- Identify, through data and analytics, initiatives to improve the quality, safety and effectiveness of cardiac care in Queensland.
- Provide data, analysis expertise, direction and advice to the Department of Health and Hospital and Health Services concerning cardiac care-related service planning and emerging issues at the local, statewide and national levels.
- Provide decision support, expertise, direction and advice to clinicians caring for patients within the domain of cardiac care services.
- Develop an open and supportive environment for clinicians and consumers to discuss data and analysis relative to cardiac care in Queensland.
- Foster education and research in cardiac care best practice.

Registry data collections and application modules are maintained and administered by the Statewide Cardiac Clinical Informatics Unit (SCCIU), which forms the business unit of QCOR. The SCCIU performs data quality, audit and analysis functions, and coordinates individual QCOR committees, whilst also providing expert technical and informatics resources and subject matter expertise to support continuous improvement and development of specialist Registry application modules and reporting.

The SCCIU team consists of:

Mr Graham Browne, Database Administrator	Mr Michael Mallouhi, Clinical Analyst
Mr Marcus Prior, Informatics Analyst	Mr William Vollbon, Manager*
Dr Ian Smith, PhD, Biostatistician	Mr Karl Wortmann, Application Developer

* Principal contact officer/QCOR program lead

The application custodian for QCOR is the Executive Director, Healthcare Improvement Unit, CEQ, while data custodianship for the overarching data collection of QCOR is the Chair/s of the QCCN. The individual modular data collections are governed by the Chair of each of the individual QCOR specialty committees.

The QCOR Clinical specialty committees provide direction and oversight for each domain of the Registry. An overarching QCOR Advisory Committee provides collective oversight with each of these groups reporting to the QCCN. Through the QCOR committees, clinicians are continually developing and shaping the scope of the Registry based on contemporary best practices and the unique requirements of each clinical domain.

QCOR manages the Cardiothoracic Surgery Quality Assurance Committee which has been formed under Part 6, of the *Hospital and Health Boards Act 2011* to facilitate the participation of clinicians and administrators responsible for the management and delivery of cardiac services. This group enables the peer review of safety and quality of the cardiothoracic services delivered in Queensland and guides any service improvement activities that may be required.

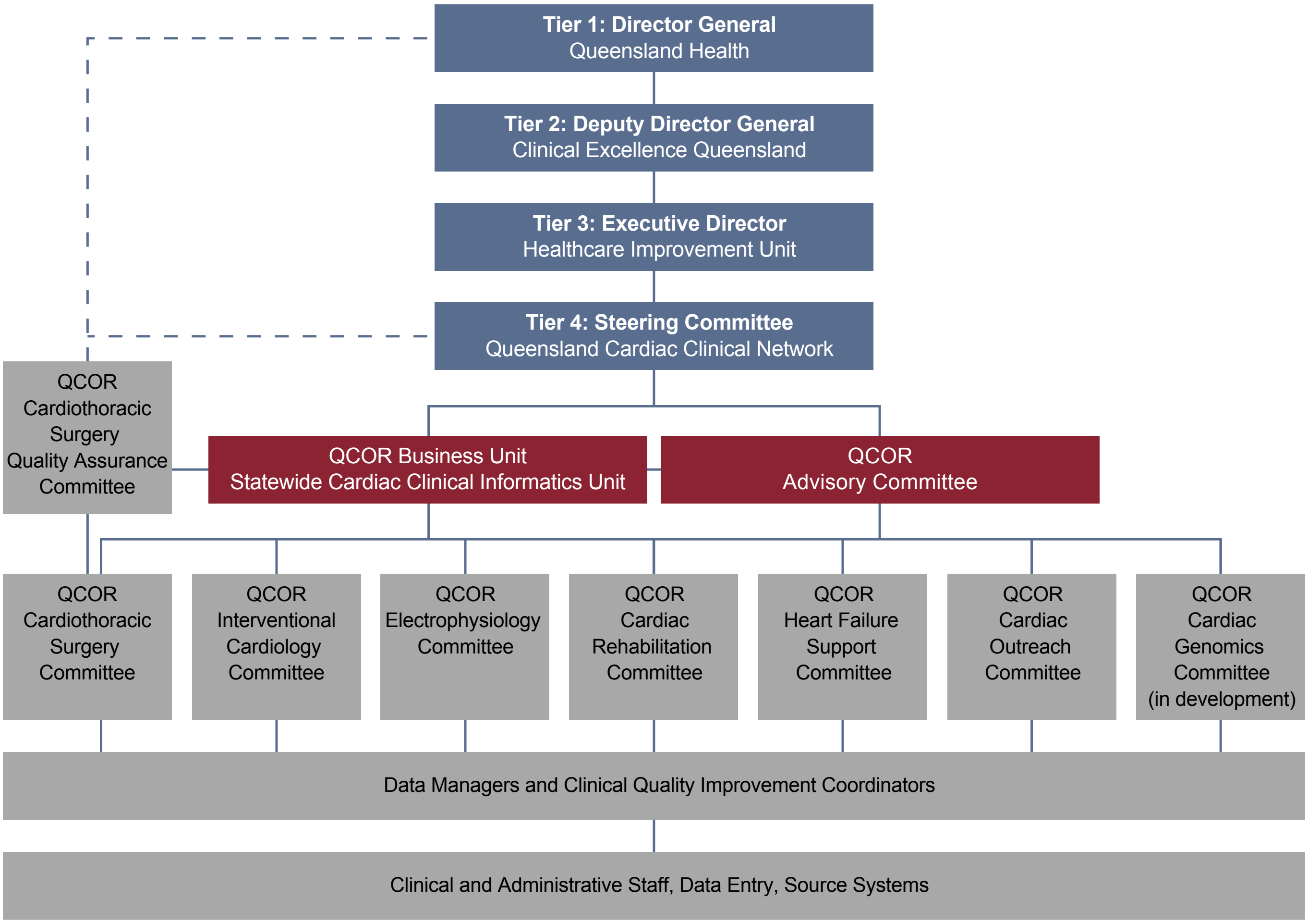


Figure 1: Governance structure

QCOR functions in line with the accepted and endorsed clinical quality registry feedback loop where improvements in clinical care through data-based initiatives and regular interaction with clinicians and stakeholders.

QCOR acts under a well-defined data custodianship model that ensures clearly defined processes and usage of the data collected. The operation of QCOR is guided by the principles outlined by the Australian Commission on Safety and Quality in Health Care in the Framework for Australian clinical quality registries.

The Registry data collection is a blend of clinician-entered data along with various data linkages activities as outlined above. The data is scrutinised using in-app data validations and automated routine data quality reporting. The data quality auditing processes aim to identify and resolve incomplete or inaccurate data to ensure clinician trust in the analysis and outcome reporting process, along with routine reporting and requests for information functions.

In 2014, the Australian Commission on Safety and Quality in Healthcare published a Framework for Australian clinical quality registries*. Since then, QCOR has worked to align itself with these guidelines and standards which form the basis of its quality and safety program. It is recognised that clinical quality registries collect, analyse and report back essential risk-adjusted clinical information to patients, consumers, frontline clinicians and government, with a focus on quality improvement.

The measurement of clinical indicators and benchmarks aims to support the feedback of safety and quality data to several levels of the health system, including consumers, clinicians, administrators and funders. Meaningful metrics are required to understand what the major safety issues are across the care continuum, proactively mitigate patient safety risks and stimulate improvement. Evidence demonstrates that safety and quality improve when clinicians and managers are provided with relevant and timely clinical information.

Through the availability of data insights, clinical reporting and clinical documentation produced by both patient-facing and technical solutions. QCOR has allowed the instantaneous delivery of clinical reports and documentation to clinicians via enterprise solutions. Data insights, performance measure and clinical indicator reporting is also made available in real time via dashboards and reports delivered to clinicians at a frequency and medium of their choosing. Access to real-time data enables key staff to plan and deliver more efficient care to more patients.

QCOR data and analytics have informed and supported statewide healthcare planning activities for capital expansion as well as made possible market share activities for procurement of high-cost clinical consumables resulting in multimillion dollar savings to the healthcare system.

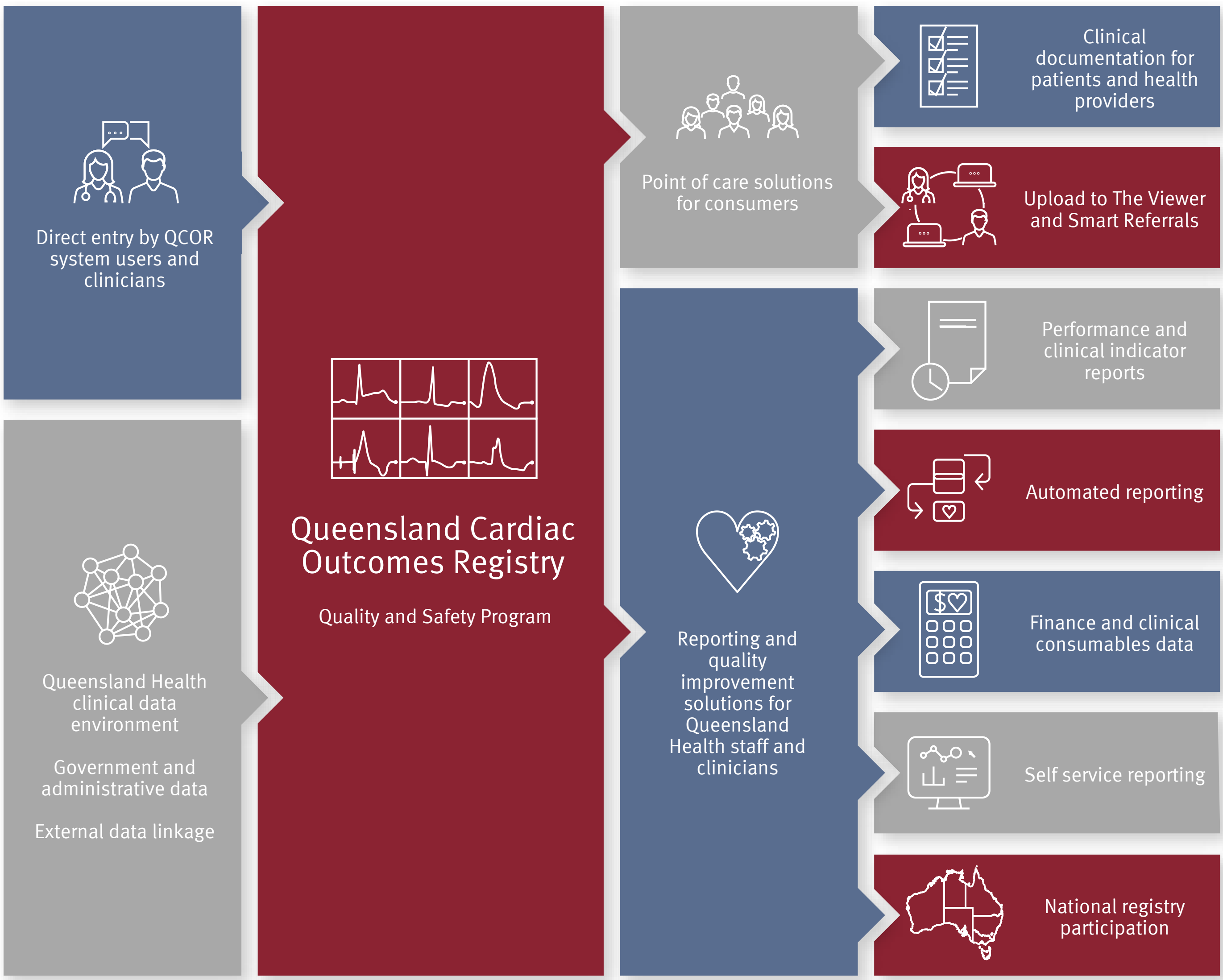


Figure 2: QCOR data flow

* The Australian Commission on Safety and Quality in Health Care (ACSQHC). Framework for Australian clinical quality registries. Sydney: ACSQHC; 2014.

Queensland Cardiac Outcomes Registry

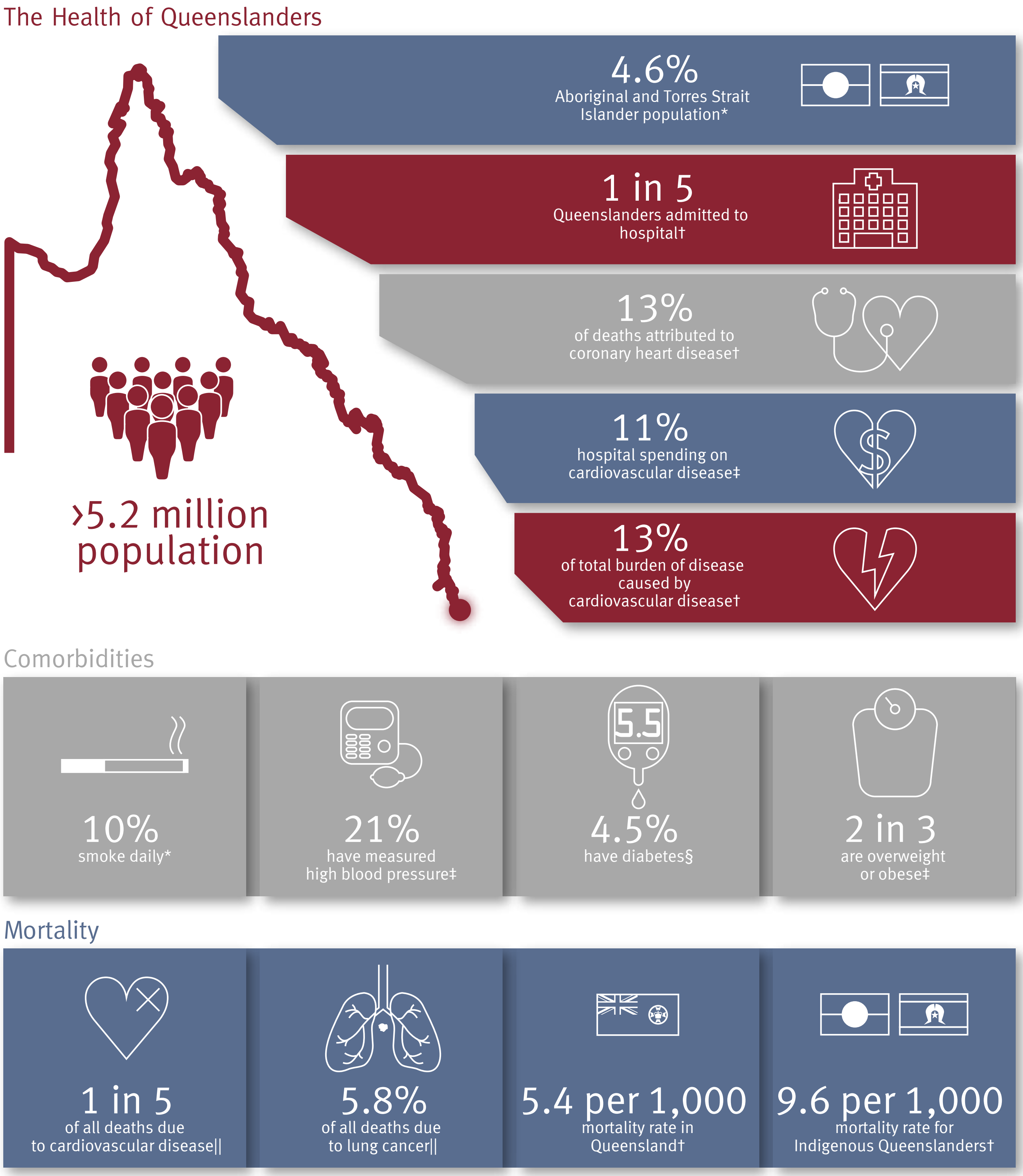


Figure 3: QCOR 2021 infographic

* Australian Bureau of Statistics. (2022, July 1). Queensland: Aboriginal and Torres Strait Islander population summary. ABS. https://www.abs.gov.au/articles/queensland-aboriginal-and-torres-strait-islander-population-summary

† Queensland Health. (2020). The health of Queenslanders 2020. *Report of the Chief Health Officer Queensland*. Queensland Government: Brisbane

‡ Australian Bureau of Statistics. (2019). *National health survey: first results, 2017-18*. Cat. no. 4364.0.55.001. ABS: Canberra.

§ Diabetes Australia. (2018). *State statistical snapshot: Queensland*. As at 30 June 2018

|| Australian Institute of Health and Welfare (2021). MORT (Mortality Over Regions and Time) books: State and territory, 2015–2019. https://www.aihw.gov.au/getmedia/8967a11e-905f-45c6-848b-6a7dd4ba89cb/MORT_STE_2015_2019.xlsx.aspx

2021 Activity at a Glance

What's New?

- Cardiac surgery outcomes and mortality
- Cardiac genomics spotlight
- Cardiac surgery bleeding complications audit
- NSTEMI patients: Interhospital transfers analysis

Interventional Cardiology

4,894
percutaneous coronary interventions

485
structural heart disease interventions

239
transcatheter aortic valve replacements

15,443
total coronary procedures

Cardiothoracic Surgery

2,623
adult cardiac surgeries

1,067
adult thoracic surgeries

Electrophysiology & Pacing

5,269
electrophysiology and pacing procedures

3,500
cardiac implantable electronic device procedures

Heart Failure Support Services

6,326
heart failure support services referrals

Cardiac Rehabilitation

10,647
cardiac rehabilitation referrals

Paediatric Cardiac Surgery

312
paediatric cardiac surgeries

Clinical Indicator Progress

83 mins
median first diagnostic ECG to reperfusion time for primary PCI

0.3%
procedural tamponade rate for cardiac device and electrophysiology procedures

91%
of patients referred to a heart failure support service on an ACEI, ARB or ARNI at discharge

93%
of cardiac rehabilitation referrals within 3 days of discharge

1.3%
mortality rate for coronary artery bypass surgery at 30 days

4 Facility profiles

4.1 Townsville University Hospital

- Referral hospital for Townsville and North West Hospital and Health Services, serving a population of approximately 295,000
- Public tertiary level invasive cardiac services provided at Townsville University Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Cardiothoracic surgery
- Networked cardiac services outreach hub for Townsville and North West Hospital and Health Services

4.2 The Prince Charles Hospital

- Referral hospital for Metro North, Wide Bay and Central Queensland Hospital and Health Services, serving a population of approximately 900,000 (shared referral base with the Royal Brisbane and Women's Hospital)
- Public tertiary level invasive cardiac services provided at The Prince Charles Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Cardiothoracic surgery
  - Heart/lung transplant unit
  - Adult congenital heart disease unit
- Cardiac genomics clinics provider

4.3 Queensland Children's Hospital

- Children's Health Queensland is a specialist statewide Hospital and Health Service dedicated to caring for children and young people from across Queensland and northern New South Wales
- Public tertiary level invasive cardiac services provided at the Queensland Children's Hospital include:
  - Percutaneous congenital cardiac abnormality diagnostics and intervention
  - Electrophysiology
  - ICD and pacemaker implantation
  - Paediatric cardiothoracic surgery

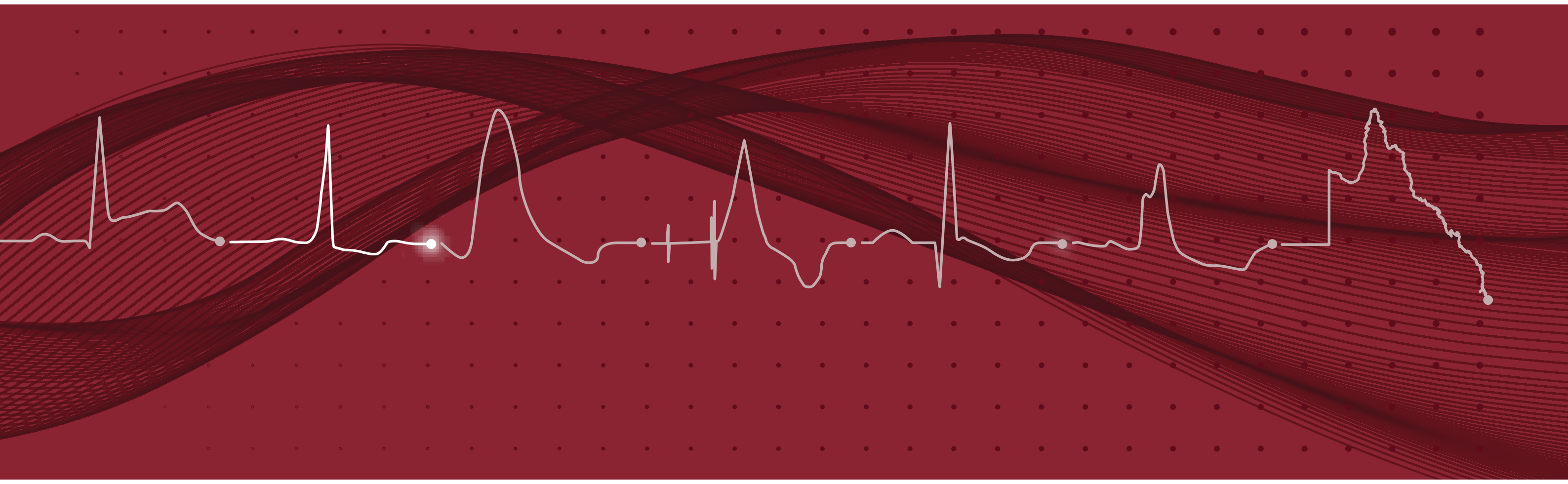
4.4 Princess Alexandra Hospital

- Referral hospital for Metro South and South West Hospital and Health Services, serving a population of approximately 1,000,000
- Public tertiary level invasive cardiac services provided at the Princess Alexandra Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Cardiothoracic surgery
- Cardiac genomics clinics provider
- Networked cardiac services outreach hub for Metro South, Darling Downs and South West Hospital and Health Services

4.5 Gold Coast University Hospital

- Referral Hospital for Gold Coast and northern New South Wales regions, serving a population of approximately 700,000
- Public tertiary level invasive cardiac services provided at the Gold Coast University Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Cardiothoracic surgery

Cardiac Surgery Audit



1 Message from the QCOR Cardiothoracic Steering Committee Chair

Here is presented the audit of cardiac surgical activity in public hospital units in 2021.

The numbers and types of procedures and the characteristics of the patients who underwent cardiac surgery in Queensland public units are presented, as well as an analysis of the outcomes for these patients. The majority of the risk that a patient faces when they undergo surgery is related to the nature of their disease, and the underlying health or disease of the organs that make up their body's systems. A patient at increased age, with multiple organs that are diseased or dysfunctional faces a high degree of risk when undergoing cardiac surgery. Across Queensland, our system of hospitals and ambulances that transport patients, the doctors and nurses and allied health professionals all work in concert to change the course of patients lives, extending their lives, and improving their day to day, despite the challenges and risks their face because of their underlying health and disease. This report presents the outcomes of those systems.

As leaders of these systems, and as individual clinicians who perform surgery, the surgeons of the cardiothoracic surgery committee have commenced a regular process through a Quality Assurance Committee (QAC) to look at the specific outcomes of individual surgeons and units. A QAC allows for open and free discussion and confidence from the cardiac surgeons of Queensland that their individual performance and the performs of their units can be discussed, rigorously analysed statistically and improvements be made and measured. This committee has made measurable improvements in the specific outcomes, for which the statewide outcomes are presented within this report. The outcomes section of this report demonstrates the Exponentially Weighted Moving Average approach that is used within the QAC for multiple outcome measures.

In 2021, the challenge of COVID-19 was not yet being felt in increased hospital bed utilisation or limitations on nursing staff availability and so the overall activity of cardiac surgery continued throughout this period.

Queenslanders who underwent cardiac surgery in 2021 experienced high quality care with low levels of morbidity and mortality despite their underlying risk factors. This reassurance cannot be made without the hard work of the SCCIU.

Dr Christopher Cole
Chair
QCOR Cardiothoracic Surgery Committee

2 Key findings

This Queensland Cardiac Surgery Audit describes baseline demographics, risk factors, surgeries performed and surgery outcomes for 2021.

Key findings include:

- The number of surgeries performed across the four public adult cardiac surgery units in Queensland were 2,623.
- The majority of patients were aged between 61 years and 80 years of age (67%) with a median age of 66 years old.
- Approximately three quarters of patients were male (74%).
- The majority of all patients were overweight or obese (77%), with less than one quarter (22%) of patients having a body mass index within the normal range.
- The overall proportion of Aboriginal and Torres Strait Islander patients was 7%, and had a wide variation between sites with 20% of patients in Townsville identifying as Aboriginal and Torres Strait Islander.
- The majority of patients had high blood pressure (66%) or high cholesterol (64%) or presented with a combination of several background risk factors.
- There were 28% of patients reported to be diabetic at the time of their operation, increasing to 38% of all patients undergoing coronary artery bypass grafting (CABG).
- Over one quarter (28%) of patients had an element of left ventricular systolic dysfunction.
- Over half (55%) of all cases were elective admissions with 19% of elective patients being admitted on the day of surgery.
- In 2021, 1,499 patients had a CABG procedure, of whom the majority (91%) had multi-vessel disease.
- There were 287 patients who underwent aortic surgery. The majority of aortic procedures involved aortic replacement surgery (70%).
- Among the 1,137 patients undergoing valve surgery, the most common interventions performed were replacement of the aortic valve (66%) and mitral valve (18%). Approximately 12% of valve surgeries involved multiple valves.
- The primary pathology for patients undergoing valvular surgery was degenerative valve disease (54%).
- Cardiac urgeons were involved in 49% of the 239 transcatheter aortic valve replacements performed in Queensland public hospitals.
- Major morbidities were evaluated using Society of Thoracic Surgeons (STS) models with most results demonstrating that the observed rate of adverse events is within or better than expected.
- The mortality rate after surgery is either within the expected range or lower than expected, depending on the risk model used to evaluate this outcome.

3 Participating sites

There are four public cardiac surgery units located throughout Queensland's Metropolitan and rural areas. The QCOR cardiac surgery database program received data directly from each surgical unit.

