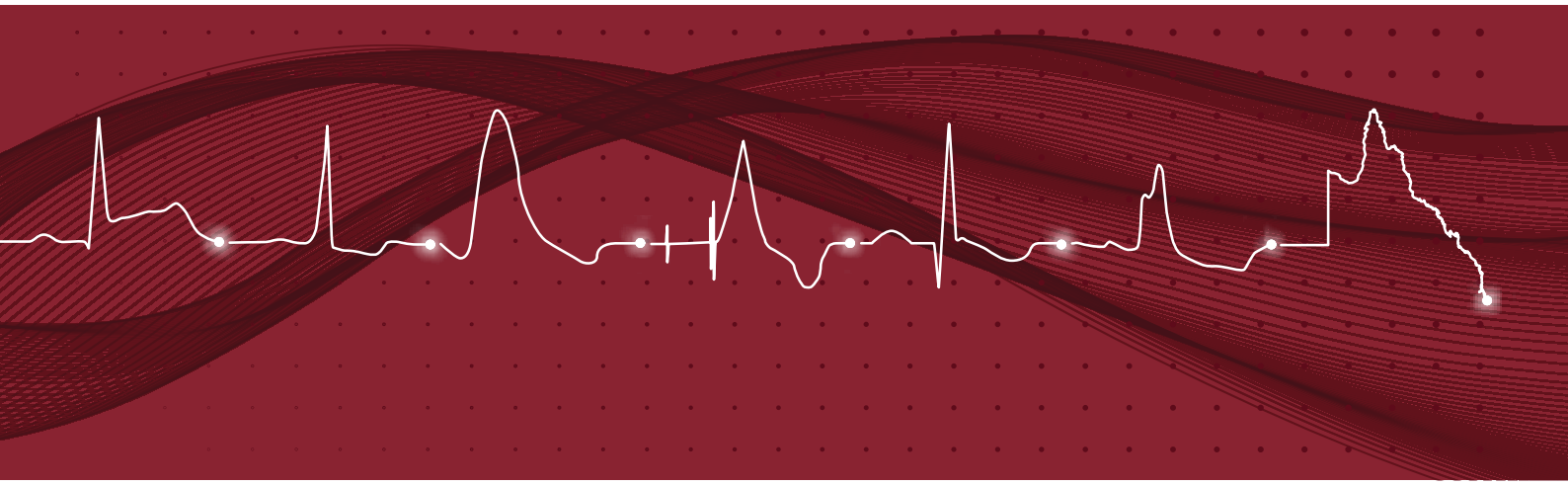
Queensland Cardiac Clinical Network

Queensland Cardiac Outcomes Registry

2021 Annual Report



Queensland Cardiac Outcomes Registry
2021 Annual Report

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An electronic version of this document is available at:
clinicalexcellence.qld.gov.au/priority-areas/clinician-engagement/queensland-clinical-networks/cardiac

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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.

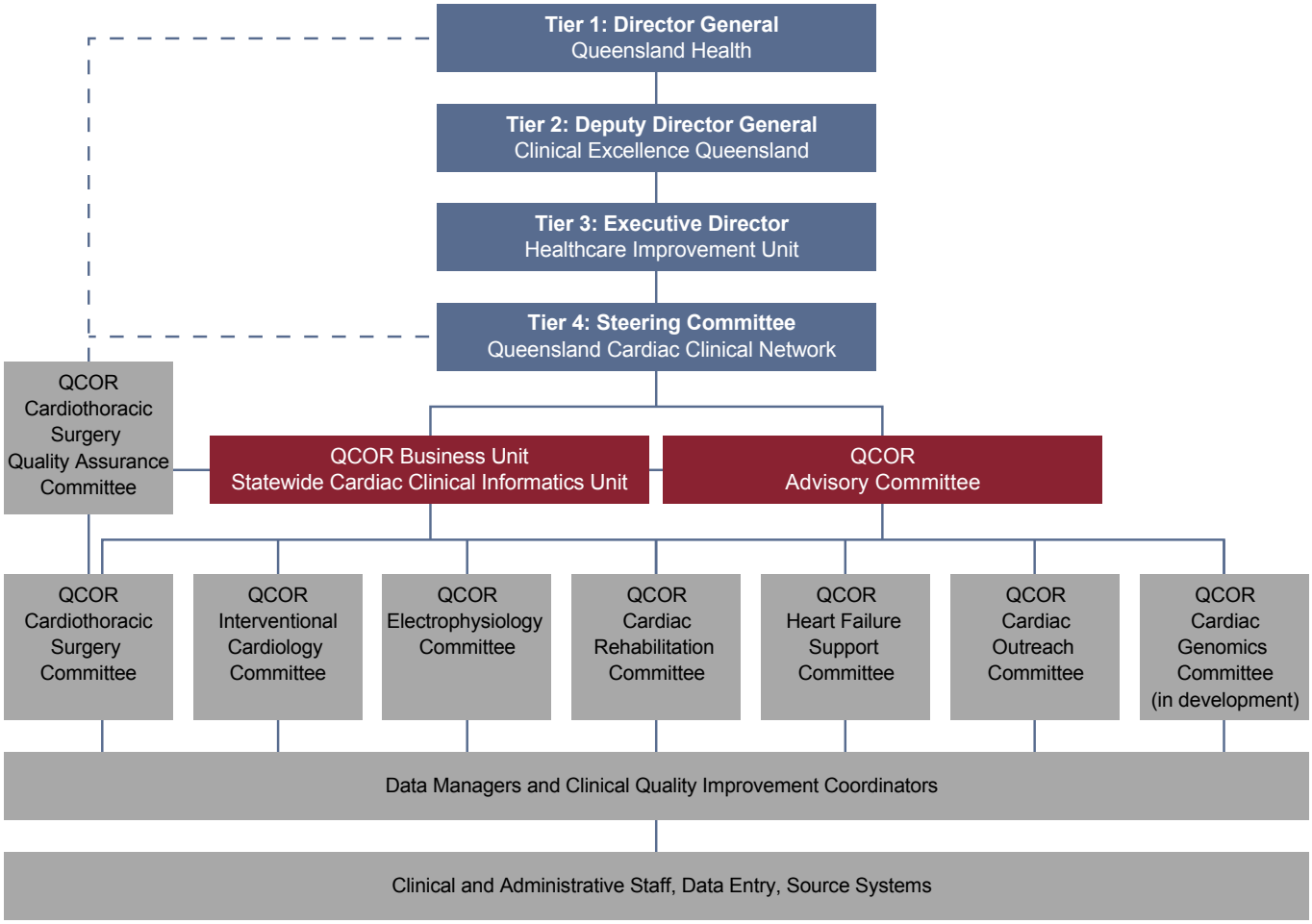


Figure 1: Governance structure

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.

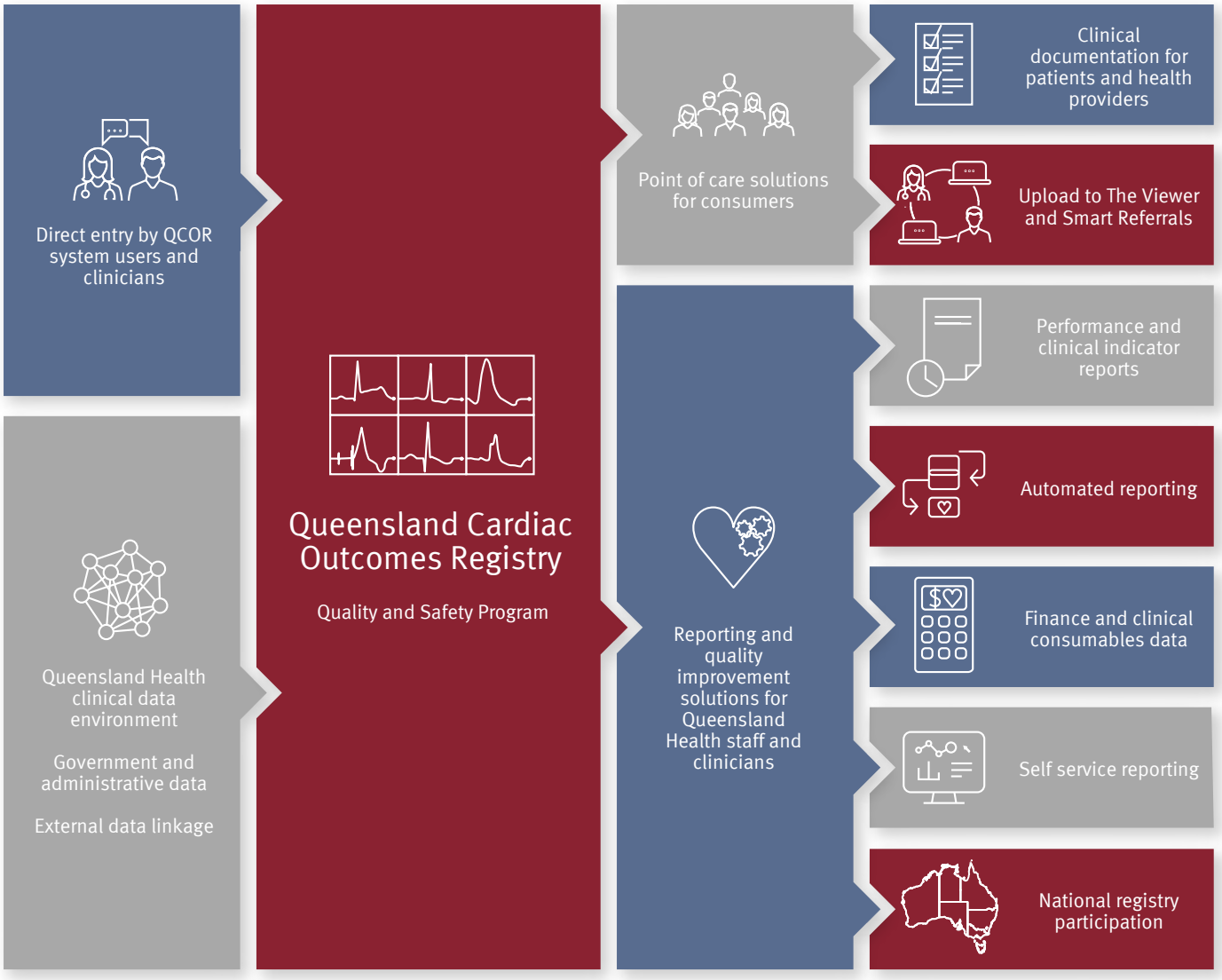
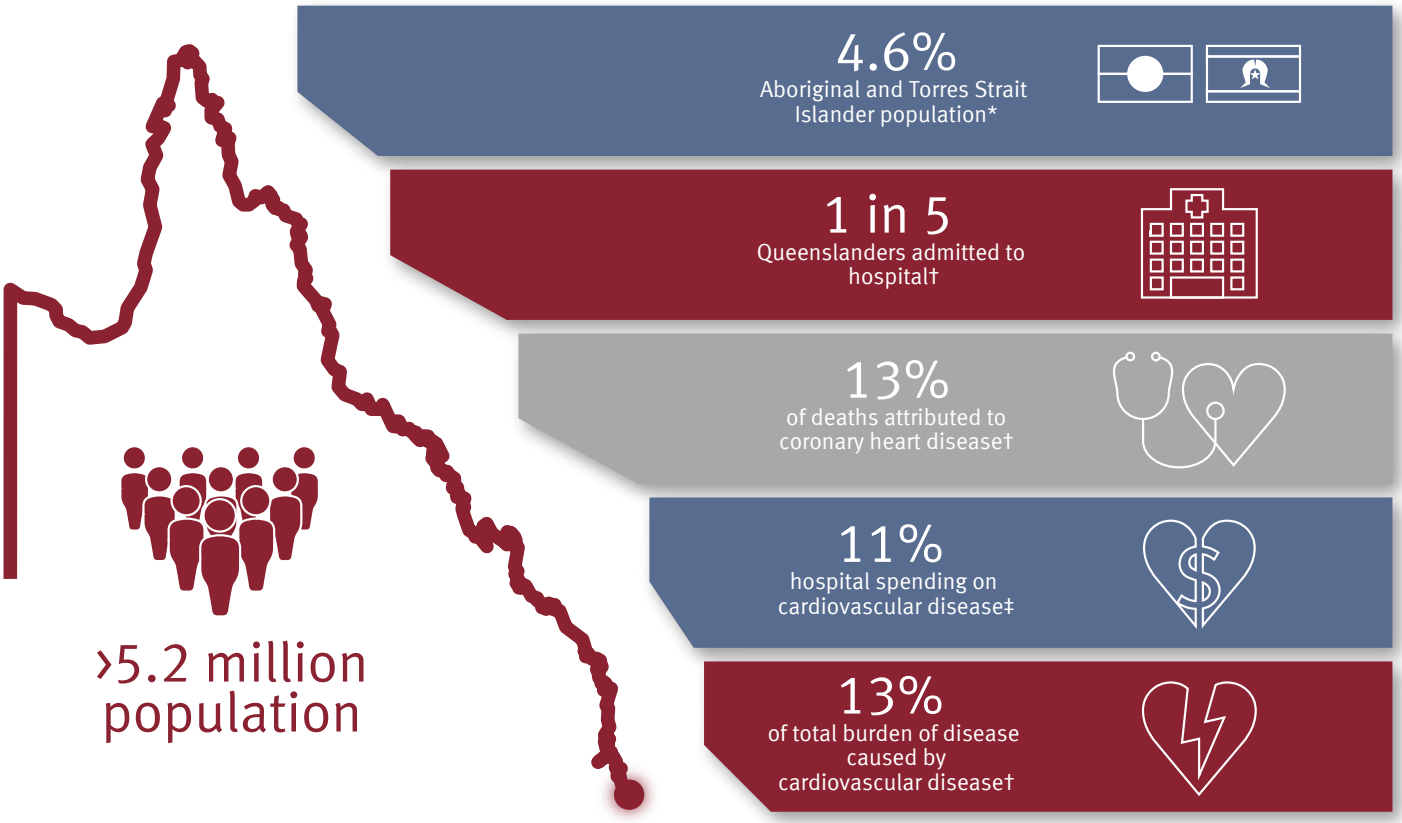


Figure 2: QCOR data flow

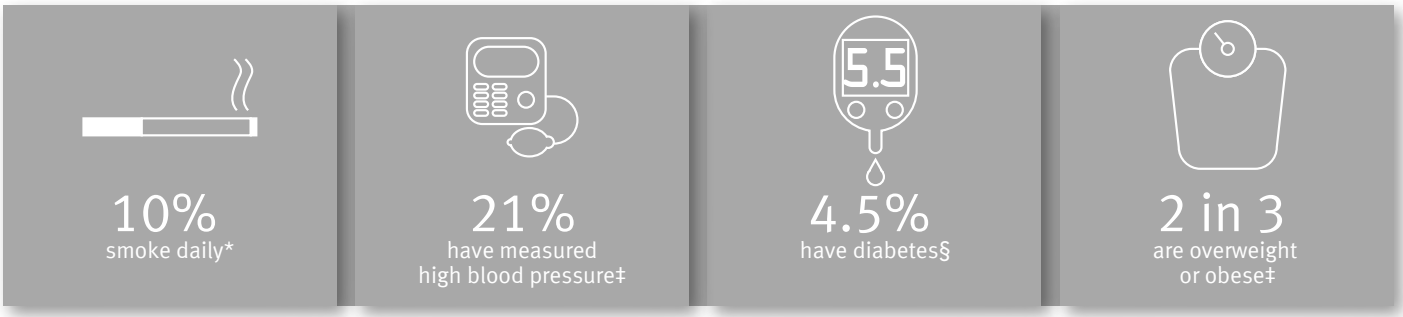
* The Australian Commission on Safety and Quality in Health Care (ACSQHC). Framework for Australian clinical quality registries. Sydney: ACSQHC; 2014.

Queensland Cardiac Outcomes Registry

The Health of Queenslanders



Comorbidities



Mortality

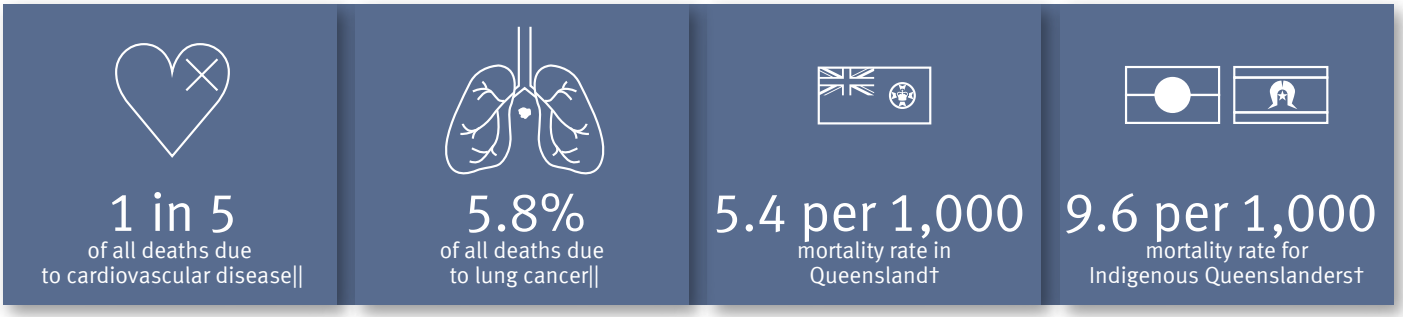


Figure 3: QCOR 2021 infographic

* 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

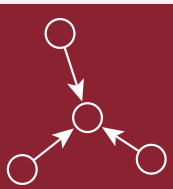
1,067
adult thoracic surgeries

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

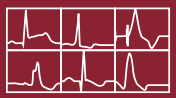
Cardiac Rehabilitation

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 Executive summary

This report comprises an account for cases performed in the eight cardiac catheterisation laboratories (CCL), nine electrophysiology and pacing (EP) facilities, along with five cardiothoracic surgery units operating across Queensland public hospitals in 2021. All referrals to heart failure support (HFSS) and cardiac rehabilitation (CR) services have also been included in this Annual Report.

- 15,443 diagnostic or interventional cases were performed across the eight public CCL facilities in Queensland hospitals. Percutaneous coronary intervention (PCI) was performed in 4,894 of these cases.
- Patient outcomes following PCI remain encouraging. The 30 day all-cause mortality rate following PCI was 1.8%, and of the 89 deaths observed, over three quarters (76%) were classed as either salvage or emergency PCI.
- When analysing the ST segment elevation myocardial infarction (STEMI) cohort presenting within six hours of symptom onset, the median time from first diagnostic electrocardiograph (ECG) to reperfusion was 83 minutes, while the median time from arrival at PCI facility to reperfusion 39 minutes.
- For STEMI presenting within six hours of symptom onset the median time from arrival to PCI facility to reperfusion was 32 minutes for cases performed in working hours (8am to 6pm, Monday to Friday), while cases occurring out of hours had a median time of 42 minutes.
- There were 485 structural heart interventions performed across participating CCL facilities. This included 326 transcatheter valve procedures, of which 239 were transcatheter aortic valve replacements. The unadjusted all-cause 30 day mortality rate for all SHD interventions was 1.2%.
- Across the four sites with a cardiac surgery unit, a total of 2,623 cases were performed including 1,502 cases involving coronary artery bypass grafting and 1,137 valve procedures.
- The observed rates for cardiac surgery mortality and morbidity are either within the expected range or better than expected depending on the risk model used to evaluate these outcomes. This is consistent with the results of previous Audits.
- Across the period of July 2016 to June 2021 1,357 children underwent cardiac surgery, including 287 children in 2021.
- There were 1,512 paediatric cardiac surgical procedures performed from July 2016 to June 2021, either with or without cardiopulmonary bypass (1,148 and 364 procedures respectively).
- Thirty day mortality after paediatric cardiac surgery was observed at 0.7% between July 2016 to June 2021.
- A total of 1,067 thoracic surgery (TS) cases were performed across the five public hospitals providing TS services in 2021. Over one quarter (27%) of surgeries followed a surgical indication of primary lung cancer, whereas pleural disease accounted for 28% all cases.
- The unadjusted all-cause 30 day mortality rate following TS was 1.2%, increasing to 2.4% at 90 days post surgery.
- At the nine public EP sites, a total of 5,269 cases were performed, which included 3,500 cardiac device procedures and 1,345 cardiac electrophysiology procedures.
- The EP clinical indicator audit identified a median wait time of 78 days for complex ablation procedures, and 21 days for elective implantable cardioverter defibrillator (ICD) implants. Meanwhile the median wait time for a standard ablation procedure was 99 days.
- There was a total of 10,647 referrals to public CR services in 2021. Almost three quarters of referrals followed an admission at a public hospital in Queensland.
- Over two thirds (69%) of CR referrals proceeded to pre assessment by a CR service. The most common reason this did not take place was that the patient declined or was not interested.
- The vast majority (93%) of referrals to CR were created within three days of the patient being discharged from hospital, while over half of patients went on to complete an initial assessment by CR within 28 days of discharge (59%). This result is consistent with performance data for 2020.
- There were 6,326 new referrals to a HFSS in 2021, a 12 percent increase over the previous year.
- Upon discharge from hospital, the prescription of an ACEI/ARB or ARNI, beta blocker or MRA for heart failure with reduced ejection fraction (HFrEF) were measured at 91%, 90% and 51% respectively.
- At the time of clinical review 93% of patients with HFrEF were prescribed ACEI/ARB or ARNI, and 92% were prescribed a beta blocker.
- Beta blocker titration to clinical guideline target or maximum tolerated dose was achieved by time of titration review for 80% of HFrEF patients.

5 Spotlight: Cardiac Outreach

The Networked Cardiac Services (NCS) program has enabled significant and tangible system reform as well as improved healthcare for patients across many parts of the state. From 2019 to present, cardiology services and their partners across Queensland have begun to adopt this integrated model of care, underpinned by strong regional capability and organisational accountability.

In 2017/18, the Statewide Cardiac Clinical Network commissioned an investigative Report on the state of cardiac care and outreach services provided by Queensland Health. This led to the development of the Implementation Framework for Networked Cardiac Care and Outreach Services in Queensland (2018), written in partnership with the Aboriginal and Torres strait Islander Division (then, Branch). In 2019, the Ministerial Rapid Results Program nominated to support, progressively fund, and implement the Framework (Networked Cardiac Services) across the state (Figure 1).

The initial investigative Report identified several key opportunities for improvement:

- Significant variations in health care and outcomes across Queensland. People living in rural and remote locations and Aboriginal and Torres Strait Islander people are admitted to hospital for cardiac-related conditions two to three times more than the broader population.
- Inequitable access to health care due to Queensland's vast geographical size and dispersed population.
- Lack of integration and continuity between and within health care sectors.
- Poor access to and/or use of technology.
- Limited or no data about or evaluation of existing services.
- Unreliable funding and disparate resource allocation.
- Historical models of care persist, whereby patients and clinicians travel past the closest health care facility, creating inefficiency, inequitable resource allocation, untapped potential, uncoordinated and potentially unsafe care.
- Successful, existing improvement initiatives in the field are not leveraged or spread to other jurisdictions.

In response, an implementation framework recommended the following improvements:

Improve access, equity, quality & safety, and efficiency

- **Care close to home, delivered by consistent, regional teams**

  It was identified that the eight cardiac tertiary hospital services spread along the east coast of Queensland and their adjacent healthcare services should be enabled and accountable for providing quality, cardiac care for their own communities – 'Networked' or 'Hub' and 'Spoke' model of care.

  Restructure cardiac services to reflect natural patient flow and harness full potential of services i.e., 8 cardiac specialist 'hubs' and adjacent 'spokes'.

  Build capability and capacity of regional teams to provide care for their own communities.

- **Coordination and integration**

  High-value, patient care-coordination model and shared care across health sectors (public and private, primary health, and Aboriginal and Torres Strait Islander health services).

- **Evidence, evaluation, and improvement**

  Evidence-based care informed by data.

- **Technology**

  Regional teams provided with and enabled to use technology to support healthcare.

- **Sustainable funding and resources**

  Funding model that resolves initial inequity and ongoing sustainability, including activity and value-based approaches.

- **Governance and accountability**

  Regions lead and are responsible for clinical and service outcomes via stakeholder engagement, formal governance arrangements and access to information.

- **Harness existing investments and programs**

  For exponential benefits and efficiency.

Since 2019, eight Hospital and Health Services (HHSs) have progressively implemented the roll-out of NCS. All remaining HHSs have participated in planning for and endorsed implementation of NCSs, given financial support from the Queensland Department of Health (Table 1). Business Cases have been approved by the Rapid Results Cardiac Steering Committee. Funding for the remaining stages is yet to be identified.

Through 2018–2019, the SCCIU and Rapid Results Program collaborated with staff and subject matter experts across the various Queensland Health cardiac outreach units to develop a new QCOR module specifically oriented towards this work. The new QCOR Outreach Module establishes a foundation for cardiac outreach care coordination across the health system, and a reporting platform which allows an unprecedented amount of information to be available for an area otherwise characterised by relative paucity of data.

The QCOR Outreach Module provides Queensland Health practitioners with:

- Patient-centric clinical case management – tailored towards the outreach setting,
- Improved follow up and activity-based reporting for outreach patients and services,
- Reporting of outreach-specialty clinical indicators and other key performance measures, and
- Potential for future integration with other Queensland Health and QCOR systems.

The new QCOR Outreach Module was deployed from 2019 as part of a staggered rollout, with the Far North Queensland Outreach Unit as the first site commencing in November 2019. Further units have been added to the system over the following year as either new outreach programs are established or existing services transition to the system.

Table 1: QCOR cardiac outreach module – participating outreach units

Cardiac outreach unit	Hub facility	Commenced date
Far North Queensland	Cairns Hospital	November 2019
Townsville and North West Queensland	Townsville University Hospital	January 2020
Princess Alexandra Hospital	Princess Alexandra Hospital	July 2020
Ipswich Hospital	Ipswich Hospital	November 2020
Redland Hospital	Redland Hospital	July 2021
Toowoomba Hospital	Toowoomba Hospital	August 2020

NCS programs are delivering on their core philosophy of providing care to Aboriginal and Torres Strait Islander people and delivering care closer to home. A variety of models of care exist across outreach units with most providing cardiologist/medical consults, cardiac physiologists including cardiac sonographers, nursing staff, Aboriginal and Torres Strait Islander health workers and pharmacists. Multidisciplinary teams are vital to delivering on the core outputs of NCS.

Table 2: Practitioner roles provided in outreach clinics

Cardiac outreach unit	Cardiologist/ medical	Cardiac physiologist / sonographer	Nurse	Indigenous health worker	Pharmacist
Far North Queensland	✓	✓	✓	–	✓
Townsville and North West Queensland	✓	✓	✓	✓	✓
Princess Alexandra Hospital	✓	✓	✓	✓	–
Toowoomba Hospital	✓	✓	✓	✓	–
Redland Hospital	✓	✓	✓	–	–
Ipswich Hospital	✓	✓	–	–	–

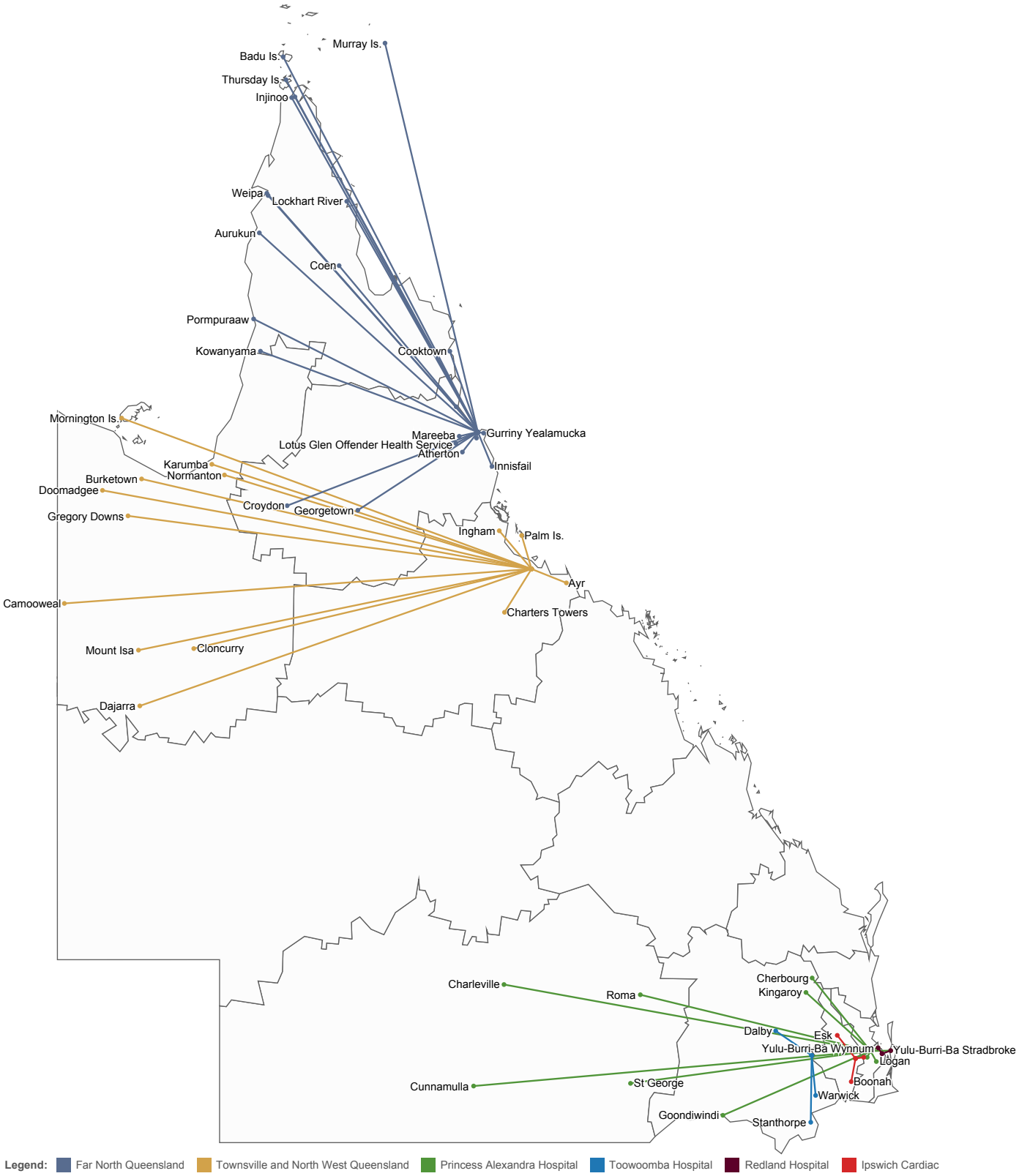


Figure 1: Cardiac outreach hub and spoke locations

Cardiac outreach units each have a responsibility to provide services to a differing number of spoke sites. Each spoke site has its own requirements and workflow which requires units to be agile and able to adapt to many different clinic environments. Spoke sites numbers may change over time with new services being identified based on need and the capacity for the hub units to provide services.

Table 3: Networked cardiac outreach– total spoke sites by outreach unit

Cardiac outreach unit	Total spokes n
Far North Queensland	23
Townsville and North West Queensland	14
Princess Alexandra Hospital	13
Toowoomba Hospital	3
Redland Hospital	2
Ipswich Hospital	3
All	**56**

Over the course of 2021, there were 473 clinics operated through the NCS model. Not all units were operating at full capacity for the entire duration of the year due to COVID-19 related clinic cancellations. This is reflected in Table 4 below. Some units also took on clinic sites that were previously operated by other services whilst some units continued their previous work which were services offered for many years but transitioned to the NCS model.

Table 4: Networked cardiac outreach – participating outreach unit total clinics

Cardiac outreach unit	Total clinics n
Far North Queensland	103
Townsville and North West Queensland	174
Princess Alexandra Hospital	138
Toowoomba Hospital	29
Redland Hospital	7
Ipswich Hospital	22
All	**473**

* Note varying start dates of some services

There have been 6,343 total consults delivered as part of the NCS program. Larger and more established hub sites comprise of the greatest numbers which is also reflective of the higher number of clinics performed and number of spoke sites the unit is responsible for.

Table 5: Networked cardiac outreach total consults performed and total distinct patients per hub site

Cardiac outreach unit	Total consults n	Total patients n
Far North Queensland	1,764	1,451
Townsville and North West Queensland	1,786	1,335
Princess Alexandra Hospital	2,282	1,654
Toowoomba Hospital	334	255
Redland Hospital	54	48
Ipswich Hospital	123	109
All	**6,343**	**4,838**

There were 4,838 patients enrolled in the NCS outreach service since its inception. Of these patients 1,601 (59%) were male. The largest subgroup of this cohort were males aged between 60 and 69 years and males aged between 70 and 79 years. The largest proportion of females was in the cohort aged between 60 and 69 years of age.

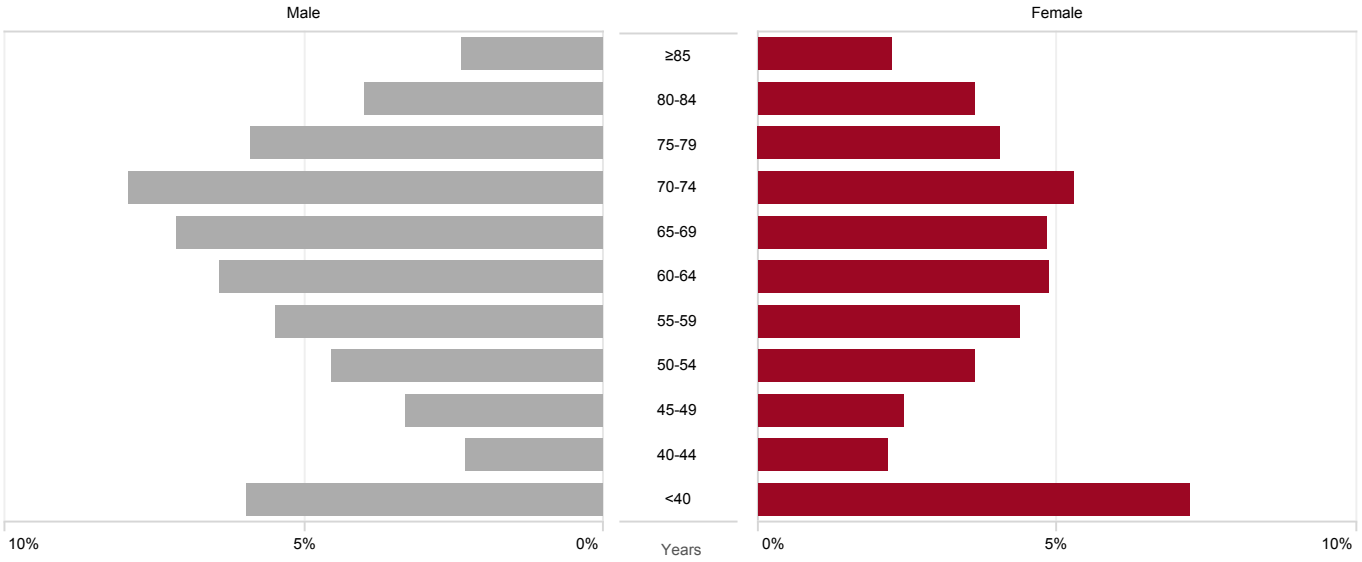


Figure 2: Proportion of outreach consults by age and gender

Table 6: Networked cardiac outreach number of patients by age group and gender at all sites

Gender	Age group	All patients n (%)
Male	<40	316 (6.5)
	40–49	275 (5.7)
	50–59	498 (10.3)
	60–69	651 (13.5)
	70–79	650 (13.4)
	80–89	272 (5.6)
	≥90	28 (0.6)
Female	<40	374 (7.7)
	40–49	219 (4.5)
	50–59	402 (8.3)
	60–69	466 (9.6)
	70–79	436 (9.0)
	80–89	249 (5.1)
	≥90	30 (0.6)
Total		**4,838 (100.0)**

Of the overall cohort enrolled in NCS outreach programs, 4,838 distinct patients were seen by treating teams. Aboriginal and Torres Strait Islander patients accounted for 35% of the group. This is considerably higher than the resident proportion of Aboriginal and Torres Strait Islander population of Queensland of 4.6%.

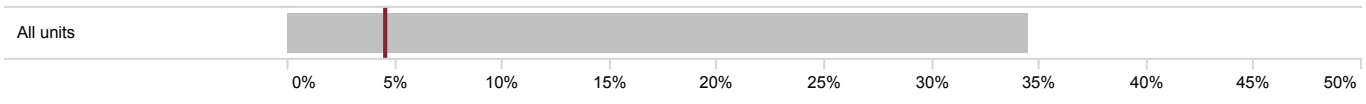
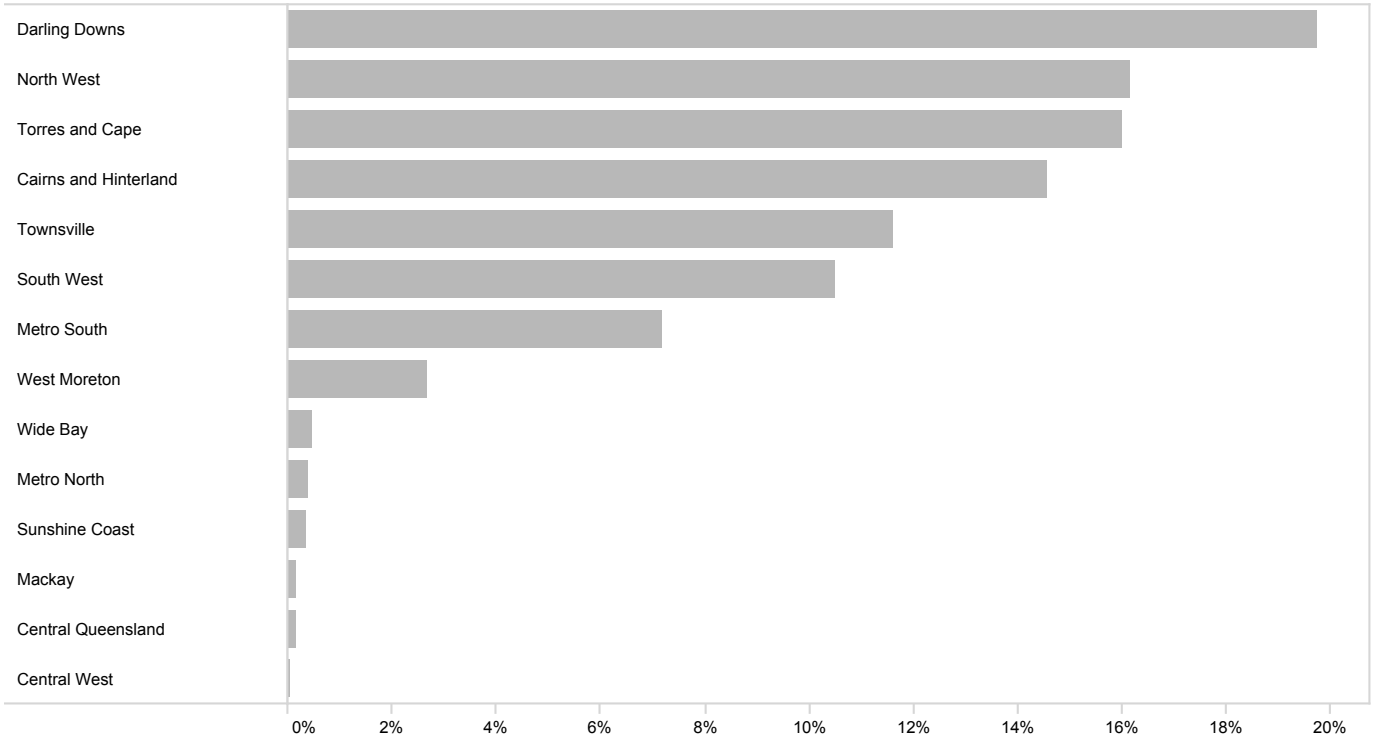


Figure 3: Proportion of Aboriginal and Torres Strait Islander patients seen in cardiac outreach

Patients who reside in the Darling Downs HHS account for the largest proportion (20%) of patients seen. This is followed closely by the North West HHS (16%) and Torres and Cape HHS (15%). A small proportion of patients resided interstate at the time of their encounter (1.1%). It should be noted that some patients may temporarily reside in one HHS but their permanent address is elsewhere but for the purpose of this analysis, permanent address is presented.



* Note varying start dates of each regional service

Figure 4: Proportion of patients by HHS of residence since commencement

Of the 6,343 total consults delivered as part of the NCS program, 43% of these consults were new encounters, which represents a large volume of clinical work and focus to establish patient rapport, assess often complex medical history, and formulate a plan of treatment and management. It is evident that over time, the proportion of new to review patients will shift (previously 45%), reflective of the fact that cardiac conditions are mostly a chronic disease.

Table 7: Number and proportion of new and review cardiac outreach consults

Consult type	n (%)
New	2,715 (42.8)
Review	3,628 (57.2)
Total	**6,343 (100.0)**

Integrated outreach services are flexible and look to add value where opportunity presents. Opportunistic specialist review of inpatients while treating teams are in regional facilities allows for expert clinical treatment and efficient facilitation of treatment and escalation for transfer where appropriate (in person, non-clinic). NCS teams are also instrumental in the organisation and provision of telehealth consultations which are performed both in clinic and in other non-clinic locations such as GP practices and other healthcare facilities (telehealth, non-clinic). Due to the COVID-19 outbreak, larger than anticipated numbers of telehealth consultations were performed (18%).

Table 8: Number and proportion of in person and telehealth consults by clinic mode

Delivery mode	Clinic n (%)	Non-clinic n (%)	Total n (%)
In person	5,153 (98.8)	63 (1.2)	5,216 (82.2)
Telehealth	487 (43.2)	640 (56.8)	1,127 (17.8)
Total	**5,640 (88.9)**	**703 (11.1)**	**6,343 (100.0)**

The majority of patients seen in outreach resided less than 50 kilometres from their encounter facility (80%), demonstrating that NCSs are meeting their objective to provide care closer to home. A smaller proportion of patients (8%) still needed to travel more than 150 kilometres to access specialist care, which highlights the barriers to care and travel distances faced by Queenslanders living in regional and remote locations.

Table 9: Number and proportions of patients by driving distance to consult

Driving distance – home to consult	n (%)
≤50 km	5,058 (79.7)
50–100 km	648 (10.2)
100–150 km	129 (2.0)
>150 km	502 (7.9)
Incomplete data	6 (0.1)
All	**6,343 (100.0)**

Outreach services offered large travel distance savings as a result of patients attending clinics at spoke sites instead of travelling to the hub site. These values are determined by calculating the difference in driving distance between the patient's place of residence to the hub site and the patient's place of residence to the spoke site. The largest travel distance savings were observed in the cohort residing furthest from the outreach unit hub.

Table 10: Median distance of patient address to hub sites

Distance category	Median distance km
≤50 km	7.5
50–100 km	80.2
100–150 km	112.0
>150 km	472.5

The ability to perform cardiac investigations on site at the time the patient is in attendance at the outreach clinic further demonstrates savings in travel, increases treatment efficiency due to immediate availability of information and decreases complexity of investigations for patients who often have significant barriers to care. As previously mentioned, the models of care employed at various units varies, and as such the ability to perform investigations within NSC clinics differs by unit and the site being visited. The most frequently performed investigation during outreach was 12 lead electrocardiography followed by transthoracic echocardiography (TTE).

Table 11: Investigations offered in outreach clinics

Cardiac outreach unit	Cardiology consults	12 lead ECG	TTE	CIED* interrogation	Exercise stress test
Far North Queensland	✓	✓	✓	✓	✓
Townsville and North West Queensland	✓	✓	✓	–	–
Princess Alexandra Hospital	✓	✓	✓	✓	✓
Toowoomba Hospital	✓	✓	✓	–	–
Redland Hospital	✓	✓	✓	–	–
Ipswich Hospital	✓	✓	✓	–	–

* Cardiac implantable electronic device

Table 12: Number of investigations performed in outreach clinics

Investigation	n
12 lead ECG	3,424
Transthoracic echocardiogram	1,784
Cardiac implantable electronic device interrogation	61
Exercise stress test	27
24 hour Holter ECG monitor	2
Other	153
Total	**5,451**

6 Spotlight: COVID-19 pandemic

6.1 Introduction

Throughout 2021 health services in the state of Queensland have been impacted by restrictions and changes to the way healthcare is provided due to the COVID-19 pandemic. The first case of COVID-19 in Queensland was detected in late January 2020, after which a series of public health measures subsequently followed that significantly changed the way that healthcare was delivered over 2020 and 2021.

Following the declaration of a global pandemic by the World Health Organisation on 11 March 2020, Australia entered the first stage of a nationwide shutdown on 23 March 2020, which limited activity, travel and social interaction. In 2021, a series of periods where COVID-19 cases detected in the community resulted in disruptions to elective procedures.

Overall, access to cardiac services were impacted with reductions in the number of elective admissions and procedures as well as inpatient and outpatient diagnostic studies and outpatient consultations. Outpatient support services such as cardiac rehabilitation and heart failure support services were also affected. Some community health facilities pivoted to provide COVID-19 testing support while some outpatient programs were temporarily closed due to the redeployment of staff to other areas of healthcare, or the reclaiming of clinical spaces to deliver COVID-19 screening clinics and vaccination hubs.

Public health directives also placed restrictions on outpatient programs by limiting the number of people per square metre and mandating the use of face masks. Outpatient programs responded to these challenges while maintaining service provision, and many adapted their services to deliver these via alternative means such as telehealth.

With all these effects plus the likely negative influence on patient presentations to medical facilities and changed way is which hospital resources are utilised, this section was added once again to this year's Report, aiming to characterise the effects the pandemic had on cardiac services in Queensland in 2020 and 2021.

With a surge in cases in Queensland following vaccination campaigns and cessation of border restrictions at the end of 2021, the effects of COVID-19 are likely to be more evident in the first part of 2022 and will be examined further in subsequent QCOR Reports.

6.2 Procedure volumes

In the Queensland public health system, the utilisation of most cardiac services declined during April 2020 more than expected based on seasonal variation alone. Similar findings have been well documented both nationally and internationally across many medical and surgical specialties, with particular impacts noted on the rates of hospitalisation for acute coronary syndromes.*,†

Interventional cardiology

An overall reduction in cardiac catheterisation laboratory cases was observed in April 2020. This is owed mainly to a decreased volume of elective procedures. Case volumes returned to pre-pandemic volumes by June 2020 and tapered toward the end of the year as is usual for that time of year due to Christmas period service closures.

Total case volumes for all of 2021 decreased by 2.5% for PCI procedures when compared to the benchmark year of 2019. Similarly, case numbers for other diagnostic coronary procedures were stable with only a 0.8% decrease compared to the previous year.

Cardiac surgery

In 2021, there were 2,624 cardiac surgery procedures which was a minor increase on 2019. A significant consideration in cardiac surgery is the requirement for an intensive care unit bed following the operation. With intensive care units being an integral part of the COVID-19 response, this may explain the small reduction in cardiac surgeries in 2021 compared to 2020.

Thoracic surgery

There was a 2.4% decrease in thoracic surgery cases performed in 2021 compared to 2021 and a 2.4% increase in 2021 compared to 2019. This is despite the challenges of the COVID-19 pandemic. Monthly case volumes for 2021 were more consistent compared with previous years.

Electrophysiology and pacing

Electrophysiology and pacing services saw a 12% growth in cases from 2019 to 2021 and a modest 1.3% increase from 2020 to 2021. A portion of this growth can be attributed to extra case detail captured for Toowoomba Hospital which was also evident in 2020. In 2021, there were small increases observed in the proportion of category 1 cases and also for elective cases when compared to 2020, however when compared to 2019, elective cases declined and the proportion of category 1 cases increased.

Table 1: Total cases for interventional cardiology, cardiac surgery, thoracic surgery and electrophysiology and pacing by year, 2019–2021

Service line	2019 n	2020 n	2021 n
Interventional cardiology	5,002	4,966	4,894
Cardiac surgery	2,622	2,651	2,624
Thoracic surgery	1,042	1,093	1,067
Electrophysiology and pacing	4,654	5,201	5,269

* Solomon, M.D., McNulty, E.J., Rana, J.S., Leong, T., Lee, C., Sung, S., … Go, A.S. (2020). The COVID-19 pandemic and the incidence of acute myocardial infarction. *N Engl J Med*; 383:691-693.

† De Filippo, O., D'Ascenzo, F., Angelini, F., Bocchino, P.B., Conrotto, F., Saglietto, A., … De Ferrari, G. (2020). Reduced rate of hospital admissions for ACS during Covid-19 outbreak in northern Italy. *N Engl J Med*; 383:88-89

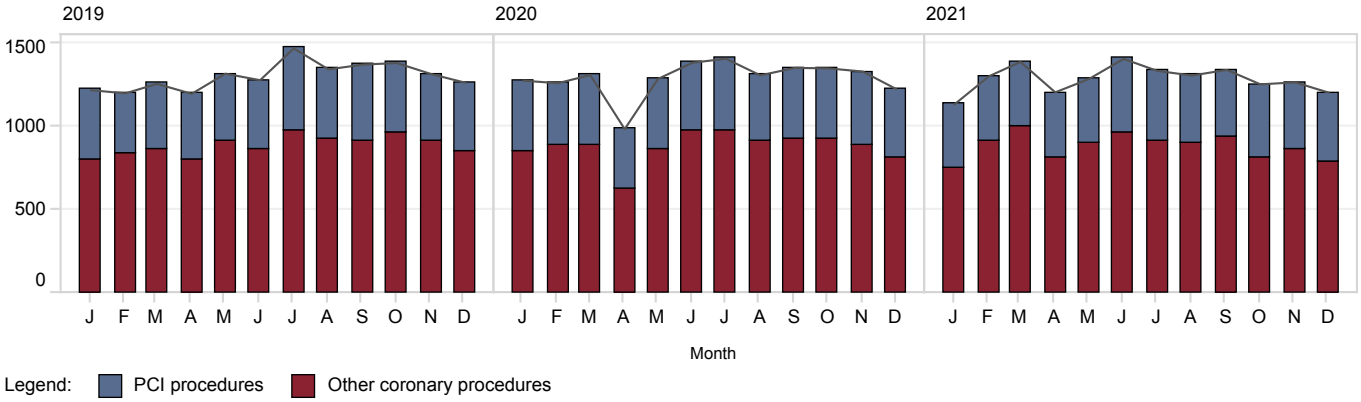


Figure 1: Proportion of all diagnostic and interventional cardiology cases by case category and month, 2019–2021

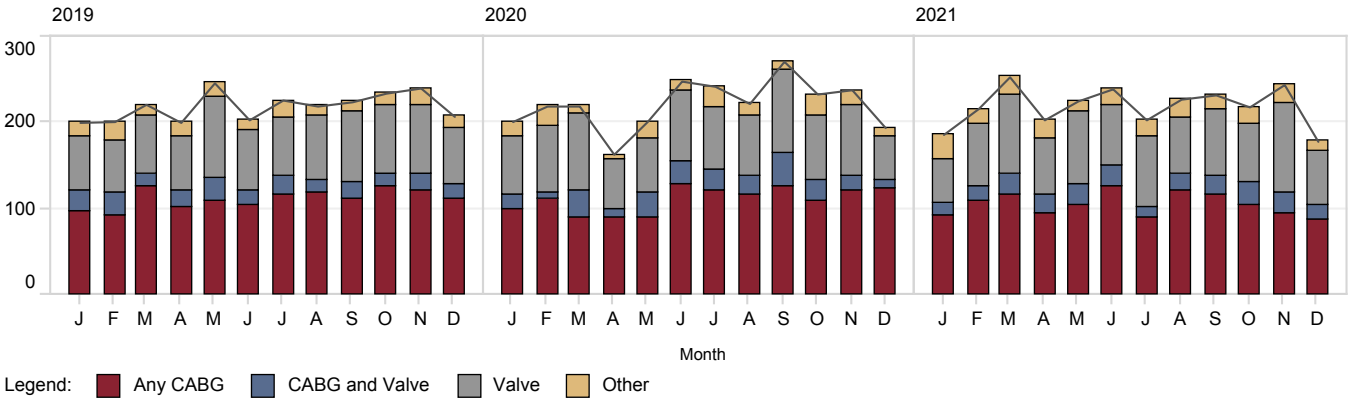


Figure 2: Proportion of all cardiac surgery cases by procedure category and month, 2019–2021

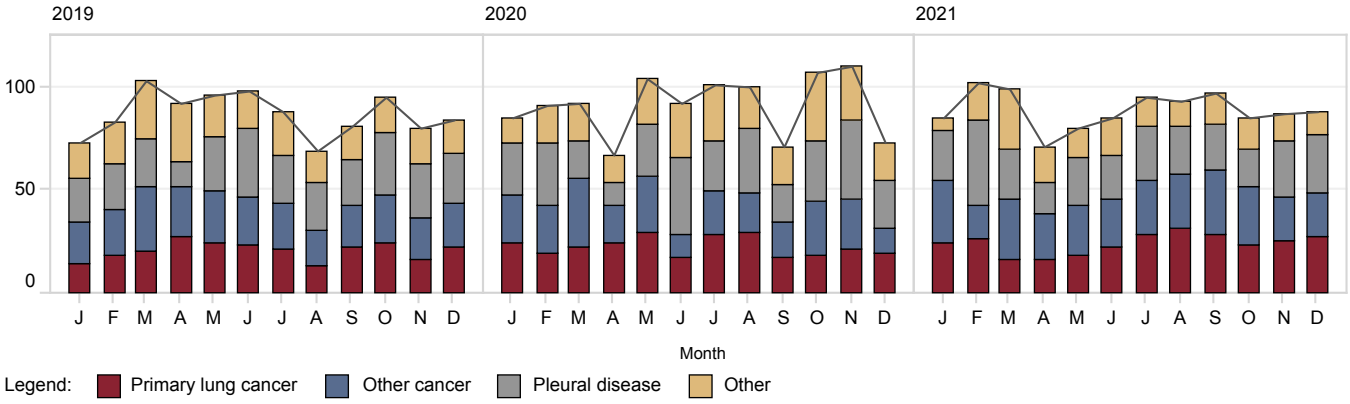


Figure 3: Proportion of all thoracic surgery cases by indication and month, 2019–2021

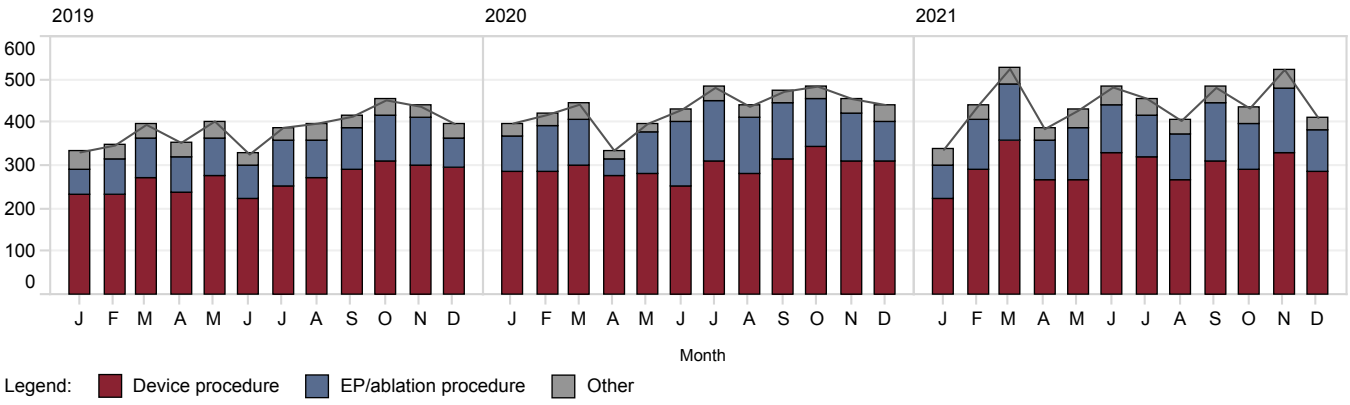


Figure 4: Proportion of all electrophysiology and pacing cases by procedure category and month, 2019–2021

6.3 Interstate and international patients

When examining the place of residence for patients undergoing cardiac interventions between 2019 and 2021, a notable decrease in the proportion of interstate and overseas patients was observed. The proportion of interstate patients reduced from 5.7% to 4.0%, while the proportion of overseas patients reduced by over two thirds (0.7% to 0.2%). This is reflective of travel restrictions in place, limiting international and interstate travel for a large part of 2020 and 2021.

Table 2: Patient place of residence at time of procedure, 2019–2021

Service line	2019 %	2020 %	2021 %
Queensland	93.6	95.1	95.1
Interstate	5.7	4.5	4.5
Overseas	0.7	0.4	0.4

Excludes missing data (0.1%)

6.4 Admission status

There was a reduced proportion of elective procedures and category 3 procedures observed across all service lines from 2019 to 2021. The reduction in elective cases appears to be concentrated around April 2020, coinciding with the announcement of the COVID-19 pandemic. These findings are likely reflective of the redistribution of clinical services in response to the pandemic as well as public health directives leading to a reduction in elective procedure bookings.

Table 3: Procedure status for interventional cardiology, cardiac surgery, thoracic surgery and electrophysiology and pacing by year, 2019–2021

Service line	2019	2020	2021
Interventional cardiology, n	5,002	4,966	4,894
Elective, n (%)	1,094 (21.9)	1,059 (21.3)	1,055 (21.6)
Urgent, n (%)	2,719 (54.3)	2,585 (52.1)	2,568 (52.5)
Emergent, n (%)	1,104 (22.1)	1,252 (25.2)	1,174 (24.0)
Salvage, n (%)	87 (1.7)	70 (1.4)	91 (1.9)
Cardiac Surgery, n	2,622	2,651	2,624
Elective, n (%)	1,523 (58.1)	1,472 (55.5)	1,432 (54.6)
Urgent, n (%)	913 (34.8)	990 (37.3)	970 (37.0)
Emergent, n (%)	169 (6.4)	185 (7.0)	211 (8.0)
Salvage, n (%)	17 (0.6)	4 (0.2)	10 (0.4)
Thoracic surgery, n	1,042	1,093	1,067
Elective, n (%)	730 (70.1)	719 (65.8)	734 (68.8)
Urgent, n (%)	254 (24.4)	282 (25.8)	131 (12.3)
Emergent, n (%)	58 (5.6)	92 (8.4)	202 (18.9)
Electrophysiology and pacing, n	4,654*	5,201†	5,269‡
Category 1, n (%)	2,636 (56.6)	3,051 (58.7)	3,123 (59.3)
Category 2, n (%)	1,143 (24.6)	1,365 (26.2)	1,377 (26.1)
Category 3, n (%)	548 (11.8)	459 (8.8)	487 (9.2)

Category 1: Clinically indicated within 30 days

Category 2: Clinically indicated within 90 days

Category 3: Clinically indicated within 365 days

* 7.0% missing data

† 6.3% missing data

‡ 5.4% missing data

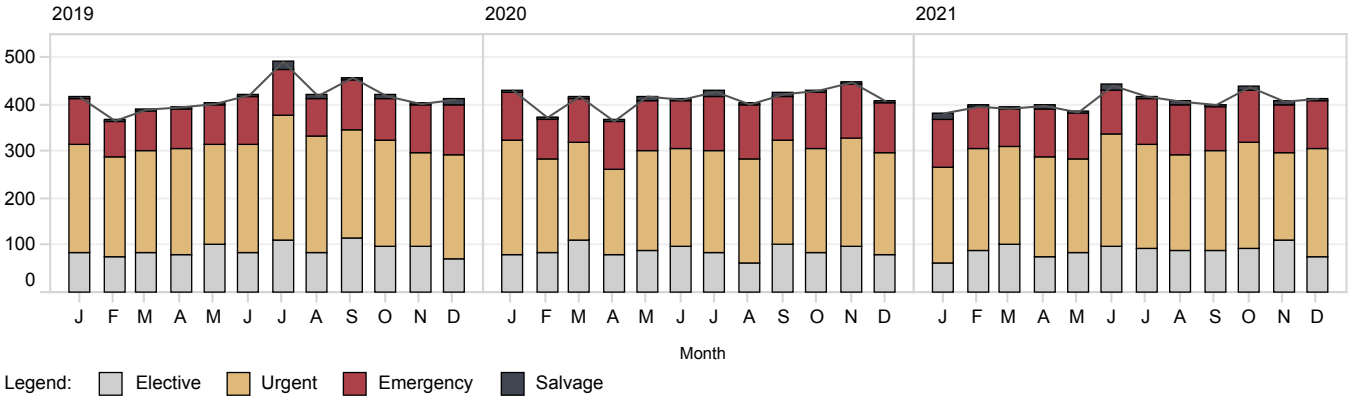


Figure 5: Proportion of all interventional cardiology cases by admission status and month, 2019–2021

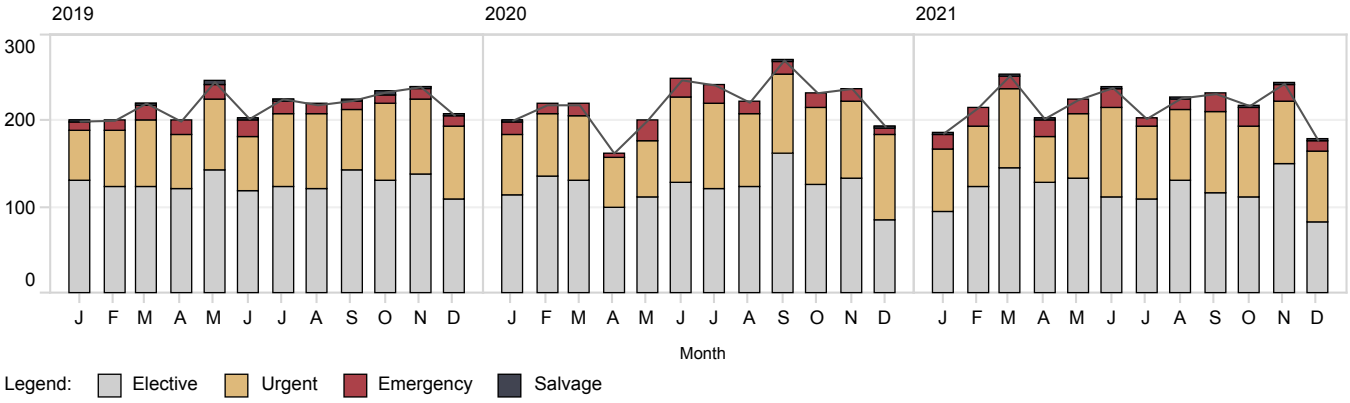


Figure 6: Proportion of all cardiac surgery cases by admission status and month, 2019–2021

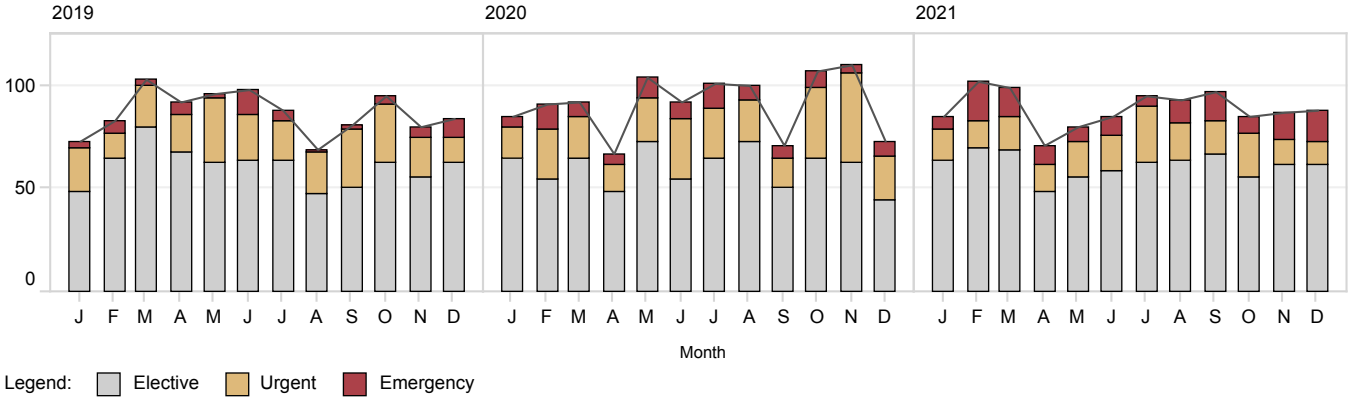
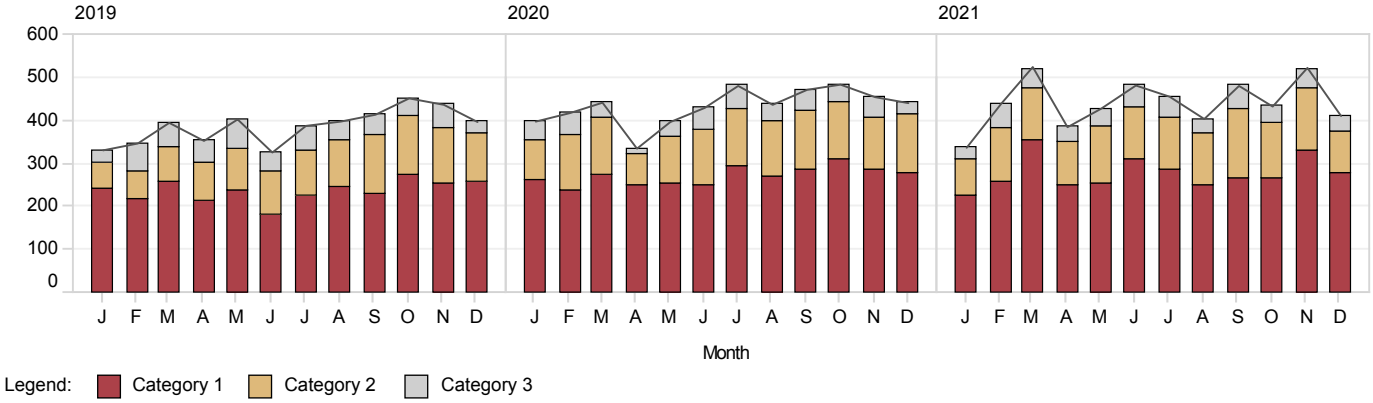


Figure 7: Proportion of all thoracic surgery cases by admission status and month, 2019–2021



Note: imputed missing data

Figure 8: Proportion of all electrophysiology and pacing cases by urgency status and month, 2019–2021

6.5 Outpatient support services

Cardiac rehabilitation services across the state were subject to disruption due to resources being redistributed to support the state's COVID-19 response. The overall number of referrals in 2021 was less than 2019 and 2020, with a total of 10,647 referrals, 8.1% less than 2019.

Heart failure support services showed a 16.2% increase in referrals received in 2021 compared to 2019. The impacts on heart failure support services appear to have been limited.

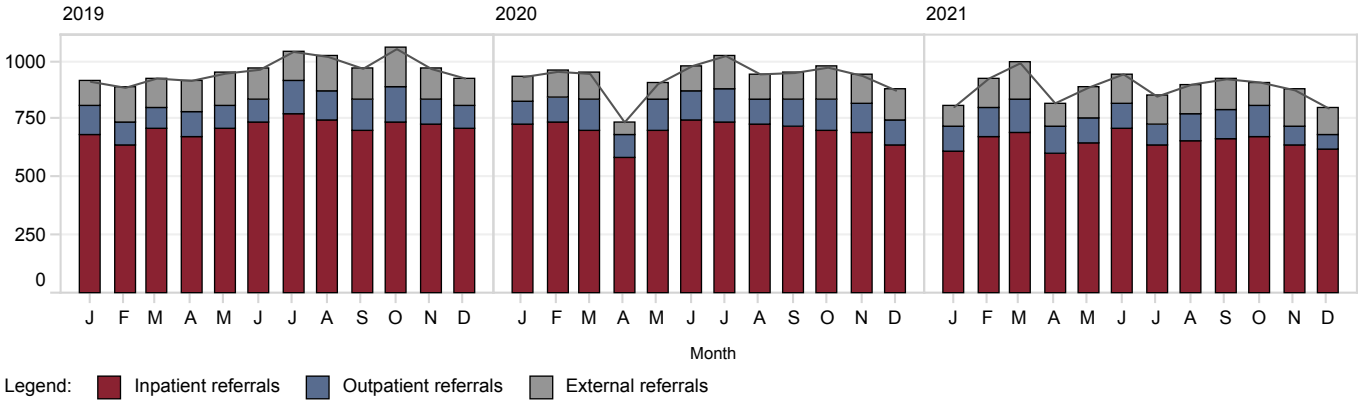


Figure 9: Cardiac rehabilitation referral source, 2019–2021

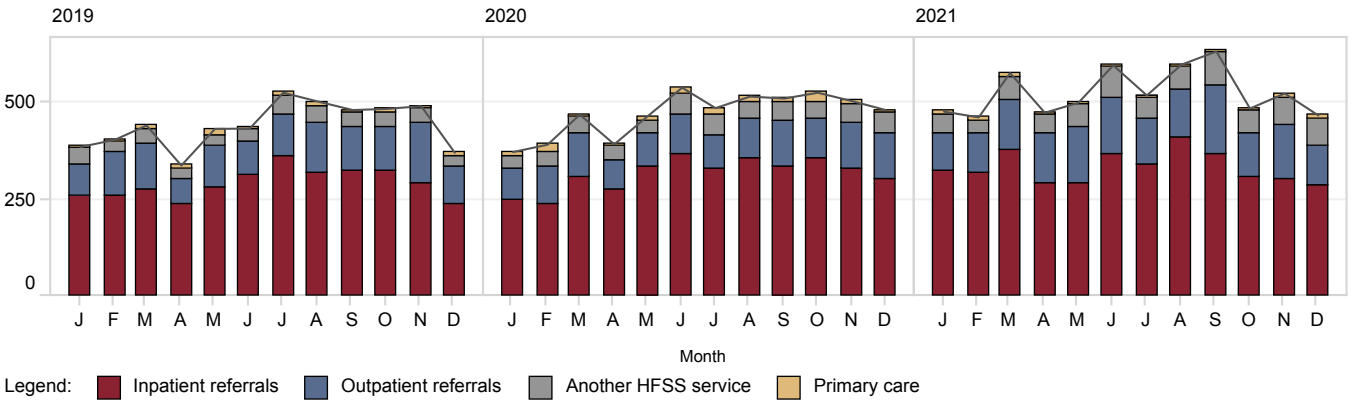


Figure 10: Heart failure support services referral source, 2019–2021

Table 4: Outpatient support services referral volumes, 2019–2021

Service line	2019 n	2020 n	2021 n
Cardiac rehabilitation	11,547	11,177	10,647
Heart failure support services	5,304	5,664	6,326

6.6 Clinical performance indicators

Key clinical performance indicators for Queensland cardiac services in 2021 were largely similar to the previous year. It is difficult to draw conclusions as any impact is likely to be multifactorial. These issues are examined in more detail in the relevant sections of this report.

Table 5: Performance measures for interventional cardiology, electrophysiology and pacing, cardiac rehabilitation and heart failure support services by year, 2019–2021

Service line	2019	2020	2021
Interventional cardiology			
Proportion of STEMI* patients presenting within six hours of symptom onset who received an intervention within 90 minutes of first diagnostic ECG (%)	65	67	63
Proportion of STEMI* patients with arrival at PCI facility to first device time less than 60 minutes (%)	70	70	74
Proportion of all NSTEMI† patients who received angiography within 72 hours of first hospital admission (%)	60	69	69
Electrophysiology and pacing			
Median wait time for elective pacemaker implantation (days)	21	3	2
Median wait time for elective ICD‡ implantation (days)	32	36	21
Median wait time for elective standard ablation (days)	117	99	99
Median wait time for elective complex ablation (days)	65	104	78
Cardiac rehabilitation			
Timely referral – documented referral to CR within three days of discharge (%)	94	93	93
Timely assessment (inpatients) – initial CR pre assessment completed within 28 days of discharge date (%)	59	62	64
Timely assessment (non acute patients) – proportion of CR patients completing a CR pre assessment within 28 days of referral date (%)	61	57	61
Timely journey (inpatients) – composite of timely referral and assessment (%)	56	58	59
Heart failure support services			
Follow-up of acute patients within two weeks (%)	79	80	78
Follow-up of non acute patients within four weeks (%)	82	84	84
Assessment of left ventricular ejection fraction within two years (%)	96	96	97
ACEI/ARB§ or ARNI‖ prescription at hospital discharge (%)	92	92	91
ACEI/ARB§ or ARNI‖ at first clinical review (%)	90	92	92
Beta blocker prescription at hospital discharge (%)	89	92	90
Beta blocker prescription at first clinical review (%)	91	92	92
Prescription of MRA# for HFrEF** at time of hospital discharge (%)	45	46	51
Prescription of MRA# for HFrEF** at time of first HFSS clinical review (%)	43	46	51
Beta blocker titration status review at six months post referral (%)	67	75	79
Beta blocker achievement of guideline recommended target (%)	35	32	31
Beta blocker achievement of guideline recommended target dose or maximum tolerated dose (%)	75	77	80

* ST-elevation myocardial infarction

† Non-ST-elevation myocardial infarction

‡ Implantable cardioverter defibrillator

§ Angiotensin converting enzyme inhibitor/angiotensin II receptor blocker

‖ Angiotensin receptor-neprilysin inhibitor

\# Mineralocorticoid receptor antagonists

** Heart failure with reduced ejection fraction

7 Spotlight: Cardiac genomics

Medical genetics is one of the fastest-growing fields in healthcare. An individual's genetic makeup can affect the occurrence, diagnosis and treatment of many medical issues including disease of the cardiovascular system. Queensland cardiac genomics services provide genetic counselling, testing and clinical management advice to improve the care and treatment of patients and affected family members.

In 2020, the Queensland Genomics Health Alliance (QGHA) facilitated and funded a clinical project to support mainstreaming of genomics in cardiac healthcare through the Queensland Cardiology Genomics Project (QCGP). The aim of the QCGP was to establish four specialist multi-disciplinary cardiac genetics clinics that "support continuity of care for patients with inherited heart disease, or individuals who may be at risk of inherited conditions, by bringing together clinical care, gene discovery and family screening".

The QCGP was sponsored by the Queensland Cardiac Clinical Network (QCCN) and implemented by the Genomics Institute, commencing cardiologist-led clinical services at the following hospitals:

- Cairns Hospital
- The Prince Charles Hospital
- Royal Brisbane & Women's Hospital
- Princess Alexandra Hospital

A Queensland Cardiac Genomics Steering Committee was established to provide governance and strategic oversight of the project and associated working groups including the QCGP Work Group. Partnerships were formed with Genetic Health Queensland and Pathology Queensland.

7.1 Service rationale

Advances in genomic medicine and related technologies are rapidly growing, and cardiologists are looking for effective ways to enhance access to cardiac genetic services and information for patients in a way that supports the best use of these advances in healthcare information.

Patients and at-risk family members have often been reluctant to engage in genetic testing due to the complexities of navigating the process while also simultaneously attending cardiology follow-up. By offering a combined clinical and testing cardiology-led model, patients benefited from a more supported, accessible and holistic clinical genetic service, and decreased appointment burden.

7.2 Service description

Cardiology genomics clinics seek to improve access to clinical genetic services and information for cardiologists. Cardiology genomics clinics provide a specialist service that includes genetic counselling, testing and clinical management advice for individuals and family members who have or are at risk of having an inherited cardiac condition:

- Cardiomyopathy
- Arrhythmia
- Aortopathy
- Familial hypercholesterolaemia

Services are delivered by a multidisciplinary team that includes a cardiologist, genetic counsellor (GC), clinical nurse consultant (CNC) or nurse navigator (NN), with additional support from Pathology Queensland. Most patients in the service are reviewed as outpatients, however, the service also caters for inpatients, which is beneficial for long-distance and complex cases.

Appointments are divided into three pathways:

- Diagnostic testing – full workup for clinically affected patients (probands)
- Cascade testing – genetic counselling and testing for at-risk relatives
- Clinical screening – cardiac diagnostic investigations and review for at-risk relatives

7.3 Service components

Pre-clinic intake

Prior to the first clinical appointment, the patient is contacted via telephone by a CNC, NN or GC to discuss their referral. This first encounter provides the patient with information on the overall process and gives clinicians an opportunity to review the patient's family history and arrange diagnostic tests where required.

New patient consultation

The referred patient is seen either face-to-face or via telehealth, by a CNC or NN as well as a GC and/or cardiologist. Patients may attend individually or with family members.

Investigations such as electrocardiogram, echocardiogram and blood tests may be organised to help with the diagnosis. Following genetic counselling and the patient's informed consent, a genetic test is requested by the cardiologist where clinically appropriate.

Genetic testing

Blood samples are collected by a public hospital pathology provider and sent to Pathology Queensland for DNA extraction, whole exome sequencing and variant curation.

Multidisciplinary team meeting (MDT)

In some cases, a full case review including patient clinical history, family history, family genetic history, diagnostic tests, and genetic results is conducted. This occurs for complex cases and variants of unknown significance. The MDT is attended by cardiology genomics clinic cardiologists, GC, CNC, NN, clinical geneticist and pathologist.

Results appointment

Any patients who proceeded with genetic testing have a follow-up appointment where results are discussed, including implications for the patient and family members. This follow-up appointment either occurs in-person or via telehealth.

Patients are then provided with a letter outlining conclusions of testing, with additional letters as appropriate for their family members – to facilitate further referrals and/or cascade genetic testing.

The cardiac genomics service can offer combined family appointments, with consent and where this may be beneficial to the family.

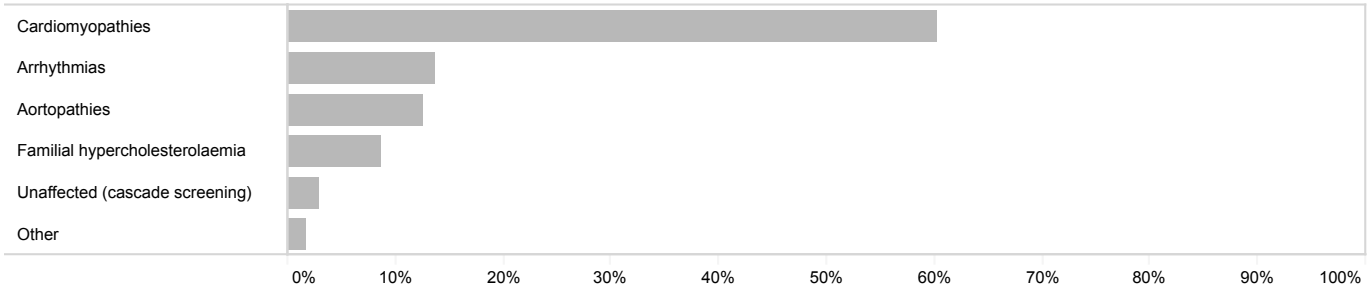


Figure 1: Proportion of cardiac genomics referrals by diagnosis, 2020–2021

Table 1: Cardiology cardiac referrals by diagnosis, 2020–2021

Referral diagnosis	**n (%)**
Aortopathies	35 (12.6)
Arrhythmias	
Brugada syndrome	10 (3.6)
Catecholaminergic polymorphic ventricular tachycardia	3 (1.1)
Long QT syndrome	25 (9.0)
Cardiomyopathies	
Arrhythmogenic cardiomyopathy	8 (2.9)
Dilated cardiomyopathy	67 (24.2)
Hypertrophic cardiomyopathy	92 (33.2)
Familial hypercholesterolaemia	24 (8.7)
Other	5 (1.8)
Unaffected (Cascade screening)	8 (2.9)
All	**277 (100.0)**

7.4 Evaluation

The QCGP was formally evaluated by the Healthcare Evaluation and Assessment of Technology team, Healthcare Improvement Unit, Clinical Excellence Queensland, in June 2022.

The outcomes of the evaluation demonstrated the following results:

- Valuable and clear clinical benefits for patients with direct or potential cardiac health impacts based on their genetic background and family history.
- High levels of patient and clinician satisfaction for the referral, follow-up, genetic testing and clinical review processes that occurred.
- Patient psychosocial wellbeing improved for all measures after participating in the program, as measured by pre and post clinic surveys.
- Higher pathogenic variant detection rates than noted in clinical literature.

7.5 Collaboration with QCOR

Queensland clinicians have collaborated with QCOR to develop and implement a bespoke application for cardiac genetic consultations, testing and management, allowing data to be recorded across the patient journey. As of June 2022, the QCOR cardiac genomics application has been deployed in all four public hospitals offering cardiac genetics services. The new system enables streamlined data collection, enhances clinical care delivery and allows clinicians to produce clinically relevant comprehensive documentation to form part of the patient medical record.