Many patients lived close to Queensland's eastern coastline; however patients came from a wide range of geographic locations, including interstate.

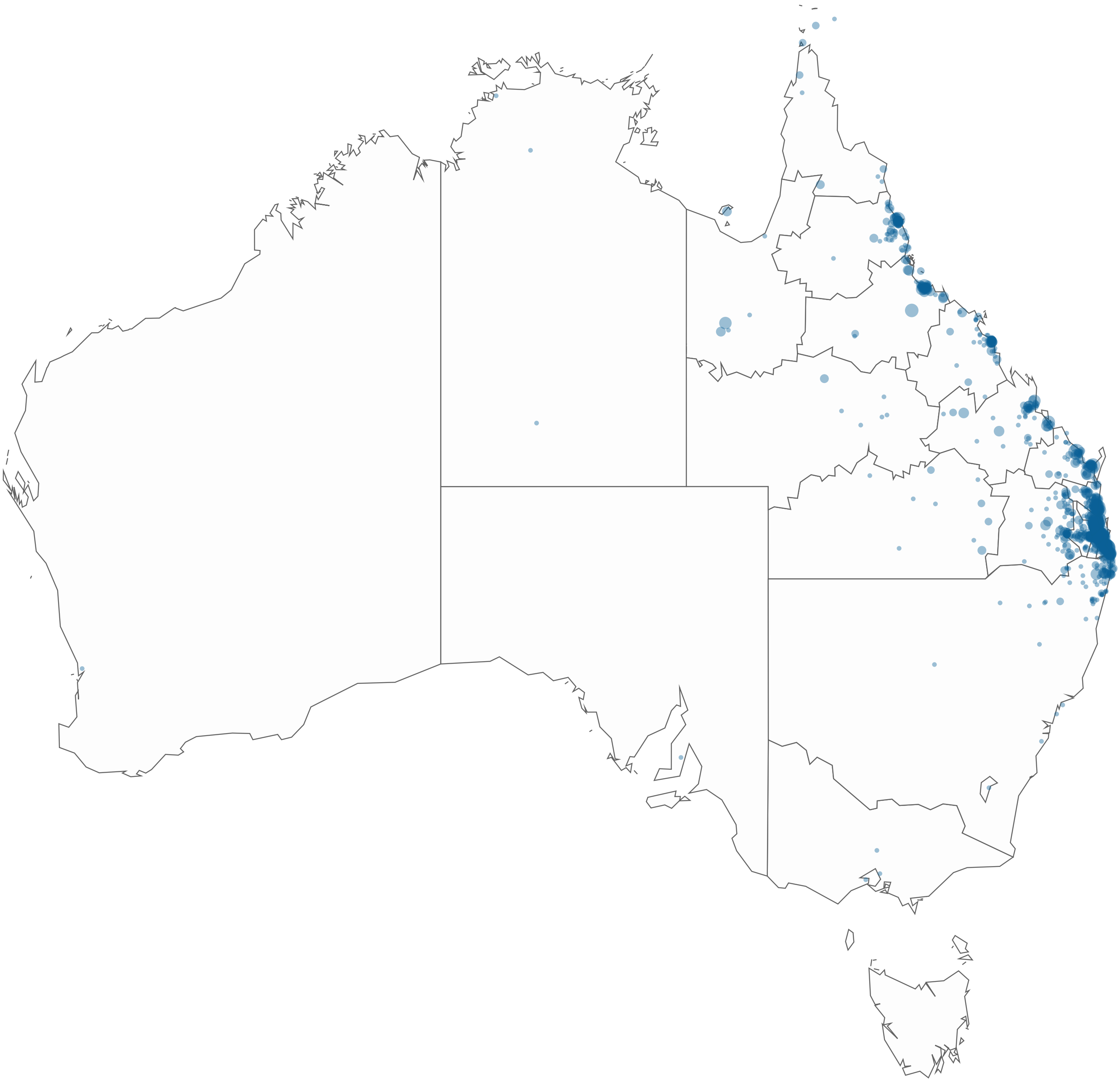


Figure 1: Cardiac surgery cases by residential postcode

Table 1: Participating sites

Acronym	Name
TUH	Townsville University Hospital
TPCH	The Prince Charles Hospital
PAH	Princess Alexandra Hospital
GCUH	Gold Coast University Hospital

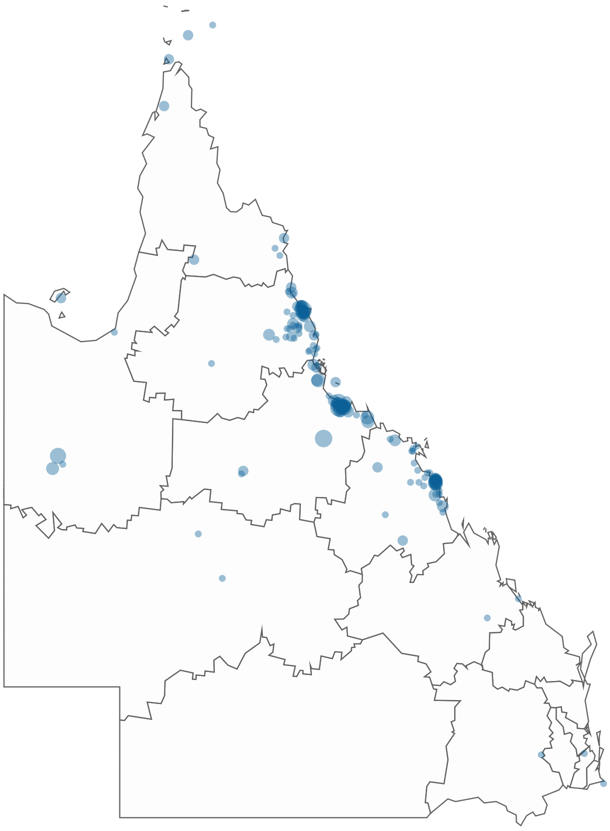


Figure 2: *Townsville University Hospital*

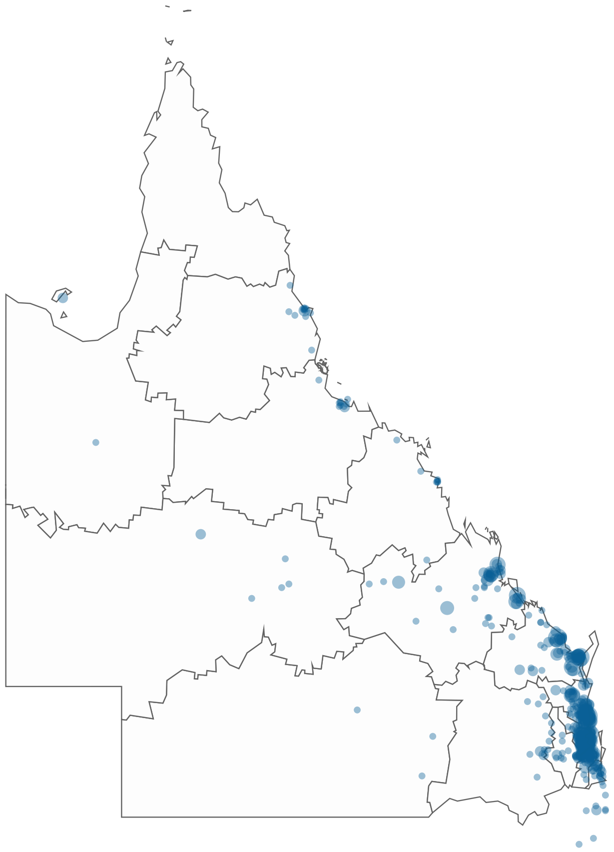


Figure 3: *The Prince Charles Hospital*

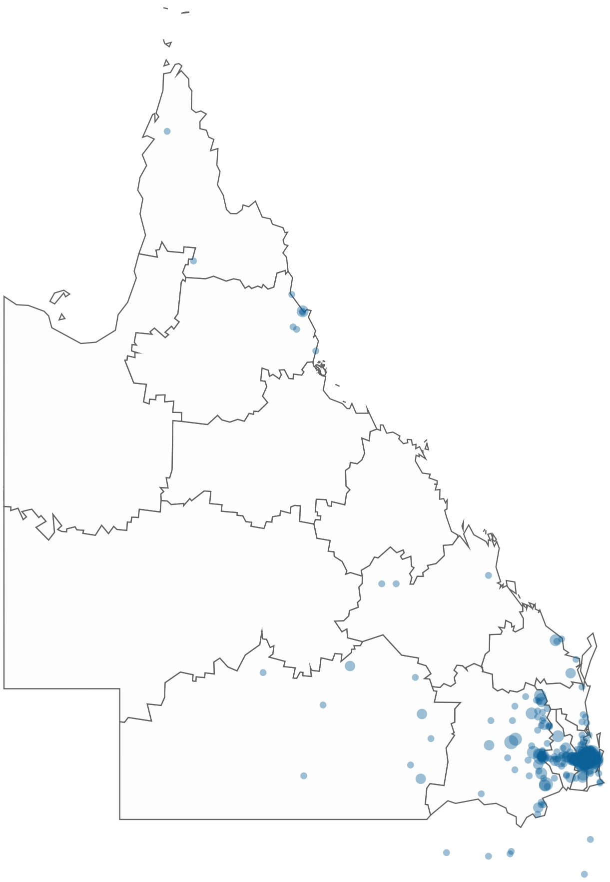


Figure 4: *Princess Alexandra Hospital*

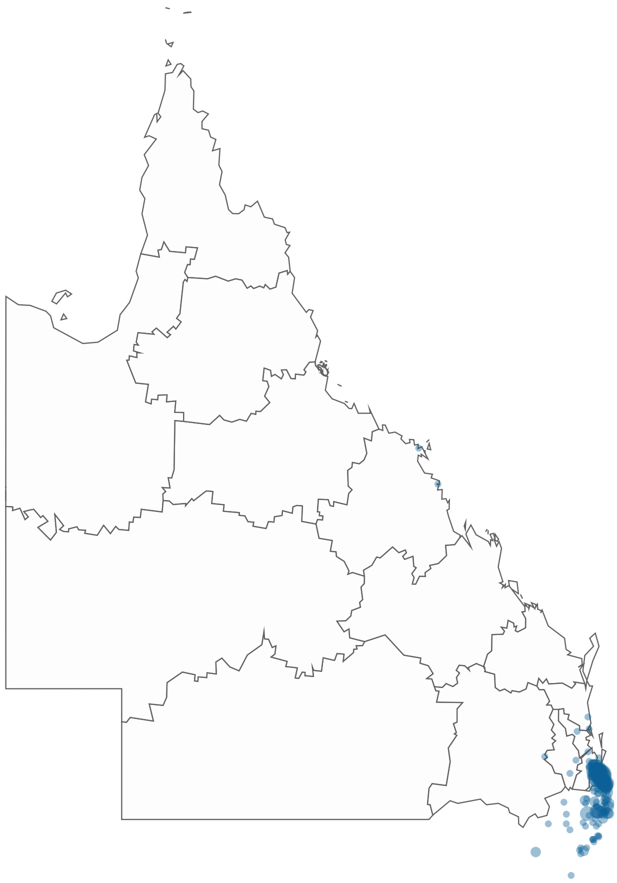


Figure 5: *Gold Coast University Hospital*

4 Case totals

4.1 Total surgeries

In 2021, the four public hospitals performed a total of 2,623 cardiac surgical procedures. For the purposes of this report, each of the procedure combinations included in those cases has been assigned to a cardiac surgery procedure category.

Table 2: Procedure counts and surgery category

Procedure combination	Category*	Count n
CABG	ANY CABG	1,181
CABG + other cardiac procedure		54
CABG + other non cardiac procedure		13
CABG + aortic procedure		7
CABG + aortic procedure + other cardiac procedure		1
CABG + valve	CABG + VALVE	179
CABG + valve + other cardiac procedure		32
CABG + valve + aortic procedure		27
CABG + valve + aortic procedure + other cardiac procedure		6
CABG + valve + other cardiac procedure + other non cardiac procedure		2
Valve	VALVE†	642
Valve + aortic procedure		123
Valve + other cardiac procedure		98
Valve + aortic procedure + other cardiac procedure		23
Valve + other cardiac procedure + other non cardiac procedure		2
Valve + other non cardiac procedure		2
Valve + aortic procedure + other non cardiac procedure		1
Other cardiac procedure	OTHER	122
Aortic procedure		82
Aortic procedure + other cardiac procedure		14
Other cardiac procedure + other non cardiac procedure		9
Aortic procedure + other non cardiac procedure		3
All		**2,623**

* Category procedure combination allocated

† Includes TAVR procedures (n=118)

Cardiac Surgery

4.2 Cases by category

Over half (57%) of all cardiac surgery procedures involved coronary artery bypass grafting (CABG) with 9% involving a simultaneous CABG and valve procedure.

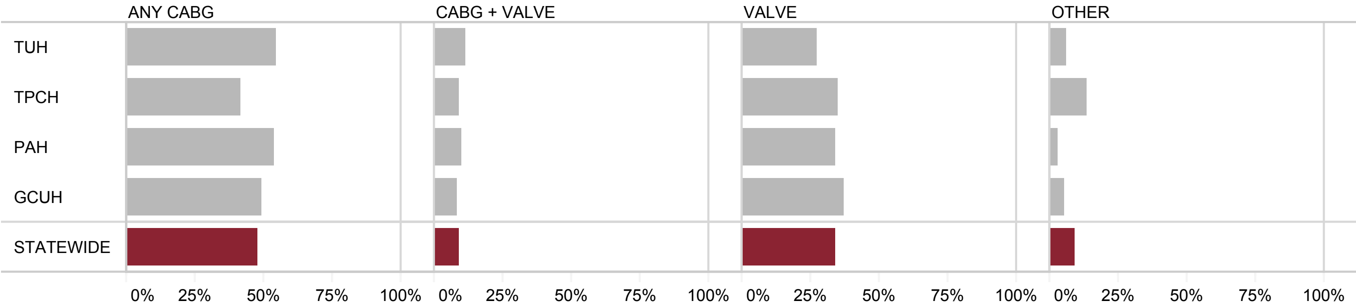


Figure 6: Proportion of cases by site and surgery category

Table 3: Proportion of cases by surgery category

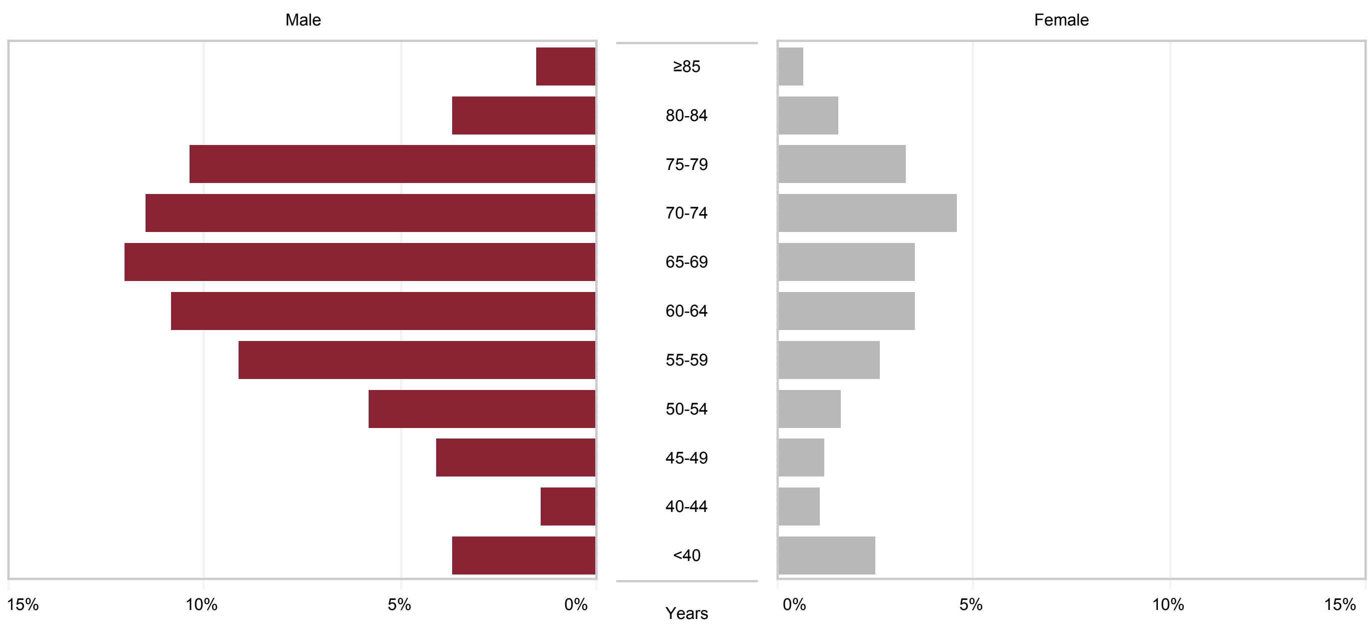
SITE	All cases n	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)
TUH	380	209 (55.0)	43 (11.3)	104 (27.4)	24 (6.3)
TPCH	1,175	493 (42.0)	107 (9.1)	410 (34.9)	165 (14.0)
PAH	617	331 (53.6)	59 (9.6)	209 (33.9)	18 (2.9)
GCUH	451	223 (49.4)	37 (8.2)	168 (37.3)	23 (5.1)
STATEWIDE	**2,623**	**1,256 (47.9)**	**246 (9.4)**	**891 (34.0)**	**230 (8.7)**

5 Patient characteristics

5.1 Age and gender

Age is a demonstrated risk factor for developing cardiovascular disease. More than two thirds of patients were aged between 61 years and 80 years (67%). The male cohort of 65 years to 69 years accounted for the largest proportion of cases (12% of all cases or 16% of males). Approximately 9% of surgeries were performed on patients younger than 45 years of age.

The median age for both males and females undergoing cardiac surgery was 66 years. Males undergoing valve surgery were more likely to be older than females (71 years vs. 68 years respectively).



% of total (n=2,623)

Figure 7: Proportion of all cases by age group and gender

Table 4: Median age by gender and surgery category

	Total cases n	Male years	Female years	Total years
ANY CABG	1,256	66	66	66
CABG + VALVE	246	71	68	70
VALVE	891	67	67	67
OTHER	230	57	54	57
ALL	**2,623**	**66**	**66**	**66**

Overall, almost three quarters of patients were male (74%).

The largest proportion of females were represented in the valve (37%) and other cardiac surgery (34%) categories, whilst surgeries involving CABG were more commonly performed on males than females (82% vs. 18% respectively).

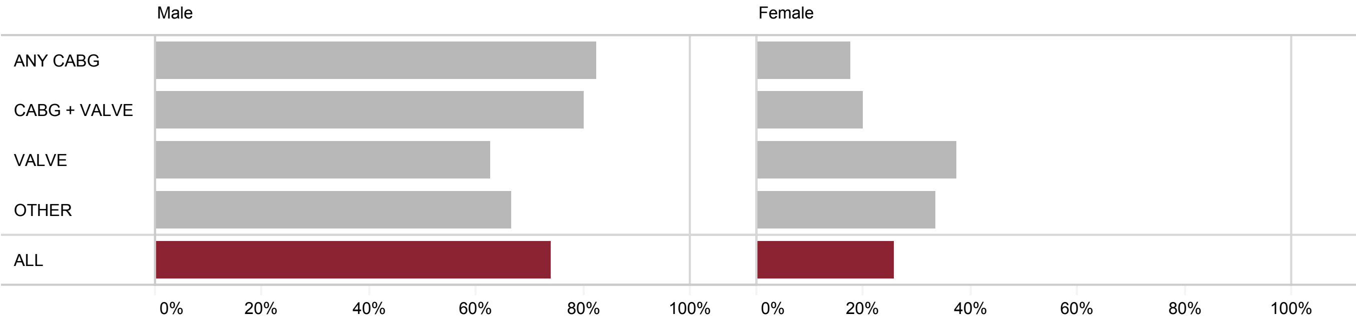


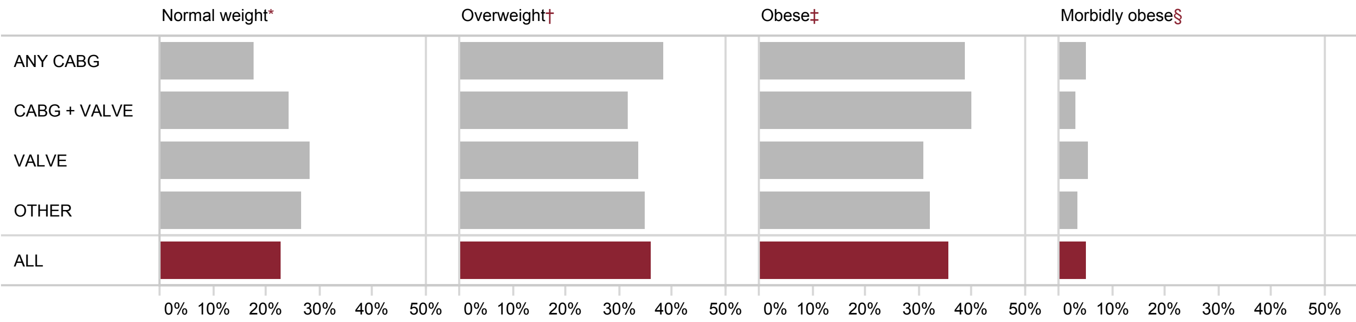
Figure 8: Proportion of cases by gender and surgery category

5.2 Body mass index

Only 22% of patients undergoing heart surgery had a body mass index (BMI) in the healthy range, compared to 77% of patients who fell into the categories of overweight, obese, or severely obese.

Just over one quarter (28%) of all patients undergoing valve surgery were classed as having a BMI in the normal range.

Patients classed as underweight (BMI <18.5kg/m^2) represented 1% of all cases.



Excludes missing data (<0.1%)

* BMI 18.5–24.9 kg/m^2

† BMI 25.0–29.9 kg/m^2

‡ BMI 30.0–39.9 kg/m^2

§ BMI ≥40.0 kg/m^2

Figure 9: Proportion of cases by BMI and surgery category

Table 5: Cases by BMI and surgery category

	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Morbidly obese n (%)
ANY CABG	2 (0.2)	219 (17.4)	483 (38.5)	487 (38.8)	65 (5.2)
CABG + VALVE	2 (0.8)	60 (24.4)	78 (31.7)	98 (39.8)	8 (3.3)
VALVE	17 (1.9)	248 (27.8)	301 (33.8)	276 (31.0)	49 (5.5)
OTHER	7 (3.1)	61 (26.6)	80 (34.9)	73 (31.9)	8 (3.5)
ALL	**28 (1.1)**	**588 (22.4)**	**942 (35.9)**	**934 (35.6)**	**130 (5.0)**

Excludes missing data (<0.1%)

5.3 Aboriginal and Torres Strait Islander status

Ethnicity is an important determinant of cardiovascular disease development. Aboriginal and Torres Strait Islander peoples, in particular are recognised as having higher incidence and prevalence of coronary heart disease than other ethnic groups.[1]

Overall, the proportion of identified Aboriginal and Torres Strait Islander patients undergoing cardiac surgery was 7.0%. This proportion is larger than the estimated 4.6% of the overall Queensland population that Aboriginal and Torres Strait Islander people account for.[2]

One fifth (20%) of patients undergoing cardiac surgery at TUH were identified as Aboriginal and Torres Strait Islander.

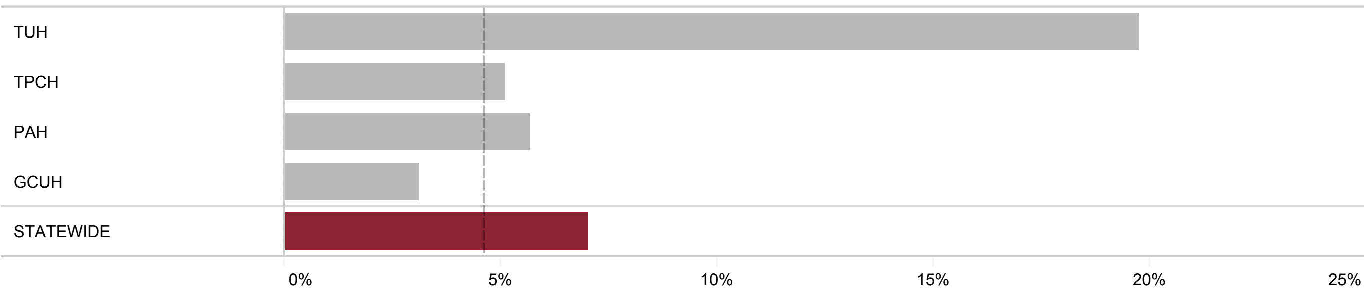


Figure 10: Proportion of all cardiac surgical cases by identified Aboriginal and Torres Strait Islander status and site

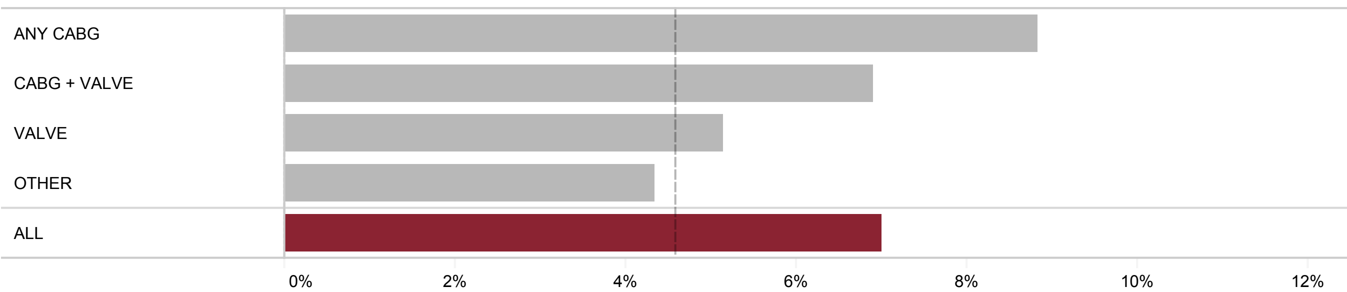
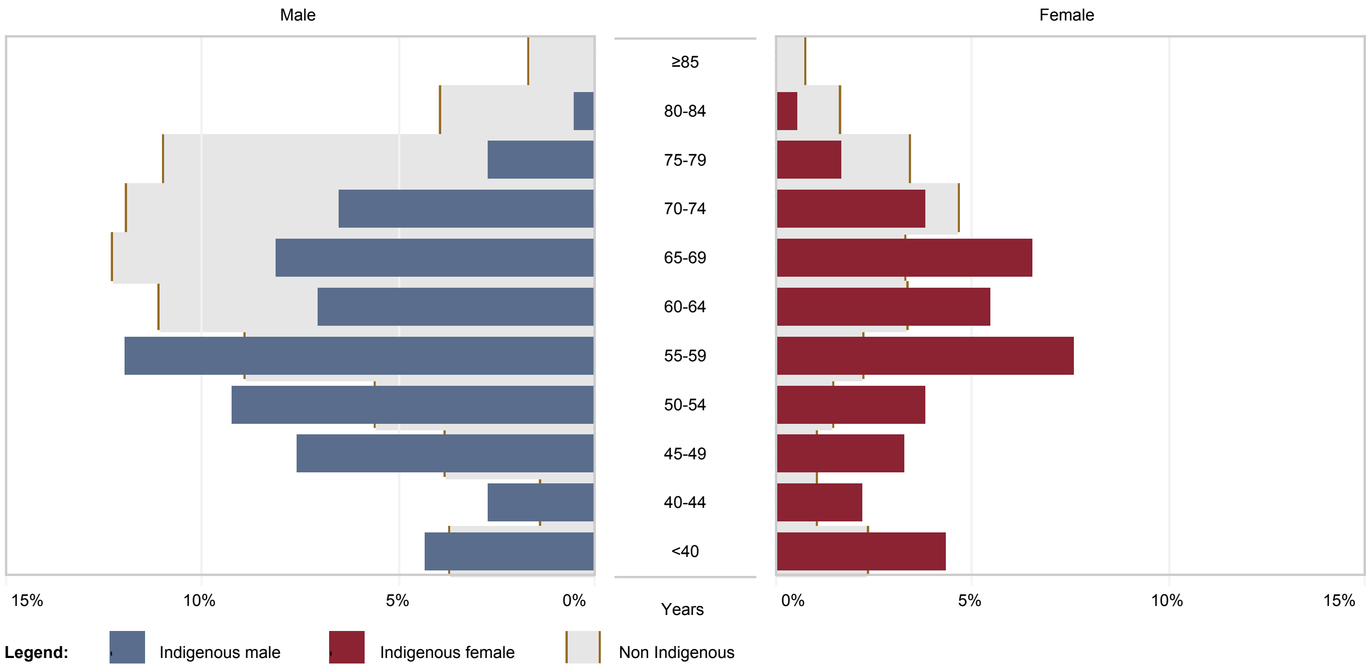


Figure 11: Proportion of cases by identified Aboriginal and Torres Strait Islander status and surgery category

The median age for Aboriginal and Torres Strait Islander Queenslanders undergoing cardiac surgery was 58 years, whereas the median age of non-Indigenous patients was 67 years.



% of total Aboriginal and Torres Strait Islander (n=184) vs. total non-Indigenous (n=2,439)

Figure 12: Aboriginal and Torres Strait Islander status and age category

Table 6: Median patient age by gender and Aboriginal and Torres Strait Islander status

	Male years	Female years	Total years
Aboriginal and Torres Strait Islander	60	57	58
Non Aboriginal and Torres Strait Islander	67	66	67
All	**66**	**66**	**66**

6 Risk factors and comorbidities

The development of coronary artery disease is dependent on several background variables and risk factors. Within our cohort the majority of patients undergoing cardiac surgery present with a combination of several different risk factors.

- The majority of patients (60%) had a history of tobacco use including 16% current smokers (defined as smoking within 30 days of the procedure) and 44% former smokers. Of the remaining patients, 40% reported never having smoked.
- Overall, 28% of all cardiac surgical patients were reported as diabetic. The prevalence of diabetes was highest in the CABG patient group (38%).
- Hypertension, defined as receiving antihypertensive medications at the time of surgery, was present in 66% of patients with considerable variation by surgery type (range 46% to 75%).
- Overall, 64% of patients had hypercholesterolaemia at the time of surgery, ranging from 80% in the CABG category to 36% in the other surgery category.
- Over half (54%) of all patients were identified as having impaired renal function (eGFR ≤89 mL/min/1.73 m^2) at the time of their surgery.
- There were 109 patients with active or previous infective endocarditis.
- Over one quarter (28%) of patients were classed as having an impaired left ventricular ejection fraction (LVEF), including, 4% with severe LV dysfunction (LVEF less than 30%), 6% with moderate LV dysfunction (LVEF between 30% to 39%) and 18% having mild LV dysfunction (LVEF between 40% to 49%) at the time of surgery.
- Overall, 41% of patients had a BMI which was classed as obese or morbidly obese (BMI ≥30 kg/m^2).

Table 7: Summary of risk factors by surgery category

	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)	ALL n (%)
Former smoker	588 (46.8)	103 (41.9)	344 (38.6)	93 (40.4)	1,128 (43.0)
Current smoker	245 (19.5)	49 (19.9)	99 (11.1)	20 (8.7)	413 (15.7)
Diabetes	478 (38.1)	77 (31.3)	155 (17.4)	27 (11.7)	737 (28.1)
Hypertension	943 (75.1)	170 (69.1)	521 (58.5)	105 (45.7)	1,739 (66.3)
Hypercholesterolaemia	1,004 (79.9)	182 (74.0)	412 (46.2)	82 (35.7)	1,680 (64.0)
eGFR 60–89 mL/min/1.73 m^2	416 (33.1)	92 (37.4)	283 (31.8)	59 (25.7)	850 (32.4)
eGFR 30–59 mL/min/1.73 m^2	177 (14.1)	64 (26.0)	215 (24.1)	31 (13.5)	487 (18.6)
eGFR <30 mL/min/1.73 m^2	38 (3.0)	4 (1.6)	29 (3.3)	4 (1.7)	75 (2.9)
Infective endocarditis	1 (0.1)	14 (5.7)	5 (2.2)	89 (10.0)	109 (4.2)
LVEF 40–50%	281 (22.4)	49 (19.9)	131 (14.7)	18 (7.8)	479 (18.3)
LVEF 30–39%	84 (6.7)	19 (7.7)	42 (4.7)	9 (3.9)	154 (5.9)
LVEF <30%	55 (4.4)	16 (6.5)	18 (2.0)	19 (8.3)	108 (4.1)
BMI ≥30 kg/m^2	552 (43.9)	106 (43.1)	325 (36.5)	81 (35.2)	1,064 (40.6)

The majority of patients (89%) had a combination of two or more of those risk factors outlined in Table 8, while almost one third of patients undergoing CABG (32%) had five or more risk factors. This demonstrates the variation of disease processes associated with underlying pathology and highlights the complex medical history of this cohort.

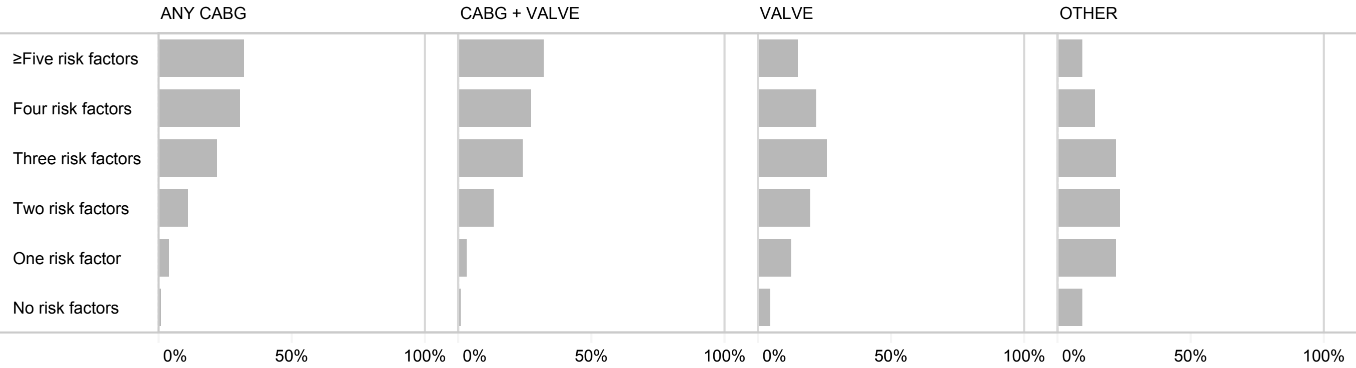


Figure 13: Number of patient risk factors by surgery category

Table 8: Aggregated patient risk factors by surgery category

	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)	ALL n (%)
Five or more risk factors	407 (32.4)	79 (32.1)	132 (14.8)	21 (9.1)	639 (24.4)
Four risk factors	382 (30.4)	67 (27.2)	196 (22.0)	32 (13.9)	677 (25.8)
Three risk factors	274 (21.8)	59 (24.0)	233 (26.2)	51 (22.2)	617 (23.5)
Two risk factors	141 (11.2)	32 (13.0)	177 (19.9)	54 (23.5)	404 (15.4)
One risk factor	49 (3.9)	8 (3.3)	114 (12.8)	50 (21.7)	221 (8.4)
No risk factors	3 (0.2)	1 (0.4)	39 (4.4)	22 (9.6)	65 (2.5)
Total	**1,256 (100.0)**	**246 (100.0)**	**891 (100.0)**	**230 (100.0)**	**2,623 (100.0)**

6.1 Infective endocarditis

There were 109 cases of infective endocarditis (IE) that required cardiac surgical intervention. At the time of surgery, nearly three quarters (n=80) were active infections.

Native valve endocarditis was observed in 81% of active infections, with prosthetic valve infection apparent in 13% of active endocarditis cases.

Table 9: Infective endocarditis status

Endocarditis status	n (%)
Active	80 (73.4)
Treated	29 (26.6)
Total	**109 (100.0)**

Table 10: Active infective endocarditis by site of infection

Active endocarditis site	n (%)
Native valve	65 (81.3)
Prosthetic valve	7 (8.8)
Aortic root	3 (3.8)
Aortic root + prosthetic valve	2 (2.5)
Aortic root + mitral annulus	1 (1.3)
Aortic root + prosthetic valve + pacemaker	1 (1.3)
Intracardiac shunt	1 (1.3)
Total	**80 (100.0)**

6.1.1 Organism

Over one quarter (29%) of all active IE cases were identified as a streptococcus infection, while Methicillin-susceptible Staphylococcus aureus was responsible for one quarter of all surgeries for active IE. The responsible organism was unidentified in 6% of cases.

Table 11: Identified organism in active IE cases

Active organism	n (%)
Streptococcus	23 (28.7)
MSSA*	20 (25.0)
Other	17 (21.3)
Staphylococcus (other)	8 (10.0)
Organism unidentified	5 (6.3)
Enterococcus faecalis	4 (5.0)
Propionibacterium acnes	3 (3.8)
All	**80 (100.0)**

* Methicillin-susceptible Staphylococcus aureus

6.1.2 Intravenous drug use

Overall, 14% of all active infective endocarditis cases were linked to a history of intravenous drug use (IVDU) with the majority being current IVDU.

Table 12: Proportion of intravenous drug use associated with active IE

IVDU history	n (%)
Current IVDU (≤3 months)	7 (8.8)
Previous IVDU (>3 months)	4 (5.0)
No history of IVDU	63(78.8)
Unknown	6 (7.5)
Total	**80 (100.0)**

7 Care and treatment of patients

7.1 Admission status

The admission status of patients undergoing cardiac surgery varied widely across surgery categories.. Most CABG cases were performed as urgent cases, whilst also contributing to a significant proportion (37%) of the emergency cases. Approximately one third (33.5%) of all operations in the 'Other surgery' category were performed on an emergent basis, in particular correction of aortic dissection. Valve procedures were mostly performed on an elective basis.

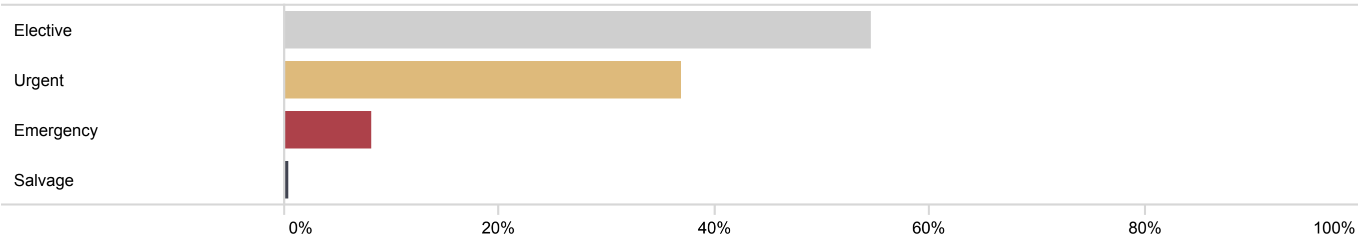


Figure 14: Proportion of cases by admission status

Table 13: Cases by admission status and surgery category

	Elective n (%)	Urgent n (%)	Emergency n (%)	Salvage n (%)
ANY CABG	456 (36.3)	718 (57.2)	79 (6.3)	3 (0.2)
CABG + VALVE	144 (58.5)	87 (35.4)	14 (5.7)	1 (0.4)
VALVE	705 (79.1)	144 (16.2)	41 (4.6)	1 (0.1)
OTHER	127 (55.2)	21 (9.1)	77 (33.5)	5 (2.2)
ALL	**1,432 (54.6)**	**970 (37.0)**	**211 (8.0)**	**10 (0.4)**

7.2 Day of surgery admission

Day of surgery admission (DOSA) rates accounted for 19% of all elective cases, with some variation observed across some surgery categories.

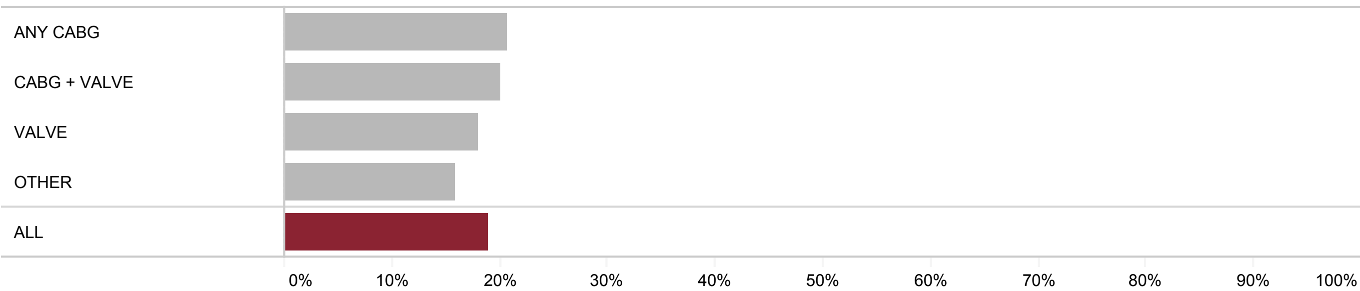


Figure 15: Proportion of elective cases for DOSA cases by surgery category

Table 14: DOSA cases by surgery category

	Total elective cases n	DOSA cases n (%)
ANY CABG	456	94 (20.6)
CABG + VALVE	144	29 (20.1)
VALVE	705	127 (18.0)
OTHER	127	20 (15.7)
Total	**1,432**	**270 (18.9)**

7.3 Coronary artery bypass grafting

7.3.1 Number of diseased vessels

There were 1,499 CABG procedures performed across all sites. The majority (91%) had multi-vessel disease.

When CABG was performed in conjunction with a valve procedure, 63% of patients had multi-vessel disease compared to 96% when CABG surgery was performed without a valve intervention.

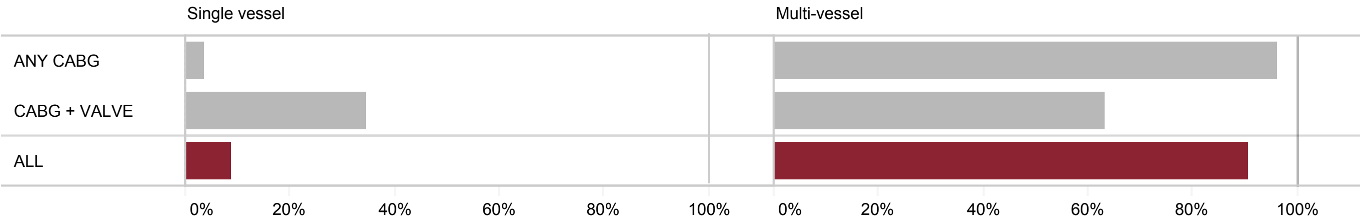


Figure 16: Number of diseased vessels by surgery category

Table 15: Number of diseased vessels by surgery category

	Single vessel n (%)	Multi-vessel n (%)	Total n (%)
ANY CABG	46 (3.7)	1,207 (96.2)	1,255 (100.0)
CABG + VALVE	84 (34.4)	154 (63.1)	244 (100.0)
ALL	**130 (8.7)**	**1,361 (90.8)**	**1,499 (100.0)**

Missing data not displayed (n=8)

7.3.2 Number of grafts

For CABG procedures an average of 2.7 grafts were used. In multi vessel CABG, the mean number of grafts utilised was 2.8.

Table 16: Number of grafts by number of diseased vessels

	Single vessel mean	Multi-vessel mean	Multi-vessel median	Total mean
ANY CABG	1.1	2.9	3.0	2.8
CABG + VALVE	1.1	2.5	2.0	2.0
ALL	**1.1**	**2.8**	**3.0**	**2.7**

7.3.3 Conduits used

In CABG, including surgeries involving valvular intervention, the most common method of revascularisation included the use of a combination of an arterial and venous graft (68%). Total arterial revascularisation occurred in one quarter of cases.

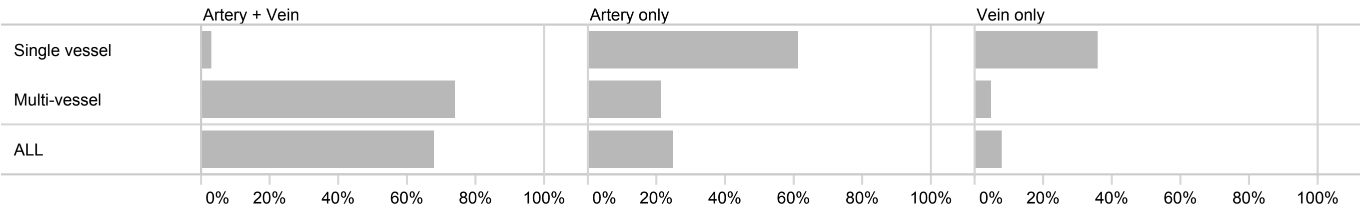


Figure 17: Proportion of diseased vessels by conduits used

Table 17: Conduits used by number of diseased vessels

	Artery + vein n (%)	Artery only n (%)	Vein only n (%)
Single vessel	4 (3.1)	80 (61.1)	47 (35.9)
Multi-vessel	1,008 (74.0)	288 (21.1)	66 (4.8)
ALL	**1,012 (67.8)**	**368 (24.6)**	**113 (7.6)**

Excludes missing data (n=8)

7.3.4 Off pump CABG

Overall, 3% of isolated CABG operations were performed without the use of cardiopulmonary bypass.

Table 18: Off pump CABG

	Total cases n	Off pump n (%)
Isolated CABG	1,181	37 (3.1)

7.3.5 Y or T grafts

Approximately 6% of all CABG surgeries utilised a Y or T graft.

Table 19: Y or T graft used by procedure category

	Total cases n	Y or T graft n (%)
ANY CABG	1,256	77 (6.1)
CABG + VALVE	246	9 (3.7)
ALL	**1,502**	**86 (5.7)**

7.4 Aortic surgery

There were 287 cases that included a procedure involving the aorta (not including procedures performed on the aortic valve). Aortic aneurysm was the primary reason for aortic surgery (62%), while acute aortic dissection was the pathology responsible for 18% of aortic surgery cases.

Most aortic surgery procedures included replacement of the ascending aorta in isolation (47%), while surgery to replace both the ascending aorta and aortic arch accounted for 11% of cases.

Aortoplasty involving patch repair was performed in approximately 13% of aortic surgery cases.

Table 20: Aortic surgery by procedure type

Aortic surgery type	n (%)
Replacement	185 (64.5)
Ascending aorta	136 (47.4)
Ascending aorta + aortic arch	30 (10.5)
Descending aorta	6 (2.1)
Ascending aorta + aortic arch + descending aorta	4 (1.4)
Ascending aorta + descending aorta	2 (0.7)
Aortic arch + descending aorta	1 (0.3)
Aortic arch + descending aorta + thoraco-abdominal	1 (0.3)
Aortic arch + thoraco-abdominal	1 (0.3)
Ascending aorta + aortic arch + descending aorta + thoraco-abdominal	1 (0.3)
Ascending aorta + aortic arch + thoraco-abdominal	1 (0.3)
Ascending aorta + descending aorta + thoraco-abdominal	1 (0.3)
Descending aorta + thoraco-abdominal	1 (0.3)
Aortoplasty	87 (30.3)
Direct aortoplasty	54 (18.8)
Patch repair	33 (11.5)
Aortoplasty and replacement	15 (5.2)
Direct aortoplasty + ascending aorta replacement	5 (1.7)
Direct aortoplasty + ascending aorta replacement + aortic arch replacement	5 (1.7)
Patch repair + ascending aorta replacement	2 (0.7)
Direct aortoplasty + descending aorta replacement	1 (0.3)
Patch repair + descending aorta replacement + thoraco-abdominal replacement	1 (0.3)
Patch repair + ascending aorta replacement + aortic arch replacement	1 (0.3)
ALL	**287 (100.0)**

7.4.1 Aortic pathology

Table 21: Aortic surgery cases by pathology type

Aortic pathology type	n (%)
Aortic aneurysm	179 (62.4)
Aortic dissection (≤2 weeks)	51 (17.8)
Abscess	11 (3.8)
Calcification	9 (3.1)
Aortic dissection (>2 weeks)	5 (1.7)
Traumatic transection	1 (0.3)
Other	31 (10.8)
ALL	**287 (100.0)**

7.5 Valve surgery

There were 1,137 valve surgery procedures performed at the participating sites during 2021.

The aortic valve was the most commonly operated on valve either with or without other valves (67%). While almost one quarter (24%) of valve surgeries were performed on the mitral valve in isolation.

Overall, 12% of valve operations performed comprised of intervention to multiple valves.

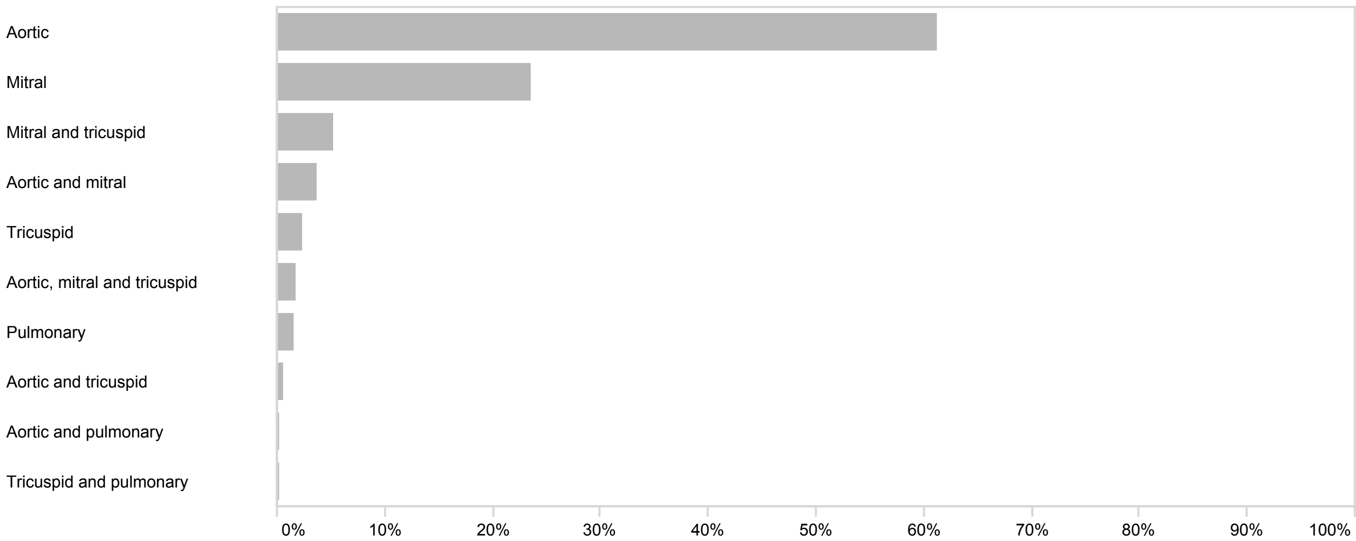


Figure 18: Proportion of valve surgery cases by valve

Table 22: Valve surgery cases by valve

Type of valve surgery	n (%)
Aortic	695 (61.1)
Mitral	267 (23.5)
Mitral and tricuspid	59 (5.2)
Aortic and mitral	42 (3.7)
Tricuspid	27 (2.4)
Aortic, mitral and tricuspid	20 (1.8)
Pulmonary	17 (1.5)
Aortic and tricuspid	6 (0.5)
Aortic and pulmonary	2 (0.2)
Tricuspid and pulmonary	2 (0.2)
ALL	**1,137 (100.0)**

7.5.1 Valve pathology

The most common valve pathology across all valve types was a degenerative cause (54%) which accounted for more than half of all aortic (56%) and mitral (57%) valve procedures.