Future work is focused on expanding the QCOR cardiac genomics application and the scope of the analyses made possible while continuing to explore avenues to contextualise and report on the quality of outcomes for this group of patients.

8 Facility profiles

8.1 Cairns Hospital

- Referral hospital for Cairns and Hinterland and Torres and Cape Hospital and Health Services, serving a population of approximately 280,000
- Public tertiary level invasive cardiac services provided at Cairns Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - ICD, CRT and pacemaker implantation
- Cardiac genomics clinics provider
- Networked cardiac services outreach hub for Cairns and Hinterland and Torres and Cape Hospital and Health Services

8.2 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 Service

8.3 Mackay Base Hospital

- Referral hospital for Mackay and Whitsunday regions, serving a population of approximately 182,000
- Public tertiary level invasive cardiac services provided at Mackay Base Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - ICD and pacemaker implants

8.4 Sunshine Coast University Hospital

- Referral hospital for Sunshine Coast and Wide Bay Hospital and Health Services, serving a population of approximately 563,000
- Public tertiary level invasive cardiac services provided at Sunshine Coast University Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation

8.5 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 & 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

8.6 Royal Brisbane & Women's 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 Prince Charles Hospital)
- Public tertiary level invasive cardiac services provided at The Royal Brisbane & Women's Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Thoracic surgery
- Cardiac genomics clinics provider

8.7 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 cardiac and thoracic surgery

8.8 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 Service

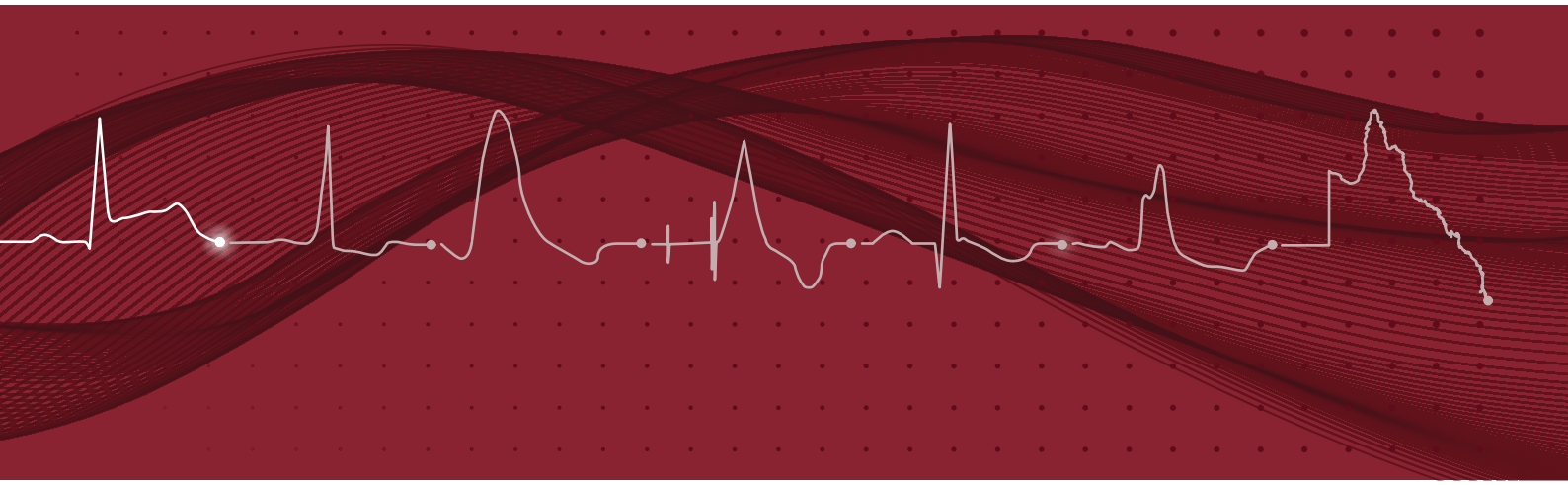
8.9 Toowoomba Hospital

- Referral hospital for Darling Downs Hospital and Health Services, servicing a population of approximately 280,000
- Public invasive cardiac services provided at the Toowoomba Hospital include:
  - ICD, CRT and pacemaker implantation
- Networked cardiac services outreach hub for Metro South, Darling Downs and South West Hospital and Health Service

8.10 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

Interventional Cardiology Audit



1 Message from the Interventional Cardiology Committee Chair

I am proud to present the 2021 QCOR Interventional Cardiology Audit, the eighth of its kind and first as Chair of this committee. Following another challenging and extraordinary year for the provision of healthcare in Queensland, 2021 yet again demonstrated the quality of care that our health system is capable of delivering. The continuous and rapidly evolving effects of the COVID-19 pandemic has required cardiology departments across the state to operate with agility and react with varied approaches at times across Hospital and Health Services to care for Queenslanders. Nonetheless, it is reassuring to know that despite the pressures and challenges presented during the COVID-19 pandemic the provision of care to Queenslanders remains at an extremely high standard as clinical indicators and all outcome measures remain stable, are improving or exceeding benchmarks.

Interventional cardiology services exist in a dynamic and ever-changing environment, which is often pressured by the increasing needs of the community and challenged by a complex healthcare environment. With this challenge comes the opportunity to continue to embrace, drive and apply the use of data. By informing business cases for new services and assisting with future planning and future-proofing the health system, the various data presented in this, and previous reports have proved to be invaluable in moving Queensland public cardiology services forward.

Access to quality and real-time data has never been more relevant and important to the provision of healthcare. Through a concerted effort of clinicians, data managers and the QCOR team, the reporting of clinical quality and indicators of the process of care will be more readily available to stakeholders who are responsible for monitoring and improving care. Through an iterative approach that has quality and relevance as its core ethos, this new functionality will serve to further improve clinical care and performance.

In this Audit, QCOR has continued its work to explore interhospital transfer efficiency for patients with NSTEMI by reporting patient flow and time taken from a presentation at the originating facility to undergoing invasive investigation. By understanding where opportunities for improvement exist, we can better plan and work to implement strategies to improve care for this group of Queenslanders who often reside in regional and remote locations.

Looking forward, we keenly await the delivery of a contemporary statewide cardiovascular information system for diagnostic and interventional cardiology and echocardiography services. This project will be one of the largest generational opportunities for enhancing data collection for cardiology in Queensland and will enable the reporting of new quality metrics and indicators while providing a valuable clinical tool for information sharing and improving the quality of care.

These efforts outline a whole-of-system approach to achieving quality and safe cardiac care for all Queenslanders. We continue to partner with national registries to use the learnings in Queensland to assist with moving forward with these high-value initiatives. There are many synergies in this space that enable all participants to learn from others and apply those learnings to local jurisdictions.

Dr Rohan Poulter
Chair
QCOR Interventional Cardiology Committee

2 Key findings

The Interventional Cardiology Audit describes key aspects of the care and treatment of cardiac patients receiving percutaneous coronary interventions (PCI) during 2021.

Key findings include:

- 15,443 diagnostic coronary or interventional cases were performed across the eight cardiac catheterisation laboratory (CCL) facilities in Queensland public hospitals, including 4,894 PCI cases.
- 77% of all PCI patients residing in Queensland had a place of residence within 50 km of the nearest public PCI capable facility, while 11% of patients resided more than 150 km from the nearest facility.
- A large proportion of PCI patients (79%) were classed as having an unhealthy body mass index (BMI) over 25 kg/m^2.
- The proportion of patients identified as Aboriginal and Torres Strait Islander (7.4%) illustrates a stepwise gradient based on geographical area, with the highest proportions found in the north of the state and lower proportions in the South East corner. This is consistent with previous analyses. The median age of Aboriginal and Torres Strait Islander patients was 10 years younger than non Aboriginal and Torres Strait Islander patients.
- The majority of PCI cases (78%) were classed as urgent, emergent or salvage, highlighting the acute and often unstable patient cohort.
- There were 1,560 PCI cases following presentation with ST elevation myocardial infarction (STEMI), of which 58% were managed by primary PCI.
- There was a total of 401 thrombolysed STEMI presentations, for whom the median time from first diagnostic electrocardiograph (ECG) to the administration of thrombolysis was 34 minutes. The median time from thrombolysis to coronary angiography was 16 hours, with 70% of cases receiving angiography within 24 hours.
- Median time to reperfusion from first diagnostic ECG for STEMI patients presenting within six hours of symptom onset was 83 minutes (range 69 minutes to 90 minutes across sites).
- Median hospital door-to-device time for STEMI patients presenting within six hours of symptom onset was 39 minutes (range 32 minutes to 58 minutes across sites).
- PCI for non-ST elevation myocardial infarction (NSTEMI) represented 29% of all cases, with the median time to angiography of 46 hours. Patients presenting to a non PCI capable facility have a median wait time to coronary angiography of 32 hours longer than those who present directly to a PCI capable facility (63 hours vs. 31 hours).
- Mortality within 30 days following PCI was 1.8% (89 deaths). Of these 89 deaths, 76% were classed as either salvage or emergency PCI.
- Of all cases, 0.84% recorded a major intra-procedural complication. Coronary artery perforation (0.63%) accounted for the majority of these events.
- Radiation doses were found to be under the high dose threshold in 98.7% of PCI cases across all sites and 99.9% of other coronary procedures.

3 Participating sites

There were eight public hospitals which offered CCL services across metropolitan and regional Queensland.

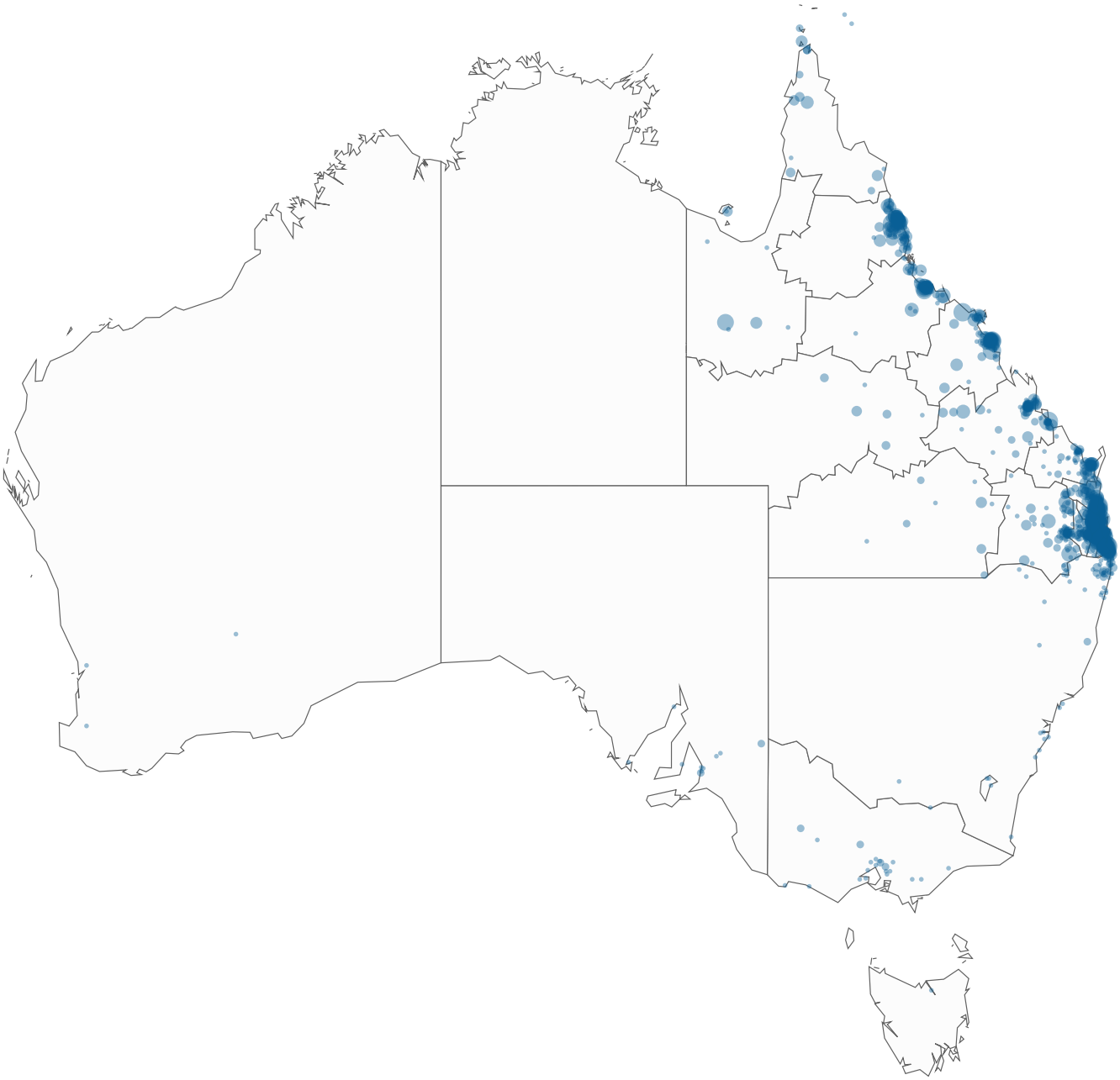


Figure 1: Statewide PCI cases by patient place of usual residence (by residential postcode)

Table 1: Participating sites

Acronym	Site name
CH	Cairns Hospital
TUH	Townsville University Hospital
MBH	Mackay Base Hospital
SCUH	Sunshine Coast University Hospital
TPCH	The Prince Charles Hospital
RBWH	Royal Brisbane & Women's Hospital
PAH	Princess Alexandra Hospital
GCUH	Gold Coast University Hospital

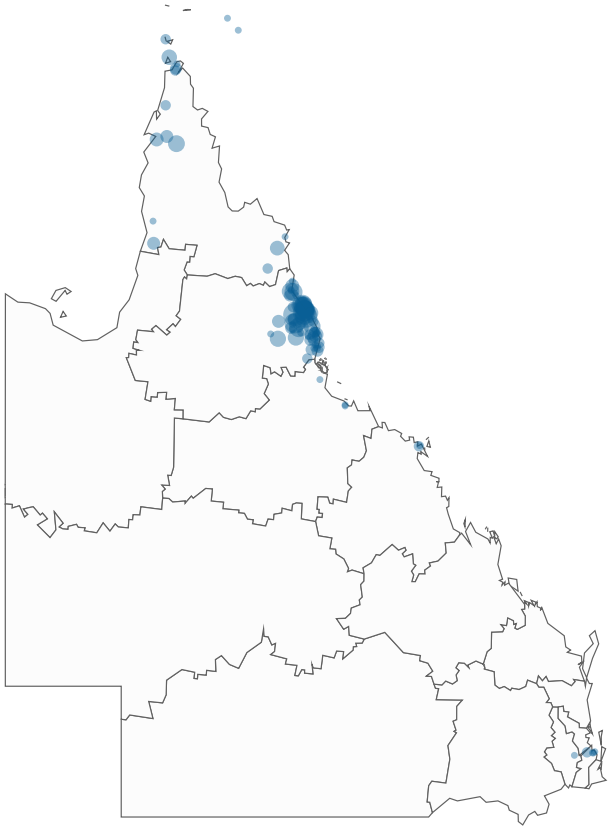


Figure 2: Cairns Hospital

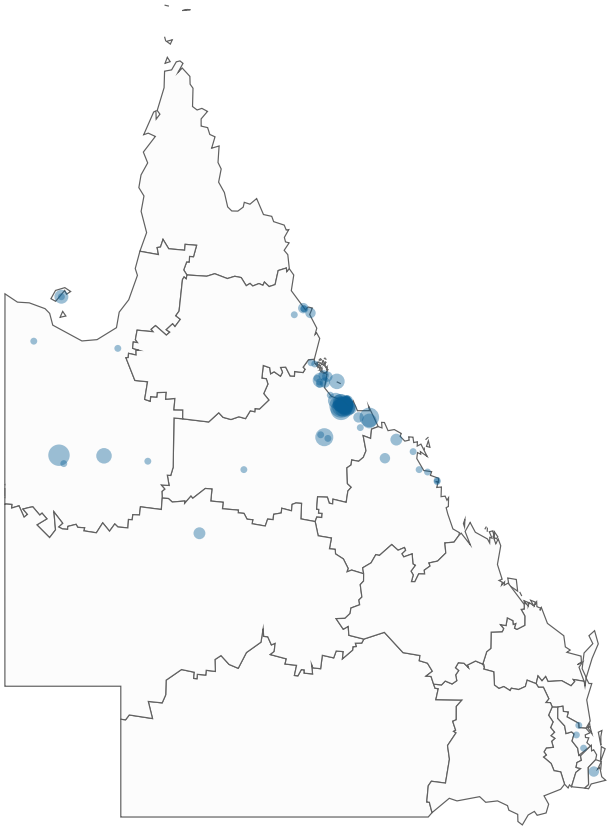


Figure 3: Townsville University Hospital

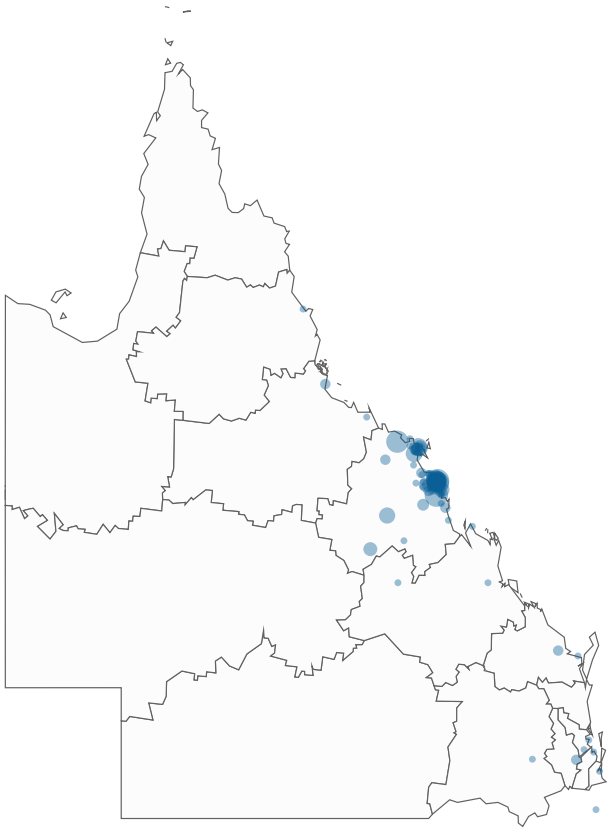


Figure 4: Mackay Base Hospital

Figure 5: Sunshine Coast University Hospital

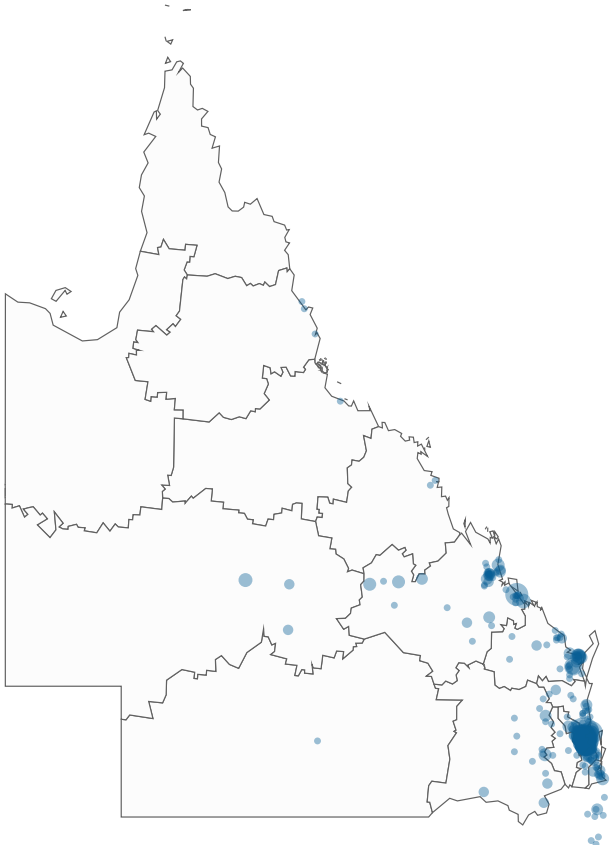


Figure 6: The Prince Charles Hospital

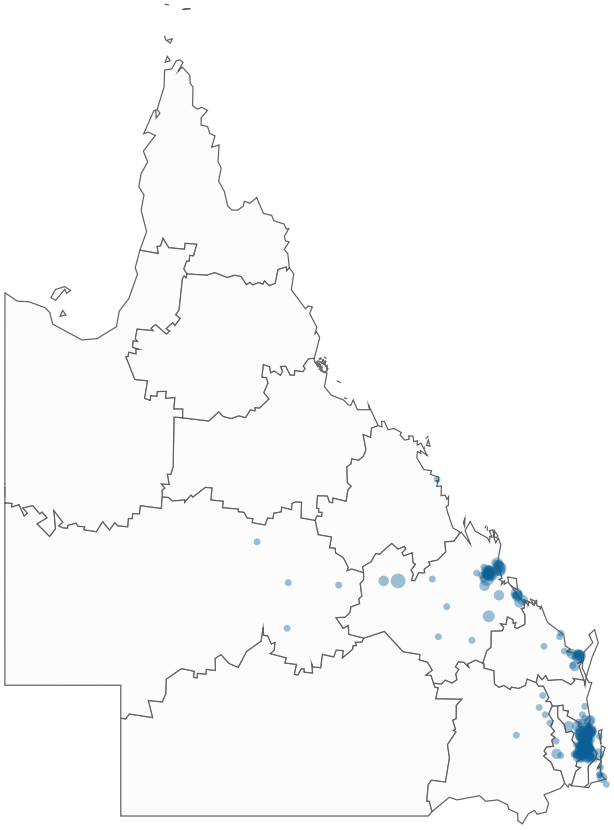


Figure 7: Royal Brisbane & Women's Hospital

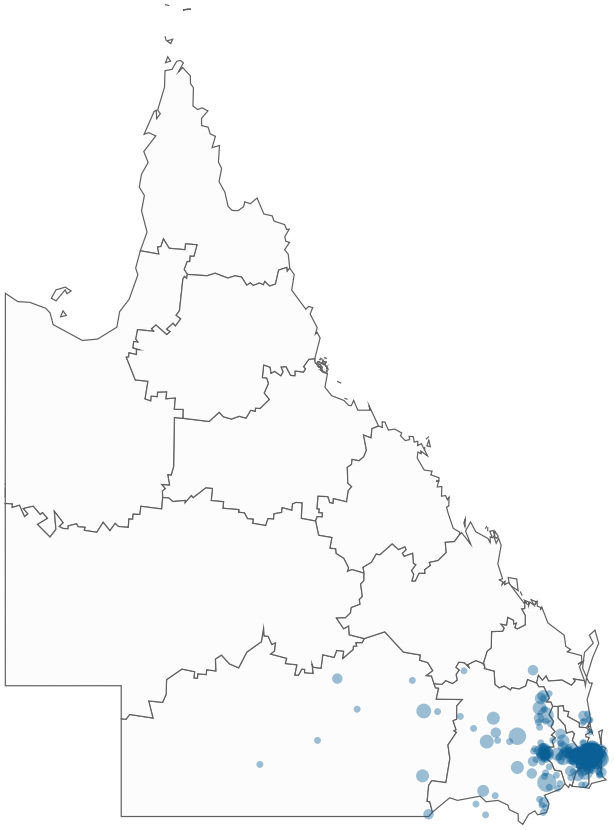


Figure 8: Princess Alexandra Hospital

Figure 9: Gold Coast University Hospital

4 Total coronary cases

A total of 15,443 coronary cases were performed across the eight contributing cardiac catheterisation sites, with 4,894 patients (32%) undergoing a PCI. These patients form the cohort at the centre of this Audit.

Since the focus of this report is a specialised subset of invasive cardiology cases performed in the CCL, non coronary procedures such as right heart catheterisation, right ventricular cardiac biopsy and peripheral intervention cases are excluded from analysis.

In addition, detail for 485 structural heart disease interventions including percutaneous valve replacement, valvuloplasty and device closure procedures is included as a supplement to this Audit. Furthermore, Queensland electrophysiology and pacing procedure activity is included in a separate Audit within the QCOR Annual Report.

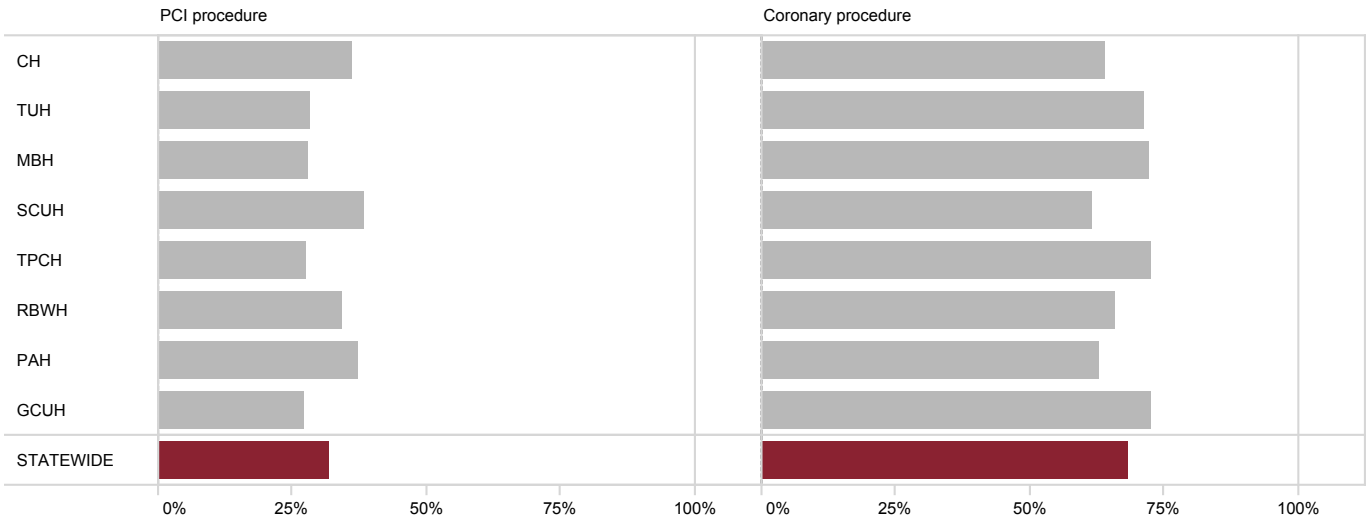


Figure 10: Proportion of cases by procedure category

Table 2: Total cases by procedure category

Site	PCI procedure* n (%)	Other coronary procedure† n (%)	Total coronary cases n
CH	536 (36.1)	950 (63.9)	1,486
TUH	361 (28.5)	906 (71.5)	1,267
MBH	332 (27.9)	856 (72.1)	1,188
SCUH	528 (38.5)	845 (61.5)	1,373
TPCH	1,007 (27.5)	2,657 (72.5)	3,664
RBWH	430 (34.1)	831 (65.9)	1,261
PAH	1,062 (37.1)	1,804 (62.9)	2,866
GCUH	638 (27.3)	1,700 (72.7)	2,338
STATEWIDE	**4,894 (31.7)**	**10,549 (68.3)**	**15,443**

* Includes balloon angioplasty, coronary stenting, PTCRA/atherectomy, coronary lithotripsy and thrombectomy of coronary arteries

† Includes coronary angiography, aortogram, coronary artery bypass graft study, left ventriculography, left heart catheterisation, coronary fistula embolisation, intravascular ultrasound, optical coherence tomography, and pressure derived indices for assessing coronary artery stenosis

4.1 Total cases by clinical presentation

Within the larger cohort, the most common presentation category was of NSTEMI, while STEMI cases represented 12% of all cases, and 32% of all PCI cases.

The most common clinical presentation across all cases was acute coronary syndrome (ACS), which accounted for approximately one third of all cases (32%). The majority of PCI procedures undertaken were categorised as either STEMI or NSTEMI (61%).

Clinical presentation is derived from the procedural indication and reflects the diagnosis made with respect to the findings of the investigation/procedure. It must be acknowledged that there is some degree of variation in practice across sites which is a focus for future work.

Table 3: Total coronary cases by clinical presentation category

Site	STEMI n (%)	NSTEMI n (%)	Other n (%)
CH	171 (11.5)	303 (20.4)	1,012 (68.1)
TUH	108 (8.5)	233 (18.4)	926 (73.1)
MBH	78 (6.6)	163 (13.7)	947 (79.7)
SCUH	259 (18.9)	306 (22.3)	808 (58.8)
TPCH	339 (9.3)	592 (16.2)	2,733 (74.6)
RBWH	156 (12.4)	342 (27.1)	763 (60.5)
PAH	517 (18.0)	779 (27.2)	1,570 (54.8)
GCUH	287 (12.3)	373 (16.0)	1,678 (71.8)
STATEWIDE	**1,915 (12.4)**	**3,091 (20.0)**	**10,437 (67.6)**

Table 4: PCI cases by clinical presentation category

Site	STEMI n (%)	NSTEMI n (%)	Other n (%)
CH	143 (26.7)	185 (34.5)	208 (38.8)
TUH	85 (23.5)	79 (21.9)	197 (54.6)
MBH	68 (20.5)	59 (17.8)	205 (61.7)
SCUH	210 (39.8)	128 (24.2)	190 (36.0)
TPCH	281 (27.9)	260 (25.8)	466 (46.3)
RBWH	116 (27.0)	181 (42.1)	133 (30.9)
PAH	422 (39.7)	380 (35.8)	260 (24.5)
GCUH	235 (36.8)	164 (25.7)	239 (37.5)
STATEWIDE	**1,560 (31.9)**	**1,436 (29.3)**	**1,898 (38.8)**

4.2 Place of residence

The vast majority of PCI patients (97%) had a usual place of residence within Queensland, with a smaller proportion originating from interstate (3%) and overseas (<1%). For the Gold Coast University Hospital, 14% of cases originated from outside of Queensland.

Patients came from a wide geographical area with a large proportion of patients residing on the Eastern Seaboard. Almost three quarters (74%) of all patients were seen inside their local Hospital and Health Service (HHS). Of those patients residing in Queensland, the majority (77%) had a usual place of residence within 50 kilometres of the nearest public PCI facility. While this proportion is high, it must be acknowledged that access to PCI services for a large number of Queenslanders involves considerable distance and travel.

Table 5: PCI cases by place of usual residence category

Site	Queensland %	Within HHS %	Interstate %	Overseas %
CH	96.8	85.4	3.2	–
TUH	97.8	80.3	2.2	–
MBH	99.7	94.6	0.3	–
SCUH	99.1	83.1	0.8	0.2
TPCH	98.7	69.9	1.3	–
RBWH	98.4	50.2	1.4	0.2
PAH	99.1	63.2	0.8	0.1
GCUH	86.5	80.8	13.3	0.2
STATEWIDE	**97.0**	**73.7**	**2.9**	**0.1**

Excludes missing data (<0.1%)

Table 6: Queensland PCI cases by distance from usual place of residence to nearest public PCI facility

Site	<50 km %	50–150 km %	>150 km %
CH	65.3	25.1	9.7
TUH	70.0	17.0	13.0
MBH	70.4	17.2	12.4
SCUH	73.3	18.8	7.9
TPCH	78.0	5.1	16.9
RBWH	67.6	3.1	29.3
PAH	80.3	13.6	6.0
GCUH	99.3	0.4	0.4
STATEWIDE	**77.0**	**11.7**	**11.3**

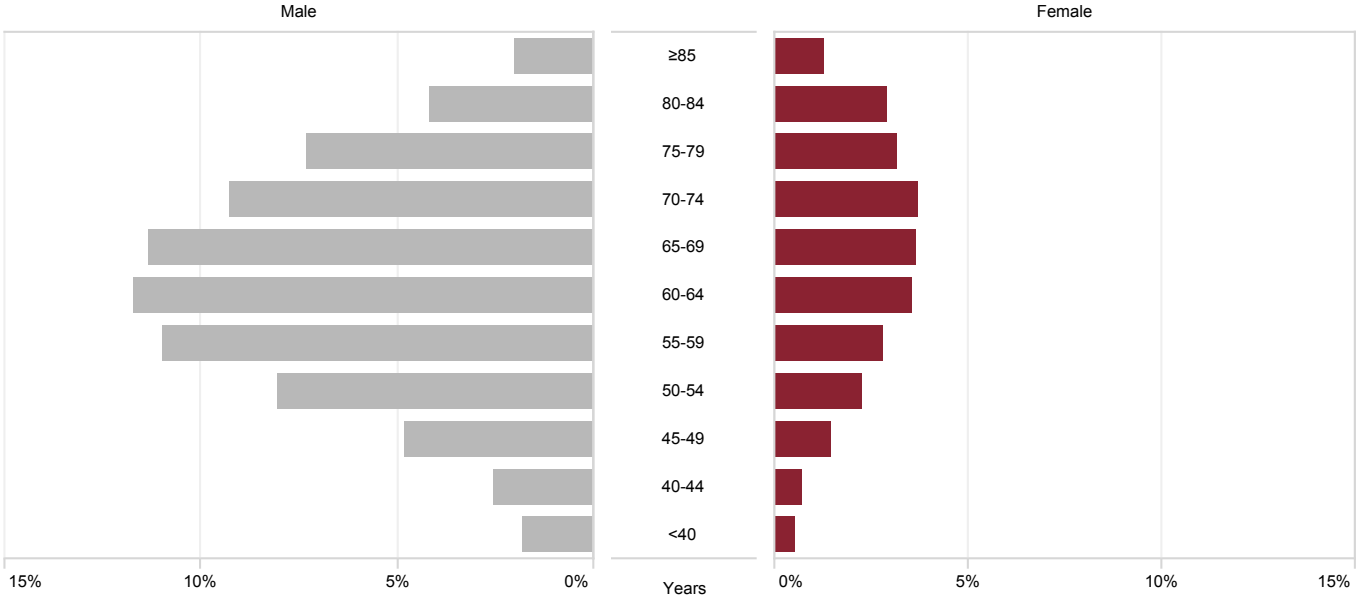
Excludes missing data (0.3%)

5 Patient characteristics

5.1 Age and gender

Age is a well described risk factor in the development of cardiovascular disease. The median age of patients undergoing PCI was 65 years of age and ranged from 62 years to 67 years across sites.

The majority of patients were male (74%), which reflects the increased risk of cardiovascular disease by gender. The median age for females was also higher than for males (68 years vs. 64 years).



% of total PCI (n=4,894)

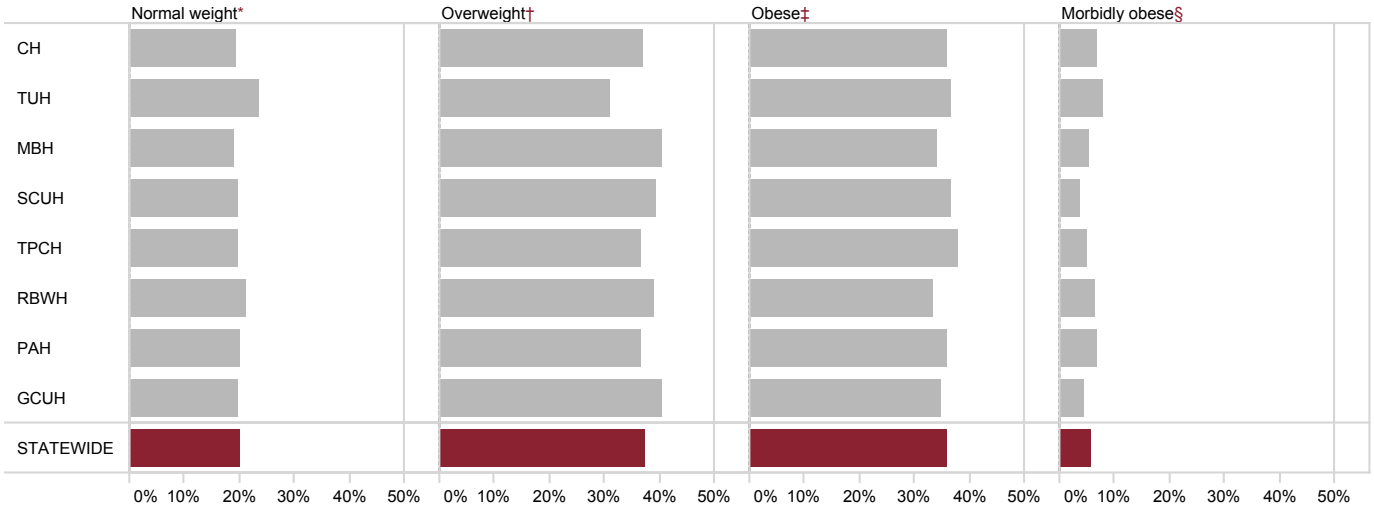
Figure 11: Proportion of all PCI cases by gender and age group

Table 7: Median PCI patient age by gender and site

Site	Male years	Female years	All years
CH	63	64	64
TUH	62	63	63
MBH	66	70	67
SCUH	65	70	66
TPCH	65	72	67
RBWH	62	61	62
PAH	62	64	63
GCUH	65	69	66
STATEWIDE	**64**	**68**	**65**

5.2 Body mass index

Patients across all sites displayed similar trends for BMI, with one fifth of patients (20%) in the normal BMI range and 38%, 36% and 6% classified as overweight, obese and morbidly obese respectively. There were 1% of cases classified as underweight (BMI <18.5 kg/m²).



Excludes missing/invalid data (0.2%)

* BMI 18.5–24.9 kg/m²

† BMI 25.0–29.9 kg/m²

‡ BMI 30.0–39.9 kg/m²

§ BMI ≥40.0 kg/m²

Figure 12: Proportion of all PCI cases by body mass index category

Table 8: All PCI cases by body mass index category

Site	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Morbidly obese n (%)
CH	9 (1.7)	102 (19.1)	197 (36.8)	191 (35.7)	36 (6.7)
TUH	4 (1.1)	84 (23.3)	112 (31.0)	132 (36.6)	29 (8.0)
MBH	4 (1.2)	63 (19.0)	134 (40.4)	113 (34.0)	18 (5.4)
SCUH	5 (0.9)	103 (19.5)	208 (39.4)	193 (36.6)	19 (3.6)
TPCH	9 (0.9)	197 (19.6)	367 (36.6)	379 (37.8)	51 (5.1)
RBWH	1 (0.2)	91 (21.2)	168 (39.1)	143 (33.3)	27 (6.3)
PAH	4 (0.4)	213 (20.1)	388 (36.6)	381 (35.9)	74 (7.0)
GCUH	6 (0.9)	124 (19.5)	256 (40.3)	221 (34.8)	28 (4.4)
STATEWIDE	**42 (0.9)**	**977 (20.0)**	**1,830 (37.5)**	**1,753 (35.9)**	**282 (5.8)**

Excludes missing data (0.2%)

5.3 Aboriginal and Torres Strait Islander status

Ethnicity is an important determinant of health with a particular impact on the development of cardiovascular disease. It is recognised that the Aboriginal and Torres Strait Islander people experience high levels of health inequality resulting in a higher incidence and prevalence of coronary artery disease.[1]

The increased proportion of identified Aboriginal and Torres Strait Islander patients undergoing PCI in the northern HHSs (CH, 23% and TUH, 20%) is reflective of the resident population within these areas and should be noted for service provision and planning.

Despite accounting for only 4.6% of the Queensland population[2], Aboriginal and Torres Strait Islander patients are overrepresented in the PCI cohort across all sites (7.6%).

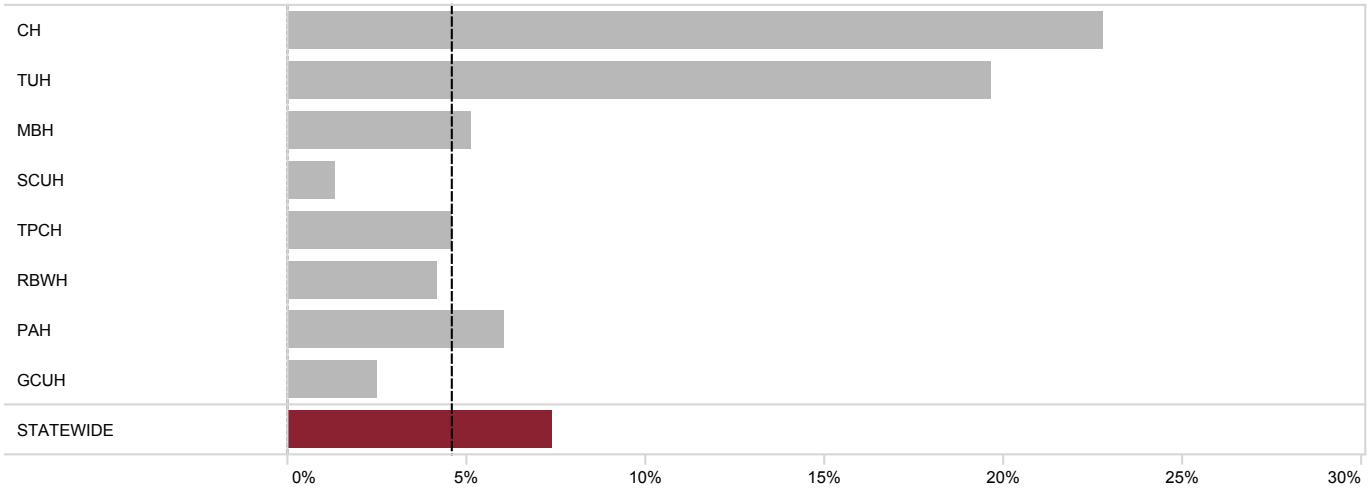


Figure 13: Proportion of all PCI cases by identified Aboriginal and Torres Strait Islander status

The median age of Aboriginal and Torres Strait Islander patients undergoing PCI was lower than that of non Aboriginal and Torres Strait Islander patients (55 years vs. 65 years).

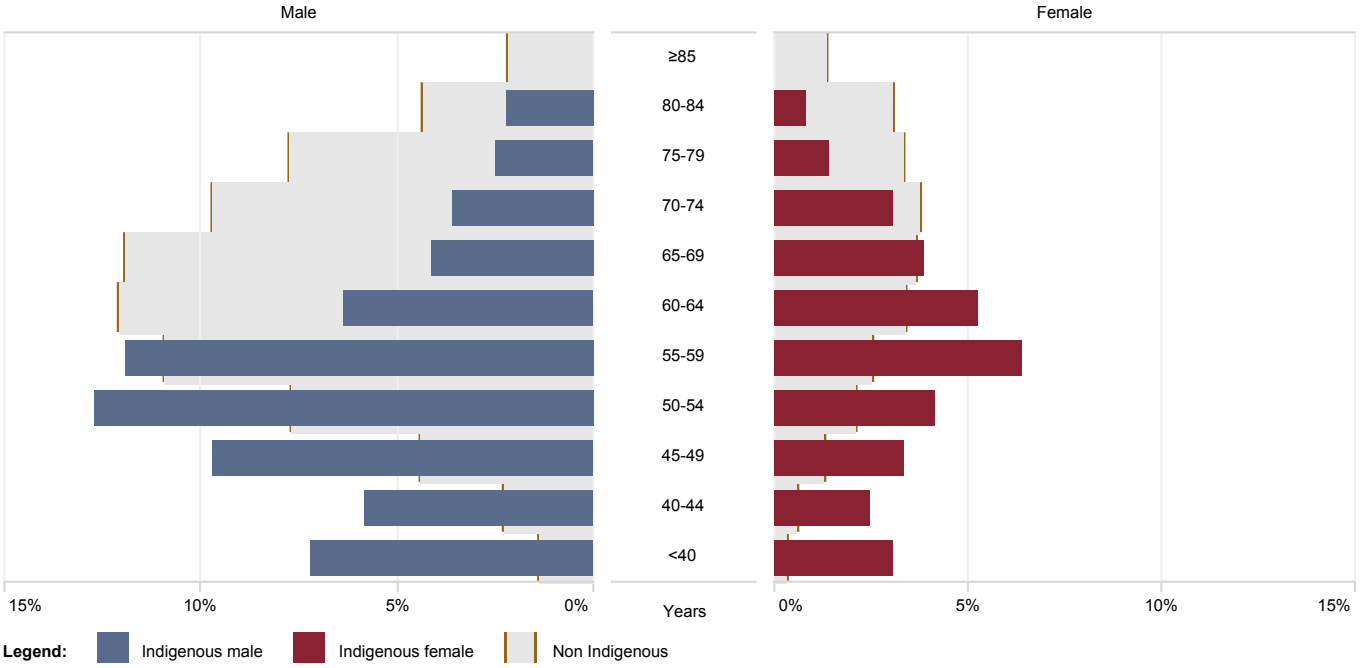


Figure 14: Proportion of all PCI cases by age group and Indigenous status

Table 9: PCI cases median patient age by gender and Indigenous status

	Male years	Female years	Total years
Aboriginal and Torres Strait Islander	54	58	55
Non Aboriginal and Torres Strait Islander	64	68	65
All	**64**	**68**	**65**

6 Care and treatment of PCI patients

6.1 Admission status

There were 4,894 PCI procedures performed in 2021 by the eight public sites across Queensland. Patients are categorised by admission status, with elective, urgent and emergency categories defined according to the National Cardiovascular Data Registry (NCDR) as stated below.[3]

From 2019, a contemporary definition of the salvage status was developed by the QCOR Interventional Cardiology Committee in order to best describe this subset of acutely ill patients who presented to Queensland public CCL services.

This definition expands on the previous NCDR classification to include the subset of patients who did not fit the strict salvage inclusion criteria but were indeed on a trajectory for a poor clinical outcome regardless of intervention.

Table 10: Diagnostic coronary angiography status

Status	Definition
Elective	The procedure can be performed on an outpatient basis or during a subsequent hospitalisation without significant risk of infarction or death. For stable inpatients, the procedure is being performed during this hospitalisation for convenience and ease of scheduling and not because the patient's clinical situation demands the procedure prior to discharge.
Urgent	The procedure is being performed on an inpatient basis and prior to discharge because of significant concerns that there is risk of ischaemia, infarction and/or death. Patients who are outpatients or in the emergency department at the time the cardiac catheterisation is requested would warrant an admission based on their clinical presentation.
Emergency	The procedure is being performed as soon as possible because of substantial concerns that ongoing ischaemia and/or infarction could lead to death. "As soon as possible" refers to a patient who is of sufficient acuity that you would cancel a scheduled case to perform this procedure immediately in the next available room during business hours, or you would activate the on call team were this to occur during off hours.
Salvage	The procedure is performed on a critically unwell patient with a high risk of imminent death from either a cardiac or non cardiac cause, and it is recognised that PCI may not change the outcome AND; The patient is in cardiogenic shock (SCAI Class C or greater[4]) when the PCI begins (i.e. at the time of the first guidewire or intracoronary device introduction into a coronary artery or bypass graft for the purpose of mechanical revascularisation) AND/OR; The patient has also received active cardiopulmonary resuscitation within the last ten minutes prior to the start of the case or during the diagnostic portion of the case, OR; The patient has been on unanticipated extracorporeal circulatory support (e.g. extracorporeal mechanical oxygenation) OR cardiopulmonary support that includes non elective intubation.

Urgent and emergent cases accounted for the majority (78%) of PCI cases, reflecting the acute and often complex case mix flowing to Queensland public hospitals.

Salvage cases varied between institutions, however these exceptional and highly complex clinical scenarios accounted for less than 2% of statewide PCI volume, ranging from 0.4% to 4.2% across sites.

Continued monitoring of the application of the recently developed salvage definition demonstrates a return to similar numbers to the 2018 audit (n=64, 1.3%), prior to the definition change.

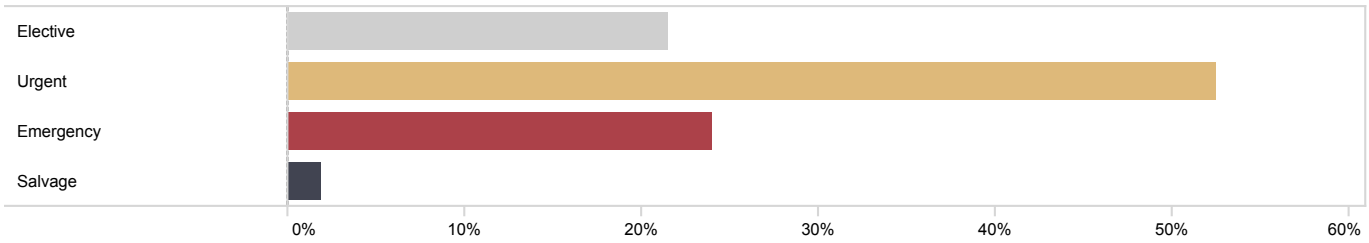


Figure 15: Proportion of all PCI cases by admission status

Table 11: PCI cases by site and admission status

Site	Elective n (%)	Urgent n (%)	Emergent n (%)	Salvage n (%)
CH	125 (23.3)	315 (58.8)	85 (15.9)	11 (2.1)
TUH	75 (20.8)	198 (54.8)	86 (23.8)	2 (0.6)
MBH	150 (45.2)	129 (38.9)	51 (15.4)	2 (0.6)
SCUH	102 (19.3)	272 (51.5)	152 (28.8)	2 (0.4)
TPCH	294 (29.2)	473 (47.0)	229 (22.7)	11 (1.1)
RBWH	63 (14.7)	269 (62.6)	85 (19.8)	13 (3.0)
PAH	143 (13.5)	620 (58.4)	276 (26.0)	23 (2.2)
GCUH	107 (16.8)	294 (46.1)	210 (32.9)	27 (4.2)
STATEWIDE	**1,059 (21.6)**	**2,570 (52.5)**	**1,174 (24.0)**	**91 (1.9)**

6.2 Stent usage

The majority of PCI cases (93%) involved the deployment of one or more stents, which ranged from 90% to 96% of PCI cases between centres. The mean number of stents deployed for each case was 1.5.

Table 12: Mean number of stents used for PCI cases by site

Site	Total stenting cases n	Proportion of PCI cases %	Mean stents per case n
CH	484	90.3	1.49
TUH	346	95.8	1.39
MBH	299	90.1	1.37
SCUH	500	94.7	1.80
TPCH	921	91.5	1.39
RBWH	405	94.2	1.57
PAH	998	94.0	1.53
GCUH	586	91.8	1.41
STATEWIDE	**4,539**	**92.7**	**1.50**

6.3 Access route

The majority of PCI cases (93%) used a single access route, with 80% being via the radial approach and 26% femoral. Another access route including brachial or ulnar was utilised in less than 1% of cases. The use of the radial approach varied between different PCI centres (61% to 94%) which is a smaller range than observed in previous years and consistent with a trend toward increased radial access use.

Table 13: PCI access route by site

Site	Total PCI cases n	Radial approach %	Femoral approach %	Other approach %
CH	536	83.4	21.1	0.2
TUH	361	78.9	23.8	1.4
MBH	332	90.4	12.7	0.6
SCUH	528	94.1	7.8	2.7
TPCH	1,007	82.3	28.8	0.2
RBWH	430	78.8	28.8	0.9
PAH	1,062	61.4	44.7	0.1
GCUH	638	85.7	18.8	0.5
STATEWIDE	**4,894**	**79.6**	**26.4**	**0.7**

Totals >100% due to multiple access sites

Table 14: PCI total access routes by site

Site	Single approach %	Multiple approaches %
CH	95.3	4.7
TUH	95.8	4.2
MBH	96.4	3.6
SCUH	95.6	4.4
TPCH	88.7	11.3
RBWH	91.4	8.6
PAH	93.8	6.2
GCUH	95.0	5.0
STATEWIDE	**93.4**	**6.6**

There was minimal variation observed between access routes in the overall PCI cohort and the STEMI presenting within six hours of symptom onset cohort (26.4% vs. 25.5% respectively).

The trend towards utilising the radial approach for patients with STEMI presenting within six hours of symptom onset continues from previous years.

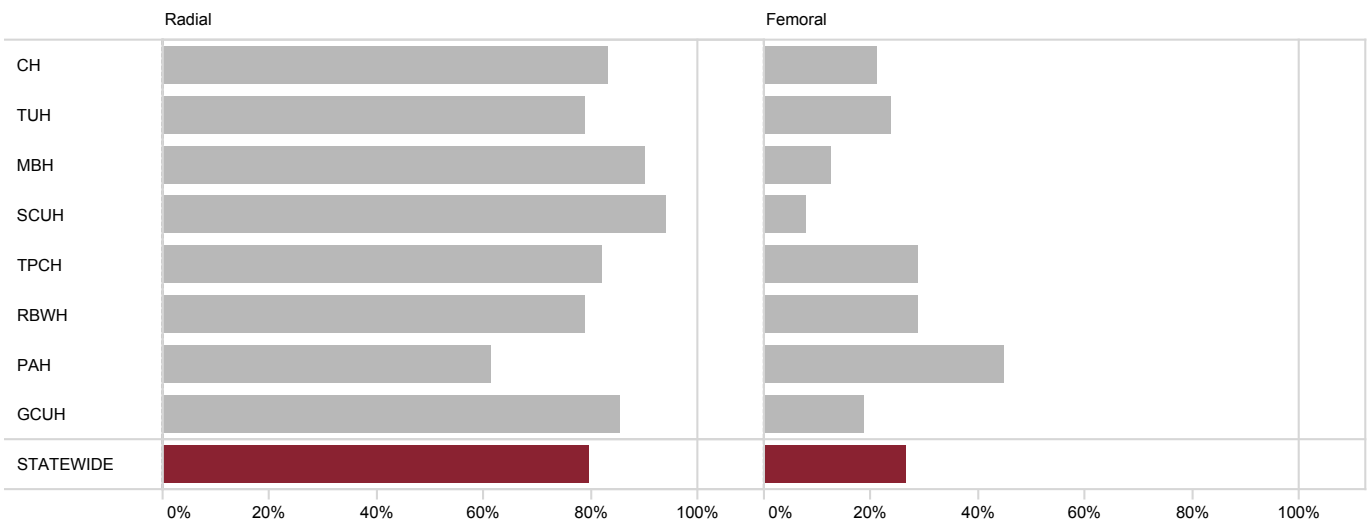


Figure 16: Proportion of PCI cases using radial and femoral access routes by site

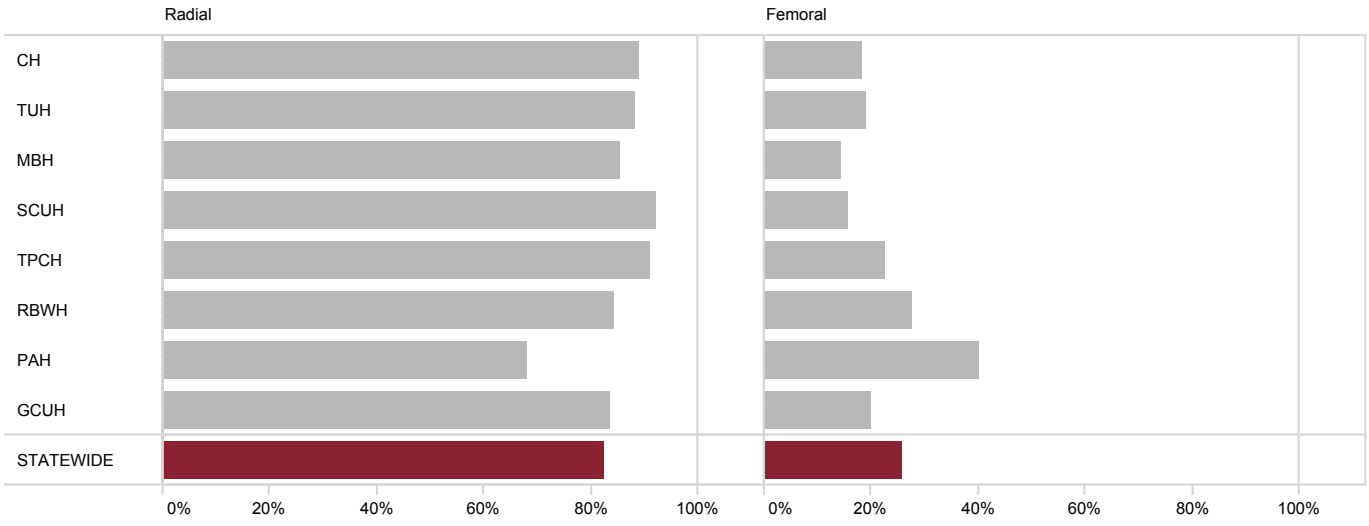


Figure 17: Proportion of STEMI presenting within six hours PCI cases using radial and femoral access routes by site

6.4 Vessels treated

The vast majority of vessels treated were native vessels with coronary bypass graft PCI accounting for less than 3% of interventions.

Of the vessels treated, 46% of cases involved the left anterior descending coronary artery (LAD), followed by the right coronary artery (RCA) at 36%, the circumflex coronary artery (LCx) at 25% and the left main coronary artery (LMCA) at 4%.

Multi-vessel PCI to native coronary arteries was performed in 11% of cases.

Table 15: Grafts and vessels treated by site

Site	LAD %	LMCA %	LCx %	RCA %	Graft %
CH	48.7	2.2	24.4	31.7	2.2
TUH	49.3	3.3	23.5	29.6	1.4
MBH	45.5	3.0	25.9	28.0	2.1
SCUH	46.6	5.1	26.5	38.4	1.3
TPCH	46.9	4.7	21.9	38.0	4.8
RBWH	43.7	0.5	30.5	34.2	1.6
PAH	41.9	5.1	25.8	38.3	2.1
GCUH	46.6	3.1	21.2	36.5	3.0
STATEWIDE	**45.7**	**3.8**	**24.6**	**35.6**	**2.6**

Table 16: Total native vessels treated by site

Site	Single vessel n (%)	Two vessels n (%)	Three or more vessels n (%)
CH	479 (91.4)	40 (7.6)	5 (1.0)
TUH	329 (93.5)	20 (5.7)	3 (0.9)
MBH	309 (95.1)	15 (4.6)	1 (0.3)
SCUH	448 (86.0)	56 (10.7)	17 (3.3)
TPCH	820 (85.7)	120 (12.5)	17 (1.8)
RBWH	382 (90.3)	38 (9.0)	3 (0.7)
PAH	925 (88.9)	92 (8.8)	23 (2.2)
GCUH	564 (91.1)	46 (7.4)	9 (1.5)
STATEWIDE	**4,256 (89.4)**	**427 (9.0)**	**78 (1.6)**

Excludes any graft PCI (n=127)

Table 17: Grafts treated by site

Site	Graft only n (%)	Graft and native vessel/s n (%)
CH	12 (100.0)	–
TUH	5 (100.0)	–
MBH	7 (100.0)	–
SCUH	5 (71.4)	2 (28.6)
TPCH	36 (75.0)	12 (25.0)
RBWH	6 (85.7)	1 (14.3)
PAH	21 (95.5)	1 (4.5)
GCUH	17 (89.5)	2 (10.5)
STATEWIDE	**109 (85.8)**	**18 (14.2)**

6.5 PCI following presentation with STEMI

Acute STEMI is a recognised medical emergency in which time to treatment is critical to both short and long term patient outcomes. PCI capable hospitals have therefore developed rapid triage and transfer strategies to fast-track STEMI patients into the CCL for rapid mechanical revascularisation (primary PCI).

Choice of reperfusion method depends on many factors including the timeliness of treatment, individual patient characteristics and access to interventional facilities. Given the time-critical nature of this condition, ongoing improvement and honing of hospital and pre-hospital processes is vital to meet the recommended timeframes for reperfusion in STEMI patients.

It is important to recognise there remains a group of STEMI patients who do not present to hospital or are conservatively managed, however this element of care is outside the scope of this procedure-based registry.

6.5.1 Clinical presentation

There were 1,560 documented STEMI PCI cases, with over half (58%) presenting as primary PCI cases and 12% presenting after 12 hours (late presenters).

Less than one fifth (19%) of patients had received thrombolysis prior to invasive coronary revascularisation including 6% requiring rescue PCI as thrombolysis had been unsuccessful.

Table 18: Proportion of STEMI PCI cases by presentation

Site	Transient STEMI n (%)	STEMI <6 hours n (%)	STEMI 6–12 hours n (%)	Late presentation n (%)	Post successful thrombolysis n (%)	Rescue PCI (failed thrombolysis) n (%)
CH	25 (17.5)	55 (38.5)	5 (3.5)	13 (9.1)	30 (21.0)	15 (10.5)
TUH	5 (5.9)	52 (61.2)	2 (2.4)	10 (11.8)	12 (14.1)	4 (4.7)
MBH	4 (5.9)	35 (51.5)	1 (1.5)	12 (17.6)	10 (14.7)	6 (8.8)
SCUH	32 (15.2)	91 (43.3)	9 (4.3)	23 (11.0)	35 (16.7)	20 (9.5)
TPCH	22 (7.8)	147 (52.3)	17 (6.0)	48 (17.1)	40 (14.2)	7 (2.5)
RBWH	11 (9.5)	65 (56.0)	4 (3.4)	19 (16.4)	11 (9.5)	6 (5.2)
PAH	56 (13.3)	219 (51.9)	26 (6.2)	34 (8.1)	60 (14.2)	27 (6.4)
GCUH	15 (6.4)	148 (63.0)	31 (13.2)	26 (11.1)	7 (3.0)	8 (3.4)
STATEWIDE	**170 (10.9)**	**812 (52.1)**	**95 (6.1)**	**185 (11.9)**	**205 (13.1)**	**93 (6.0)**

6.5.2 Admission pathway

After first medical contact, 69% of STEMI PCI patients were admitted directly to the treating centre.

As expected, admission pathway varied considerably by STEMI presentation. For thrombolysed and rescue PCI, there were 84% and 73% admitted via interhospital transfer respectively, whereas a large proportion (93%) of the STEMI presenting within six hours of symptom onset cohort presented directly to a PCI facility.

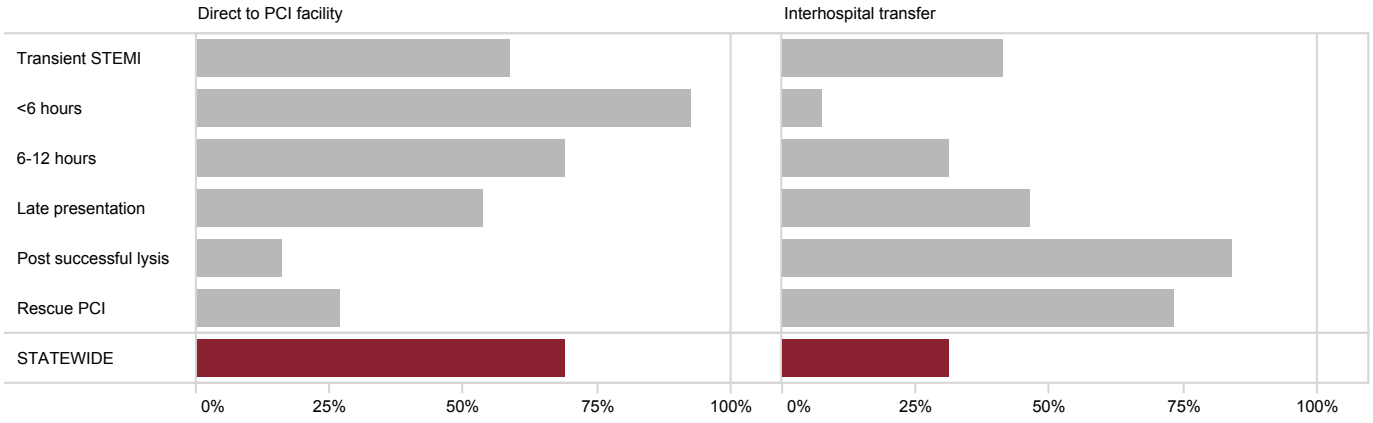


Figure 18: Proportion of STEMI PCI cases by admission pathway and clinical presentation

6.5.3 First medical contact

For STEMI cases presenting for PCI within six hours of symptom onset, most patients presented via the Queensland Ambulance Service (QAS) (83%), while a smaller proportion self-presented to the emergency department (ED) of either a PCI (on-site ED) or non PCI capable (satellite ED) facility (8% and 5% respectively). The remaining 4% presented to other health facilities such as GP clinics, community health centres or any other outpatient setting.

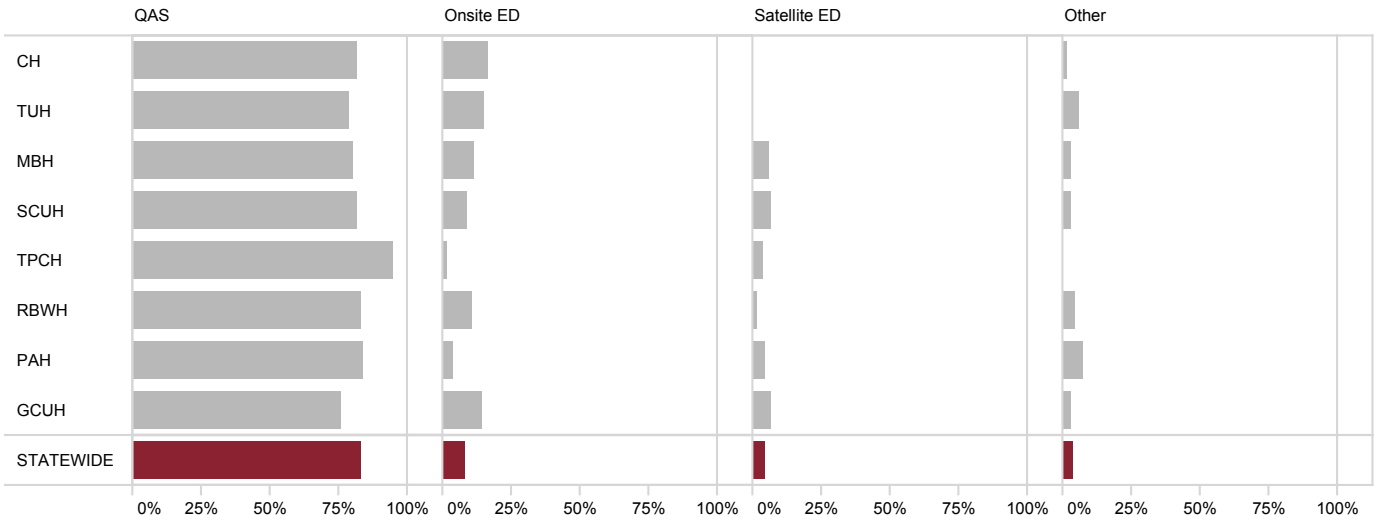


Figure 19: Proportion of STEMI PCI cases presenting within six hours of symptom onset by first medical contact

6.5.4 Thrombolysed patients

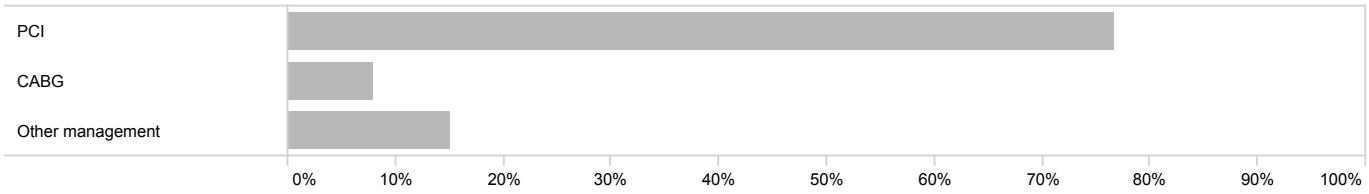
As mentioned above, the method of reperfusion depends on many factors which together determine the treatment method most appropriate for the particular presentation.

For patients presenting out of range of a PCI facility, thrombolytic therapy is highly effective and, unless medically contraindicated, is able to be administered in the field by attending paramedics or clinicians at a non PCI capable hospital.

There was a total of 401 thrombolysed STEMI presentations with the majority (74%) receiving a PCI, which increased to 77% when accounting for subsequent staged interventions within 90 days (Table 20). A smaller proportion (8%) went on to receive coronary artery bypass graft surgery (CABG) at a Queensland Health facility within 90 days.

Table 19: Total thrombolysed STEMI cases by tertiary cardiac centre

Site	Total thrombolysed STEMIs n	Receiving a PCI n (%)	Proportion of all PCI cases %
CH	59	45 (76.3)	8.4
TUH	24	16 (66.7)	4.4
MBH	20	16 (80.0)	4.8
SCUH	69	55 (79.7)	10.4
TPCH	59	47 (79.7)	4.7
RBWH	37	17 (45.9)	4.0
PAH	115	87 (75.7)	8.2
GCUH	18	15 (83.3)	2.4
STATEWIDE	**401**	**298 (74.3)**	**6.1**



PCI and CABG revascularisation not displayed (0.3%)

Figure 20: Proportion of thrombolysed patients by clinical management

Table 20: Thrombolysed patients by revascularisation method within 90 days

Site	PCI %	CABG %	PCI + CABG %	Other management* %
CH	81.5	7.4	1.9	9.3
TUH	70.8	8.3	0.0	20.8
MBH	80.0	0.0	0.0	20.0
SCUH	84.1	1.4	0.0	14.5
TPCH	80.4	5.4	0.0	14.3
RBWH	52.8	13.9	0.0	33.3
PAH	75.4	13.2	0.0	11.4
GCUH	83.3	5.6	0.0	11.1
STATEWIDE	**76.7**	**7.9**	**0.3**	**15.1**

* Includes medical management and transfer to a private or interstate facility

Overall, there were 401 thrombolysed STEMI patients who reached a public hospital CCL site in 2021. Substantially improved data quality this year sees 97% of this cohort eligible for analysis compared to 54% in 2018, 75% in 2019 and 85% in 2021.

Reassuringly, the median time from first diagnostic ECG (FdECG) to thrombolysis was similar across the patients receiving pre-hospital thrombolysis by QAS paramedics and the patients who presented directly to the thrombolysis facility (31 minutes vs. 32 minutes).

The patients in the other hospital thrombolysis group took a median of 52 minutes from FdECG to thrombolysis. The extended time delay likely representative of the travel time taken to arrive at a thrombolysis facility, noting Queensland's vast geography and rural and remote population.

Table 21: Definitions for STEMI time to thrombolysis

Time	Definition
First medical contact	The timestamp when the patient is initially assessed by a trained medical professional who can obtain and interpret an ECG and deliver initial interventions such as defibrillation. First medical contact (FMC) may occur in the hospital or pre-hospital setting.
First diagnostic ECG	First diagnostic ECG (FdECG) refers to the timestamp when the ECG shows ST-segment elevation. The interpretation of FdECG may be undertaken by ambulance personnel, general practitioner (GP) or hospital-based medical staff.
Time thrombolysis administered	The timepoint when thrombolytic therapy had been administered to the patient, which may be pre-hospital or in hospital.

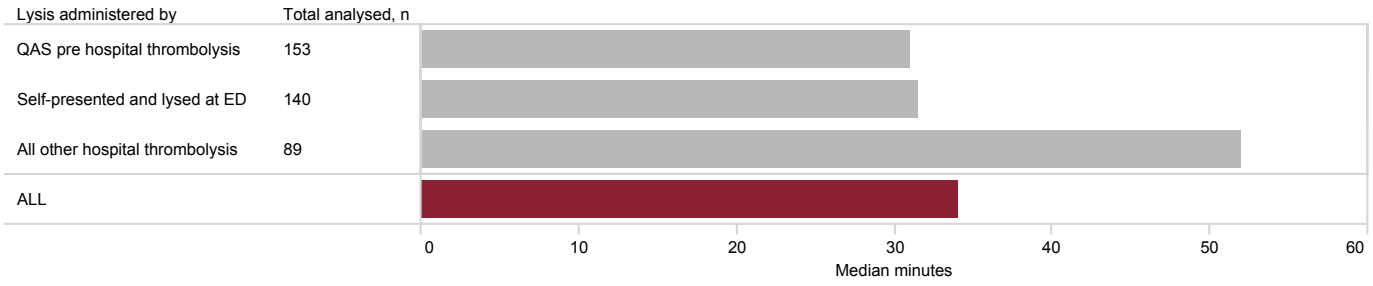
Table 22: Total thrombolysed STEMI cases by thrombolysis administration pathway

	Total thrombolysed STEMIs n	Total analysed n	Median FdECG to thrombolysis minutes	Interquartile range minutes
QAS pre-hospital thrombolysis	153	153	31	25–42
Self-presented and lysed at ED	147	140	32	21–58
Other pre-hospital thrombolysis*	5	5	N/A	N/A
All other hospital thrombolysis†	96	89	52	32–80
All	**401**	**387**	**34**	**24–56**

NA: Not displayed due to <20 cases for analysis

* Thrombolysed by Royal Flying Doctor Service or primary health care centre

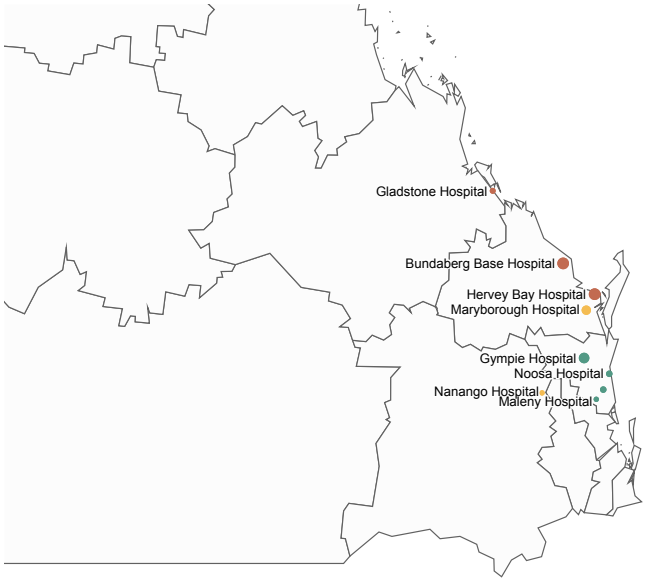
† Includes initial presentation to QAS or GP and subsequent thrombolysis in hospital



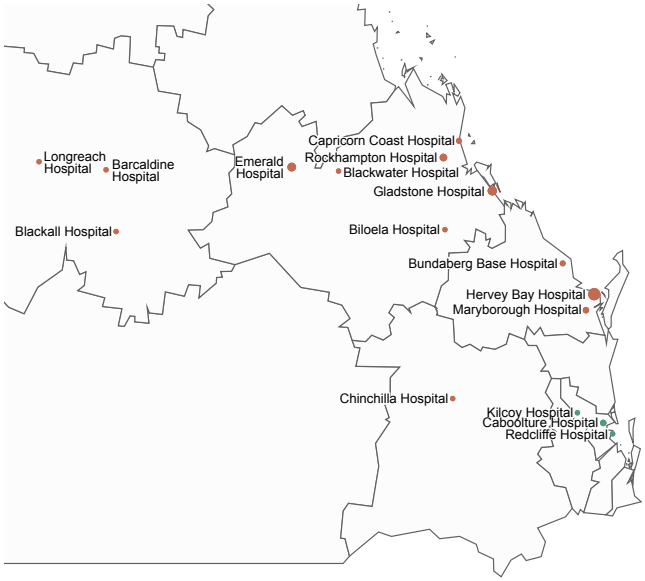
Excludes other pre-hospital thrombolysis (n=5)

Figure 21: Median time from first diagnostic ECG to thrombolysis therapy by administration pathway

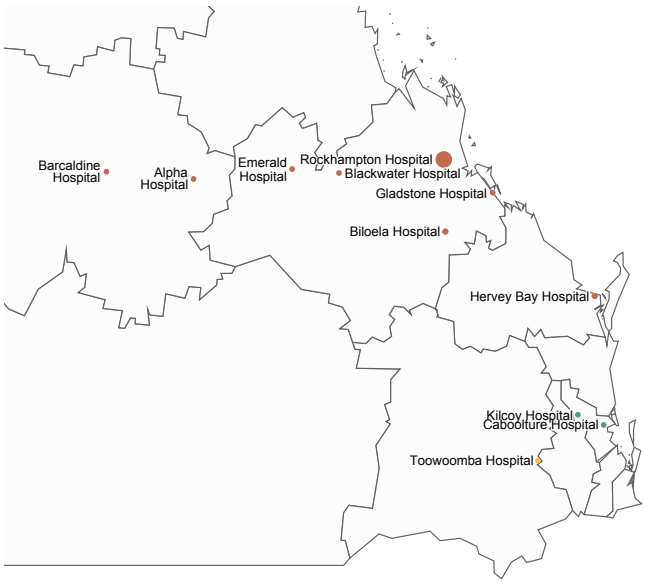
Figure 22: Thrombolysed STEMI interhospital transfers by estimated distance to transfer



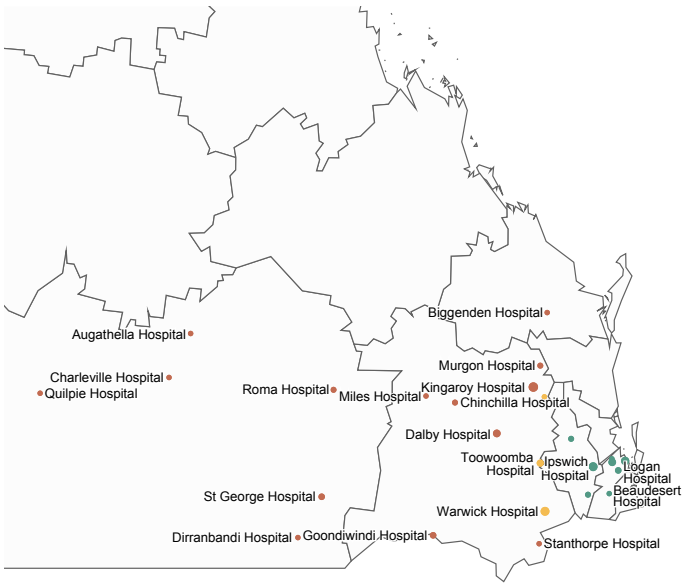
Inset A: Sunshine Coast University Hospital



Inset B: The Prince Charles Hospital



Inset C: Royal Brisbane & Women's Hospital



Inset D: Princess Alexandra Hospital

Inset E: Gold Coast University Hospital

QAS has a well-defined set of contraindications for the administration of pre-hospital thrombolysis. There were 96 thrombolysed STEMI patients (24%) who were not indicated for pre-hospital thrombolysis based on QAS criteria but were subsequently eligible for thrombolysis based on Queensland public hospital guidelines. The most common reason for this was that the patient had been located within close proximity to a hospital (63%). A smaller proportion had been contraindicated for pre-hospital thrombolysis due to advanced age (16%), other comorbidity or complex clinical presentation (Table 23).

For the cohort of thrombolysed patients, the median time to angiography was 16 hours post thrombolysis with 70% of patients undergoing coronary angiography within 24 hours. The unadjusted all-cause mortality within 30 days for STEMI patients receiving thrombolysis was 2.2%.

Table 23: Thrombolysed patients not indicated for pre-hospital thrombolysis

	n (%)
Close proximity to hospital	60 (62.5)
Advanced age >75 years	15 (15.6)
Hypertensive	6 (6.3)
Prolonged pain duration >6 hours	5 (5.2)
GCS* <15	3 (3.1)
Recent surgery	2 (2.1)
Other	5 (5.2)
All	**96 (100.0)**

* Glasgow Coma Scale

Table 24: Median time from thrombolysis to angiography by site

Site	Total cases n	Total analysed n	Median time to angiography hours	Interquartile range hours	Met 24 hours target %
CH	59	49	15	4–29	69.4
TUH	24	24	12	4–18	83.3
MBH	20	20	8	4–19	75.0
SCUH	69	69	17	5–28	66.7
TPCH	59	57	12	6–22	86.0
RBWH	37	33	20	8–27	60.6
PAH	115	113	18	6–38	60.2
GCUH	18	18	8	4–20	77.8
STATEWIDE	**401**	**383**	**16**	**5–27**	**69.5**

Table 25: Unadjusted all-cause thrombolysed STEMI mortality within 30 days of procedure

	Total cases n	Total salvage n (%)	In-lab death n	In hospital death n	Post discharge to 30 days n	Total mortality n (%)
Post successful lysis	308	8 (2.6)	0	7	0	7 (2.3)
Rescue PCI	93	7 (7.5)	0	2	0	2 (2.2)
All	**401**	**15 (3.7)**	**0**	**9**	**0**	**9 (2.2)**

6.6 NSTEMI presentations

Of all PCI and coronary cases performed in CCLs during 2021, there were 3,091 coded with a procedural indication of NSTEMI. These cases accounted for 29% of all PCI cases across all centres, with site variation ranging from 18% to 42%. These figures are similar across the previous 2019 and 2020 patient cohorts.