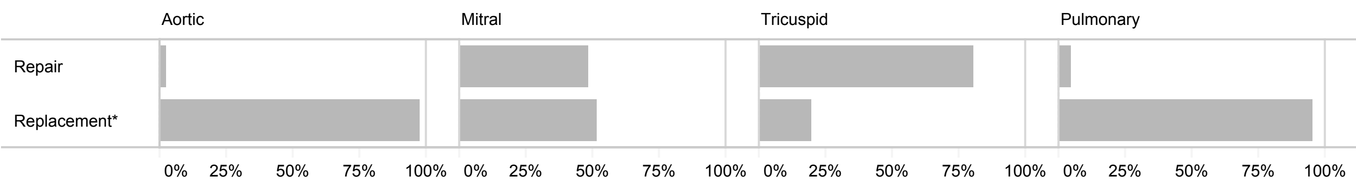
Table 23: Valve pathology by valve type

	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Degenerative	431 (56.3)	221 (57.0)	37 (32.5)	–	689 (53.5)
Congenital	137 (17.9)	13 (3.4)	6 (5.3)	13 (65.0)	169 (13.1)
Rheumatic	31 (4.1)	49 (12.6)	18 (15.8)	–	98 (7.6)
Infection	45 (5.9)	41 (10.6)	12 (10.5)	2 (10.0)	100 (7.8)
Prosthesis failure	51 (6.7)	22 (5.7)	1 (0.9)	1 (5.0)	75 (5.8)
Dissection	37 (4.8)	–	–	–	37 (2.9)
Annuloaortic ectasia	13 (1.7)	–	–	–	13 (1.0)
Functional	–	7 (1.8)	27 (23.7)	–	34 (2.6)
Ischaemic	–	26 (6.7)	–	–	26 (2.0)
Failed prior repair	–	–	1 (0.9)	2 (10.0)	3 (0.2)
Iatrogenic	1 (0.1)	–	2 (1.8)	–	3 (0.2)
Other	19 (2.5)	9 (2.3)	10 (8.8)	2 (10.0)	40 (3.1)
ALL	**765 (100.0)**	**388 (100.0)**	**114 (100.0)**	**20 (100.0)**	**1,287 (100.0)**

7.5.2 Types of valve surgery

Fifty nine percent of valve interventions involved aortic valve surgery. The most common aortic valve procedure was replacement surgery (98%).

Mitral valve procedures were more evenly distributed with replacement slightly more frequent than repair (51% vs. 49%).



Inspection only procedures not shown (n=2)

* Includes transcatheter valve replacement (TAVR or TMVR) procedures involving CTS

Figure 19: Valve surgery category by valve

Table 24: Valve surgery category by valve type

Valve surgery category	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Repair	17 (2.2)	188 (48.4)	92 (80.7)	1 (4.8)	298 (23.1)
Replacement*	747 (97.7)	199 (51.3)	22 (19.3)	20 (95.2)	988 (76.7)
Inspection only	1 (0.1)	1 (0.3)	–	–	2 (0.2)
ALL	**765 (100.0)**	**388 (100.0)**	**114 (100.0)**	**21 (100.0)**	**1,288 (100.0)**

* Includes transcatheter valve replacement (TAVR or TMVR) procedures involving CTS

Transcatheter aortic valve replacement (TAVR)

A multidisciplinary heart team involving both cardiologists and cardiac surgeons is often required to plan and perform a TAVR procedure. Despite the varied role of the surgeon in the heart team, 49% of all TAVR were performed with a cardiac surgeon involved in the valve procedure.

This Audit reflects those TAVR cases where a cardiothoracic surgeon was present during the procedure. As such, it does not represent the total number of these interventions performed in Queensland public hospitals in 2021.

More information regarding all TAVR procedures performed in Queensland public hospitals is included in the structural heart disease supplement to the Interventional Cardiology Audit of this Annual Report.

Table 25: TAVR cases by site and CS involvement

Site	All TAVR n	Combined CS and Cardiologist TAVR n (%)
TUH	13	13 (100.0)
TPCH	136	16 (11.8)
PAH	62	61 (98.4)
GCUH	28	28 (100.0)
STATEWIDE	**239**	**118 (49.4)**

7.5.3 Valve repair surgery

Almost three quarters (74%) of valve repair surgery were repair/reconstruction with annuloplasty followed by annuloplasty only (16%). The most common individual valve repair surgery type was mitral valve repair/reconstruction with annuloplasty, comprising over half of overall valve repair surgery (54%).

Table 26: Valve repair surgery by valve type

Surgery category	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Repair/reconstruction with annuloplasty	–	162 (86.2)	58 (61.9)	–	220 (73.5)
Annuloplasty only	–	21 (11.2)	28 (30.4)	–	49 (16.4)
Repair/reconstruction without annuloplasty	1 (5.9)	5 (2.7)	5 (5.4)	–	11 (3.7)
Resuspension of the aortic valve	9 (52.9)	–	–	–	9 (3.0)
Root reconstruction with valve sparing	5 (29.4)	–	–	–	5 (1.7)
Tumour tissue removal	1 (5.9)	–	–	1 (100.0)	2 (0.7)
Decalcification	1 (5.9)	–	–	–	1 (0.3)
Valvectomy only	–	–	1 (1.1)	–	1 (0.3)
ALL	**17 (100.0)**	**188 (100.0)**	**92 (100.0)**	**1 (100.0)**	**298 (100.0)**

7.5.4 Valve replacement surgery

Aortic valve replacement accounted for the majority of valve replacement surgeries (76%), which included 118 TAVR procedures and 91 aortic root reconstruction surgeries utilising a valved conduit.

Table 27: Valve replacement surgery by valve type

Surgery type	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Surgical valve replacement	538 (72.0)	197 (99.0)	22 (100.0)	20 (100.0)†	777 (78.6)
Transcatheter valve replacement*	118 (15.8)	2 (1.0)	–	–	120 (12.1)
Root reconstruction with valve conduit	91 (12.2)	–	–	–	91 (9.2)
ALL	**747 (100.0)**	**199 (100.0)**	**22 (100.0)**	**20 (100.0)**	**988 (100.0)**

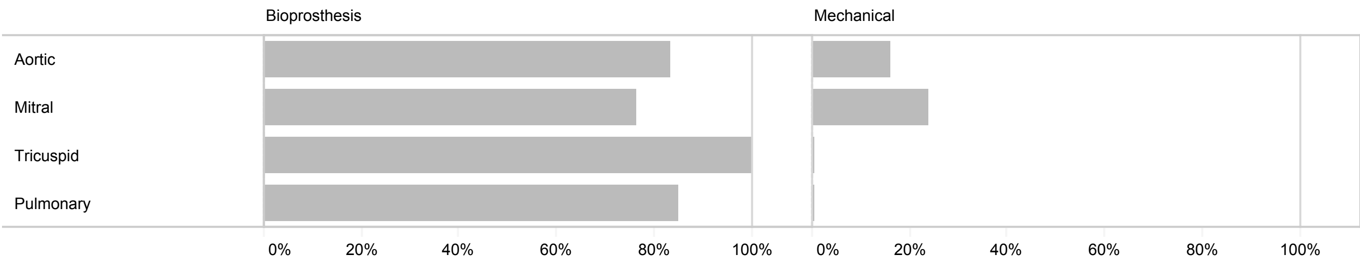
* Includes TAVR or TMVR procedures involving a cardiothoracic surgeon

† Includes replacement of pulmonary root as part of a Ross-Yacoub procedure

Prosthesis type

The most common form of valve prostheses used across all valve types were biological (82%), either bovine (57%) or porcine (26%). Mechanical prostheses were used in 17% of cases with a greater proportion represented in mitral valve replacement surgeries.

Bovine-derived aortic valve prostheses accounted for the largest proportion of all valves used, representing 70% of all aortic valve prostheses and 57% of the total valvular prostheses used.



Homograft/allograft and autograft prosthesis not displayed (0.6%)

Figure 20: Proportion of valve replacements by valve prosthesis category and valve type

Table 28: Types of valve prosthesis by valve type

Prosthesis type	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Biological – bovine	525 (70.3)	24 (12.1)	2 (9.1)	10 (50.0)	561 (56.8)
Biological – porcine	99 (13.3)	128 (64.3)	20 (90.9)	7 (35.0)	254 (25.7)
Mechanical	120 (16.1)	47 (23.6)	–	–	167 (16.9)
Homograft/allograft	2 (0.3)	–	–	2 (10.0)	4 (0.4)
Autograft	1 (0.1)	–	–	1 (5.0)	2 (0.2)
ALL	**747 (100.0)**	**199 (100.0)**	**22 (100.0)**	**20 (100.0)**	**988 (100.0)**

7.6 Other cardiac surgery

The most common forms of other cardiac surgery were left atrial appendage closure (28%), followed by atrial septal defect repair (10%). Atrial arrhythmia surgery accounted for 7% of other cardiac surgeries.

Table 29: Other cardiac procedures

Procedure	n (%)
Left atrial appendage closure	119 (28.3)
Atrial septal defect repair	42 (10.0)
Atrial arrhythmia surgery	31 (7.4)
Cardiac tumour	26 (6.2)
Other congenital cardiac procedure	22 (5.2)
Lung transplant – BSSLTx*	20 (4.8)
LVOT† myectomy for HOCM‡	15 (3.6)
Cardiac transplant	14 (3.3)
Cardiac thrombectomy	11 (2.6)
Left ventricular reconstruction	17 (4.0)
CIED§ procedure (revision/removal)	14 (3.3)
VAD‖ procedure	9 (2.1)
Acquired ventricular septal defect repair	6 (1.4)
Patent foramen ovale closure	6 (1.4)
ECMO# procedure	6 (1.4)
Atrial repair/reconstruction	6 (1.4)
Pericardiectomy	5 (1.2)
PAPVD** repair	5 (1.2)
Lung transplant – single lung	4 (1.0)
Right ventricular repair	4 (1.0)
Aortic root/LVOT† procedure to facilitate AVR	4 (1.0)
Other myectomy	4 (1.0)
Trauma	3 (0.7)
Pulmonary thrombo-endarterectomy	3 (0.7)
LV rupture repair	3 (0.7)
Coronary endarterectomy	3 (0.7)
Intracardiac foreign body removal	2 (0.5)
Pulmonary artery repair	2 (0.5)
Pulmonary embolectomy	1 (0.2)
Other	13 (3.1)
Total	**420 (100.0)**

* Bilateral sequential single lung transplantation

† Left ventricular outflow tract

‡ Hypertrophic obstructive cardiomyopathy

§ Cardiac implantable electronic device

‖ Ventricular assist device

Extracorporeal membrane oxygenation

** Partial anomalous pulmonary venous drainage

7.7 Blood product usage

The majority of surgeries did not require blood product transfusion (66%). However, as the urgency of operations increased, so too did the requirement for red blood cells (RBC) and non-red blood cells (NRBC). Over two thirds (67%) of all emergency cases utilised at least one blood product.

Blood product usage is further examined in the supplement attached to this year's report.

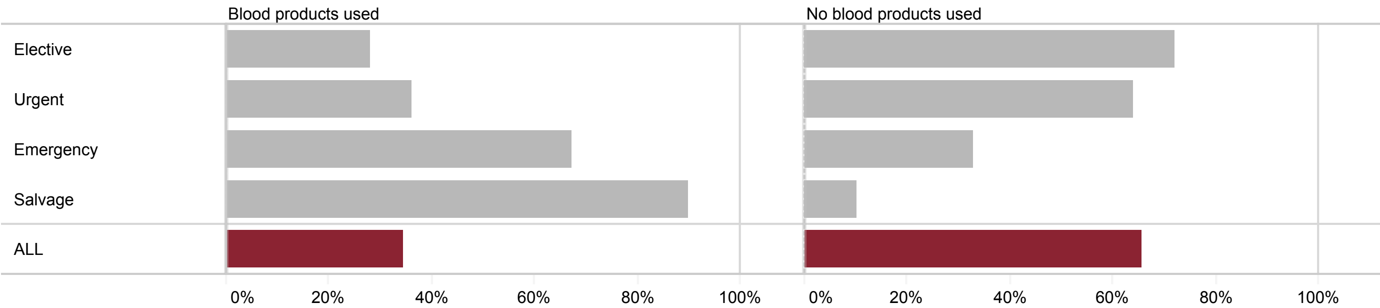


Figure 21: Blood products used by admission status

Table 30: Blood product type used by admission status

Admission status	Both RBC and NRBC n (%)	RBC only n (%)	NRBC only n (%)	No blood products n (%)
Elective	157 (11.0)	135 (9.4)	111 (7.8)	1,029 (71.9)
Urgent	129 (13.3)	157 (16.2)	64 (6.6)	620 (63.9)
Emergency	92 (43.6)	22 (10.4)	28 (13.3)	69 (32.7)
Salvage	8 (80.0)	1 (10.0)	–	1 (10.0)
ALL	**386 (14.7)**	**315 (12.0)**	**203 (7.7)**	**1,719 (65.5)**

8 Outcomes

Measures of outcomes in this cardiac surgery report comprise of factors that affect the risk of complications from procedures or operations and key targets for optimal procedural performance. The aim of this focus area is to compare the aggregated outcomes of the four Queensland adult cardiac surgical units against calculated risk scores which are in use both nationally and internationally.

8.1 Risk prediction models

Cardiac Surgery

Patient-specific comorbidities and clinical factors present at the time of surgery can significantly influence the likelihood that a patient will experience an adverse perioperative event. To account for these factors in cohort analysis, risk adjustment models are commonly employed. These statistical tools enable the adjustment of risk for individual patients, attempting to correct for patients who may be undergoing surgery in a critical pre-operative state, for example cardiogenic shock, as opposed to an elective procedure in a patient with limited comorbid factors.

Risk scores are usually established from large patient cohorts and are relevant for a particular period in time, and in a particular geographical area with specific ethnic, socioeconomic and cultural factors.

As such, it is important to explore multiple scores as a means of ensuring that relevant signals for potential improvement are not overlooked. Furthermore, it is important to adapt and adopt new risk scores as they are made available and incorporated into routine practice.

Mortality after an operation is the most common outcome evaluated using risk adjustment algorithms. However, the Society of Thoracic Surgeons (STS) has also developed a range of algorithms predictive of the post-operative risk of complications (morbidity).

The risk prediction models used in evaluating the 2021 clinical outcomes for cardiac surgical cases are:

- EuroSCORE[24]
- EuroSCORE II[25]
- ANZSCTS General Score[26]
- AusSCORE[27]
- STS Score (mortality and morbidity)[28,29,30]

8.1.1 Mortality

The risk adjustment analysis of 30 day mortality has been evaluated using a range of well described risk models. The EuroSCORE[24], EuroSCORE II[25], and ANZSCTS General Score[26] can be applied to evaluate deaths for all types of cardiac surgical cases, whereas the AusSCORE model[27] applies for mortality in CABG cases only.

All risk adjustment evaluations show that the observed mortality rate is either within or significantly lower than the predicted rate.

The STS models are constrained to clearly defined sub-groups of procedures. Patients who met the inclusion criteria were assessed and the remainder of patients excluded from the comparison analysis. In the STS model, all included case results were pooled for the CABG only, Valve only and CABG + Valve models. Similarly, the AusSCORE model has been presented side-by-side with other risk prediction models for CABG cases only.

Again, all risk adjustment evaluations show that the observed mortality rate is either within or lower than the predicted rate.

Legend: Observed   Predicted (95% confidence interval)

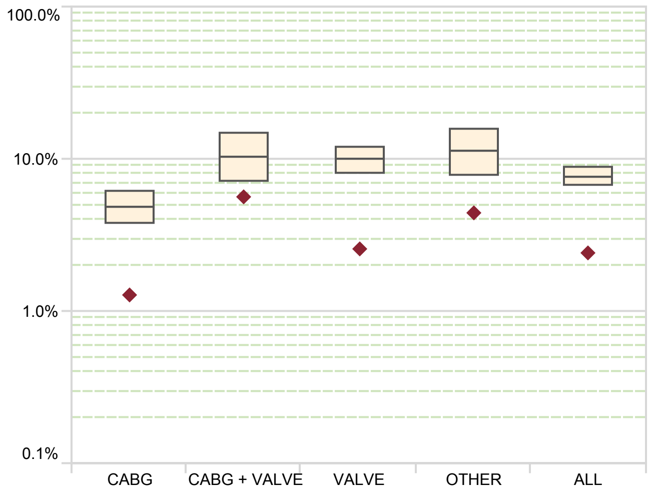


Figure 22: EuroSCORE

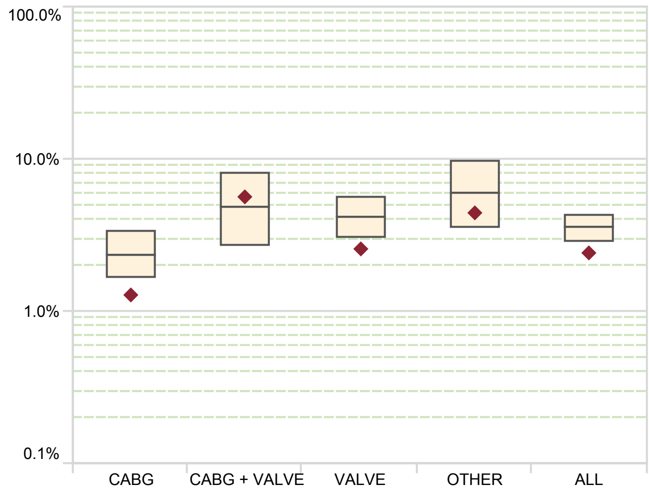


Figure 23: EuroSCORE II

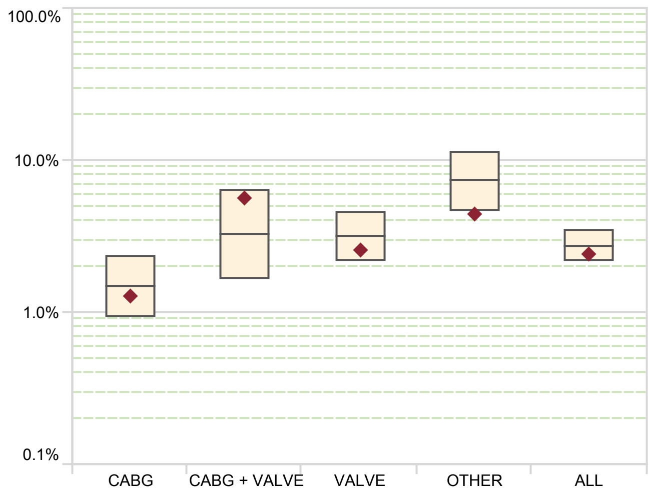


Figure 24: ANZSCTS (General Score)

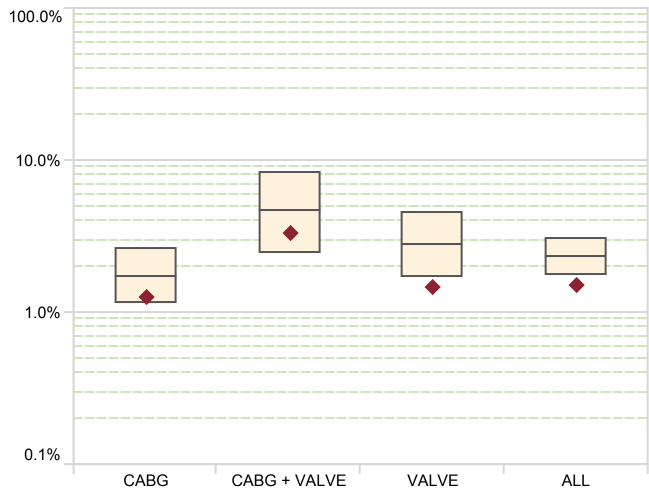


Figure 25: STS (death)

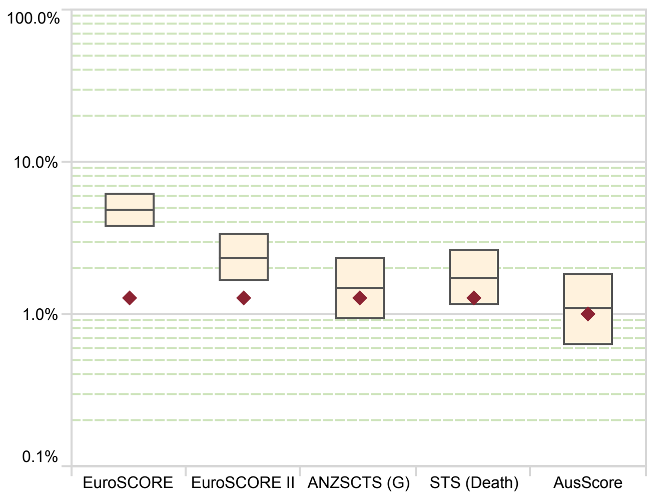


Figure 26: CABG

8.1.2 Morbidity

Patients undergoing cardiac surgery are at risk of experiencing a range of significant morbidities in the post-operative period. The STS risk models provide an estimate of the level risk for a patient undergoing cardiac surgery to be afflicted with these morbidities. These models have been applied to the defined surgical subgroups using the distinct inclusion criteria.

The aggregated morbidities chart (Figure 31) represents the observed rate of cases involving at least one of the five morbidities.

Most comparisons between the observed event rate and the rate predicted using the respective risk scores demonstrate that outcomes are within expectation. The incidence of prolonged ventilation for CABG patients and the rate of cerebrovascular accident in patients undergoing valve surgery is better than predicted.

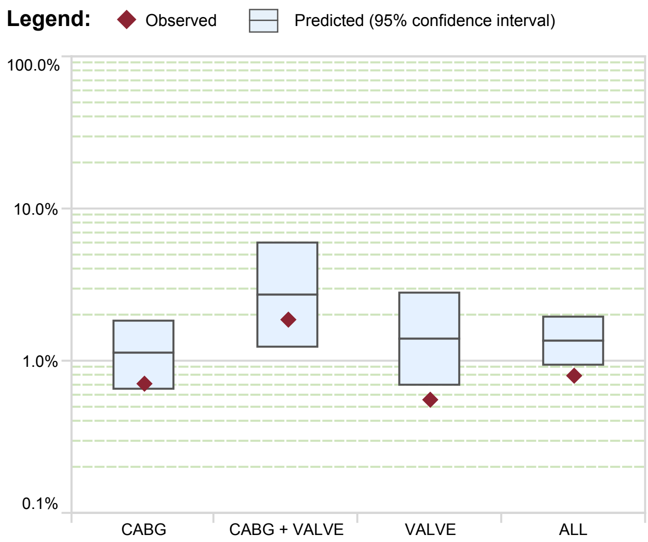


Figure 27: Cerebrovascular accident

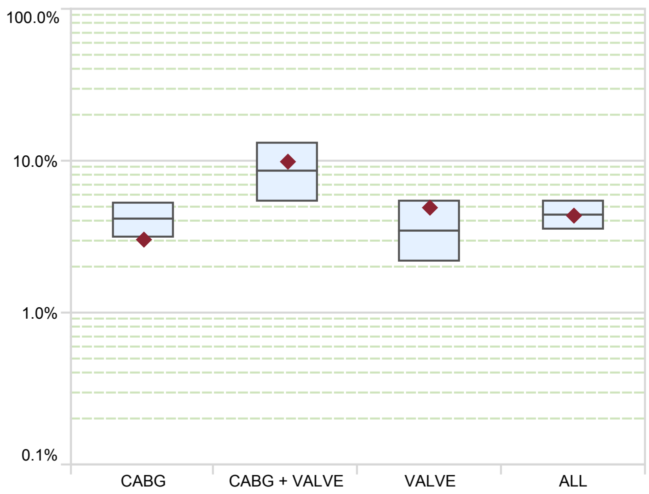


Figure 28: Renal failure

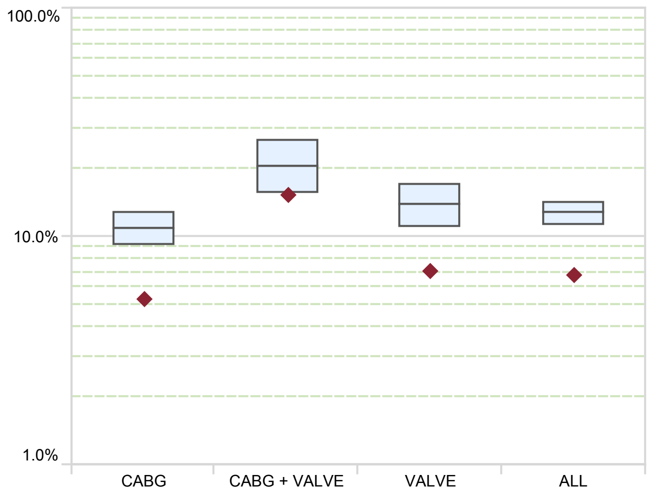


Figure 29: Ventilation >24 hours

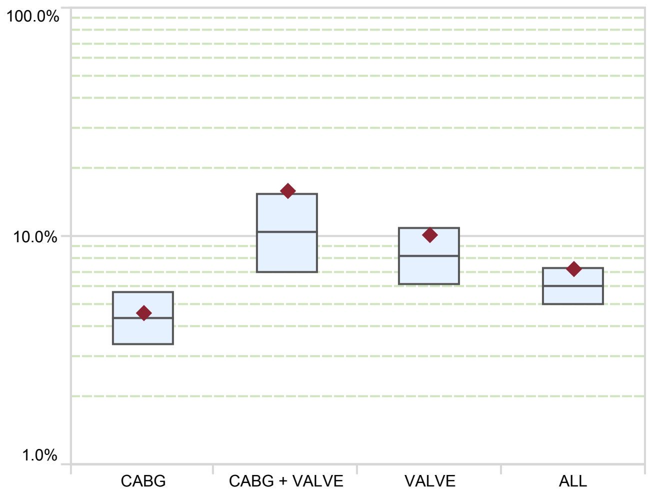


Figure 30: Reoperation

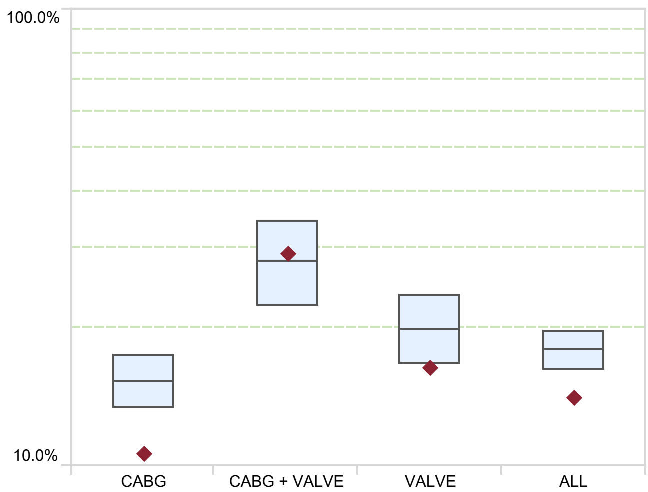


Figure 31: Major morbidity

Deep sternal infection

The rate of deep sternal wound infection (DSWI) is a significant postoperative adverse outcome that increases the risk of death for a patient and has significant consequences in terms of healthcare system resource utilisation. As such, it continues to be a focus for all participating units. Annual reports in previous years have consistently identified this occurring at a rate higher than predicted by the STS model. Since being introduced in 2008, numerous papers have been published discussing the validity of the STS risk adjustment models[28,29,30] for DSWI after cardiac surgery on external patient cohorts.