Of patients presenting with NSTEMI, 47% were revascularised via PCI, which increased to 52% when accounting for staged interventions within 90 days of index presentation (Table 27). A further 15% underwent CABG, while the remainder were medically managed or referred outside of Queensland Health.

6.6.1 Case load

Table 26: NSTEMI cases by site

Site	Total NSTEMI cases n	NSTEMI receiving PCI n (%)	Proportion of all PCI cases %
CH	303	185 (61.1)	34.5
TUH	233	79 (33.9)	21.9
MBH	163	59 (36.2)	17.8
SCUH	306	128 (41.8)	24.2
TPCH	592	260 (43.9)	25.8
RBWH	342	181 (52.9)	42.1
PAH	779	380 (48.8)	35.8
GCUH	373	164 (44.0)	25.7
STATEWIDE	**3,091**	**1,436 (46.5)**	**29.3**

Table 27: NSTEMI patients by site and revascularisation method within 90 days

Site	PCI revascularisation %	CABG revascularisation %	PCI + CABG revascularisation %	Other management* %
CH	64.8	9.9	1.1	24.2
TUH	40.7	17.2	0.0	42.1
MBH	44.0	10.7	0.0	45.3
SCUH	51.9	14.0	0.3	33.8
TPCH	47.0	13.8	0.7	38.5
RBWH	56.0	12.7	0.9	30.4
PAH	53.2	16.3	0.1	30.4
GCUH	46.4	16.1	0.5	36.9
STATEWIDE	**51.0**	**14.3**	**0.5**	**34.2**

* Medical management or referred outside of Queensland Health

6.6.2 Admission source

Overall and similar to previous years, there were more NSTEMI cases where the patient was transferred from another facility than those presenting directly to the PCI centre (52% and 48% respectively). This presents many challenges for guideline adherence with many logistical considerations making target adherence for invasive coronary angiography difficult. These issues are explored further in the clinical indicators section of the Audit.

Considerable variation was observed between sites, with the proportion of interhospital transfers for NSTEMI ranging from 28% to 74%, largely explained by catchment area. Where higher volumes and larger median distances to PCI centres exist, it is reasonable to expect that the proportion of cases meeting targets would be smaller. Table 29 and Figure 23 provide perspective based on cases where geographical data were available.

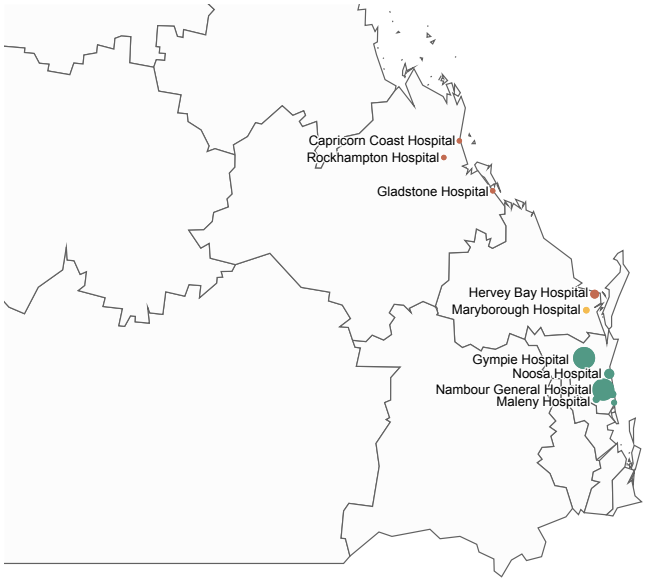
Table 28: NSTEMI admission source to treating facility

Site	Direct to PCI facility n (%)	Interhospital transfer n (%)
CH	188 (62.0)	115 (38.0)
TUH	160 (68.7)	73 (31.3)
MBH	112 (68.7)	51 (31.3)
SCUH	154 (50.3)	152 (49.7)
TPCH	308 (52.0)	284 (48.0)
RBWH	90 (26.3)	252 (73.7)
PAH	211 (27.1)	568 (72.9)
GCUH	268 (71.8)	105 (28.2)
STATEWIDE	**1,491 (48.2)**	**1,600 (51.8)**

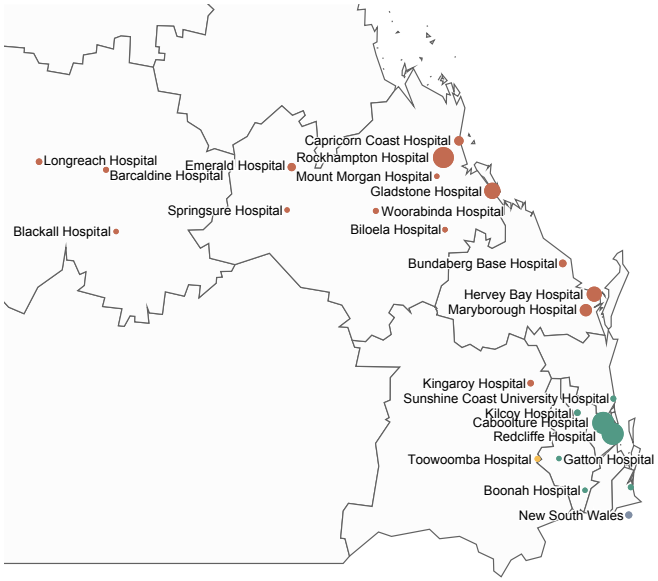
Table 29: NSTEMI interhospital transfers by estimated distance to transfer

Site	Total analysed n	Median kilometres	Interquartile range kilometres
CH	102	90	75–143
TUH	62	302	133–901
MBH	47	125	36–191
SCUH	144	35	30–93
TPCH	229	39	33–505
RBWH	220	231	45–567
PAH	521	27	24–122
GCUH	76	17	17–17
STATEWIDE	**1,401**	**45**	**27–192**

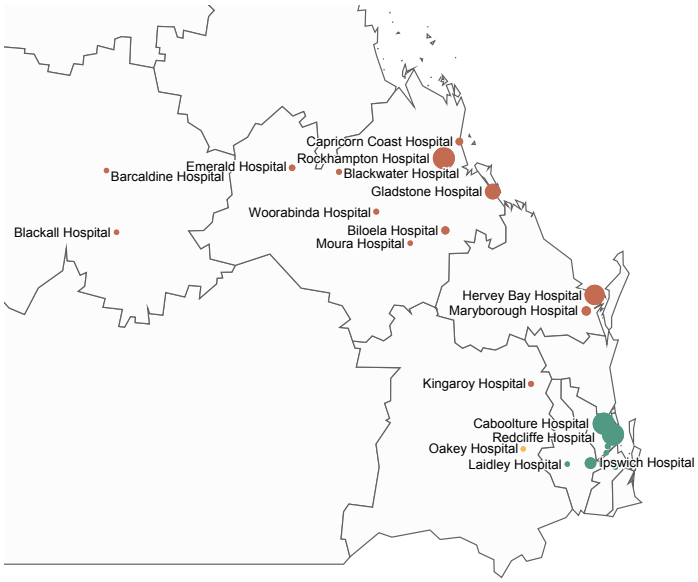
Figure 23: NSTEMI interhospital transfers by estimated distance to transfer



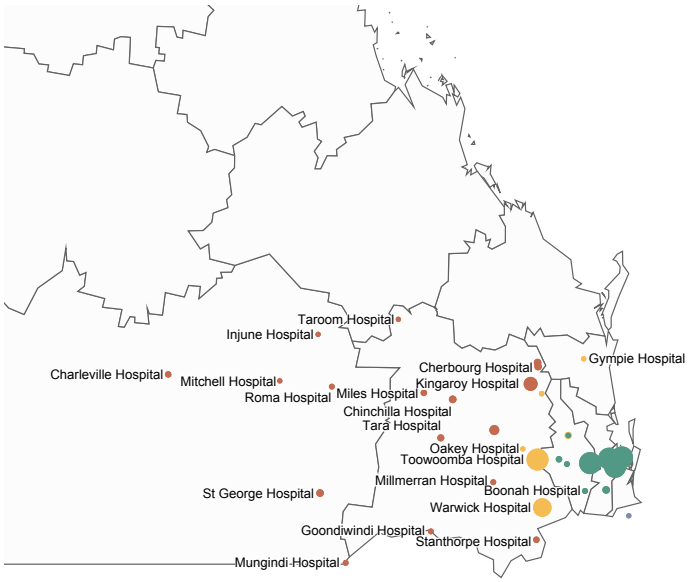
Inset A: Sunshine Coast University Hospital



Inset B: The Prince Charles Hospital



Inset C: Royal Brisbane & Women's Hospital



Inset D: Princess Alexandra Hospital

Inset E: Gold Coast University Hospital

7 Clinical indicators

The clinical indicator program is a valuable focus of QCOR. Many key guidelines advise the use of defined and validated quality indicators as a means of measuring and improving patient care. An indicator that is clinically relevant and useful should highlight specific issues that may require attention or signal areas for improvement.

The clinical quality and outcome indicators included in this Interventional Cardiology Audit have been selected after consideration of international PCI and ACS treatment guidelines and are in line with contemporary best practice recommendations. There is emerging recognition that a capacity to evaluate and report on quality is a critical building block for system-wide improvement of healthcare delivery and patient outcomes.

The quality and safety indicators which have been nominated by the QCOR Interventional Cardiology Committee are outlined in Table 30.

Table 30: Diagnostic and interventional cardiology clinical indicators

Clinical indicator	Description
1	Risk adjusted all-cause 30 day mortality post PCI
2	Proportion of STEMI patients presenting within six hours of symptom onset who received an intervention within 90 minutes of first diagnostic ECG
3	Proportion of all NSTEMI patients who received angiography within 72 hours of first hospital admission
4	Proportion of major in-lab events post PCI (coronary artery perforation, death, tamponade, emergency coronary artery bypass graft or cerebrovascular accident-stroke)
5	Proportion of cases where total entrance dose exceeded the high dose threshold (5Gy)

7.1 Mortality outcomes

7.1.1 Risk adjusted all-cause 30 day mortality post PCI

This clinical indicator includes all patient mortalities within 30 days of a PCI procedure. It does not necessarily indicate a causal relationship between the PCI procedure and the subsequent death. Overwhelmingly, death in these patients occurs from the underlying condition for which PCI is being done despite successful PCI being performed.

The overall 30 day unadjusted mortality rate for patients undergoing PCI procedures at Queensland public hospitals for 2021 was 1.8%. This result compares favourably with the 30 day mortality rate of 2.2% for the 2020 Victoria, Australia PCI cohort[6] and 2.8% presented by the British Cardiovascular Interventional Society (BCIS) in their review of PCI outcomes for the 2014 calendar year. This metric is chosen as the comparator as BCIS reports in subsequent years have given in-hospital rather than 30 day mortality.[7]

Table 31 presents unadjusted mortality according to admission status. As should be expected, the risk of death increases according to the severity of the patient's condition (admission status). 30 day mortality was 45% in the critically ill patients who underwent salvage PCI.

Table 31: All-cause unadjusted mortality within 30 days post PCI by admission status (% of total cases by presentation and site)

Site	Total cases n	Elective n (%)	Urgent n (%)	Emergency n (%)	Salvage n (%)	Total deaths n (%)
CH	536	0 (0.0)	3 (1.0)	0 (0.0)	5 (45.5)	8 (1.5)
TUH	361	0 (0.0)	1 (0.5)	4 (4.7)	0 (0.0)	5 (1.4)
MBH	332	0 (0.0)	3 (2.3)	0 (0.0)	0 (0.0)	3 (0.9)
SCUH	528	3 (2.9)	2 (0.7)	5 (3.3)	2 (100.0)	12 (2.3)
TPCH	1,007	2 (0.7)	5 (1.1)	10 (4.4)	7 (63.6)	24 (2.4)
RBWH	430	0 (0.0)	0 (0.0)	0 (0.0)	5 (38.5)	5 (1.2)
PAH	1,062	0 (0.0)	2 (0.3)	3 (1.1)	10 (43.5)	15 (1.4)
GCUH	638	0 (0.0)	0 (0.0)	5 (2.4)	12 (44.4)	17 (2.7)
STATEWIDE	**4,894**	**5 (0.5)**	**16 (0.6)**	**27 (2.3)**	**41 (45.1)**	**89 (1.8)**

Figure 24 presents the observed mortality rates by site, superimposed on the predicted mortality rates (with 95% confidence interval) calculated using the Victorian Cardiac Outcomes Registry (VCOR) risk adjustment model[9]. This analysis used an imputed dataset accounting for any missing data.

Reassuringly, observed mortality rates from all sites are within the expected range for their respective risk adjusted mortality rates. This is despite the limited risk adjustment model, which only adjusts for six factors – ACS, age, LAD coronary artery involvement, eGFR, LVEF, and cardiogenic shock. Other critical presentations with very high mortality risk, such as out of hospital ventricular fibrillation (VF) arrest with uncertain neurological recovery, are not adjusted for and therefore the model is likely to underestimate true mortality risk. This is relevant in our dataset where there were marked differences between hospitals in the proportion of high risk salvage patients taken for PCI (ranging from 0.4%–4.2% of PCI volume).

There were also considerable differences in salvage case mortality rates across different hospitals (Table 31). This variation may relate to differences in case mix at different hospitals, differences in the threshold for performing PCI in critically ill unstable patients, differences in classification of admission status, or a combination of all three factors. Given this variation, and the inability of the current risk prediction model to accurately predict expected mortality in the extreme risk salvage category, Figure 25 presents the observed and expected mortality rates excluding salvage.

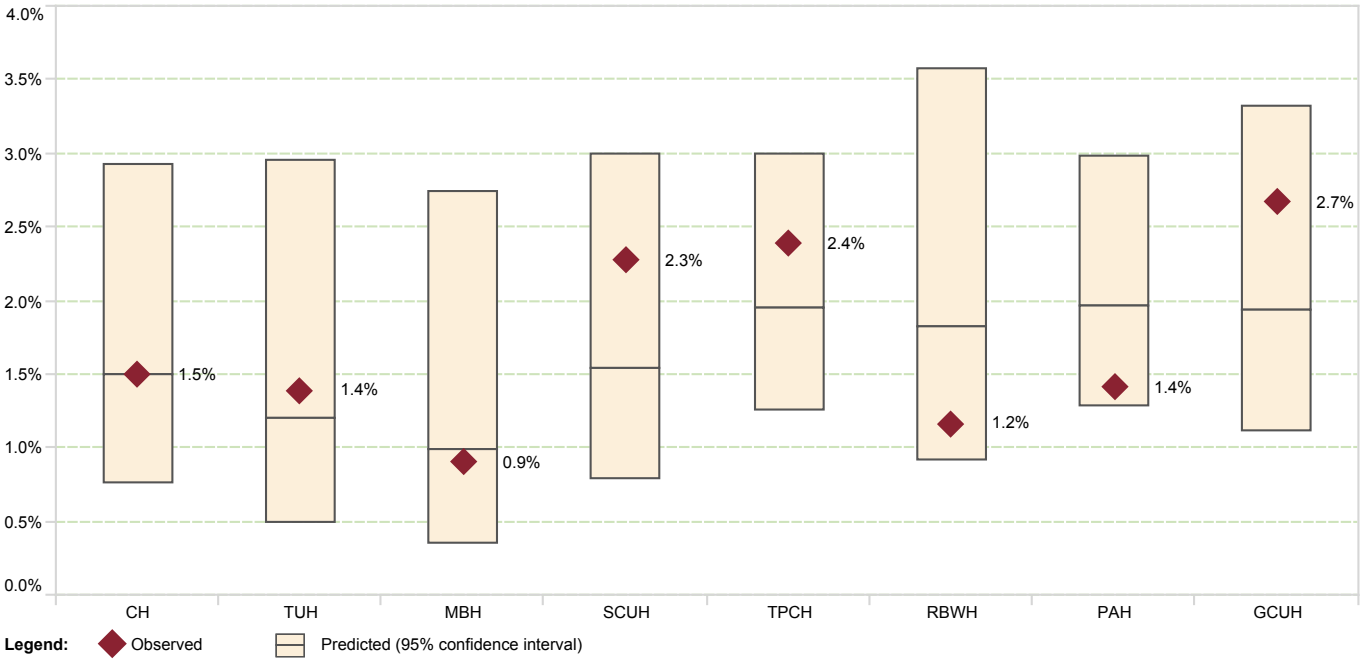
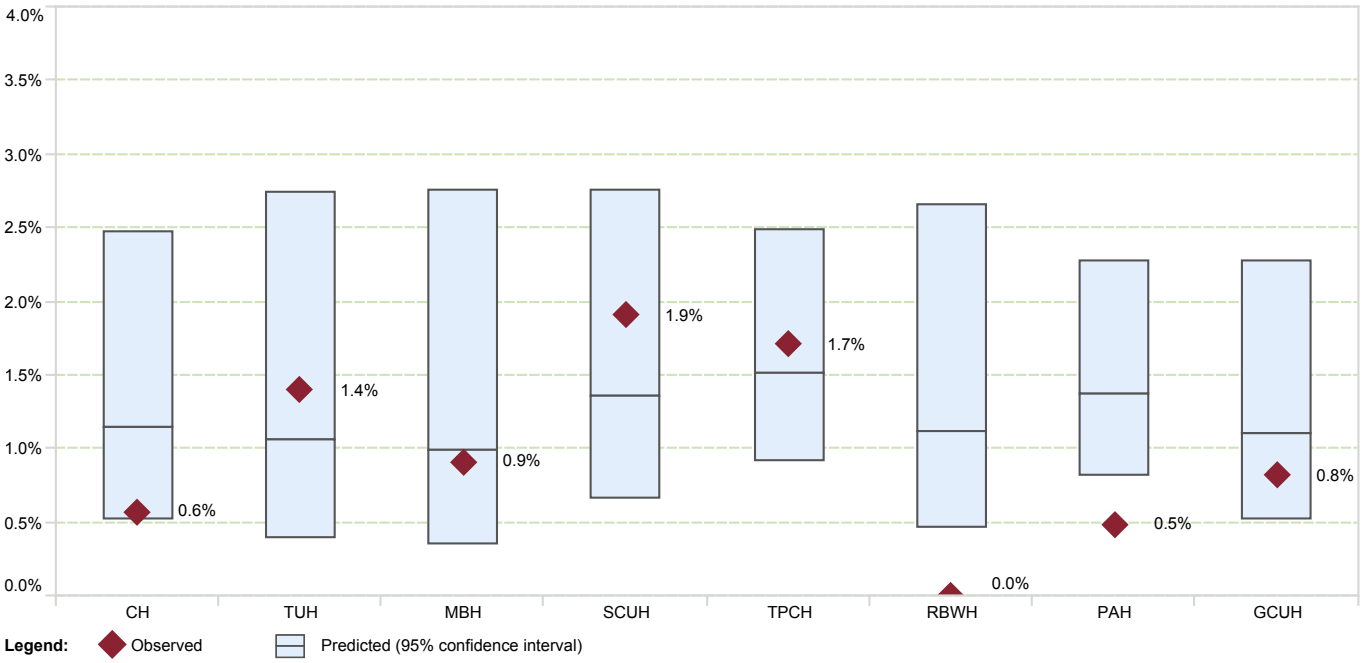


Figure 24: Comparison of observed and predicted mortality rates by site

As was outlined in previous QCOR reports, poorly calibrated risk adjustment is known to introduce bias into the monitoring process. Great care, therefore, needs to be exercised in the choice and use of risk adjustment tools to ensure they are relevant and have adequate performance for the patient cohort under scrutiny. Unfortunately, there are very few universally accepted risk models in interventional cardiology. We determined the VCOR model for risk adjustment of 30 day mortality to have the greatest utility for our current dataset, compared to other models such as those of the BCIS[7], and the American College of Cardiology (ACC) CathPCI registry.[10] These models are critically dependant on completeness of data elements.

With an expanded dataset of reliable data, a more thorough evaluation of international PCI risk adjustment models can be explored. This would allow for recalibration and the option to adapt one of these models to the specific characteristics of the QCOR dataset, or develop a new, locally relevant model. The variation in salvage cases between different hospitals highlights the importance of this. Some of these cases are STEMI complicated by out of hospital VF arrest, where there is a high yet uncertain chance of dying from a non cardiac cause (hypoxic brain injury). Small differences in the caseload of such patients, or variation in the likelihood of taking such cases for PCI, would have an undue effect on mortality rates, and yet there is no adjustment for this in the risk prediction model being applied.

In the ideal model, factors which are known to impact on patient outcomes, and which are beyond the control of the clinician or service being monitored, are either controlled for in the analysis or excluded. In measuring performance outcomes, it is important to maintain focus on the process under scrutiny (PCI outcomes), without distortion by uncorrected bias.



Excluding salvage cases (n=91)

Figure 25: Comparison of observed and predicted mortality rates by site, excluding salvage

7.1.2 STEMI mortality

A separate analysis was performed to assess mortality in patients presenting with STEMI. Of the 1,915 documented STEMI cases in 2021, 1,560 cases (81%) included a PCI intervention and are the subject of the following outcomes analyses. For this analysis, patients presenting as salvage are excluded, allowing focus to be retained on the measurement of PCI outcomes.

The outcomes for cohort of STEMI patients who underwent primary PCI remain encouraging. All-cause mortality rates at 30 days varied from 0% to 4.8% between participating centres with a statewide rate of 1.5%. Of these 1,493 patients analysed, a total of 23 mortalities were identified with the majority (70%) occurring in hospital.

Table 32: STEMI mortality up to 30 days in patients who underwent primary PCI

Site	In-lab n	In hospital n	Post discharge to 30 days n	Total cases* n	Total mortality n (%)
CH	0	0	0	136	0 (0.0)
TUH	0	2	2	83	4 (4.8)
MBH	0	0	0	67	0 (0.0)
SCUH	0	3	2	208	5 (2.4)
TPCH	0	7	0	272	7 (2.6)
RBWH	0	0	0	107	0 (0.0)
PAH	0	1	3	406	4 (1.0)
GCUH	0	3	0	214	3 (1.4)
STATEWIDE	**0**	**16**	**7**	**1,493**	**23 (1.5)**

* Excluding salvage cases (n=67)

7.1.3 STEMI presentation within 6 hours from symptom onset

Further analysis of the STEMI cohort who underwent primary PCI within six hours of symptom onset demonstrates a statewide all-cause 30 day mortality rate of 1.7%.

For this analysis, patients presenting as high risk salvage cases have been excluded.

Table 33: STEMI mortality up to 30 days for patients who underwent a primary PCI and presented within six hours of symptom onset

Site	In-lab n	In hospital n	Post discharge to 30 days n	Total cases* n	Total mortality n (%)
CH	0	0	0	50	0 (0.0)
TUH	0	1	0	51	1 (2.0)
MBH	0	0	0	35	0 (0.0)
SCUH	0	3	1	89	4 (4.5)
TPCH	0	2	0	141	2 (1.4)
RBWH	0	0	0	58	0 (0.0)
PAH	0	1	2	209	3 (1.4)
GCUH	0	3	0	133	3 (2.3)
STATEWIDE	**0**	**10**	**3**	**766**	**13 (1.7)**

* Excluding salvage cases (n=46)

7.1.4 Out of hospital cardiac arrest

Out of hospital cardiac arrest (OOHCA) is associated with very poor prognosis. It has been reported that only 12% of all OOHCA with attempted resuscitation survive to hospital discharge or 30 days following the arrest.[11] Furthermore, where the presumed cause of arrest is cardiac in nature and the case is not witnessed by emergency services, survival to hospital discharge or 30 days is also 12%. It is therefore recognised that patients who present with OOHCA have a guarded prognosis and any attempt to revascularise these patients may ultimately still result in death as a result of other factors or clinical pathology such as poor neurological recovery.

With this in mind, it is imperative that these cases be interpreted with caution noting that the outcomes reflect an 79% survival rate to 30 days which is markedly better than the larger OOHCA with resuscitation group. This is reassuring and indicates that patient selection for PCI in this high-risk, critically unwell group is appropriate.

Variation exists among sites with OOHCA accounting for 1.3% to 4.1% of total PCI cases and a statewide proportion of 2.5%. In this group, death within 30 days of the PCI procedure in 2021 almost exclusively occurred in hospital with a small number post discharge.

Table 34: Total out of hospital cardiac arrest cases by site

Site	Total cases n	Proportion of PCI cases %
CH	7	1.3
TUH	6	1.7
MBH	5	1.5
SCUH	19	3.6
TPCH	22	2.2
RBWH	7	1.6
PAH	32	3.0
GCUH	26	4.1
STATEWIDE	**124**	**2.5**

Table 35: Out of hospital cardiac arrest mortality up to 30 days post procedure

	Total cases n	In-lab n	In hospital n	Post discharge to 30 days n	Total deaths n (%)
STATEWIDE	**124**	**0**	**24**	**2**	**26 (21.0)**

7.2 STEMI less than six hours from symptom onset – time to reperfusion

The most critical factor influencing outcome for patients who experience a STEMI is the total ischaemic time, defined as the time interval from symptom onset to successful reperfusion. The exact time of symptom onset is often difficult to ascertain, and the time between symptom onset and call for help is primarily a patient dependent factor.

Therefore, STEMI guidelines worldwide now advocate FdECG-to-device time as an important modifiable and objective measure of overall STEMI system performance.[12]

Both the European and American STEMI guidelines recommend a target FdECG-to-device time less than 90 minutes.[12,13] It is widely recognised that these targets are ambitious and difficult to achieve in real-world practice as primary PCI becomes more available to larger catchment populations.

Achieving these times requires efficient coordination of care within and between the ambulance service and transferring/receiving hospitals. Accepted strategies to improve reperfusion times include pre-hospital activation of the CCL, an immediate response of the on call PCI team to be operational within 30 minutes of alert and bypass of the emergency department.

Table 36: Definitions for STEMI time to reperfusion

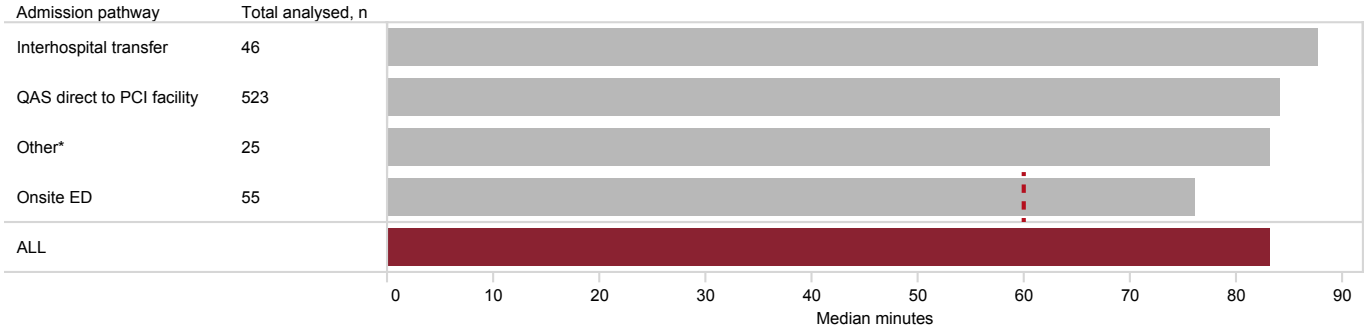
Time	Definition
First diagnostic ECG	First diagnostic ECG refers to the timestamp when the ECG shows ST-segment elevation (or equivalent) and can be regarded as time zero in the therapeutic pathway. The interpretation of the first diagnostic ECG may be undertaken by ambulance personnel, general practitioners or hospital based medical staff.
Door time	Door time refers to the timestamp when the patient presents to the PCI hospital and can be regarded as time zero in the therapeutic pathway for patients presenting via this method.
First device time	The first device time, as a surrogate for reperfusion, is the first timestamp recorded of the earliest device used: • first balloon inflation, or • first stent deployment, or • first treatment of lesion (thrombectomy/aspiration device, rotational atherectomy or coronary lithotripsy) If the lesion cannot be crossed with a guidewire or device (and thus none of the above applies), the time of guidewire introduction is used. If there is already TIMI 3* flow observed on initial angiography, that timestamp is used instead of first device time.

* Grade 3 (complete perfusion)[14]

The QCOR Interventional Cardiology Committee established the benchmark target of 75% of patients to receive timely reperfusion measured from FdECG to reperfusion, as well as from arrival at PCI facility to reperfusion.

In total, there were 812 STEMI primary PCI cases presenting within six hours of symptom onset. Of these, there were 163 cases which had been excluded per the criteria in Table 37 leaving 649 cases which are eligible for the following analysis.

As observed in previous annual reports, there was considerable variation in time from FdECG to reperfusion depending on the admission pathway to the treating facility, ranging from 88 minutes to 76 minutes for interhospital transfers and PCI facility onsite ED respectively.



* First medical contacts excluding QAS or ED, such as GP and community health

Figure 26: STEMI presenting within six hours of symptom onset – median first diagnostic ECG to first device time by admission pathway

Table 37: STEMI presenting within six hours of symptom onset cases ineligible for analysis

Summary	n (%)
Salvage	46 (28.2)
Out of hospital arrest	30 (18.4)
Previous CABG	23 (14.1)
Thrombolysis contraindicated	20 (12.3)
Unsuccessful PCI	15 (9.2)
Significant comorbidities/frailty	10 (6.1)
Intubation	4 (2.5)
Shock/acute pulmonary oedema	4 (2.5)
Incomplete data	11 (6.7)
Total	**163 (100.0)**

7.2.1 Time from first diagnostic ECG to first device

The all-site median time from FdECG to reperfusion was 83 minutes, with median individual site times ranging from 69 minutes to 90 minutes. These results indicate that overall Queensland public facilities are approaching the ambitious benchmark of 90 minutes from time of FdECG to first device. However, only 63% of patients analysed receive timely reperfusion per current guidelines (FdECG to reperfusion)[7], supporting the view that the current target is idealistic.

FdECG to reperfusion is a multi layered metric with the involvement of QAS, emergency and cardiology physicians and, along with the large geographical variations across Queensland, presents a clinical and logistical challenge for all involved. Nonetheless, the measure of time to reperfusion remains a useful tool for monitoring processes and efficiencies and demonstrates the potential for improvement or maintenance of system and hospital performance.

Table 38: First diagnostic ECG (FdECG) to reperfusion for STEMI presenting within six hours of symptom onset

Site	Total cases n	Total analysed n	Median minutes	Interquartile range minutes	Met 90 min target %
CH	55	41	69	54–95	68.3
TUH	52	41	75	64–94	70.7
MBH	35	30	90	80–107	50.0
SCUH	91	71	77	67–90	77.5
TPCH	147	130	87	76–101	59.2
RBWH	65	49	82	68–110	59.2
PAH	219	175	86	76–106	59.4
GCUH	148	112	84	73–99	63.4
STATEWIDE	**812**	**649**	**83**	**71–101**	**62.9**

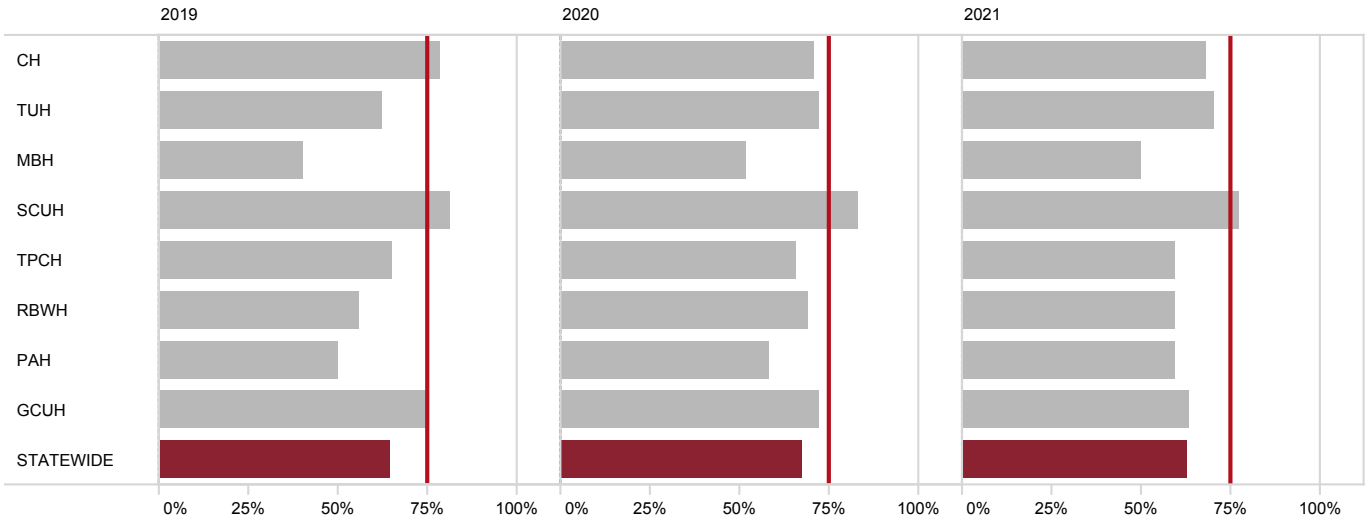


Figure 27: Proportion of STEMI cases (presenting within six hours of symptom onset) where time from first diagnostic ECG to reperfusion met 90 min target, 2019–2021

7.2.1.1 Pre-hospital notification processes

Pre-hospital emergency care is provided to the state's population by the QAS. Pre-hospital STEMI identification, pre-hospital reperfusion therapy, field activation of CCL, and rapid transport are integral parts of the treatment cascade for pre-hospital STEMI patients in Queensland.[8]

For STEMI, the QAS uses a two-tiered response model that consists of Advanced Care Paramedics (ACP) and Critical Care Paramedics (CCP). A typical response to a pre-hospital STEMI involves the concurrent deployment of ACPs and CCPs, where CCP resources are available.

On recognition of pre-hospital STEMI, paramedics fast-track treatment by either directly referring the patient to a specialist cardiac hospital for primary PCI or by administering pre-hospital fibrinolysis. Direct PCI referral is considered when the patient is located less than 60 minutes total transport time from STEMI identification to a PCI-capable hospital, has a Glasgow Coma Scale (GCS) of 15, and has classic ongoing ischaemic chest pain less than 12 hours in duration. Pre-hospital fibrinolysis is considered when the patient is located more than 60 minutes total transport time from STEMI identification to a PCI-capable hospital, has a GCS of 15, has classic ongoing ischaemic chest pain less than 6 hours in duration and is less than 75 years of age.

Some patients do not receive pre-hospital reperfusion therapy due to being contraindicated within the QAS reperfusion guidelines, and/or close proximity to a hospital, with some exceptions when patients refuse treatment. These patients were still identified for pre-notification to the receiving facility to ensure rapid assessment and treatment upon arrival.

When direct PCI referral is the selected pre-hospital reperfusion treatment pathway, a dedicated telephone line is utilised to make direct contact with the on call interventional cardiologist at the receiving PCI hospital to refer the patient and confer regarding pre-hospital management. If the patient is accepted, the CCL is activated by the receiving hospital staff, concomitant antiplatelet therapy and anticoagulant therapy are given in the field by paramedics, as requested by the cardiologist, and the patient is rapidly transported directly to the hospital for primary PCI.

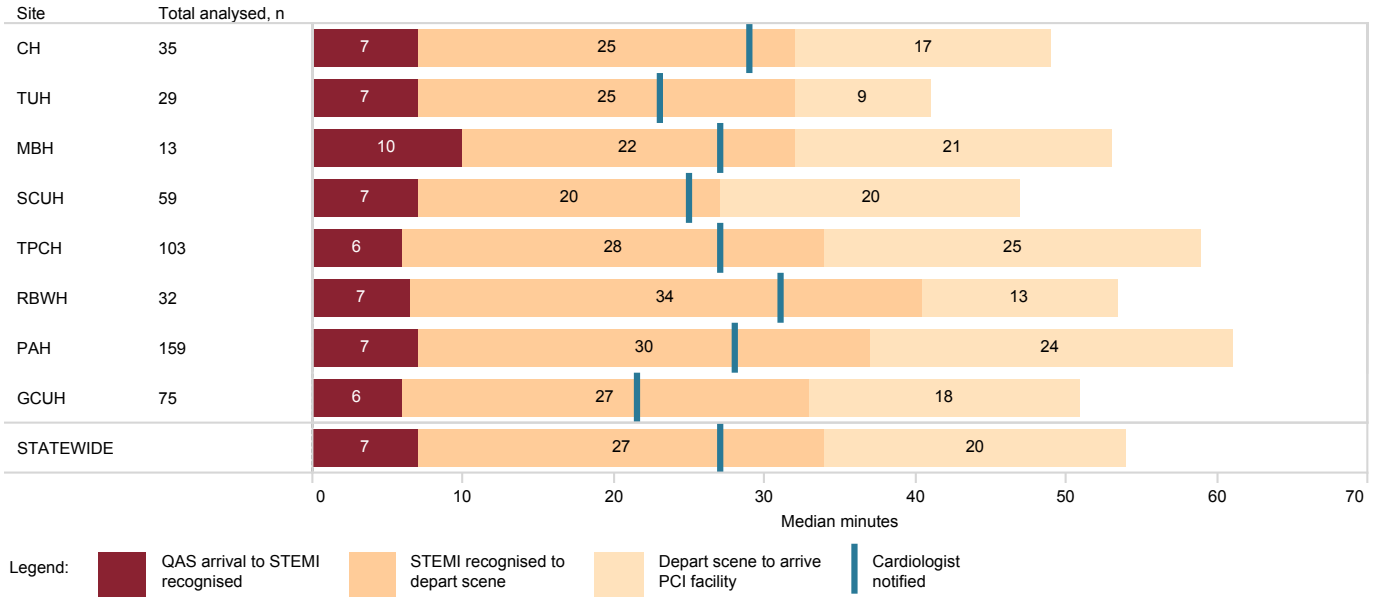


Figure 28: STEMI presenting within six hours of symptom onset pre-hospital component breakdown – QAS direct to PCI facility

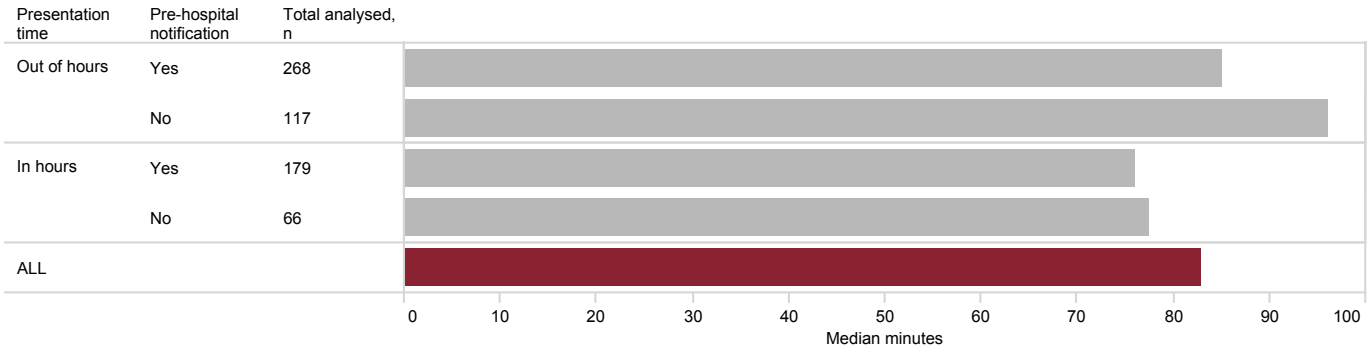
7.2.1.2 Hospital processes

All hospitals have established pathways for notification of and receiving STEMI patients. Some hospital processes vary across the state depending on factors including the time of day or the local requirement of some patients to transit via the ED.

Pre-hospital notification plays an important role in readying CCL teams for incoming patients with acute myocardial infarction. Different processes and protocols are in place depending on whether the patient presents within business hours or out of hours. For the purpose of this analysis, in hours was defined as 8am–6pm, Monday to Friday, excluding public holidays.

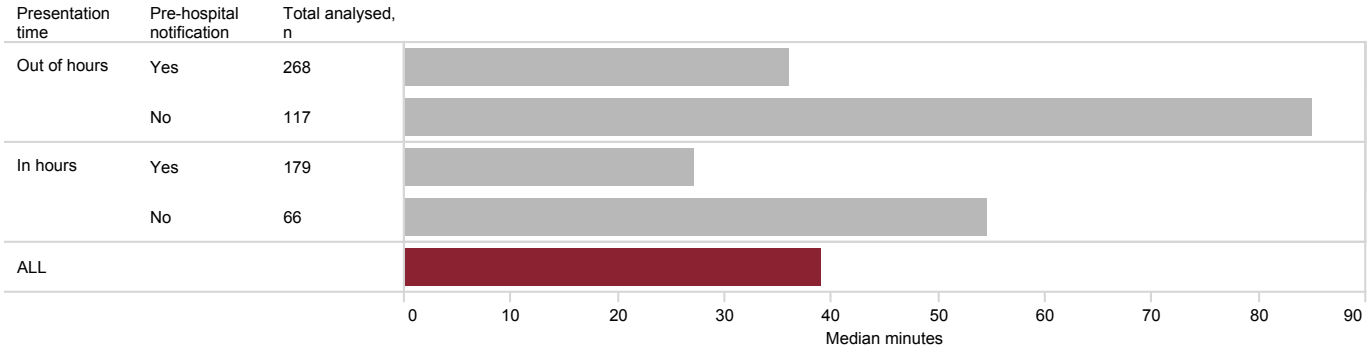
Total time to reperfusion was lowest in the in hours cohort where pre-hospital notification occurred. Even when pre-hospital notification was not a factor, in hours cases had a swifter time to reperfusion than those taking place out of hours. It is important to note that the out of hours cohort accounts for the larger proportion of cases (385 out of hours vs. 245 in hours), meaning particular attention can be paid to this group for future quality improvement activities.

When examining arrival at PCI facility to reperfusion, pre-hospital notification resulted in marked differences in system performance. Pre-hospital notification was associated with a 28 minute improvement for in hours cases and a 49 minute improvement for out of hours cases. These findings support the importance of pre-hospital notification and the effect it has on providing an efficient, systematic approach to patient care.



In hours: 8am–6pm Monday to Friday, excluding public holidays

Figure 29: STEMI presenting within six hours of symptom onset – first diagnostic ECG to reperfusion by presentation time and pre-hospital notification



In hours: 8am–6pm Monday to Friday, excluding public holidays

Figure 30: STEMI presenting within six hours of symptom onset – arrival PCI facility to reperfusion by presentation time and pre-hospital notification

7.2.2 Time from arrival PCI capable facility to first device

The time between PCI hospital arrival and reperfusion ('door-to-device time') is currently the accepted measure of PCI hospital system performance in STEMI. Historically, hospitals have worked to a goal of less than 90 minutes, although more recent guidelines have shortened this target time to less than 60 minutes.[12,13]

In 2021, COVID-19 has caused significant disruption of the usual in-hospital journey of a STEMI patient. Some Hospital and Health Services mandated rapid antigen testing of all patients presenting to the emergency department. Despite best efforts, the mandate will have prolonged treatment time and ultimately the time to reperfusion. Longer delays were experienced by patients who tested positive for COVID-19 as this required staff to don appropriate personal protective equipment and adhere to strict infection control guidelines both prior to and following the procedure.

Results demonstrate that for almost three quarters of cases (74%), participating PCI facilities are meeting a target door-to-device time of less than 60 minutes, with an overall statewide median time of 39 minutes (ranging from 32 minutes to 58 minutes across sites). These results demonstrate incremental improvement over previous years (2019 median – 42 minutes, 2020 median – 40 minutes), and two sites meeting the 75% benchmark target.

Table 39: Arrival at PCI hospital to first device for STEMI presenting within six hours of symptom onset

Site	Total cases n	Total analysed n	Median minutes	Interquartile range minutes	Met 60 min target %
CH	55	41	43	32–67	65.9
TUH	52	41	51	35–72	61.0
MBH	35	30	58	39–100	53.3
SCUH	91	71	35	24–62	73.2
TPCH	147	130	36	27–44	86.2
RBWH	65	49	38	29–68	71.4
PAH	219	175	32	25–50	81.1
GCUH	148	112	48	27–81	63.4
STATEWIDE	**812**	**649**	**39**	**27–62**	**74.0**

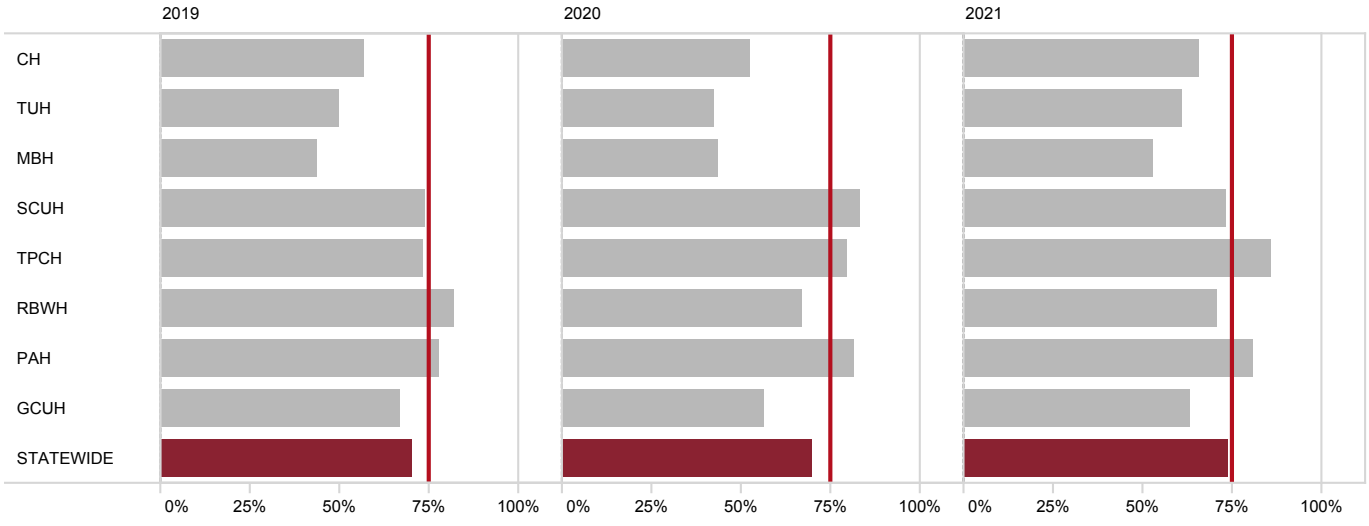


Figure 31: Proportion of cases where arrival at PCI hospital to first device ≤60 minutes was met for STEMI presenting within six hours of symptom onset, 2019–2021

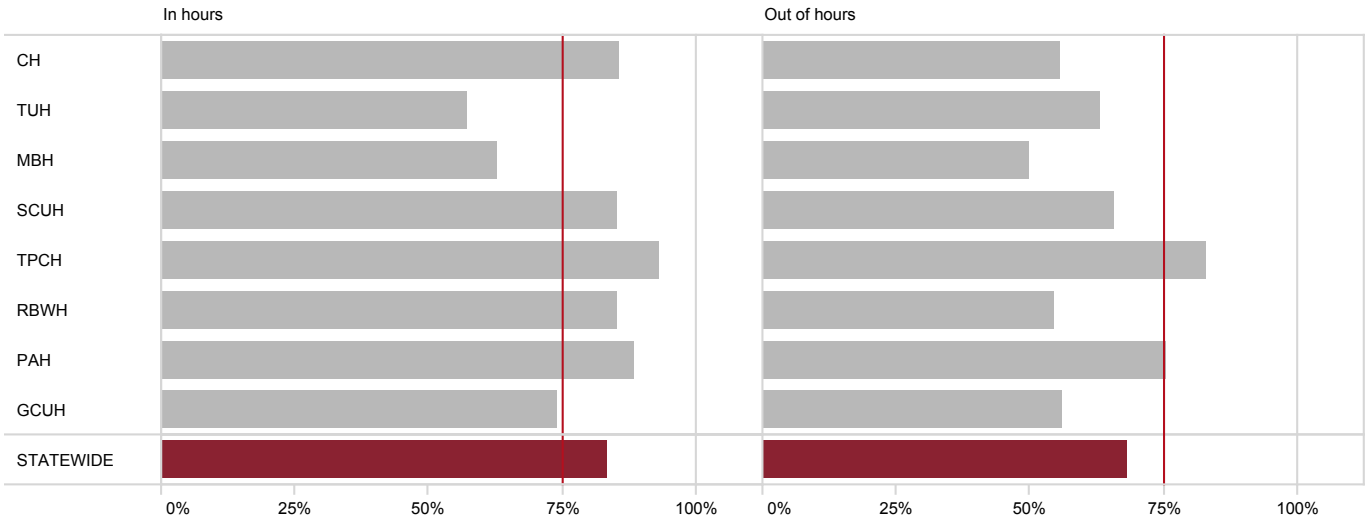
7.2.2.1 In hours versus out of hours presentation

The majority of cases (61%) presented out of hours. For the purpose of this analysis, business hours were defined as 8am–6pm, Monday to Friday, excluding public holidays. This high proportion of out of hours cases demonstrates the frequency at which teams are required to respond to these medical emergencies. Each out of hours case has its own logistical challenges and requires a whole-of-system approach to ensuring timely intervention. It is important to note that this analysis does not include all out of hours work performed by CCL teams with a wide and varied case mix regularly encountered.

When examining PCI hospital arrival and reperfusion, patient presentation in hours was associated with better performance. Over three quarters (83%) of cases met the door-to-device time target of 60 minutes in hours compared to 68% out of hours.

Table 40: STEMI presenting within six hours of symptom onset – arrival PCI facility to reperfusion by site and time of presentation

Site	Total analysed n	Proportion out of hours %	In hours median minutes	Out of hours median minutes	In hours target met %	Out of hours target met %
CH	41	65.9	38	47	85.7	55.6
TUH	41	65.9	59	48	57.1	63.0
MBH	30	73.3	39	62	62.5	50.0
SCUH	71	62.0	26	39	85.2	65.9
TPCH	130	67.7	33	37	92.9	83.0
RBWH	49	44.9	33	57	85.2	54.5
PAH	175	56.0	29	36	88.3	75.5
GCUH	112	58.9	38	51	73.9	56.1
STATEWIDE	**649**	**60.7**	**32**	**42**	**83.1**	**68.0**



In hours: 8am–6pm Monday to Friday, excluding public holidays

Figure 32: STEMI presenting within six hours of symptom onset – proportion of cases where arrival at PCI hospital to first device ≤60 minutes by time of presentation and site

7.2.2.2 Pre-hospital notification

Pre-hospital notification was utilised in two thirds (71%) of cases, with considerable variation observed among sites. Achievement of the benchmark of 75% of cases meeting the 60 minute target was achieved at all sites where pre-hospital notification was utilised. Statewide, the 60 minute timeframe was achieved in 92% of cases where there was pre-hospital notification compared to 34% without pre-hospital notification.

This further supports the importance of pre-hospital notification and the need for effective synergies between hospital departments and emergency services.

Table 41: STEMI presenting within six hours of symptom onset – arrival PCI facility to reperfusion by pre-hospital notification and site

Site	Total analysed n	Proportion with pre-hospital notification %	Pre-hospital notification median minutes	No pre-hospital notification median minutes	Pre-hospital notification target met %	No pre-hospital notification target met %
CH	41	58.5	36	67	95.8	23.5
TUH	41	61.0	36	78	84.0	25.0
MBH	29	55.2	45	100	87.5	15.4
SCUH	71	64.8	28	66	97.8	28.0
TPCH	123	87.0	35	80	94.4	43.8
RBWH	49	63.3	32	80	87.1	44.4
PAH	175	81.1	30	81	93.0	30.3
GCUH	101	55.4	38	81	87.5	44.4
STATEWIDE	**630**	**71.0**	**33**	**78**	**92.2**	**33.9**

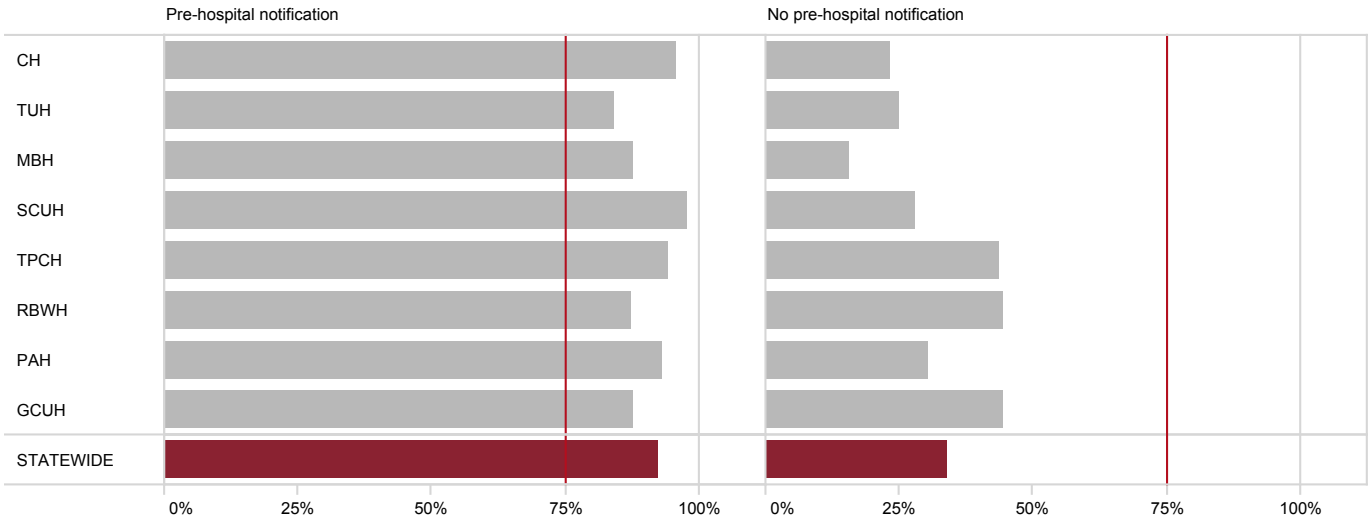


Figure 33: STEMI presenting within six hours of symptom onset – proportion of cases where arrival at PCI hospital to first device ≤60 minutes by site and pre-hospital notification

7.3 NSTEMI – time to angiography

Time to coronary angiography for patients presenting to hospital with a NSTEMI remains a key clinical quality indicator for QCOR. Coronary angiography is necessary to determine the severity of coronary disease with both quality of life and prognostic implications for patients presenting with NSTEMI. National and international guidelines recommend coronary angiography should be performed within 72 hours of diagnosis. This duration is reduced to 24 hours for those deemed to be at high risk of major cardiac events.[5]

For this indicator, the QCOR committee recommended that the treatment timeframe for analysis should remain 72 hours in order to capture all-comers with the working diagnosis of NSTEMI.

A major barrier to early angiography is the time taken to transfer patients from non PCI capable facilities to the accepting PCI centre. Multiple reasons for delays include prolonged time to tertiary facility referral, capacity constraints at the ambulance and hospital level as well as patient transfer logistics in a large geographic area. In addition, several patient factors such as anaemia, renal impairment, language barriers and other delays to a patient's readiness for care can introduce further barriers to accessing timely angiography. It is hoped this may be able to be examined in detail in subsequent QCOR Audits.

In 2021, COVID-19 caused significant lengthening of the patient journey from admission to angiography. Low risk NSTEACS patients who were tested positive to COVID-19, or were close contacts and subject to isolation measures, had their angiogram procedure delayed in accordance with CSANZ guidelines.

Table 42 lists the cases excluded from analysis and the reasons for exclusion. These often relate to the clinical status of the patient at the time of their myocardial infarct or the course of events leading to their admission to a Queensland public interventional facility.

Table 42: NSTEMI time to angiography – cases excluded from analysis

	n
Planned or staged PCI	142
Admitted with an unrelated principal diagnosis	126
Coronary angiography not performed at index procedure	31
Stable non admitted patients transferred directly to lab for planned angiography	31
Transferred from an interstate hospital	30
Transferred from a private hospital	28
Incomplete data	17
Total ineligible	**405**

Patients presenting directly to a PCI capable facility had a median wait to coronary angiography time of 31 hours and were more likely to have angiography performed within the target timeframe of 72 hours compared with interhospital transfers (80% vs. 59%).

For direct presenters, the wide range of 23 hours to 46 hours before angiography is influenced by several factors including patient demographics, clinical case mix and competing caseloads. The centres with ‹75% meeting target had the widest interquartile ranges, providing opportunity to review local factors that may be modifiable to promote time efficiencies.

Across the state, in comparison with 2020, there was for direct presenters (Table 43) a comparable number of analysable NSTEMI cases (1,313 vs. 1,343) and a similar proportion meeting target (80% vs. 80%). While for interhospital transfers (Table 44), there was a slight increase in analysable cases (1,373 vs. 1,343) and a reassuring increase in the proportion meeting the target (59% vs. 57%).

Table 43: Time to angiography – direct to PCI facility

Site	Total cases n	Total analysed n	Median hours	Interquartile range hours	Met 72 hour target %
CH	188	157	30	16–50	85.4
TUH	160	145	34	19–62	84.1
MBH	112	102	29	19–56	90.2
SCUH	154	137	29	18–50	85.4
TPCH	308	282	24	12–47	84.0
RBWH	90	77	23	17–45	88.3
PAH	211	171	37	19–80	72.5
GCUH	268	242	46	24–91	66.5
STATEWIDE	**1,491**	**1,313**	**31**	**17–62**	**80.4**

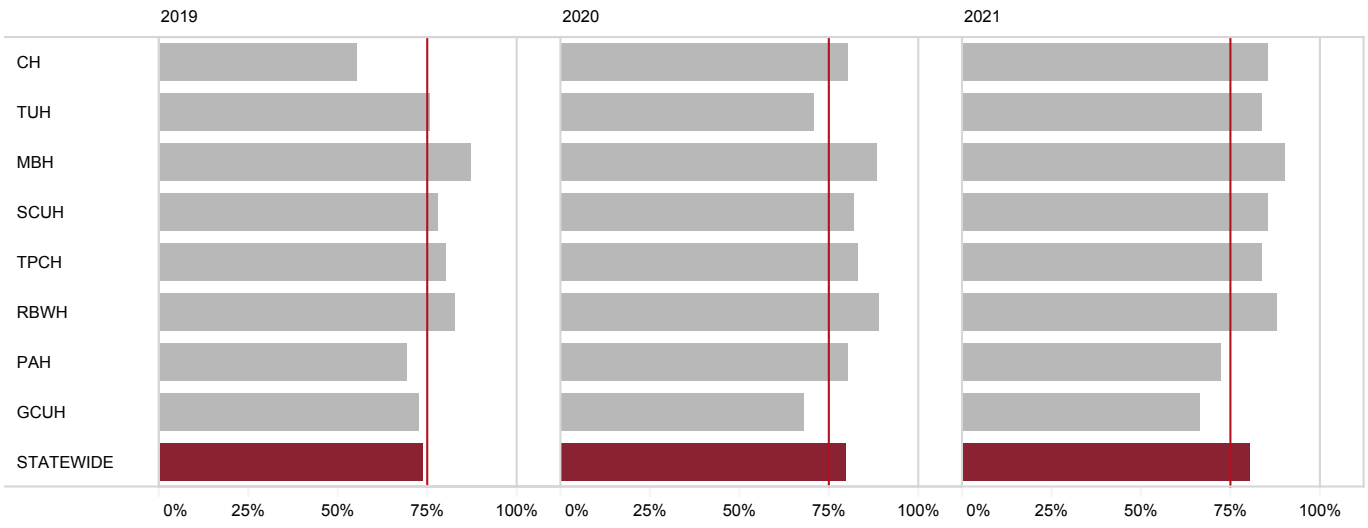


Figure 34: Proportion of NSTEMI direct presenters receiving angiography within 72 hours, 2019–2021

These data highlight the ongoing potential for overall system improvement and need to review statewide and local strategies to deal with two distinct cohorts – direct presenters and interhospital transfers. Encouragingly, the median time to angiography in this group continues to demonstrate improvement over previous years, decreasing from 65 hours in 2020 and 76 hours in 2019.

Table 44: Time to angiography – interhospital transfers

Site	Total cases n	Total analysed n	Median hours	Interquartile range hours	Met 72 hour target %
CH	115	102	41	25–60	83.3
TUH	73	61	55	32–81	70.5
MBH	51	41	29	21–59	80.5
SCUH	152	130	42	23–68	77.7
TPCH	284	228	67	41–118	53.1
RBWH	252	218	64	39–93	57.8
PAH	568	517	78	48–111	46.4
GCUH	105	76	50	27–81	71.1
STATEWIDE	**1,600**	**1,373**	**63**	**38–96**	**58.5**

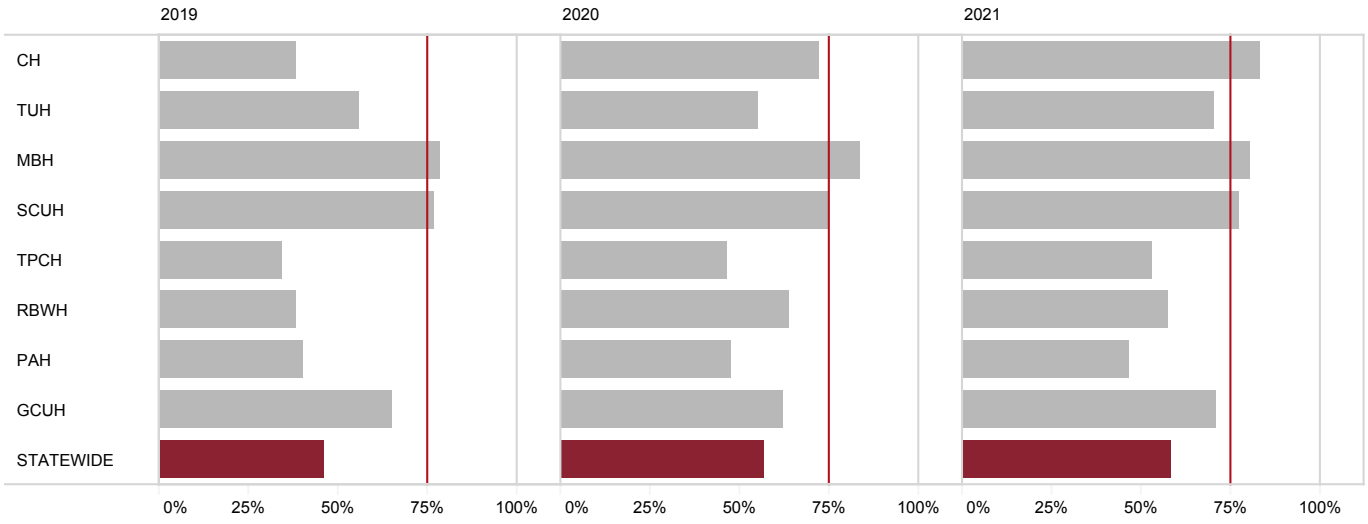


Figure 35: Proportion of NSTEMI interhospital transfers receiving angiography within 72 hours, 2019–2021

7.3.1 NSTEMI interhospital transfers – time to transfer to PCI facility

The median time to transfer NSTEMI patients to the PCI-capable facility for angiography was 32 hours, ranging from 8 hours to 51 hours by institution. This includes time spent at referring hospital prior to notification of PCI capable facility.

The trend towards increased time to transfer NSTEMI patients within the Metropolitan areas is likely attributable to referring facilities having a higher capacity to hold and monitor NSTEMI patients prior to being transferred.

Once transferred to the PCI facility the median time from arrival to angiography being performed was 31 hours. This analysis excludes interhospital transfers originating interstate, with a larger effect on GCUH given the facility's proximity to the New South Wales border.

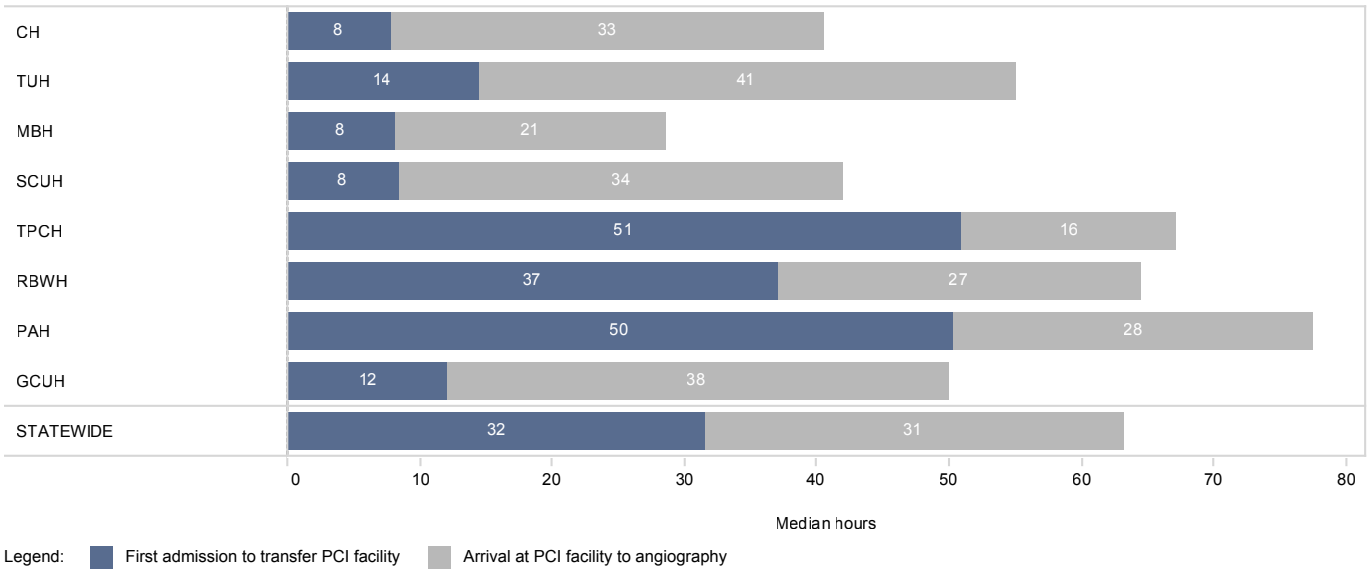
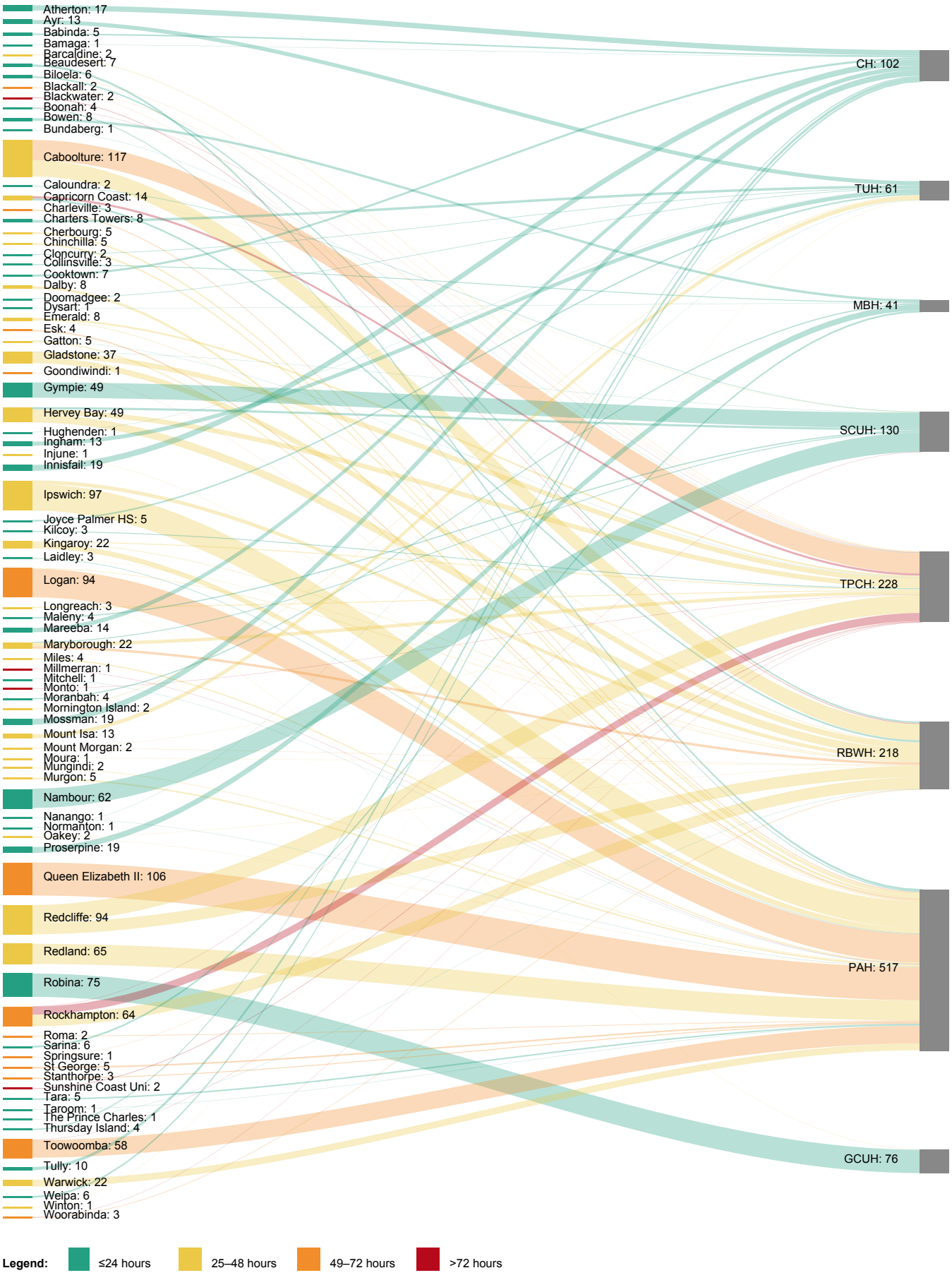


Figure 36: Median duration to transfer to PCI facility for angiography, NSTEMI interhospital transfers

Table 45: Median times to transfer to PCI facility for angiography, NSTEMI interhospital transfers

Site	Total cases n	Total analysed n	Median (IQR) distance transferred kilometres	Median time to transfer to PCI facility hours	Median overall time to angiography hours
CH	115	102	90 (75–143)	8	41
TUH	73	61	302 (133–901)	14	55
MBH	51	41	125 (36–191)	8	29
SCUH	152	130	35 (30–93)	8	42
TPCH	284	228	39 (33–505)	51	67
RBWH	252	218	231 (45–567)	37	64
PAH	568	517	27 (24–122)	50	78
GCUH*	105	76	17 (17–17)	12	50
STATEWIDE	**1,600**	**1,373**	**45 (27–192)**	**32**	**63**

* Excludes interhospital transfers originating in New South Wales



* Excludes interhospital transfers originating in New South Wales

Figure 37: Median times to transfer to PCI facility for angiography by transferring facility

Of the 3,091 total NSTEMI cases, 52% were interhospital transfers and 47% received PCI. The median time to angiography with or without PCI was 47 hours. This represents a small improvement on 2020 outcomes where the median time to angiography was 48 hours.

Table 46: NSTEMI time to angiography by site

Site	Total NSTEMI cases n	Total analysed n	Interhospital transfers %	Median hours	Interquartile range hours	Met 72 hour target %
CH	303	259	38.0	33	18–56	84.6
TUH	233	206	31.3	40	21–66	80.1
MBH	163	143	31.3	29	19–57	87.4
SCUH	306	267	49.7	35	20–61	81.6
TPCH	592	510	48.0	42	18–82	70.2
RBWH	342	295	73.7	54	28–85	65.8
PAH	779	688	72.9	68	40–102	52.9
GCUH	373	318	28.2	48	25–90	67.6
STATEWIDE	**3,091**	**2,686**	**51.8**	**46**	**23–83**	**69.2**

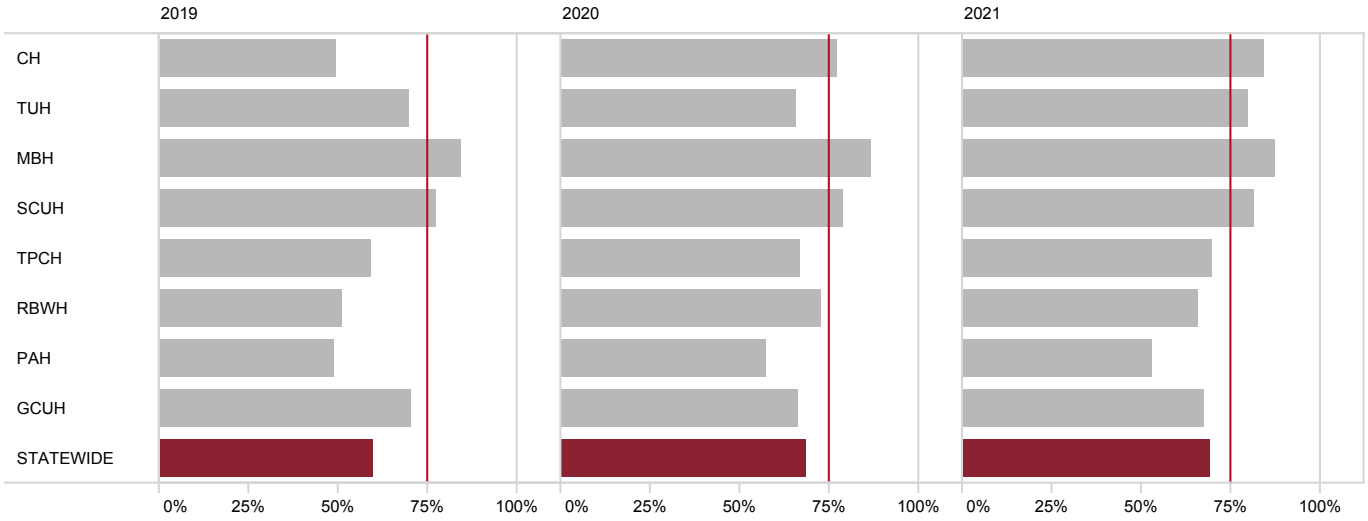


Figure 38: Proportion of NSTEMI cases meeting time to angiography target of 72 hours, 2019–2021

7.4 Major procedural complications

This quality indicator examines in-lab intra-procedural complications. In 2021, 41 cases (0.84%) recorded an immediate major procedural complication.

Events included in this analysis are coronary artery perforation, in-lab death, cerebrovascular accident (CVA), pericardial tamponade and emergency CABG. Processes are in place to ensure data integrity relating to these events. Limitations exist with using administrative datasets and intra-registry data linkage to examine complication rates, however these do assist with examining cases where complications occurred during the patient admission or encounter.

While the use of data linkage provides a means of verification and quality assurance, this indicator remains dependant on high-quality data being entered by clinicians in the first instance and as a result a degree of participation bias may exist. The numbers of reported events remain low, rendering further comment difficult other than to state that it is reassuring.

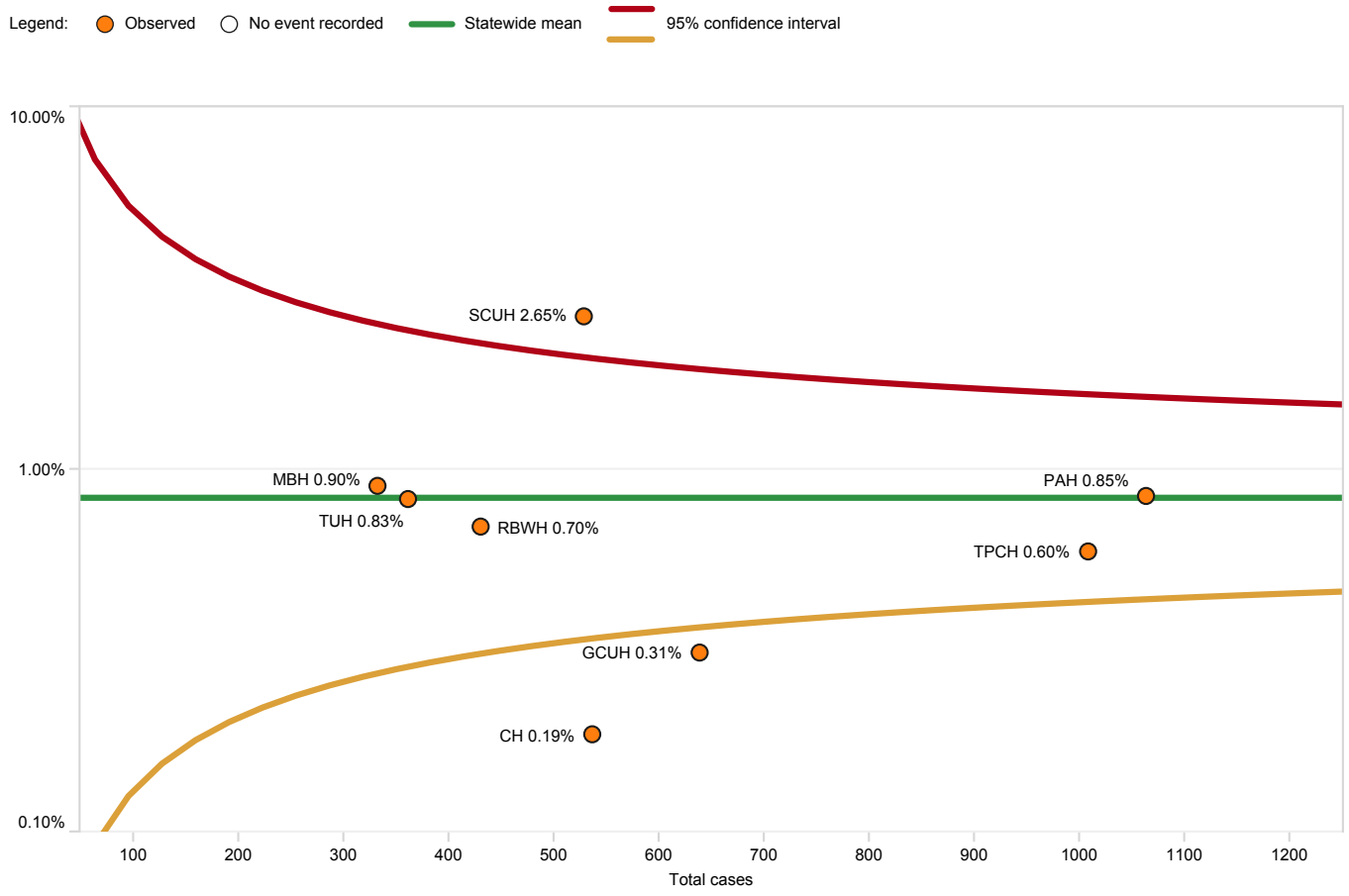


Figure 39: Proportion of PCI cases with immediate major procedure complication by site

Table 47: All PCI cases by immediate major procedural complication type

Complication type	Case n	%
Major intra-procedural complication	**41**	**0.84**
Coronary artery perforation	31	0.63
CVA	4	0.08
Tamponade	4	0.08
Emergency CABG	1	0.02
In-lab death*	1	0.02
No immediate major procedural complication	4,853	99.16
Total	**4,894**	**100.0**

* Excluding salvage deaths

7.5 High radiation doses

Staff and patients are exposed to ionising radiation during the majority of all procedures performed in the CCL. Ionising radiation is known to cause both delayed (stochastic) and immediate (deterministic) effects. The main stochastic effect is cancer, with the probability of experiencing the effect presumed to be proportional to the dose received (with no minimum threshold). For deterministic effects (such as erythema, epilation and desquamation), there is believed to be a threshold dose below which no effect is likely to occur but above which the severity of the effect is linked to the dose received.

Fortunately, conservative thresholds are applied and monitored throughout Queensland to maximise the benefit received by the patient while minimising the risk of experiencing any determinist effects. However, as the complexity of procedural work undertaken by interventional cardiologists increases, along with an increase in patients with a large body mass, it is increasingly important to remain vigilant about radiation hygiene. This indicator examines the proportion of cases exceeding the high dose threshold of 5 Gy that has been set to identify patients at risk of developing deterministic effects.

Patients exceeding this threshold are proactively managed by the individual units to ensure that any deterministic effects that may subsequently arise are identified and treated appropriately.

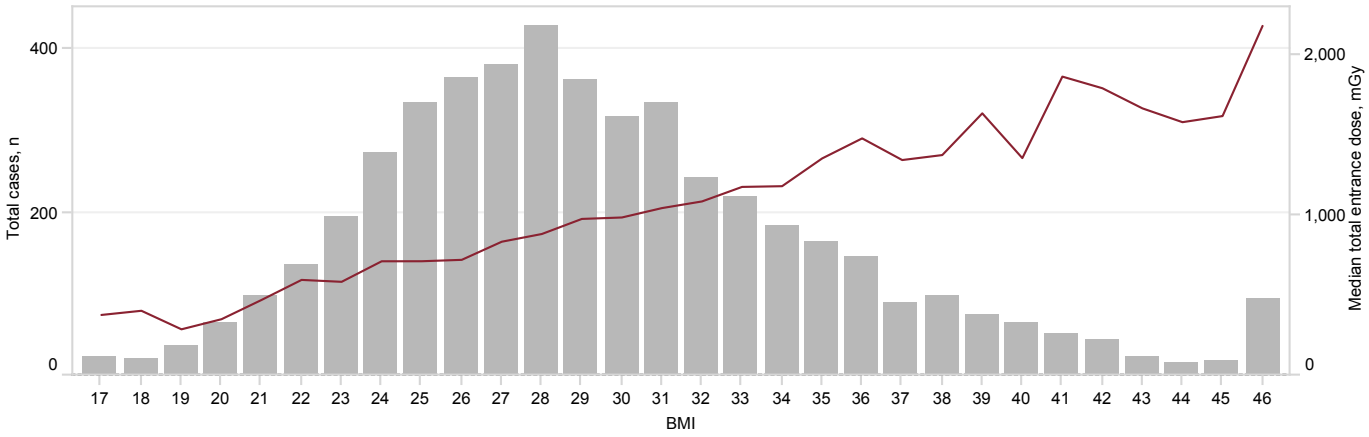


Figure 40: All coronary and PCI procedures median total entrance dose by body mass index

Table 48: Proportion of cases meeting the safe dose threshold by case type

Site	PCI procedures %	Other coronary procedures %
CH	99.6	99.9
TUH	99.4	99.8
MBH	100.0	99.9
SCUH	99.1	99.5
TPCH	99.4	100.0
RBWH	99.8	100.0
PAH	95.6	99.8
GCUH	100.0	99.9
STATEWIDE	**98.7**	**99.9**

8 Supplement: Structural heart disease

Queensland public hospitals provide care to patients with wide and varied structural heart diseases (SHD) including interventions such as cardiac defect closure and transcatheter valvuloplasty and replacement.

The ability to collect quality SHD intervention data and participate in national registries relating to this specialty area has been a longstanding focus for Queensland cardiac clinicians. Procedures such as transcatheter aortic valve replacement (TAVR), also referred to as transcatheter aortic valve implantation, offer an alternative to surgical interventions, often for patients with many comorbidities and complex chronic diseases. TAVR has emerged as a first-line treatment in preference to traditional open aortic valve surgery for growing population patients owing to a growing randomised controlled trial evidence base.

Queensland clinicians have collaborated with QCOR to develop and implement a bespoke application for SHD interventions, allowing data to be recorded across the patient journey – from the pre-procedural phase and up to one year post discharge and with data-fields that align with the mandatory Australian Cardiac Outcomes Registry for TAVR procedures. As of 2022, the QCOR SHD application has been deployed in five of the seven public hospitals offering SHD interventions. The new system has enabled enhanced data collection, as well as allowing clinicians to produce clinically relevant and encompassing documentation to form part of the patient medical record.

Future work is focused on expanding the scope of these analyses, and to continue to explore avenues to contextualise and report on the quality of outcomes for this group of patients.

Table 1: QCOR SHD application go live dates

Site	Application go live date
Cairns Hospital	17 December 2020
Townsville University Hospital	28 August 2021
Sunshine Coast University Hospital	In progress
The Prince Charles Hospital	In progress
Royal Brisbane & Women's Hospital	5 February 2021
Princess Alexandra Hospital	13 January 2021
Gold Coast University Hospital	8 March 2021

8.1 Participating sites

A total of 485 SHD interventions were performed across the seven Queensland public cardiac catheterisation laboratories. Two thirds (67%) of cases were valvular interventions including percutaneous valve replacement and valvuloplasty procedures.

Table 2: Total SHD cases by participating site

Site	Total cases n	Device closure* n (%)	Valvular intervention† n (%)	Other‡ n (%)
CH	22	18 (81.8)	4 (18.2)	–
TUH	28	13 (46.4)	15 (53.6)	–
SCUH	22	20 (90.9)	2 (9.1)	–
TPCH	237	26 (11.0)	200 (84.4)	11 (4.6)
RBWH	22	19 (86.4)	3 (13.6)	–
PAH	102	31 (30.4)	70 (68.6)	1 (1.0)
GCUH	52	20 (38.5)	32 (61.5)	–
STATEWIDE	**485**	**147 (30.3)**	**326 (67.2)**	**12 (2.5)**

* Includes percutaneous closure of ASD, PFO, PDA, LAA and paravalvular leak

† Percutaneous valve replacement and valvuloplasty

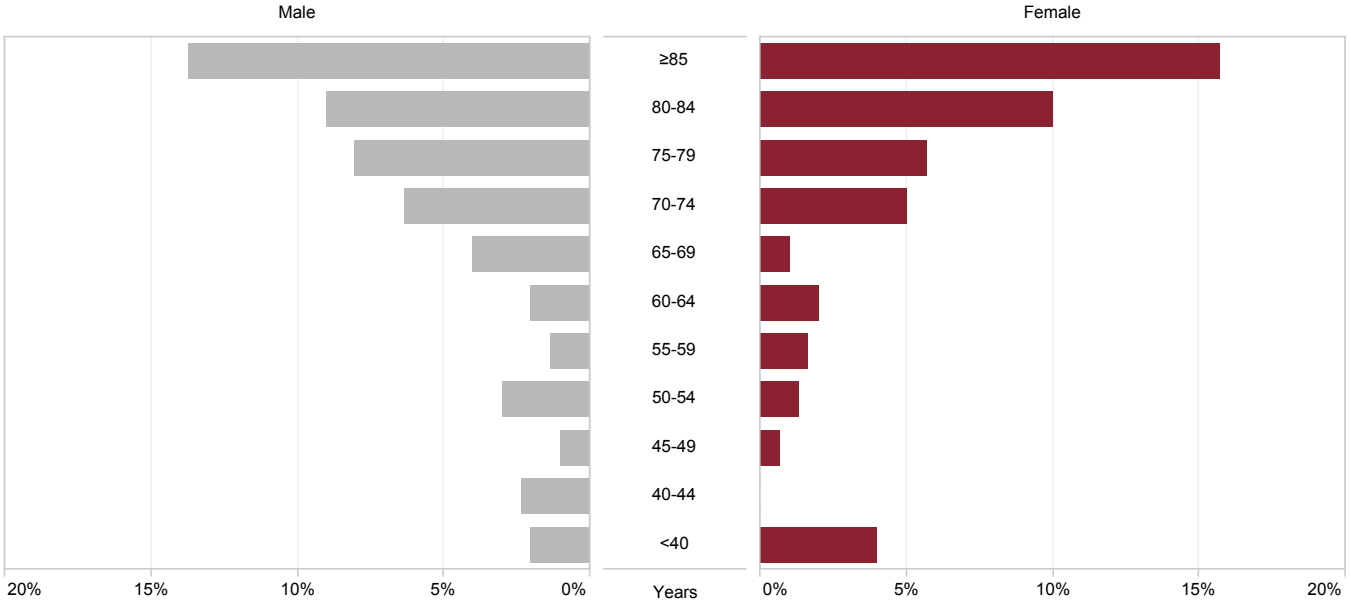
‡ Myocardial septal ablation, renal denervation and percutaneous insertion of pulmonary arterial pressure monitoring device

8.2 Patient characteristics

8.2.1 Age and gender

Gender of patients undergoing an SHD intervention were closely distributed with 53% male and 47% female. Almost one third (30%) of all procedures were performed on patients aged 85 years and older.

Age varied considerably by procedure category, with patients undergoing a valvular intervention having an overall median age of 82 years compared to 50 years for device closure procedures.



% of total (n=485 patients)

Figure 1: Proportion of all SHD cases by gender and age group

Table 3: Median age by gender and procedure category

	Male years	Female years	Total years
Device closures	50	50	50
Valvular intervention	82	83	82
Other	66	72	70
All	**76**	**78**	**77**

8.3 Care and treatment of SHD patients

8.3.1 Device closures

There were 147 device closures performed across the seven participating centres. The majority of procedures involved atrial septal closure devices for the correction of a patent foramen ovale (PFO) and atrial septal defect (ASD), at 71% and 20% of case volumes respectively. A smaller proportion of cases were for left atrial appendage closure and interventions to address prosthetic valve paravalvular leaks.

Table 4: Device closure procedures by participating site

Site	Total cases n	PFO* n (%)	ASD† n (%)	PDA‡ n (%)	LAA§ n (%)	Paravalvular leak n (%)	VSD‖ n (%)
CH	18	15 (83.3)	3 (16.7)	–	–	–	–
TUH	13	13 (100.0)	–	–	–	–	–
SCUH	20	18 (90.0)	2 (10.0)	–	–	–	–
TPCH	26	6 (23.1)	7 (26.9)	1 (3.8)	9 (34.6)	3 (11.5)	–
RBWH	19	16 (84.2)	3 (15.8)	–	–	–	–
PAH	31	21 (67.7)	9 (29.0)	–	–	–	1 (3.2)
GCUH	20	15 (75.0)	5 (25.0)	–	–	–	–
STATEWIDE	**147**	**104 (70.7)**	**29 (19.7)**	**1 (0.7)**	**9 (6.1)**	**3 (2.0)**	**1 (0.7)**

* Patent foramen ovale

† Atrial septal defect

‡ Patent ductus arteriosus

§ Left atrial appendage

‖ Ventricular septal defect

8.3.2 Valvular interventions

The total number of valvular interventions performed across the seven participating sites was 326, comprising of transcatheter valve replacement (77%) and transcatheter valvuloplasty (23%) procedures.

The aortic valve was the most common valve involving intervention, accounting for 88% of cases.

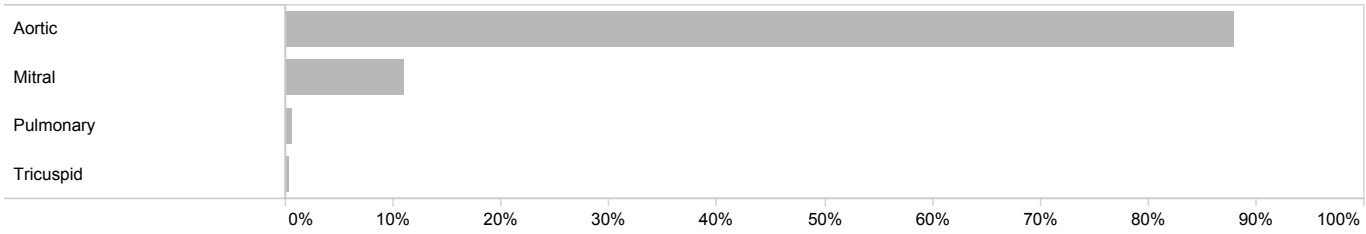


Figure 2: Proportion of all transcatheter valvular interventions by valve type

Table 5: Transcatheter valvular interventions by cardiac valve

Site	Total cases n	Aortic n (%)	Mitral n (%)	Pulmonary n (%)	Tricuspid n (%)
CH	4	4 (100.0)	–	–	–
TUH	15	13 (86.7)	2 (13.3)	–	–
SCUH	2	2 (100.0)	–	–	–
TPCH	200	166 (83.0)	31 (15.5)	2 (1.0)	1 (0.5)
RBWH	3	2 (66.7)	1 (33.3)	–	–
PAH	70	68 (97.1)	2 (2.9)	–	–
GCUH	32	32 (100.0)	–	–	–
STATEWIDE	**326**	**287 (88.0)**	**36 (11.0)**	**2 (0.6)**	**1 (0.3)**

Table 6: Transcatheter valvular interventions by type

Site	Total cases n	Transcatheter valve replacement n (%)	Transcatheter valvuloplasty n (%)
CH	4	–	4 (100.0)
TUH	15	13 (86.7)	2 (13.3)
SCUH	2	–	2 (100.0)
TPCH	200	147 (73.5)	53 (26.5)
RBWH	3	–	3 (100.0)
PAH	70	63 (90.0)	7 (10.0)
GCUH	32	28 (87.5)	4 (12.5)
STATEWIDE	**326**	**251 (77.0)**	**75 (23.0)**

The rapid evolution of transcatheter based technology has meant that transcatheter valve replacement procedures have become an increasing common approach for treating patients with conditions often otherwise reliant on cardiac surgery. There were four sites that offered transcatheter aortic valve replacement procedures where the vast majority were transcatheter aortic valve replacement (95%).

Table 7: Transcatheter valvuloplasty procedures

Site	Balloon aortic valvuloplasty n (%)	Balloon mitral valvuloplasty n (%)	Mitral leaflet clip n (%)	Balloon tricuspid valvuloplasty n (%)
CH	4 (100.0)	–	–	–
TUH	–	2 (100.0)	–	–
SCUH	2 (100.0)	–	–	–
TPCH	30 (56.6)	3 (5.7)	19 (35.8)	1 (1.9)
RBWH	2 (66.7)	1 (33.3)	–	–
PAH	6 (85.7)	1 (14.3)	–	–
GCUH	4 (100.0)	–	–	–
STATEWIDE	**48 (64.0)**	**7 (9.3)**	**19 (25.3)**	**1 (1.3)**

Table 8: Transcatheter valve replacement procedures

Site	TAVR* n (%)	TMVR† n (%)	TTVR‡ n (%)	TPVR§ n (%)
TUH	13 (100.0)	–	–	–
TPCH	136 (92.5)	9 (6.1)	1 (0.7)	1 (0.7)
PAH	62 (98.4)	1 (1.6)	–	–
GCUH	28 (100.0)	–	–	–
STATEWIDE	**239 (95.2)**	**10 (4.0)**	**1 (0.4)**	**1 (0.4)**

* Transcatheter aortic valve replacement/implantation

† Transcatheter mitral valve replacement

‡ Transcatheter tricuspid valve replacement

§ Transcatheter pulmonary valve replacement

Table 9: Other structural heart disease interventions

Site	Myocardial septal ablation n (%)	Percutaneous insertion of pulmonary arterial pressure monitoring device n (%)	Renal denervation n (%)
TPCH	–	4 (36.4)	7 (63.6)
PAH	1 (100.0)	–	–
STATEWIDE	**1 (8.3)**	**4 (33.3)**	**7 (58.3)**

8.4 Patient outcomes

8.4.1 All-cause 30 day mortality

Thirty day mortality rates typically reflect the success of the procedural or technical component of any intervention. Across the seven public cardiac catheterisation laboratories in Queensland that offer SHD interventions, the all-cause, unadjusted 30 day mortality rate for all SHD procedures was 1.2%. Further descriptions of longer term outcomes for TAVR cohorts from previous years are discussed further in the subsequent analysis.

Table 10: All-cause unadjusted 30 day mortality post SHD intervention by procedure category and site

Site	Total cases n	Device closure n (%)	Valvular intervention n (%)	Other n (%)	Total mortality n (%)
CH	24	0 (0.0)	2 (50.0)	–	2 (9.1)
TUH	28	0 (0.0)	0 (0.0)	–	0 (0.0)
SCUH	22	0 (0.0)	0 (0.0)	–	0 (0.0)
TPCH	237	0 (0.0)	2 (1.0)	0 (0.0)	2 (0.8)
RBWH	22	0 (0.0)	0 (0.0)	–	0 (0.0)
PAH	102	1 (3.2)	0 (0.0)	0 (0.0)	1 (1.0)
GCUH	52	0 (0.0)	1 (3.1)	–	1 (1.9)
STATEWIDE	**487**	**1 (0.7)**	**5 (1.5)**	**0 (0.0)**	**6 (1.2)**

8.4.2 Transcatheter aortic valve replacement cases

Patients who undergo TAVR are typically of relatively advanced age and usually present with multiple comorbidities and risk factors that result in a transcatheter therapy being a more suitable procedure than a traditional open surgical aortic valve replacement (SAVR). Patient selection is based on a large volume of published randomised control trial data. Multiple data-sets have indicated overall comparable short and longer-term outcomes with TAVR and SAVR but with shorter length of stay and a trend to a lower risk of major complications, greater patient satisfaction and lower mortality.[15,16,17,18] Longer term data is so far showing an apparent equivalent valve durability between TAVR and SAVR bio-prostheses although longer term and larger data-sets are required.[17] The age of patients undergoing TAVR is also falling and this is in-line with and supported by large randomised trial data in addition to international guidelines reflecting this data.[19] There is also an apparent growing role for TAVR as treatment for degenerated previously implanted SAVR bio-prostheses as lower risk management strategy.[20]

2021 cases

Of the four sites performing TAVR in 2021, the all-cause unadjusted mortality rate within 30 days of the procedure for the statewide cohort was 0.8%.

Table 11: All-cause unadjusted 30 day mortality post TAVR by site

Site	Total cases n	30 day mortality n (%)
TUH	13	0 (0.0)
TPCH	136	1 (0.7)
PAH	62	0 (0.0)
GCUH	28	1 (3.6)
STATEWIDE	**239**	**2 (0.8)**

2020 and 2019 cases

Of the four sites performing TAVR in 2020, the overall all-cause unadjusted mortality rate within 30 days of the procedure was 1.2%, and 9.2% at one year. For the TAVR procedures performed in 2019, the overall all-cause unadjusted mortality rate at two years post procedure was 18.9%. This is in-line with similarly age and risk matched international cohorts from high-volume TAVR centres.[21,22,23] It is recognised that all-cause mortality, especially beyond 30 days, include patient factors not necessarily related to the procedure or intervention in this older and often comorbid patient group.

Table 12: All-cause unadjusted 30 day and 1 year mortality post TAVR by site (2020 cohort)

Site	Total cases n	Median age at procedure years	Interquartile range years	30 day mortality n (%)	1 year mortality n (%)
TUH	21	84	82–86	0 (0.0)	4 (19.0)
TPCH	150	81	76–86	2 (1.3)	16 (10.7)
PAH	55	81	76–84	1 (1.8)	2 (3.6)
GCUH	23	81	78–83	0 (0.0)	1 (4.3)
STATEWIDE	**249**	**81**	**76–85**	**3 (1.2)**	**23 (9.2)**

Table 13: All cause unadjusted mortality up to 2 years post TAVR by site (2019 cohort)

Site	Total cases n	Median age at procedure years	Interquartile range years	30 day mortality n (%)	1 year mortality n (%)	2 year mortality n (%)
TUH	13	83	76–87	0 (0.0)	5 (38.5)	6 (46.2)
TPCH	156	83	78–87	5 (3.2)	22 (14.1)	33 (21.2)
PAH	54	82	78–84	0 (0.0)	3 (5.6)	6 (11.1)
GCUH	26	84	80–87	0 (0.0)	0 (0.0)	2 (7.7)
STATEWIDE	**249**	**83**	**78–86**	**5 (2.0)**	**30 (12.0)**	**47 (18.9)**

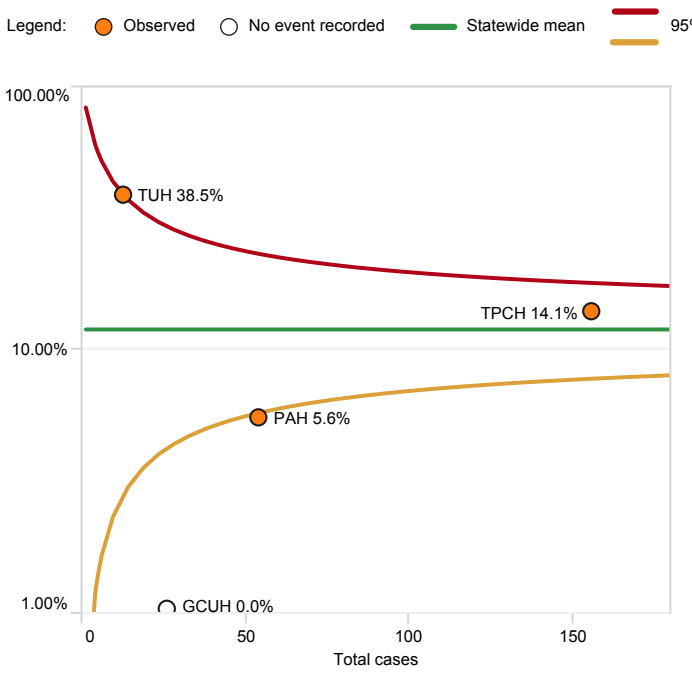


Figure 3: One year mortality post TAVR by site (2019 cohort)

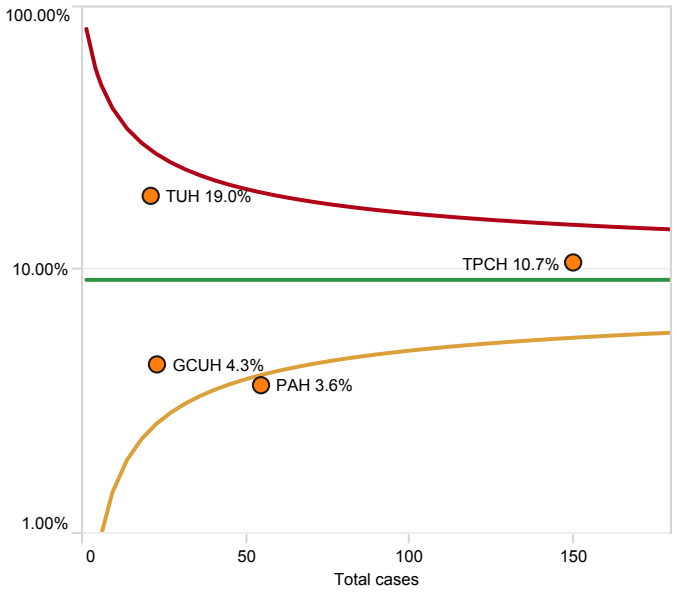


Figure 4: One year mortality post TAVR by site (2020 cohort)

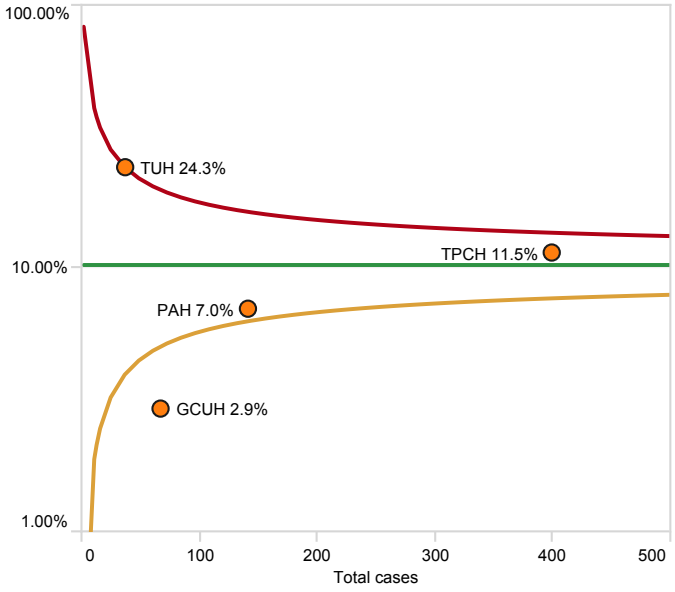
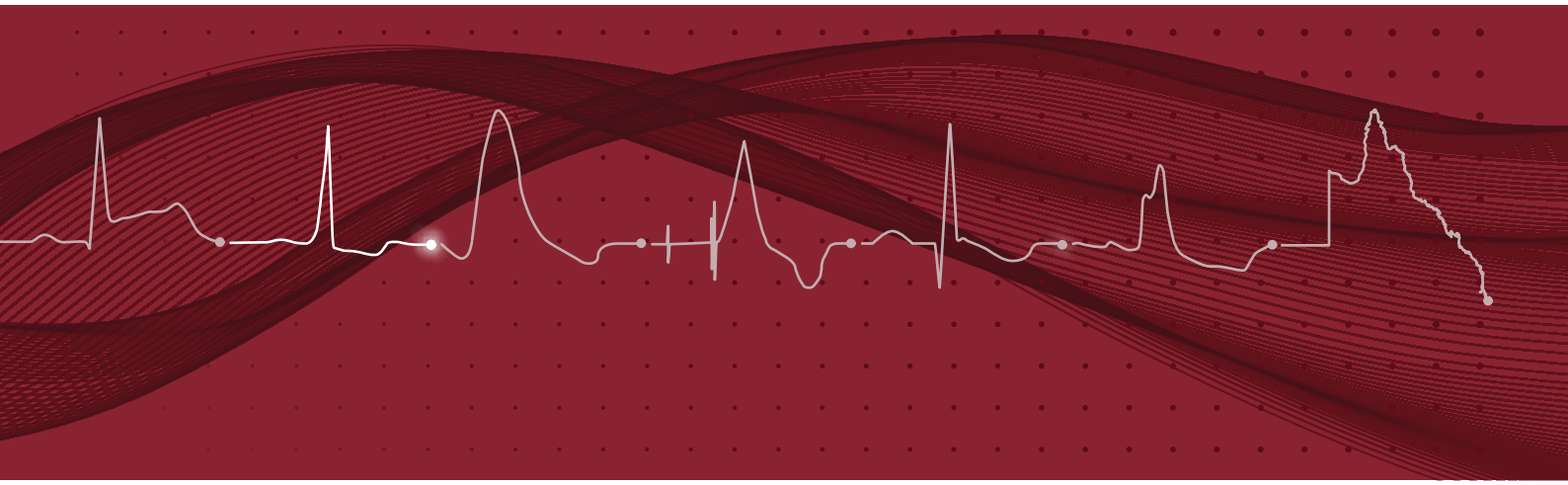


Figure 5: One year mortality post TAVR by site (2018–2020 cohort)

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.

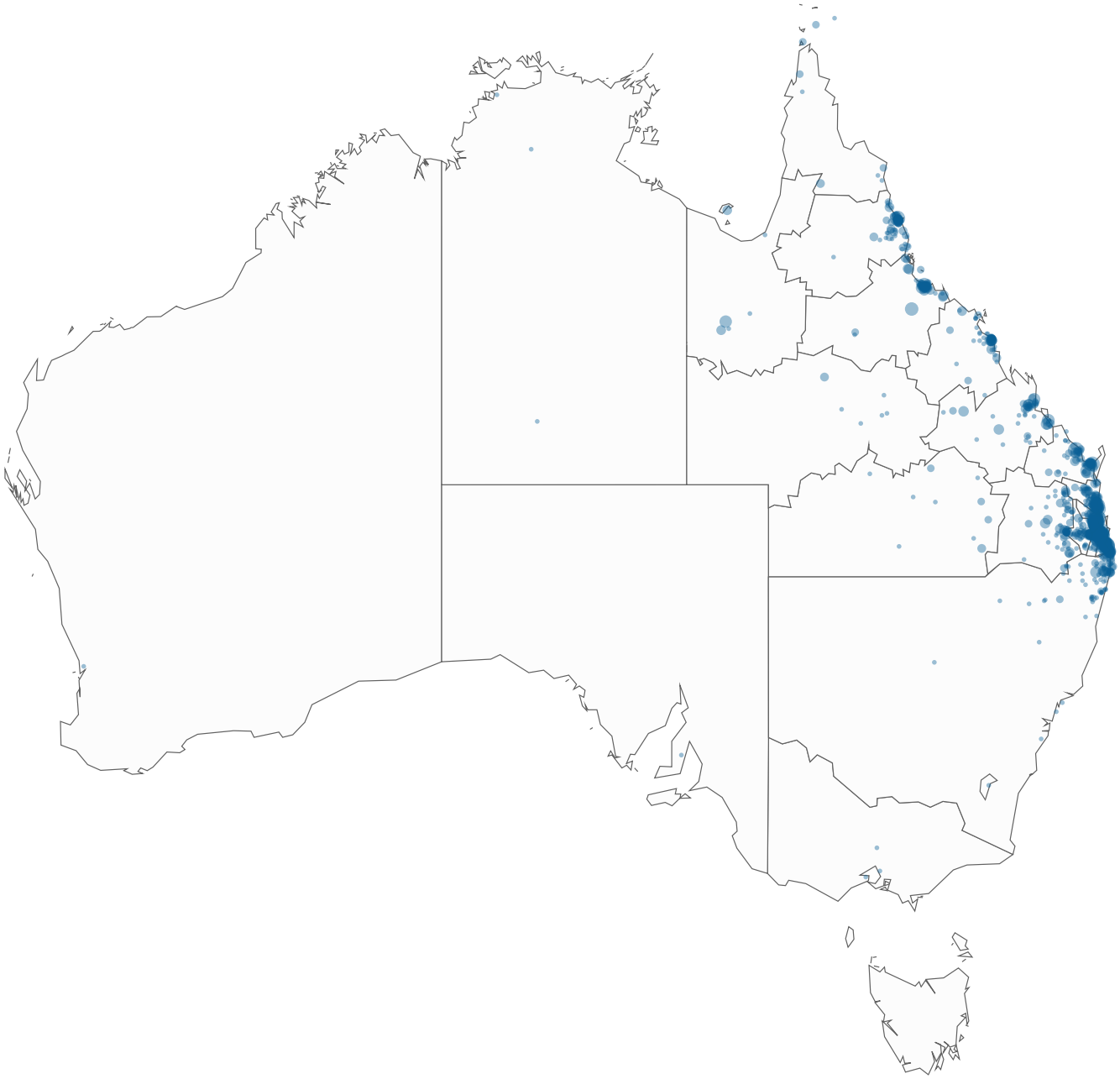


Figure 1: Cardiac surgery cases by residential postcode

Table 1: Participating sites

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

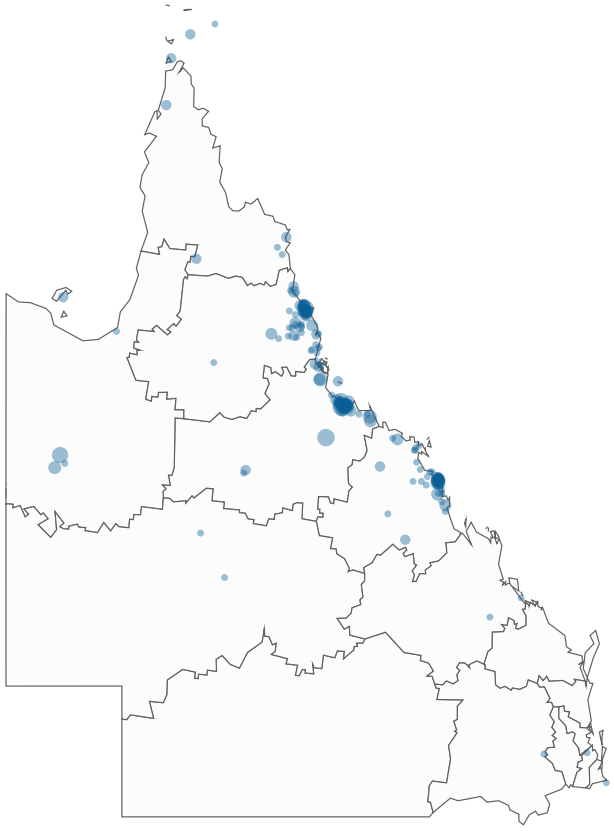


Figure 2: Townsville University Hospital

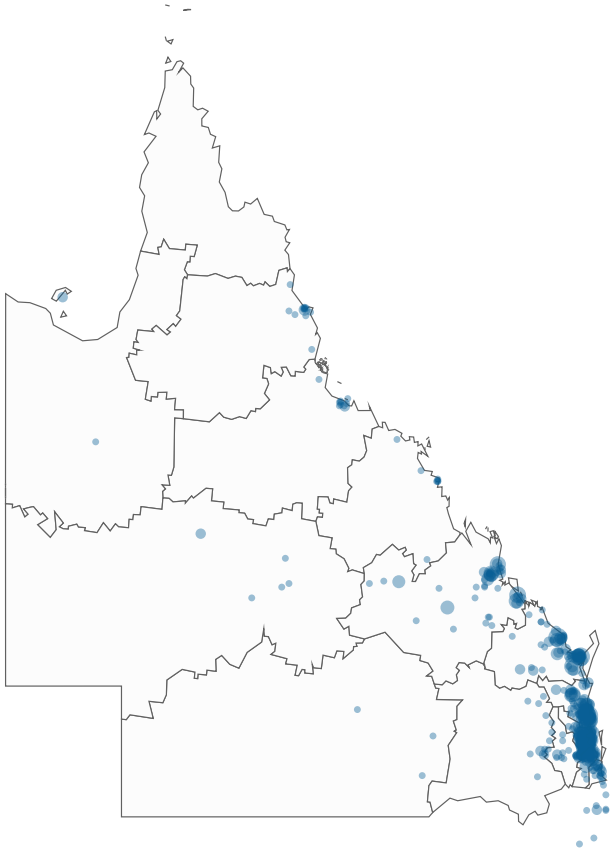


Figure 3: The Prince Charles Hospital

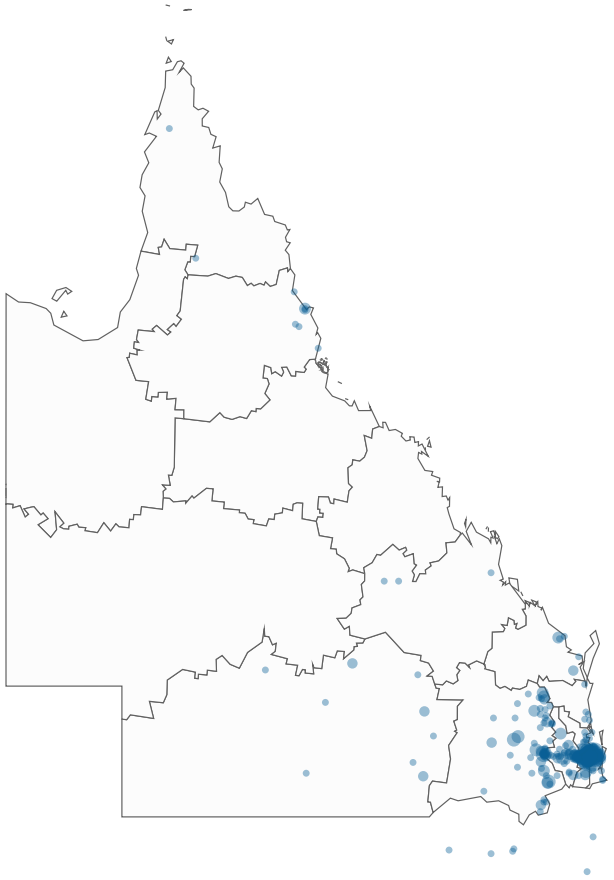


Figure 4: Princess Alexandra Hospital

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)

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.

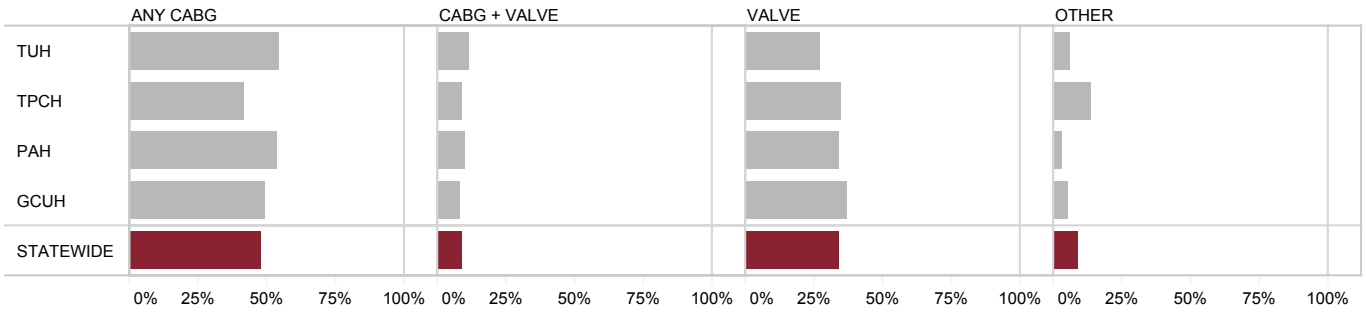


Figure 6: Proportion of cases by site and surgery category

Table 3: Proportion of cases by surgery category

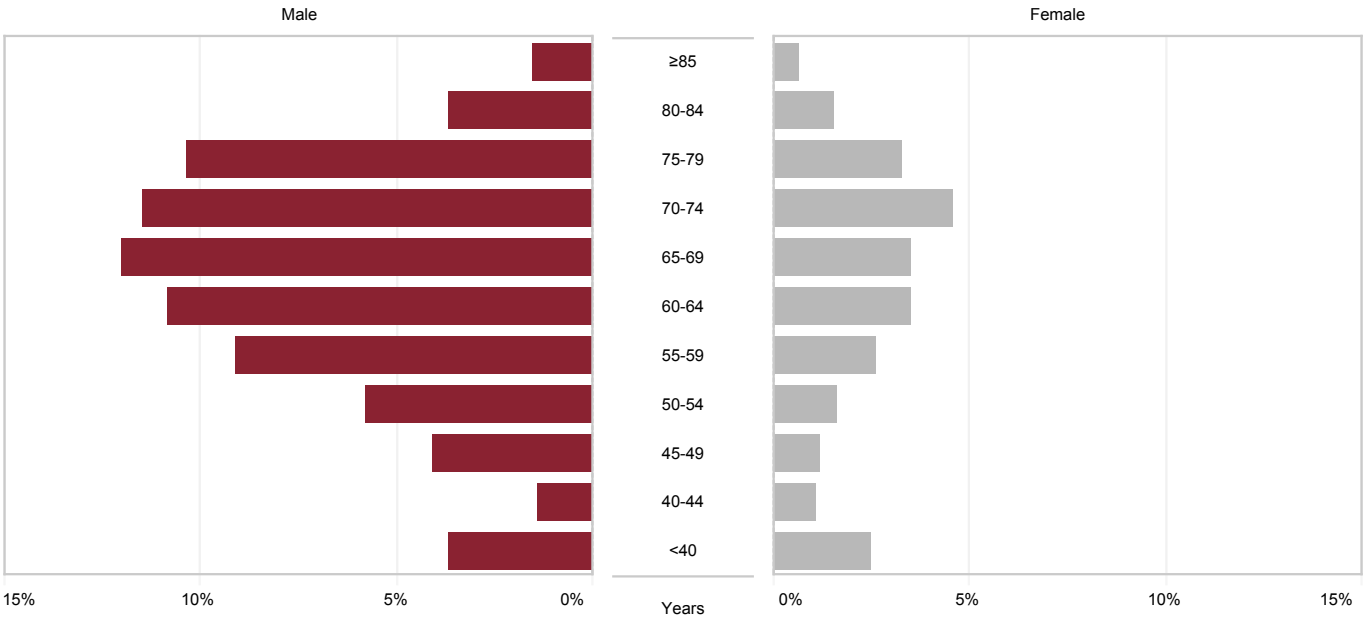
SITE	All cases n	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)
TUH	380	209 (55.0)	43 (11.3)	104 (27.4)	24 (6.3)
TPCH	1,175	493 (42.0)	107 (9.1)	410 (34.9)	165 (14.0)
PAH	617	331 (53.6)	59 (9.6)	209 (33.9)	18 (2.9)
GCUH	451	223 (49.4)	37 (8.2)	168 (37.3)	23 (5.1)
STATEWIDE	**2,623**	**1,256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

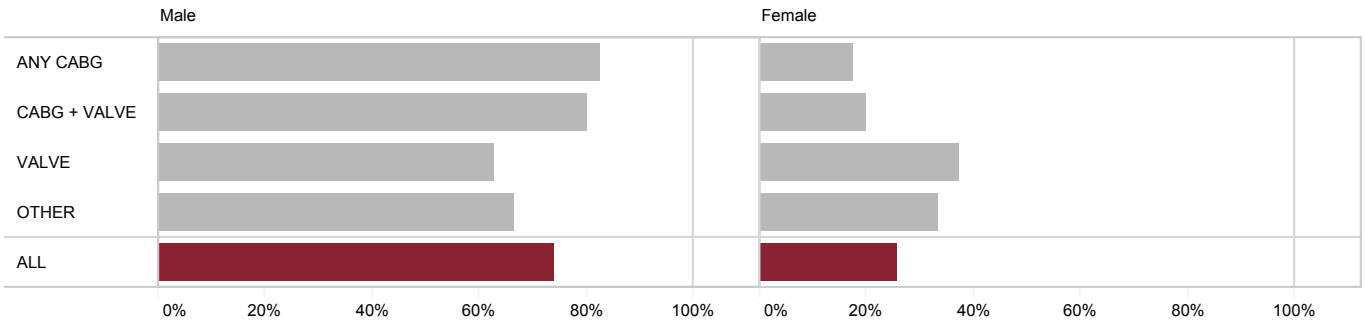


Figure 8: Proportion of cases by gender and surgery category

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/m²) represented 1% of all cases.

Excludes missing data (‹0.1%)

* BMI 18.5–24.9 kg/m²

† BMI 25.0–29.9 kg/m²

‡ BMI 30.0–39.9 kg/m²

§ BMI ≥40.0 kg/m²

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.

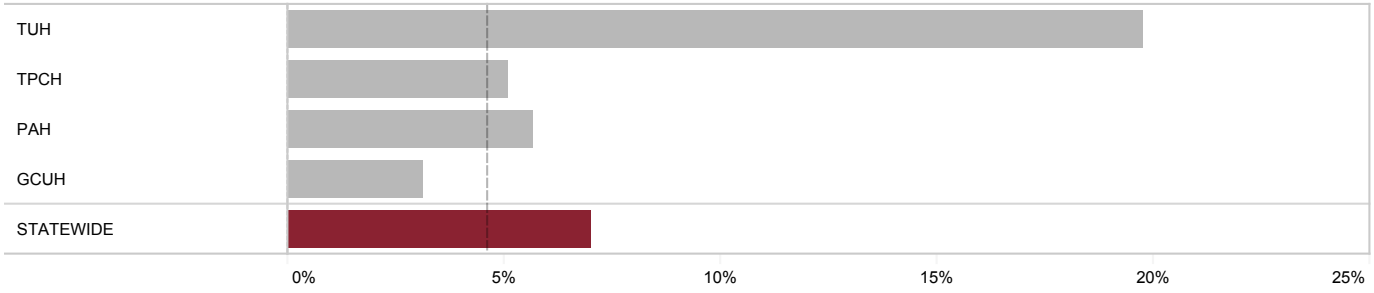


Figure 10: Proportion of all cardiac surgical cases by identified Aboriginal and Torres Strait Islander status and site

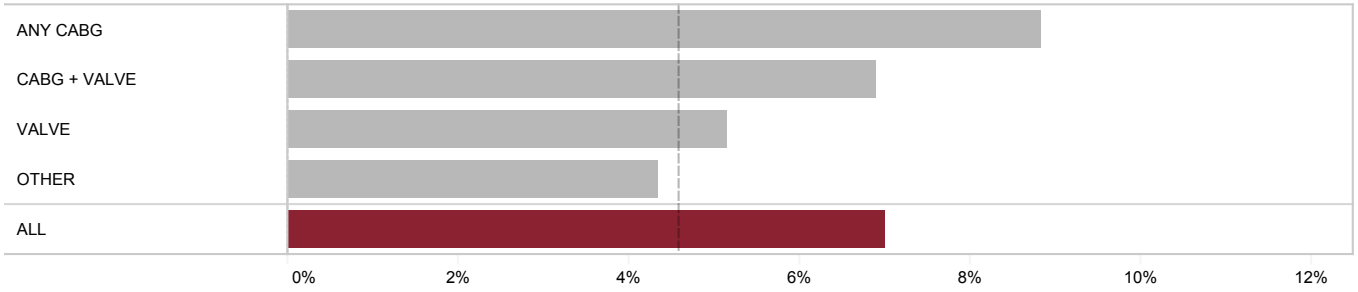
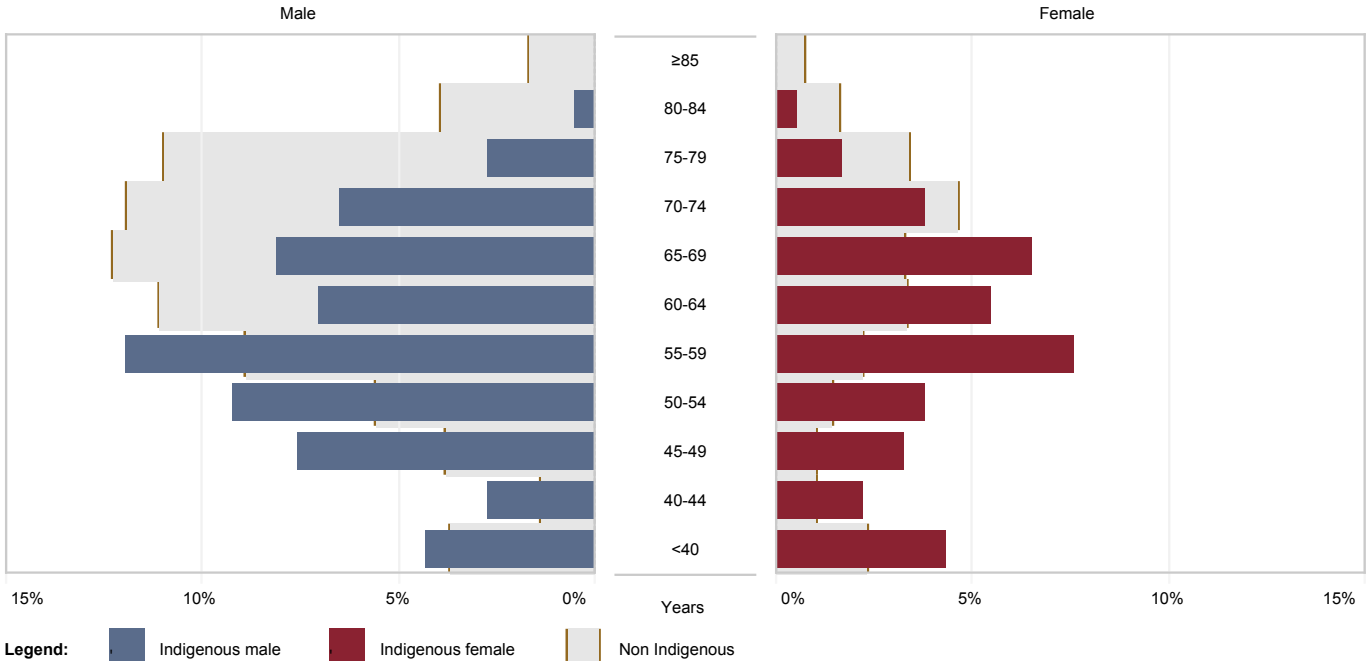


Figure 11: Proportion of cases by identified Aboriginal and Torres Strait Islander status and surgery category

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.

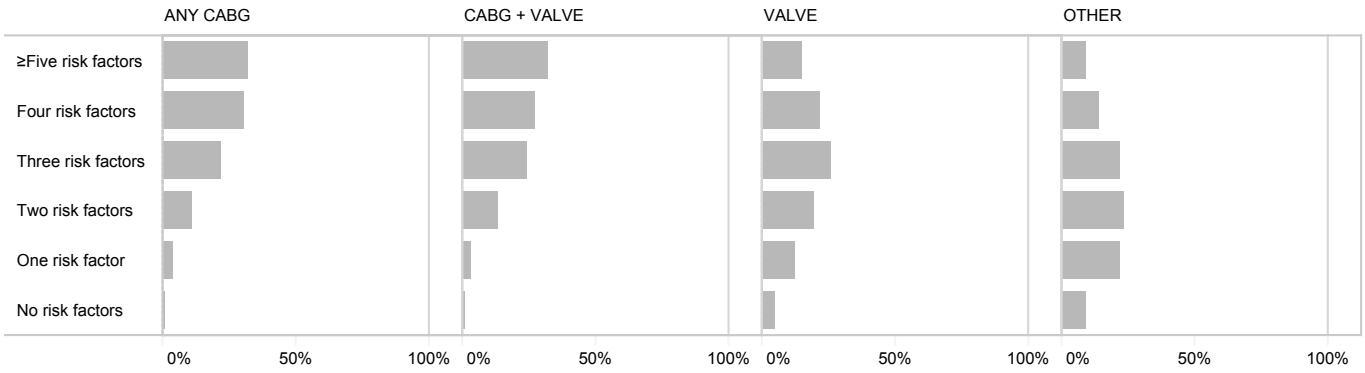


Figure 13: Number of patient risk factors by surgery category

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.

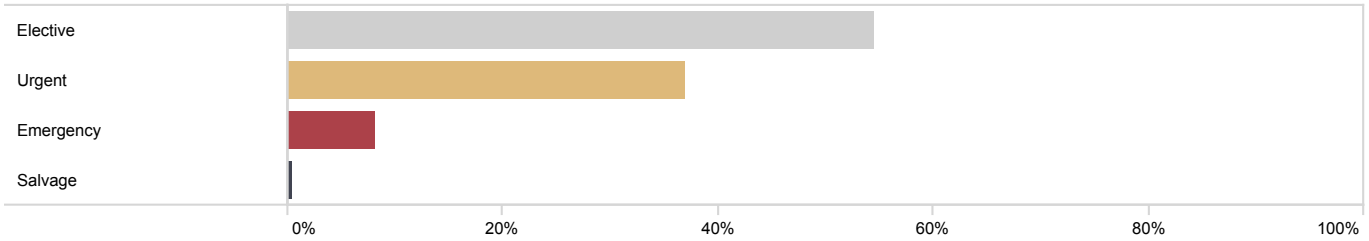


Figure 14: Proportion of cases by admission status

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.

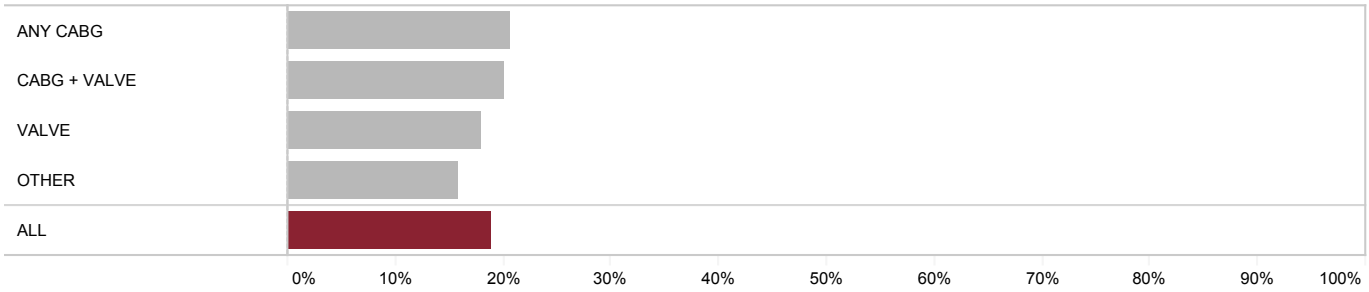


Figure 15: Proportion of elective cases for DOSA cases by surgery category

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.

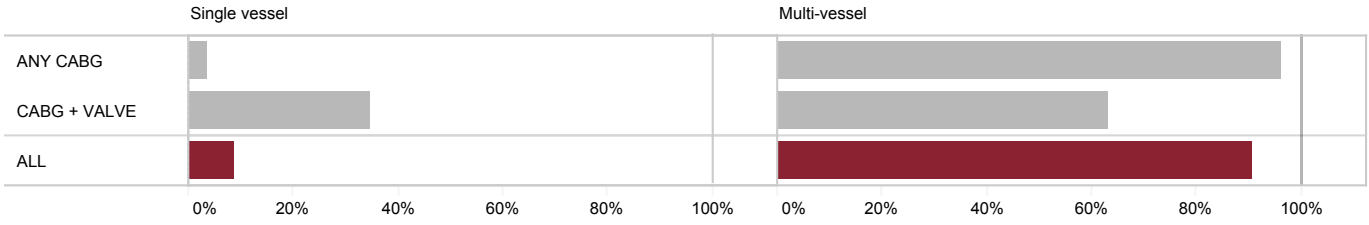


Figure 16: Number of diseased vessels by surgery category

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.

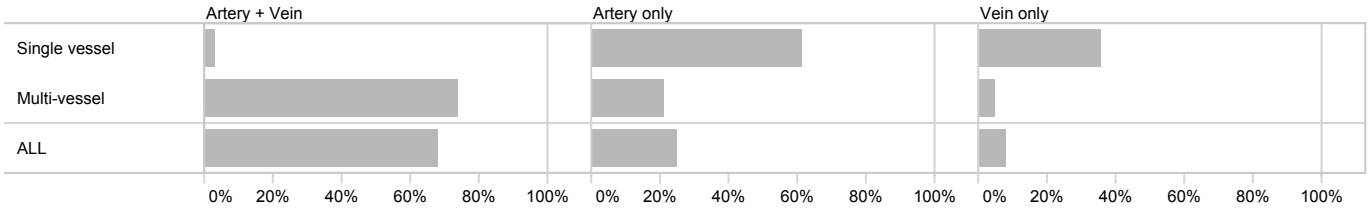


Figure 17: Proportion of diseased vessels by conduits used

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.

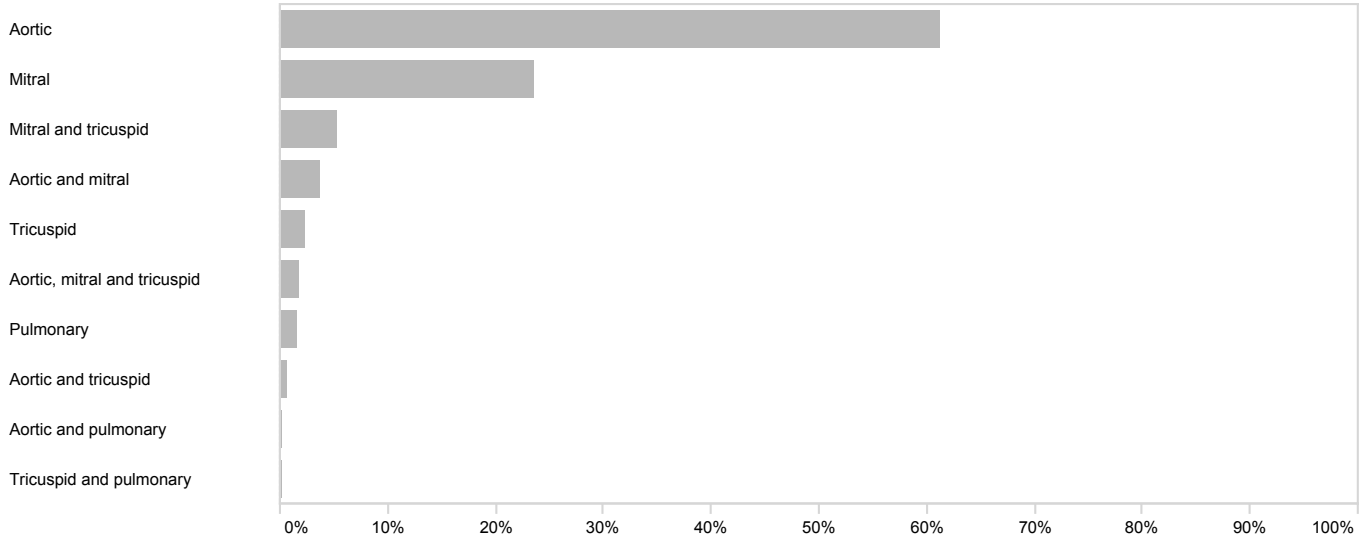


Figure 18: Proportion of valve surgery cases by valve

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.

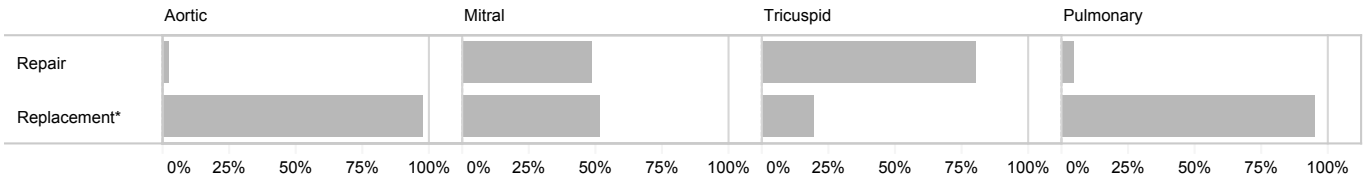
Table 23: Valve pathology by valve type

	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)**

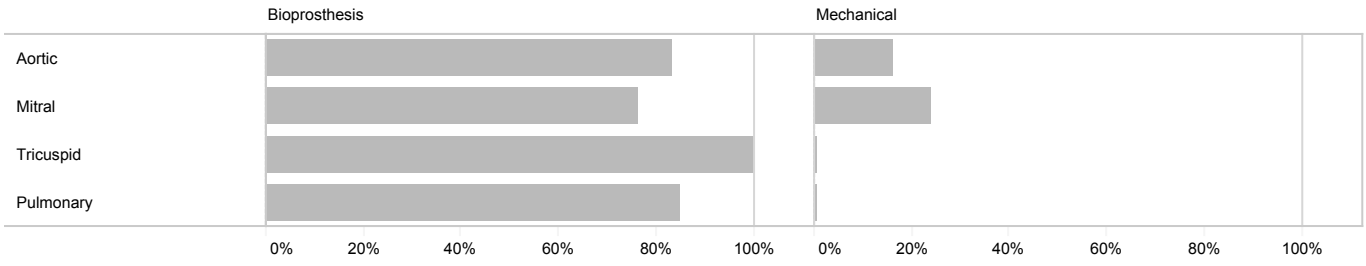
* Includes TAVR or TMVR procedures involving a cardiothoracic surgeon

† 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.

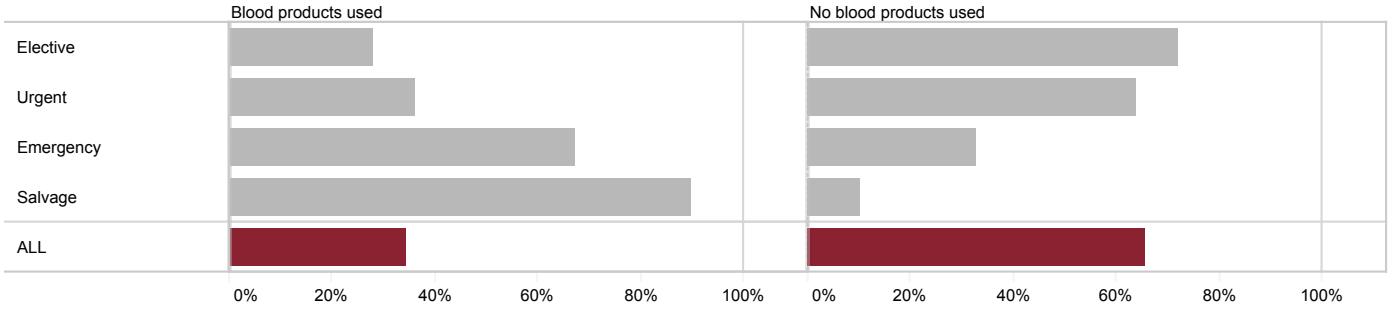


Figure 21: Blood products used by admission status

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

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.

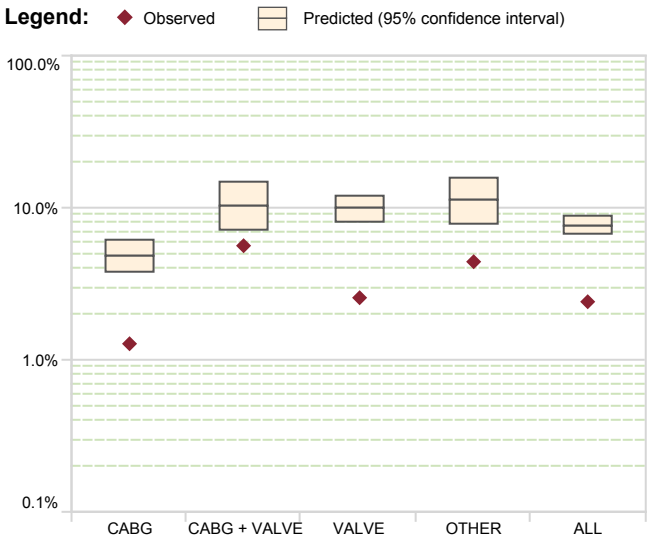


Figure 22: EuroSCORE

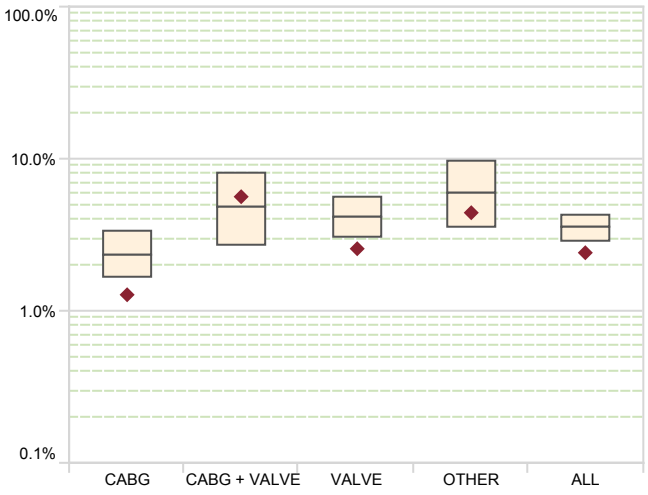


Figure 23: EuroSCORE II

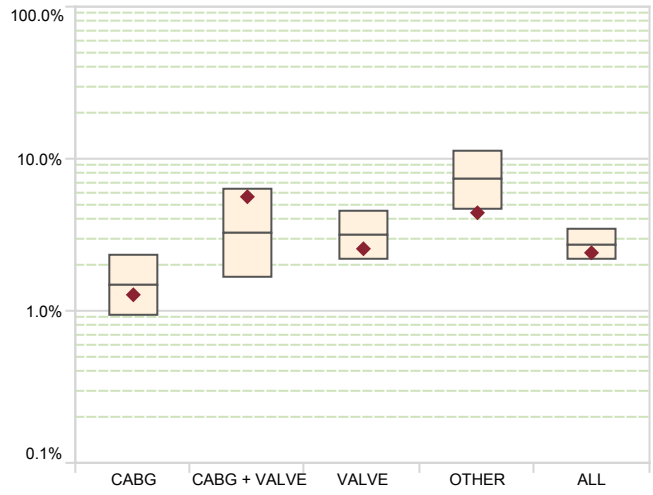


Figure 24: ANZSCTS (General Score)

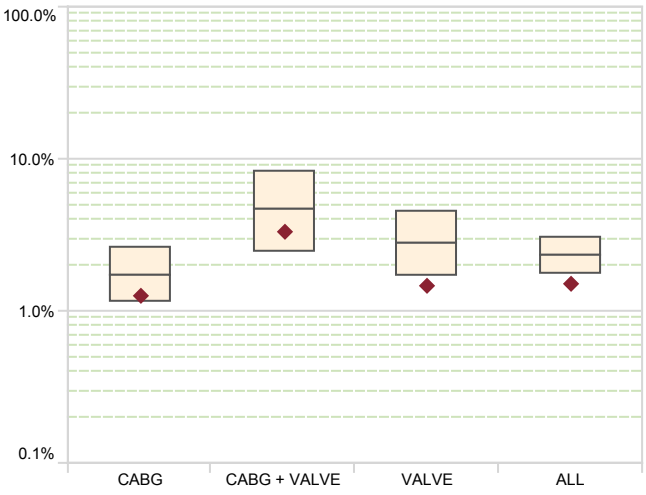


Figure 25: STS (death)

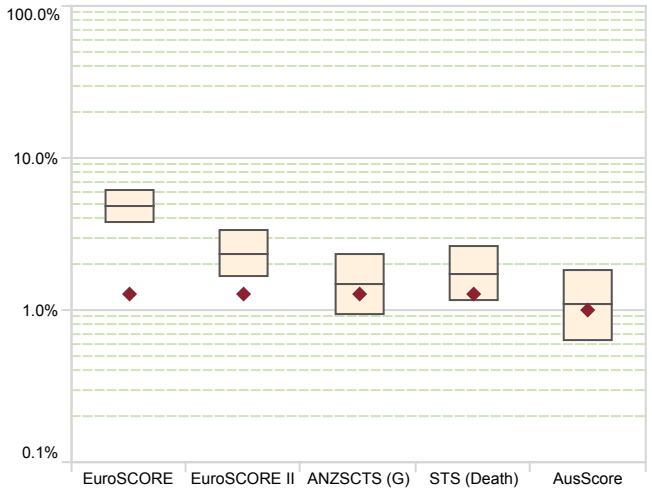


Figure 26: CABG

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.

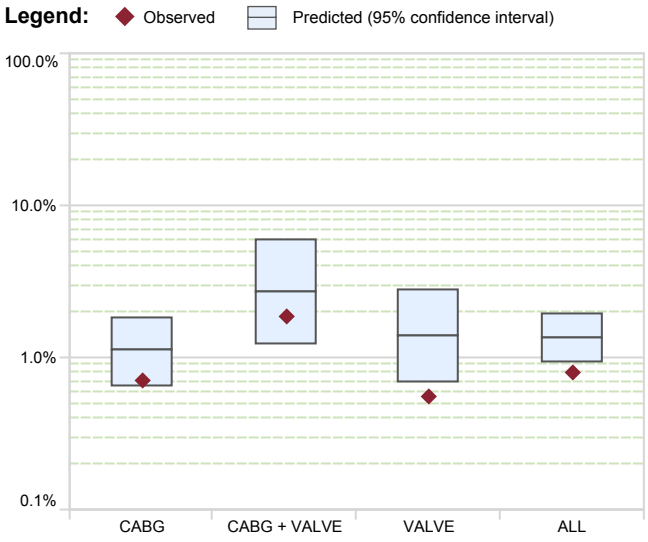


Figure 27: Cerebrovascular accident

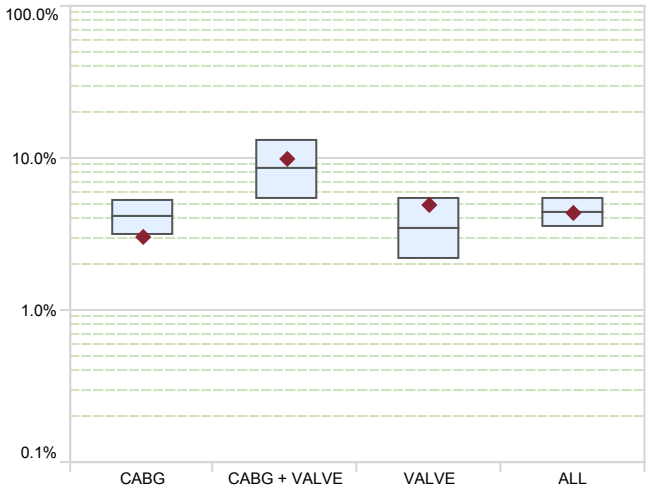


Figure 28: Renal failure

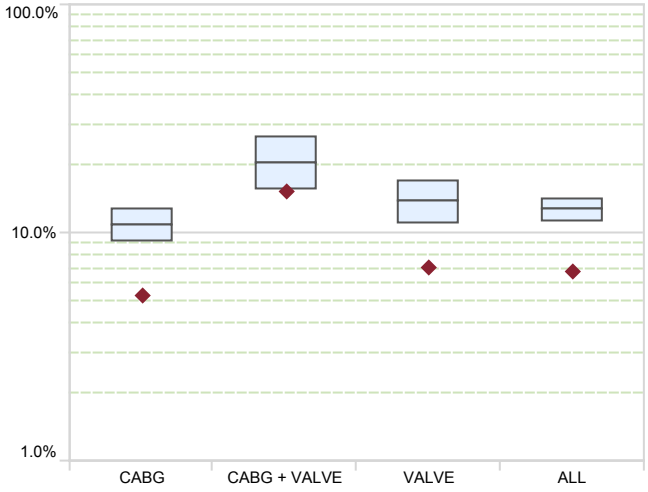


Figure 29: Ventilation >24 hours

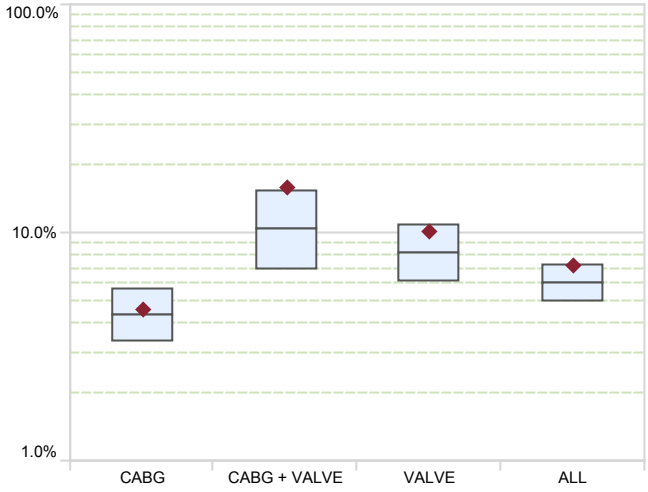


Figure 30: Reoperation

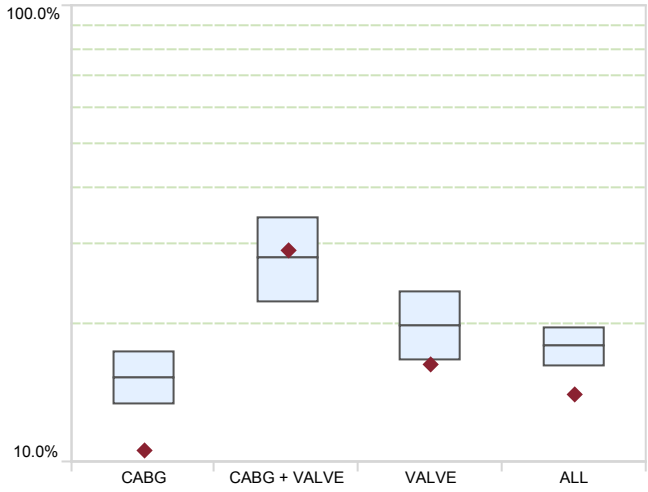


Figure 31: Major morbidity

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.

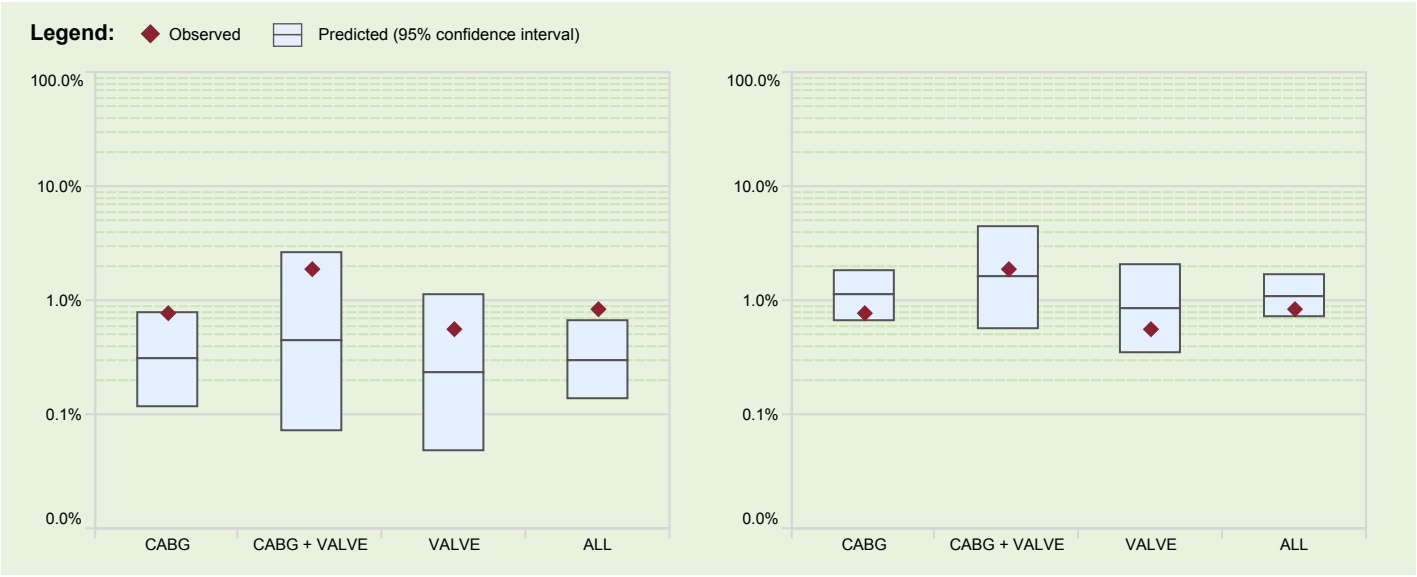


Figure 32: Comparison of 2021 deep sternal wound infection, original vs. recalibrated model

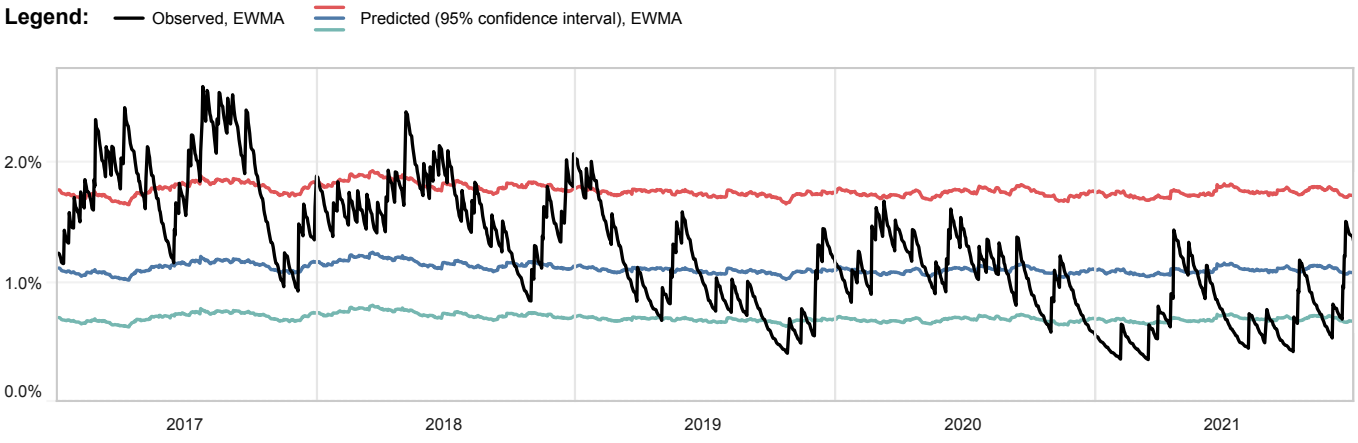


Figure 33: Deep sternal infection, 2017–2021

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.

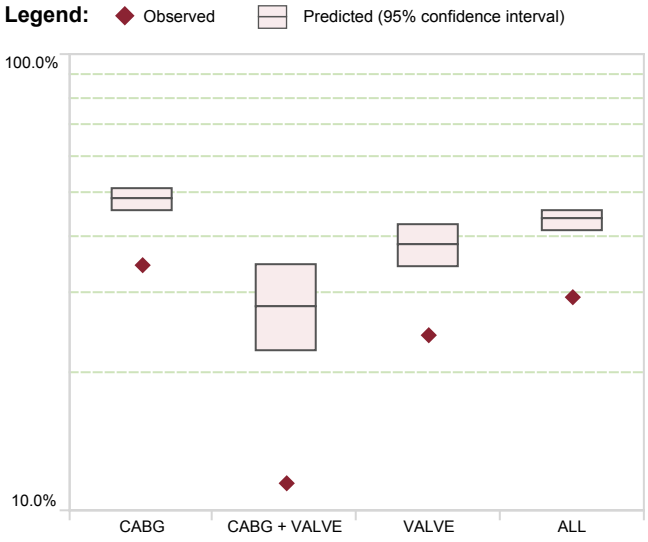


Figure 34: LOS ‹6 days

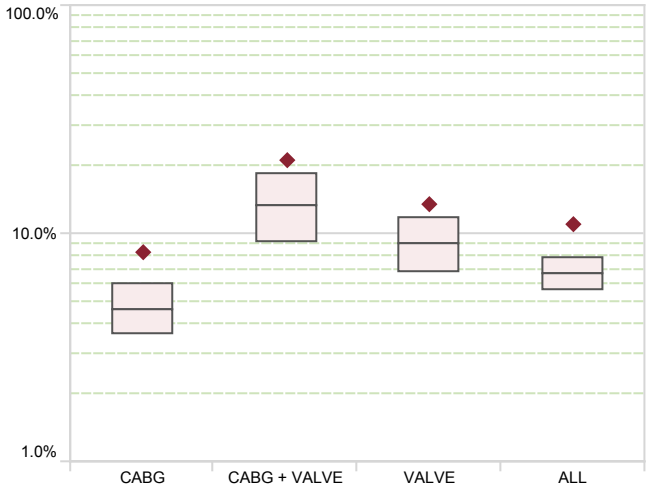


Figure 35: LOS ›14 days

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.

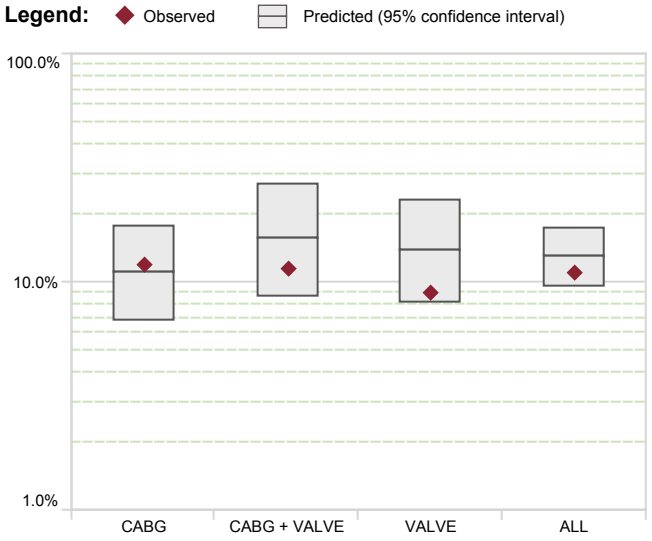


Figure 36: Failure to rescue

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.

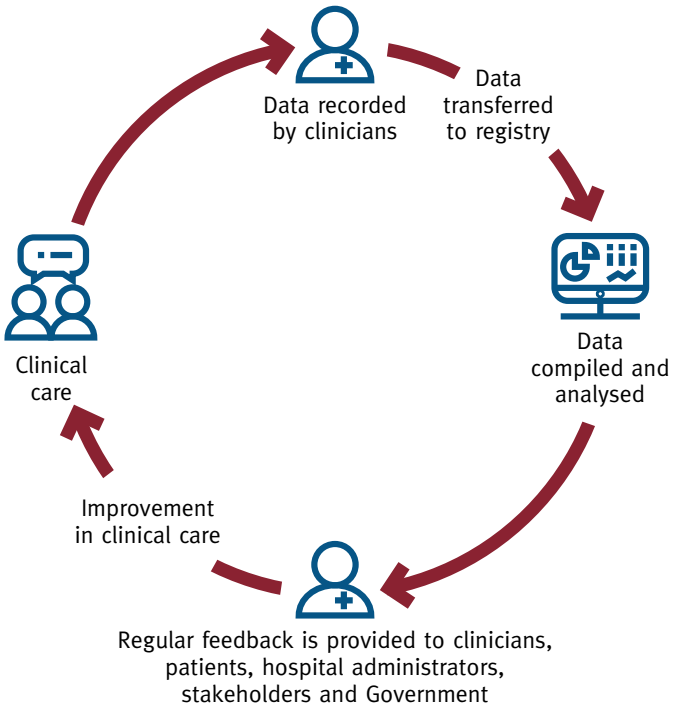


Figure 37: Clinical Quality Registry feedback loop

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.