These studies have tended to suggest that the model, as described, lacks adequate performance (discrimination or calibration) for the target patient population. In some references, where adequate discrimination has been identified, the model appears to substantially under predict the risk of the target event. For example, the paper by Kirmani et al[31] suggests that rates for DSWI in the United Kingdom at the time of writing were of the order of 2%. In their facility, where the observed rate was documented at 0.96%, the average STS predicted risk was 0.28%. As a result, a scaling factor of four was applied to account for the underestimation after confirming that the discrimination of the model was adequate.

Evaluation of the STS model against the pooled Queensland public patient cohort for the period January 2018 to December 2019 includes 3,926 eligible procedures. Of these cases, there were 49 recorded DSWI (1.25%) against a predicted number using the standard model of 12.1 events (0.31%). Evaluation of the performance of the model shows that it has sound discrimination for the evaluated cohort (AUC=0.88, $p<0.001$) but poor calibration (H-L=144, $p<0.001$). This finding, of adequate discrimination and poor calibration with a factor of four difference, is similar to that noted by Kirmani et al.[31]

As it stands, the raw STS risk adjustment cannot be directly used for quality monitoring purposes, however, the performance characteristics suggest that it can be recalibrated using a basic odds correction to provide a useful risk estimate in the local patient cohort.

Establishment of a correction factor was based on the DSWI data presented in the Australian and New Zealand Society of Cardiac & Thoracic Surgeons Cardiac Surgery Database Program Annual Report for 2020[32]. This report suggests that the national rate of DSWI in public hospitals for 2017–2019 was approximately 1.13% while for 2020 the rate had dropped to 0.91% (comparable rates for Queensland were 1.7% and 1.4% respectively).

Therefore, for the purposes of quality assurance and monitoring, the STS model was adjusted to deliver an expected event rate of 1.13% using an odds correction factor of 3.70. Using this correction factor does not impact upon the AUC evaluation, however for the baseline population the H-L drops to 9.23 ($p=0.32$).

Importantly, when applied to outcomes for 2020–2021, the subsequent period including the period under review), the discrimination remains sound (AUC=0.88, $p<0.001$), while the calibration continues to be acceptable (H-L=6.31, $p=0.61$).

After applying an odds correction of 3.70 to the 2021 cohort, the observed rate of DSWI is within the expected rate for all surgical categories. Furthermore, it is evident that over the past five years, there has been a reduction in the observed rate of DSWI. Various sites have implemented a range of quality improvement activities, projects and audits to investigate and reflect on local practices with an aim to understand the contributing factors that may increase the likelihood of a patient suffering DSWI.

Quality improvement activities which result in positive outcomes is usually a cyclical process where attention to a certain intervention or change may diverge and other clinical priorities prevail. This is evident in this sample where incidence rates vary over time. It is however pleasing and reassuring to note a consistent downward trend in the rate of DSWI with a sustained shift to be within the corrected range for incidence in this local cohort. Further efforts and focus on this important measure of morbidity will hopefully see further decreases in rates and a sustained decrease in observed cases.

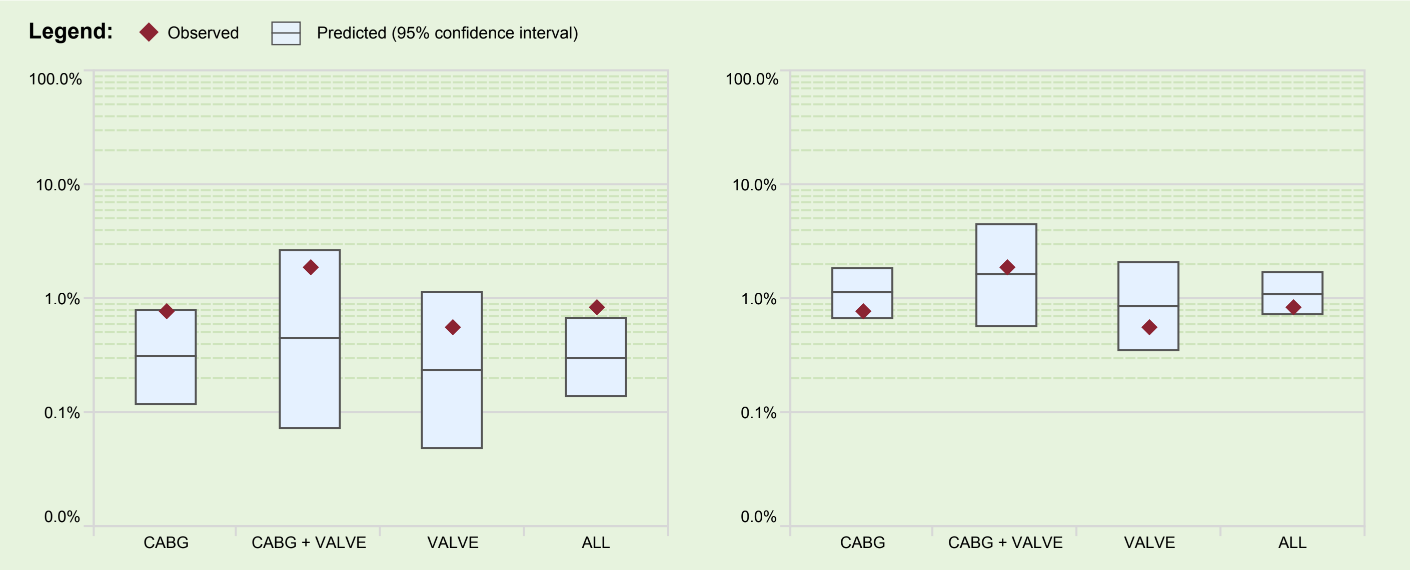


Figure 32: Comparison of 2021 deep sternal wound infection, original vs. recalibrated model

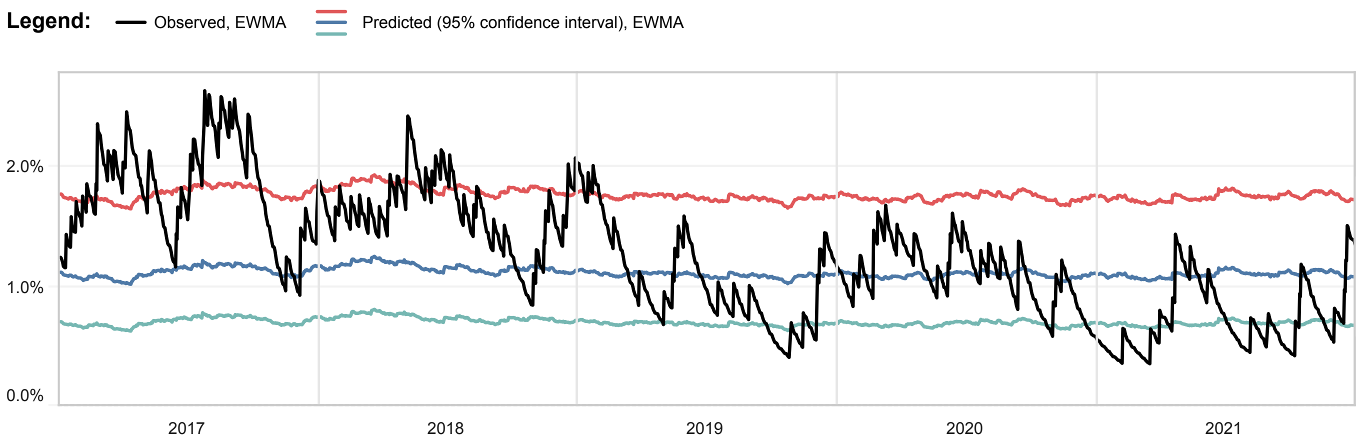


Figure 33: Deep sternal infection, 2017–2021

8.1.3 Measures of process

The following graphs assess the length of stay (LOS) of patients compared with that predicted by the STS score. LOS less than six days is a measure of process that allows for elective weekly booking procedures.

LOS greater than 14 days excludes the patients who may stay several days after the six day cut off for minor reasons, but instead are on a prolonged recovery pathway.

The LOS comparison indicates that the proportion of cases staying less than six days is lower than expected, regardless of surgery category.

Similarly, the proportion of patients who stay longer than 14 days is greater than predicted. Further investigation is needed to delineate whether this outcome is prolonged due to institutional processes or factors relating to patient care.

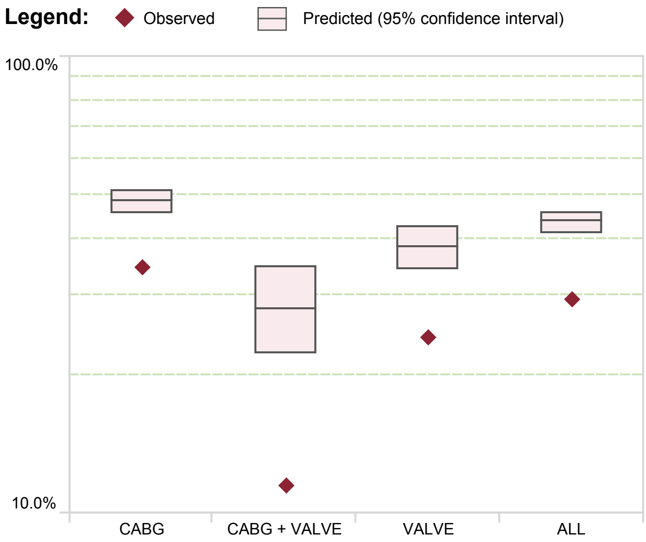


Figure 34: LOS <6 days

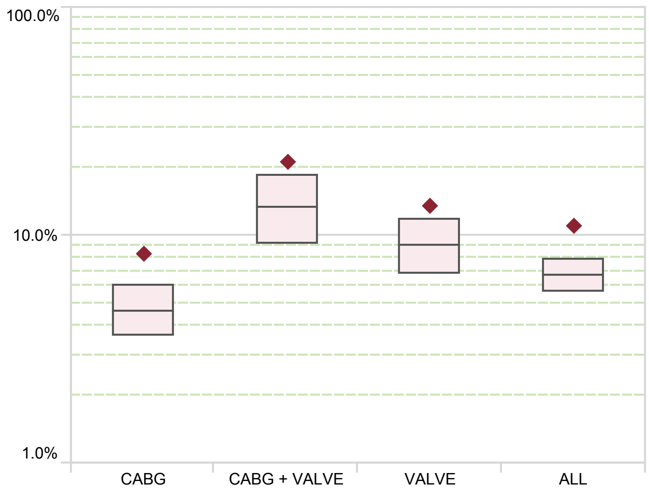


Figure 35: LOS >14 days

Cardiac Surgery

8.1.4 Failure to rescue

Failure to rescue (FTR) is an indicator of quality in surgery that focuses primarily on the system of care rather than the surgical procedure alone. It is used to describe the prognosis of the patient cohort that has experienced a post-operative complication.

FTR is calculated from the risk of adverse events and the risk of death in combination. It assumes that an adverse event can result in death if not appropriately intervened on by the hospital processes. These adverse events include a combination of stroke, renal failure, reoperation, deep sternal infection and prolonged ventilation (>24 hours) as described by the STS risk models.

From this analysis, the FTR observed rate for the isolated CABG cohort is better than the predicted rate, whilst the combined CABG and valve and isolated valve cases are within the expected range.

This suggests that the processes in place to deal with adverse events appear to be functioning at the expected level.

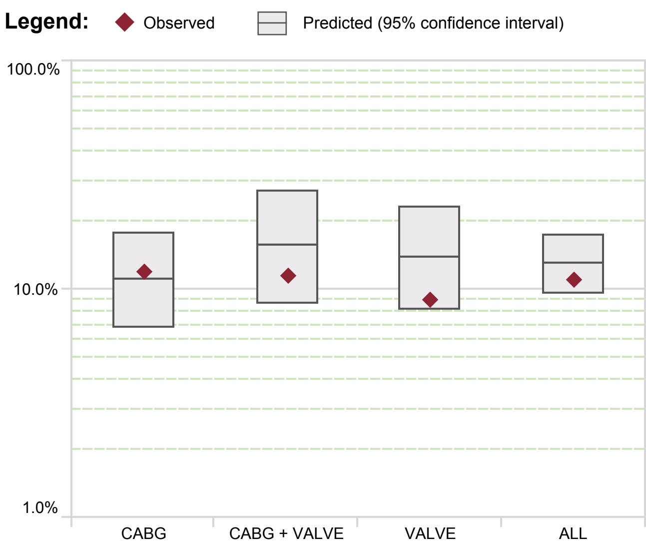


Figure 36: Failure to rescue

Cardiac Surgery

8.1.5 Outcome trends

Quality improvement systems are employed to support the effectiveness of clinical care and performance. Health service organisations should use these and other established safety and quality systems to support the monitoring, reporting and implementation of quality improvement strategies for clinical care. Stakeholder engagement at all levels of the organisation is an essential part of quality improvement systems and to lead change.

Ongoing monitoring of adverse events allows organisations to gain insight into whether there are safety gaps in their clinical care processes, and to modify these processes to suit the individual service. Evaluation allows organisations to measure the progress and impact of clinical change or intervention processes and possible improvement strategies.

Ensuring that processes are in place to facilitate feedback and provide review of findings from the monitoring of quality improvement processes to relevant committees or meetings about governance and leadership is imperative. Members of the relevant QCOR Cardiothoracic Surgery Committee are responsible to ensure that actions are taken to improve clinical performance and dissemination of performance data.

The QCOR Cardiothoracic Surgery Committee employ the clinical quality registry feedback loop whereby surgical case data is entered, analysed and made available for clinical review in a timely manner. Any outliers or variation in outcomes are promptly flagged with interventions and improvements in care implemented.

Where anomalies or outliers may exist, the pyramid model of investigation of clinical outcome variation where data is provided to sites with the opportunity for review and amendment. This ensures that a statistically sound baseline is established before escalation upward on the pyramid to investigate other potential causes of the outlier.

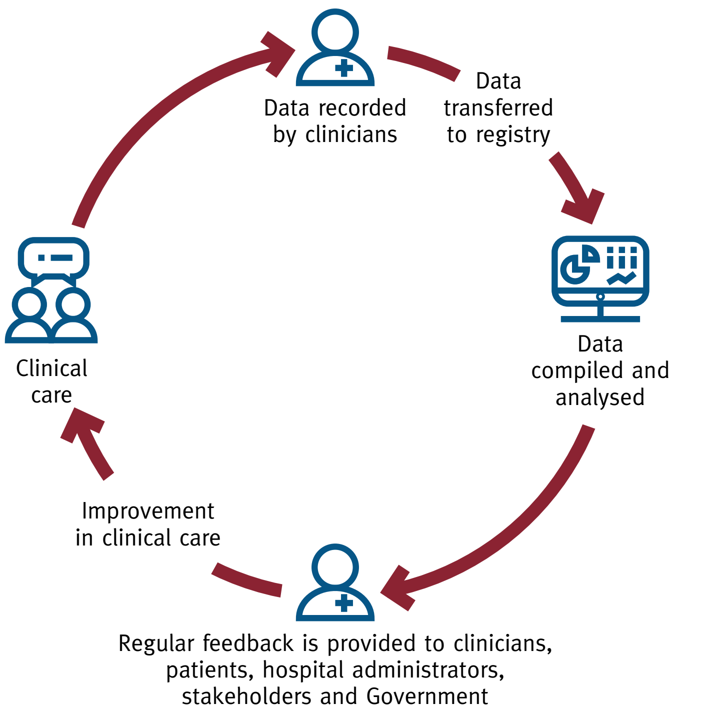


Figure 37: Clinical Quality Registry feedback loop

Since the inception of the QCOR quality and safety program for cardiac surgery, statistical models for mortality rates have been published which utilise EuroSCORE II[25], ANZSCTS General Score[26] and STS mortality models[28,29,30], while morbidity, measures of process and failure to rescue are displayed using the STS models. An exponentially weighted moving average (EWMA) is used to provide a comparison of the trend in predicted risk and observed outcomes.

The following analysis reviews trends in clinical outcomes across mortality and morbidity as well as measures of process such as length of stay and failure to rescue.

Mortality

As previously stated, EuroSCORE[24], EuroSCORE II[25], and ANZSCTS General Score[26] can be applied to evaluate mortality for all types of cardiac surgical cases, whereas the AusSCORE model[27] applies for mortality in CABG cases only and has not been shown in this analysis. For the STS model clearly defined sub-groups of procedures are used – CABG only[28], Valve only[29] and CABG + Valve[30] models. Patients who met the inclusion criteria were assessed and the remainder of patients excluded from the analysis. For EuroSCORE II data collection commenced in 2019.

Since 2017, the mortality rate for all surgery types has declined from 2.4% to 1.9% at the end of 2021. The mortality rate peaked at 4.8% and was 1.1% at its lowest. For all prediction models employed, the final mortality rate was below the predicted range. Peaks in the observed mortality rates were often accompanied by an uptick in the expected range, likely reflecting the complexity or high-risk nature of this dynamic cohort.

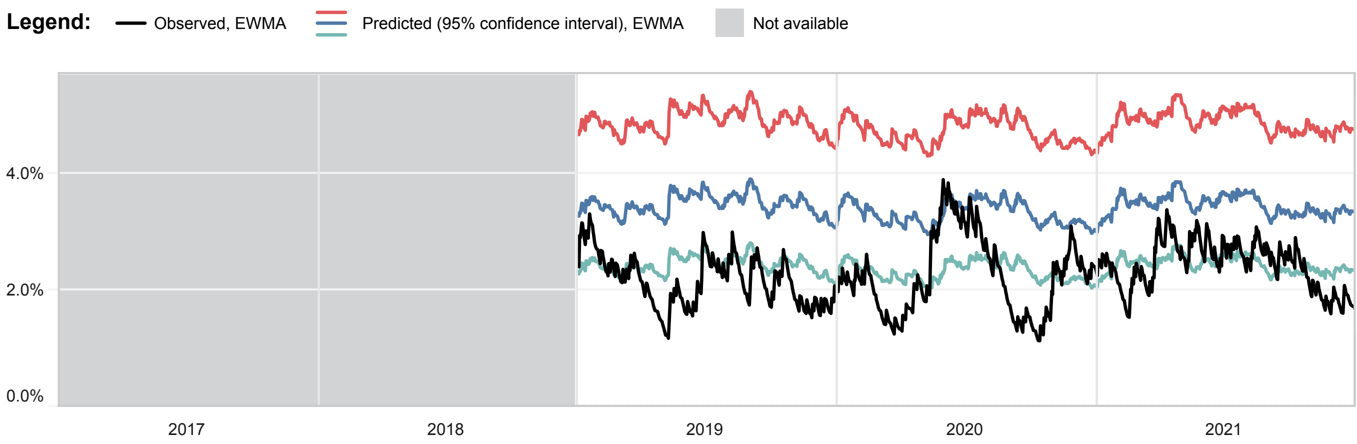


Figure 38: EuroSCORE II, 2017–2021

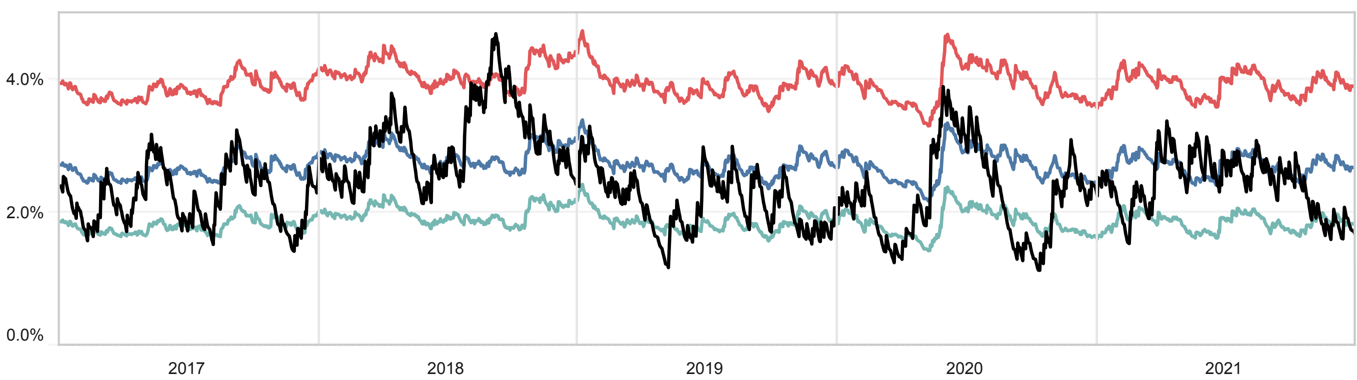


Figure 39: ANZSCTS General Score, 2017–2021

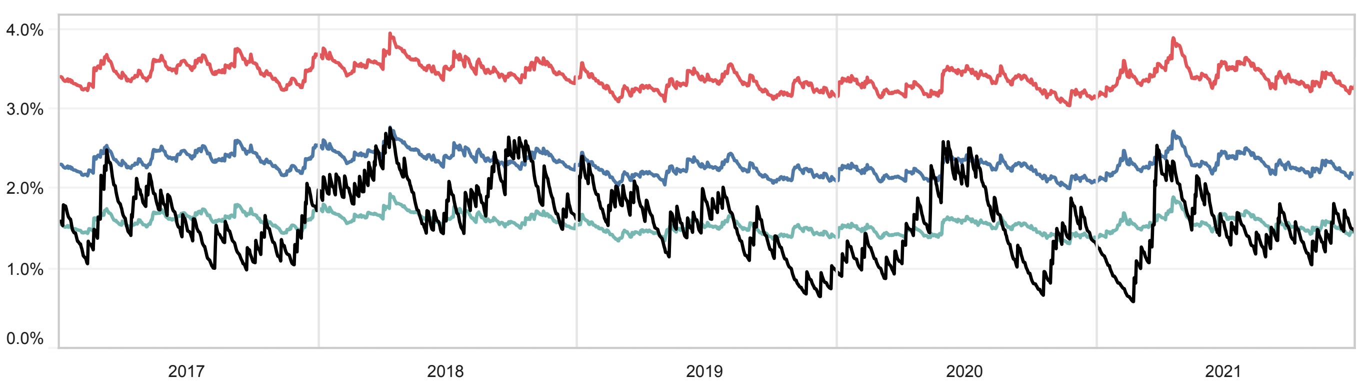


Figure 40: STS mortality, 2017–2021

Morbidity

Cerebrovascular accident or stroke, defined as a new central neurologic deficit that persists for greater than 72 hours, caused by an ischaemic or haemorrhagic event peri or post-operatively, is a recognised complication and risk of cardiac surgery. Over the monitored period the incidence of cerebrovascular accident has trended downward with cyclical variation. Reassuringly though, the rate is largely within or below the expected range.

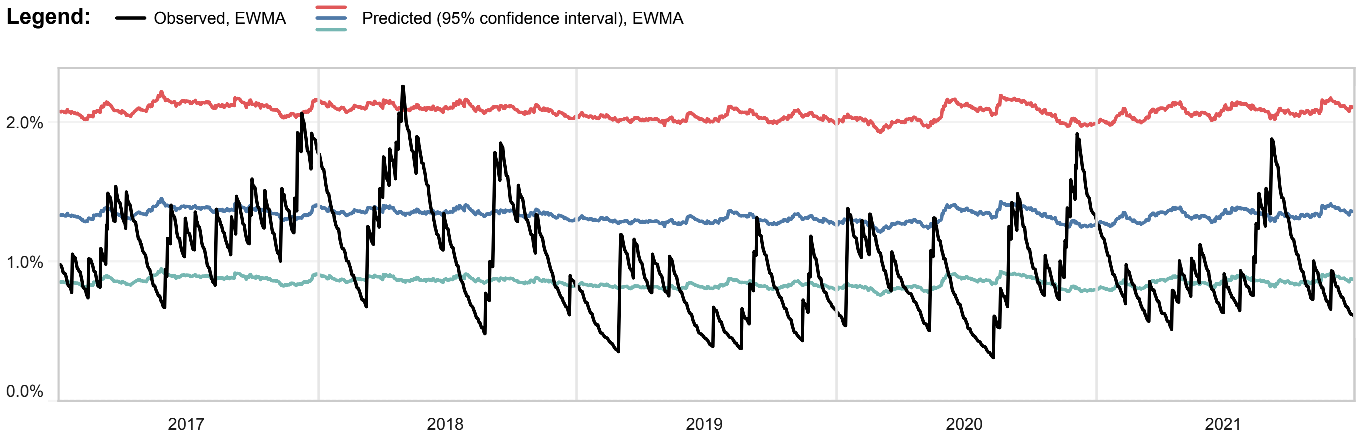


Figure 41: Cerebrovascular accident, 2017–2021

Renal insufficiency following cardiac surgery is a known postoperative complication associated with poorer patient outcomes. Renal insufficiency is measured by an increase in postoperative serum creatinine levels or a new requirement for renal dialysis or haemofiltration. The rates of renal insufficiency have decreased over time. The incidence is also lower than the expected rate for much of the sample period with some minor variation.