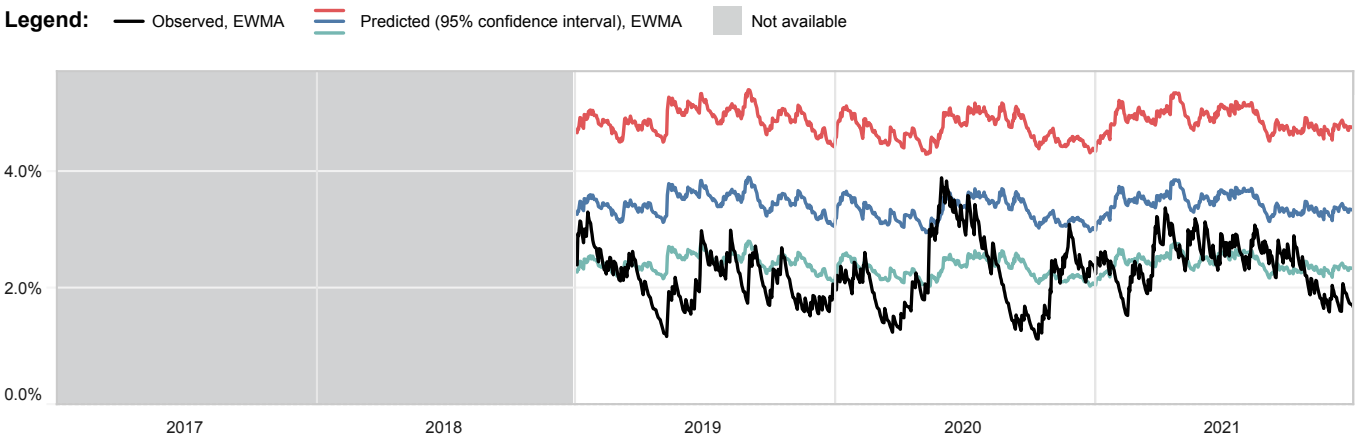


Figure 38: EuroSCORE II, 2017–2021

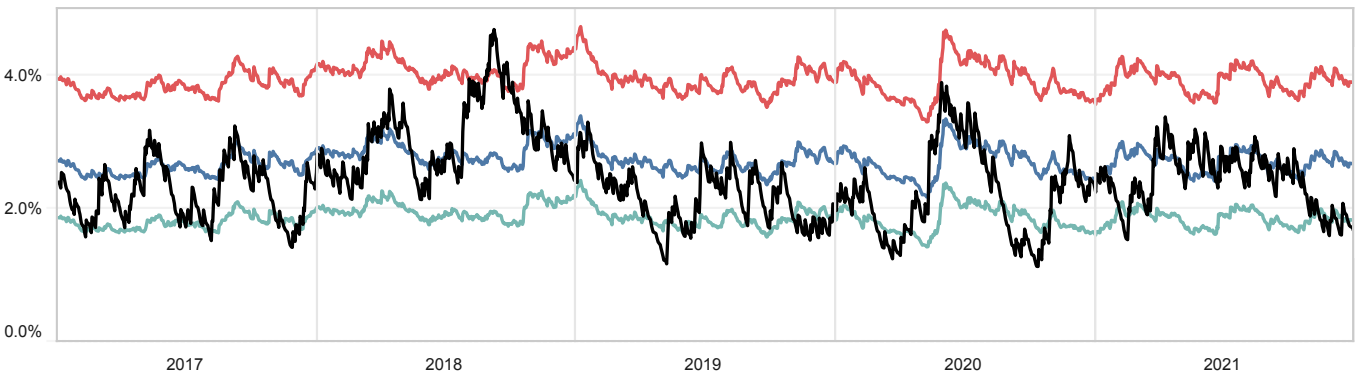


Figure 39: ANZSCTS General Score, 2017–2021

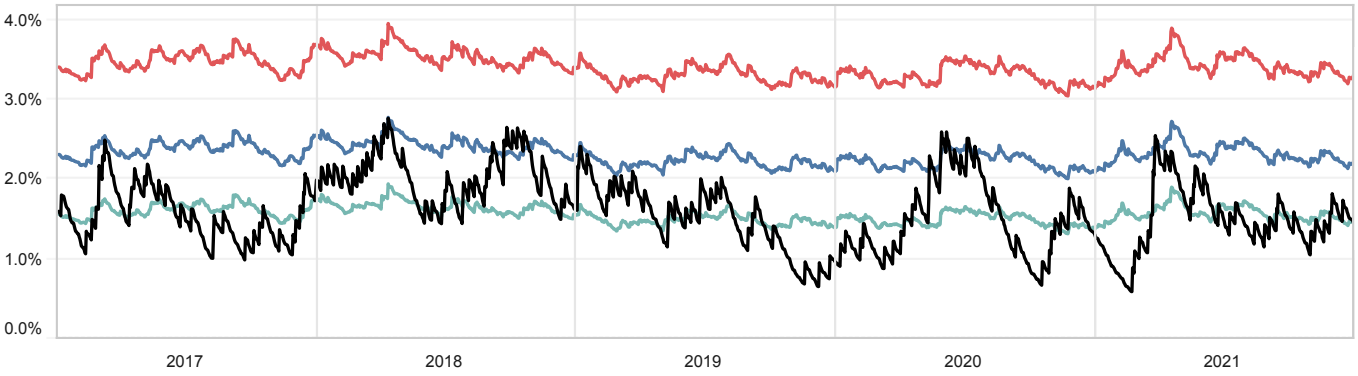


Figure 40: STS mortality, 2017–2021

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.

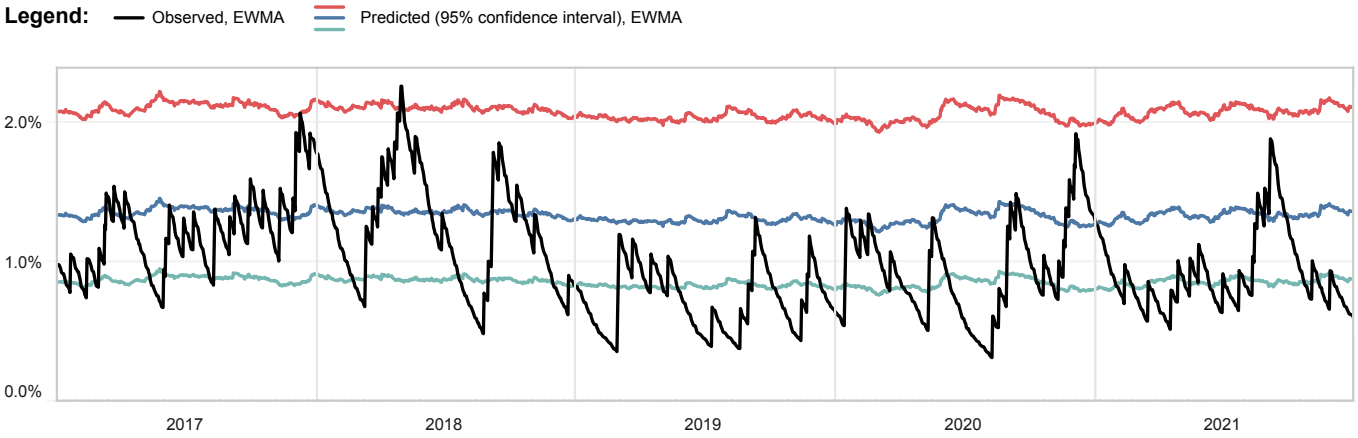


Figure 41: Cerebrovascular accident, 2017–2021

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.

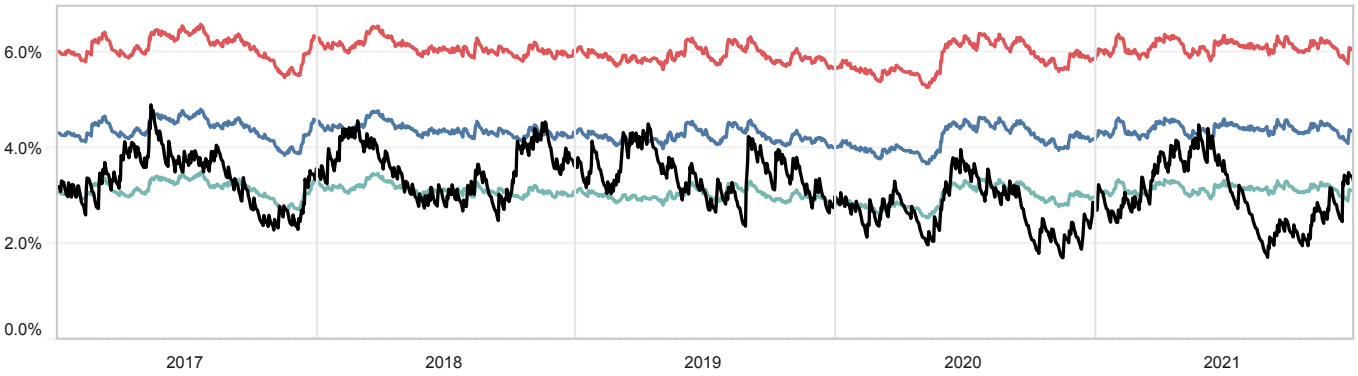


Figure 42: Renal failure, 2017–2021

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.

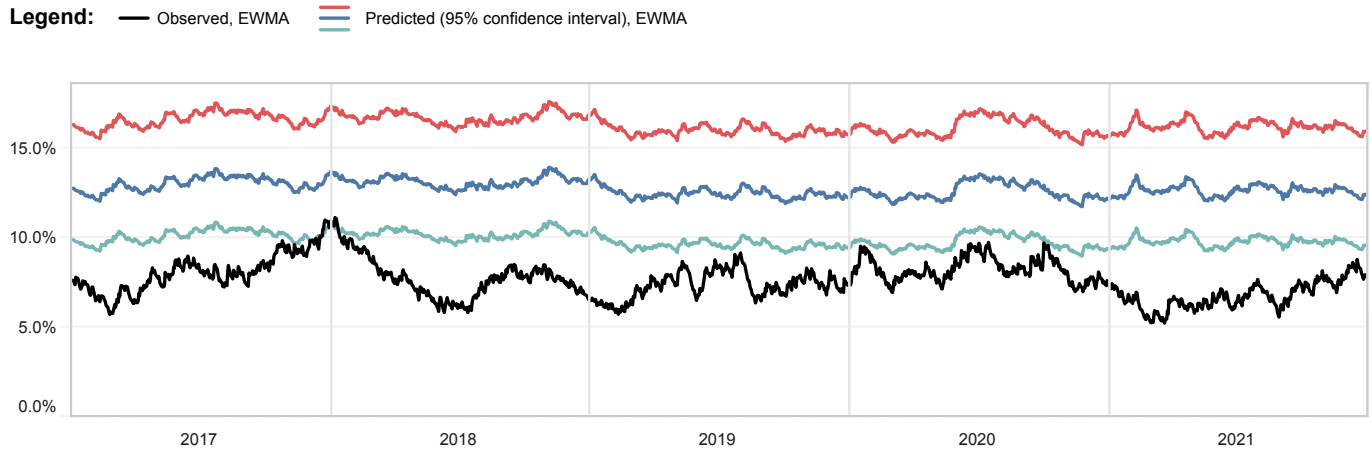


Figure 43: Ventilation >24 hours, 2017–2021

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.

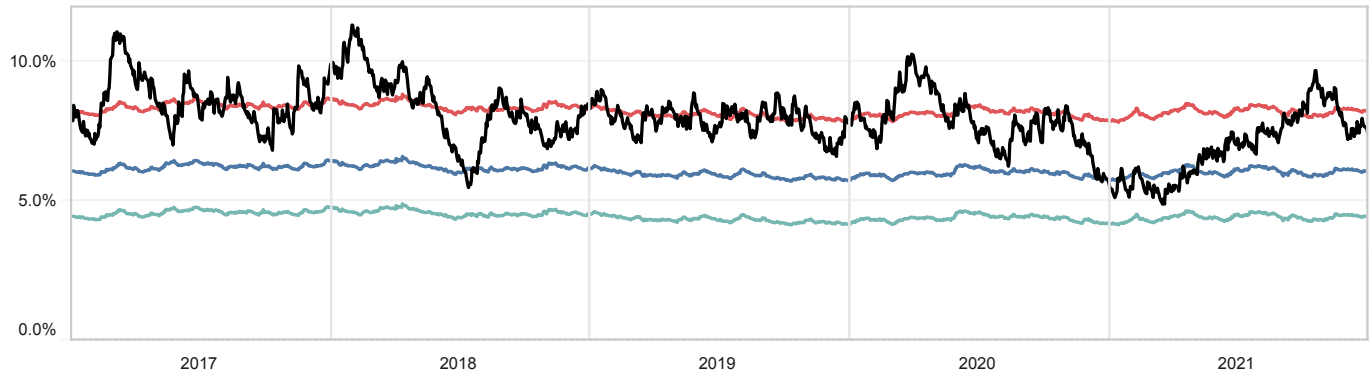


Figure 44: Reoperation, 2017–2021

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.

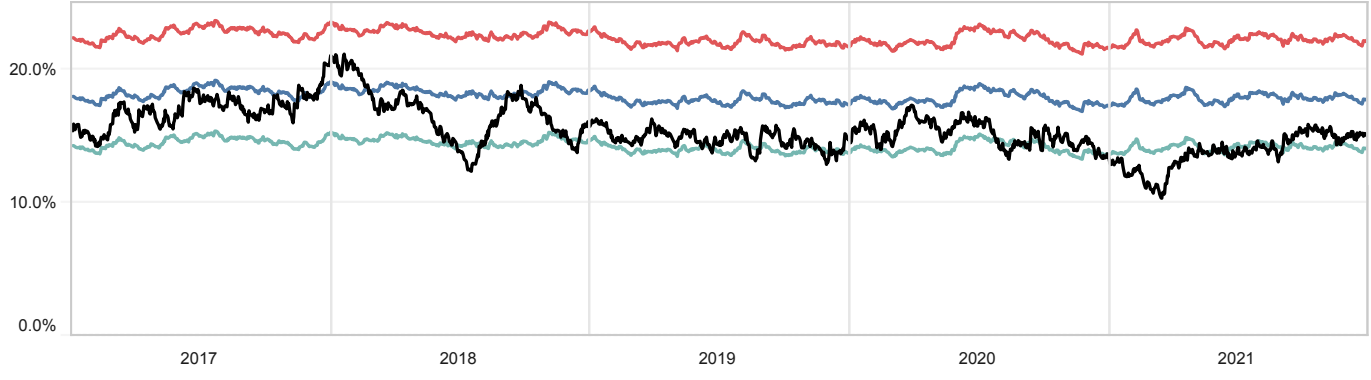


Figure 45: Major morbidity, 2017–2021

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.

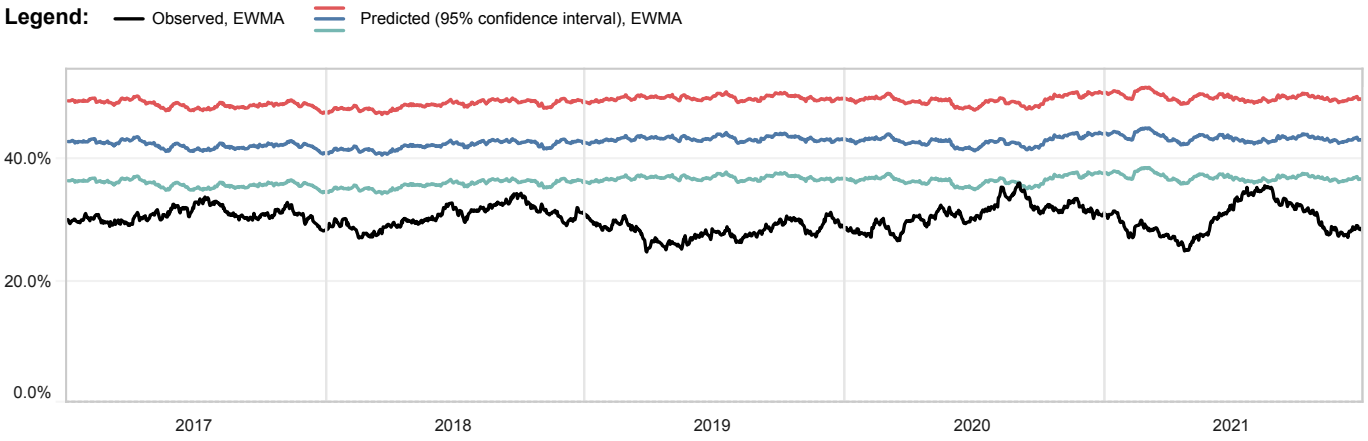


Figure 46: LOS <6 days, 2017–2021

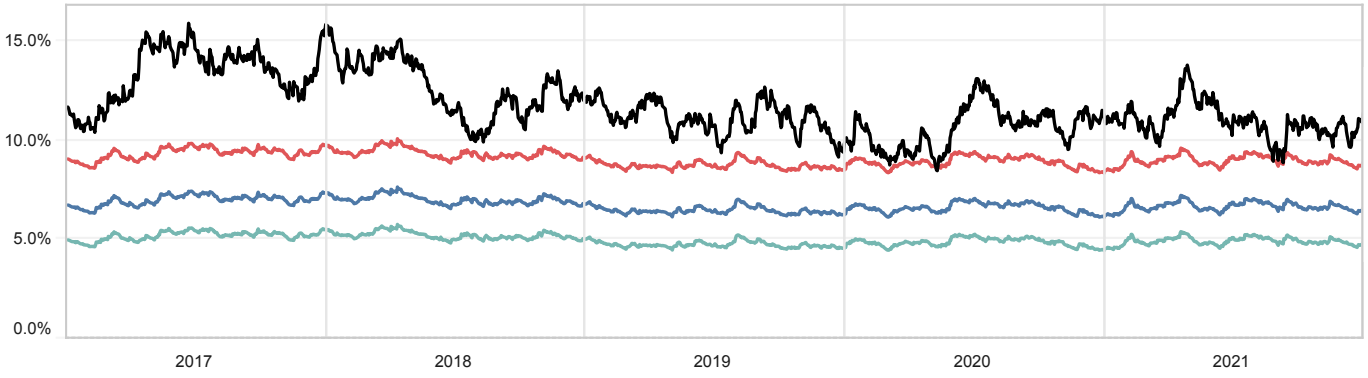


Figure 47: LOS >14 days, 2017–2021

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.

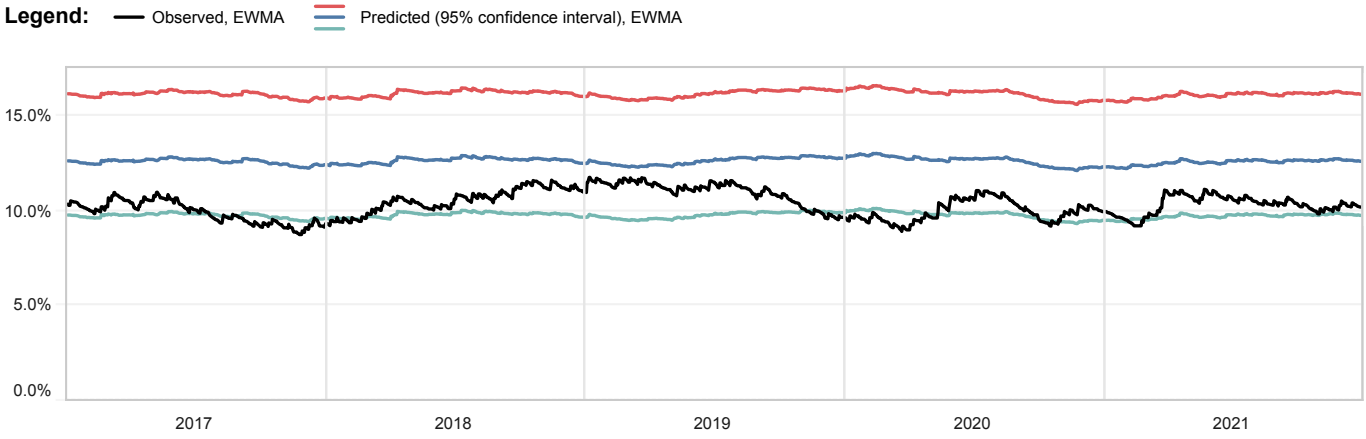


Figure 48: Failure to rescue, 2017–2021

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.

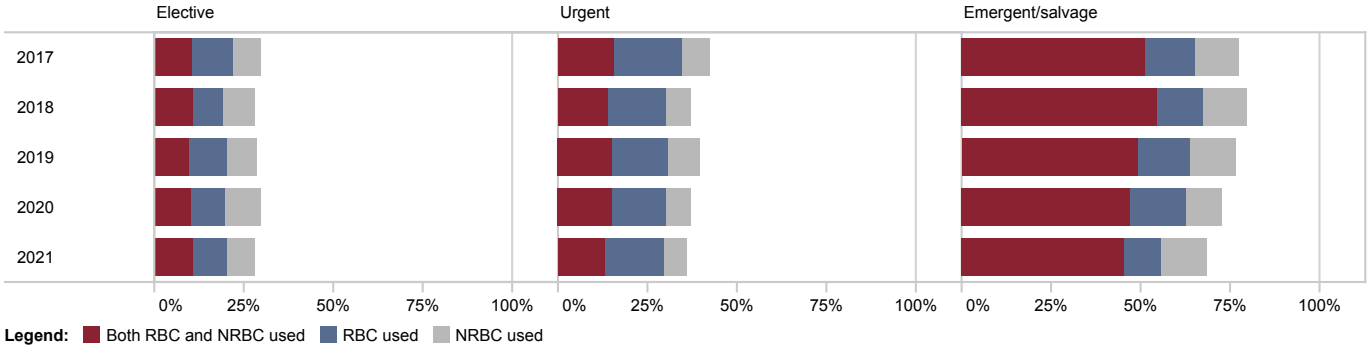


Figure 1: Proportion of blood product usage by admission status and year of surgery

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.

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.

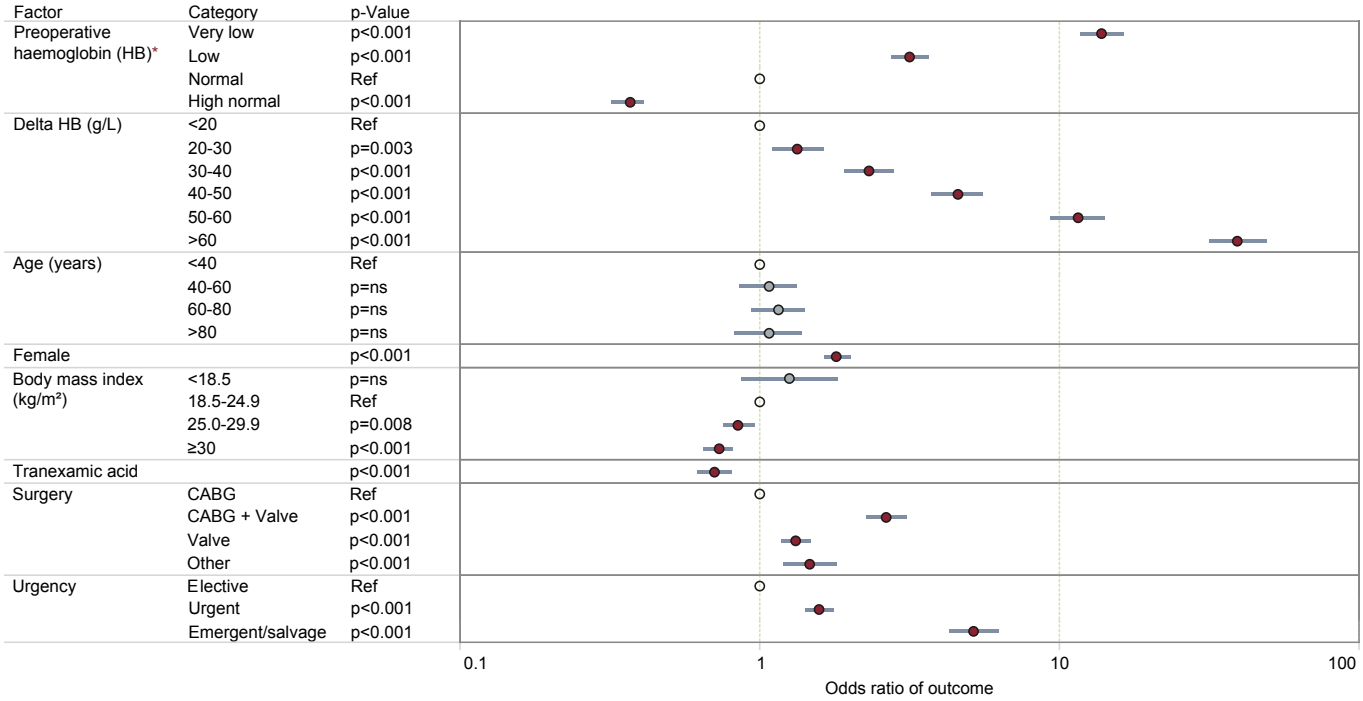
With regards the requirement for any blood product transfusion post-surgery (Figure 2), having a very low preoperative haemoglobin level, defined as less than 120 g/L for men and 110 g/L for women[40] was associated with an odds ratio of greater than 13.8 (p<0.001) signifying a high risk of requiring 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.

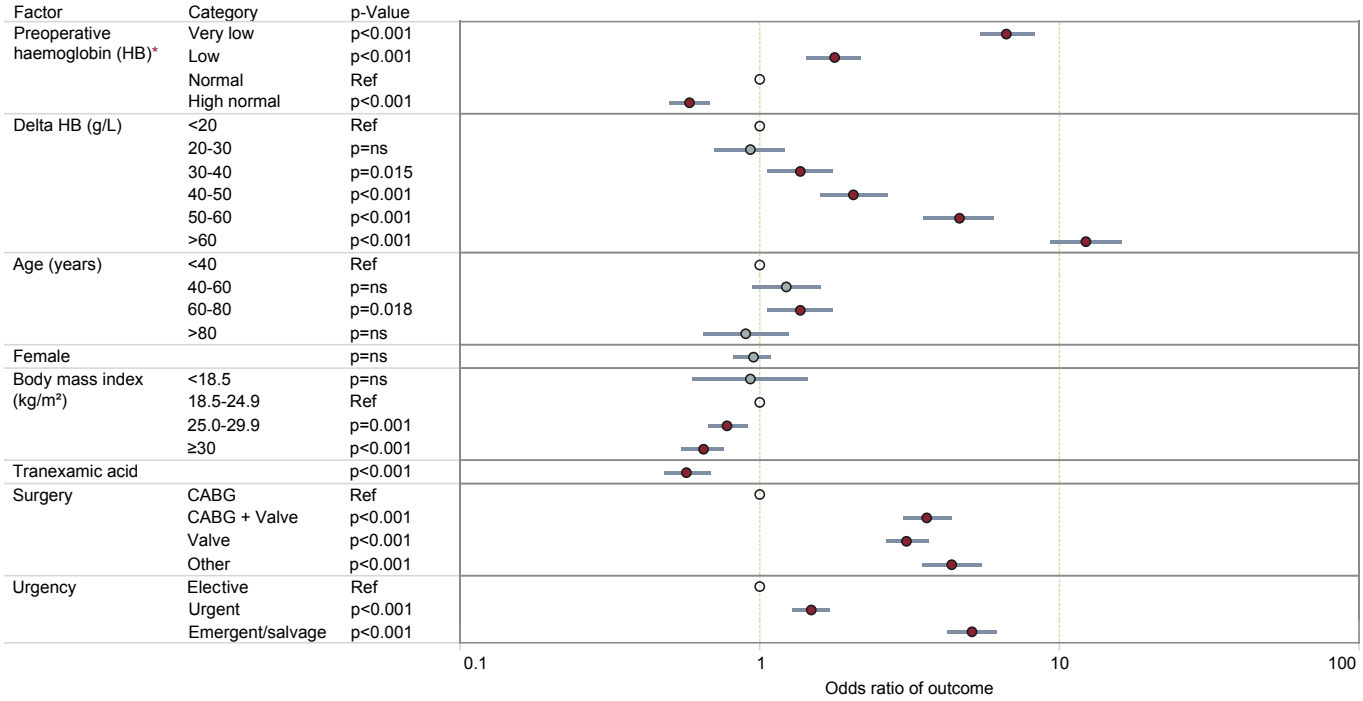
Use of the antifibrinolytic drug, TXA (OR 0.7, p<0.001) was identified as being associated with the likelihood of requiring transfusion.



* 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

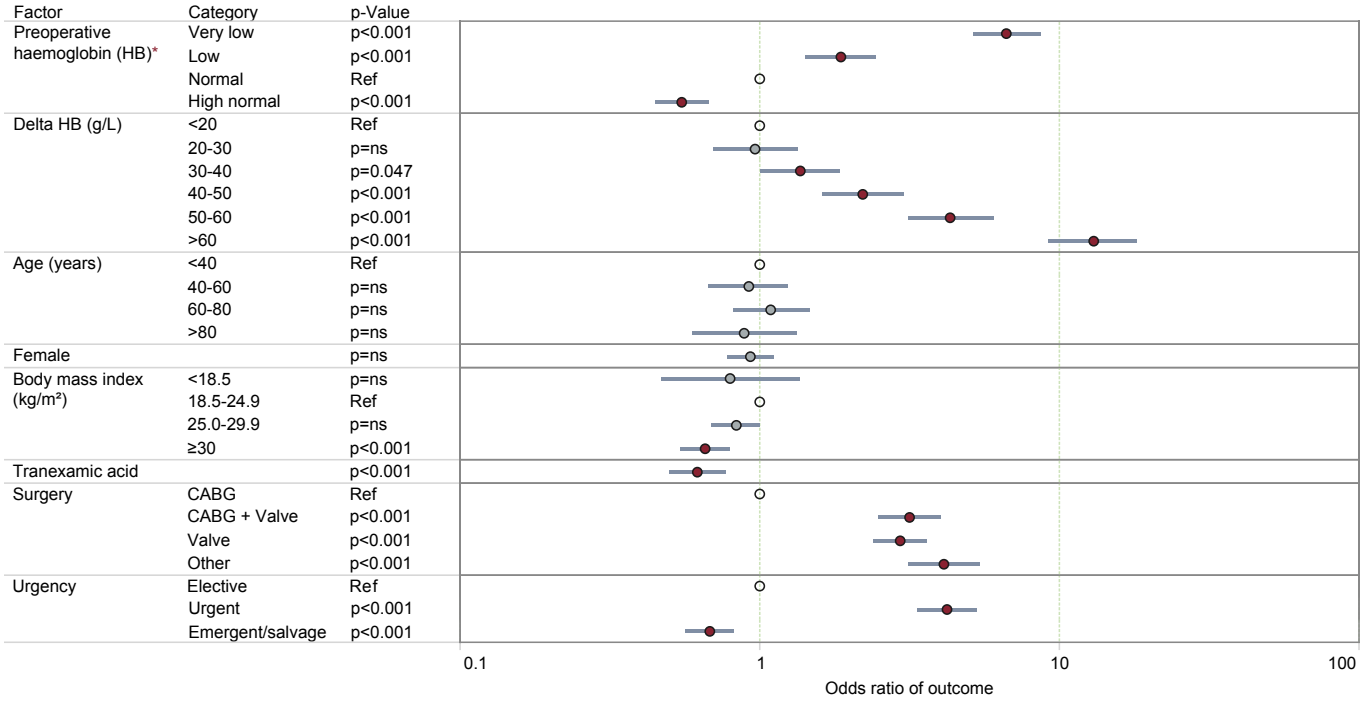
With regards moderate blood use (>5 units, Figure 3), the pattern of risk factors is similar. The exception being that the risk of requiring more than 5 units of blood increases with increasing patient age.



* 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

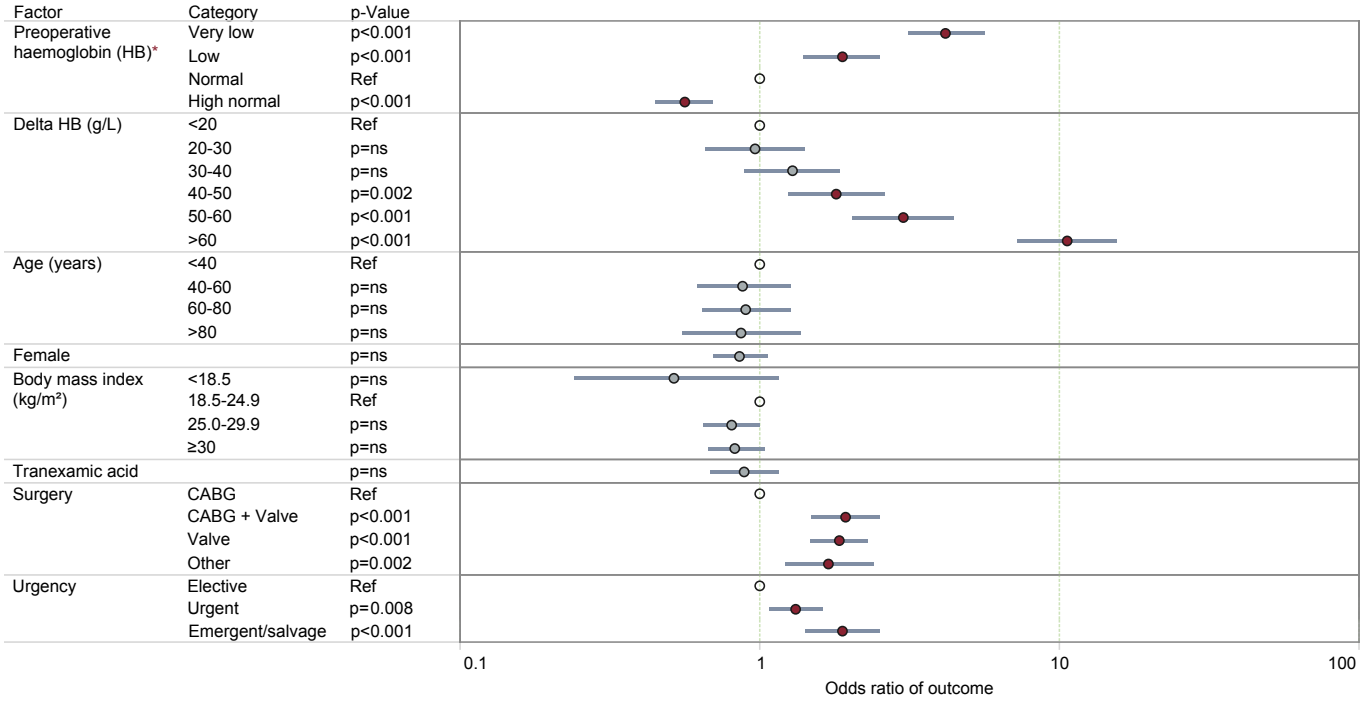
As with the other markers of blood use, excessive blood use (›10 units, Figure 4) generally follows a similar pattern.



* 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/m^2)	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

ANZCORS Data Manager

- Ms Janelle Johnson

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  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.

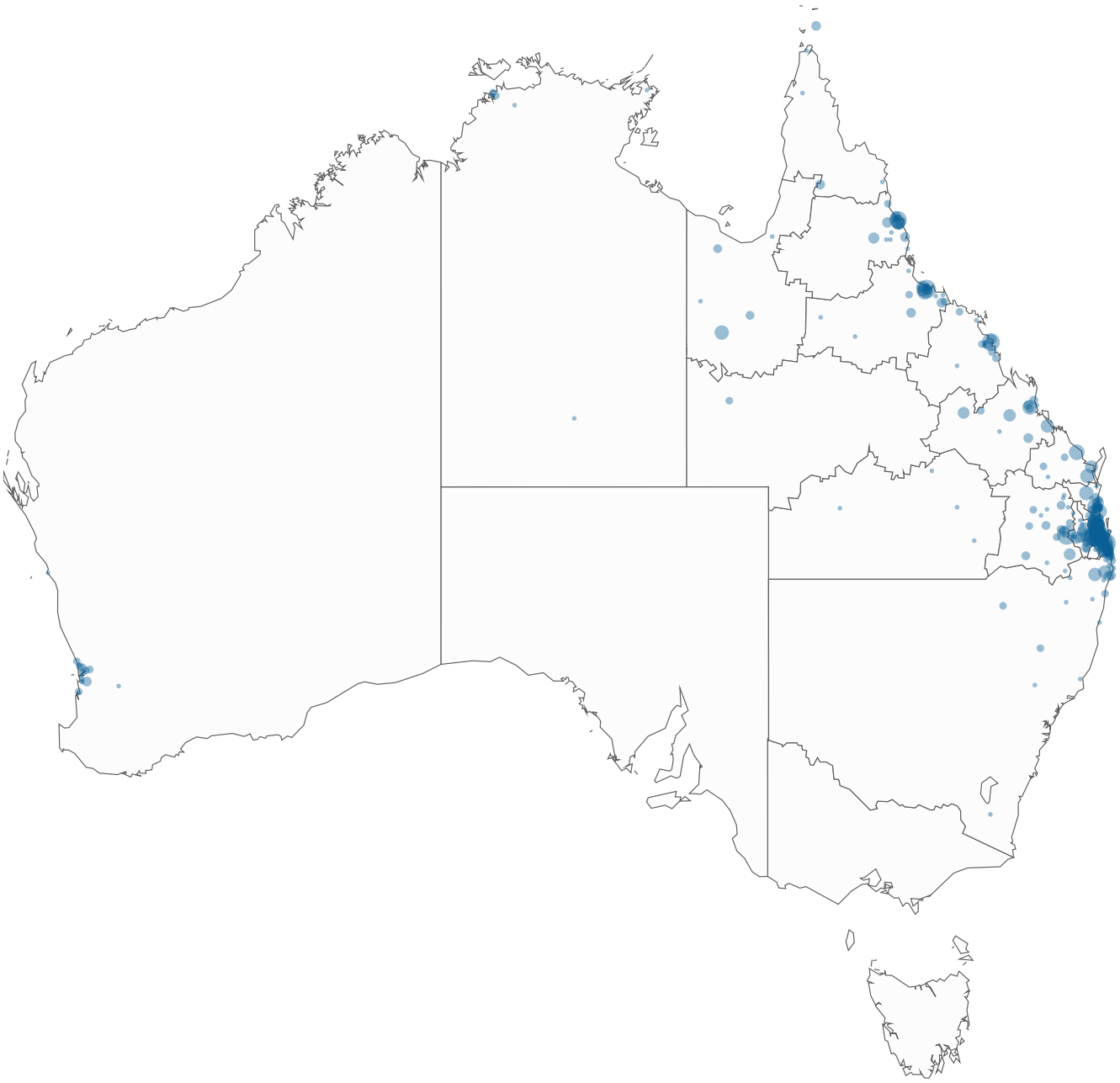


Figure 1: Cardiac patients treated by the Queensland Paediatric Cardiac Service between 2016–2021, by patient's place of usual residence (residential postcode)

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

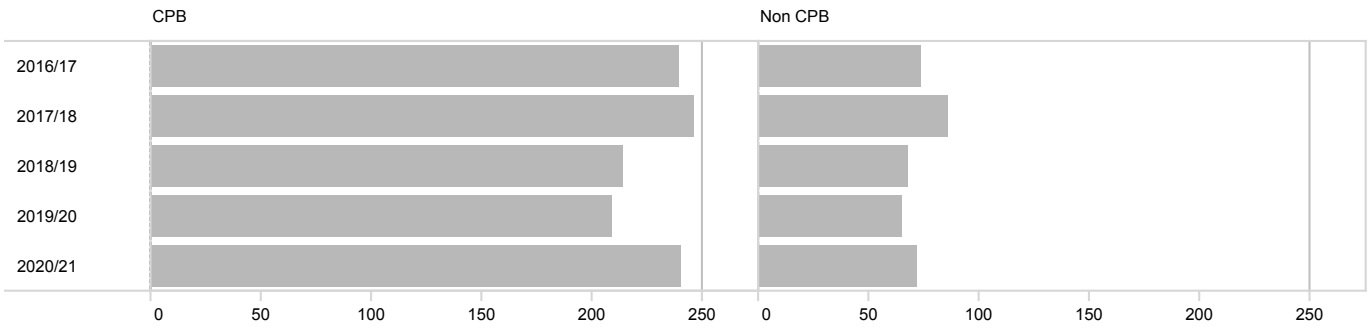


Figure 2: Number of cardiac patients by cardiopulmonary bypass utilisation, 2016–2021

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%.

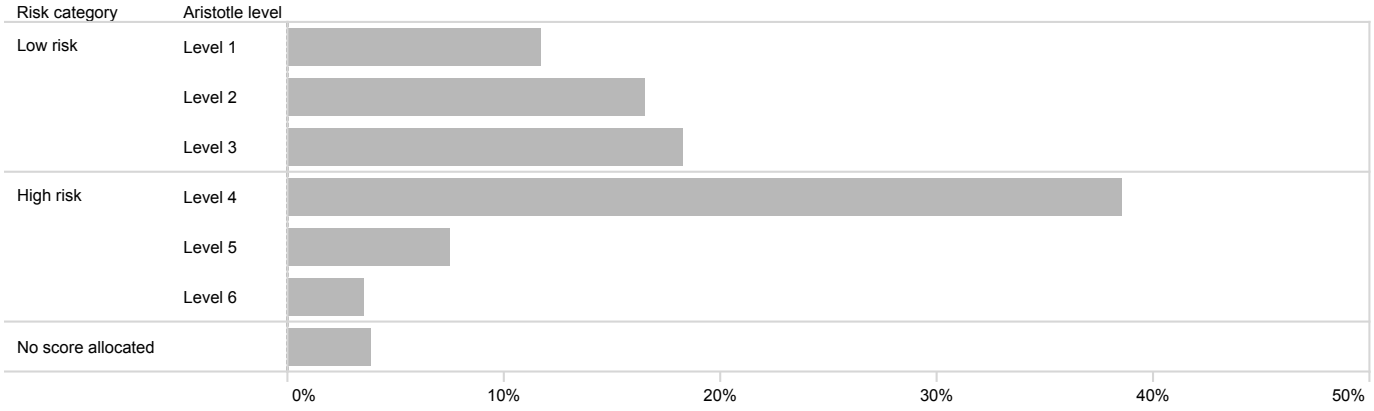


Figure 3: Proportion of all cardiac procedures stratified by Aristotle Comprehensive Complexity score and risk category

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.

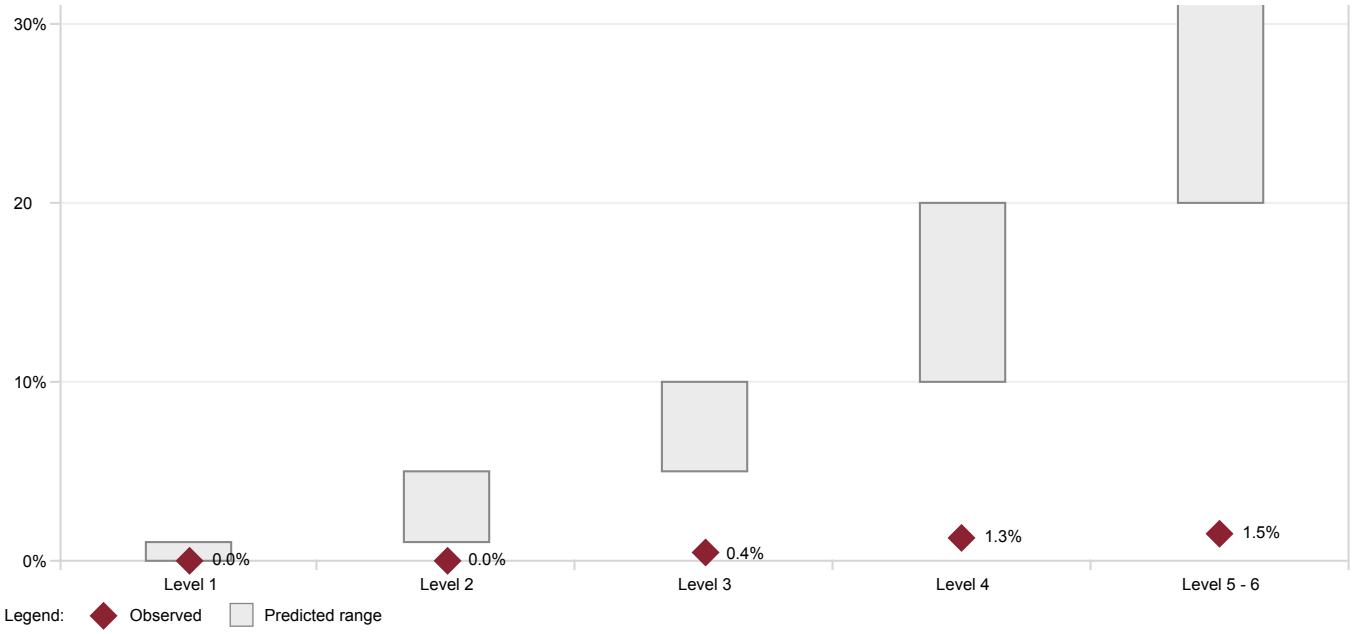


Figure 4: Cardiac patients 30 day mortality by Aristotle Comprehensive Complexity score, 2016–2021

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%

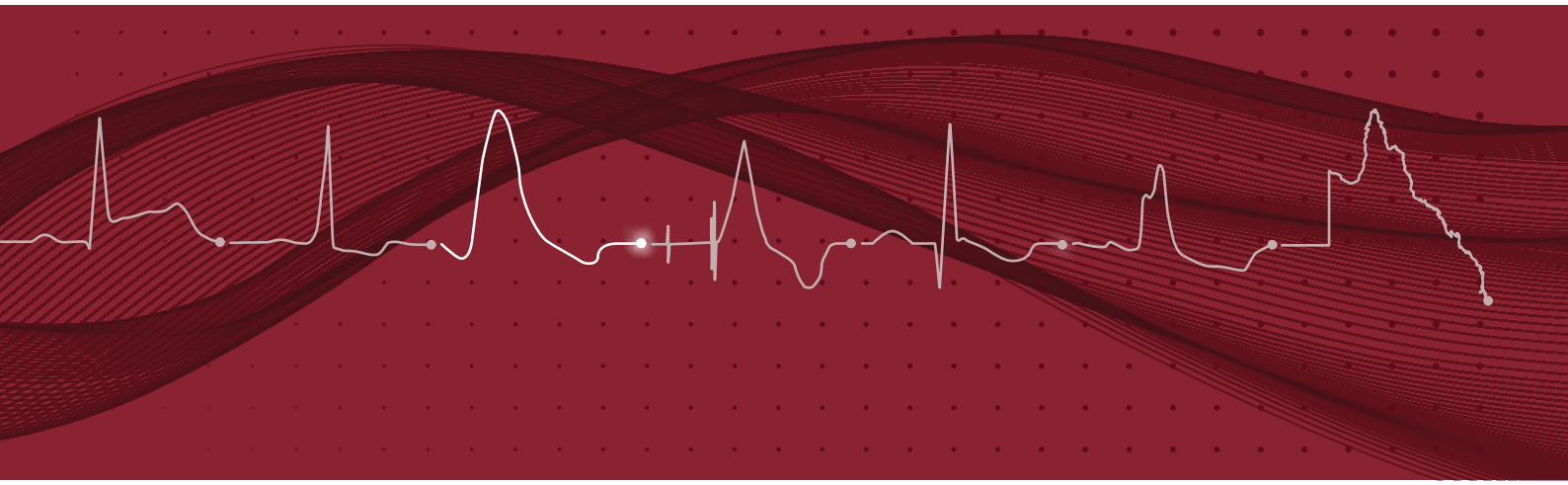
Level 5: ACC score 15.1–20.0; expected mortality >20%

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

Thoracic Surgery Audit



1 Message from the Chair

Over a thousand Queenslanders experienced thoracic surgery in 2021, some for lung cancer, some for other cancers that had metastasised, some for infection, and some for trauma.

Operating on the organ system responsible for oxygenation and fitness is not without risk. Getting patients through surgery without complications, in patients who have smoked or are currently smoking and are overweight or obese is part of the challenge of this specialty. Viewed in that context, the results in this report are excellent.

The upstaging and downstaging rate in primary lung cancer resections is perhaps the most pertinent finding in this report. Balancing the risks of surgery with the benefits of resecting lung cancer comes down to a calculation between the stage of cancer and the health of the patient. Putting patients through surgery who have an advanced cancer may not benefit them. The converse is that patients who are thought to be more advanced than they are, may be denied surgery that changes their survival. Lung cancer has gone through a revolution in staging with positron emission tomography scanning and endobronchial ultrasound, and the treatment itself is going through a dramatic change, with immunotherapy and stereotactic body radiation therapy. With more ways of staging cancer and more treatment options, putting as many Queenslanders as possible with lung cancer through potentially curative surgery is still our priority, and accurately staging patients, both preoperatively, and intraoperatively is part of the calculation of risk and benefit.

Paired with this is the low mortality rate, in which the safety of thoracic surgery in Queensland is excellent. The majority of risk in surgery comes from the underlying health of the patient, and the role of the surgical team is in the decision to operate, the technical performance of surgery and the management of the recovery phase and its risks. A low mortality rate can reflect safe decision making, meaning those at most risk are managed without surgery, in addition to the safe performance of procedures and in-hospital treatment. The counterpoint is the consideration that our surgical decision making is too conservative and that surgery should perhaps be offered to a wider array of patients at risk. This is a constant tension in surgical decision making and, knowing how our services function across the state allows us to make informed decisions about the actual risk in our units.

Dr Christopher Cole
Chair
QCOR Cardiothoracic Surgery Committee

2 Key findings

Key findings include:

- There were 1,067 thoracic surgical cases entered for 2021 across the five public thoracic surgery units in Queensland.
- The median age of patients undergoing thoracic surgery was 63 years of age, with 18% of patients aged under 40 years of age.
- One third of patients (33%) were within the normal body mass index (BMI) range, while patients classed as overweight or obese made up more than half of the patient cohort (61%) including 7% classed as morbidly obese.
- The proportion of Aboriginal and Torres Strait Islander patients undergoing thoracic surgery was 5.7% of the total cohort.
- Operations performed for preoperative diagnoses of primary lung cancer were undertaken in 27% of all cases, while pleural disease and other cancer diagnosis each accounted for 28% of all surgeries. Other thoracic surgery was performed in 17% of the cohort.
- Approximately two thirds of patients had some smoking history, including 22% who were current smokers at the time of surgery.
- Elective procedures accounted for 69% of the total surgeries performed, while 12% of cases were emergency operations. Of elective cases, half were performed on a day of surgery admission pathway.
- Lobectomy (80%) and lymph node sampling (76%) were the most common procedures performed on patients with an indication of primary lung cancer.
- Overall, 5% of all cases required a blood product transfusion.
- The median postoperative length of stay for thoracic surgery patients was 5 days.
- There were 123 cases having one or more new major morbidities recorded post procedure. Prolonged air leak greater than seven days accounted for over one quarter (25%) of all major morbidity types.
- Pathological upstaging occurred in 32% of primary lung cancer cases while 19% were downstaged postoperatively and 50% had no change to the preoperative staging classification.
- Unadjusted all-cause mortality at 30 days was 1.2%, increasing to 2.4% at 90 days. The other cancer indication group had the highest unadjusted mortality rates at 30 days and 90 days at 1.7% and 4.4% respectively.

3 Participating sites

There are five public thoracic surgery units in Queensland, all of which have participated in QCOR.

Four of the public sites offering thoracic surgery also performed cardiac surgery. The fifth public site, Royal Brisbane & Women's Hospital (RBWH), only offers thoracic surgery.

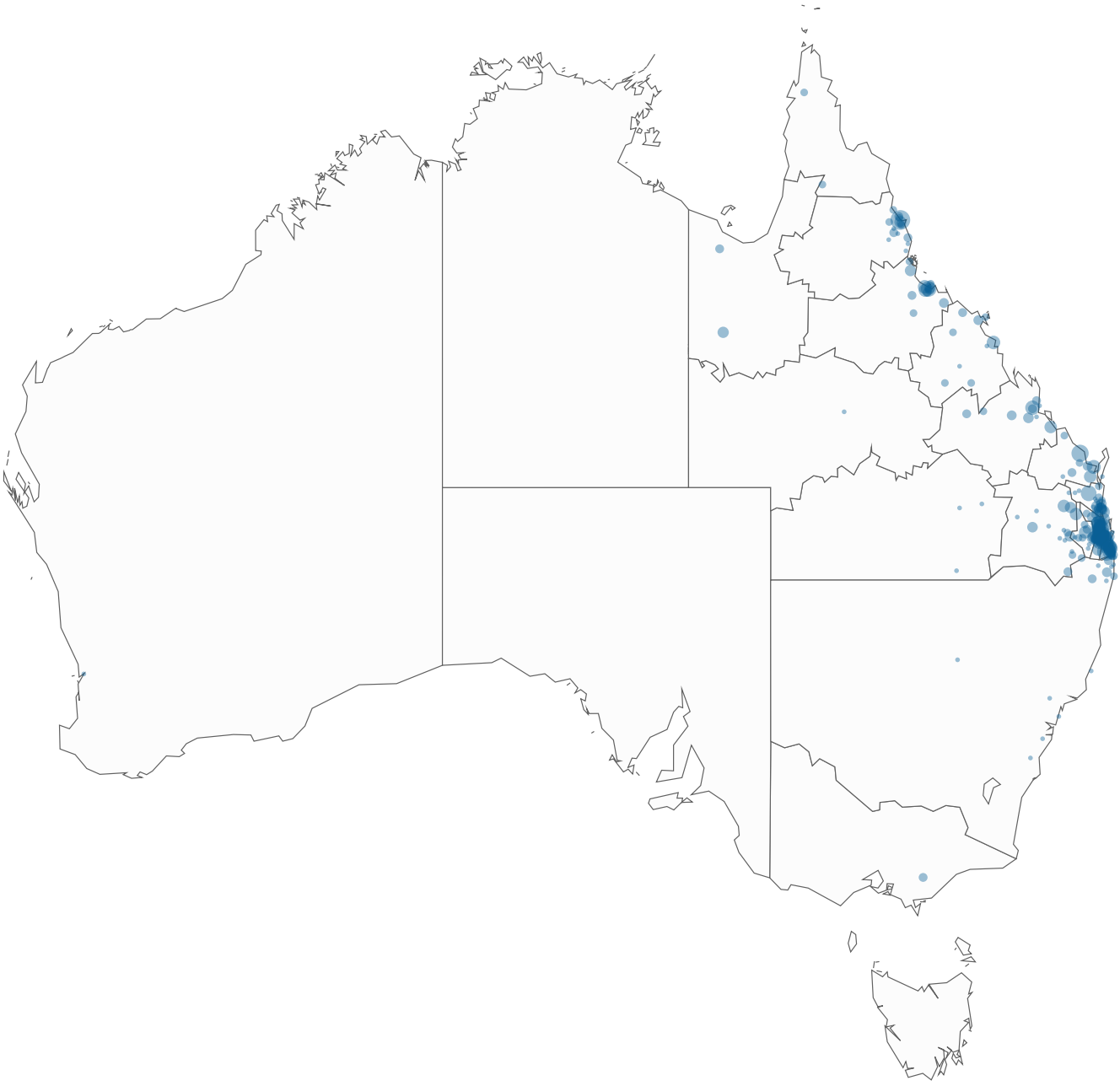


Figure 1: Thoracic surgery cases by residential postcode

Table 1: Participating sites

Acronym	Name
TUH	Townsville University Hospital
TPCH	The Prince Charles Hospital
RBWH	Royal Brisbane & Women's Hospital
PAH	Princess Alexandra Hospital
GCUH	Gold Coast University Hospital

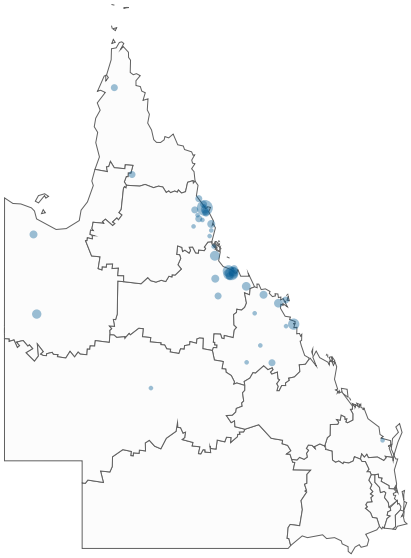


Figure 2: Townsville University Hospital

Figure 3: The Prince Charles Hospital

Figure 4: Royal Brisbane & Women's Hospital

Figure 5: Princess Alexandra Hospital

Figure 6: Gold Coast University Hospital

4 Case totals

4.1 Total surgeries

Patients undergoing thoracic surgery have been assigned an indication category of either primary lung cancer, other cancer, pleural disease or other indication for surgery.

Of the 1,067 cases performed across the five public thoracic surgery units in Queensland, over half of patients (54%) presented with an indication including some form of cancer. Diagnosis of primary lung cancer accounted for 27% and 28% had another cancer diagnosis.

Non cancer diagnoses accounted for 46% of the overall cases, including pleural disease (28%) or other non cancer indication (17%).

Table 2: Cases by site and indication category

SITE	Total n	Primary lung cancer n (%)	Other cancer* n (%)	Pleural disease† n (%)	Other‡ n (%)
TUH	151	42 (27.8)	46 (30.5)	44 (29.1)	19 (12.6)
TPCH	348	127 (36.5)	76 (21.8)	103 (29.6)	42 (12.1)
RBWH	95	37 (38.9)	23 (24.2)	21 (22.1)	14 (14.7)
PAH	319	43 (13.5)	113 (35.4)	93 (29.2)	70 (21.9)
GCUH	154	35 (22.7)	39 (25.3)	42 (27.3)	38 (24.7)
STATEWIDE	**1,067**	**284 (26.6)**	**297 (27.8)**	**303 (28.4)**	**183 (17.2)**

* Lung metastases, solitary lung lesion of uncertain aetiology, pleural malignancy or other thoracic cancer

† Pneumothorax, haemothorax, empyema or pleural thickening/nodules

‡ Chest wall disease, mediastinal disease, tracheal disease, oesophageal disease, infective focus or other diagnosis

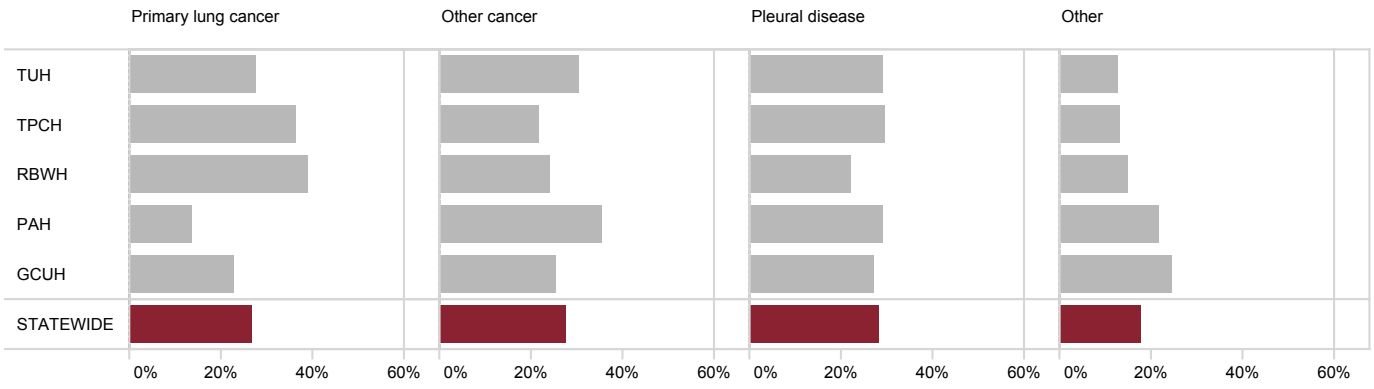


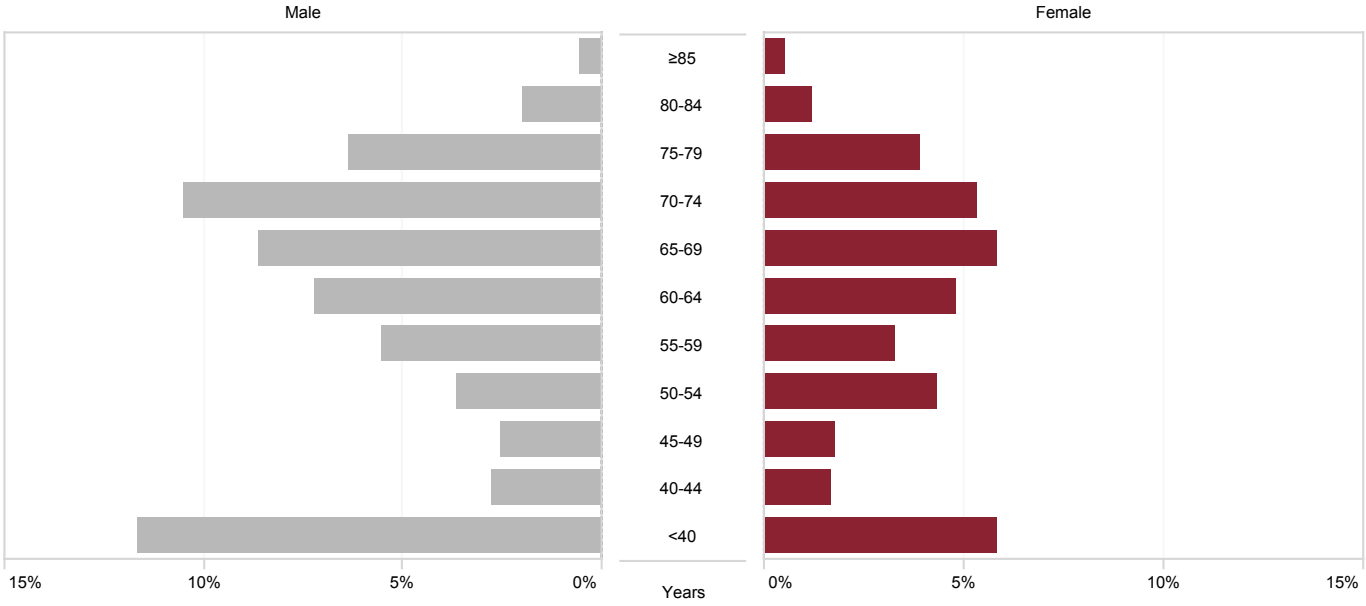
Figure 7: Proportion of cases by site and indication category

5 Patient characteristics

5.1 Age and gender

The median age for thoracic surgical patients was 63 years, while nearly one in five (18%) patients were less than 40 years of age at the time of surgery.

Whilst the majority of patients were male (61%), there was a nearly even distribution of cases between genders among patients with a preoperative cancer diagnosis. By contrast, three quarters of patients with pleural disease were male.



% of total (n=1,067)

Figure 8: Proportion of all cases by age group and gender

Table 3: Median age by gender and indication category

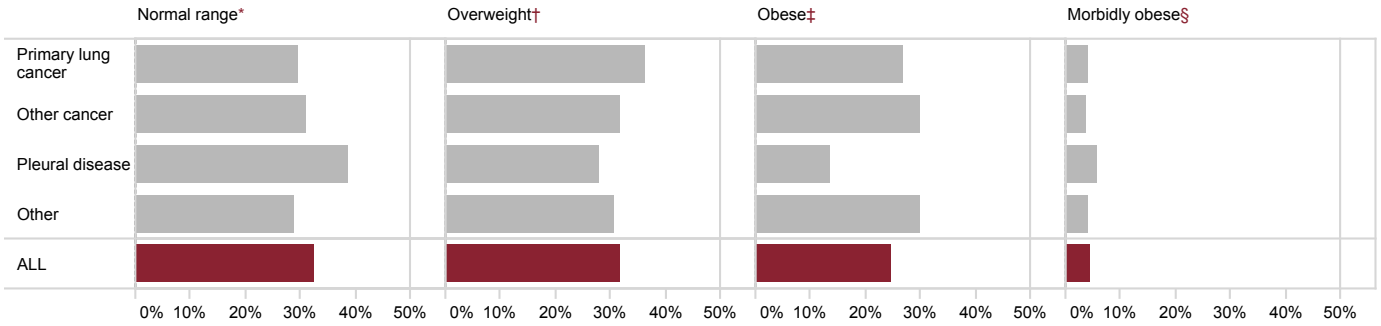
Indication	Male years	Female years	Total years
Primary lung cancer	71	67	70
Other cancer	65	61	64
Pleural disease	52	43	52
Other	59	53	58
All	**64**	**62**	**63**

Table 4: Proportion of cases by gender and indication category

Indication	Male n (%)	Female n (%)
Primary lung cancer	143 (50.4)	141 (49.6)
Other cancer	163 (54.9)	134 (45.1)
Pleural disease	228 (75.2)	75 (24.8)
Other	119 (65.0)	64 (35.0)
All	**653 (61.2)**	**414 (38.8)**

5.2 Body mass index

The majority of thoracic surgery patients (61%) were classed as overweight or obese, while 33% of patients had a body mass index (BMI) classed within the normal range. More than 7% of patients were classed as underweight.



Underweight category (BMI <18.5 kg/m^2) is not displayed (7.2%)

Excludes missing data (10.0%)

* 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 indication categories

Table 5: BMI category by indication category

Indication	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Morbidly obese n (%)
Primary lung cancer	9 (3.6)	73 (29.3)	90 (36.1)	67 (26.9)	10 (4.0)
Other cancer	10 (3.7)	85 (31.1)	87 (31.9)	81 (29.7)	10 (3.7)
Pleural disease	39 (14.0)	107 (38.5)	78 (28.1)	38 (13.7)	16 (5.8)
Other	11 (6.9)	47 (29.4)	49 (30.6)	46 (28.7)	7 (4.4)
All	**69 (7.2)**	**312 (32.5)**	**304 (31.7)**	**232 (24.2)**	**43 (4.5)**

Excludes missing data (10.0%)

5.3 Aboriginal and Torres Strait Islander status

The overall proportion of identified Aboriginal and Torres Strait Islanders undergoing thoracic surgery was 5.7%.

Table 6: Aboriginal and Torres Strait Islander status by indication category

Indication	Indigenous n (%)	Non-Indigenous n (%)
Primary lung cancer	14 (5.0)	267 (95.0)
Other cancer	19 (6.4)	276 (93.6)
Pleural disease	16 (5.3)	285 (94.7)
Other	11 (6.1)	170 (93.9)
All	**60 (5.7)**	**998 (94.3)**

Excludes missing data (0.8%)

6 Risk factors and comorbidities

6.1 Smoking history

Almost one quarter of patients (22%) were current smokers (defined as smoking within 30 days prior to surgery), while 41% of patients had a smoking history recorded. Only 24% of patients were identified as having never smoked. In 13% of cases, smoking status was unknown.

There was considerable variation for patients in the primary lung cancer category, where the majority (80%) were recorded as either current or former smokers.

Table 7: Smoking history by indication category

Indication	Current smoker n (%)	Former smoker n (%)	Never smoked n (%)	Unknown n (%)
Primary lung cancer	69 (25.2)	159 (58.0)	41 (15.0)	5 (1.8)
Other cancer	47 (16.5)	113 (39.6)	90 (31.6)	35 (12.3)
Pleural disease	84 (28.7)	94 (32.1)	66 (22.5)	49 (16.7)
Other	27 (16.6)	47 (28.8)	48 (29.4)	41 (25.2)
All	**227 (22.4)**	**413 (40.7)**	**245 (24.1)**	**130 (12.8)**

Excludes missing data (4.9%)

6.2 Respiratory disease

The majority of patients (75%) did not have respiratory disease, while around one quarter (23%) were recorded as having mild or moderate respiratory disease.

Table 8: Respiratory disease according to indication category

Indication	Mild* n (%)	Moderate† n (%)	Severe‡ n (%)
Primary lung cancer	41 (15.8)	39 (15.0)	3 (1.2)
Other cancer	32 (11.6)	24 (8.7)	4 (1.5)
Pleural disease	30 (10.6)	36 (12.8)	15 (5.3)
Other	12 (7.4)	11 (6.8)	2 (1.2)
All	**115 (11.7)**	**110 (11.2)**	**24 (2.5)**

Excludes missing data (8.6%)

* Patient is on chronic inhaled or oral bronchodilator therapy

† Patient is on chronic oral steroid therapy directed at lung disease

‡ Mechanical ventilation for chronic lung disease, pO_2 on room air ‹60 mmHg or pCO2 on room air ›50 mmHg

6.3 Diabetes

There were 15% of thoracic surgery patients recorded as having diabetes. The incidence of diabetes was similar across indication categories, ranging from 20% in the other thoracic indication category to 10% in the pleural disease cohort.

Table 9: Diabetes status by indication category

Indication	Diabetes n (%)	No diabetes n (%)
Primary lung cancer	49 (17.9)	224 (82.1)
Other cancer	39 (13.6)	247 (86.4)
Pleural disease	30 (10.3)	262 (89.7)
Other	32 (19.6)	131 (80.4)
All	**150 (14.8)**	**864 (85.2)**

Excludes missing data (5.0%)

6.4 Coronary artery disease

Overall, 11% of thoracic surgery patients were identified as having a preoperative history of coronary artery disease (CAD), while 12% of the cohort had an unknown CAD history.

Table 10: Coronary artery disease status by indication category

Indication	CAD n (%)	No CAD n (%)	Unknown n (%)
Primary lung cancer	44 (16.3)	176 (65.2)	50 (18.5)
Other cancer	23 (8.2)	230 (81.6)	29 (10.3)
Pleural disease	23 (7.9)	238 (82.1)	29 (10.0)
Other	22 (13.6)	125 (77.2)	15 (9.3)
All	**112 (11.2)**	**769 (76.6)**	**123 (12.3)**

Excludes missing data (5.9%)

6.5 Renal function

One third (33%) of patients had mild renal impairment at the time of surgery. Renal function has been determined using estimated glomerular filtration rate (eGFR) calculated from the creatinine measurement recorded preoperatively.

Table 11: Renal function by indication category

Indication	Normal* n (%)	Mild† n (%)	Moderate‡ n (%)	Severe§ n (%)
Primary lung cancer	90 (35.4)	112 (44.1)	49 (19.3)	3 (1.2)
Other cancer	143 (52.0)	97 (35.3)	31 (11.3)	4 (1.5)
Pleural disease	178 (64.0)	71 (25.5)	29 (10.4)	–
Other	99 (62.3)	38 (23.9)	19 (11.9)	3 (1.9)
All	**510 (52.8)**	**318 (32.9)**	**128 (13.3)**	**10 (1.0)**

Excludes missing data (13.4%)

* eGFR ≥90 mL/min/1.73 m^2

† eGFR 60–89 mL/min/1.73 m^2

‡ eGFR 30–59 mL/min/1.73 m^2

§ eGFR <30 mL/min/1.73 m^2

6.6 Cerebrovascular disease

Approximately 5% of patients were described as having a preoperative history of cerebrovascular disease. Of these patients, 4% were characterised by a reversible neurological deficit with a complete return of function within 72 hours while around 1% exhibited residual symptoms greater than 72 hours post onset.

Table 12: Cerebrovascular disease type by indication category

Indication	Reversible* n (%)	Irreversible† n (%)	No n (%)
Primary lung cancer	16 (5.8)	5 (1.8)	251 (91.6)
Other cancer	8 (2.8)	4 (1.4)	273 (95.5)
Pleural disease	10 (3.4)	2 (0.7)	280 (95.9)
Other	5 (3.0)	1 (0.6)	161 (96.4)
All	**39 (3.8)**	**12 (1.2)**	**965 (94.7)**

Excludes missing data (4.8%)

* Typically includes transient ischaemic attack

† Typically includes cerebrovascular accident

6.7 Peripheral vascular disease

The prevalence of peripheral vascular disease was 5% in patients undergoing thoracic surgery.

Table 13: Peripheral vascular disease status by indication category

Indication	Yes n (%)	No n (%)
Primary lung cancer	16 (5.8)	258 (94.2)
Other cancer	13 (4.6)	271 (95.4)
Pleural disease	9 (3.1)	283 (96.9)
Other	8 (4.9)	154 (95.1)
All	**46 (4.5)**	**966 (95.5)**

Excludes missing data (5.2%)

6.8 Previous interventions

6.8.1 Previous thoracic surgery

There were 13% of patients with a history of prior thoracic surgery, ranging from 8% in the primary lung cancer group to 19% in the pleural disease category.

Table 14: Previous thoracic surgery by indication category

Indication	Yes n (%)	No n (%)
Primary lung cancer	22 (8.3)	242 (91.7)
Other cancer	25 (8.9)	255 (91.1)
Pleural disease	56 (19.4)	233 (80.6)
Other	23 (14.4)	137 (85.6)
All	**126 (12.7)**	**867 (87.3)**

Excludes missing (6.9%)

6.8.2 Previous pulmonary resection

Overall, 6% of patients had undergone a previous pulmonary resection operation.

Table 15: Previous pulmonary resection surgery by indication category

Indication	Yes n (%)	No n (%)
Primary lung cancer	15 (5.5)	256 (94.5)
Other cancer	12 (4.2)	273 (95.8)
Pleural disease	25 (8.6)	266 (91.4)
Other	10 (6.2)	151 (93.8)
All	**62 (6.2)**	**946 (93.8)**

Excludes missing data (5.3%)

7 Care and treatment of patients

7.1 Admission status

Over two thirds of all cases (69%) were classed as elective, while emergency admissions accounted for 12% of cases.

An indication of pleural disease was noted in 66% of all emergency cases and 57% of all urgent cases.

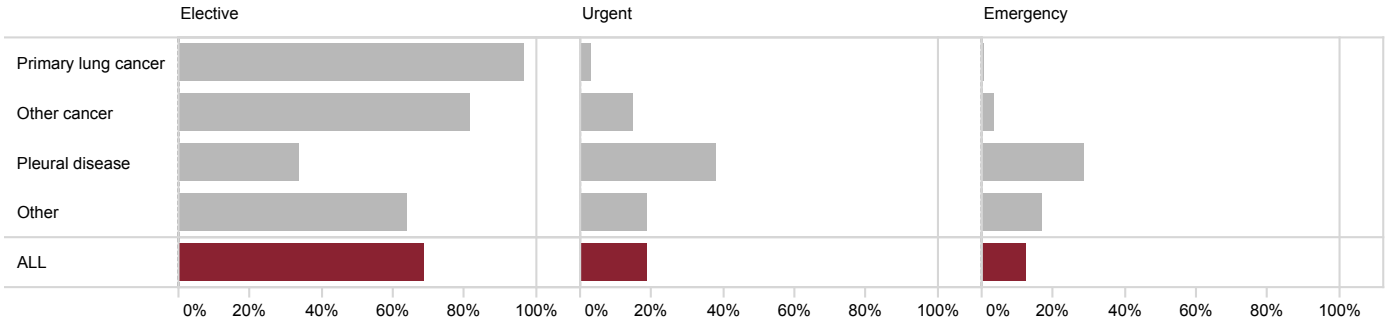


Figure 10: Admission status by indication category

Table 16: Admission status by indication category

Indication	Total n	Elective n (%)	Urgent n (%)	Emergency n (%)
Primary lung cancer	284	274 (96.5)	8 (2.8)	2 (0.7)
Other cancer	297	242 (81.5)	44 (14.8)	11 (3.7)
Pleural disease	303	102 (33.7)	115 (38.0)	86 (28.4)
Other	183	116 (63.4)	35 (19.1)	32 (17.5)
All	**1,067**	**734 (68.8)**	**202 (18.9)**	**131 (12.3)**

7.1.1 Elective day of surgery admissions

Of the 738 elective cases, half were recorded as day of surgery admissions (DOSA).

Table 17: Day of surgery admissions by indication category

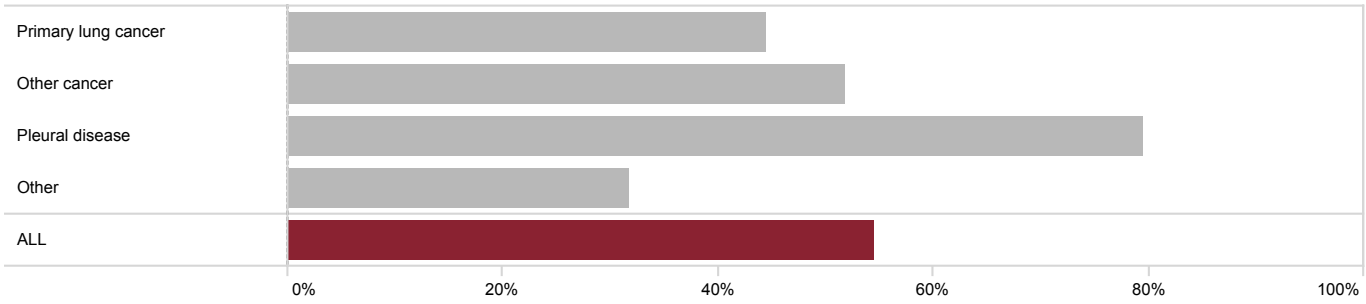
Indication	DOSA n (%)
Primary lung cancer	110 (40.1)
Other cancer	135 (55.8)
Pleural disease	48 (47.1)
Other	70 (60.3)
All	**363 (49.5)**

7.2 Surgical technique

7.2.1 Video-assisted thoracic surgery

Overall, 53% of cases utilised video-assisted thoracic surgery (VATS), including 79% of cases in the pleural disease category.

Of procedures undertaken through VATS, 35% utilised 3 ports for the operation.



Excludes missing data (1.1%)

Figure 11: Proportion of cases utilising VATS by indication category

Table 18: VATS cases by number of ports used and indication category

Indication	1 port n (%)	2 ports n (%)	3 ports n (%)	≥4 ports n (%)
Primary lung cancer	26 (21.0)	60 (48.4)	37 (29.8)	1 (0.8)
Other cancer	43 (28.7)	62 (41.3)	41 (27.3)	4 (2.7)
Pleural disease	67 (28.0)	74 (31.0)	98 (41.0)	–
Other	15 (31.3)	13 (27.1)	19 (39.6)	1 (2.1)
All	**151 (26.9)**	**209 (37.3)**	**195 (34.8)**	**6 (1.1)**

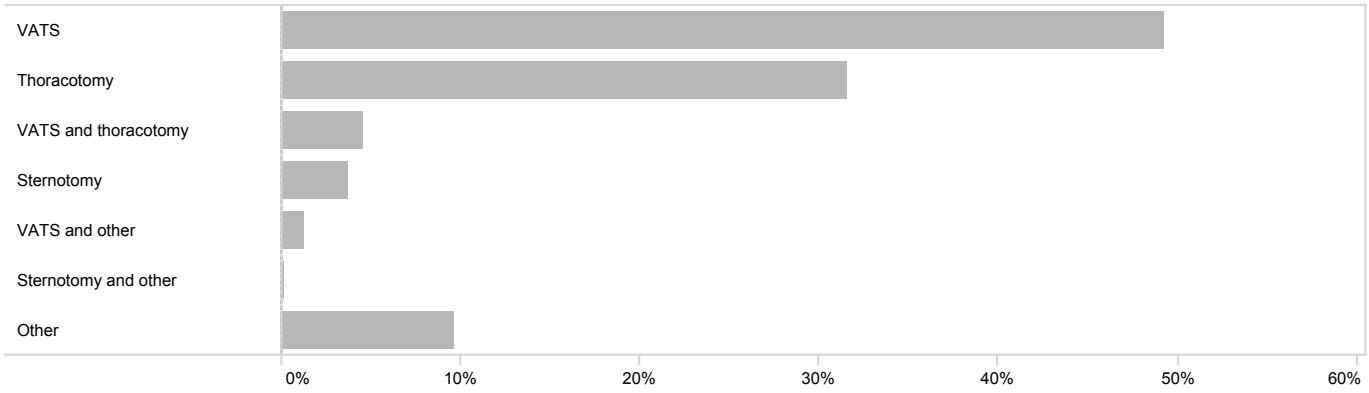
Excludes missing data (1.1%)

7.2.2 Incision type

Approximately half of all surgeries (49%) were solely video assisted, while 32% of the total surgeries were performed via thoracotomy.

Thoracotomy access was more likely for patients presenting with a cancer diagnosis, where the most common approaches were by thoracotomy only (41%), VATS only (40%), or VATS and thoracotomy (7%).

Use of sternotomy accounted for 4% of overall cases.



Excludes missing data (3.1%)

Figure 12: Proportion of all cases by incision type

Table 19: Incision type by indication category

Incision type	Primary lung cancer n (%)	Other cancer n (%)	Pleural disease n (%)	Other n (%)	Total n (%)
VATS	89 (31.4)	138 (47.4)	235 (77.8)	45 (28.5)	507 (49.0)
Thoracotomy	155 (54.8)	82 (28.2)	53 (17.5)	38 (24.1)	328 (31.7)
VATS and thoracotomy	31 (11.0)	7 (2.4)	5 (1.7)	4 (2.5)	47 (4.5)
Sternotomy	1 (0.4)	29 (10.0)	2 (0.7)	6 (3.8)	38 (3.7)
VATS and other	4 (1.4)	6 (2.1)	1 (0.3)	2 (1.3)	13 (1.3)
Sternotomy and other	–	1 (0.3)	–	–	1 (0.1)
Other	3 (1.1)	28 (9.6)	6 (2.0)	63 (39.9)	100 (9.7)
All	**283 (100.0)**	**291 (100.0)**	**302 (100.0)**	**158 (100.0)**	**1,034 (100.0)**

Excludes missing data (3.1%)

7.3 Surgery types

Thoracic surgery cases will often involve a number of procedures undertaken in combination. For patients with an indication of primary lung cancer, there was an average of 2.0 procedures per operation with a lobectomy being the most frequently performed procedure type (80%).