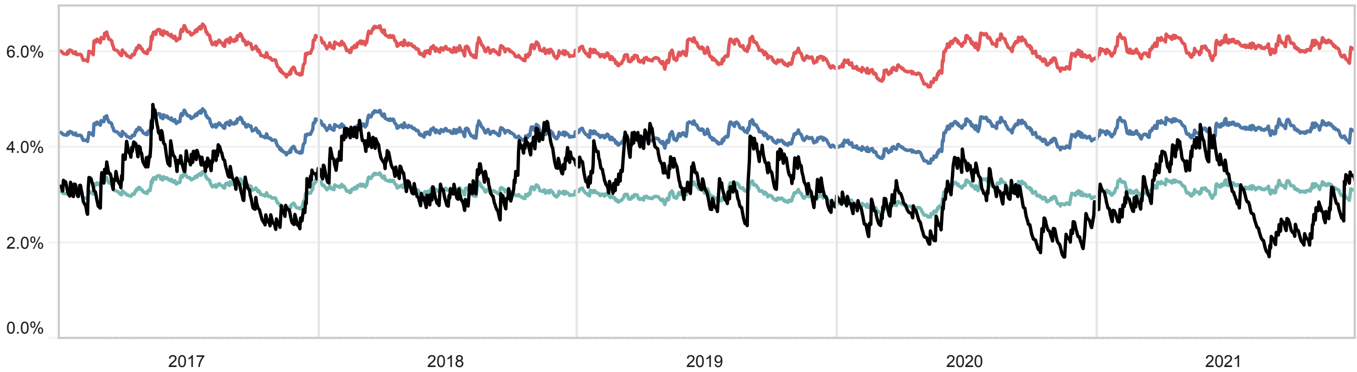


Figure 42: Renal failure, 2017–2021

The requirement for ventilator support for over 24 cumulative hours postoperatively is an index of importance in cardiac surgery as it may be associated with a considerable risk of morbidity and mortality. The incidence of prolonged ventilation in this cohort is consistently low compared to the expected rate.

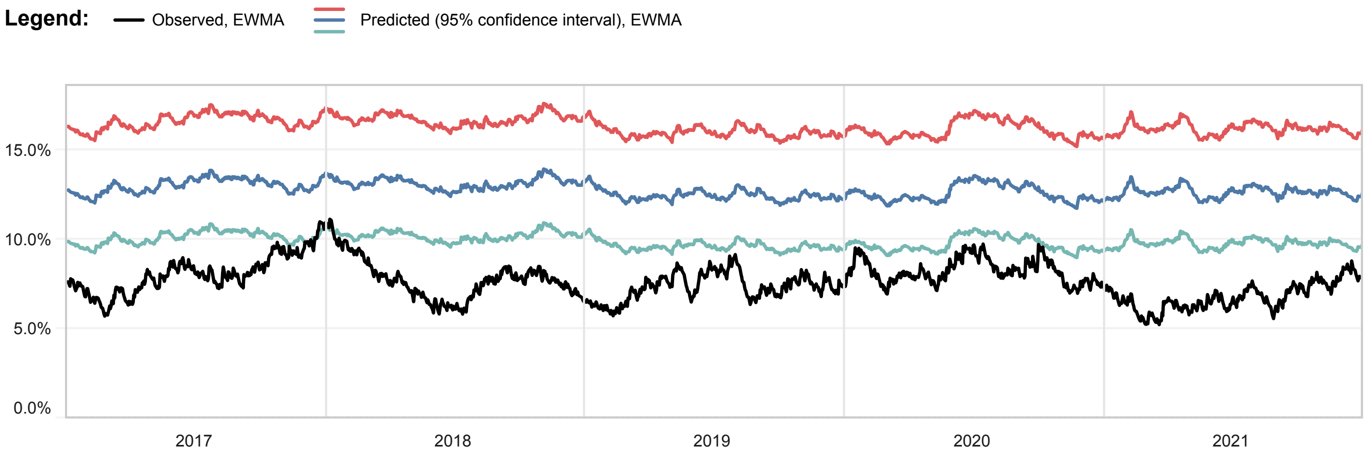


Figure 43: Ventilation >24 hours, 2017–2021

Reoperation following cardiac surgery is performed as a last resort to correct a surgical complication or unplanned sequalae of the index operation. Although largely tracking at the upper limit of the predicted rate, there has been a net decrease in the reoperation rate from 7.9% at the beginning of the sample period to 7.5% at the end of 2021.

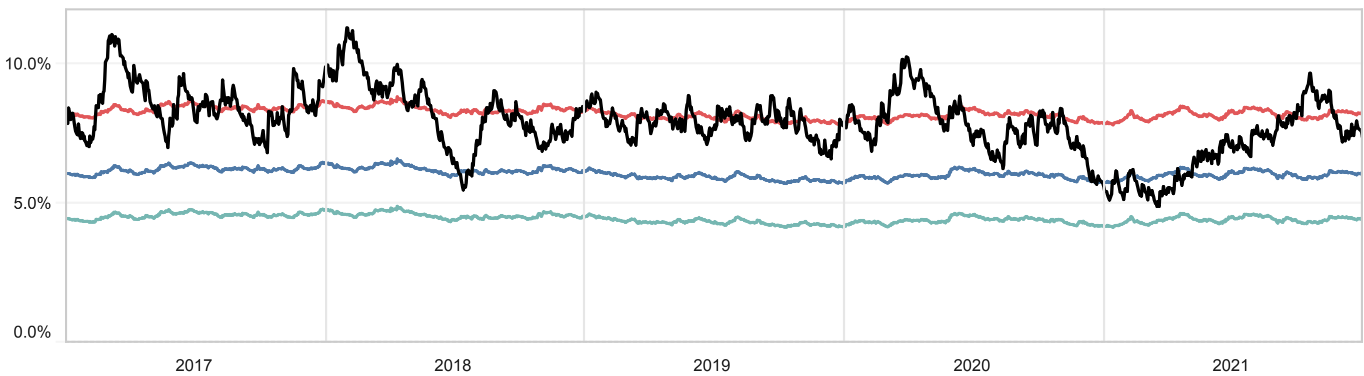


Figure 44: Reoperation, 2017–2021

The development of any of the five major morbidities previously described (including DSWI) is an important aggregate measure of surgical outcomes. Since the inception of the quality program for cardiac surgery, major morbidity rates have decreased from 15.4% to 14.9% with some variation over time. It is encouraging to note that the major morbidity rate is consistent within the expected range or below the expected rate.

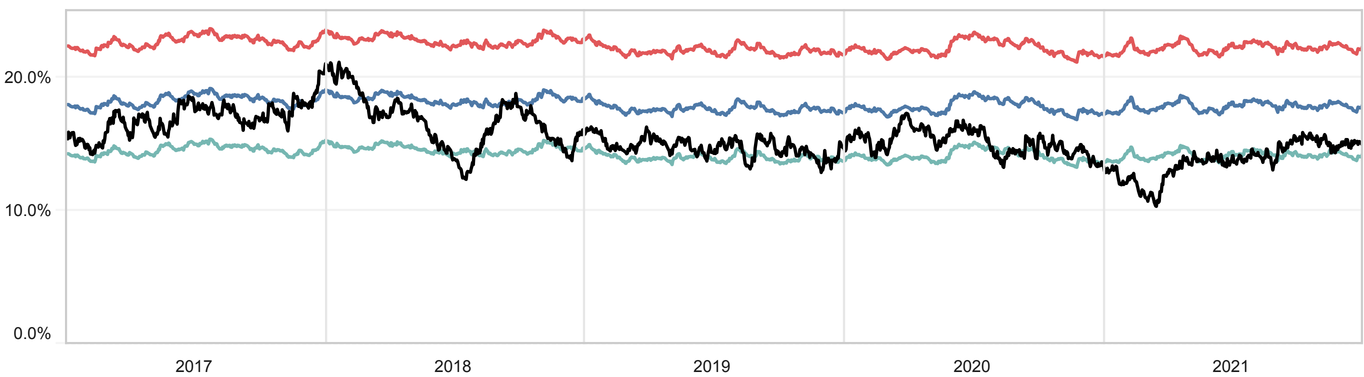


Figure 45: Major morbidity, 2017–2021

Measures of process

Previous QCOR Reports have investigated factors which influence postoperative length of stay and, after adjusting for clinical characteristics and other procedural factors, found a positive correlation between the remoteness of the patient's place of residence and the likelihood the patient would remain in hospital >14 days postoperatively. Paradoxically, it was also found that patients residing in an Inner Regional and Outer Regional area had a higher likelihood of having a length of stay <6 days.

The analysis demonstrates the length of stay of patients compared with that predicted by the STS score. The LOS comparison indicates that the proportion of cases staying less than six days is consistently less than expected, indicating that despite efforts to investigate and communicate this measure that has capacity for improvement, benchmarks are not being met despite being close at some points.

Similarly, the proportion of patients who stay longer than 14 days is consistently larger than expected, however the rate has decreased marginally over time. Over the five year period, a range of 15.9% to 8.5% was observed demonstrating that at the lower rate, sites are able to achieve very close to the expected rate. This suggests that the STS targets are realistic, even though they may not account for Queensland's well-described geographic challenges and with sustained focus, performance within the benchmark range may be possible.

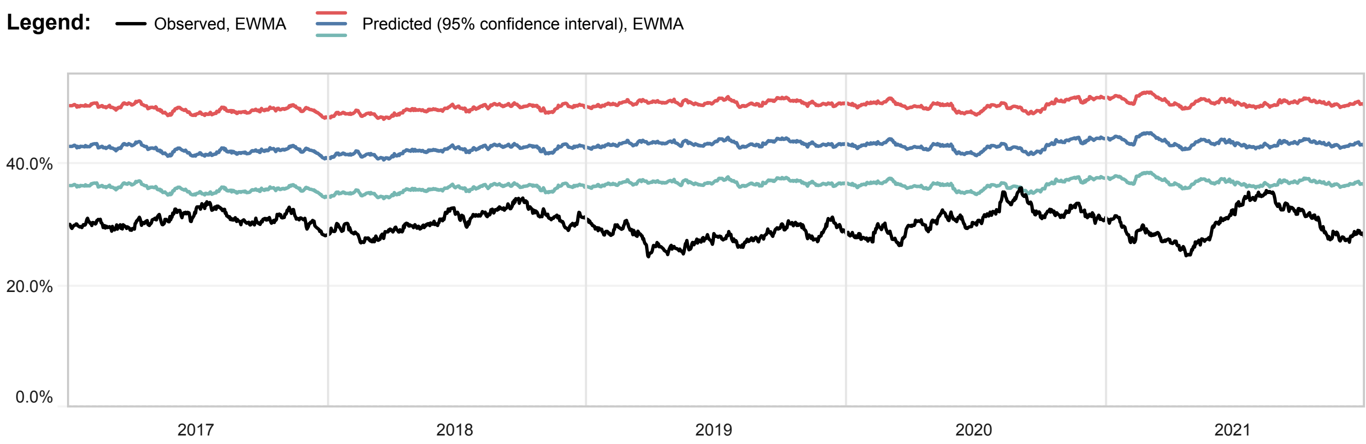


Figure 46: LOS <6 days, 2017–2021

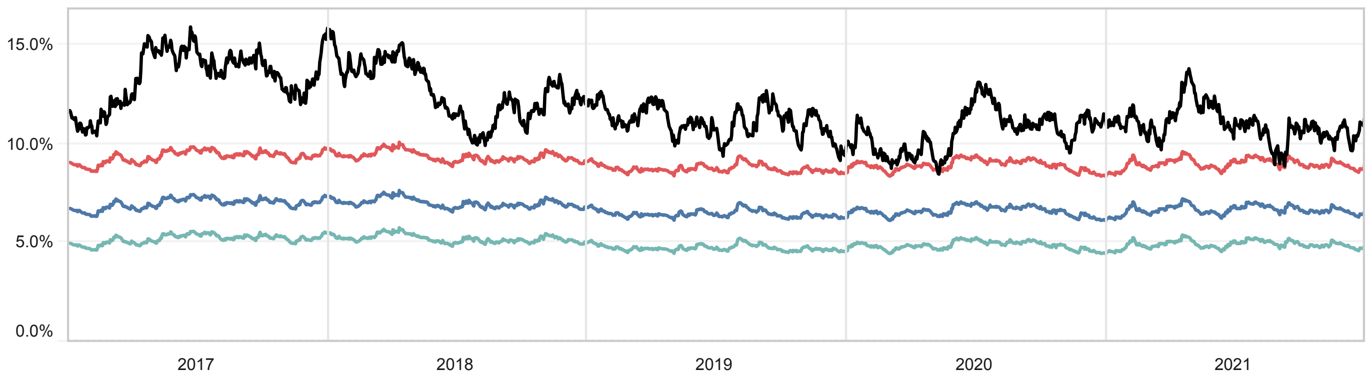


Figure 47: LOS >14 days, 2017–2021

Failure to rescue

As previously described FTR is calculated from the risk of adverse events and the risk of death in combination. It assumes that an adverse event can result in death if not appropriately intervened on by the hospital processes. For this analysis all surgical categories are examined, and it has found that for the majority of the sample period, the rates of FTR are lower than expected.

As FTR is an indicator of quality that focuses primarily on the system of care rather than the surgical procedure, it suggests that processes are in place to deal with adverse events and appear to be functioning at or better than the expected level.

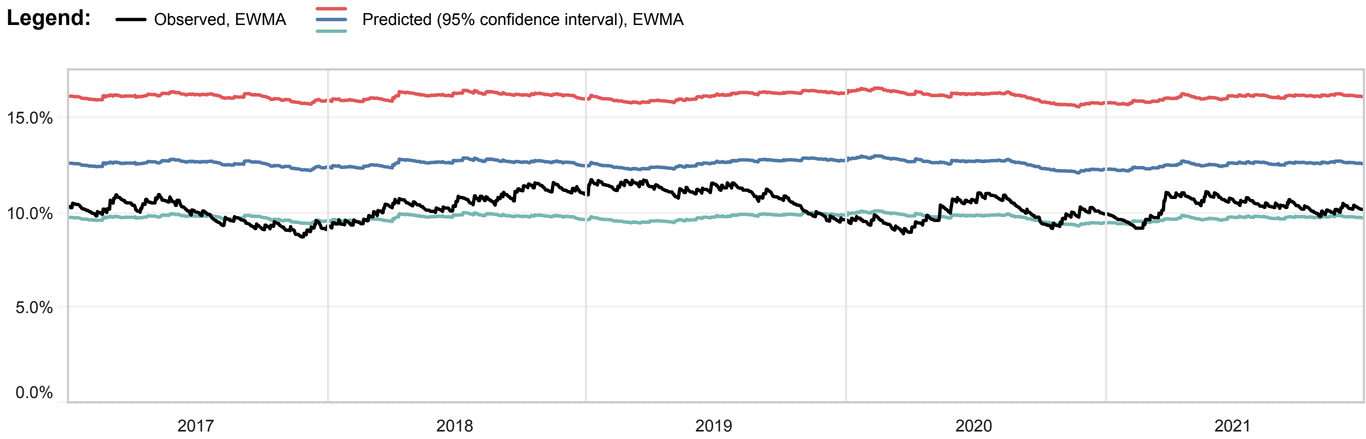


Figure 48: Failure to rescue, 2017–2021

9 Supplement: Cardiac surgery and bleeding

Excess blood loss following cardiac surgery is a major complication as it exposes the patient to increased risks through the need for transfusion or reoperation to manage technical or haemostatic issues. Blood is a scarce, donated resource that carries risks and benefits. Significant bleeding has an adverse impact on morbidity and mortality[33] while re-exploration for bleeding is associated with prolonged hospital stay and the associated increase in resource utilisation this entails. It is associated with increased risk of adverse outcomes such as deep sternal wound infection, renal impairment, and postoperative arrhythmias.[34] Antifibrinolytic drugs such as tranexamic acid (TXA) have been proposed as an adjunct that reduces the rate of bleeding complications. However, although effective at reducing bleeding related complications, routine use has also been linked to significant short- and long-term complications such as the increased risk of neurological events, renal dysfunction and premature graft failure.

All available adjuncts to minimise postoperative bleeding should be employed, but their risks should also be considered.[35]

Perioperative bleeding in patients undergoing cardiac surgery may be insignificant, requiring no intervention. It may be serious and life threatening. Bleeding is frequently treated with allogeneic blood product transfusion (packed red blood cells), fresh frozen plasma, or platelet concentrates. Although transfusion is recognised to adversely affect early and late outcomes,[36,37] it remains common after cardiac surgery despite improvements in transfusion medicine and system-based protocols.[38]

Bleeding after cardiac surgery can be attributed to a combination of two main reasons:

- surgical (unrecognised bleeding from bones, vessels, anastomosis, or other suture lines) or,
- nonsurgical bleeding (caused by coagulopathy).

Factors influencing both surgical and nonsurgical bleeding can be further broken down into those linked to the preoperative condition of the patient and the circumstance of their surgery and those that arise as a consequence of the surgery or postoperative management. A thorough understanding of these factors is necessary to reduce bleeding related complications and is imperative, as excessive bleeding is associated with an increased risk of adverse outcomes.

Contemporary literature and practice guidelines have brought periprocedural bleeding into focus as an important outcome measure in cardiac surgery practice, and frequently serves as a component of combined end points in randomised clinical trials.[39] Although precise definitions for complications such as renal failure, acute myocardial infarction, and neurologic complications after cardiac surgery exist, limited standardised definitions for perioperative bleeding have been established, making the interpretation of clinical trials more difficult and hindering attempts to study patient blood management. In this analysis, patient cohorts that require any transfusion of blood and blood transfusions of >5 units and >10 have been analysed as well as groups who may require reoperation for bleeding postoperatively.

This supplement was prepared by Dr Ian Smith, PhD (Biostatistician, SCCIU), and Dr Chris Cole.

9.1 Patient characteristics

A total of 12,652 patients having surgery between 2017 and 2022 were included in the analysis. Of this cohort, over one third (36%) received transfusion of blood products post-surgery with both red blood cell (RBC) and non-RBC products required in 15% of cases.

Females received more blood products than males (41% vs. 34%, p<0.001).

RBC transfusion was highest in patients over 70 years of age, while almost one in five (19%) patients under 40 years of age undergoing cardiac surgery required both RBC and NRBC transfusion.

The proportion of blood products required decrease with an increasing BMI. An underweight classification using the BMI was associated with a higher need for blood products at time of cardiac surgery, with 56% requiring some blood products.

Table 1: Blood product usage by patient characteristic

	Both RBC and NRBC used n (%)	RBC used n (%)	NRBC used n (%)	No blood products used n (%)
Gender				
Male	1,352 (14.5)	897 (9.6)	901 (9.7)	6,147 (66.1)
Female	533 (15.9)	698 (20.8)	138 (4.1)	1,986 (59.2)
Age group (years)				
<40	138 (19.1)	93 (12.9)	53 (7.4)	437 (60.6)
40–49	153 (15.5)	113 (11.5)	90 (9.1)	629 (63.9)
50–59	318 (13.2)	240 (10.0)	204 (8.5)	1,650 (68.4)
60–69	558 (14.5)	457 (11.8)	325 (8.4)	2,519 (65.3)
70–79	573 (15.6)	540 (14.7)	301 (8.2)	2,264 (61.6)
80+	145 (14.5)	152 (15.2)	66 (6.6)	634 (63.6)
Body mass index category				
Underweight*	49 (30.8)	32 (20.1)	8 (5.0)	70 (44.0)
Normal range†	580 (20.0)	418 (14.4)	229 (7.9)	1,670 (57.6)
Overweight‡	713 (15.4)	583 (12.6)	398 (8.6)	2,933 (63.4)
Obese§	486 (11.1)	485 (11.1)	365 (8.4)	3,029 (69.4)
Morbidly obese‖	57 (9.4)	77 (12.7)	39 (6.5)	431 (71.4)
Aboriginal and Torres Strait Islander status				
Indigenous	142 (16.7)	158 (18.6)	45 (5.3)	505 (59.4)
Non Indigenous	1,743 (14.8)	1,437 (12.2)	994 (8.4)	7,628 (64.6)
All	**1,885 (14.9)**	**1,595 (12.6)**	**1,039 (8.2)**	**8,133 (64.3)**

* BMI <18.5 kg/m^2

† BMI 18.5–24.9 kg/m^2

‡ BMI 25.0–29.9 kg/m^2

§ BMI 30.0–39.9 kg/m^2

‖ BMI ≥40.0 kg/m^2

9.2 Care and treatment of patients

Patients undergoing a standalone CABG procedure were less likely to require blood products (30%) while almost 60% of patients undergoing surgery for CABG + valve received some form of transfusion.

Higher acuity cases tended to use more blood products with nearly three quarters of emergency (74%) and 83% of salvage cases requiring a blood product.

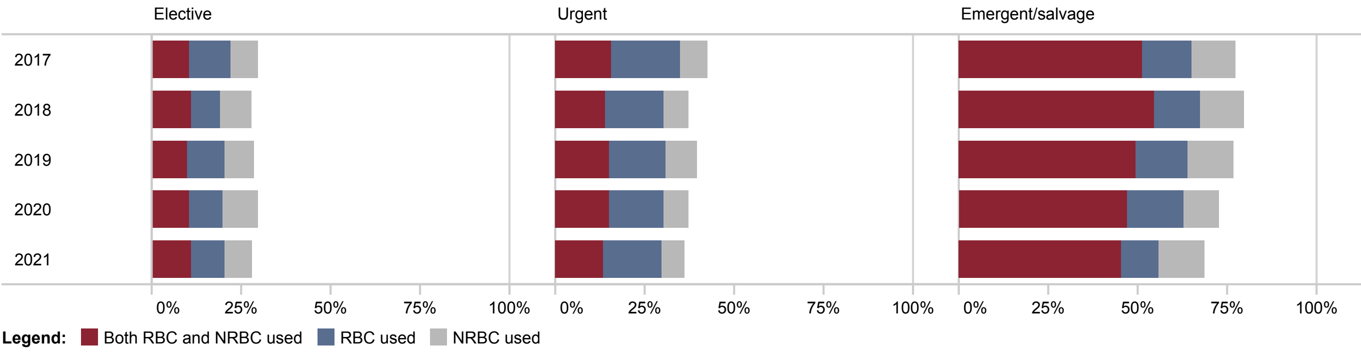


Figure 1: Proportion of blood product usage by admission status and year of surgery

Table 2: Blood product usage by treatment characteristic

	Both RBC and NRBC used n (%)	RBC used n (%)	NRBC used n (%)	No blood products used n (%)
Surgery category				
ANY CABG	597 (9.5)	817 (13.0)	454 (7.2)	4,415 (70.3)
CABG + VALVE	329 (26.8)	237 (19.3)	136 (11.1)	526 (42.8)
VALVE	630 (15.1)	435 (10.4)	384 (9.2)	2,719 (65.2)
OTHER	329 (33.8)	106 (10.9)	65 (6.7)	473 (48.6)
Isolated CABG	545 (9.1)	779 (12.9)	421 (7.0)	4,275 (71.0)
Admission status				
Elective	739 (10.5)	696 (9.9)	584 (8.3)	5,020 (71.3)
Urgent	678 (14.5)	771 (16.5)	340 (7.3)	2,871 (61.6)
Emergency	437 (48.2)	122 (13.5)	114 (12.6)	234 (25.8)
Salvage	31 (67.4)	6 (13.0)	1 (2.2)	8 (17.4)
Elective day of surgery admission	80 (7.0)	93 (8.1)	62 (5.4)	907 (79.4)
All	**1,885 (14.9)**	**1,595 (12.6)**	**1,039 (8.2)**	**8,133 (64.3)**

9.3 Patient outcomes

To explore the impact of patient and procedural factors on bleeding related outcomes, multivariate logistic regression analysis was employed. Inputs for this analysis included factors inherent in the patient preoperatively (age, gender, BMI, haemoglobin level), the urgency with which the surgery was required, the type of surgery (CABG only, CABG + valve, valve or other) and the extent to which the haemoglobin dropped while undergoing surgery. In addition to the analysis of bleeding related outcomes, secondary outcomes with a possible link to the interventions associated with the management of blood loss were also examined. These included the risk of CVA, DSWI and any major adverse outcome (as defined by the STS). The output of this analysis for each factor is the odds ratio. This is a measure of association of the factor (or category of factor) in the context of the other factors explored compared to a reference cohort.

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An odds ratio of:

- **Approximately 1.0** (p=not significant) indicates that the odds of exposure among case-patients are the **same** as, or similar to, the odds of exposure among the reference cohort. The exposure is not associated with the disease.
- **Greater than 1.0** ($p<0.05$) indicates that the odds of exposure among case-patients are greater than the odds of exposure among controls. The exposure might be a **risk factor** for the disease.
- **Less than 1.0** ($p<0.05$) indicates that the odds of exposure among case-patients are lower than the odds of exposure among controls. The exposure might be a **protective factor** against the disease.

The magnitude of the odds ratio reflects the likelihood the patient will experience the outcome if the factor is present by comparison to the reference cohort.

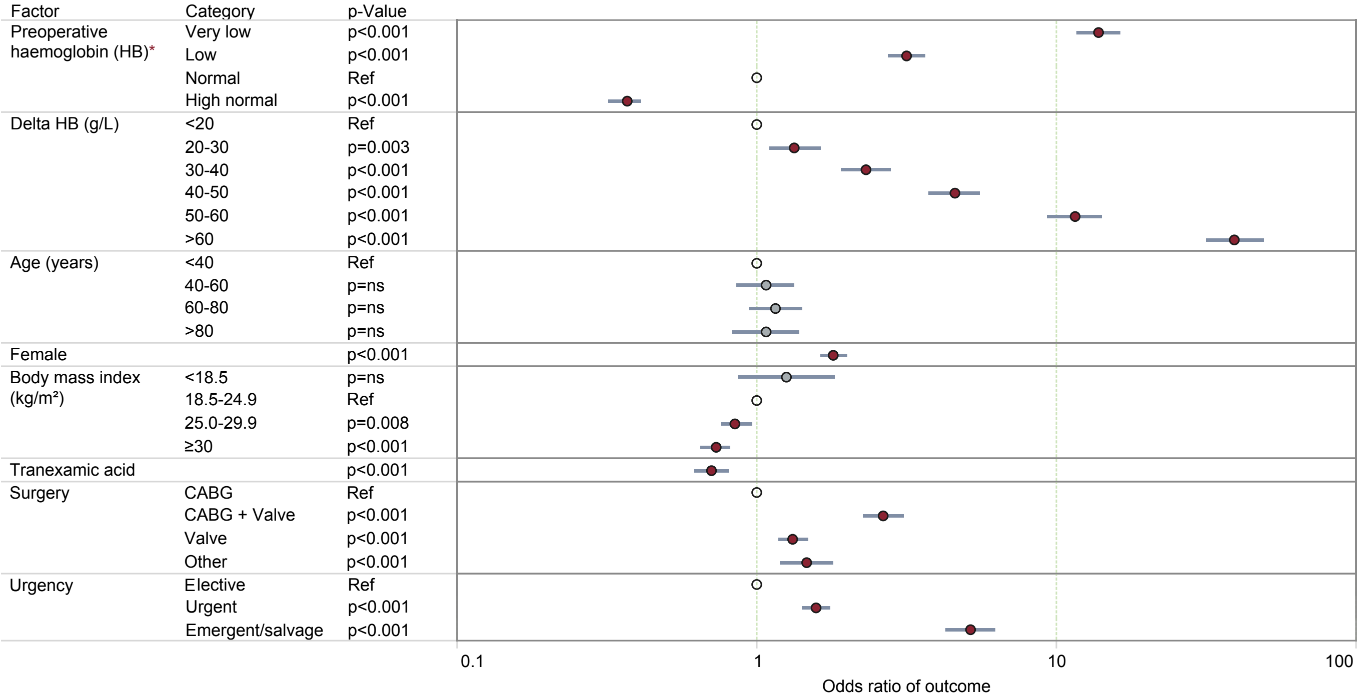
With regards the requirement for any blood product transfusion post-surgery (Figure 2), having a very low preoperative haemoglobin level, defined as less than 120 g/L for men and 110 g/L for women[40] was associated with an odds ratio of greater than 13.8 ($p<0.001$) signifying a high risk of requiring a transfusion of blood products following cardiac surgery. Furthermore, it is evident that a low haemoglobin level preoperatively results in an odds ratio of 3.2 ($p<0.001$). Any reduction in haemoglobin level of more than 20 g/L was associated with a need for transfusion with a drop >60 g/L being associated with an odds ratio of approximately 40 ($p<0.001$), representing a very strong association with a requirement for blood products. There was an upward trend in the correlation of blood product requirements as the change in haemoglobin levels pre and post-operatively increased.

A very low BMI, female sex, and any surgery other than an isolated CABG operation carry an increased likelihood of requirement for blood products post-operatively.

The urgency with which surgery was required also had a strong association with transfusion requirements with any classification other than elective carrying an increased risk of transfusion (urgent: OR 1.6, $p<0.001$ or emergent/salvage: OR 5.2, $p<0.001$). A possible explanation for this finding is that there is insufficient time to appropriately cease anti-platelet medication prior to surgery.

Patients with an overweight or obese body mass index were less likely to require blood. Age was not found to be associated with a requirement for transfusion.

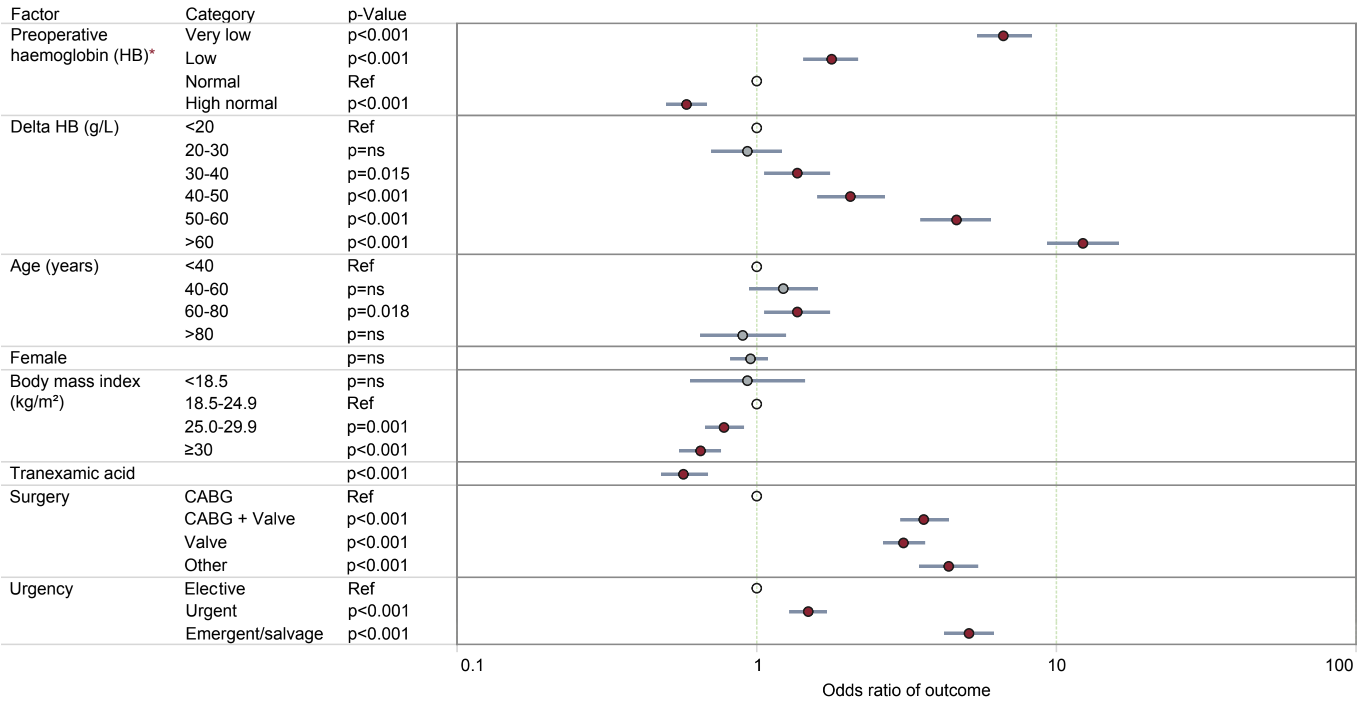
Use of the antifibrinolytic drug, TXA (OR 0.7, p<0.001) was identified as being associated with the likelihood of requiring transfusion.



* Preoperative haemoglobin (g/L) – Very Low: Male <120, Female <110; Low: Male 120-130, Female 110-120; Normal: Male 130-145, Female 120-135; High Normal: Male >145, Female >135

Figure 2: Association of factors with any blood product usage

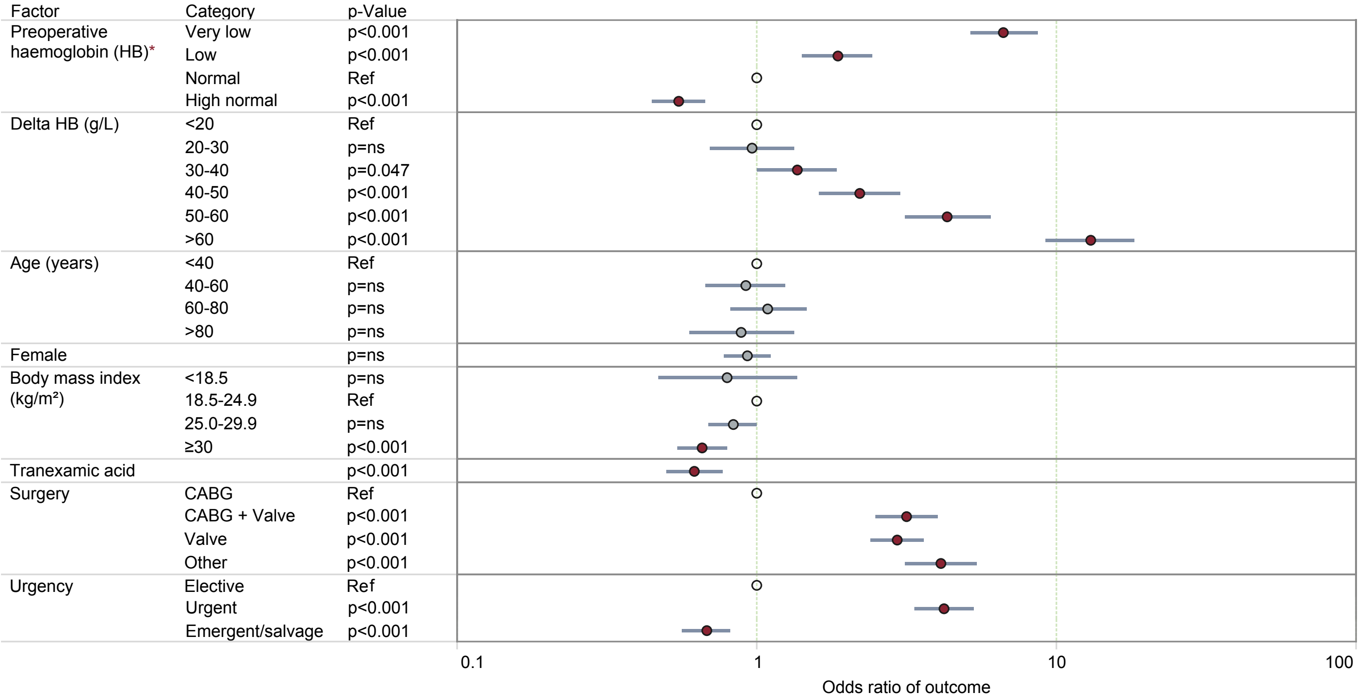
With regards moderate blood use (>5 units, Figure 3), the pattern of risk factors is similar. The exception being that the risk of requiring more than 5 units of blood increases with increasing patient age.



* Preoperative haemoglobin (g/L) – Very Low: Male <120, Female <110; Low: Male 120-130, Female 110-120; Normal: Male 130-145, Female 120-135; High Normal: Male >145, Female >135

Figure 3: Association of factors with moderate (>5 units) blood product usage

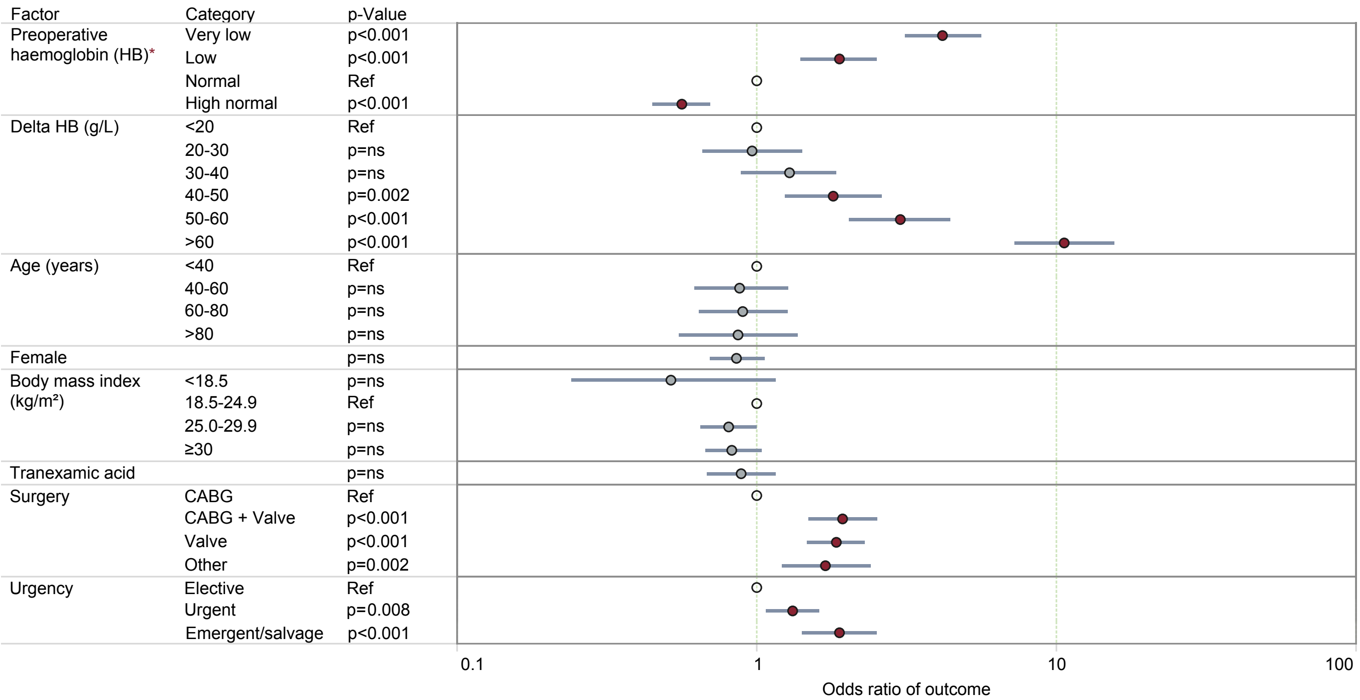
As with the other markers of blood use, excessive blood use (>10 units, Figure 4) generally follows a similar pattern.



* Preoperative haemoglobin (g/L) – Very Low: Male <120, Female <110; Low: Male 120-130, Female 110-120; Normal: Male 130-145, Female 120-135; High Normal: Male >145, Female >135

Figure 4: Association of factors with excessive (>10 units) blood product usage

As with blood use patterns, analysis of the factors associated with a return to theatre for bleeding related complications (Figure 5) identifies the level of haemoglobin preoperatively (p<0.001) and the change in haemoglobin levels pre- vs. post-surgery (p<0.001) are strongly linked to the odds of this event. Age, gender and BMI have no apparent association with the risk of reoperation. Patients undergoing valve surgery are at higher risk of reoperation as are patients requiring non elective procedures. Unlike blood use, however, the use of TXA does not appear to have a significant impact on the risk of the outcome.



* Preoperative haemoglobin (g/L) – Very Low: Male <120, Female <110; Low: Male 120-130, Female 110-120; Normal: Male 130-145, Female 120-135; High Normal: Male >145, Female >135

Figure 5: Association of factors with return to theatre for bleeding

The analysis presented in Table 3 summarises the association of patient and procedural factors, including blood use, with adverse outcomes post-surgery. Of note in this analysis is that the level of transfusion required post-surgery is associated with an increased risk of experiencing a major complication. Unlike bleeding outcomes, however, this risk does not appear to be attenuated by the use of an antifibrinolytic.

Table 3: Analysis of association of patient and procedural factors. including blood use, with adverse outcomes

Factor	Category	CVA		DSWI		Major morbidities	
		Odds Ratio	p-Value	Odds Ratio	p-Value	Odds Ratio	p-Value
Preoperative haemoglobin (HB)*	Very low	1.23 (0.71–2.14)	p=ns	2.57 (1.43–4.63)	p=0.002	2.17 (1.81–2.60)	p<0.001
	Low	1.20 (0.72–2.00)	p=ns	1.58 (0.87–2.89)	p=ns	1.31 (1.10–1.57)	p=0.002
	Normal	Ref	p=ns	Ref	p=0.017	Ref	p<0.001
	High normal	0.71 (0.47–1.05)	p=ns	1.12 (0.73–1.72)	p=ns	0.74 (0.64–0.84)	p<0.001
Delta HB (g/L)	<20	Ref	p=0.011	Ref	p=0.001	Ref	p<0.001
	20–30	1.78 (0.87–3.65)	p=ns	1.10 (0.54–2.24)	p=ns	1.22 (0.98–1.51)	p=ns
	30–40	1.89 (0.94–3.81)	p=ns	1.16 (0.58–2.31)	p=ns	1.12 (0.90–1.38)	p=ns
	40–50	1.70 (0.81–3.55)	p=ns	1.23 (0.60–2.53)	p=ns	1.52 (1.22–1.89)	p<0.001
	50–60	2.38 (1.11–5.13)	p=0.026	1.42 (0.65–3.11)	p=ns	1.84 (1.46–2.33)	p<0.001
	>60	3.88 (1.79–8.42)	p=0.001	3.53 (1.65–7.54)	p=0.001	3.84 (3.02–4.88)	p<0.001
Age (years)	<40	Ref	p=ns	Ref	p=0.039	Ref	p=0.012
	40–60	0.75 (0.38–1.47)	p=ns	1.10 (0.41–2.94)	p=ns	1.03 (0.80–1.32)	p=ns
	60–80	1.14 (0.61–2.15)	p=ns	1.86 (0.72–4.79)	p=ns	1.25 (0.99–1.59)	p=ns
	>80	1.47 (0.65–3.32)	p=ns	1.00 (0.28–3.62)	p=ns	1.22 (0.91–1.64)	p=ns
Female		1.26 (0.89–1.79)	p=ns	1.00 (0.67–1.49)	p=ns	0.91 (0.81–1.03)	p=ns
BMI category (kg/m²)	BMI <18.5	1.02 (0.30–3.52)	p=ns	–	–	1.09 (0.72–1.66)	p=ns
	BMI 18.5–24.9	Ref	p=0.029	Ref	p=0.003	Ref	p<0.001
	BMI 25.0–29.9	1.32 (0.84–2.06)	p=ns	1.03 (0.63–1.67)	p=ns	1.04 (0.90–1.20)	p=ns
	BMI ≥30	1.87 (1.21–2.89)	p=0.005	1.91 (1.22–3.01)	p=0.005	1.70 (1.48–1.96)	p<0.001
Surgery	CABG	Ref	p<0.001	Ref	p=0.001	Ref	p<0.001
	CABG + valve	1.76 (1.05–2.95)	p=0.031	0.50 (0.28–0.89)	p=0.020	1.84 (1.56–2.18)	p<0.001
	Valve	1.56 (1.00–2.42)	p=0.049	0.42 (0.25–0.69)	p=0.001	1.90 (1.66–2.18)	p<0.001
	Other	3.32 (1.90–5.79)	p<0.001	1.01 (0.54–1.91)	p=ns	2.32 (1.87–2.89)	p<0.001
Tranexamic acid		1.08 (0.68–1.71)	p=ns	1.12 (0.66–1.90)	p=ns	1.07 (0.91–1.25)	p=ns
Urgency	Elective	Ref	p=0.013	Ref	p=0.043	Ref	p<0.001
	Urgent	1.33 (0.90–1.99)	p=ns	1.63 (1.11–2.39)	p=0.012	1.47 (1.30–1.66)	p<0.001
	Emergent/ salvage	2.12 (1.28–3.51)	p=0.004	1.26 (0.68–2.36)	p=ns	3.20 (2.65–3.87)	p<0.001
Transfusion (units)	0	Ref	p<0.001	Ref	p<0.001	Ref	p<0.001
	1–5	1.79 (1.15–2.79)	p=0.009	1.54 (0.99–2.40)	p=ns	2.82 (2.47–3.22)	p<0.001
	6–10	1.79 (0.90–3.54)	p=ns	3.39 (1.87–6.13)	p<0.001	6.31 (5.20–7.66)	p<0.001
	>10	4.00 (2.43–6.58)	p<0.001	3.45 (1.97–6.03)	p<0.001	13.8 (11.4–16.6)	p<0.001

* Preoperative haemoglobin (g/L) – Very Low: Male <120, Female <110; Low: Male 120-130, Female 110-120; Normal: Male 130-145, Female 120-135; High Normal: Male >145, Female >135

9.4 Discussion

Despite recent advances in cardiac surgery, patients undergoing operations requiring cardiopulmonary bypass are at risk of developing significant post-operative bleeding and substantial blood requirements.[41]

Three main factors that prevent excessive bleeding are blood vessel constriction, platelet activation and the activity of clotting factors that circulate in the blood. Any abnormalities in these compensatory mechanisms may lead to potentially dangerous bleeding. Perioperative bleeding is linked to surgical injury of blood vessels and limitations or complications of the haemostatic mechanisms applied. In cardiac surgery, the tendency for excessive bleeding is further due to the surgical intervention itself which often involves major vascular structures and the effect of extracorporeal circulation on bleeding control mechanisms.[41]

This investigation found that in a local cohort, bleeding and blood use in is closely associated with preoperative haemoglobin, a change in post operative haemoglobin, female sex, underweight body mass index, urgency of surgery, use of antifibrinolytic and operation type. Age was not found to be a contributing factor for the use of any blood products. Some of these factors can be controlled to minimise or prevent transfusion-associated complications. However, the knowledge of these factors is important in the control or awareness of the likelihood of postoperative bleeding and blood transfusion.

Based on available evidence, institution-specific protocols should screen for high-risk patients, as blood conservation interventions are likely to be most productive for this high-risk subset. Available evidence-based blood conservation techniques include:

- Medications that increase preoperative blood volume or decrease postoperative bleeding
- Devices that conserve blood (for example, intraoperative blood salvage and blood sparing interventions)
- Interventions that protect the patient's own blood from the stress of operation
- Consensus, institution-specific blood transfusion algorithms supported by point-of-care testing
- A multifaceted approach to blood conservation combining all of the above.

This new analysis provides a new platform for future investigation and intervention to aid clinicians in improving patient outcomes in a local cohort. Although local use of blood products has remained relatively consistent over time, future work is always possible to further conserve the use of this important resource.

10 Supplement: Australia and New Zealand Congenital Outcomes Registry for Surgery

10.1 Message from the chair

It is my pleasure to present Queensland's paediatric cardiac surgical data from the Australia and New Zealand Congenital Outcomes Registry for Surgery (ANZCORS) as part of the Queensland Cardiac Outcomes Registry (QCOR) Annual Report for 2021. The continued inclusion of paediatric cardiac surgery results reflects the commitment of Queensland Health and specifically Clinical Excellence Queensland to the ongoing improvement in statewide cardiac surgical care. The Queensland Paediatric Cardiac Research Group (QPCR) at the Queensland Children's Hospital has validated all data included in this report.

ANZCORS was created in 2017 and represents a collaborative effort between the five institutions delivering paediatric cardiac surgery across Australia and New Zealand. The Registry is managed by the QPCR team based at the Children's Health Research Centre, Brisbane. Through ANZCORS, we benchmark outcomes after paediatric cardiac surgery across the region and translate findings that are important to consumers into practice in a timely manner. The most recent iteration of the risk model used by ANZCORS incorporates machine learning methodology. The ANZCORS team also disseminates their findings through peer-reviewed publications. The Registry will shortly begin a pilot project to evaluate and embed patient reported outcome measures and patient reported experience measures into routine clinical care initially in Queensland. To better understand longer-term outcomes, the Registry is also expanding its data linkage activities.

It is important to acknowledge that like 2020, 2021 continued to mark a year of worldwide change. The COVID-19 pandemic has resulted in health systems being placed under enormous strain worldwide. However, even during this difficult time, clinical teams across our region have continued to work tirelessly to maintain the highest levels of care while supporting the activities and goals of the Registry.

I would like to take this opportunity to thank all those involved with the ongoing management of the Registry and the production of this report. The ANZCORS management team, steering committee members, and national data managers are to be congratulated for the quality of work and their dedication to the Registry and its outputs. The ANZCORS team is also very grateful for the support of the Queensland Health and QCOR, which provides funding for the Registry's core activities and advice and infrastructure support.

Finally, as always, a special thank you to the surgical teams across Australia and New Zealand, patients, and parents for permitting us to use their data to build the Registry. Without their support, the work of the Registry would not be possible.

Dr Prem Venugopal
Director of Cardiac Surgery, Children's Health Queensland
Chair, ANZCORS Steering Committee

10.2 Acknowledgements

Data Custodian

- Dr Nelson Alphonso

ANZCORS Program Manager

- Ms Jessica Suna

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- Jayme Bennetts
  ANZSCTS President

10.3 Introduction

This report provides an overview of the major findings from the 2021 annual ANZCORS report for Queensland. The data covers the five year rolling period from July 2016 to June 2021 and includes 1,746 cardiothoracic procedures (1,148 using cardiopulmonary bypass, 364 without cardiopulmonary bypass and 234 delayed sternal closures).

Currently, there is only one hospital in Queensland (Queensland Children's Hospital) that provides paediatric cardiac surgical care to individuals across Queensland, Northern New South Wales, and the Torres Strait, as shown in the heat map below. Every year the paediatric cardiac service at Perth Children's Hospital also refers patients with complex congenital heart defects to the team at the Queensland Children's Hospital for surgical management.