Wedge resection (22%) and lobectomy (20%) were the most common procedures performed in the other cancer cohort, while pleural disease was commonly treated with pleural drainage and pleurodesis (43% and 41% respectively).

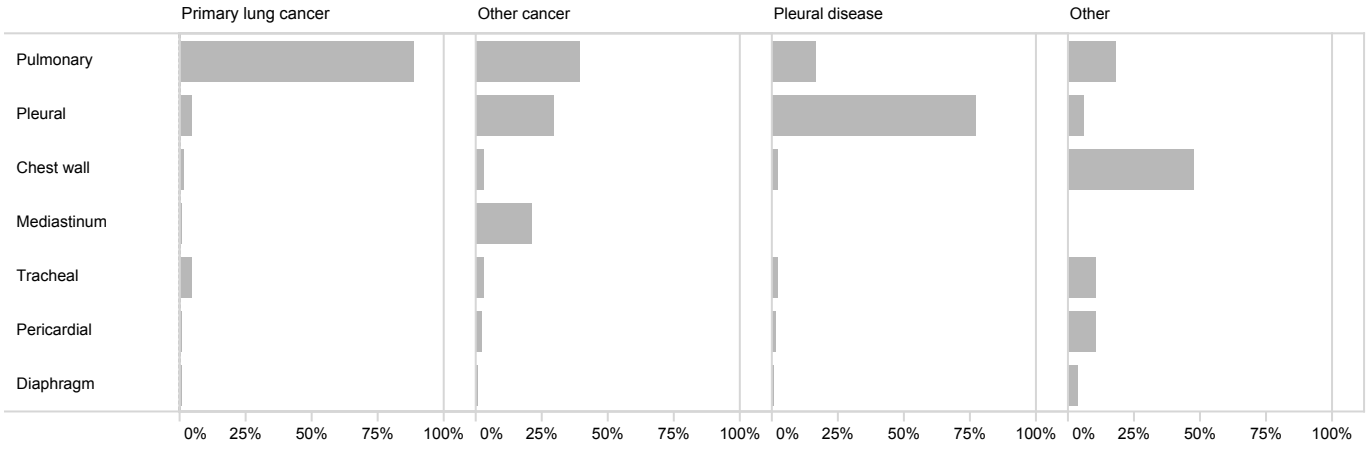


Figure 13: Proportion of procedure types by thoracic structure and indication category

Table 20: Surgical procedures for primary lung cancer

	n (%)
Lobectomy	226 (79.6)
Lymph node sampling	216 (76.1)
Wedge resection	29 (10.2)
Bronchoscopy	19 (6.7)
Segmentectomy	10 (3.5)
Lymph node dissection	9 (3.2)
Pleural drainage	8 (2.8)
Pleurodesis	8 (2.8)
Pneumonectomy	7 (2.5)
Pleural biopsy	6 (2.1)
Bilobectomy	5 (1.8)
Rib resection	4 (1.4)
Endobronchial ablation	3 (1.1)
Sleeve resection	3 (1.1)
Decortication	2 (0.7)
ORIF* ribs	2 (0.7)
Bronchial repair	1 (0.4)
Chest wall biopsy	1 (0.4)
Planned surgery abandoned	1 (0.4)
Thymectomy	1 (0.4)
Other	7 (2.5)
All	**284 (100.0)**

* Open reduction internal fixation

Table 21: Surgical procedures for other cancer

	n (%)
Wedge resection	64 (21.5)
Lobectomy	60 (20.2)
Pleural biopsy	53 (17.8)
Lymph node sampling	51 (17.2)
Pleural drainage	43 (14.5)
Pleurodesis	39 (13.1)
Resection mediastinal mass	30 (10.1)
Thymectomy	25 (8.4)
Mediastinoscopy	17 (5.7)
Bronchoscopy	13 (4.4)
Sympathectomy	11 (3.7)
Decortication	8 (2.7)
Pericardial window	6 (2.0)
Segmentectomy	5 (1.7)
Open biopsy	5 (1.7)
Bilobectomy	4 (1.3)
Chest wall resection	4 (1.3)
Rib resection	4 (1.3)
Chest wall reconstruction	3 (1.0)
Endobronchial ablation	3 (1.0)
Lymph node dissection	3 (1.0)
Chest wall biopsy	2 (0.7)
Plication	2 (0.7)
Planned surgery abandon	1 (0.3)
Pneumonectomy	1 (0.3)
Other	10 (3.4)
All	**297 (100.0)**

Table 22: Surgical procedures for pleural disease

	n (%)
Pleural drainage	130 (42.9)
Pleurodesis	125 (41.3)
Decortication	100 (33.0)
Pleural biopsy	87 (28.7)
Wedge resection	69 (22.8)
Clot evacuation	31 (10.2)
Pleural washout	28 (9.2)
Bullectomy	23 (7.6)
Bronchoscopy	13 (4.3)
Air leak control	9 (3.0)
Pericardial window	5 (1.7)
Rib resection	2 (0.7)
Lung volume reduction	2 (0.7)
Lymph node sampling	2 (0.7)
Great vessel repair	1 (0.3)
Pleural tent	1 (0.3)
Other	19 (6.3)
All	**303 (100.0)**

Table 23: Surgical procedures for all other surgeries

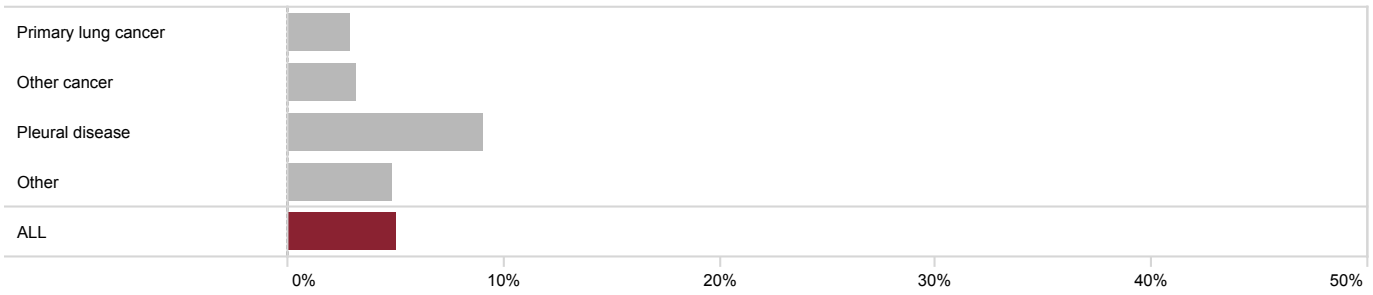
	n (%)
ORIF* ribs	24 (13.1)
Wedge resection	18 (9.8)
Sternal wiring/plating procedure	17 (9.3)
Bronchoscopy	15 (8.2)
Rib resection	12 (6.6)
Nuss bar procedure	12 (6.6)
Lobectomy	9 (4.9)
Pericardial window	9 (4.9)
Chest wall reconstruction	6 (3.3)
Lymph node sampling	6 (3.3)
Chest wall resection	5 (2.7)
Decortication	5 (2.7)
Sternal debridement	5 (2.7)
Plication	5 (2.7)
CIED# procedure	4 (2.2)
Hernia repair	4 (2.2)
Muscle flap	4 (2.2)
Open biopsy	4 (2.2)
Pectus repair	4 (2.2)
Washout procedure	4 (2.2)
Pericardial drainage	3 (1.6)
Chest wall biopsy	2 (1.1)
Clot evacuation	2 (1.1)
Endobronchial ablation	2 (1.1)
Great vessel repair	2 (1.1)
Hydatid cyst	2 (1.1)
Tracheobronchial stent	2 (1.1)
Sternectomy	2 (1.1)
Cardiopulmonary bypass	1 (0.5)
Chyle leak control	1 (0.5)
Pleural biopsy	1 (0.5)
Pleural drainage	1 (0.5)
Pneumonectomy	1 (0.5)
Removal of foreign body	1 (0.5)
Tracheoesophageal fistula repair	1 (0.5)
Tracheal repair	1 (0.5)
Other	43 (23.5)
All	**183 (100.0)**

* Open reduction internal fixation

\# Cardiac implantable electronic device

7.4 Blood product usage

Approximately 5% of all thoracic surgical cases required blood product usage. Just over 1% of patients were transfused with both red blood cell (RBC) and non-red blood cell products (NRBC). Overall, 9% of patients diagnosed with pleural disease required some blood product transfusion.



Excludes missing data (5.4%)

Figure 14: Proportion of cases requiring blood product transfusion

Table 24: Blood product types used by indication category

Indication	RBC and NRBC n (%)	RBC only n (%)	NRBC only n (%)	No blood products used n (%)
Primary lung cancer	2 (0.7)	6 (2.2)	–	265 (97.1)
Other cancer	5 (1.8)	4 (1.4)	–	275 (96.8)
Pleural disease	5 (1.7)	19 (6.6)	2 (0.7)	262 (91.0)
Other	2 (1.2)	6 (3.7)	–	156 (95.1)
All	**14 (1.4)**	**35 (3.5)**	**2 (0.2)**	**958 (94.9)**

Excludes missing data (5.4%)

8 Clinical outcomes

8.1 Length of stay

The median postoperative length of stay for thoracic surgery patients was five days, which ranged from three days to eleven days across indication categories.

For primary lung cancer cases the median post operative length of stay was five days, which compares similarly to results published through the Queensland Lung Cancer Quality Index.[43]

Table 25: Postoperative length of stay by indication category

Indication	Median days	Interquartile range days
Primary lung cancer	5	4–7
Other cancer	4	3–6
Pleural disease	5	3–11
Other	3	2–7
All	**5**	**3–8**

8.2 Major morbidity

There were 123 cases (12%) having one or more new major morbidities recorded post procedure. The incidence rate of major morbidity ranged from 15% in the primary lung cancer and pleural disease groups to 7% in the other indication category.

An air leak lasting greater than seven days occurred postoperatively in 2.9% of thoracic surgeries.

Table 26: New major morbidity by diagnosis category

Indication	Yes n (%)	No n (%)
Primary lung cancer	41 (15.0)	232 (85.0)
Other cancer	25 (8.8)	260 (91.2)
Pleural disease	45 (15.4)	247 (84.6)
Other	12 (7.3)	153 (92.7)
All	**123 (12.1)**	**892 (87.9)**

Excludes missing data (4.7%)

Table 27: Type of major morbidity

Major morbidity type	n (%)
Air leak >7days	31 (2.9)
Air leak 3–7days	25 (2.3)
Atrial fibrillation	25 (2.3)
Wound infection	21 (2.0)
Reoperation	14 (1.3)
Pneumonia	13 (1.2)
Pulmonary embolism	4 (0.4)
Bronchopleural fistula	2 (0.2)
Other major morbidity	13 (1.2)

Excludes missing data (4.7%)

8.3 Primary lung cancer outcomes

8.3.1 Final histopathology

In patients with a preoperative suspicion of primary lung malignancy, adenocarcinoma (69%) was the most common lung cancer according to final histopathology, followed by squamous cell carcinoma (16%).

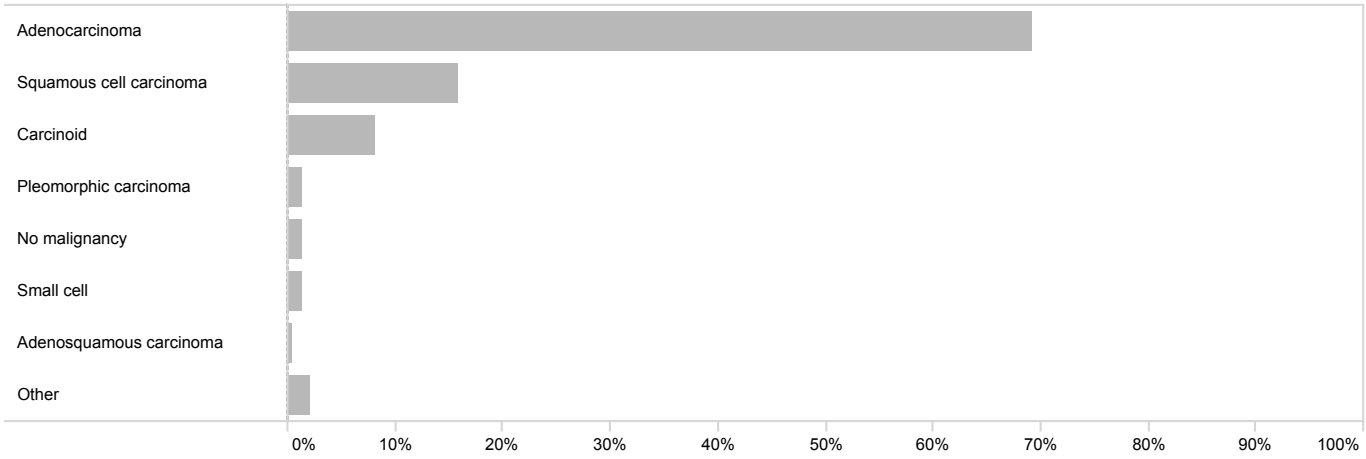


Figure 15: Proportion of primary lung cancer cases by final histopathology

Table 28: Final histopathology results for primary lung malignancy

Histopathology	n (%)
Adenocarcinoma	196 (69.0)
Squamous cell carcinoma	45 (15.8)
Carcinoid	23 (8.1)
Pleomorphic carcinoma	4 (1.4)
Small cell	4 (1.4)
Adenosquamous carcinoma	2 (0.7)
No malignancy	4 (1.4)
Other	6 (2.1)
All	**284 (100.0)**

Excludes missing data (4.9%)

8.3.2 Stage classification

The tumour-node-metastasis (TNM)[44] staging classification system has been used to categorise lung cancer cases into stages of severity. Primary lung malignancy patients are clinically staged in the preoperative period as well as pathologically staged postoperatively. Assessing cancer staging plays an important role in guiding treatment options for patients. It is important to note that these cases below are the cohort of primary lung cancer patients who proceeded to surgical intervention.

Tumours graded Ia2 (22%) and Ib (22%) were the most common postoperative pathological TNM classification for primary lung malignancy, followed by Ia3 (19%). Preoperatively diagnosed stage four cancers (1.3%) are the least likely malignancy to proceed to surgery when compared with other cancer stages.

Table 29: Primary lung malignancy by preoperative clinical classification

Clinical classification	n (%)
Ia1	12 (5.3)
Ia2	61 (26.9)
Ia3	46 (20.3)
Ib	49 (21.6)
IIa	12 (5.3)
IIb	24 (10.6)
IIIa	18 (7.9)
IIIb	2 (0.9)
IVa	2 (0.9)
IVb	1 (0.4)
All	**227 (100.0)**

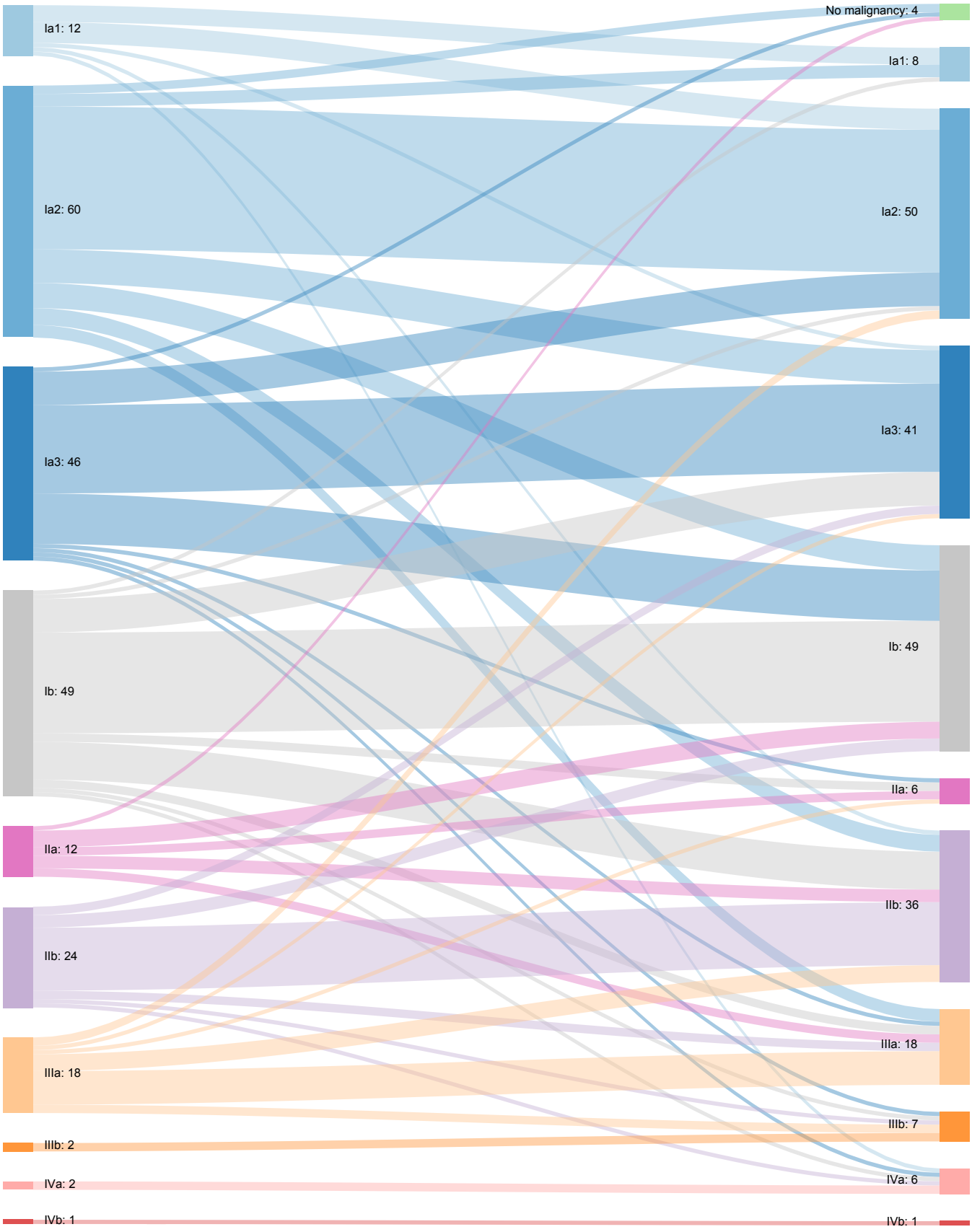
Excludes missing data (20.1%)

Table 30: Primary lung malignancy by postoperative pathological classification

Pathological classification	n (%)
Ia1	8 (3.5)
Ia2	50 (22.0)
Ia3	42 (18.5)
Ib	49 (21.6)
IIa	6 (2.6)
IIb	36 (15.9)
IIIa	18 (7.9)
IIIb	7 (3.1)
IVa	6 (2.6)
IVb	1 (0.4)
No malignancy	4 (1.8)
All	**227 (100.0)**

Excludes missing data (20.1%)

Of the 227 primary lung cancer procedures with complete data, pathological upstaging occurred in 32% of cases while 19% were downstaged postoperatively and 50% had no change to the preoperative staging classification.



Excludes missing data (20.1%)

Figure 16: Primary lung cancer cases by clinical and pathological TNM classification

8.4 Unadjusted all-cause mortality

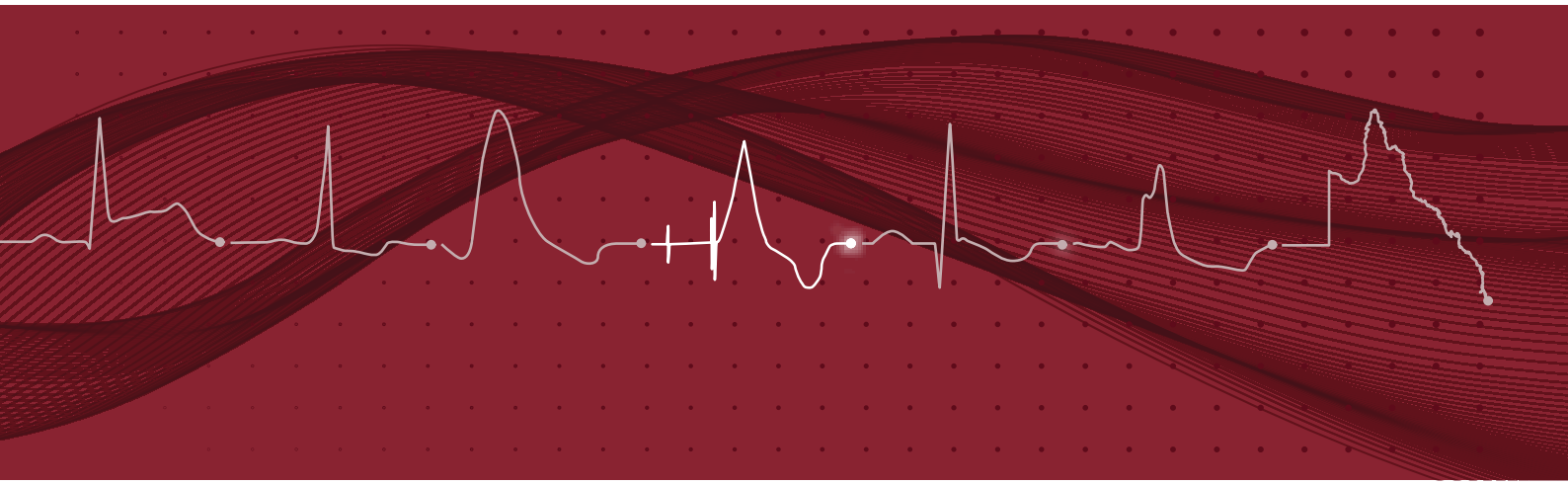
The unadjusted all-cause mortality rate within 30 days of all thoracic surgery was 1.2%, increasing to 2.4% at 90 days. Mortality rates at 90 days for malignancy related surgeries are higher than the overall group, though caution should be used when interpreting these results due to small patient volumes in this cohort.

Survival following thoracic surgery is influenced by many factors which are not always directly related to the operation itself. Outcomes of thoracic surgery for cancer can be affected by how advanced the malignancy is. Within this cohort, approximately 3% of lung cancers are postoperatively classified as stage IV, which is associated with an inherently high short-term mortality rate.

Table 31: All-cause unadjusted mortality up to 90 days post surgery

Indication	Total cases n	Death in 30 days n (%)	Death in 90 days n (%)
Primary lung cancer	284	3 (1.1)	5 (1.8)
Other cancer	297	5 (1.7)	13 (4.4)
Pleural disease	303	4 (1.3)	5 (1.7)
Other	183	1 (0.5)	3 (1.6)
All	**1,067**	**13 (1.2)**	**26 (2.4)**

Electrophysiology and Pacing Audit



1 Message from the QCOR Electrophysiology and Pacing Committee

Electrophysiology and pacing services in Queensland public facilities continue to experience growth and expansion. In particular, electrophysiology (EP) and ablation procedures continue to increase in volume demonstrating the demand for these investigations and interventions. These increases have been accommodated despite uncertainty and disruptions to services due to COVID-19. Once again, COVID-19 has highlighted the flexibility and adaptability of EP clinicians in ensuring the best possible care to Queenslanders.

This 2021 Annual Report once again offers detailed insight into key aspects of these procedures across the state of Queensland. All nine public sites once again are included in this analysis with detailed information on patient demographics, procedures and their outcomes. With each year of additional data, the registry builds an increasingly detailed picture to guide improvements in EP service delivery around the state and performs the role of a quality and safety program.

Furthermore, a sustained increase in volumes of complex EP studies continues to be observed with these technically challenging procedures now accounting for more than three quarters of all electrophysiology procedures with a commensurate increase in pulmonary vein isolation cases. It is expected that this demand will only increase over time, given the ageing population.

For yet another year, quality and safety indicators continue to demonstrate that procedural safety is in line with, or better than international benchmarks. The value of the data that underpins these analyses is reflected through site-based investigations into procedural volumes, outcomes and trends that ensure appropriate service planning, practice reflection and quality improvement activities can take place.

Significant savings for the health system continue to be realised through processes supported by QCOR. Cost savings have enabled funds to be reinvested into further improvements to the provision of patient care and service expansion. With a growing pool of data and analyses available to inform its stakeholders, it is hoped that the future of EP and pacing services can continue to expand and evolve to serve the needs of all Queenslanders.

On behalf of the
QCOR Electrophysiology and Pacing Committee

2 Key findings

This Electrophysiology and Pacing Audit describes baseline demographics, risk factors, procedures performed and outcomes for 2021.

Key findings include:

- Across Queensland, nine public sites contributed to the registry with all sites contributing a complete year of data.
- Of the 5,269 electrophysiology and pacing cases, 3,500 were device procedures and 1,345 were electrophysiology procedures.
- An increase of 311 device procedures was observed in 2021 over 2019 volumes and an additional 297 electrophysiology procedures were performed.
- Complex electrophysiology has increased as proportion of all electrophysiology cases from 64% in 2019 to 76% in 2021.
- Pulmonary vein isolation for atrial fibrillation cases have increased from 290 in 2019 to 367 in 2021.
- Almost three quarters of patients were aged 60 years or over (69%) with a median age of 69 years.
- The overall proportion of Aboriginal and Torres Strait Islander patients was 4.5%.
- The vast majority of patients (72%) were classed as having an unhealthy body mass index (BMI) of greater than 30 kg/m^2.
- Complex electrophysiology procedures which utilise three-dimensional mapping technology, involve pulmonary vein isolation or ventricular arrhythmias accounted for 76% of this case cohort.
- Atrial flutter, pulmonary vein isolation for atrial fibrillation, and atrioventricular node re-entry tachycardia ablations accounted for 70% of all ablation cases.
- The reported complication rate for all device procedures was 0.9%, while electrophysiology procedures had a 1.3% complication rate.
- There was a 0.3% procedural tamponade rate reported for all cases.
- The statewide median wait time for complex ablation was 78 days with 78% of cases meeting the 180 day benchmark.
- The 12 month device system loss rate due to infection was 0.4%.

3 Participating sites

There were nine public electrophysiology and pacing units spread across Metropolitan and regional Queensland. All of these entered data directly into the Queensland Cardiac Outcomes Registry (QCOR) electrophysiology and pacing application.

Patients came from a wide geographical area, with the majority of patients residing on the Eastern Seaboard.

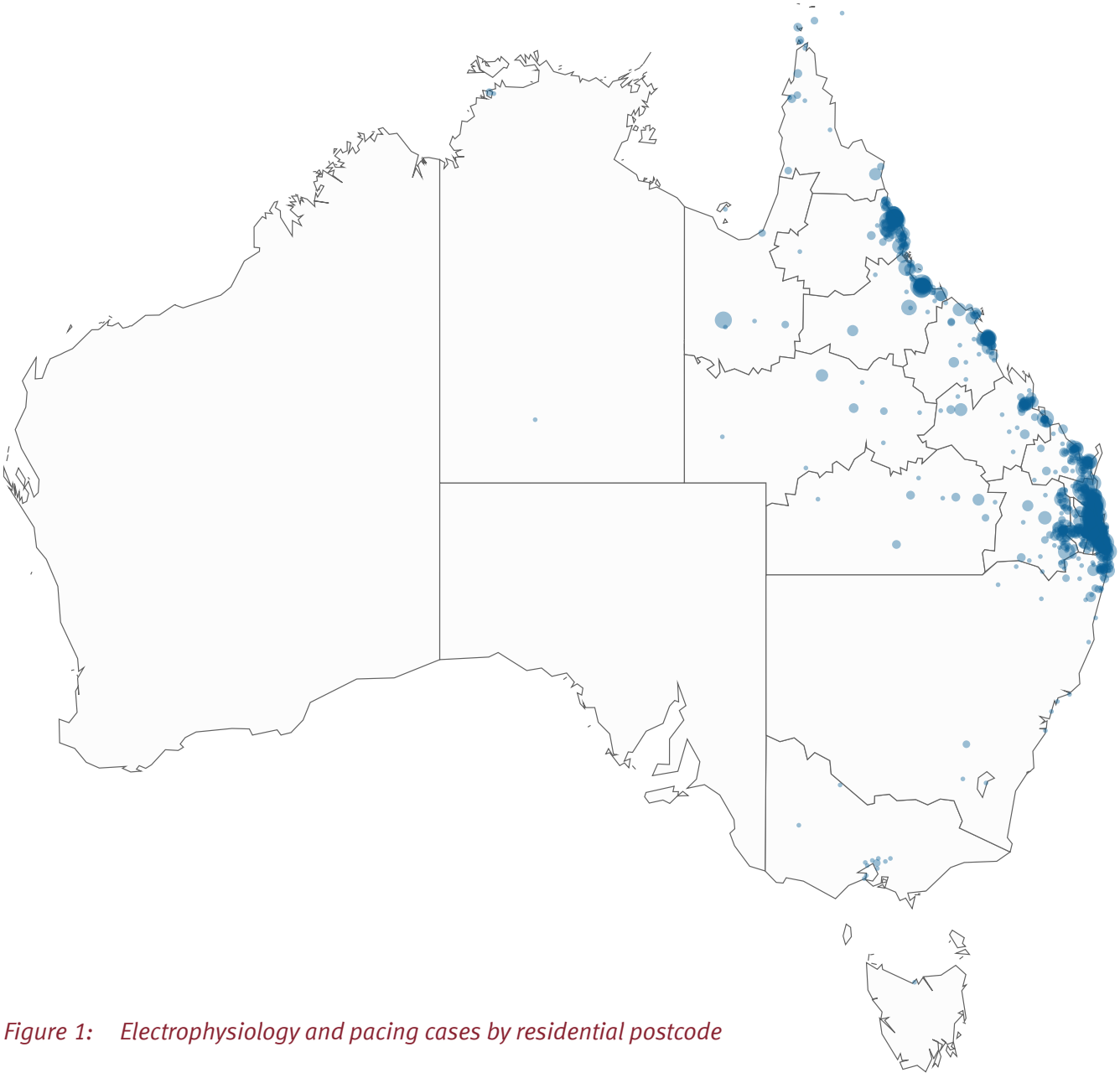


Figure 1: Electrophysiology and pacing cases by residential postcode

Table 1: Participating sites

Acronym	Site name
CH	Cairns Hospital
TUH	Townsville University Hospital
MBH	Mackay Base Hospital
SCUH	Sunshine Coast University Hospital
TPCH	The Prince Charles Hospital
RBWH	Royal Brisbane & Women's Hospital
PAH	Princess Alexandra Hospital
TWH	Toowoomba Hospital
GCUH	Gold Coast University Hospital

4 Case totals

4.1 Case volume

In 2021, were 5,269 electrophysiology and pacing procedures documented using the QCOR electrophysiology and pacing application.

Table 2: Total cases by category

Procedure combination	Category	Total cases n (%)
Cardiac device procedure	Device	3,452 (65.5)
Cardiac device procedure + EP study		31 (0.6)
Cardiac device procedure + other procedure		8 (0.2)
Cardiac device procedure + cardioversion		3 (0.1)
Cardiac device procedure + drug challenge		3 (0.1)
Cardiac device procedure + EP study + ablation		2 (<0.1)
Cardiac device procedure + EP study + drug challenge		1 (<0.1)
EP study + ablation	EP	968 (18.4)
EP study		176 (3.3)
Ablation		147 (2.8)
EP study + ablation + cardioversion		32 (0.6)
EP study + drug challenge		7 (0.1)
EP study + ablation + other procedure		6 (0.1)
EP study + ablation + drug challenge		2 (<0.1)
EP study + cardioversion		2 (<0.1)
EP study + other procedure		2 (<0.1)
Ablation + cardioversion		1 (<0.1)
EP study + ablation + cardioversion + pericardiocentesis		1 (<0.1)
EP study + ablation + pericardiocentesis		1 (<0.1)
Cardioversion	Other	344 (6.5)
Drug challenge		34 (0.6)
Other procedure		31 (0.6)
Pericardiocentesis		9 (0.2)
Cardioversion + other procedure		3 (0.1)
Drug challenge + cardioversion		1 (<0.1)
Drug challenge + other procedure		1 (<0.1)
Pericardiocentesis + other procedure		1 (<0.1)
All		**5,269 (100.0)**

4.2 Cases by category

The majority of cases performed were cardiac device procedures accounting for two thirds (66%) of documented procedures. The rest of the cases were electrophysiology and ablation procedures (26%), with the remainder categorised as 'other' procedures (8%).

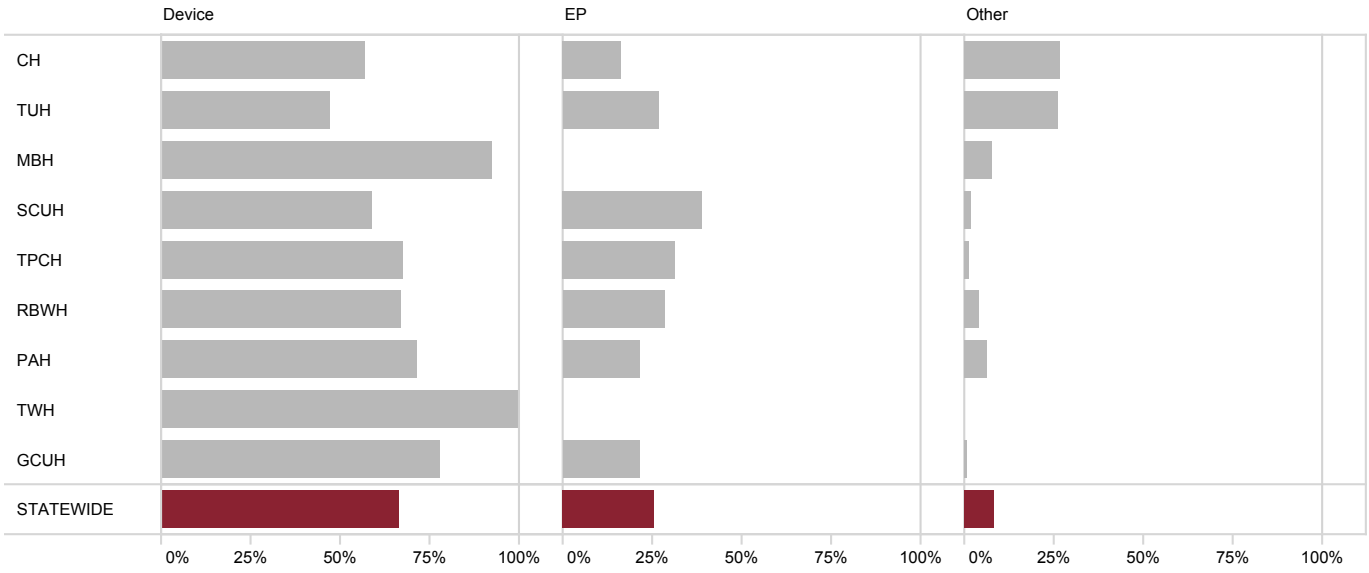


Figure 2: Proportion of cases by site and category

Table 3: Cases by case category

Site	Device n (%)	EP n (%)	Other n (%)	Total n (%)
CH	342 (9.8)	97 (7.2)	160 (37.7)	599 (11.4)
TUH	250 (7.1)	141 (10.5)	140 (33.0)	531 (10.1)
MBH	123 (3.5)	–	10 (2.4)	133 (2.5)
SCUH	366 (10.5)	249 (18.5)	9 (2.1)	624 (11.8)
TPCH	764 (21.8)	352 (26.2)	11 (2.6)	1,127 (21.4)
RBWH	424 (12.1)	180 (13.4)	26 (6.1)	630 (12.0)
PAH	683 (19.5)	208 (15.5)	64 (15.1)	955 (18.1)
TWH	122 (3.5)	–	–	122 (2.3)
GCUH	426 (12.2)	118 (8.8)	4 (0.9)	548 (10.4)
STATEWIDE	**3,500 (66.4)**	**1,345 (25.5)**	**424 (8.1)**	**5,269 (100.0)**

4.3 Yearly case distribution

Yearly growth has been noted over the years since QCOR reporting has begun and this can now be better understood with a larger dataset. It is evident that since 2019 that the volume of cardiac device procedures and electrophysiology procedures has increased. The reasons for these increases are likely multifactorial and include expansion of services at some sites and new services offered at others.

The complexity of electrophysiology procedures has a large bearing on the time taken and resources used to perform these procedures. A notable increase in the volume and proportion of complex electrophysiology procedures can be seen over time. Again, there are multiple underlying contributing factors to this increase and that this increase in ability to treat complex cases underlines the quality services in place.

An increase in the proportion and volume of pulmonary vein isolation/atrial fibrillation ablation has been observed over the past three years. It is recognised that there is a significant demand for these services.

Wait times for procedure categories and urgency status has varied over the past three years. Of particular note is a decrease in wait time for both elective PPM and ICD procedures. Also, wait times for complex ablation procedures has reduced in 2021 (104 days to 78 days).

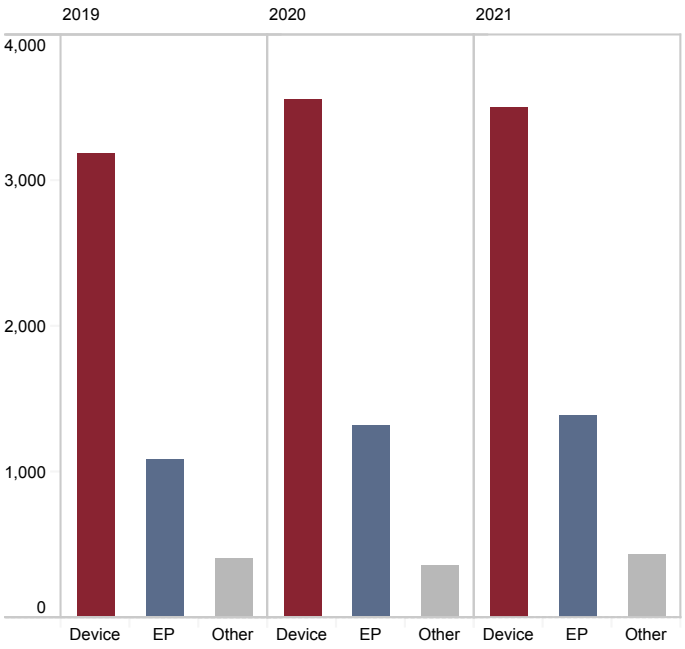


Figure 3: Proportion of cases by category, 2019–2021

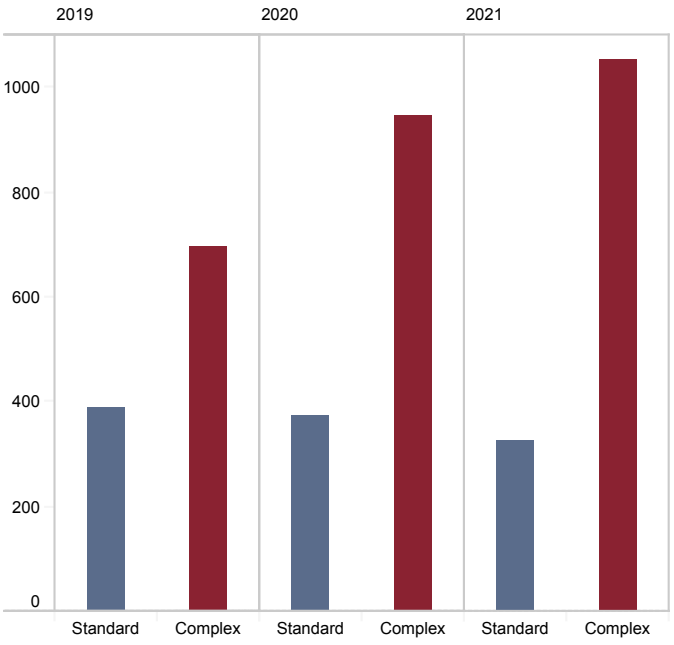


Figure 4: Yearly case volume by electrophysiology procedural complexity, 2019–2021

Table 4: Yearly case volume by case category, 2019–2021

Case category	2019 n	2020 n	2021 n
Device	3,189	3,551	3,500
EP	1,082	1,319	1,379
Other	407	364	424

Table 5: Yearly case volume by electrophysiology procedural complexity, 2019–2021

Electrophysiology procedure complexity	2019 n (%)	2020 n (%)	2021 n (%)
Standard	389 (36.0)	374 (28.3)	327 (23.7)
Complex	693 (64.0)	946 (71.7)	1,052 (76.3)

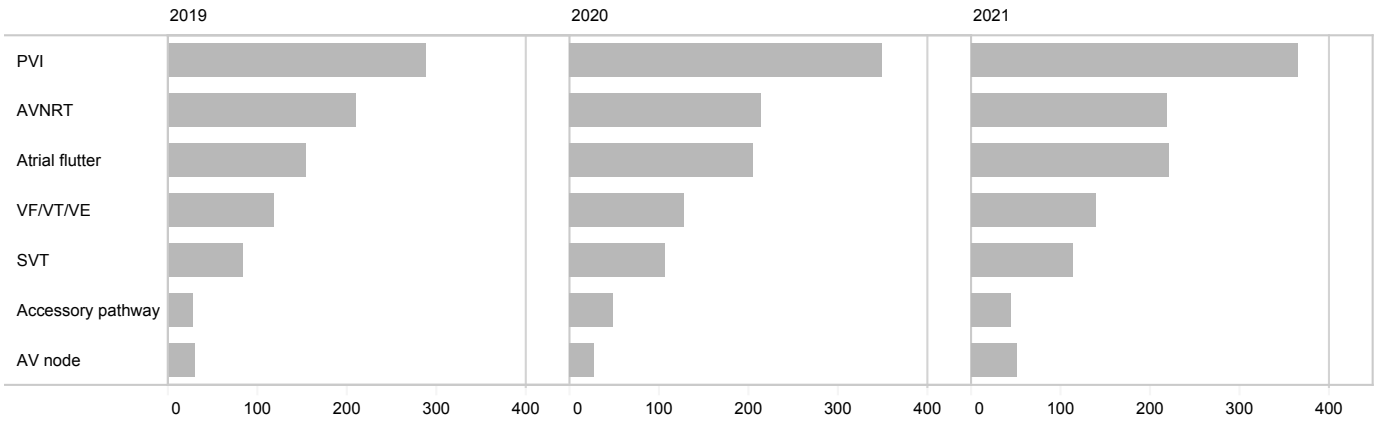


Figure 5: Number of yearly ablation cases by arrhythmia type, 2019–2021

Table 6: Yearly ablation cases by arrhythmia type, 2019–2021

Ablation type	2019 n	2020 n	2021 n
Pulmonary vein isolation	290	349	367
AVNRT	210	214	219
Atrial flutter	154	205	221
Ventricular arrhythmia/ectopy	118	129	141
Supraventricular tachycardia	83	107	115
Accessory pathway	29	49	45
AV node	30	27	52

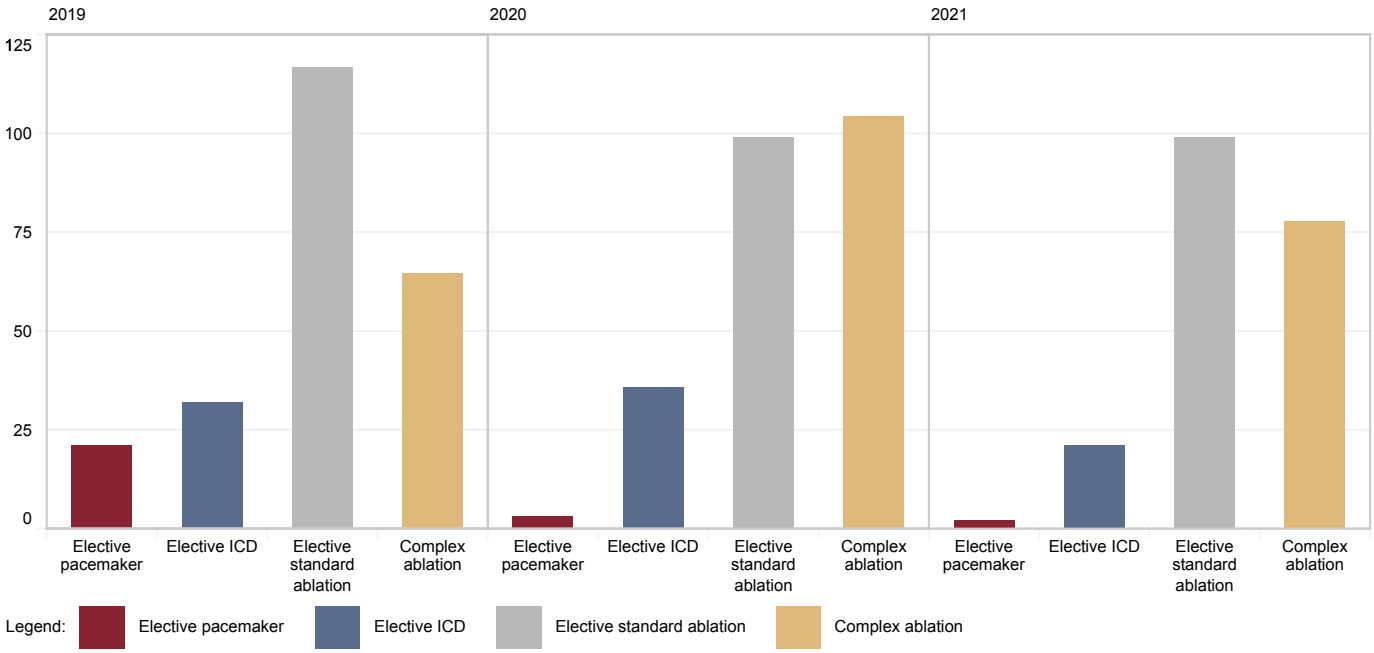


Figure 6: Median wait time analysis by procedure category, 2019–2021

Table 7: Median wait time analysis by procedure category, 2019–2021

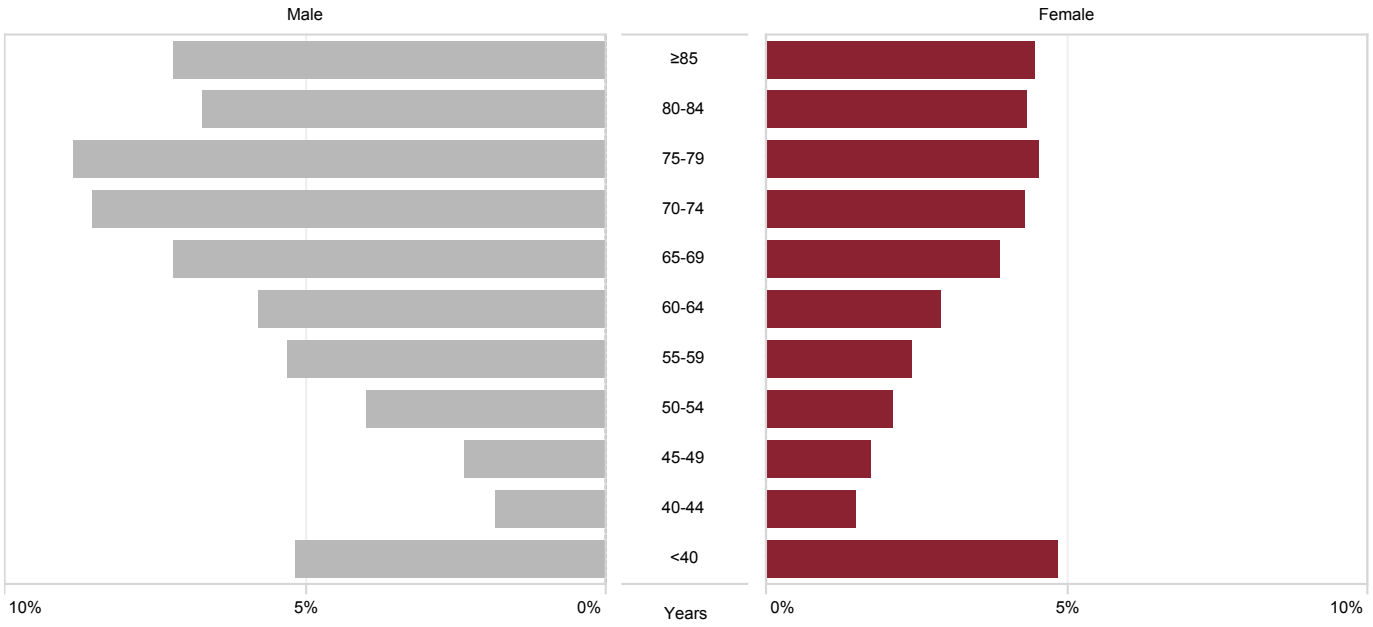
Procedure category	2019 days	2020 days	2021 days
Elective PPM	21	3	2
Elective ICD	32	36	21
Elective standard ablation	117	99	99
Complex ablation	65	104	78

5 Patient characteristics

5.1 Age and gender

Age is an important risk factor for developing cardiovascular disease with the majority of patients in this cohort aged 60 years and above (69%). The median age of the overall electrophysiology and pacing patient cohort was 69 years of age. Males between the age of 75 and 79 comprised the largest proportion by age and gender.

The median age of males was 69 years with females marginally younger at 68 years. Patient age differed considerably by procedure category with the median age of patients undergoing electrophysiology procedures being 57 years compared to 74 years for cardiac device procedures.



% of total (n=5,269)

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

Table 8: Median age by gender and case category

	Total cases n	Male years	Female years	All years
Device	3,500	73	74	74
EP	1,345	59	54	57
Other	424	64	67	65
Total	**5,269**	**69**	**68**	**69**

Overall, 63% of patients were male with a similar distribution across all procedure categories. The largest proportion of females was represented in the electrophysiology category (39%).

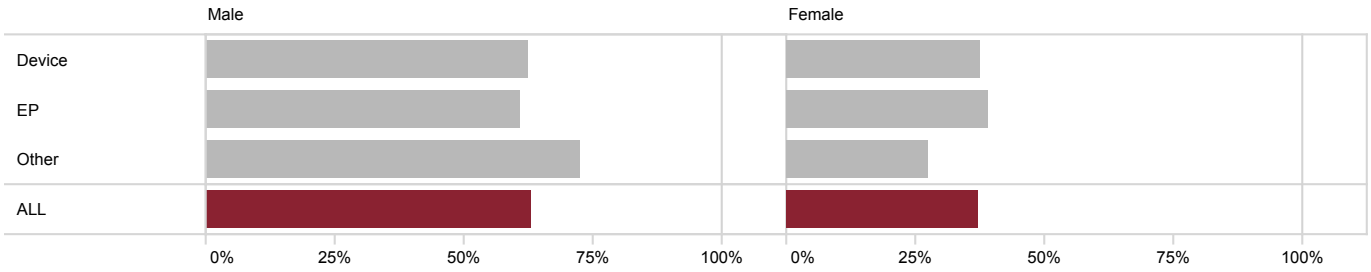


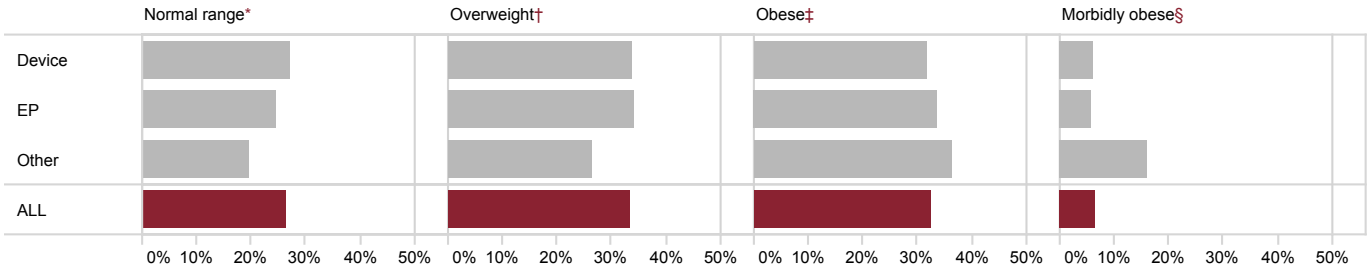
Figure 8: Proportion of cases by gender and category

Table 9: Proportion of cases by gender and category

	Total cases n	Male n (%)	Female n (%)
Device	3,500	2,186 (62.5)	1,314 (37.5)
EP	1,345	820 (61.0)	525 (39.0)
Other	424	308 (72.6)	116 (27.4)
All	**5,269**	**3,314 (62.9)**	**1,955 (37.1)**

5.2 Body mass index

Patients classed as having a body mass index (BMI) category of overweight (33%), obese (33%) or morbidly obese (6%) represented almost three quarters of all electrophysiology and pacing patients. Patients classed as underweight represented less than 2% of all cases.



* 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 case category

5.3 Aboriginal and Torres Strait Islander status

Overall, the proportion of identified Aboriginal and Torres Strait Islander patients undergoing electrophysiology and pacing procedures was 4.5%. This correlates closely to the estimated proportion of Aboriginal and Torres Strait Islander peoples within Queensland (4.6%).[2] There was large variation between units, with the North Queensland and western Queensland sites seeing a larger proportion of Aboriginal and Torres Strait Islander patients.

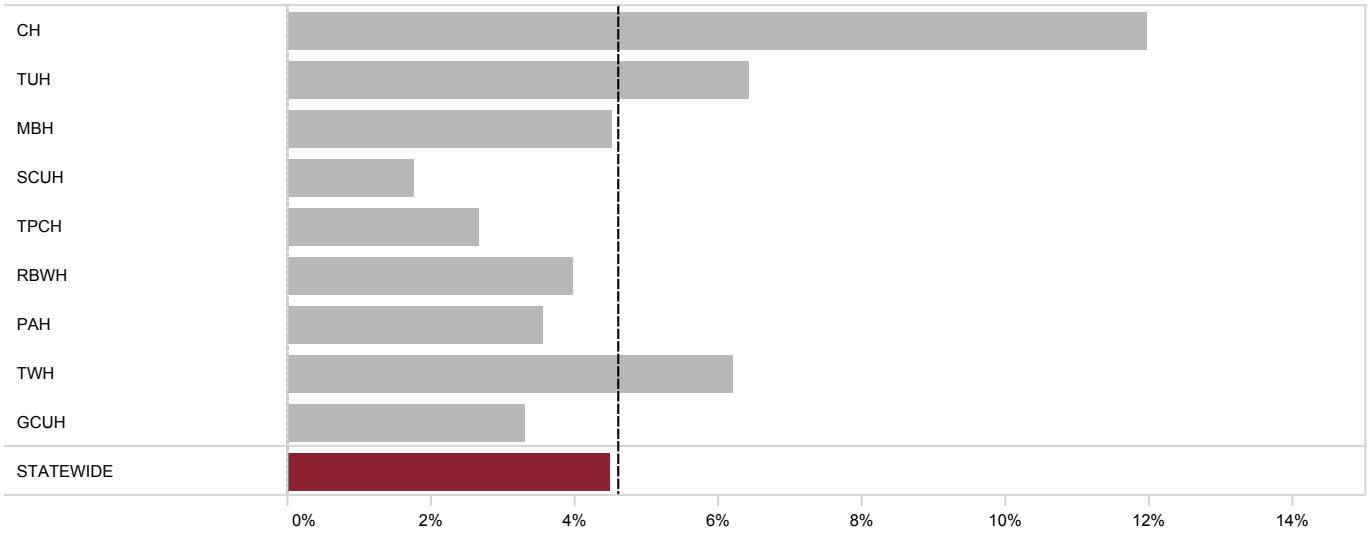


Figure 10: Proportion of cases by identified Aboriginal and Torres Strait Islander status and site

5.4 Device procedures

Case types and procedure combinations varied across the state and is driven primarily by services offered at individual sites. Single and dual chamber pacemaker implants/generator changes accounted for the majority of cases. There were eight sites across the state offering biventricular (BiV) pacemaker/ implantable cardioverter defibrillator insertion, with six sites providing leadless pacemaker implants.

Table 10: Cardiac device case types by site

Procedure type	CH	TUH	MBH	SCUH	TPCH	RBWH	PAH	TWH	GCUH
	n	n	n	n	n	n	n	n	n
Pacemaker procedure*	147	112	56	183	374	164	396	84	253
Loop recorder implant/explant	99	25	66	62	73	127	73	10	39
ICD procedure*	54	45	–	46	110	69	97	12	64
BiV ICD procedure*	23	31	–	34	98	32	53	6	34
BiV pacemaker procedure*	4	25	–	22	24	8	12	5	9
Lead revision/replacement/pocket revision	6	2	1	17	24	16	19	5	14
Device explant	4	3	–	2	50	3	8	–	2
Temporary pacing system	2	3	–	–	4	3	24	–	4
Leadless pacemaker implant	3	4	–	–	6	2	1	–	7
Defibrillation threshold testing	–	–	–	–	1	–	–	–	–
All	**342**	**250**	**123**	**366**	**764**	**424**	**683**	**122**	**426**

* Implant/generator change/upgrade

5.5 Electrophysiology studies/ablations

Electrophysiology studies involving radiofrequency ablation were the most common individual procedure performed across all sites, ranging from 57% of case volume at Cairns Hospital to 84% at TUH.

Table 11: Electrophysiology study/ablation types by site

Site	Procedure type	Complex EP n	Standard EP n	Case n (%)
CH	Radiofrequency ablation	17	39	56 (56.6)
	Cryotherapy ablation	20	–	20 (20.2)
	Electrophysiology study	9	10	19 (19.2)
	Radiofrequency and cryotherapy ablation	3	–	3 (3.0)
	Electrophysiology study and drug challenge	–	1	1 (1.0)
TUH	Radiofrequency ablation	97	21	118 (83.7)
	Electrophysiology study	10	3	13 (9.2)
	Cryotherapy ablation	8	–	8 (5.7)
	Radiofrequency and cryotherapy ablation	2	–	2 (1.4)
SCUH	Radiofrequency ablation	160	16	176 (69.6)
	Electrophysiology study	28	9	37 (14.6)
	Cryotherapy ablation	36	–	36 (14.2)
	Electrophysiology study and drug challenge	–	4	4 (1.6)
TPCH	Radiofrequency ablation	177	68	245 (67.7)
	Cryotherapy ablation	63	1	64 (17.7)
	Electrophysiology study	25	25	50 (13.8)
	Radiofrequency and cryotherapy ablation	2	–	2 (0.6)
	Electrophysiology study and drug challenge	–	1	1 (0.3)
RBWH	Radiofrequency ablation	125	1	126 (68.1)
	Electrophysiology study	29	4	33 (17.8)
	Cryotherapy ablation	19	–	19 (10.3)
	Radiofrequency and cryotherapy ablation	5	–	5 (2.7)
	Electrophysiology study and drug challenge	2	–	2 (1.1)
PAH	Radiofrequency ablation	123	52	175 (79.2)
	Electrophysiology study	17	24	41 (18.6)
	Electrophysiology study and drug challenge	2	1	3 (1.4)
	Cryotherapy ablation	2	–	2 (0.8)
GCUH	Radiofrequency ablation	55	35	90 (76.3)
	Electrophysiology study	4	10	14 (11.9)
	Cryotherapy ablation	11	1	12 (10.2)
	Radiofrequency and cryotherapy ablation	1	–	1 (0.8)
	Electrophysiology study and drug challenge	–	1	1 (0.8)
STATEWIDE		**1,052**	**327**	**1,379**

5.5.1 Ablation type/arrhythmia

The most frequently ablated clinical arrhythmia was atrial fibrillation (pulmonary vein isolation), which accounted for 32% of ablations across all sites. This was followed by atrioventricular nodal re-entry tachycardias (AVNRT) (19%) and atrial flutter (19%).

Age and gender varied depending on the arrythmia ablated. Patients undergoing accessory pathway ablation had a lower median age than those who underwent pulmonary vein isolation or AV node ablation. Furthermore, almost three quarters of patients undergoing pulmonary vein isolation were male which contrasts with the AVNRT cohort which is predominately a female group.

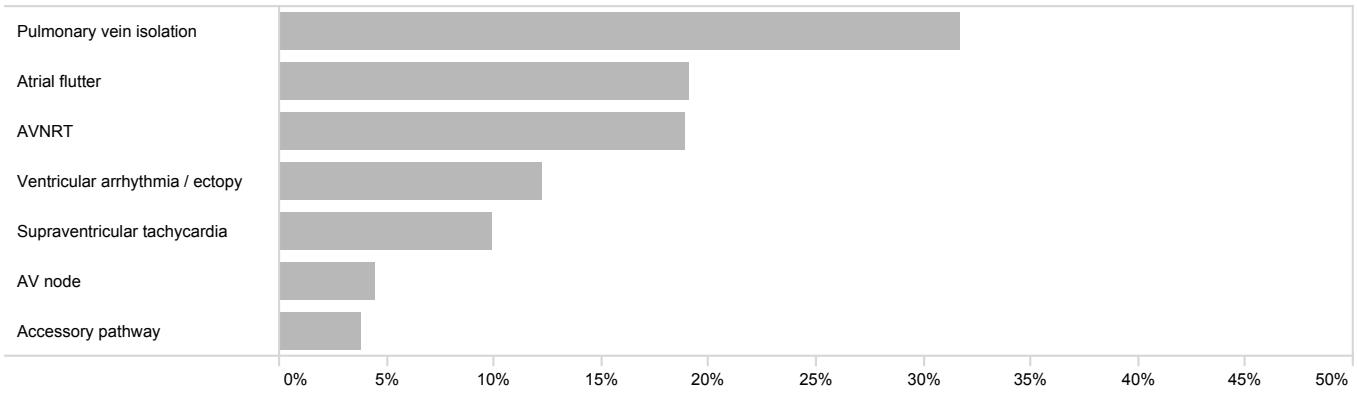


Figure 11: Proportion of arrhythmias ablated

Table 12: Median age and gender by ablation type

Ablation type	Gender	Total cases n (%)	Median age years
Pulmonary vein isolation	Male	270 (73.6)	58
	Female	97 (26.4)	64
Atrial flutter	Male	158 (71.5)	64
	Female	63 (28.5)	65
AVNRT	Male	85 (38.8)	60
	Female	134 (61.2)	47
Ventricular arrhythmia/ectopy	Male	87 (61.7)	61
	Female	54 (38.3)	47
Supraventricular tachycardia	Male	60 (52.2)	43
	Female	55 (47.8)	36
AV node	Male	22 (42.3)	76
	Female	30 (57.7)	74
Accessory pathway	Male	32 (71.1)	33
	Female	13 (28.9)	32
All		**1,160 (100.0)**	**58**

Table 13: Arrhythmia type by site

Site	Ablation type	Count n (%)
CH	Pulmonary vein isolation	29 (2.5)
	AVNRT	17 (1.5)
	Atrial flutter	16 (1.4)
	AV node	11 (0.9)
	Supraventricular tachycardia	4 (0.3)
	Ventricular arrhythmia/ectopy	2 (0.2)
TUH	Pulmonary vein isolation	39 (3.4)
	AVNRT	26 (2.2)
	Ventricular arrhythmia/ectopy	25 (2.2)
	Atrial flutter	16 (1.4)
	Supraventricular tachycardia	8 (0.7)
	AV node	8 (0.7)
	Accessory pathway	6 (0.5)
SCUH	Pulmonary vein isolation	71 (6.1)
	Atrial flutter	65 (5.6)
	AVNRT	29 (2.5)
	AV node	18 (1.6)
	Supraventricular tachycardia	15 (1.3)
	Ventricular arrhythmia/ectopy	8 (0.7)
	Accessory pathway	6 (0.5)
TPCH	Pulmonary vein isolation	96 (8.3)
	Ventricular arrhythmia/ectopy	60 (5.2)
	AVNRT	57 (4.9)
	Atrial flutter	45 (3.9)
	Supraventricular tachycardia	36 (3.1)
	Accessory pathway	13 (1.1)
	AV node	4 (0.3)
RBWH	Pulmonary vein isolation	40 (3.4)
	AVNRT	34 (2.9)
	Atrial flutter	32 (2.8)
	Supraventricular tachycardia	20 (1.7)
	Ventricular arrhythmia/ectopy	17 (1.5)
	Accessory pathway	6 (0.5)
	AV node	1 (0.1)
PAH	Pulmonary vein isolation	55 (4.7)
	AVNRT	36 (3.1)
	Atrial flutter	28 (2.4)
	Ventricular arrhythmia/ectopy	21 (1.8)
	Supraventricular tachycardia	20 (1.7)
	Accessory pathway	11 (0.9)
	AV node	6 (0.5)
GCUH	Pulmonary vein isolation	37 (3.2)
	AVNRT	20 (1.7)
	Atrial flutter	19 (1.6)
	Supraventricular tachycardia	12 (1.0)
	Ventricular arrhythmia/ectopy	8 (0.7)
	AV node	4 (0.3)
	Accessory pathway	3 (0.3)
STATEWIDE		**1,160 (100.0)**

5.6 Other procedures

The most common other procedure was cardioversion (82%). Variations in clinical practice across sites can be observed here with not all cardioversions performed being carried out in the electrophysiology laboratory environment or documented using the QCOR module.

Table 14: Other procedures

	Total n	Cardioversion n (%)	Drug challenge n (%)	Other procedure n (%)	Pericardiocentesis n (%)
CH	160	139 (86.9)	12 (7.5)	4 (2.5)	5 (3.1)
TUH	140	130 (92.9)	3 (2.1)	7 (5.0)	–
MBH	10	10 (100.0)	–	–	–
SCUH	9	1 (11.1)	5 (55.6)	1 (11.1)	2 (22.2)
TPCH	11	–	5 (45.5)	3 (27.3)	3 (27.3)
RBWH	26	13 (50.0)	5 (19.2)	8 (30.8)	–
PAH	64	55 (85.9)	4 (6.3)	5 (7.8)	–
GCUH	4	–	1 (25.0)	3 (75.0)	–
STATEWIDE	**424**	**348 (82.1)**	**35 (8.3)**	**31 (7.3)**	**10 (2.4)**

6 Procedural complications

Complications are a well-known, but rare outcome following any medical procedure or intervention. Some complications are more severe than others with a wide range of management options. The summary of complications below denotes events observed during and post procedure. The QCOR electrophysiology application is predominantly utilised for procedural detail reporting and as such, documentation of peri and post-procedural complications is the responsibility of site practitioners.

The complication rates for procedures are reflected as the proportion of the total number of device and electrophysiology procedures respectively. On some rare occasions, the development of an intraprocedural complication such as coronary sinus dissection necessitated a change of procedure type from BiV implant/upgrade to a non BiV device procedure. In these instances, complications are reported against the final procedure type.

The overall device procedure complication rate was 0.9%, while electrophysiology procedures had a 1.3% complication rate.

Table 15: Cardiac device procedure complications

Procedure type	Complication	Total n (%)
Pacemaker implant/generator change	Lead complication	2 (0.1)
	Pericardial effusion with tamponade	2 (0.1)
	Vascular injury	2 (0.1)
	Coronary sinus dissection	1 (0.1)
	Pericardial effusion without tamponade	1 (0.1)
	Other	1 (0.1)
ICD implant/generator change/upgrade	Cardiac arrest	1 (0.2)
	Coronary sinus dissection	1 (0.2)
	Haemodynamic instability	1 (0.2)
	Drug reaction	1 (0.2)
	Pericardial effusion with tamponade	1 (0.2)
BIV ICD implant/generator change/upgrade	Cardiac arrest	6 (1.9)
	Coronary sinus dissection	3 (1.0)
	Pneumothorax	1 (0.3)
	Haemodynamic instability	1 (0.3)
BIV pacemaker implant/generator change/upgrade	Coronary sinus dissection	1 (0.9)
Lead revision/replacement/pocket revision	Vascular injury	1 (1.0)
	Lead complication	1 (1.0)
Temporary pacing system	Drug reaction	1 (2.5)
	Conduction block	1 (2.5)
All		**30 (0.9)**

Table 16: Electrophysiology procedure complications by study type and complexity

Procedure type	Complexity	Complication	Total n (%)
Electrophysiology study	Complex EP	Pericardial effusion with tamponade	1 (0.8)
		Cardiac arrest	1 (0.8)
		Other	1 (0.8)
Cryotherapy ablation	Complex EP	Phrenic nerve injury	3 (1.9)
Radiofrequency ablation	Standard EP	Pericardial effusion with tamponade	1 (0.4)
	Complex EP	Pericardial effusion with tamponade	9 (1.2)
		Conduction block	2 (0.3)
All			**18 (1.3)**

7 Clinical indicators

Clinical indicators are important measures of the clinical management and outcomes of patient care. An indicator that is clinically relevant and useful should highlight specific issues that may require attention or signal areas for improvement. Rate-based indicators typically identify the rate of occurrence of an event. There is emerging recognition that a capacity to evaluate and report on quality is a critical building block for system-wide improvement of healthcare delivery and patient outcomes.

The quality and safety indicators which have been nominated by the QCOR Electrophysiology and Pacing Committee are outlined below.

Table 17: Electrophysiology and pacing clinical indicators

Clinical indicator	Description
1	Waiting time from booking date to procedure by case category
2	Procedural tamponade rates
3	Reintervention within one year of procedure date due to cardiac device lead dislodgement
4	Rehospitalisation within one year of procedure due to infection resulting in loss of the device
5	12 month all-cause mortality for cardiac device procedures

7.1 Waiting time from referral date to procedure by case category

Waiting times for clinical interventions and investigations are an important metric for monitoring service provision and identifying potential unmet need. This clinical indicator examines the waiting time for various cardiac device procedure types. Specifically, the median wait time from the date the procedure was referred to the date of the case. For the purpose of this indicator, procedures classed as elective (not performed as part of an acute admission) are examined.

The adverse consequences of treatment delay are well known and include deterioration in the condition for which treatment is awaited, the loss of utility from delay (especially if treatment can relieve significant disability), a rise in the costs of total treatment, accumulation of any loss of income from work, and, as an extreme outcome, death.

An important distinction exists between the waiting time of the patients booked for their procedure and those who are referred for specialist opinion and subsequent treatment. As this indicator examines the wait time from booking date to case date, it is reflective of system performance that is specifically focused on electrophysiology and pacing demand and need.

7.1.1 Elective pacemaker

Examination of the waiting time for elective pacemaker procedures is below. Of the 282 cases with complete data, the median wait time was two days. There were one quarter of patients waiting more than one month.

Table 18: Elective pacemaker wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
STATEWIDE	385	282	2	0–232

7.1.2 Elective ICD wait time and proportion within 28 days

This analysis examines the waiting time for elective ICD procedures and the proportion adhering to the benchmark of 28 days or less.

Table 19: Elective ICD wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
STATEWIDE	236	182	21	0–316	56.0

7.1.3 Standard ablation

Waiting times for standard ablation procedures are presented below. Of the 152 cases eligible for analysis, the median wait time was 99 days.

Table 20: Elective standard ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
STATEWIDE	179	152	99	43–1084

7.1.4 Complex ablation with proportion within 180 days or less

Complex ablations are defined as cases using three-dimensional mapping technology or involving ventricular arrhythmia or pulmonary vein isolation. This indicator examines the waiting time for these procedures and the proportion adhering to the benchmark of 180 days or less.

A median wait time of 78 days was observed, with a large interquartile range demonstrating there are a number of patients with considerably long waits.

Table 21: Elective complex ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
STATEWIDE	797	577	78	22–1307	77.6

7.2 Procedural tamponade rates

Cardiac tamponade is a known complication of cardiac device and electrophysiology procedures. This indicator examines the rate of procedural pericardial tamponade in these procedure categories. As pericardial tamponade is a clinical diagnosis, this indicator explicitly reports those patients with this specific diagnosis and does not include those patients with the diagnosis or finding of pericardial effusion.

Table 22: Procedural tamponade analysis

Procedure category	Total cases analysed n	Procedural tamponade observed n	Procedural tamponade rate %
Device	3,500	3	<0.1
EP	1,345	10	0.7
All	**4,837**	**13**	**0.3**

7.3 Reintervention within one year of procedure date due to cardiac device lead dislodgement

This indicator identifies the number of cases where lead dislodgement was observed within one year of lead insertion. The cases included in this indicator were all new device implants or upgrades where a new lead/s had been implanted and a lead revision or replacement was subsequently required due to dislodgement. Index implant procedures were cases performed within Queensland Health implanting facilities in the 2020 calendar year.

The analysis found 48 cases (2.2%) where reintervention was required within 12 months of the index procedure. There were 25 right ventricular lead dislodgements, 17 right atrial, 4 left ventricular and two other locations.

These results compare similarly with international cohorts, where observed dislodgement rates for pacemaker system implants vary from 1.0% to 2.7%.[45]

Table 23: Reintervention due to lead dislodgement analysis

	Cases analysed n	12 month lead dislodgement n	12 month lead dislodgement rate %	Median time to dislodgement days	Interquartile range days
Eligible 2020 device cases	2,204	48	2.2	7	1–78

7.4 Rehospitalisation within one year of procedure due to infection resulting in loss of the device system

One of the most serious long-term complications related to mortality and morbidity for patients with cardiac implantable electronic devices is infection. Complete removal of all hardware is the recommended treatment for patients with established device infection because infection relapse rates due to retained hardware are high. For this indicator, implant cases where new devices or leads were implanted form the cohort.

A system loss rate of 0.4% was observed at 12 months post procedure. This is reassuring when compared to international literature which suggests infection rates necessitating explant of approximately 2.4%.[46]

Table 24: Rehospitalisation with device loss analysis

	Cases analysed n	12 month system loss due to infection n	12 month system loss rate %
Eligible 2020 device cases	2,741	11	0.4

7.5 12 month all-cause mortality for cardiac device procedures

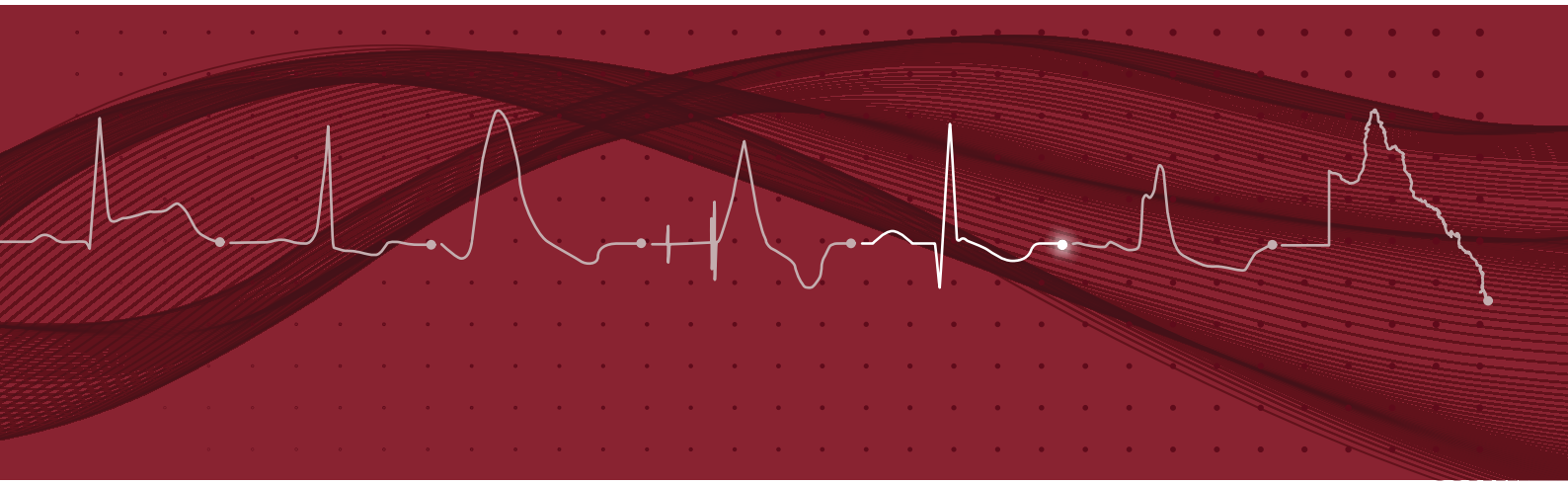
The all-cause unadjusted mortality rate following cardiac device procedure was 5.3%. To allow complete follow up over 12 months, these outcomes are reported for the previous 2020 patient cohort.

When interpreting this figure, it is important to note patients undergoing cardiac device procedures are often of advanced age (median age 75 years old). In addition, many patients have advanced symptomology such as advanced heart failure, or most likely suffering from multiple underlying risk factors or comorbidities.

Table 25: 12 month all-cause unadjusted mortality for cardiac device procedures

	Cases analysed n	12 month mortality observed n	12 month mortality rate %	Median age at procedure years	Interquartile range years
Any BiV procedure	343	20	5.8	71	62–77
ICD procedure	582	13	2.2	63	53–72
Pacemaker procedures	2,031	125	6.2	78	71–85
All 2020 device cases	**2,956**	**158**	**5.3**	**75**	**65–82**

Cardiac Rehabilitation Audit



1 Introduction

The 2021 Annual Report for cardiac rehabilitation (CR) services in Queensland is the fifth report produced, which details the patient cohort that is receiving a referral to CR and the patient outcomes after program completion. Over five years, little variation to patient demographics, referral trends and timeliness of patient journey has been observed. This provides reassuring clarity about which patients are recipients of the many benefits CR provides. However, much can still be explored about how to engage those patients that are less likely to attend CR, particularly those from specific socioeconomic groups and geographic locations.

The effects of the global COVID-19 pandemic remained during 2021, with service delivery impacted by temporary closures of programs due to staff redeployment or the reclamation of gym spaces for other purposes. This is reflected in the reduction of the volume of patients attending a post-program six minute walk test compared to 2019, however a slight improvement on 2020, the time when statewide lockdowns and restrictions were implemented. Whilst 2021 experienced no sustained statewide lockdowns, a Public Health directive remained, restricting how CR outpatient programs were able to deliver their centre-based group programs.

A variety of models of care exist in Queensland to flexibly deliver CR to support patient goals and comply with Hospital and Health Service constraints. When reviewing patient outcomes, knowledge of local service delivery models is imperative to ensure appropriate context. The development of a system to capture model of care information at the time of data entry will allow the analysis of patient outcomes against model of care. It will also provide important information about preferred service delivery models. This update is planned for implementation in early 2023.

I would like to acknowledge the efforts of clinicians around Queensland to adapt to the continued pressures they face, and their dedication to delivering care to patients requiring CR.

Samara Phillips
Queensland Cardiac Rehabilitation CR Program Adviser

2 Key findings

This fifth Cardiac Rehabilitation (CR) Audit examines the characteristics and outcomes for patients referred to and assessed by public CR services in Queensland. It also outlines clinical indicator performance for participating services.

- There were 56 public cardiac rehabilitation (CR) sites that contributed data to QCOR.
- A total of 10,647 referrals were made to public CR programs across Queensland. A further 1,428 referrals were declined, unsuitable or referred outside of Queensland Health at the point of first contact.
- Approximately 73% of referrals originated from an inpatient setting, while 14% of referrals originated from outside of Queensland Health.
- There were 7,341 referrals (69%) which proceeded to a pre assessment by CR. The most common reasons that the pre assessment did not take place was that the patient declined, was medically unsuitable or inappropriate, had been uncontactable or failed to attend the appointment.
- Male patients accounted for 71% of all CR referrals.
- The median age of patients was 66 years, with three quarters of patients aged 57 years and above. There was considerable variation in median age between Aboriginal and Torres Strait Islander patients (55 years) and patients of other descent (66 years).
- The total proportion of Aboriginal and Torres Strait Islander patients was 6.6%. Large geographical variance was noted, with sites in North Queensland having a significantly higher proportion of Aboriginal and Torres Strait Islander patients.
- Overall, 66% of referrals had a pre assessment diagnosis of ischaemic heart disease.
- At pre assessment, 81% of patients were classed as having an unhealthy body mass index (BMI) including 38% classed as overweight, 36% obese and 6% morbidly obese.
- The most common procedure undergone by patients who attended a CR pre assessment was a percutaneous coronary intervention, which had been performed for 41% of patients. There were 18% of patients who had undergone coronary artery bypass grafting.
- Only 38% of patients were recorded as being sufficiently active at pre assessment.
- Completion of a timely referral for Queensland Health inpatients (within 3 days of discharge from hospital) was achieved in 93% of cases.
- A timely overall journey occurred in 59% of cases (Queensland Health inpatients referred within 3 days of discharge and assessed by CR program within 28 days of discharge).
- 42% of patients who completed a pre assessment continued CR to the completion of a post assessment.
- The majority of patients completing a post assessment reported an improved health status following completion of CR, regardless of which measure was used.

3 Participating sites

Table 1: Participating CR sites

Legend: ⊘ Engaged and contributing ◑ Partially contributing (‹50% of referrals) ○ Not contributing

HHS/Organisation	CR program	Locations	2019	2020	2021
Cairns and Hinterland	Cairns Outpatient CR Program	Cairns	⊘	⊘	⊘
	Cassowary Area CR	Innisfail, Tully	⊘	⊘	⊘
	Tablelands CR	Atherton, Mareeba	⊘	⊘	⊘
	Mossman CR and Prevention Program	Mossman	⊘	⊘	⊘
Central Queensland	Community Health CR	Gladstone	⊘	⊘	⊘
	Biloela CR Program	Biloela	⊘	⊘	⊘
	CR Outpatient Program	Rockhampton, Capricorn Coast	⊘	⊘	⊘
	Mount Morgan CR	Mount Morgan	⊘	⊘	⊘
Central West	Longreach and Central West CR Program	Longreach	⊘	⊘	⊘
		Blackall	⊘	⊘	⊘
		Winton	⊘	⊘	⊘
		Barcaldine*	–	⊘	⊘
Darling Downs	Toowoomba Hospital Heart Care	Toowoomba	⊘	⊘	⊘
	Warwick CR Service	Warwick	⊘	⊘	⊘
	Chinchilla-Miles CR Service	Chinchilla, Miles	⊘	⊘	⊘
	Dalby-Tara CR Service	Dalby, Tara	⊘	⊘	⊘
	Kingaroy Hospital South Burnett CR	Kingaroy	⊘	⊘	⊘
	Goondiwindi CR	Goondiwindi	⊘	⊘	⊘
	Texas OPCR Program	Texas	⊘	○	○
	Stanthorpe Health CR Program	Stanthorpe	○	○	○
Gold Coast	Gold Coast Heart Health Service	Robina	⊘	⊘	⊘
HCC†	SMoCC‡	Health Contact Centre	⊘	⊘	⊘
Mackay	Mackay Heart Health Service	Mackay	⊘	⊘	⊘
	Mackay Rural District CR	Proserpine, Bowen	○	○	○
Metro North	Complex Chronic Disease	Caboolture, Chermside, North Lakes, Redcliffe	⊘	⊘	⊘
	TPCH Cardiac Rehabilitation Service*	The Prince Charles Hospital§	–	⊘	N/A
Metro South	PAH Heart Recovery Program	Princess Alexandra Hospital	⊘	⊘	⊘
	Bayside CR Program	Redland	⊘	⊘	⊘
	Brisbane South CR Service	Eight Mile Plains, Inala	⊘	⊘	⊘
	Logan-Beaudesert CR Service	Browns Plains	⊘	⊘	⊘
North West	North West CR Program	Mount Isa	⊘	⊘	⊘
South West	South West HHS CR Services	Charleville, Roma	⊘	⊘	⊘
		St George	⊘	⊘	⊘
Sunshine Coast	Sunshine Coast HHS Cardiac Rehab	Caloundra, Gympie, Maroochydore, Nambour, Noosa	⊘	⊘	⊘
Townsville	Townsville CR Outpatient Program	Townsville	⊘	⊘	⊘
	Ingham CR Outpatient Program	Ingham	◑	○	○
	Charters Towers CR	Charters Towers	◑	◑	N/A
	Ayr Health Service	Ayr	○	◑	○
West Moreton	Ipswich and West Moreton CR	Ipswich, Boonah, Esk, Gatton, Laidley	⊘	⊘	⊘
Wide Bay	Fraser Coast CR	Hervey Bay, Maryborough	⊘	⊘	⊘
	Wide Bay Rural and Allied Health*	Biggenden, Eidsvold, Gayndah, Mundubbera	⊘	⊘	⊘

* New service commencing in 2020
† Health Contact Centre
‡ Self Management of Chronic Conditions (delivering the COACH program)
§ Temporary service as part Metro North HHS COVID-19 response
N/A Existing service ceased operations

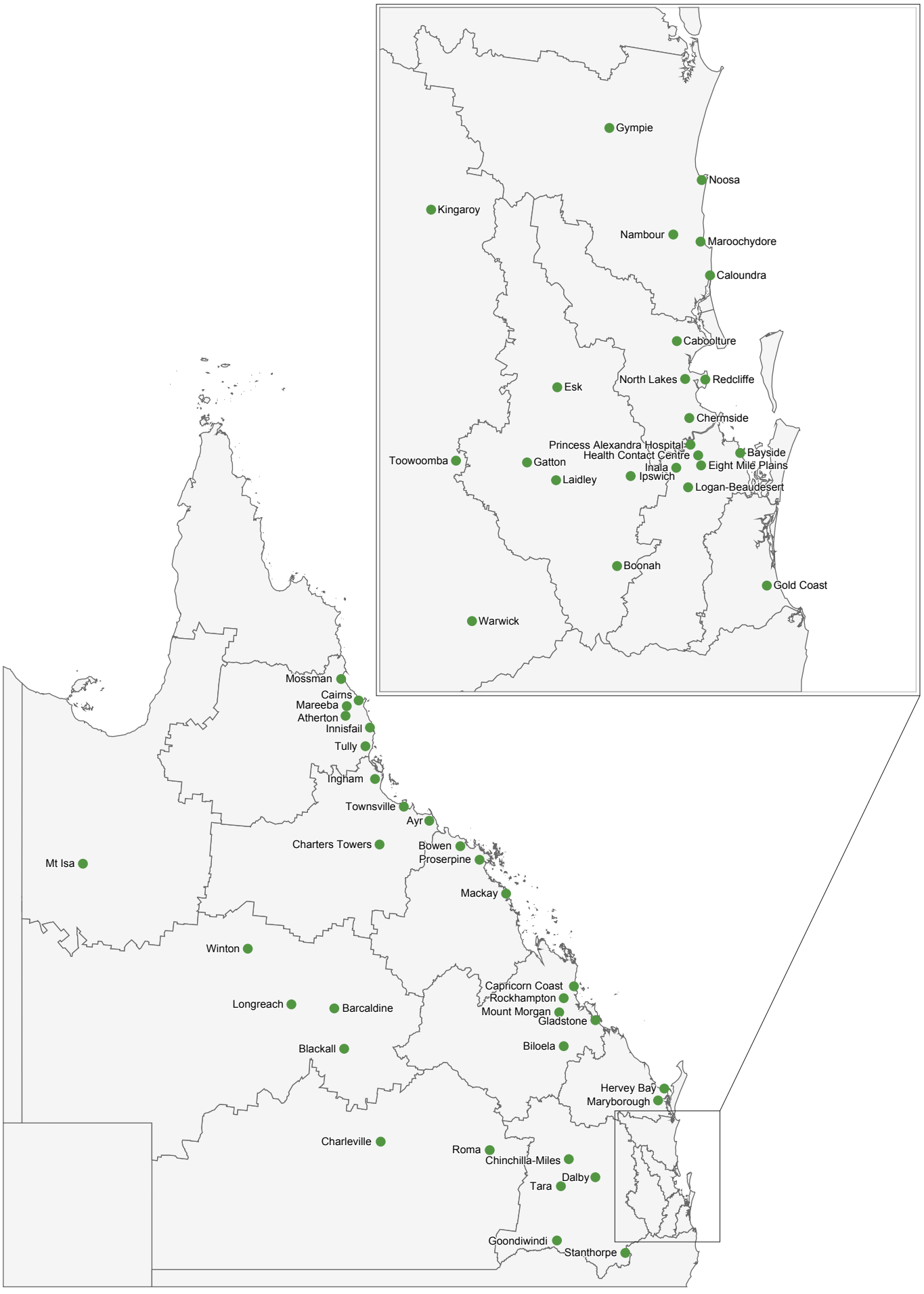


Figure 1: Map of Queensland public CR sites

4 Total referrals

4.1 Statewide

The volume of cardiac rehabilitation (CR) referrals entered into the QCOR clinical application expanded through 2021 to include an additional 10,647 new referrals for the calendar year. This brings the overall total to over 50,000 referrals since data collection commenced in July 2017.

Clinicians at 56 Queensland CR sites have incorporated data entry into their daily practices. A smaller number of sites deliver public outpatient CR but contribute to the database inconsistently or not at all. This can be a result of various factors such as resource availability. These sites remain a focus for engagement and involvement.

There is now an increased level of detail that can be recorded in the QCOR module in cases where the patient declined or was unsuitable to participate in CR. This has increased the availability of data, allowing these cases to be examined in more detail.

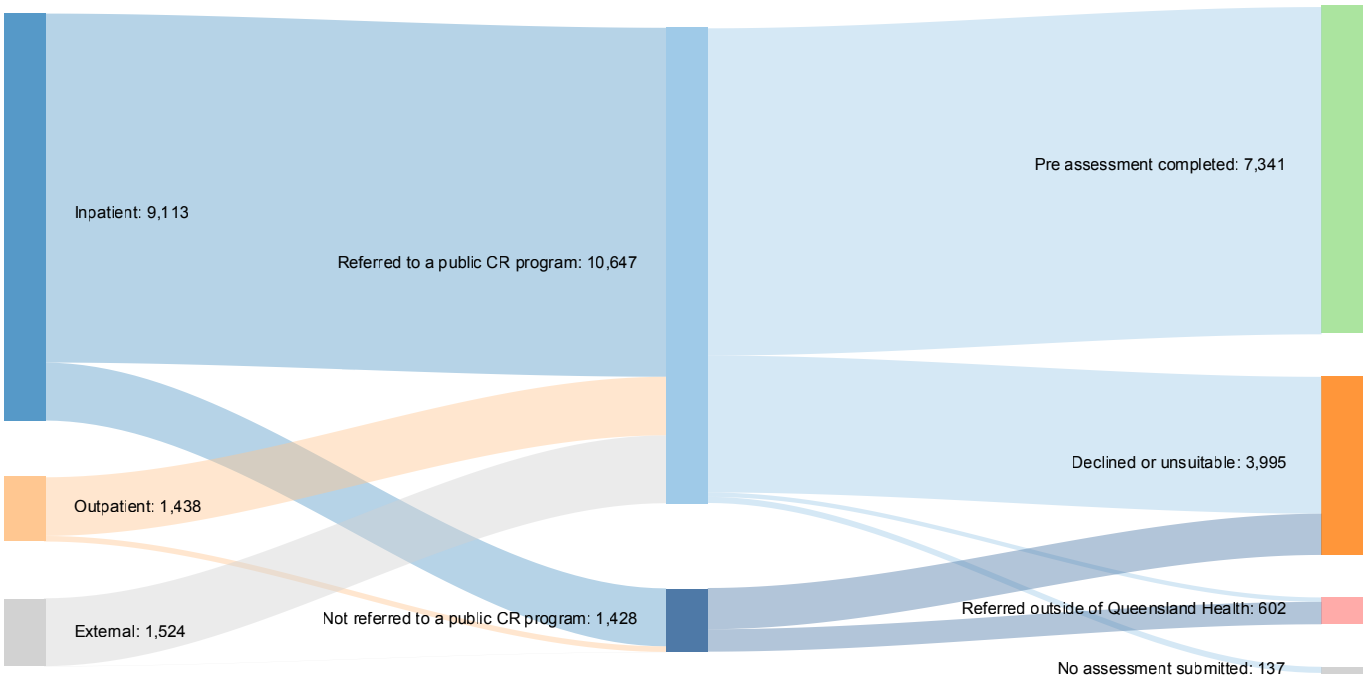


Figure 2: Statewide cardiac rehabilitation referrals flow

Patients were located across a wide geographical area with the majority residing in population centres along the Eastern Seaboard (Figure 3).

It is important to note that referrals for patients residing interstate or overseas are not generally accepted by Queensland public CR programs. The inclusion of these data is reflective of local site processes and may also vary based on available resources.

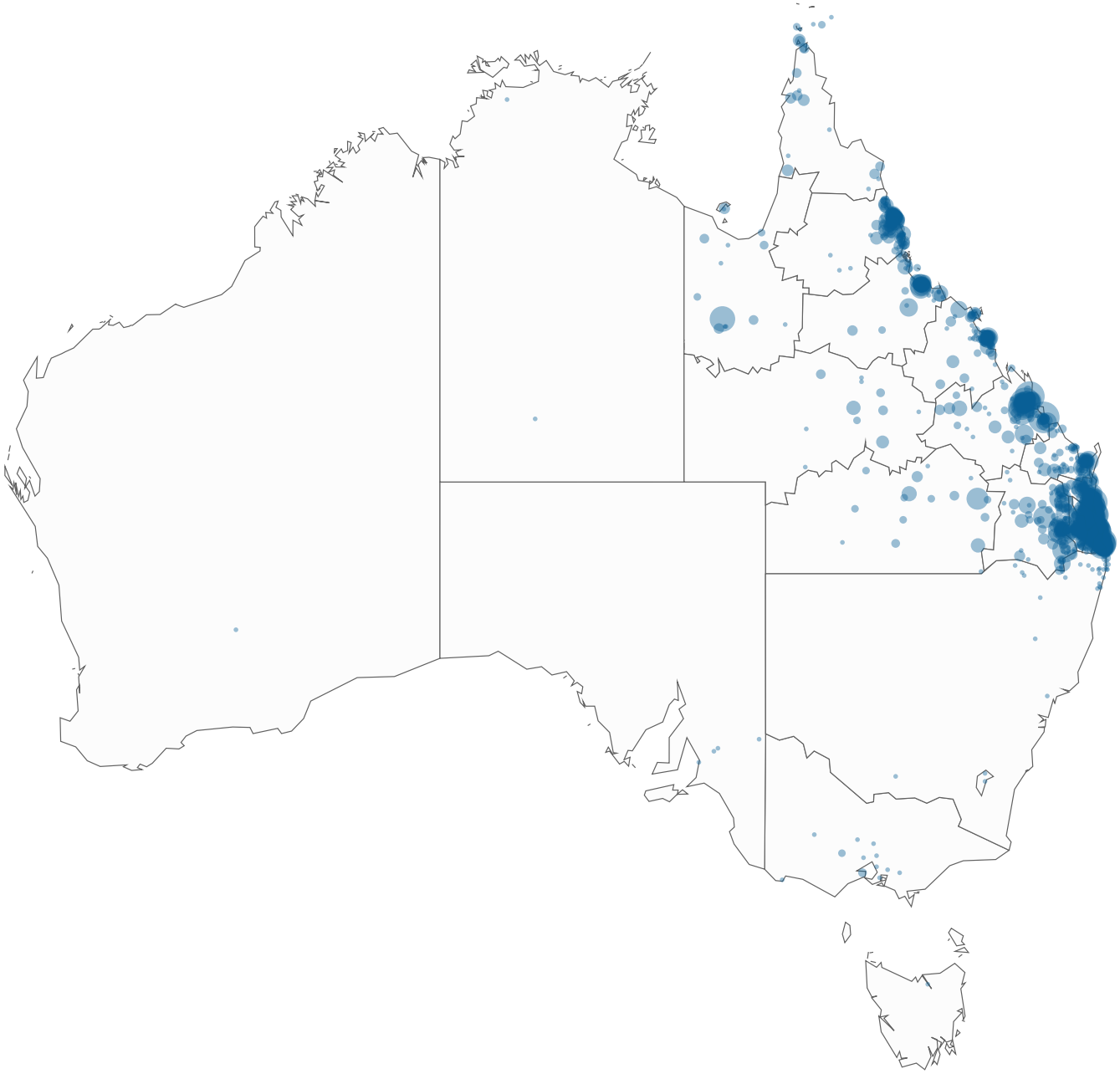


Figure 3: Distribution of CR referrals by usual place of residence

Table 2: Proportion of CR referrals by remoteness classification

Remoteness area*	**%**
Major Cities of Australia	54.8
Inner Regional Australia	26.5
Outer Regional Australia	15.3
Remote Australia	1.3
Very Remote Australia	2.1
ALL	**100.0**

Excludes missing data (0.3%)

* Classified by Australian Statistical Geography Standard remoteness area

4.2 Origin of referrals

The majority of referrals (73%) originated from an inpatient setting, with smaller proportions of referrals flowing to CR from an outpatient setting (12%) and outside of Queensland Health (14%).

There was considerable variation across participating CR programs in the proportion of referrals from external sources, which ranged from <1% to 26%. It is possible that not all sites are entering referrals received from general practitioners, private hospitals or external specialists.

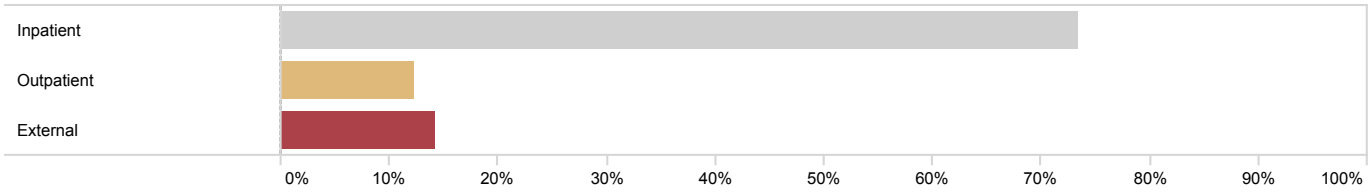


Figure 4: Proportion of referrals by referral source

Table 3: Referral sources by outpatient program HHS

HHS/division	Total referrals n	Inpatient* n (%)	Outpatient* n (%)	External n (%)
Cairns and Hinterland	685	595 (86.9)	51 (7.4)	39 (5.7)
Central Queensland	958	507 (52.9)	210 (21.9)	241 (25.2)
Central West	32	18 (56.3)	14 (43.8)	–
Darling Downs	570	364 (63.9)	95 (16.7)	111 (19.5)
Gold Coast	1,370	1,195 (87.2)	97 (7.1)	78 (5.7)
Health Contact Centre	1,103	899 (81.5)	126 (11.4)	78 (7.1)
Mackay	306	190 (62.1)	96 (31.4)	20 (6.5)
Metro North	1,470	1,066 (72.5)	148 (10.1)	256 (17.4)
Metro South	1,710	1,139 (66.6)	121 (7.1)	450 (26.3)
North West	62	36 (58.1)	19 (30.6)	7 (11.3)
South West	81	35 (43.2)	44 (54.3)	2 (2.5)
Sunshine Coast	967	853 (88.2)	61 (6.3)	53 (5.5)
Townsville	421	348 (82.7)	72 (17.1)	1 (0.2)
West Moreton	681	380 (55.8)	125 (18.4)	176 (25.8)
Wide Bay	231	190 (82.3)	34 (14.7)	7 (3.0)
Statewide	**10,647**	**7,815 (73.4)**	**1,313 (12.3)**	**1,519 (14.3)**

* Includes referrals from a Queensland Health public facility

More than half of all patients were residing in major cities (55%), and the remainder in regional and remote areas of Queensland. This is consistent with the decentralised distribution of the population within the state.

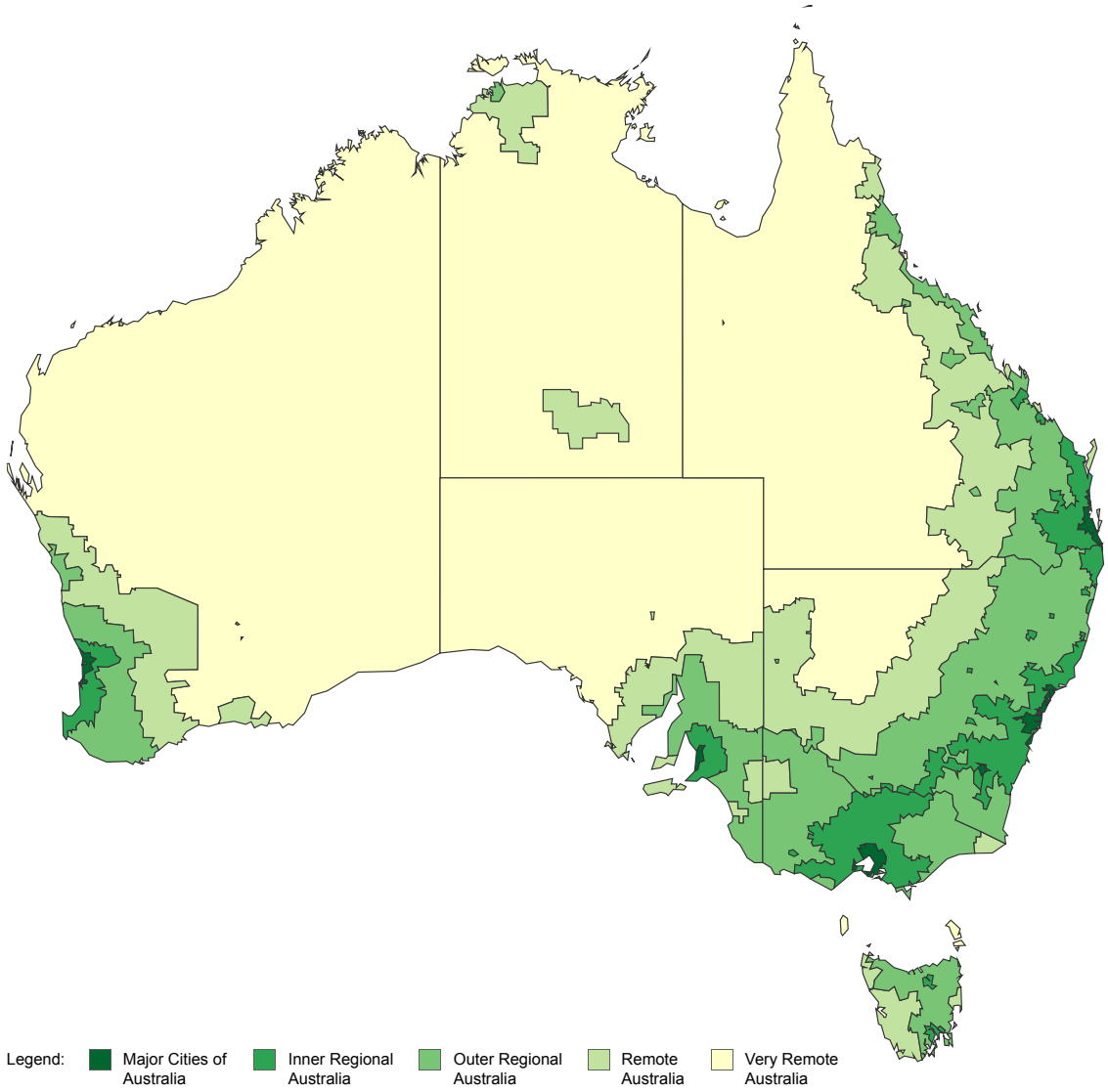


Figure 5: Australian Statistical Geography Standard remoteness areas

Table 4: CR referrals by outpatient HHS and patient remoteness classification

HHS/organisation	Major Cities n (%)	Inner Regional n (%)	Outer Regional n (%)	Remote n (%)	Very Remote n (%)
Cairns and Hinterland	1 (0.1)	1 (0.1)	604 (90.0)	23 (3.4)	42 (6.3)
Central Queensland	1 (0.1)	872 (91.0)	73 (7.6)	12 (1.3)	–
Central West	–	–	1 (3.1)	–	31 (96.9)
Darling Downs	8 (1.4)	434 (76.1)	126 (22.1)	1 (0.2)	1 (0.2)
Gold Coast	1,310 (96.0)	53 (3.9)	2 (0.1)	–	–
Health Contact Centre	565 (51.6)	240 (21.9)	179 (16.3)	55 (5.0)	56 (5.1)
Mackay	–	174 (56.9)	123 (40.2)	9 (2.9)	–
Metro North	1,292 (88.0)	173 (11.8)	2 (0.1)	–	1 (0.1)
Metro South	1,567 (91.9)	113 (6.6)	16 (0.9)	10 (0.6)	–
North West	–	–	1 (1.6)	2 (3.2)	59 (95.2)
South West	–	–	35 (43.2)	18 (22.2)	28 (34.6)
Sunshine Coast	615 (63.7)	344 (35.6)	6 (0.6)	–	–
Townsville	3 (0.7)	1 (0.2)	405 (96.2)	6 (1.4)	6 (1.4)
West Moreton	451 (66.3)	227 (33.4)	2 (0.3)	–	–
Wide Bay	–	184 (79.7)	47 (20.3)	–	–
Statewide	**5,813 (54.8)**	**2,816 (26.5)**	**1,622 (15.3)**	**136 (1.3)**	**224 (2.1)**

4.3 Inpatient referrals

For referrals originating from an inpatient setting, the largest referrer was Metro North HHS which accounted for over one quarter (27%) of these referrals. Gold Coast HHS and Metro South HHS received the largest volumes of inpatient referrals (15% each).

Table 5: CR inpatient referrals by source and destination HHS

HHS/organisation	Outgoing inpatient referrals n (%)	Incoming inpatient referrals n (%)
Cairns and Hinterland	542 (6.9)	595 (7.6)
Central Queensland	290 (3.7)	507 (6.5)
Central West	–	18 (0.2)
Darling Downs	145 (1.9)	364 (4.7)
Gold Coast	1,208 (15.5)	1,195 (15.3)
Health Contact Centre	–	899 (11.5)
Mackay	124 (1.6)	190 (2.4)
Mater Health Services	69 (0.9)	–
Metro North	2,136 (27.3)	1,066 (13.6)
Metro South	1,776 (22.7)	1,139 (14.6)
North West	1 (<0.1)	36 (0.5)
South West	–	35 (0.4)
Sunshine Coast	733 (9.4)	853 (10.9)
Townsville	637 (8.1)	348 (4.5)
West Moreton	123 (1.6)	381 (4.9)
Wide Bay	31 (0.4)	190 (2.4)
Statewide	**7,815 (100.0)**	**7,815 (100.0)**

The flow of inpatient referrals from the originating HHS or organisation (acute site) to the CR outpatient program HHS is illustrated in Figure 6. The majority of inpatient referrals remained within the originating HHS, though there was some variation noted.

It should be highlighted that there are no outpatient programs for Mater Health Services, and conversely the Health Contact Centre provides an outpatient (telephone based) service only.

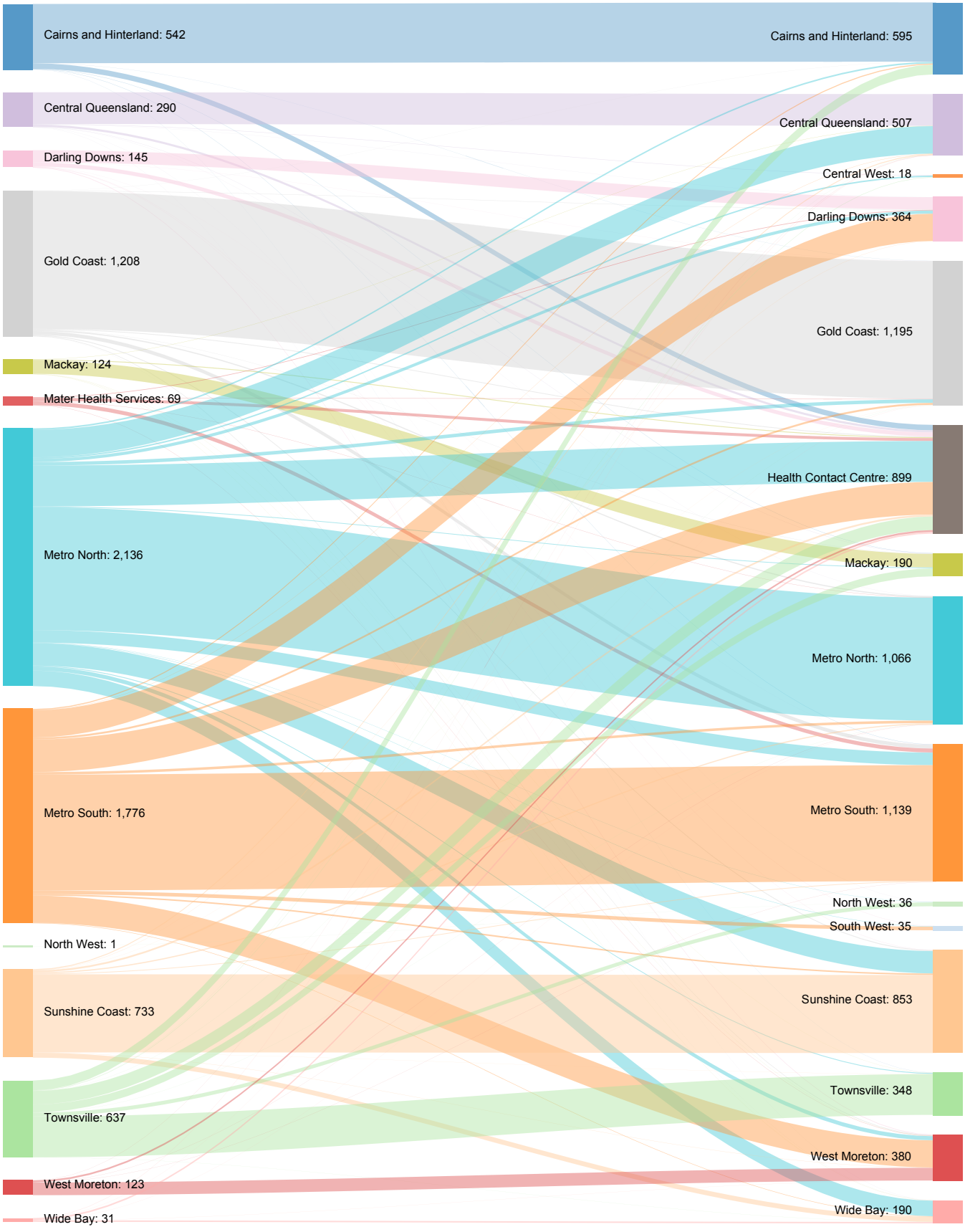


Figure 6: CR inpatient referrals by source and destination HHS

5 Program participation

5.1 Pre assessment stage

The assessment of a patient attending CR comprises a comprehensive cardiovascular disease risk factor review. This extends beyond a patient's presenting medical and social history to encompass overall health, physical well-being, psychological factors, availability of social support and patient-reported quality of life.

An assessment within outpatient CR is generally conducted in two stages which occur before and after a patient attends the specialist CR program. These stages are referred to as the pre assessment and post assessment. The pre assessment signifies the successful enlistment of a patient onto the CR program. Assessments may be undertaken via telehealth or face-to-face.

The proportion of total referrals which proceeded to a pre assessment within any timeframe was 69%. This is a limited metric which should be interpreted with caution due to varying processes across the state for patients refusing or not interested in attending CR, and for patients residing overseas and interstate.

Capacity for service delivery is also a contributing factor for referrals not proceeding to pre assessment, these issues are explored later in the report.

Table 5: Total pre assessments completed by outpatient HHS/division

Outpatient HHS/division	Pre assessment completed n (%)	Declined/not assessed n (%)	No assessment submitted n (%)
Cairns and Hinterland	529 (77.2)	156 (22.8)	–
Central Queensland	666 (69.5)	291 (30.4)	1 (0.1)
Central West	28 (87.5)	4 (12.5)	–
Darling Downs	369 (64.7)	181 (31.8)	20 (3.5)
Gold Coast	1,026 (74.9)	344 (25.1)	–
Health Contact Centre	786 (71.3)	317 (28.7)	–
Mackay	173 (56.5)	84 (27.5)	49 (16.0)
Metro North	1,043 (71.0)	427 (29.0)	–
Metro South	1,222 (71.5)	488 (28.5)	–
North West	44 (71.0)	18 (29.0)	–
South West	70 (86.4)	11 (13.6)	–
Sunshine Coast	533 (55.1)	434 (44.9)	–
Townsville	198 (47.0)	171 (40.6)	52 (12.4)
West Moreton	467 (68.6)	199 (29.2)	15 (2.2)
Wide Bay	187 (81.0)	44 (19.0)	–
Statewide	**7,341 (68.9)**	**3,169 (29.8)**	**137 (1.3)**

* Referrals to Gold Coast HHS include 11% patients residing interstate, typically referred on for CR outside of Queensland Health

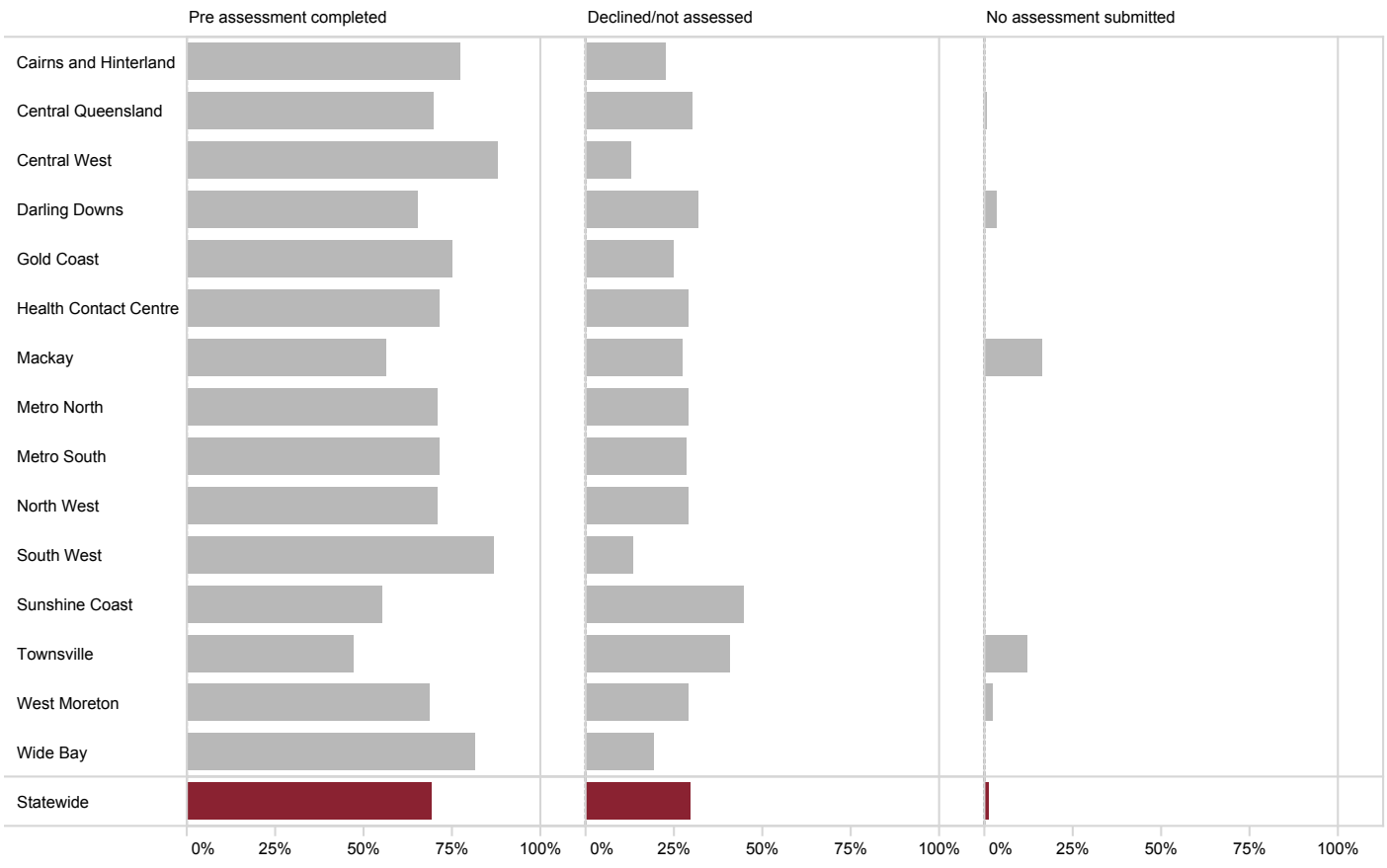


Figure 7: Proportion of CR referrals proceeding to pre assessment by outpatient HHS/division

5.2 Post assessment stage

In most cases, the post assessment is representative of completion and graduation from the specialist CR outpatient program. This provides an opportunity for the patient and clinician to reflect upon the targets defined at the pre assessment and discuss the impact of the program. Of 7,341 completed pre assessments, 42% proceeded to post assessment which compares similarly to the previous year.

Completion rates and median time interval from pre assessment to post assessment varied considerably by HHS. The median time from pre assessment to post assessment was 81 days, with a range of 53 days to 149 days across outpatient HHS. There was considerable variation in the proportion of cases where a post assessment was completed, suggesting the model of care and data entry vary at a local level. A range of issues can contribute to completion of the post assessment which may include timing, patient availability or other factors outside the control of the program. Reasons for non-participation in the post assessment presents an opportunity for investigation in the future.

Data reported in this section uses a six month cut-off period for post assessment completion.

Table 6: Total post assessments completed by HHS

Outpatient HHS/division	Post assessment completed n (%)	Median time to post assessment days
Cairns and Hinterland	202 (38.2)	63
Central Queensland	391 (58.7)	70
Central West	1 (3.6)	N/A
Darling Downs	217 (58.8)	56
Gold Coast	320 (31.2)	57
Health Contact Centre	514 (65.4)	149
Mackay	50 (28.9)	80
Metro North	406 (38.9)	103
Metro South	474 (38.8)	73
North West	9 (20.5)	N/A
South West	31 (44.3)	88
Sunshine Coast	91 (17.1)	145
Townsville	19 (9.6)	N/A
West Moreton	267 (57.2)	61
Wide Bay	70 (37.4)	53
Statewide	**3,062 (41.7)**	**81**

N/A: Not displayed due to <20 post assessments for analysis

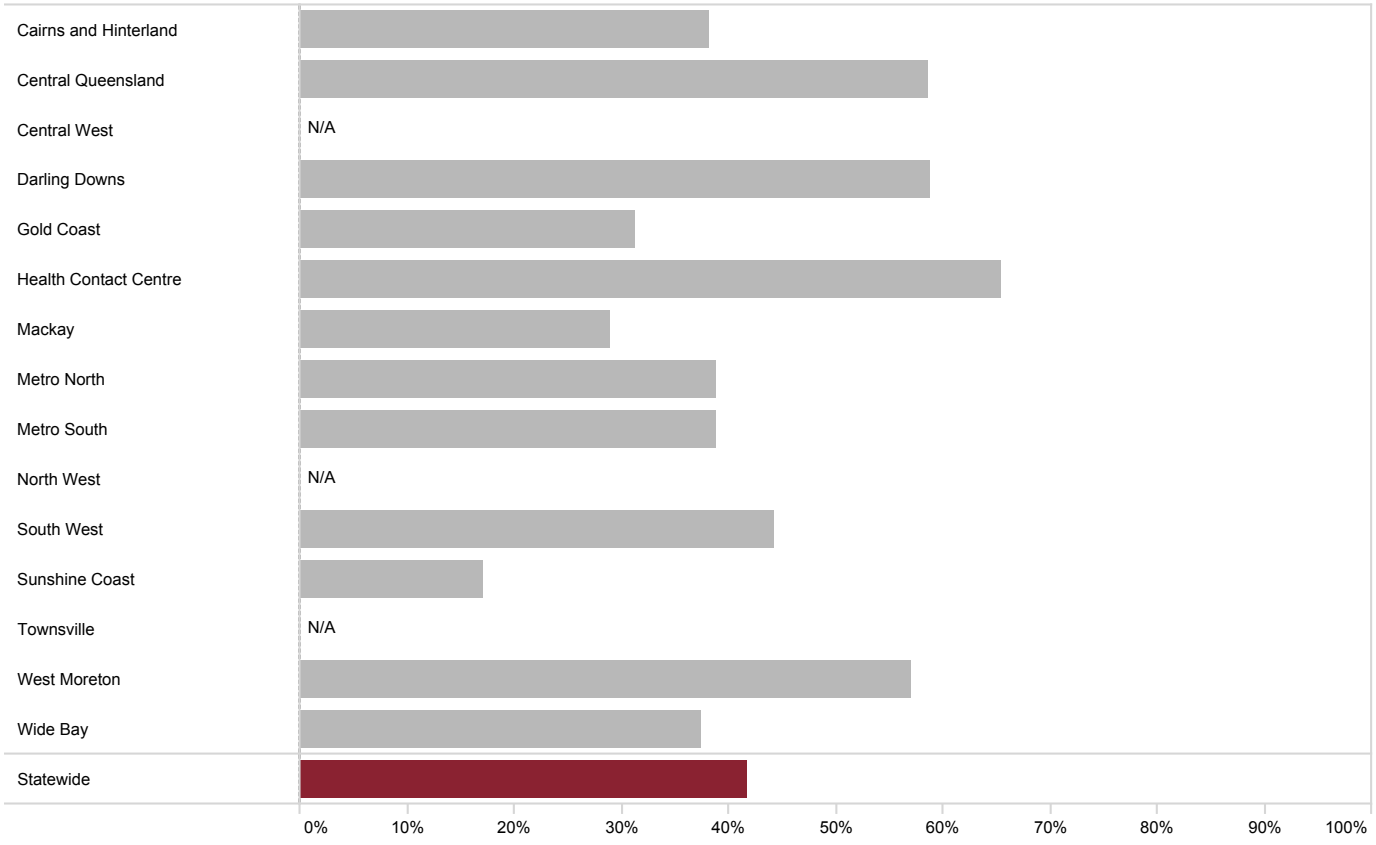


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Figure 8: Proportion of CR assessments proceeding to post assessment

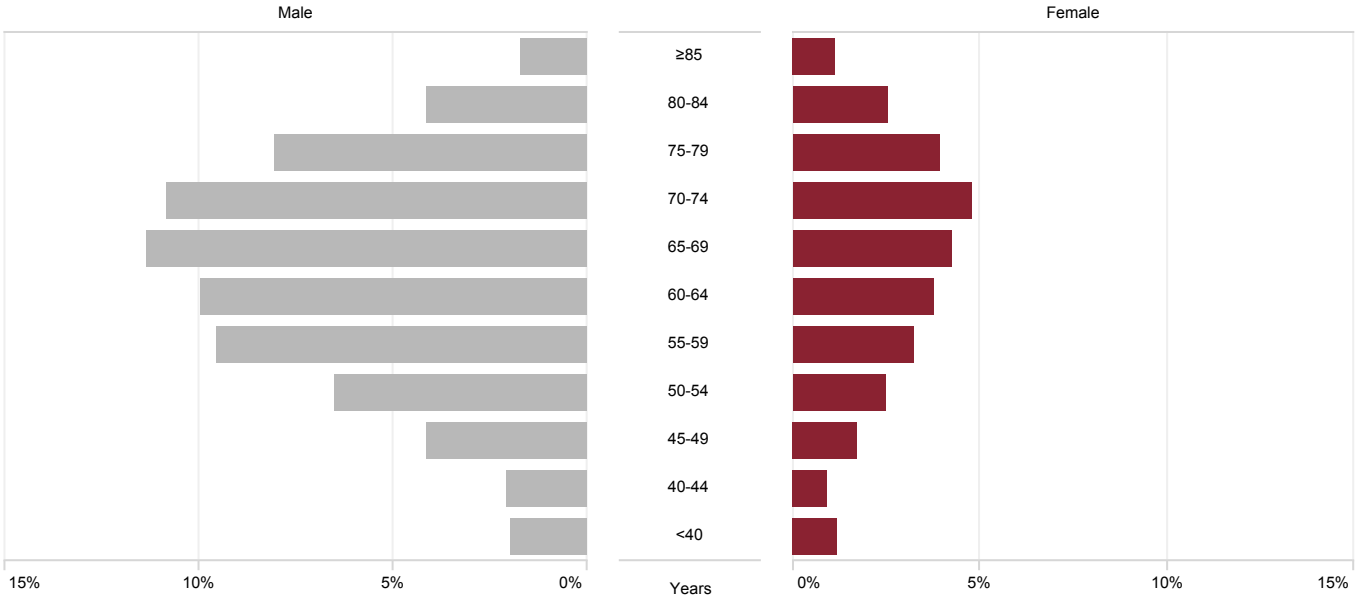
6 Patient characteristics

The following analysis examines the characteristics of the 10,647 patients who were referred to a public CR program. Largely these characteristics are similar to those reported over previous years.

6.1 Age and gender

Development of cardiovascular disease is related to age. Overall, 71% of patients were male and 29% female. The age distribution of referrals was similar for genders, though the median age for males was slightly lower than for females (65 years vs. 67 years).

Overall, three quarters of patients were 57 years of age or older (interquartile range 57 years to 74 years).



% of total referrals (n=10,647)

Figure 9: Referrals by patient gender and age group

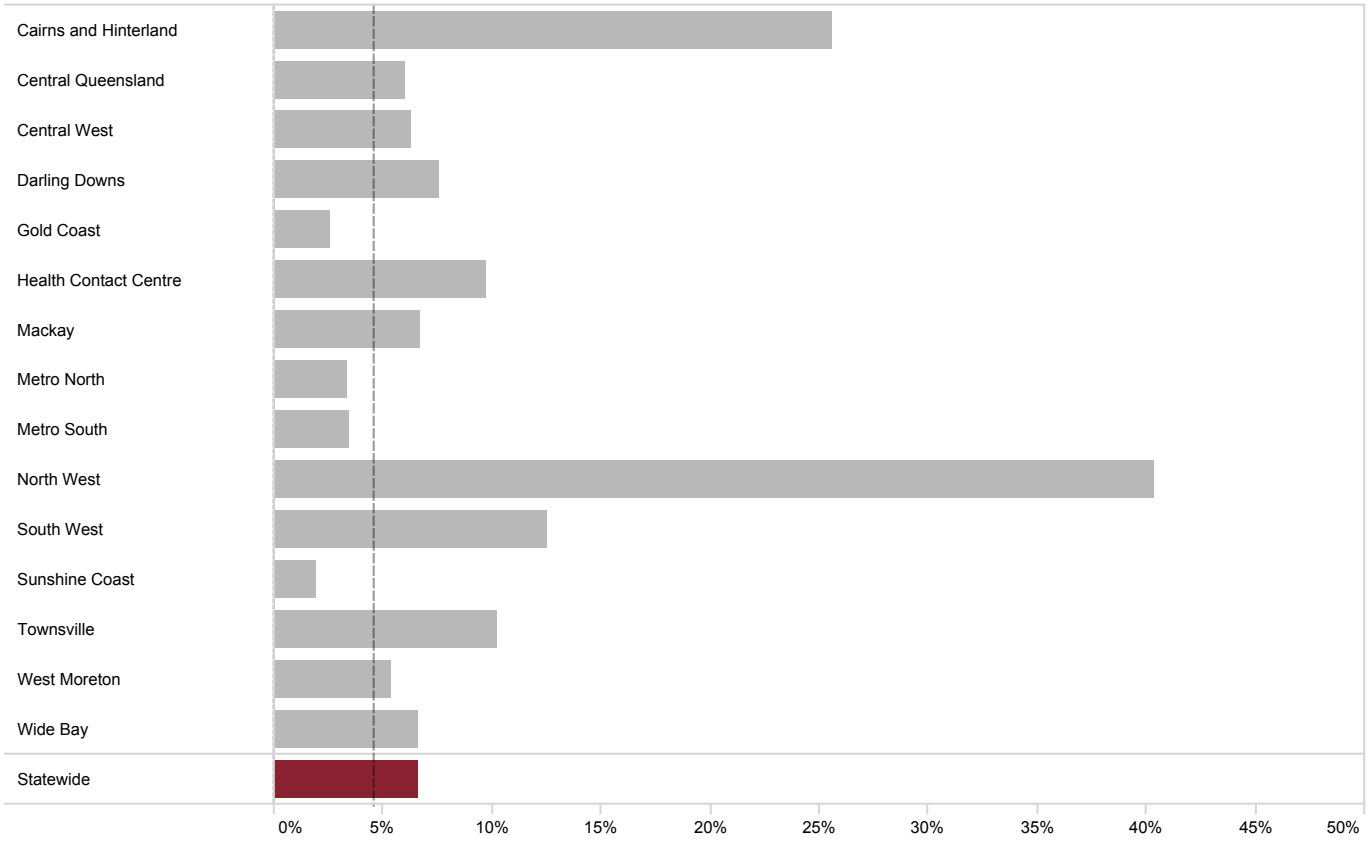
Table 8: Median patient age by gender and HHS

Outpatient HHS/division	Male years	Female years	All years
Cairns and Hinterland	64	63	64
Central Queensland	67	68	68
Central West	66	72	67
Darling Downs	67	66	67
Gold Coast	66	69	67
Health Contact Centre	64	66	64
Mackay	64	68	65
Metro North	67	68	67
Metro South	64	66	65
North West	60	59	60
South West	65	68	66
Sunshine Coast	68	70	68
Townsville	62	61	62
West Moreton	64	67	64
Wide Bay	66	69	67
Statewide	**65**	**67**	**66**

6.2 Aboriginal and Torres Strait Islander status

It is recognised that the Aboriginal and Torres Strait Islander population has a higher incidence and prevalence of coronary artery disease with ischaemic heart disease identified as the leading cause of death among Indigenous Australians in 2020.[47]

In this cohort, Aboriginal and Torres Strait Islander patients represent 6.6% of all statewide referrals with considerable variation observed across CR programs. By comparison, the estimated overall proportion of the Aboriginal and Torres Strait Islander population in Queensland is 4.6%.[2]

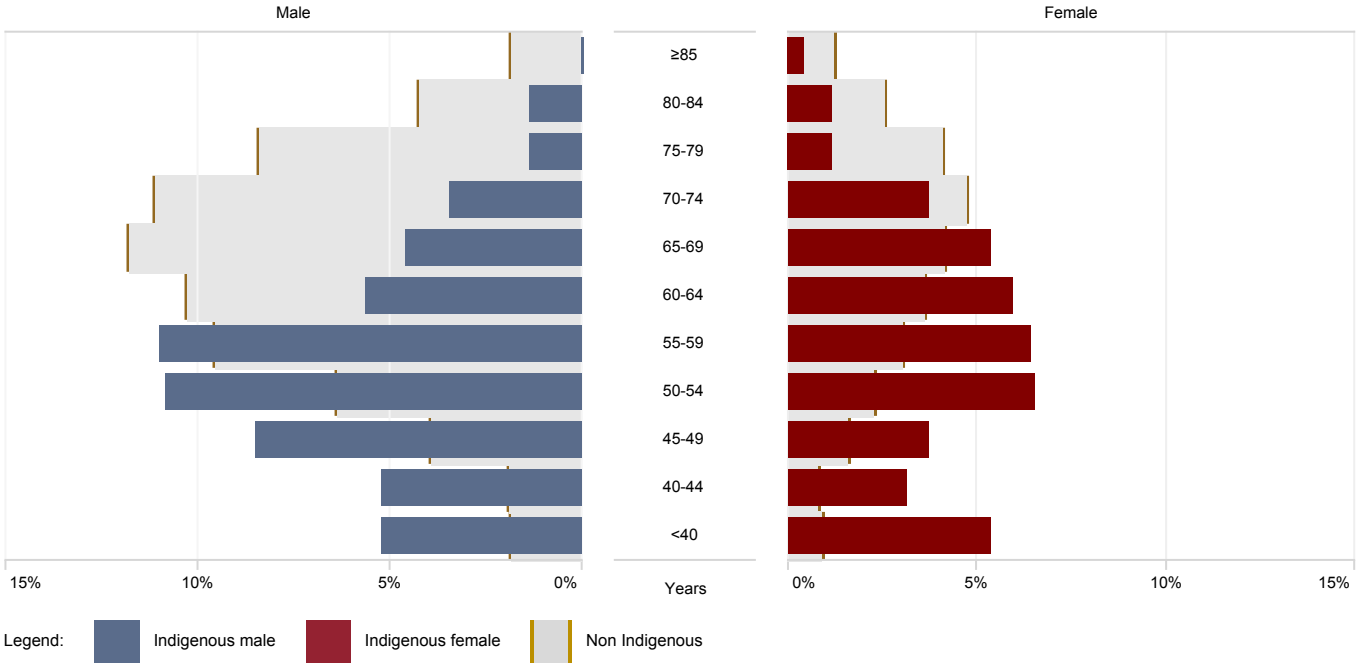


Excludes missing data (4.1%)

Figure 10: Proportion of identified Aboriginal and Torres Strait Islander patients by outpatient HHS

The proportion of Aboriginal and Torres Strait Islander patients referred to CR had a median age considerably lower than other patients (55 years vs. 66 years respectively).

The rate of cardiovascular disease among Aboriginal and Torres Strait Islander patients is largely different to that seen among other Australians. The disparity in median age and proportionate numbers of Aboriginal and Torres Strait Islander patients undertaking CR is consistent with chronic diseases occurring more often and at a younger age compared to non-Indigenous Australians.



Excludes missing data (4.1%)

Figure 11: Proportion of all CR referrals by age group and Indigenous status

Table 9: Median patient age by gender and Indigenous status

	Male years	Female years	Total years
Aboriginal and Torres Strait Islander	55	58	55
Non Aboriginal and Torres Strait Islander	66	68	66
All	**65**	**67**	**66**

Excludes missing data 4.1%

7 Clinical presentation

7.1 Diagnosis

For the following analysis, patients attending a CR pre assessment have been grouped into a diagnosis category based on clinical patient information obtained through the course of referral and pre assessment.

The majority of pre assessments (66%) followed a previous diagnosis of ischaemic heart disease (IHD).

Table 9: Pre assessments by diagnosis category

Diagnosis category	n	%
Ischaemic heart disease*	4,833	65.9
Valvular disease	605	8.2
Other†	1,903	25.9
All	**7,341**	**100.0**

* STEMI, NSTEMI and angina

† Typically includes arrhythmia, congestive heart failure and any other diagnosis

7.2 Most recent procedure

The most common procedure preceding a referral to CR was PCI. This was documented for 41% of all referrals and 56% of referrals for patients with IHD.

There were 12% of cases where the most recent procedure had not been identified. These cases can be attributed to missing data, or to patients being conservatively managed and thus having no previous invasive cardiac procedure at the time of program commencement.

Table 11: Most recent procedure noted at pre assessment by diagnosis category

Most recent procedure	Ischaemic heart disease n (%)	Valvular disease n (%)	Other n (%)	All n (%)
PCI	2,718 (56.2)	4 (0.7)	299 (15.7)	3,021 (41.2)
Coronary angiogram	772 (16.0)	10 (1.7)	282 (14.8)	1,064 (14.5)
CABG	844 (17.5)	12 (2.0)	320 (16.8)	1,176 (16.0)
Valve procedure	13 (0.3)	481 (79.5)	163 (8.6)	657 (8.9)
Device procedure	6 (0.1)	2 (0.3)	137 (7.2)	145 (2.0)
CABG + valve procedure	61 (1.3)	61 (10.1)	42 (2.2)	164 (2.2)
Other	30 (0.6)	13 (2.1)	206 (10.8)	249 (3.4)
Not specified	389 (8.0)	22 (3.6)	454 (23.9)	865 (11.8)

7.3 Risk factors and comorbidities

The following risk factors and comorbidities are discussed with the patient through the assessment phase and are generally self reported by the patient. With all self reporting instances, it is important to note that sometimes responses are not accurately conveyed while the patient and clinician are in the establishment phase of their relationship. As a result, some of the risk factor metrics may be understated.

At the time of the pre assessment:

- The majority of patients (90%) had a history of abnormal cholesterol levels or had been prescribed lipid lowering therapy at the time of assessment. This ranged from 66% to 96% across diagnosis categories.
- Only 38% of patients met the physical activity guidelines for their age and were sufficiently active. Furthermore, 21% of patients were classed as inactive, which is defined as only undertaking activities associated with daily living.
- The majority of patients were identified as having an unhealthy body mass index (BMI) with less than one fifth (19%) of patients having a BMI within the normal range.
- Overall, 27% of patients had diabetes as a comorbidity with some variation observed between diagnosis categories.
- Almost half (46%) of patients had a family history of cardiovascular disease.
- Overall, there were 16% of patients assessed by outpatient CR who were documented as having heart failure.
- Of the patients documented to have heart failure, 86% were classed as having a reduced ejection fraction (LVEF <50%).
- Over one quarter (27%) of patients had a documented history of depression.
- More than half of patients (59%) were identified as having a history of hypertension.
- There were 12% of patients identified as current smokers (defined as smoking within 30 days), while 48% were classed as former smokers.

Table 12: Summary of risk factors by diagnosis category

Risk factor	Ischaemic heart disease %	Valvular disease %	Other %	All %
Abnormal cholesterol*	96.4	65.5	80.4	89.7
Activity level				
Sufficiently active	38.7	40.1	35.2	37.9
Insufficiently active	40.9	39.2	43.7	41.5
Inactive	20.4	20.7	21.1	20.6
Body mass index				
Normal range†	17.8	24.9	19.0	18.7
Overweight‡	39.1	36.7	35.9	38.1
Obese§	37.0	32.8	34.4	36.0
Morbidly obese‖	5.4	3.5	9.7	6.3
Diabetes	27.9	19.5	25.1	26.5
Family history of CVD#	48.9	33.2	42.9	46.0
Heart failure	12.6	11.2	24.0	15.5
Heart failure, LVEF**				
≥50%	6.1	31.8	23.1	14.4
40–49%	40.8	25.8	26.7	34.3
30–39%	40.4	25.8	27.8	34.6
‹30%	12.6	16.7	22.4	16.7
History of depression	27.0	25.1	28.5	27.2
Hypertension	57.9	56.6	61.5	58.7
Smoking status				
Current smoker††	15.2	3.8	7.5	12.2
Former smoker	49.2	46.0	45.9	48.1
Never smoked	35.7	50.3	46.7	39.7

% from total complete data per case category

* Total cholesterol ›4.0 mmol/L, HDL ‹1.0 mmol/L, LDL ›2.0 mmol/L or triglycerides ›2.0 mmol/L

† BMI 18.5–24.9 kg/m²

‡ BMI 25.0–29.9 kg/m²

§ BMI 30.0–39.9 kg/m²

‖ BMI ≥40.0 kg/m²

Cardiovascular disease

** Left ventricular ejection fraction

†† Within 30 days

7.4 Current medications

Over three quarters of patients were being treated with aspirin (83%) and lipid lowering medications (84%). As expected, there was variation in medication across diagnosis categories. Patients with IHD tended to use antiplatelet and sublingual nitrate medications more than patients with valvular disease. This is consistent with the different disease processes and respective treatment regimes.

Table 13: Current medications by diagnosis category

Medications	IHD %	Valvular disease %	Other %	All %
Aspirin	90.8	67.1	66.8	82.6
ACEI/ARB*	65.4	44.6	54.7	60.9
Antiplatelet	69.7	9.5	30.8	54.7
Anticoagulant	15.7	46.1	25.5	20.7
Beta blocker	68.0	53.9	58.6	64.4
Diabetic medications	24.4	17.4	22.0	23.2
Dual antiplatelet	65.4	5.7	24.5	49.9
Lipid lowering	92.3	57.3	73.1	84.4
Sublingual nitrate	62.3	5.5	21.1	47.0
Other	69.5	85.3	79.1	73.3

* Angiotensin converting enzyme inhibitor/angiotensin receptor blocker

8 Program outcomes

The following outcome measures use paired observations from the pre assessment and post assessment stages to identify changes in health status for patients participating in CR. Measures included in this analysis relate to patient reported outcome measures (PROMS) and other functional or pathological investigations.

A limiting factor for this analysis is availability of data for the post assessment stage. Specifically, the availability of updated pathology and other investigations as well as the model of care employed by the CR program. This may result in limited data from which conclusions can be drawn and is a focus for future reporting and enhancements to data collection.

Table 14: Summary of program outcome measures

Program outcome	Category	Measure
1	Pathology	Lipid profile
2	Functional	Six minute walk test
3	PROMS	Patient Health Questionnaire
4	PROMS	Assessment of Quality of Life
5	PROMS	Other patient reported outcomes

8.1 Lipid profile

Data for lipid values such as total cholesterol was available for a smaller proportion of patients completing CR. A barrier to reporting this outcome is that updated pathology results are not always available for the post assessment stage. It is hoped that this limitation may be reduced with increased availability of data and linkage with other Queensland Health data collections.

Overall a reduction in the mean total cholesterol was observed as was a reduction in triglycerides and LDL-C levels. This may be attributable to the impact of CR and adherence with pharmacotherapy.

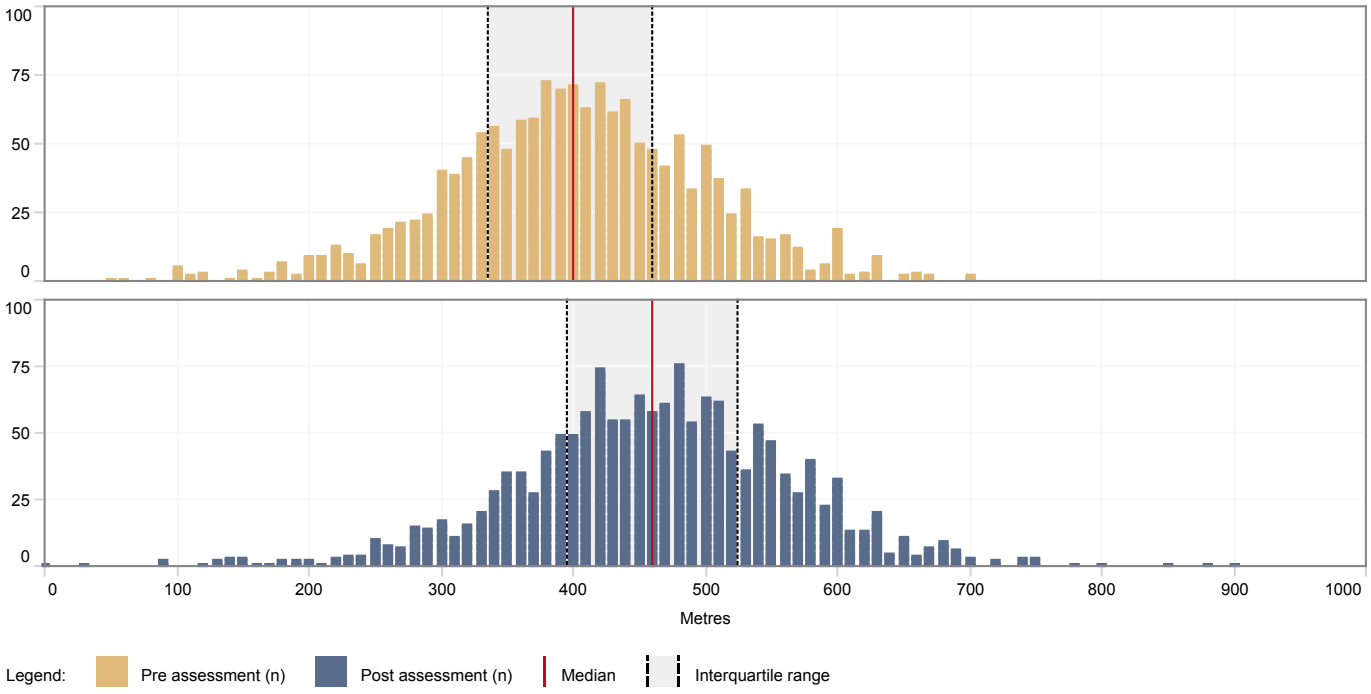
Table 15: Summary of lipid values

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Total cholesterol (mmol/L)	326	4.5 ± 1.3	3.5 ± 0.8	-1.0 ± 1.3
Triglycerides (mmol/L)	306	1.9 ± 1.1	1.5 ± 0.8	-0.3 ± 1.0
HDL-C (mmol/L)	284	1.1 ± 0.6	1.1 ± 0.3	-0.1 ± 0.6
LDL-C (mmol/L)	278	2.5 ± 1.1	1.6 ± 0.6	-0.9 ± 1.1

8.2 Six minute walk test

A functional measure is commonly utilised prior to implementing an exercise program in order to determine exercise prescription and enable changes to be measured. The six minute walk test (6MWT) is a standardised investigation of submaximal exercise capacity that is often used in patients with cardiopulmonary disease. Changes in the six minute walk distance are useful in assessing functional capacity and the efficacy of therapeutic interventions such as pharmacotherapy and CR.[48]

There were 1,537 cases where the patient completed a 6MWT at the pre assessment and post assessment stages. The 6MWT is not always feasible due to the different models of care that exist, with some programs not offering an exercise component. In the majority of instances (74%) patients demonstrated an improvement in 6MWT, with 56% recording an increase of greater than 50 metres (Table 16).



Results rounded to 10 metres

Figure 12: Comparison of pre assessment and post assessment six minute walk test results

Table 16: Summary of six minute walk test results

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Distance travelled (metres)	1,537	398.0 ± 96.2	458.0 ± 104.3	59.9 ± 59.5

Table 17: Change in six minute walk test results

	n (%)
Improved ≥50 metres	856 (55.7)
Improved 26–49 metres	279 (18.2)
No change (±25 metres)	339 (22.1)
Worsened >25 metres	63 (4.1)
All	**1,537 (100.0)**

8.3 Patient reported outcome measures

Patient Health Questionnaire

The CR assessment often includes a brief screening for anxiety and depressive disorders. Both of these are significant risk factors for patients suffering coronary artery disease and are associated with adverse cardiovascular outcomes independent of other risk factors.

The Patient Health Questionnaire-4 (PHQ-4) is a validated tool for screening anxiety and depressive disorders.[49] This instrument is a four item composite measure derived from the Generalized Anxiety Disorder-7 scale (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9). Each of the four items on the PHQ-4 is scored using a four point scale:

- high psychological distress being scored 9–12 points
- mild psychological distress scoring between 3–5 points
- minimal depression and anxiety scoring between 0–2 points.

A total of 2,343 paired data were available for analysis. One third of patients (33%) demonstrated an improved PHQ-4 score at post assessment and 52% recorded no change to their PHQ-4 score. Given a large proportion of patients reported minimal depression and anxiety at the pre assessment there is often no scope for improvement via this metric.

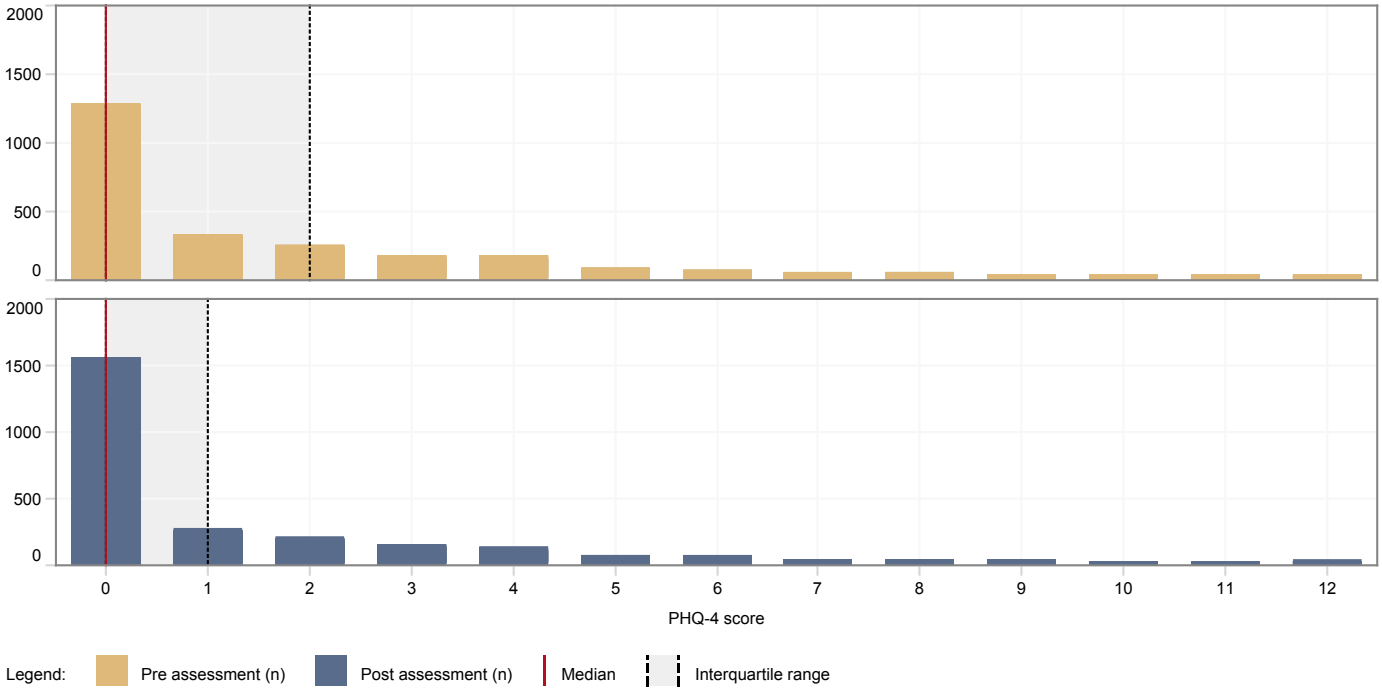


Figure 13: Comparison of pre assessment and post assessment PHQ-4 results

Table 18: Summary of PHQ-4 results

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Depression score (PHQ-2)	2,343	0.7 ± 1.2	0.4 ± 1.0	-0.2 ± 1.2
Anxiety score (GAD-2)	2,343	0.8 ± 1.3	0.6 ± 1.1	-0.2 ± 1.3
Overall score	**2,343**	**1.5 ± 2.3**	**1.0 ± 1.9**	**-0.5 ± 2.1**

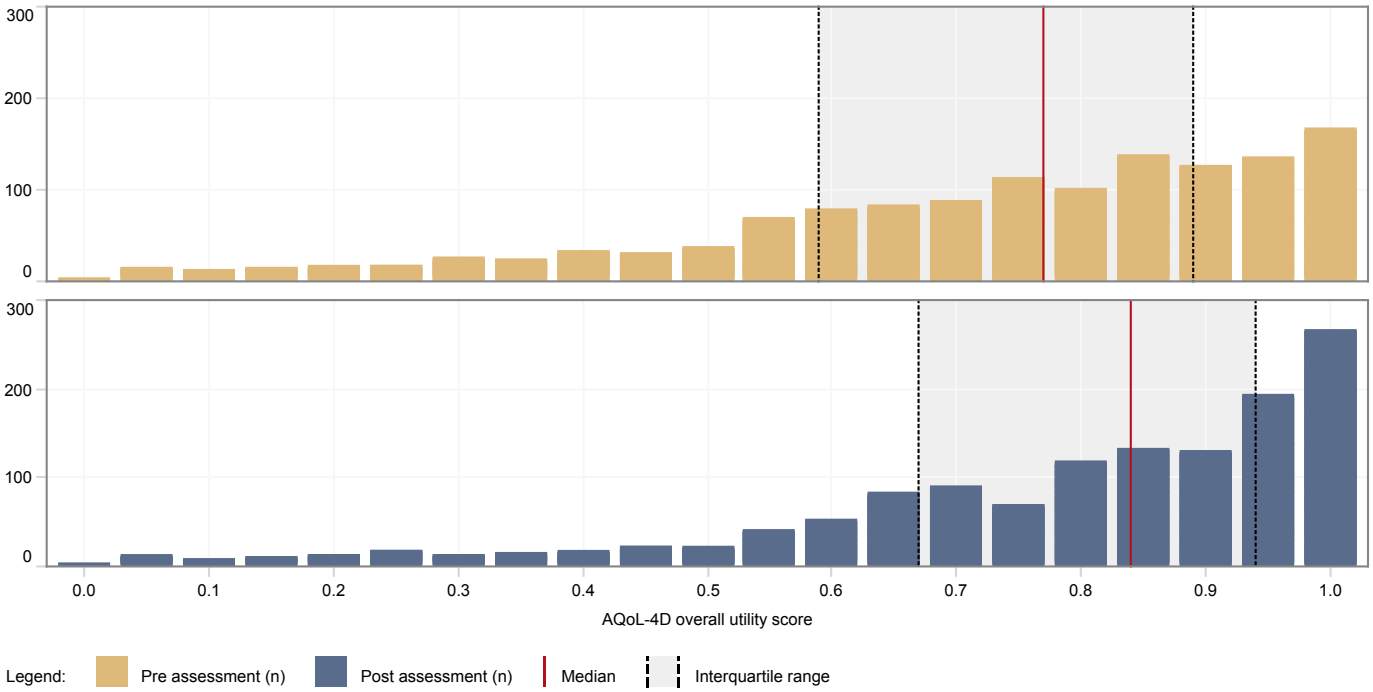
Table 19: Change in PHQ-4 results

	n (%)
Any improvement	783 (33.4)
No change	1207 (51.5)
Any worse result	353 (15.1)
All	**2,343 (100.0)**

Assessment of Quality of Life

The Assessment of Quality of Life (AQoL-4D) is a multi-attribute utility instrument developed to assess health related quality of life. It measures PROMS across four domains of health, scored individually, as well as providing an overall score. Overall AQoL-4D utility score ranges from 0.00–1.00, with scores closer to 1.00 indicating higher satisfaction of patients reporting the status of their own health.

For the 1,258 records available at the pre and post CR timeframes, the mean overall pre assessment AQoL-4D utility score was 0.72 which compares similarly to expected results for patients with a cardiovascular diagnosis.[50] This utility score improved to 0.78 at the post assessment stage, where 59% of patients demonstrated an improved overall utility score after CR intervention (Table 20 and Table 21).



Results rounded to 0.05 utility score

Figure 14: Comparison of pre assessment and post assessment AQoL-4D results

Table 20: Summary of AQoL-4D results

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Independent living	1,258	0.90 ± 0.18	0.95 ± 0.13	0.05 ± 0.16
Relationships	1,258	0.91 ± 0.15	0.92 ± 0.15	0.01 ± 0.15
Senses	1,258	0.94 ± 0.07	0.94 ± 0.07	0.01 ± 0.07
Mental health	1,258	0.90 ± 0.11	0.91 ± 0.11	0.02 ± 0.12
Overall score	**1,258**	**0.72 ± 0.23**	**0.78 ± 0.21**	**0.06 ± 0.21**

Table 21: Change in AQoL-4D results

	n (%)
Any improvement	737 (58.6)
No change	134 (10.7)
Any worse result	387 (30.8)
All	**1,258 (100.0)**

Other patient reported outcomes

Any assessment by a CR clinician includes a component assessing for quality of life (QOL). However, the use of a long-form questionnaire (such as AQoL-4D) is often impractical or unwarranted. The assessment of patient reported QOL takes the form of an abbreviated questionnaire allowing patients to self-report their health-related status across three domains.

The questions asked include:

- In general, how would you describe your health at present?
- In general, how would you describe your mood at present?
- How fit are you now compared with 6 months ago?

The abbreviated questionnaire often provides a gauge to whether the CR practitioner may need to apply a more detailed QOL assessment to better understand the status and needs of the individual patient.

Paired data on the condensed QOL survey were available for 1,368 assessments.

Self reported health

There were 44% of patients reporting a health status of very good or excellent at post assessment, compared with 13% at the pre assessment phase. Over three quarters (79%) reported a feeling of improved health. Reductions in the numbers of patients reporting fair or poor health were observed, with only 1% of patients reporting poor health at post assessment.

Decreases in self reported health status were reported by 6% of patients, however caution should be exercised when interpreting this result as there are many confounding factors which may affect the health status of a patient with what is often a newly diagnosed complex chronic disease.

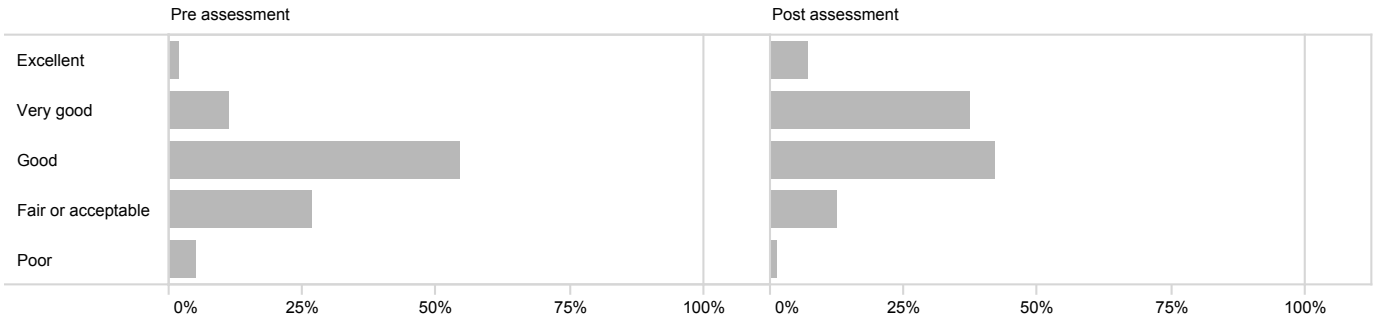


Figure 15: Comparison of patient reported health status at pre and post assessment

Table 22: Change in patient reported health status at pre and post assessment

	n (%)
Any improvement	995 (78.9)
No change	191 (15.1)
Any worse result	75 (5.9)
All	**1,261 (100.0)**

Self reported mood

Approximately half of patients (51%) reported an improved mood compared to the pre assessment stage. The proportion of patients reporting excellent mood scores at post assessment increased from 3% to 9%, while those with very good mood scores increased from 13% to 39%.

There were 7% of patients who reported a decrease in mood, however it is reassuring to note an overall decrease in the proportion of patients reporting fair or poor mood.

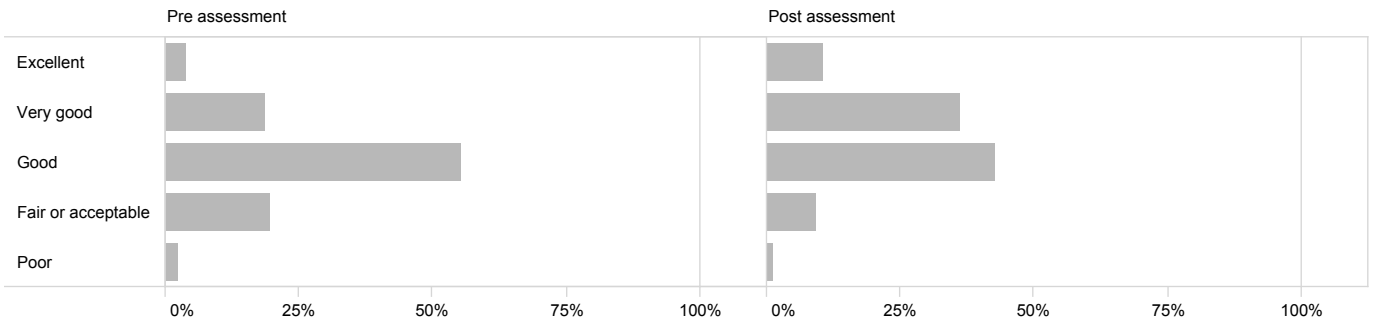


Figure 16: Comparison of patient reported mood at pre and post assessment

Table 23: Change in patient reported mood at pre and post assessment

	n (%)
Any improvement	645 (51.1)
No change	532 (42.2)
Any worse result	84 (6.7)
All	**1,261 (100.0)**

Self reported fitness

When asked to compare fitness level to the period six months prior to completing a CR program, 45% of patients reported that their fitness had improved. Decreases in fitness were reported by 19% of patients. This finding may warrant further investigation as there may be various factors contributing to their reported decrease in fitness level.

Issues such as the development of significant cardiac dysfunction as a result of myocardial infarction may explain a decline in fitness. Given the result is compared to a baseline six months prior to completing CR, the patient's index cardiac event may also have occurred in this time and therefore regression may not be unexpected.