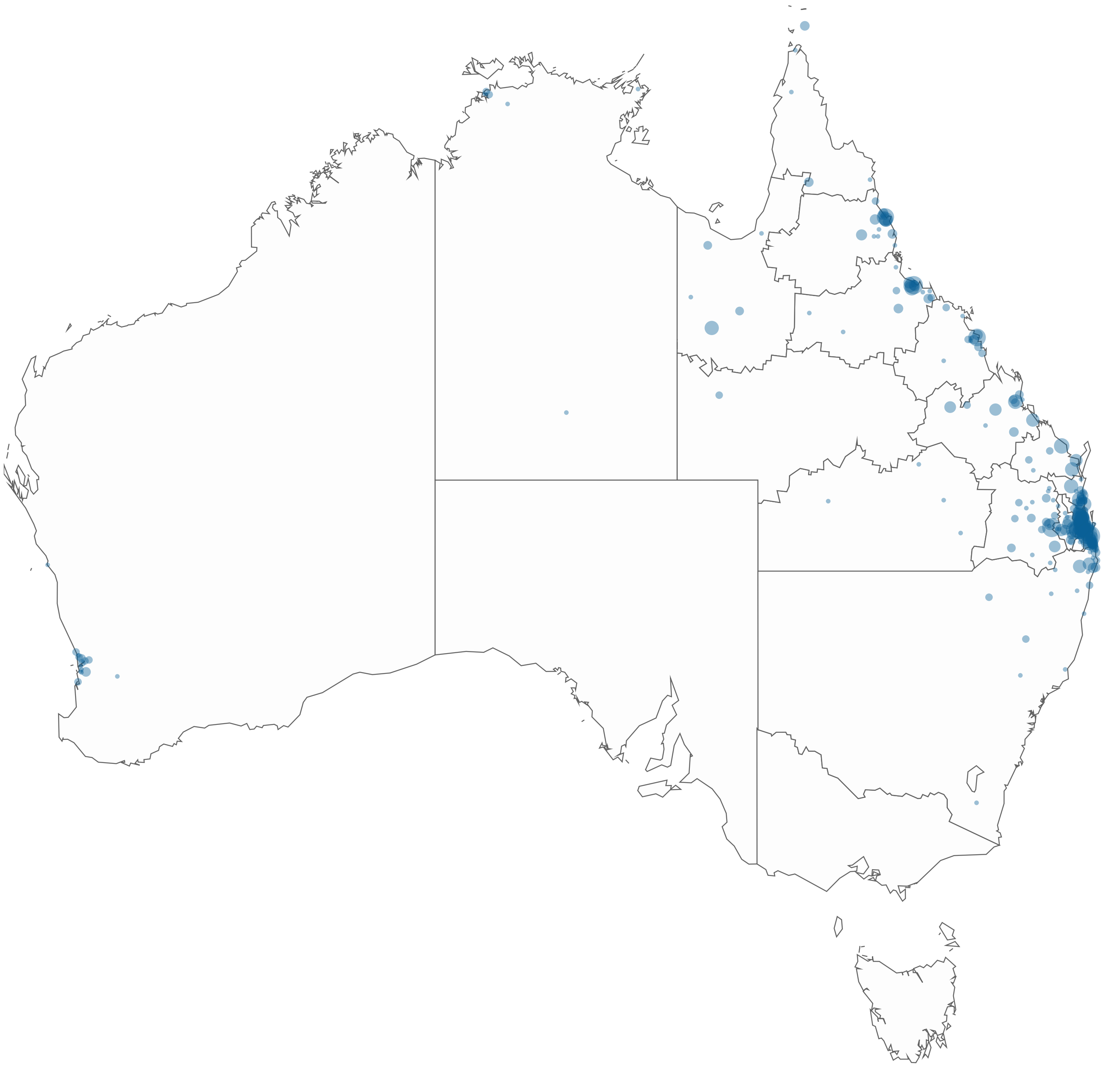

Figure 1: Cardiac patients treated by the Queensland Paediatric Cardiac Service between 2016–2021, by patient's place of usual residence (residential postcode)

10.4 Childhood heart surgery patients and procedures

During the five year reporting period from July 2016 to June 2021 there were 2,399 procedures performed by the Queensland Paediatric Cardiac Service at the Queensland Children's Hospital. These procedures included cardiac surgical procedures with and without the use of cardiopulmonary bypass, extracorporeal membrane oxygenation (ECMO), thoracic and delayed sternal wound closure procedures (Table 1). The focus of this report is cardiac surgical procedures for childhood heart disease and as such delayed sternal closure, ECMO and thoracic procedures are excluded from the analysis.

Over the five year reporting period, there were 1,357 patients with childhood heart disease who underwent 1,512 cardiothoracic surgical procedures either with or without cardiopulmonary bypass (1,148 and 364 procedures respectively) at the Queensland Children's Hospital.

Table 1: Total procedures by case category, 2016–2021

Procedure category	2016/17 n	2017/18 n	2018/19 n	2019/20 n	2020/21 n	All n (%)
CPB*	239	246	214	209	240	1,148 (47.9)
Non-CPB*	73	86	68	65	72	364 (15.2)
Delayed sternal closure	45	55	40	44	50	234 (9.8)
ECMO†	70	61	50	68	34	283 (11.8)
Thoracic‡	63	43	74	82	63	325 (13.5)
Other§	7	9	7	11	11	45 (1.9)
Total	**497**	**500**	**453**	**479**	**470**	**2,339 (100.0)**

* Cardiopulmonary bypass

† Extracorporeal membrane oxygenation – includes pre and post cardiotomy and all non cardiac ECMO

‡ Thoracic procedures include pectus procedures, lung procedures, pleural drain insertions and diaphragm plications

§ Other procedures include catheterisation procedures, hybrid procedures, ventricular assist device procedures and miscellaneous procedures

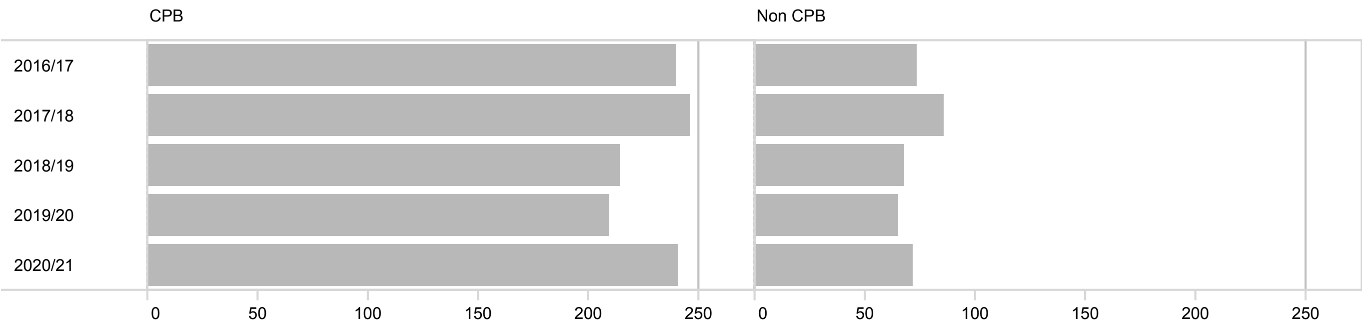

Figure 2: Number of cardiac patients by cardiopulmonary bypass utilisation, 2016–2021

Table 2: Total cardiac patients and procedures, 2016–2021

	2016/17 n	2017/18 n	2018/19 n	2019/20 n	2020/21 n	All n
Cardiac patients	286	287	245	252	287	1,357
Cardiac procedures	312	332	282	274	312	1,512

10.5 Patient characteristics

10.5.1 Age and gender

Approximately 20% of the patient population were neonates aged between 0 and 28 days. Thirty-two percent were infants aged between 29 days and 365 days. Forty-six percent of the cohort were aged between one and sixteen years, and 2% were over sixteen years of age.

Fifty-five percent of the patients were male and 45% were female.

Table 3: Cardiac procedures by age group and year, 2016–2021

Age group	2016/17 n (%)	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	2020/21 n (%)	All n (%)
>16 years	7 (2.2)	12 (3.6)	7 (2.5)	3 (1.1)	5 (1.6)	34 (2.2)
1–16 years	132 (42.3)	149 (44.9)	139 (49.3)	124 (45.3)	145 (46.5)	689 (45.6)
29–365 days	117 (37.5)	102 (30.7)	84 (29.8)	85 (31.0)	101 (32.4)	489 (32.3)
0–28 days	56 (17.9)	69 (20.8)	52 (18.4)	62 (22.6)	61 (19.6)	300 (19.8)
Total	**312 (100.0)**	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**1,512 (100.0)**

Table 4: Cardiac procedures by gender and year, 2016–2021

Gender	2016/17 n (%)	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	2020/21 n (%)	All n (%)
Female	139 (44.6)	146 (44.0)	127 (45.0)	130 (47.4)	136 (43.6)	678 (44.8)
Male	173 (55.4)	186 (56.0)	155 (55.0)	144 (52.6)	176 (56.4)	834 (55.2)
Total	**312 (100.0)**	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**1,512 (100.0)**

10.5.2 Aboriginal and Torres Strait Islander status

The overall proportion of identified Aboriginal and Torres Strait Islander patients undergoing cardiac surgery was 13% with an increasing trend over the 5 year period.

Table 5: Cardiac procedures by Aboriginal and Torres Strait Islander status, 2016–2021

	2016/17 n (%)	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	2020/21 n (%)	All n (%)
Indigenous	36 (11.5)	38 (11.4)	32 (11.3)	41 (15.0)	43 (13.8)	190 (12.6)
Non-Indigenous	276 (88.5)	294 (88.6)	250 (88.7)	233 (85.0)	269 (86.2)	1,322 (87.4)
Total	**312 (100.0)**	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**1,512 (100.0)**

10.6 Procedural complexity

10.6.1 Aristotle Comprehensive Complexity score

The Aristotle Comprehensive Complexity Score (ACC)[42] is a risk stratification tool that rates the projected complexity of the surgical procedures performed. By stratifying patients by complexity, the ACC aims to facilitate more realistic evaluation of surgical outcomes and more meaningful comparison of outcomes between paediatric cardiac surgical centres. The complexity score is based on three subjective determinations; potential for mortality, potential for morbidity, and anticipated surgical difficulty. Complexity is calculated in two phases. Firstly, the basic complexity of the procedure involved is scored from 0.5 to 15.0. This rates only the simplest form of the cardiac surgical procedure. Secondly, a specific value is added, based on a precise analysis of the associated pathology along with any co-morbid conditions that are present. Procedure dependent factors include anatomical variations, associated procedures, and patient age, and can add a maximum of five points to the basic score. Procedure independent factors include patient characteristics which are more general but have the potential to significantly affect the outcome. Procedure independent factors can add an additional five points.

Between 2016 and 2021, 1,357 patients underwent 1,512 cardiac procedures, including those performed without using cardiopulmonary bypass. Fifty percent of procedures belonged in the higher-risk categories, with an ACC score of 10 or above and a predicted mortality of ›10%.

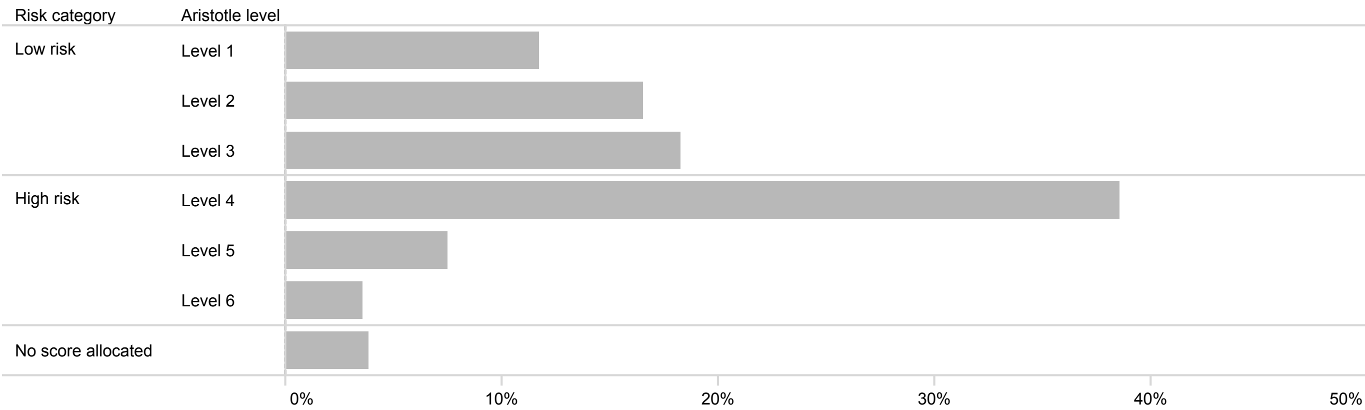

Figure 3: Proportion of all cardiac procedures stratified by Aristotle Comprehensive Complexity score and risk category

Table 6: Cardiac procedures by Aristotle Comprehensive Complexity score, 2016–2021

Complexity category	2016/17 n	2017/18 n	2018/19 n	2019/20 n	2020/21 n	All n (%)
Level 1	37 (11.9)	39 (11.7)	33 (11.7)	26 (9.5)	42 (13.5)	177 (11.7)
Level 2	45 (14.4)	57 (17.2)	45 (16.0)	49 (17.9)	53 (17.0)	249 (16.5)
Level 3	49 (15.7)	69 (20.8)	43 (15.2)	53 (19.3)	62 (19.9)	276 (18.3)
Level 4	130 (41.7)	115 (34.6)	127 (45.0)	102 (37.2)	110 (35.3)	584 (38.6)
Level 5	34 (10.9)	26 (7.8)	10 (3.5)	22 (8.0)	22 (7.1)	114 (7.5)
Level 6	9 (2.9)	11 (3.3)	10 (3.5)	13 (4.7)	11 (3.5)	54 (3.6)
No score	8 (2.6)	15 (4.5)	14 (5)	9 (3.3)	12 (3.8)	58 (3.8)
Total	**312 (100.0)**	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**1,512 (100.0)**

Level 1: ACC score 1.5–5.9; expected mortality ‹1%

Level 2: ACC score 6.0–7.9; expected mortality 1–5%

Level 3: ACC score 8.0–9.9; expected mortality 5–10%

Level 4: ACC score 10.0–15.0; expected mortality 10–20%

Level 5: ACC score 15.1–20.0; expected mortality ›20%

Level 6: ACC score ›20.1; expected mortality ›20%

10.7 Outcomes – length of stay

10.7.1 Paediatric intensive care unit length of stay for cardiac patients

In 2016–2021, the median length of stay in the paediatric intensive care unit (PICU) for cardiac patients was two days, with a mean of 6.7 days.

Table 7: Median PICU length of stay for cardiac patients by year

PICU length of stay	2016/17 days	2017/18 days	2018/19 days	2019/20 days	2020/21 days	All days
Maximum length of stay	163	294	97	504	186	504
Median length of stay	2	2	2	2	2	2
Mean length of stay	6.3	7.6	5.6	9.1	6.4	6.7

10.7.2 Hospital length of stay for cardiac patients

In 2016–2021, the median hospital length of stay for cardiac patients was 10 days, with a mean of 22.6 days.

Table 8: Hospital length of stay for cardiac patients by year

Hospital length of stay	2016/17 days	2017/18 days	2018/19 days	2019/20 days	2020/21 days	All days
Maximum length of stay	258	329	272	504	308	504
Median length of stay	10	9	10	8	9	10
Mean length of stay	21.7	21.3	23.0	22.1	25.0	22.6

10.8 Outcomes – mortality

10.8.1 30 day mortality by Aristotle Comprehensive Complexity score

Overall, the 30 day mortality after paediatric cardiac surgery from 2016–2021 was less than 1%. Most deaths (9 of 10) were within the high-risk procedure categories (ACC level 4–6). Twenty percent of the deaths occurred after surgical procedures belonging in the highest risk ACC category. The observed incidence of mortality across the five year period was consistently below the predicted mortality for each ACC risk category.

There was some variation noted across the reporting period, reflective of the complex and unpredictable nature of the work. The mortality rate was higher for non-CPB patients compared to those performed with CPB (1.1% vs. 0.7% over the five year reporting period). This relates primarily to the inclusion of premature babies with multiple non cardiac comorbidities undergoing ligation of a patent ductus arteriosus in this group.

Table 9 shows the 30 day mortality for only cardiac surgical procedures performed with or without using cardiopulmonary bypass over the five year period. In 2017 there were three deaths in patients who underwent ligation of a patent ductus arteriosus without using cardiopulmonary bypass. These three mortalities were related to non cardiac abnormalities and not to the cardiac surgical procedure. Of the 10 post-surgical deaths over the five year period, nine belonged in the higher risk ACC categories.

Table 9: Cardiac patients 30 day surgical mortality by case category (patients), 2016–2021

	2016/17	2017/18	2018/19	2019/20	2020/21	All
Patients, n	**286**	**287**	**245**	**252**	**287**	**1,357**
CPB, n	224	231	199	196	228	1,078
Non-CPB, n	62	56	46	56	59	279
Deaths, n (%)	**2 (0.7)**	**4 (1.4)**	**2 (0.8)**	**0 (0.0)**	**2 (0.7)**	**10 (0.7)**
CPB, n	0	3	2	0	2	7
Non-CPB, n	2	1	0	0	0	3

Figure 4 shows the observed mortality rate over the five year reporting period, superimposed on the predicted mortality rates given by the ACC score.

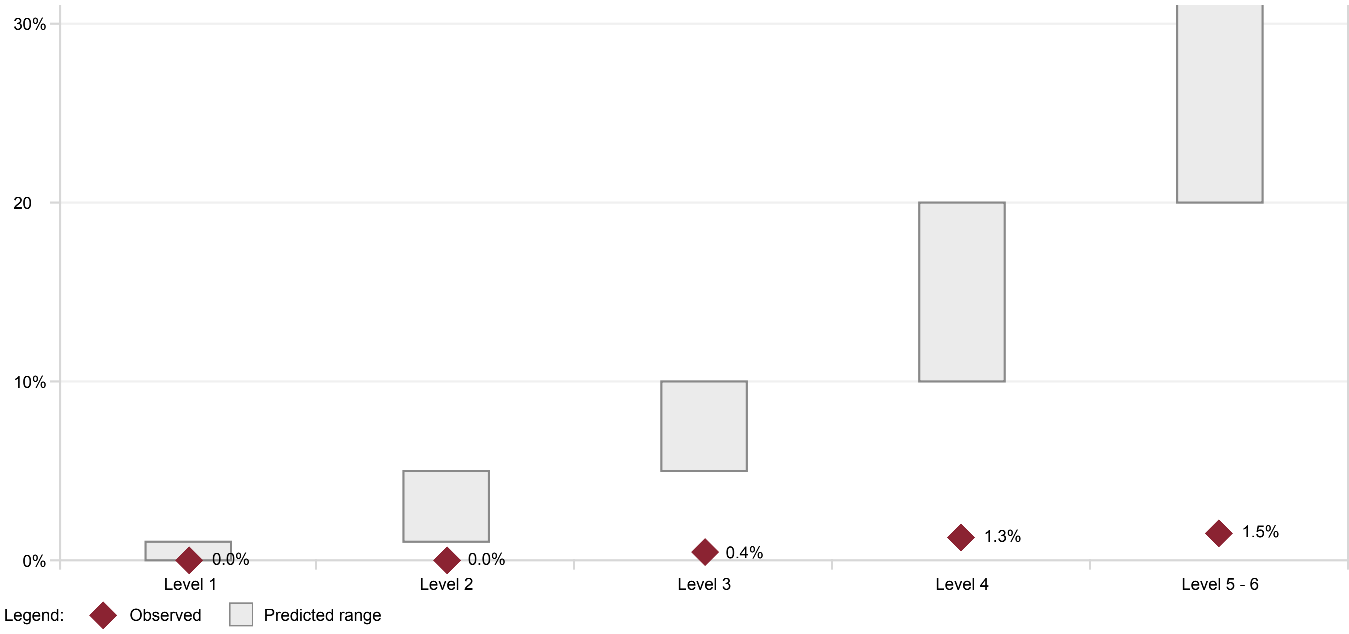

Figure 4: Cardiac patients 30 day mortality by Aristotle Comprehensive Complexity score, 2016–2021

Level 1: ACC score 1.5–5.9; expected mortality <1%

Level 2: ACC score 6.0–7.9; expected mortality 1–5%

Level 3: ACC score 8.0–9.9; expected mortality 5–10%

Level 4: ACC score 10.0–15.0; expected mortality 10–20%

Level 5: ACC score 15.1–20.0; expected mortality >20%

Level 6: ACC score >20.1; expected mortality >20%

Table 10: Cardiac patients 30 day surgical mortality by procedure category (patients), 2016–2021

	2016/17	2017/18	2018/19	2019/20	2020/21	All
Patients, n	**286**	**287**	**245**	**252**	**287**	**1,357**
Level 1, n	35	30	28	26	42	161
Level 2, n	44	56	42	47	52	241
Level 3, n	48	62	39	53	58	260
Level 4, n	122	110	119	96	106	553
Level 5, n	27	20	9	19	20	95
Level 6, n	7	8	6	7	9	37
No score, n	3	1	2	4	0	10
Deaths, n (%)	**2 (0.7)**	**4 (1.4)**	**2 (0.8)**	**0 (0.0)**	**2 (0.7)**	**10 (0.7)**
Level 1, n	0	0	0	0	0	0
Level 2, n	0	0	0	0	0	0
Level 3, n	0	0	1	0	0	1
Level 4, n	2	2	1	0	2	7
Level 5, n	0	0	0	0	0	0
Level 6, n	0	2	0	0	0	2
No score, n	0	0	0	0	0	0

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Glossary

6MWT	Six Minute Walk Test
ACC	Aristotle Comprehensive Complexity
ACEI	Angiotensin Converting Enzyme Inhibitor
ACP	Advanced Care Paramedic
ACS	Acute Coronary Syndromes
AEP	Accredited Exercise Physiologist
ANZCORS	Australia and New Zealand Congenital Outcomes Registry for Surgery
ANZSCTS	Australian and New Zealand Society of Cardiac and Thoracic Surgeons
AQoL	Assessment of Quality of Life
AUC	Area Under Curve
ARB	Angiotensin II Receptor Blocker
ARF	Acute Rheumatic Fever
ARNI	Angiotensin Receptor-Neprilysin Inhibitors
ASD	Atrial Septal Defect
AV	Atrioventricular
AVNRT	Atrioventricular Nodal Re-entry Tachycardia
BCIS	British Cardiovascular Intervention Society
BiV	Biventricular
BMI	Body Mass Index
BMS	Bare Metal Stent
BNH	Bundaberg Hospital
BSSLTx	Bilateral Sequential Single Lung Transplant
BVS	Bioresorbable Vascular Scaffold
CABG	Coronary Artery Bypass Graft
CAD	Coronary Artery Disease
CBH	Caboolture Hospital
CCL	Cardiac Catheter Laboratory
CCP	Critical Care Paramedic
CH	Cairns Hospital
CI	Clinical Indicator
CIED	Cardiac Implantable Electronic Device
COVID-19	Coronavirus disease 2019
CPB	Cardiopulmonary Bypass
CR	Cardiac Rehabilitation
CRT	Cardiac Resynchronisation Therapy
CS	Cardiac Surgery
CVA	Cerebrovascular Accident
DAOH	Days Alive and Out of Hospital
DES	Drug Eluting Stent
DOSA	Day of Surgery Admission
DSWI	Deep Sternal Wound Infection
ECG	12 lead Electrocardiograph
ECMO	Extracorporeal membrane oxygenation
ED	Emergency Department
eGFR	Estimated Glomerular Filtration Rate
EP	Electrophysiology
EuroSCORE	European System for Cardiac Operative Risk Evaluation
EWMA	Exponentially Weighted Moving Average
FdECG	First Diagnostic Electrocardiograph
FMC	First Medical Contact
FTR	Failure to Rescue
GAD	Generalized Anxiety Disorder
GCCH	Gold Coast Community Health
GCS	Glasgow Coma Scale
GCUH	Gold Coast University Hospital
GLH	Gladstone Hospital
GP	General Practitioner
GYH	Gympie Hospital
HB	Haemoglobin
HBH	Hervey Bay Hospital (includes Maryborough)
HCC	Health Contact Centre
HF	Heart Failure
HFpEF	Heart Failure with Preserved Ejection Fraction
HFrEF	Heart Failure with Reduced Ejection Fraction
HFSS	Heart Failure Support Service
HHS	Hospital and Health Service
H-L	Hosmer–Lemeshow Test Statistic
HOCM	Hypertrophic Obstructive Cardiomyopathy
HSQ	Health Support Queensland
IC	Interventional Cardiology
ICD	Implantable Cardioverter Defibrillator
IE	Infective Endocarditis
IHT	Inter-hospital Transfer
IPCH	Ipswich Community Health
IVDU	Intravenous Drug Use
LAA	Left Atrial Appendage
LAD	Left Anterior Descending Artery
LCX	Circumflex Artery
LGH	Logan Hospital
LOS	Length Of Stay
LV	Left Ventricle
LVEF	Left Ventricular Ejection Fraction
LVOT	Left Ventricular Outflow Tract
MBH	Mackay Base Hospital
MI	Myocardial Infarction

MIH	Mt Isa Hospital
MKH	Mackay Base Hospital
MRA	Mineralocorticoid Receptor Antagonists
MSSA	Methicillin Susceptible Staphylococcus Aureus
MTHB	Mater Adult Hospital, Brisbane
NCDR	The National Cardiovascular Data Registry
NCR	National Cardiac Registry
NCS	Networked Cardiac Services
NP	Nurse Practitioner
NRBC	Non-Red Blood Cells
NSTEMI	Non ST Elevation Myocardial Infarction
OR	Odds Ratio
OOHCA	Out of Hospital Cardiac Arrest
ORIF	Open Reduction Internal Fixation
PAH	Princess Alexandra Hospital
PAPVD	Partial Anomalous Pulmonary Venous Drainage
PCI	Percutaneous Coronary Intervention
PDA	Patent Ductus Arteriosus
PFO	Patent Foramen Ovale
PHQ	Patient Health Questionnaire
PICU	Paediatric intensive care unit
PROMS	Patient Reported Outcome Measures
QAS	Queensland Ambulance Service
QCCN	Queensland Cardiac Clinical Network
QCOR	Queensland Cardiac Outcomes Registry
QEII	Queen Elizabeth II Jubilee Hospital
QHAPDC	Queensland Hospital Admitted Patient Data Collection
QPCR	Queensland Paediatric Cardiac Research
RBC	Red Blood Cells
RBWH	Royal Brisbane & Women's Hospital
RCA	Right Coronary Artery
RDH	Redcliffe Hospital
RHD	Rheumatic Heart Disease
RKH	Rockhampton Hospital
RLH	Redland Hospital
SCCIU	Statewide Cardiac Clinical Informatics Unit
SCUH	Sunshine Coast University Hospital
SHD	Structural Heart Disease
SMoCC	Self Management of Chronic Conditions
STEMI	ST-Elevation Myocardial Infarction
STS	Society of Thoracic Surgery
TAVR	Transcatheter Aortic Valve Replacement
TIMI	Thrombolysis in Myocardial Infarction
TMVR	Transcatheter Mitral Valve Replacement
TNM	Tumour, Lymph Node, Metastases
TPCH	The Prince Charles Hospital
TPVR	Transcatheter Pulmonary Valve Replacement
TUH	Townsville University Hospital
TWH	Toowoomba Hospital
TXA	Tranexamic Acid
VAD	Ventricular Assist Device
VATS	Video Assisted Thoracic Surgery
VCOR	Victorian Cardiac Outcomes Registry
VF	Ventricular Fibrillation
VSD	Ventricular Septal Defect