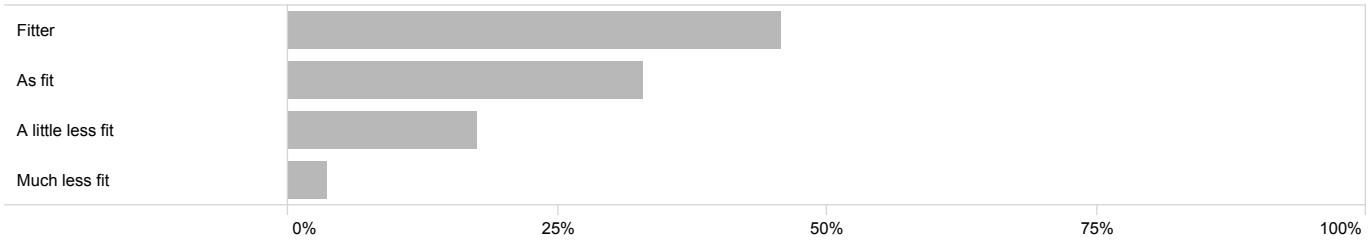


Figure 17: Patient reported change in fitness at post assessment

Table 24: Patient reported change in fitness at post assessment

	n (%)
Fitter	570 (45.2)
As fit	453 (35.9)
A little less fit	193 (15.3)
Much less fit	45 (3.6)
All	**1,261 (100.0)**

8.4 Failure to participate

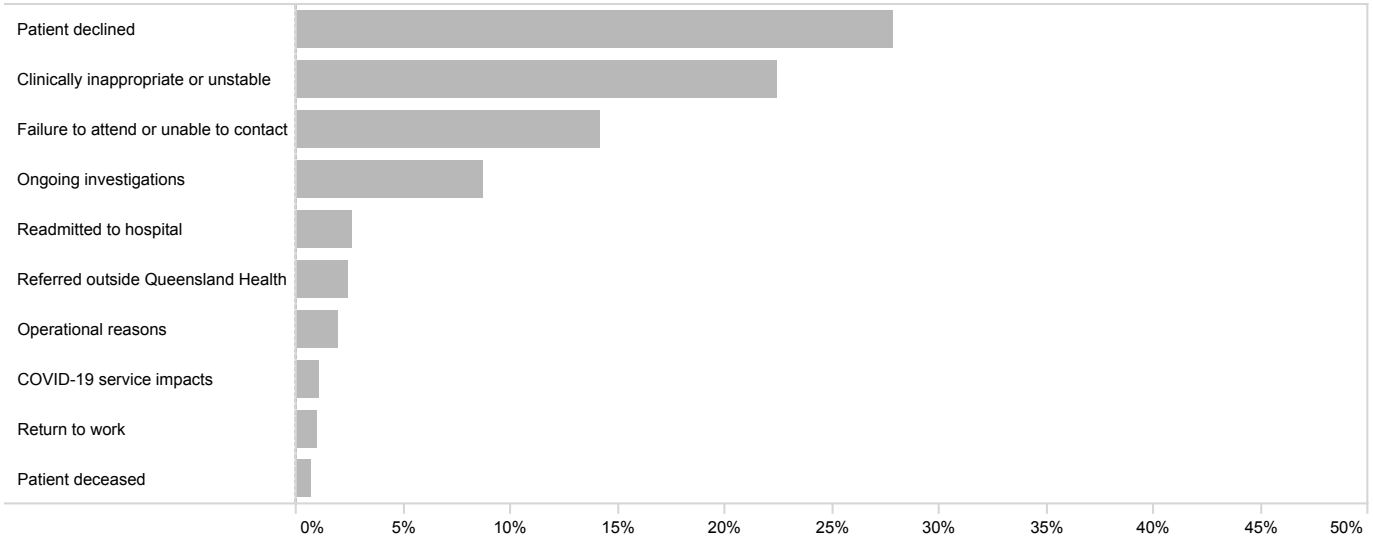
There are many reasons a patient may not participate in a CR program. In this cohort, which includes patients who declined or were unsuitable during phase 1 and phase 2, the most common reason for not participating in a CR program was that the patient had declined (28%). Twenty two percent were medically inappropriate to participate or had been uncontactable or failed to attend (12%).

For 2021 referrals, 1% were declined due to impacts of the global COVID-19 pandemic such as compulsory service closures, staff redeployment and patient unwillingness to proceed.

An ongoing initiative has been to further define the subset of patients who did not participate in CR. The aim is to increase the level of detail available to describe the barriers to participation, identify common themes and opportunities to improve patient participation rates.

In some of these instances, the clinician may still provide opportunistic education and advice to these patients, however this is difficult to incorporate into reporting.

A limiting factor for this analysis is the amount of data available to describe this cohort, as this is limited to the information included on the initial referral only.



Not displaying other reasons (17%)

Figure 18: Reasons for no pre assessment being conducted

8.4.1 Age and gender

There is considerable variation in patient age when comparing patients who participated in CR as opposed to patients who declined or were not interested and patients who were medically unsuitable. Patients who participated in CR had a median age of 65 years, whilst patients who declined or were medically unsuitable had a median age five years older and two years older respectively.

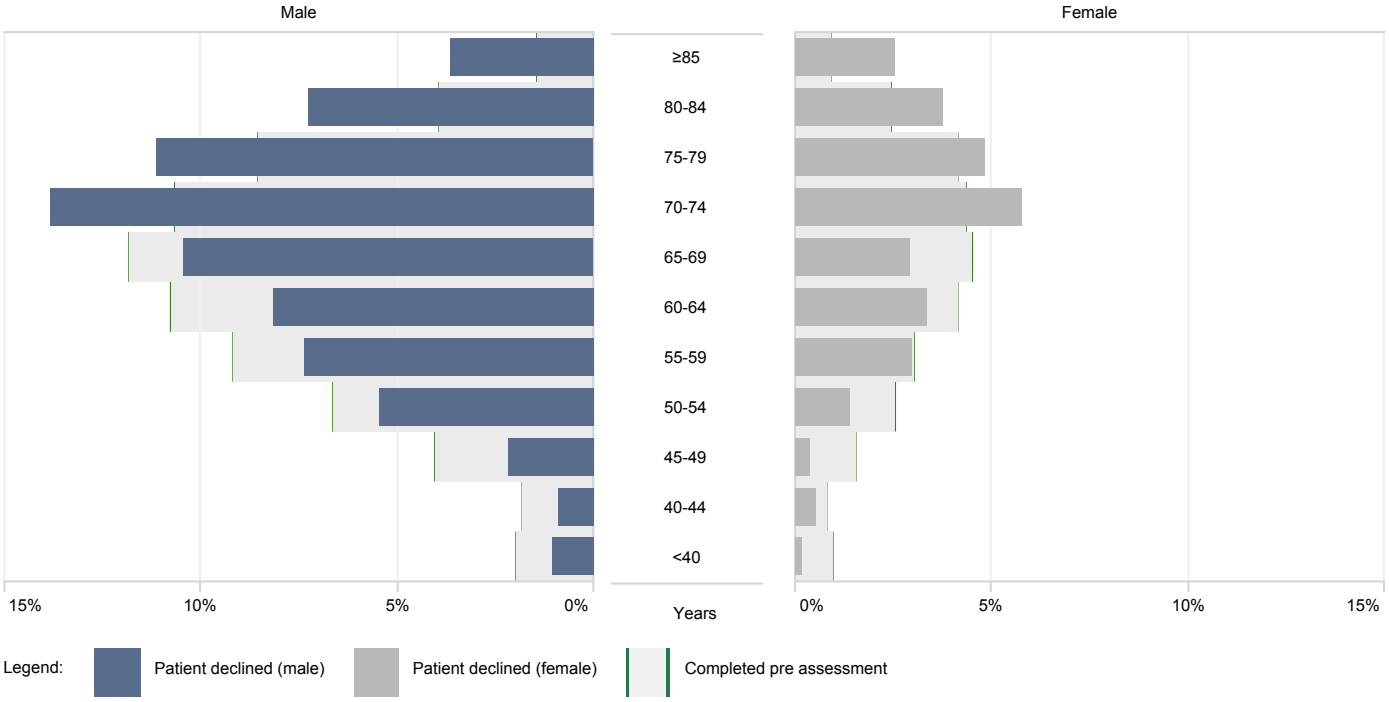


Figure 19: Patient age group and gender, patient declined vs. completed pre assessment

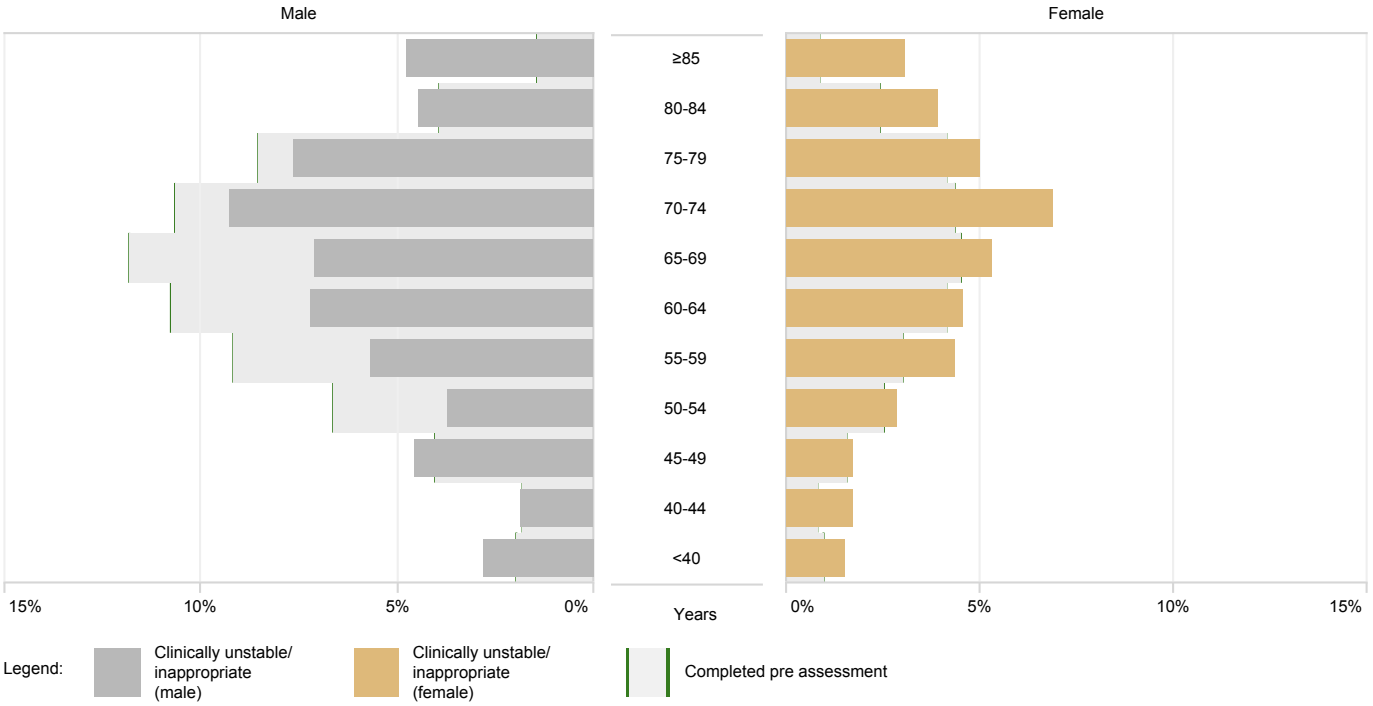


Figure 20: Patient age group and gender, clinically unstable/inappropriate vs. completed pre assessment

Table 24: Patient age (years) by program participation status

	Male Median (IQR)	Female Median (IQR)	All Median (IQR)
Pre assessment completed	65 (56–73)	66 (57–75)	65 (57–73)
Patient declined	70 (60–76)	72 (62–78)	70 (60–77)
Clinically unstable or inappropriate	67 (56–76)	67 (57–76)	67 (57–76)
Other reason not assessed	65 (56–73)	66 (54–76)	65 (55–74)

Table 26: Patient gender by program participation status

Gender	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
Female	2,151 (59.9)	326 (9.1)	376 (10.5)	738 (20.6)
Male	5,190 (62.9)	815 (9.9)	542 (6.6)	1,701 (20.6)
All	**7,341 (62.0)**	**1,141 (9.6)**	**918 (7.8)**	**2,439 (20.6)**

8.4.2 Diagnosis category

Of the patients who declined, 33% had a diagnosis of ischaemic heart disease and approximately 3% had valvular disease. The majority (65%) had an other diagnosis. By comparison, patients who had completed an initial assessment via CR were more likely to have a diagnosis of ischaemic heart disease or valvular heart disease (66% and 8% respectively).

Patients with no IHD or valvular disease were unlikely to commence a CR program, with 58% of these referrals declined by either the patient or the service. This may provide opportunities for services to review program offerings for these patients.

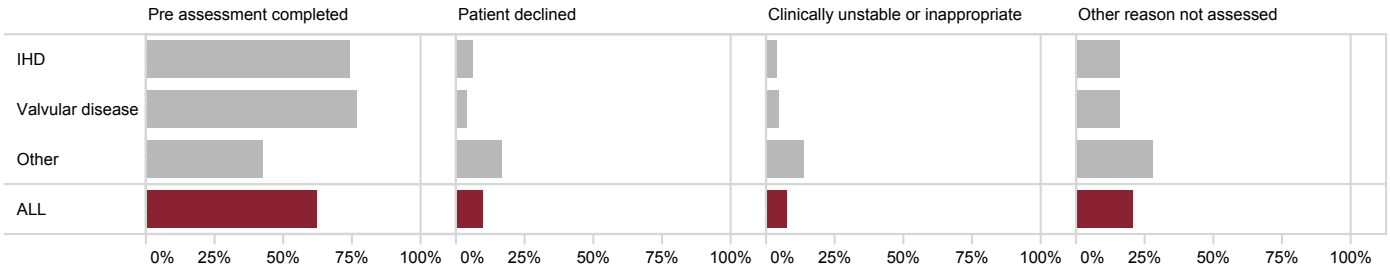


Figure 21: Proportion of cases by diagnosis category and program participation status

Table 27: Diagnosis category by program participation status

	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
IHD	4,833 (74.2)	372 (5.7)	268 (4.1)	1,039 (16.0)
Valvular disease	605 (76.3)	30 (3.8)	35 (4.4)	123 (15.5)
Other	1,903 (42.0)	739 (16.3)	615 (13.6)	1,277 (28.2)
All	**7,341 (62.0)**	**1,141 (9.6)**	**918 (7.8)**	**2,439 (20.6)**

8.4.3 Most recent procedure

For the cohort that proceeded to assessment, their most recent procedure was closely related to their participation status. 79% of patients who had a PCI procedure and 84% of patients who underwent CABG completed a pre assessment. This suggests that patients who have undergone an invasive cardiac procedure are more likely to have participated in a CR program.

The majority of patients who declined CR (60%) had no recent procedure specified. Furthermore, 17% of patients that elected not to participate in CR were recorded as having undergone PCI, while approximately 5% had undergone CABG (with or without a concomitant valve procedure).

Care should be taken when interpreting these findings as this data element is not always completed at the time of referral. Therefore, it may not fully reflect the patient's medical history.

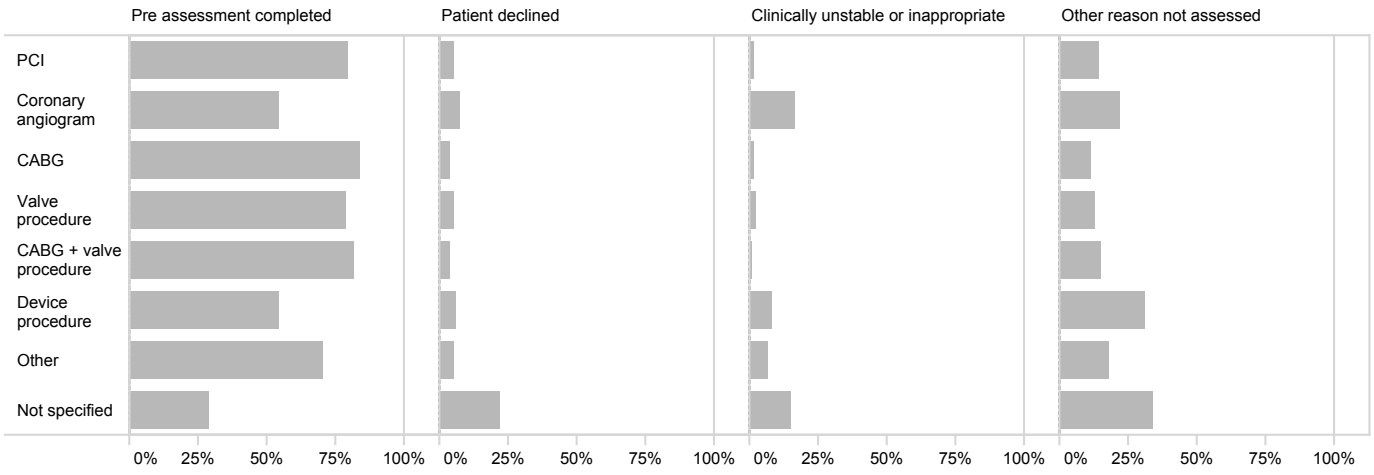


Figure 22: Proportion of referrals by most recent procedure and program participation status

Table 28: Most recent procedure by program participation status

Most recent procedure	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
PCI	3,021 (79.3)	197 (5.2)	53 (1.4)	539 (14.1)
Coronary angiogram	1,064 (54.3)	142 (7.2)	332 (16.9)	422 (21.5)
CABG	1,176 (83.8)	50 (3.6)	16 (1.1)	162 (11.5)
Valve procedure	657 (78.9)	47 (5.6)	22 (2.6)	107 (12.8)
CABG + valve procedure	164 (81.2)	7 (3.5)	1 (0.5)	30 (14.9)
Device procedure	145 (54.5)	16 (6.0)	22 (8.3)	83 (31.2)
Other	249 (70.3)	19 (5.4)	23 (6.5)	63 (17.8)
Not specified	865 (28.7)	663 (22.0)	449 (14.9)	1,033 (34.3)
All	**7,341 (62.0)**	**1,141 (9.6)**	**918 (7.8)**	**2,439 (20.6)**

8.4.4 Place of residence

Compared to patients who had taken up CR, a higher proportion of patients who elected not to participate resided in regional and remote areas of Queensland.

While there are many reasons a patient may wish not to participate in CR, this trend toward lower participation rates for patients in regional areas should be noted for service planning and model of care selection. These figures should be interpreted with caution due to the small numbers residing in the remote areas.

Table 29: Remoteness classification by program participation status

Remoteness area*	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
Major cities	4,138 (67.0)	604 (9.8)	300 (4.9)	1,131 (18.3)
Inner regional	1,889 (59.6)	297 (9.4)	191 (6.0)	792 (25.0)
Outer regional	1,058 (52.3)	209 (10.3)	362 (17.9)	394 (19.5)
Remote	78 (47.3)	11 (6.7)	20 (12.1)	56 (33.9)
Very remote	157 (60.4)	15 (5.8)	38 (14.6)	50 (19.2)
All	**7,320 (62.1)**	**1,136 (9.6)**	**911 (7.7)**	**2,423 (20.6)**

Excludes missing data (0.4%)

* Classified by Australian Statistical Geography Standard remoteness area

9 Clinical indicators

The CR clinical indicator program has been focused towards the timely provision of CR to admitted patients discharged from public hospitals. This requires collaboration between the acute and outpatient services, with each having their own targets (clinical indicators 1 and 2a respectively).

Overall system performance is measured through clinical indicator 3, which requires the acute and outpatient services to both meet their respective targets. For the purpose of this indicator any referrals crossing between HHSs are counted under both the referring and receiving HHS/organisation.

Table 30: Cardiac rehabilitation clinical indicators

#	Clinical indicator	Description
1	Timely referral – inpatients	Documented referral to CR within three days of discharge
2a	Timely assessment – inpatients	Initial CR pre assessment completed within 28 days of discharge
2b	Timely assessment – non acute patients	Initial CR pre assessment completed within 28 days of referral date
3	Timely journey – inpatients	Composite of timely referral and assessment

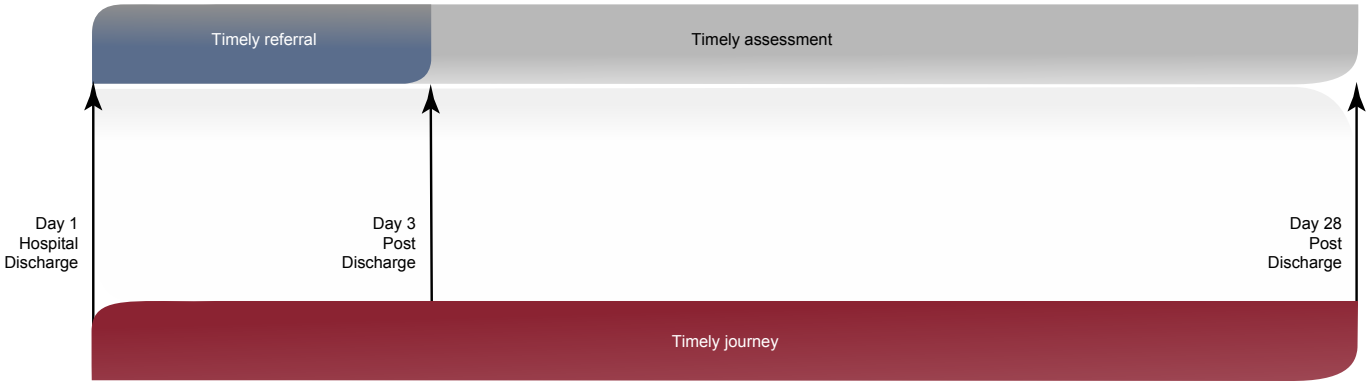


Figure 23: Timely referral, assessment and overall journey for inpatient referrals

9.1 Timely referral

This indicator examines the proportion of inpatient referrals to CR originating from a public hospital which had been provided to the CR program in a timely manner (within 3 days of referral). This requires the referral to be submitted to the outpatient program within three days of the patient being discharged from hospital.

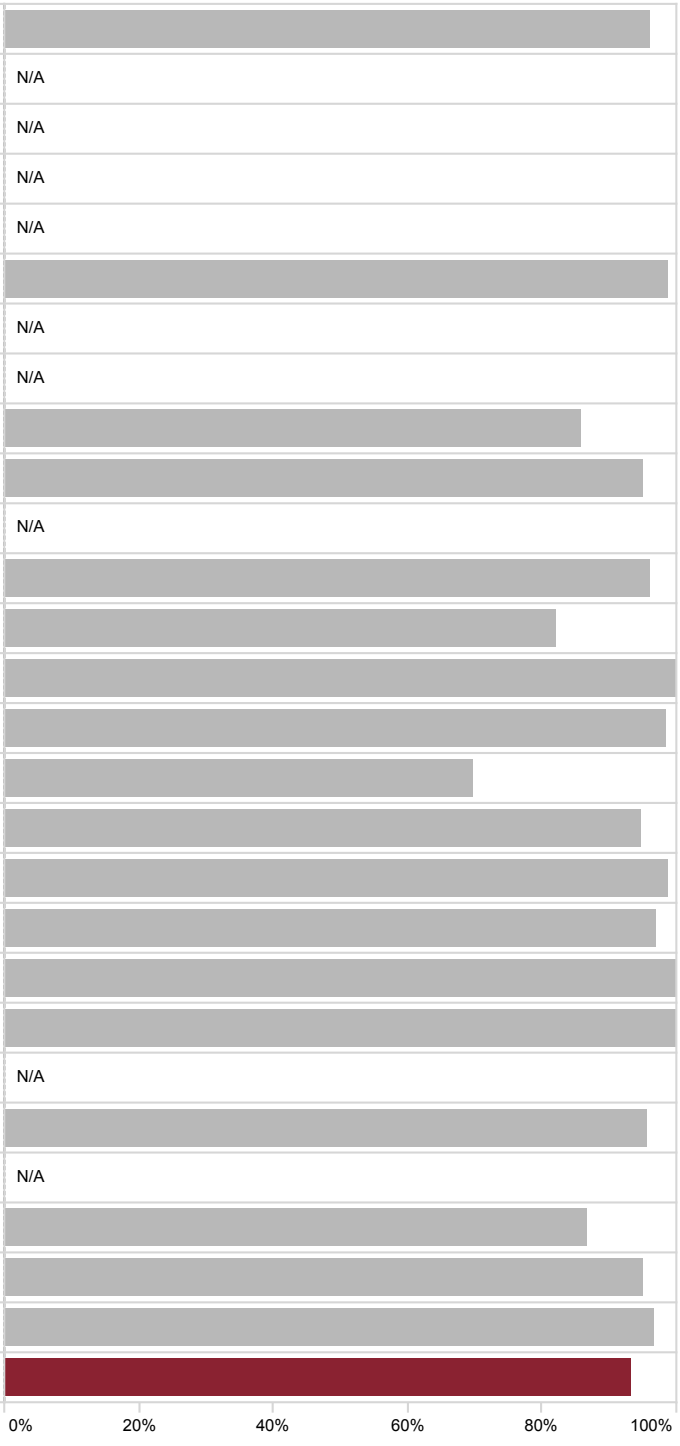
Overall, performance is high with 93% of referrals contributed to QCOR being submitted within three days of discharge.

Table 31: Timely referrals by referring HHS

Referring HHS/organisation	Total inpatient referrals n	Total eligible for analysis n	Target met n (%)
Cairns and Hinterland	542	533	511 (95.9)
Central Queensland	290	243	235 (96.7)
Darling Downs	145	141	121 (85.8)
Gold Coast	1,208	1,195	1,134 (94.9)
Mackay	124	120	115 (95.8)
Mater Health Services	69	67	55 (82.1)
Metro North	2,136	2,115	1,902 (89.9)
Metro South	1,776	1,751	1,702 (97.2)
South West	1	1	N/A
Sunshine Coast	733	708	678 (95.8)
Townsville	637	634	550 (86.8)
West Moreton	123	120	114 (95.0)
Wide Bay	31	30	29 (96.7)
Statewide	**7,815**	**7,658**	**7,147 (93.3)**

N/A: Not displayed due to <20 referrals eligible for analysis

Referred by HHS	Referred by hospital	Total analysed, n
Cairns and Hinterland	Cairns Hospital	532
	Innisfail Hospital	1
Central Queensland	Capricorn Coast Hospital	10
	Gladstone Hospital	8
	Mount Morgan Hospital	5
	Rockhampton Hospital	219
	Woorabinda Hospital	1
Darling Downs	Kingaroy Hospital	1
	Toowoomba Hospital	140
Gold Coast	Gold Cost University Hospital	1,194
	Robina Hospital	1
Mackay	Mackay Base Hospital	120
Mater Health Services	Mater Hospital Brisbane	67
Metro North	Caboolture Hospital	133
	Redcliffe Hospital	59
	Royal Brisbane & Women's Hospital	446
	The Prince Charles Hospital	1,477
Metro South	Logan Hospital	80
	Princess Alexandra Hospital	1,545
	Queen Elizabeth II Jubilee Hospital	74
	Redland Hospital	52
North West	Mount Isa Base Hospital	1
Sunshine Coast	Sunshine Coast University Hospital	708
Townsville	Ingham Hospital	1
	Townsville University Hospital	633
West Moreton	Ipswich Hospital	120
Wide Bay	Bundaberg Base Hospital	30
Statewide		



N/A: Not displayed due to <20 referrals eligible for analysis

Figure 24: Timely referrals by referring hospital

9.2 Timely assessment – inpatients

This indicator examines the proportion of referrals to CR which proceed to an assessment within 28 days of discharge. In order to retain focus on the performance of the outpatient CR program, referrals which are not provided in a timely manner (<3 days from discharge) have been excluded from the analysis. Further to this, other ineligibility criteria are outlined in Table 32. The exclusions are applied where information is available and has been documented in the application.

Overall, more than half of all patients (64%) are being assessed in a timely manner, however there was some variation across health services.

Table 32: Summary of referrals ineligible for timely assessment clinical indicator – inpatients

Summary	n
Not referred within 3 days of discharge	486
Same day admission	156
Clinically unstable/inappropriate	118
Patient readmitted to hospital	88
Referred outside of Queensland Health	70
Patient accepted onto existing program	61
Patient deceased	26
Total ineligible	**1,005**

Table 33: Timely assessment indicator by outpatient HHS – inpatients

Outpatient HHS/division	Total inpatient referrals n	Total eligible for analysis n	Target met n (%)
Cairns and Hinterland	595	523	343 (65.6)
Central Queensland	507	394	247 (62.7)
Central West	18	13	10 (76.9)
Darling Downs	364	321	146 (45.5)
Gold Coast	1,195	1,039	802 (77.2)
Health Contact Centre	899	731	458 (62.7)
Mackay	190	170	60 (35.3)
Metro North	1,066	961	535 (55.7)
Metro South	1,139	1,045	757 (72.4)
North West	36	31	15 (48.4)
South West	35	34	19 (55.9)
Sunshine Coast	853	718	426 (59.3)
Townsville	348	302	139 (46.0)
West Moreton	380	356	267 (75.0)
Wide Bay	190	172	108 (62.8)
Statewide	**7,815**	**6,810**	**4,332 (63.6)**

Outpatient HHS/division	Outpatient program	Total analysed, n
Cairns and Hinterland	Atherton	60
	Cairns	423
	Innisfail	36
	Tully	22
Central Queensland	Capricorn Coast	84
	Gladstone	92
	Rockhampton	256
Darling Downs	Dalby-Tara	32
	Kingaroy	71
	Toowoomba	186
	Warwick	41
Gold Coast	Gold Coast	1,182
Health Contact Centre	SMoCC	879
Mackay	Mackay	152
	Proserpine	21
Metro North	Caboolture	318
	Chermside	312
	North Lakes	303
	Redcliffe	117
Metro South	Bayside	271
	Eight Mile Plains	156
	Inala	89
	Logan-Beaudesert	500
	Princess Alexandra Hospital	101
North West	Mt Isa	36
Sunshine Coast	Caloundra	256
	Gympie	135
	Maroochydore	165
	Nambour	168
	Noosa	108
Townsville	Ayr	27
	Townsville	299
West Moreton	Ipswich	378
Wide Bay	Hervey Bay	123
	Maryborough	53
Statewide		

Sites with <20 referrals for analysis not displayed

Figure 25: Timely assessment by outpatient program – inpatients

9.3 Timely assessment – non acute patients

This indicator examines the proportion of referrals from the non acute setting which proceed to an assessment within 28 days of referral. The majority of non acute patients (61%) are being assessed in a timely manner, with some notable variation between health services.

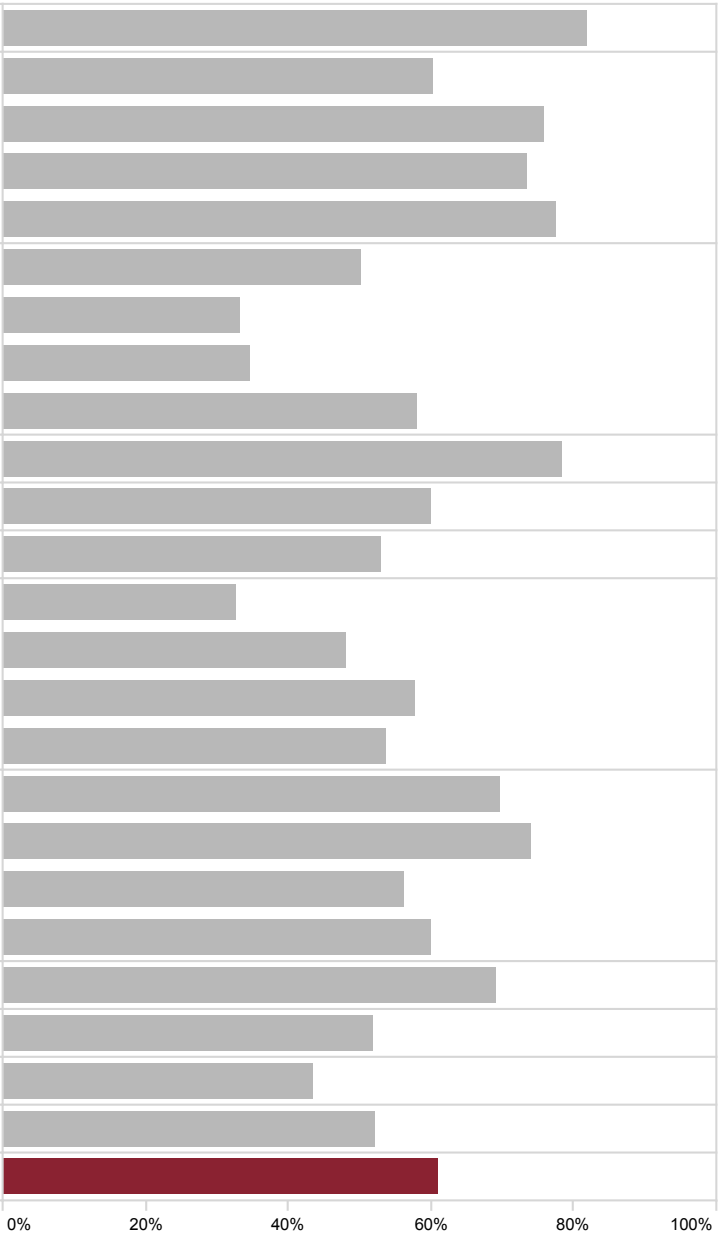
Table 33: Summary of referrals ineligible for timely assessment clinical indicator – non acute patients

Summary	n
Referred outside of Queensland Health	28
Patient accepted onto an existing program	21
Clinically unstable/inappropriate	18
Patient admitted to hospital	15
Patient deceased	2
Total ineligible	**84**

Table 35: Timely assessment indicator by outpatient HHS – non acute patients

Outpatient HHS/division	Total non acute referrals n	Total eligible for analysis n	Target met n (%)
Cairns and Hinterland	90	90	73 (81.1)
Central Queensland	451	438	320 (73.1)
Central West	14	14	11 (78.6)
Darling Downs	206	202	90 (44.6)
Gold Coast	175	166	130 (78.3)
Health Contact Centre	204	195	117 (60.0)
Mackay	116	114	52 (45.6)
Metro North	404	392	187 (47.7)
Metro South	571	558	372 (66.7)
North West	26	26	18 (69.2)
South West	46	46	35 (76.1)
Sunshine Coast	114	99	55 (55.6)
Townsville	73	73	30 (41.1)
West Moreton	301	295	154 (52.2)
Wide Bay	41	40	33 (82.5)
Statewide	**2,832**	**2,748**	**1,677 (61.0)**

Outpatient HHS/division	Outpatient program	Total analysed, n
Cairns and Hinterland	Cairns	44
Central Queensland	Capricorn Coast	91
	Gladstone	70
	Mount Morgan	49
	Rockhampton	222
Darling Downs	Dalby-Tara	26
	Kingaroy	45
	Toowoomba	72
	Warwick	38
Gold Coast	Gold Coast	166
Health Contact Centre	SMoCC	195
Mackay	Mackay	98
Metro North	Caboolture	123
	Chermside	50
	North Lakes	135
	Redcliffe	84
Metro South	Bayside	230
	Eight Mile Plains	92
	Inala	39
	Logan-Beaudesert	183
North West	Mt Isa	26
Sunshine Coast	Caloundra	27
Townsville	Townsville	69
West Moreton	Ipswich	295
Statewide		



Sites with <20 referrals for analysis not displayed

Figure 26: Timely assessment by outpatient program – non acute patients

9.4 Timely journey

This patient-centric measure of overall system performance requires strong coordination and links between the referring acute and outpatient CR sites. It measures the proportion of eligible inpatient referrals submitted by the acute site within three days of discharge, as well as the ability of the receiving CR program to meet the target of completing a pre assessment within 28 days of discharge.

Referrals are excluded from the analysis for the reasons outlined in Table 36. The exclusions are applied where information is available and has been documented in the application.

It is important to note that for the purpose of this indicator, any referral which crosses between HHSs is counted for both participating services.

Table 36: Summary of referrals ineligible for timely journey clinical indicator – inpatients

Summary	n
Same day admission	156
Clinically unstable/inappropriate	118
Patient readmitted to hospital	88
Referred outside of Queensland Health	70
Patient accepted onto existing program	61
Patient deceased	26
Total ineligible	**519**

Table 37: Timely journey indicator by participating HHS – inpatients

Participating HHS/ organisation	Total inpatient referrals* n	Total eligible for analysis* n	Target met n (%)
Cairns and Hinterland	1137	600	365 (60.8)
Central Queensland	797	441	253 (57.4)
Central West	18	14	N/A
Darling Downs	509	380	161 (42.4)
Gold Coast	2,403	1,170	834 (71.3)
Health Contact Centre	899	848	458 (54.0)
Mackay	314	195	68 (34.9)
Mater Health Services	69	67	41 (61.2)
Metro North	3,202	2,085	1,180 (56.6)
Metro South	2,915	1,868	1,260 (67.5)
North West	37	36	15 (41.7)
South West	35	35	19 (54.3)
Sunshine Coast	1,586	837	478 (57.1)
Townsville	985	634	286 (45.1)
West Moreton	503	382	275 (72.0)
Wide Bay	221	201	118 (58.7)
Statewide	**7,815**	**7,296**	**4,332 (59.4)**

N/A: Not displayed due to <20 referrals eligible for analysis

* Includes both incoming and outgoing referrals

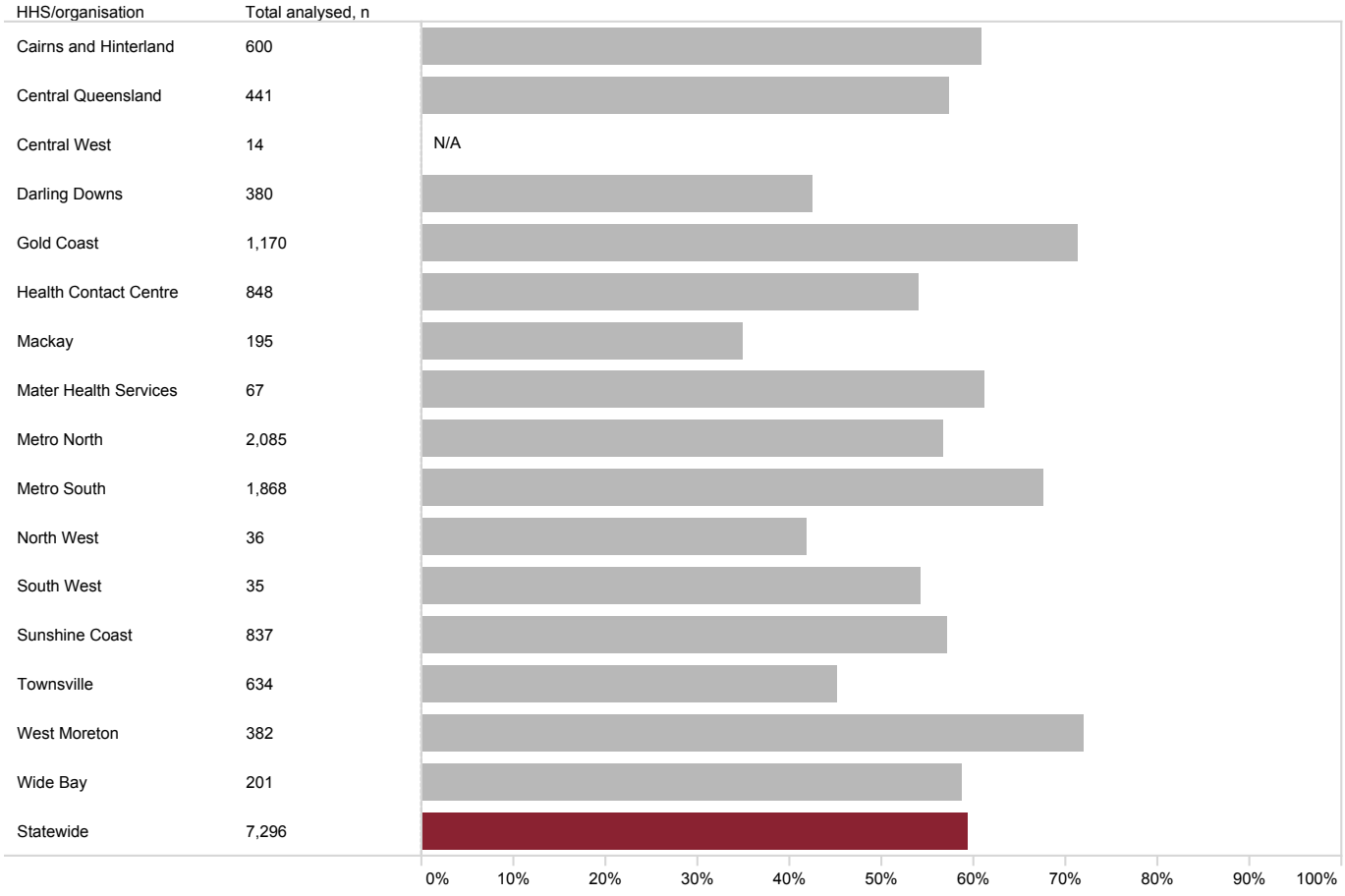
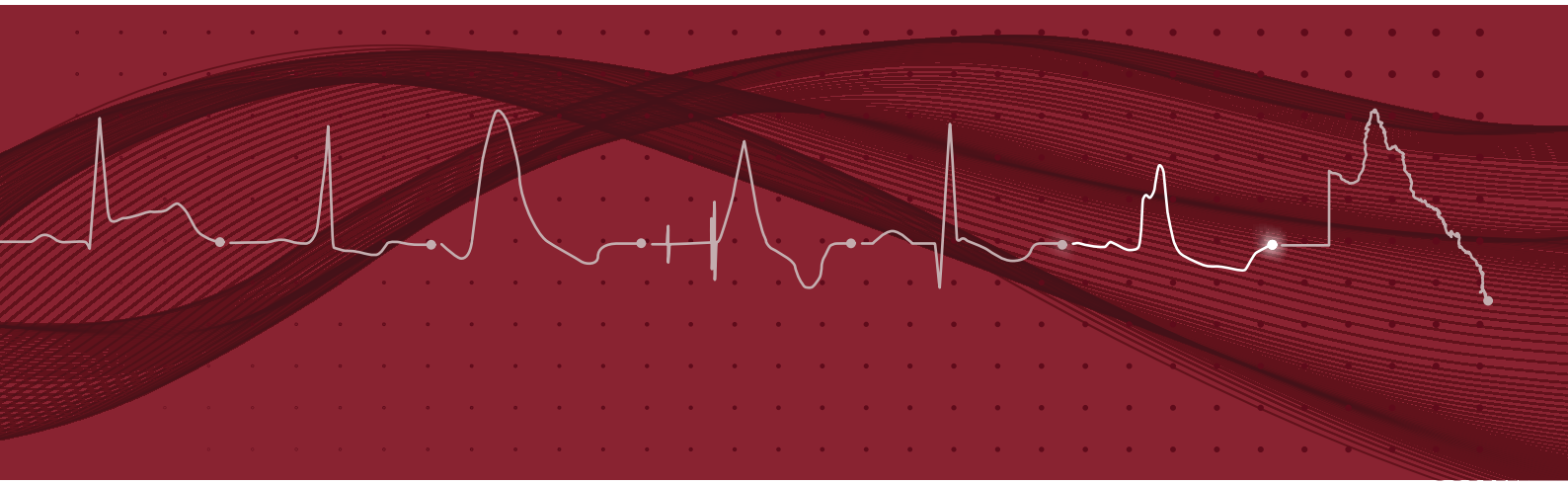


Figure 27: Timely journey indicator by participating HHS – inpatients

Heart Failure Support Services Audit



1 Message from the QCOR Heart Failure Steering Committee Chair

The last few years have been exciting times in heart failure management with advances in medications, cardiac electronic devices, and heart valve surgery. While these breakthroughs give hope to patients, the complexity of care has become greater, and the role of heart failure support teams is more important than ever.

Data collection for Heart Failure Support Services continues to grow and evolve to respond to changing evidence and practice. When data collection began in 2016, we focused on two drug classes recommended as first line treatments for patients with HFrEF and none for HFpEF. This 2021 QCOR Heart Failure Support Services Audit looks at the prescription of three drug classes. In the last year, a combination of four drug classes is now recommended for HFrEF, with emerging evidence also suggesting new medical therapy for patients with HFpEF. These changes in evidence will be reflected in the 2022 QCOR Annual Report.

The indicators related to the timeliness of follow up of referrals reflect the importance of support. Patients with heart failure need to self-manage symptoms through diet, exercise, and medications; a job that can be overwhelming for many patients and their families. As with many chronic diseases, heart failure disproportionately affects Aboriginal and Torres Strait Islander patients, the socially disadvantaged, the elderly and those with mental illness. Fortunately, patients in Queensland have access to 21 heart failure teams across the state which contribute to this registry. These teams including nurses and allied health staff support patients and liaise between medical specialists, GPs, and other primary care providers to integrate transitional care during high-risk periods.

Future plans include the introduction of comprehensive clinical performance indicators at six months from referral as it frequently takes many months to optimise the patient's care.

This registry is coupled with a statewide quality improvement program that explores barriers to change and the HERO data are used to inform the success of initiatives in implementation in the rapidly changing landscape of heart failure management.

On behalf of the QCOR Heart Failure Support Services Committee, I would like to thank all the clinicians that contribute data and the responsiveness of the SCCIU in adapting the QCOR data collection application to reflect changes in practice.

Professor John Atherton
Chair
QCOR Heart Failure Support Services Committee

2 Key findings

Characteristics of referrals to a Heart Failure Support Service (HFSS)

There were 6,326 new referrals in 2021, a 57% growth in referrals since 2016. Characteristics of referrals included: male (66%), Aboriginal and Torres Strait Islander patients (5.5%), HFrEF (81%), and patients referred from hospital (63%).

The median age of referrals was 69 years old with male patients presenting younger than females (68 years vs. 71 years respectively). Aboriginal and Torres Strait Islander patients represented a younger cohort compared with non-Indigenous patients (57 years vs. 70 years respectively), and HFrEF patients are younger than HFpEF patients (67 years vs. 77 years respectively). Patients aged 75 years or older represented approximately one third of total cases (34%).

Clinical indicator performance

Most indicators met benchmarks at a statewide level. MRA§ prescription is trending towards improvement: 43% (2019), 46% (2020) and 51% (2021). The titration and review of beta blockers (clinical indicator 6a, 6b and 6c) show that while achievement of guideline recommended targets remains low at 31% the review of beta blockers status at 6 months has improved to almost achieve benchmark (79%) and beta blocker achievement of maximum tolerated dose has reached the benchmark of 80% for the first time.

There is variation in practice between sites except for clinical indicators 3 and 4 which are uniformly above benchmarks (i.e., prescription ACEI/ARB or ARNI† and beta blockers‡.

Table 1: Summary of statewide clinical indicator performance

#	Clinical indicator	% referrals
Non pharmacological indicators		
1a	Follow-up of acute patients within 2 weeks	78.2
1b	Follow-up of non acute patients within 4 weeks	84.1*
2	Assessment of left ventricular ejection fraction within 2 years	96.7*
Pharmacological indicators		
3a	ACEI/ARB or ARNI† prescription at hospital discharge	91.2*
3b	ACEI/ARB or ARNI† at first clinical review	92.7*
4a	Beta blocker‡ prescription at hospital discharge	90.1*
4b	Beta blocker‡ prescription at first clinical review	91.5*
5a	Prescription of MRA§ for HFrEF at time of hospital discharge	51.4
5b	Prescription of MRA§ for HFrEF at time of first HFSS clinical review	51.4
6a	Beta blocker‡ titration status review at six months post referral	79.1
6b	Beta blocker‡ achievement of guideline recommended target	30.8
6c	Beta blocker‡ achievement of guideline recommended target dose or maximum tolerated dose	80.0*

* Benchmark met (benchmark is 80% achievement except for 6b which is 50%)

† Angiotensin-converting-enzyme inhibitor (ACEI), angiotensin II receptor blockers (ARB) or angiotensin receptor neprilysin inhibitor (ARNI)

‡ Bisoprolol, carvedilol, metoprolol sustained release or nebivolol

§ Mineralocorticoid receptor antagonists

Patient outcomes

Patient outcomes are based on inpatient referrals from the previous year (n 3,297) to allow for 12 month follow-up from the index hospitalisation. Mortality was 1.4% at 30 days and 11.4% at 12 months. Death/rehospitalisation was 17.7% at 30 days and 53.8% at 12 months. Based on 3,297 eligible patients, 101,548 days were lost due to death or hospitalisation over 12 months.

Table 2: Summary of outcomes for patients referred from a hospital setting

#	Measures post index hospitalisation*	30 days	1 year
1	All-cause mortality	1.4%	11.4%
2	a) All-cause rehospitalisation	17.2%	52.8%
	b) Heart failure rehospitalisation	5.8%	20.7%
3	Composite all-cause hospitalisation or all-cause mortality	17.7%	53.8%
4	Days alive and out of hospital†	N/A	364 median days

Conclusion

Follow up time of new referrals remain high overall. Optimal therapy can be difficult to achieve at hospital discharge or by the first clinical review for a range of valid reasons. As medication optimisation become more complex, it is recommended that pharmacological clinical indicators include a review of prescription and titration for all medications at 6 months so that the uptake of combination therapies be measured.

3 Participating sites

Heart Failure Support Services (HFSS) consists of teams of specialised nurses, with medical support and allied health services. There are 21 services which contributed data to this year's Annual Report and the locations and services offered are shown in Figure 3 and Table 4 respectively.

Table 3: Queensland Heart Failure Support Services (HFSS) facilities and acronyms

Hospital and Health Service (HHS)	HFSS Facility	Acronym
Cairns and Hinterland	Cairns Hospital	CH
Central Queensland	Gladstone Hospital	GLH
	Rockhampton Hospital	RKH
Darling Downs	Toowoomba Hospital	TWH
Gold Coast	Gold Coast Community Health	GCCH
Mackay	Mackay Base Hospital	MKH
Metro North	Caboolture Hospital	CBH
	Redcliffe Hospital	RDH
	Royal Brisbane & Women's Hospital	RBWH
	The Prince Charles Hospital	TPCH
Metro South	Logan Hospital	LGH
	Princess Alexandra Hospital	PAH
	Queen Elizabeth II Hospital	QEII
	Redland Hospital	RLH
North West	Mt Isa Hospital	MIH
Sunshine Coast	Gympie Hospital	GYH
	Sunshine Coast University Hospital	SCUH
Townsville	Townsville Hospital	TTH
West Moreton	Ipswich Community Health	IPCH
Wide Bay	Bundaberg Hospital	BNH
	Hervey Bay Hospital (includes Maryborough)	HBH

Figure 1: Heart Failure Support Service (HFSS) locations

Table 4: Components of Queensland Heart Failure Support Services (HFSS)

		HFSS disciplines				Modes of service (telephone + ...)				
HHS	**Facility**	**Nurse**	**NP***	**Pharm†**	**Physio or AEP‡**	**In-patient**	**Nurse or MD clinics**	**Home visits**	**Group rehab**	**Medical mentor§**
Cairns and Hinterland	CH	✓	✓	–	✓	✓	✓	✓	✓	✓
Central Queensland	GLH	✓	✓[VC]	–	✓	–	–	–	✓	–
	RKH	✓	✓	–	✓	✓	✓	–	✓	✓
Darling Downs	TWH	✓	–	–	R	✓	✓	✓	✓	✓
Gold Coast	GCCH	✓	–	✓	✓	✓	✓	✓	✓	✓
Mackay	MKH	✓	–	–	✓	✓	✓	–	✓	✓
Metro North	CBH	✓	–	✓	–	–	✓	–	–	✓
	RDH	✓	✓	–	–	–	✓	✓	–	✓
	RBWH	✓	–	✓	✓	✓	✓	–	✓	✓
	TPCH	✓	✓	✓	✓	✓	✓	–	✓	✓
Metro South	LGH	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PAH	✓	✓	✓	✓	✓	✓	✓	✓	✓
	QEII	✓	✓	✓	R	✓	✓	✓	–	✓
	RLH	✓	✓	–	✓	✓	✓	✓	✓	✓
North West	MIH	✓	–	✓	R	✓	✓	✓	–	Outreach
Sunshine Coast	GYH	✓	✓[VC]	–	–	✓	✓	✓	–	✓
	SCUH	✓	✓	–	R	✓	✓	✓	–	✓
Townsville	TTH	✓	✓	✓	R	✓	✓	✓	–	✓
West Moreton	IPCH	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wide Bay	BNH	✓	✓	–	R	✓	✓	✓	–	✓
	HBH	✓	✓	–	✓	✓	✓	✓	✓	Video clinic
Statewide		100%	62%	48%	86%	86%	95%	70%	62%	100%

* Nurse practitioner who can prescribe medications

† Pharmacist

‡ Physiotherapist or accredited exercise physiologist

§ The HFSS has a cardiologist or general physician mentor

R Referral for exercise that is routinely accepted by another program such as cardiac or pulmonary rehabilitation

VC Videoconference service is provided by an NP elsewhere in the HHS

4 New referrals

There were 6,326 new referrals reported by the 21 participating HFSS, with Metropolitan sites comprising 55% of all referrals. Five year trends in referral to HFSS can be seen in the figure below. Between 2016 and 2021 referral volumes increased by 57%.

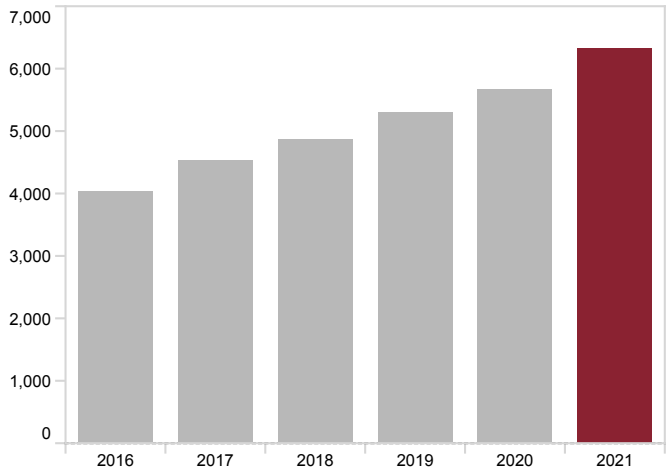


Figure 2: Total yearly HF referrals, 2016–2021

Table 5: Yearly HF referral volume, 2016–2021

	2016 n	2017 n	2018 n	2019 n	2020 n	2021 n
Yearly referrals	4,021	4,528	4,878	5,304	5,664	6,326

4.1 Location of referrals

Table 6: Distribution of new referrals by HFSS location

Referrals per HHS	n (%)	Referrals per facility	n (%)
Cairns and Hinterland	289 (4.6)	Cairns Hospital	289 (4.6)
Central Queensland	270 (4.3)	Gladstone Hospital	19 (0.3)
		Rockhampton Hospital	251 (4.0)
Darling Downs	49 (0.8)	Toowoomba Hospital	49 (0.8)
Gold Coast	475 (7.5)	Gold Coast Community Health	475 (7.5)
Mackay	136 (2.1)	Mackay Base Hospital	136 (2.1)
Metro North	2,020 (31.9)	Caboolture Hospital	439 (6.9)
		Redcliffe Hospital	151 (2.4)
		Royal Brisbane & Women's Hospital	454 (7.2)
		The Prince Charles Hospital HFS	976 (15.4)
Metro South	1,484 (23.5)	Logan Hospital	518 (8.2)
		Princess Alexandra Hospital	635 (10.0)
		Queen Elizabeth II Hospital	175 (2.8)
		Redland Hospital	156 (2.5)
North West	43 (0.7)	Mt Isa Hospital	43 (0.7)
Sunshine Coast	667 (10.5)	Gympie	93 (1.5)
		Sunshine Coast University Hospital	574 (9.1)
Townsville	240 (3.8)	Townsville Hospital	240 (3.8)
West Moreton	440 (7.0)	Ipswich Community Health	440 (7.0)
Wide Bay	213 (3.4)	Bundaberg Hospital	123 (1.9)
		Hervey Bay Hospital	90 (1.4)
Statewide			**6,326 (100.0)**

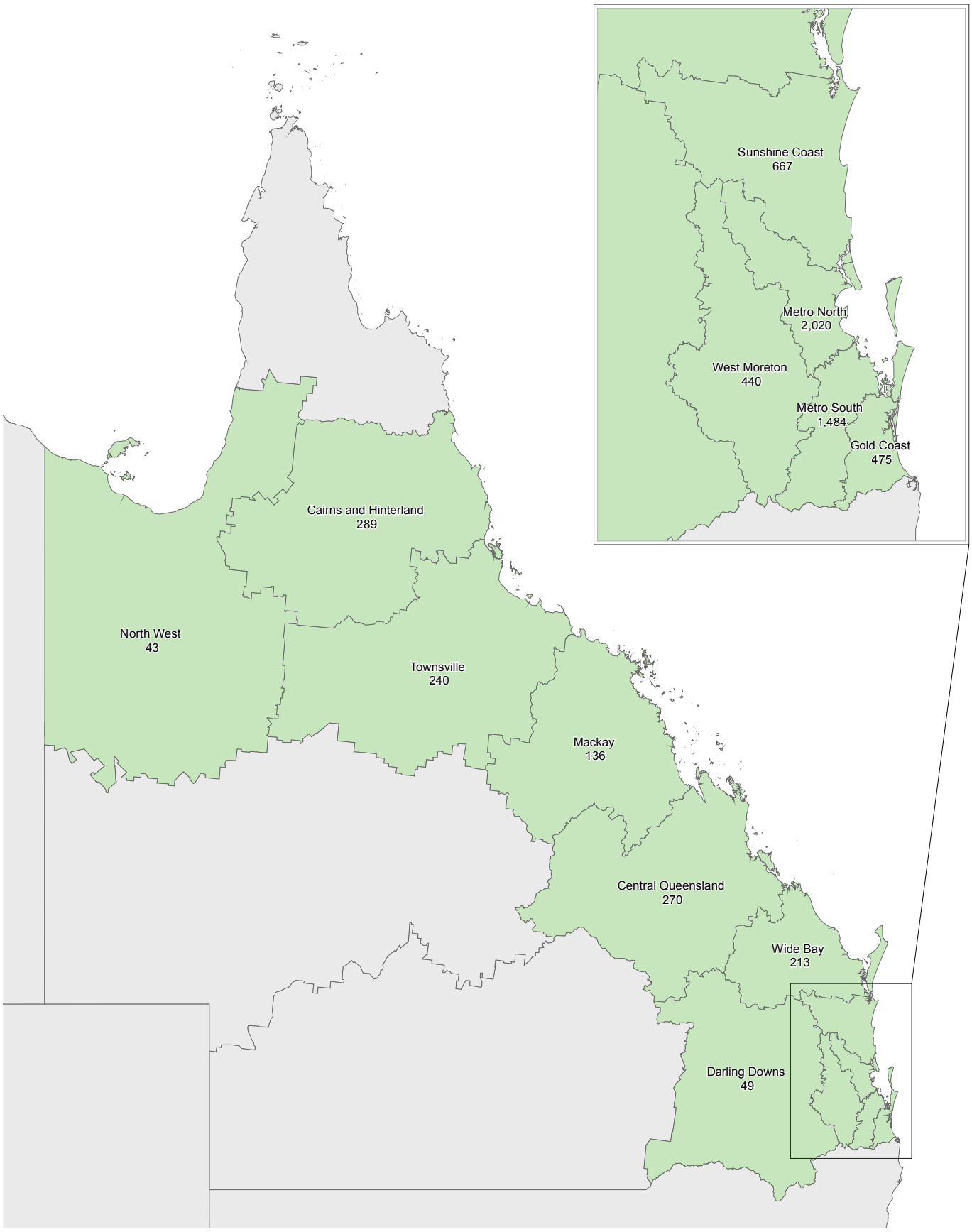


Figure 3: Regional distribution of new referrals

4.2 Referral source

Most referrals originated from an inpatient setting (63%), with smaller proportions originating from an outpatient setting (24%) or as a transfer from another service (11.7%).

Few referrals came directly from primary care (1.3%), which is expected as most referrals flow to specialty outpatient clinics for diagnosis and treatment optimisation prior to referral to an HFSS.

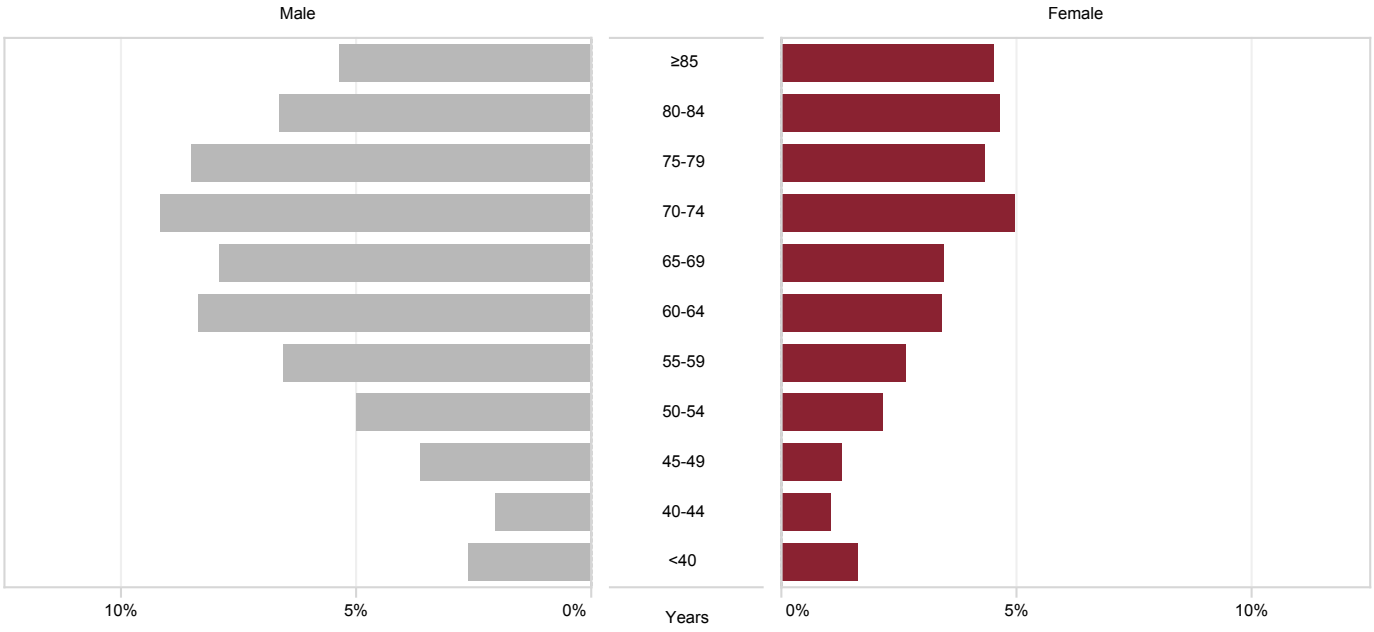
Table 7: Source of HFSS referral

HHS	HFSS	Inpatient n (%)	Outpatient n (%)	Another HFSS n (%)	Primary care n (%)
Cairns and Hinterland	Cairns Hospital	232 (80.3)	53 (18.3)	4 (1.4)	–
Central Queensland	Gladstone Hospital	9 (47.4)	3 (15.8)	7 (36.8)	–
	Rockhampton Hospital	161 (64.1)	77 (30.7)	3 (1.2)	10 (4.0)
Darling Downs	Toowoomba Hospital	9 (18.4)	38 (77.6)	2 (4.1)	–
Gold Coast	Gold Coast Community Health	285 (60.0)	145 (30.5)	31 (6.5)	14 (2.9)
Mackay	Mackay Base Hospital	60 (44.1)	68 (50.0)	7 (5.1)	1 (0.7)
Metro North	Caboolture Hospital	178 (40.5)	136 (31.0)	95 (21.6)	30 (6.8)
	Redcliffe Hospital	34 (22.5)	52 (34.4)	64 (42.4)	1 (0.7)
	Royal Brisbane & Women's Hospital	324 (71.4)	118 (26.0)	12 (2.6)	–
	The Prince Charles Hospital	687 (70.4)	282 (28.9)	6 (0.6)	1 (0.1)
Metro South	Logan Hospital	330 (63.7)	25 (4.8)	155 (29.9)	8 (1.5)
	Princess Alexandra Hospital	605 (95.3)	21 (3.3)	9 (1.4)	–
	Queen Elizabeth II Hospital	110 (62.9)	26 (14.9)	38 (21.7)	1 (0.6)
	Redland Hospital	21 (13.5)	52 (33.3)	83 (53.2)	–
North West	Mt Isa Hospital	2 (4.7)	39 (90.7)	1 (2.3)	1 (2.3)
Sunshine Coast	Gympie Hospital	25 (26.9)	11 (11.8)	56 (60.2)	1 (1.1)
	Sunshine Coast University Hospital	410 (71.4)	137 (23.9)	24 (4.2)	3 (0.5)
Townsville	Townsville Hospital	130 (54.2)	104 (43.3)	2 (0.8)	4 (1.7)
West Moreton	Ipswich Community Health	276 (62.7)	89 (20.2)	72 (16.4)	3 (0.7)
Wide Bay	Bundaberg Hospital	73 (59.3)	12 (9.8)	34 (27.6)	4 (3.3)
	Hervey Bay Hospital	17 (18.9)	35 (38.9)	36 (40.0)	2 (2.2)
Statewide		**3,978 (62.9)**	**1,523 (24.1)**	**741 (11.7)**	**84 (1.3)**

5 Patient characteristics

5.1 Age and gender

The statewide median age of patients managed by an HFSS was 69 years. The median age of women (71 years) was three years older than men. Approximately one third of patients (34%) were 75 years of age and older.



% of total (n=6,326)

Figure 4: Proportion of all referrals by gender and age group

Table 8: Median age in years by gender and HFSS

HHS	HFSS	Male years	Female years	All years
Cairns and Hinterland	Cairns Hospital	66	68	67
Central Queensland	Gladstone Hospital	62	69	66
	Rockhampton Hospital	68	71	69
Darling Downs	Toowoomba Hospital	63	63	63
Gold Coast	Gold Coast Community Health	68	72	69
Mackay	Mackay Base Hospital	64	63	64
Metro North	Caboolture Hospital	71	75	73
	Redcliffe Hospital	72	79	75
	Royal Brisbane & Women's Hospital	69	70	70
	The Prince Charles Hospital	69	74	71
Metro South	Logan Hospital	66	69	67
	Princess Alexandra Hospital	66	71	67
	Queen Elizabeth II Hospital	67	69	68
	Redland Hospital	66	70	67
North West	Mt Isa Hospital	59	64	60
Sunshine Coast	Gympie Hospital	67	74	70
	Sunshine Coast University Hospital	70	70	70
Townsville	Townsville Hospital	63	65	64
West Moreton	Ipswich Community Health	68	74	70
Wide Bay	Bundaberg Hospital	70	70	70
	Hervey Bay Hospital	70	73	71
Statewide		**68**	**71**	**69**

5.2 Gender

The majority of patients were male (66%), ranging from 61% to 73% across participating sites.

Table 9: Referrals by gender and HFSS

HHS	HFSS	Male n (%)	Female n (%)
Cairns and Hinterland	Cairns Hospital	206 (71.3)	83 (28.7)
Central Queensland	Gladstone Hospital	13 (68.4)	6 (31.6)
	Rockhampton Hospital	158 (62.9)	93 (37.1)
Darling Downs	Toowoomba Hospital	35 (71.4)	14 (28.6)
Gold Coast	Gold Coast Community Health	325 (68.4)	150 (31.6)
Mackay	Mackay Base Hospital	92 (67.6)	44 (32.4)
Metro North	Caboolture Hospital	273 (62.2)	166 (37.8)
	Redcliffe Hospital	93 (61.6)	58 (38.4)
	Royal Brisbane & Women's Hospital	313 (68.9)	141 (31.1)
	The Prince Charles Hospital	633 (64.9)	343 (35.1)
Metro South	Logan Hospital	317 (61.2)	201 (38.8)
	Princess Alexandra Hospital	462 (72.8)	173 (27.2)
	Queen Elizabeth II Hospital	111 (63.4)	64 (36.6)
	Redland Hospital	103 (66.0)	53 (34.0)
North West	Mt Isa Hospital	28 (65.1)	15 (34.9)
Sunshine Coast	Gympie Hospital	59 (63.4)	34 (36.6)
	Sunshine Coast University Hospital	384 (66.9)	190 (33.1)
Townsville	Townsville Hospital	152 (63.3)	88 (36.7)
West Moreton	Ipswich Community Health	266 (60.5)	174 (39.5)
Wide Bay	Bundaberg Hospital	89 (72.4)	34 (27.6)
	Hervey Bay Hospital	59 (65.6)	31 (34.4)
Statewide		**4,171 (65.9)**	**2,155 (34.1)**

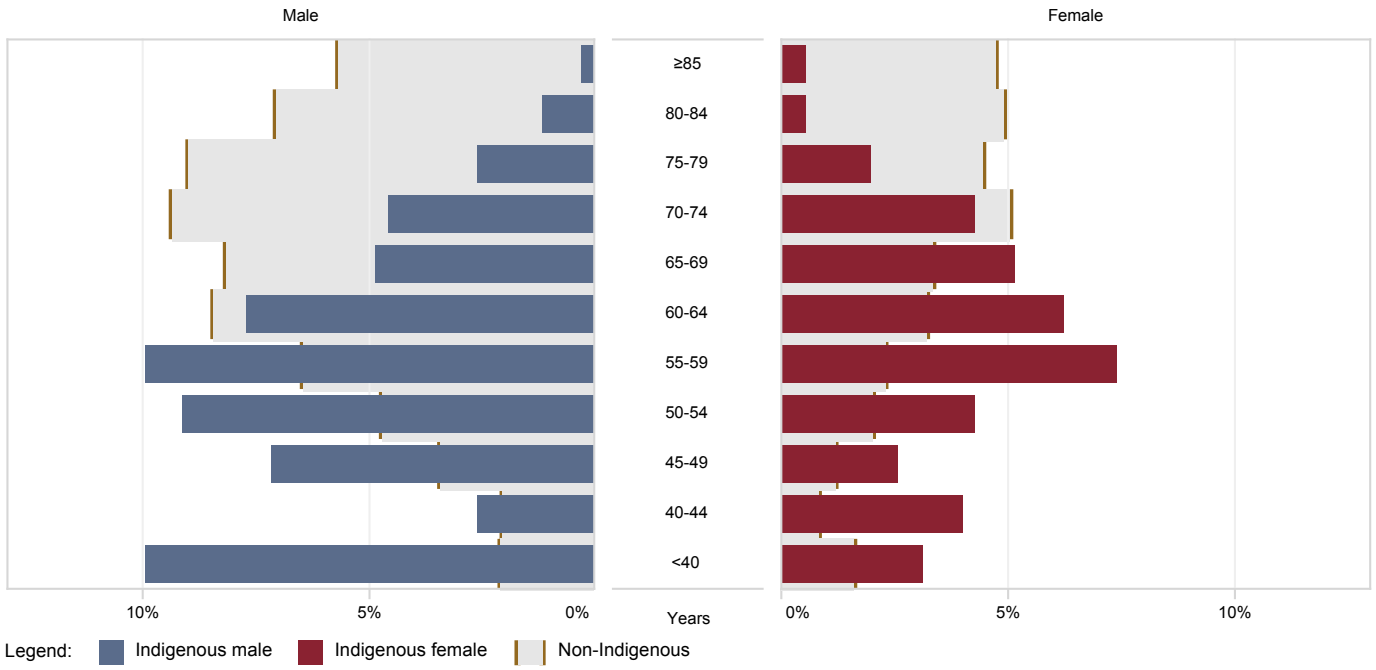
5.3 Aboriginal and Torres Strait Islander status

Patients of identified Aboriginal and Torres Strait Islander status made up 5.5% of all referrals. The number of referrals (n 351) was slightly increased in comparison the previous year (n 260). Aboriginal and Torres Strait Islander patients were significantly younger than other Queenslanders (57 years vs. 70 years). The proportion of caseload of Aboriginal and Torres Strait Islander patients was highest in Mount Isa (42%), followed by Cairns (29%) and Townsville (15%).

The number of Aboriginal and Torres Strait Islander referrals in the Greater Brisbane area (Metro North HHS and Metro South HHS) was 131 (37% of referrals statewide for Indigenous Australians).

Table 10: Aboriginal and Torres Strait Islander HFSS referrals as a proportion of caseload

HHS	HFSS	Indigenous n (%)	Non Indigenous n (%)	Not stated / unknown n (%)
Cairns and Hinterland	Cairns Hospital	84 (29.1)	204 (70.6)	1 (0.3)
Central Queensland	Gladstone Hospital	1 (5.3)	18 (94.7)	–
	Rockhampton Hospital	27 (10.8)	217 (86.5)	7 (2.8)
Darling Downs	Toowoomba Hospital	2 (4.1)	42 (85.7)	5 (10.2)
Gold Coast	Gold Coast Community Health	9 (1.9)	456 (96.0)	10 (2.1)
Mackay	Mackay Base Hospital	11 (8.1)	123 (90.4)	2 (1.5)
Metro North	Caboolture Hospital	15 (3.4)	412 (93.8)	12 (2.7)
	Redcliffe Hospital	5 (3.3)	140 (92.7)	6 (4.0)
	Royal Brisbane & Women's Hospital	13 (2.9)	429 (94.5)	12 (2.6)
	The Prince Charles Hospital	26 (2.7)	937 (96.0)	13 (1.3)
Metro South	Logan Hospital	20 (3.9)	487 (94.0)	11 (2.1)
	Princess Alexandra Hospital	42 (6.6)	590 (92.9)	3 (0.5)
	Queen Elizabeth II Hospital	4 (2.3)	164 (93.7)	7 (4.0)
	Redland Hospital	6 (3.8)	142 (91.0)	8 (5.1)
North West	Mt Isa Hospital	18 (41.9)	25 (58.1)	–
Sunshine Coast	Gympie Hospital	4 (4.3)	87 (93.5)	2 (2.2)
	Sunshine Coast University Hospital	5 (0.9)	559 (97.4)	10 (1.7)
Townsville	Townsville Hospital	35 (14.6)	200 (83.3)	5 (2.1)
West Moreton	Ipswich Community Health	15 (3.4)	414 (94.1)	11 (2.5)
Wide Bay	Bundaberg Hospital	7 (5.7)	116 (94.3)	–
	Hervey Bay Hospital	2 (2.2)	77 (85.6)	11 (12.2)
Statewide		**351 (5.5)**	**5,839 (92.3)**	**136 (2.1)**



% of total Indigenous (n=351) vs. total non-Indigenous (n=5,839). Excludes missing data (2.1%)

Figure 5: Proportion of all referrals by age group and identified Aboriginal and Torres Strait Islander status

Table 11: Median patient age by gender and Indigenous status

	Total referrals* n	Male years	Female years	Total years
Aboriginal and Torres Strait Islander	352	56	59	57
Non Aboriginal and Torres Strait Islander	5,839	69	72	70
All	**6,191**	**68**	**71**	**69**

Excludes missing data (0.3%)

5.4 Phenotype of heart failure

The table below shows rates of different HF phenotypes referred to each HFSS, these include:

- HFrEF: heart failure with reduced ejection fraction, where the left ventricular ejection fraction is less than 50% at time of diagnosis,
- HFpEF: heart failure with preserved ejection fraction, where the left ventricular ejection fraction is 50% or greater at time of diagnosis,
- Primary right heart failure e.g. cor pulmonale.

The most common referral to a HFSS was for HFrEF (81%). The median age for HFrEF was ten years younger than for patients with HFpEF (67 vs. 77 years respectively). More men had HFrEF than women (70% male), whereas HFpEF did not have a significant gender difference (46% male and 54% female).

Table 12: Proportion of patients by heart failure phenotype

HHS	HFSS	HFrEF* n (%)	HFpEF† n (%)	Primary right HF n (%)	Unsure/ unknown n (%)
Cairns and Hinterland	Cairns Hospital	259 (89.6)	11 (3.8)	15 (5.2)	4 (1.4)
Central Queensland	Gladstone Hospital	17 (89.5)	2 (10.5)	–	–
	Rockhampton Hospital	207 (82.5)	36 (14.3)	7 (2.8)	1 (0.4)
Darling Downs	Toowoomba Hospital	47 (95.9)	1 (2.0)	–	1 (2.0)
Gold Coast	Gold Coast Community Health	380 (80.0)	78 (16.4)	4 (0.8)	13 (2.7)
Mackay	Mackay Base Hospital	123 (90.4)	11 (8.1)	1 (0.7)	1 (0.7)
Metro North	Caboolture Hospital	310 (70.6)	89 (20.3)	14 (3.2)	26 (5.9)
	Redcliffe Hospital	101 (66.9)	41 (27.2)	3 (2.0)	6 (4.0)
	Royal Brisbane & Women's Hospital	382 (84.1)	62 (13.7)	2 (0.4)	8 (1.8)
Metro South	The Prince Charles Hospital	677 (69.4)	241 (24.7)	25 (2.6)	33 (3.4)
	Logan Hospital	410 (79.2)	90 (17.4)	14 (2.7)	4 (0.8)
	Princess Alexandra Hospital	567 (89.3)	54 (8.5)	14 (2.2)	–
	Queen Elizabeth II Hospital	153 (87.4)	19 (10.9)	1 (0.6)	2 (1.1)
	Redland Hospital	143 (91.7)	12 (7.7)	1 (0.6)	–
North West	Mt Isa Hospital	24 (55.8)	8 (18.6)	–	11 (25.6)
Sunshine Coast	Gympie Hospital	75 (80.6)	14 (15.1)	3 (3.2)	1 (1.1)
	Sunshine Coast University Hospital	534 (93.0)	31 (5.4)	5 (0.9)	4 (0.7)
Townsville	Townsville Hospital	230 (95.8)	8 (3.3)	1 (0.4)	1 (0.4)
West Moreton	Ipswich Community Health	316 (71.8)	74 (16.8)	40 (9.1)	10 (2.3)
Wide Bay	Bundaberg Hospital	95 (77.2)	25 (20.3)	2 (1.6)	1 (0.8)
	Hervey Bay Hospital	72 (80.0)	13 (14.4)	5 (5.6)	–
Statewide		**5,122 (81.0)**	**920 (14.5)**	**157 (2.5)**	**127 (2.0)**

* Heart failure with reduced ejection fraction (LVEF <50%)

† Heart failure with preserved ejection fraction (LVEF ≥50%)

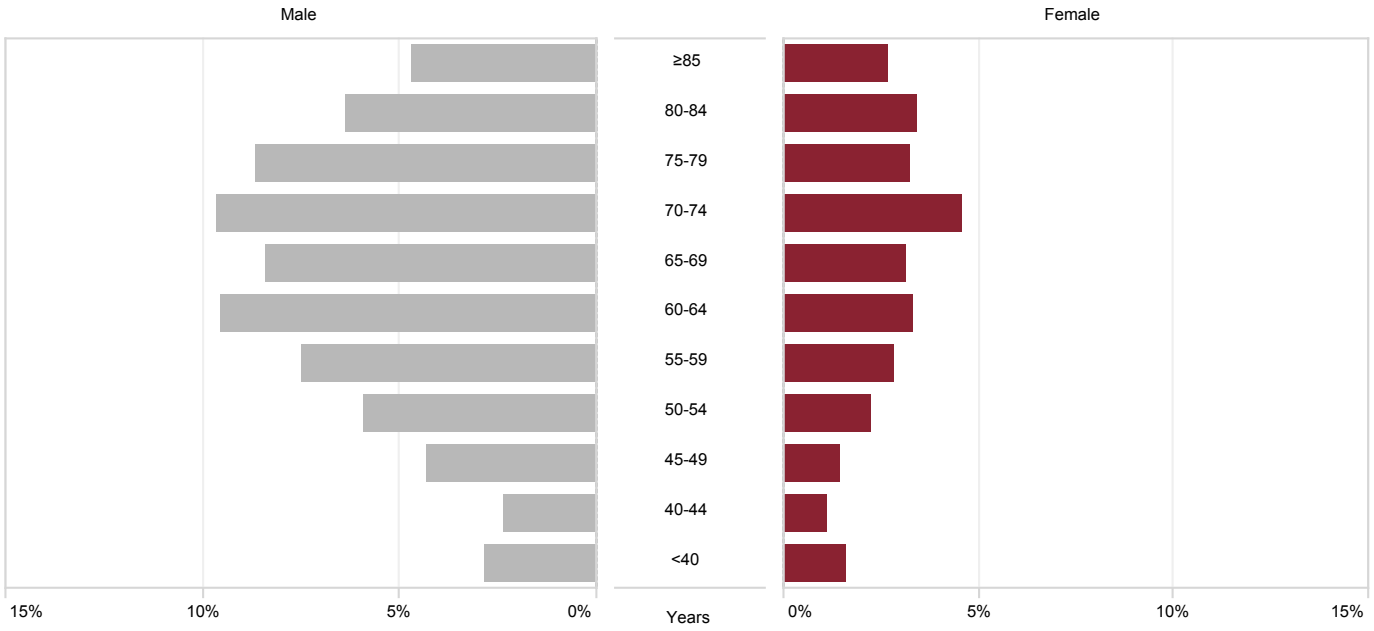
Table 13: Summary of patient age, gender and Indigenous status by heart failure phenotype

	HFrEF*	HFpEF†	Primary right HF
Number	5,122	920	157
Age (median years)	67	77	74
% male	70.4%	45.8%	43.3%
% Aboriginal and Torres Strait Islander	6.0%	3.3%	3.2%

Excludes unsure/unknown HF phenotype (2.0%)

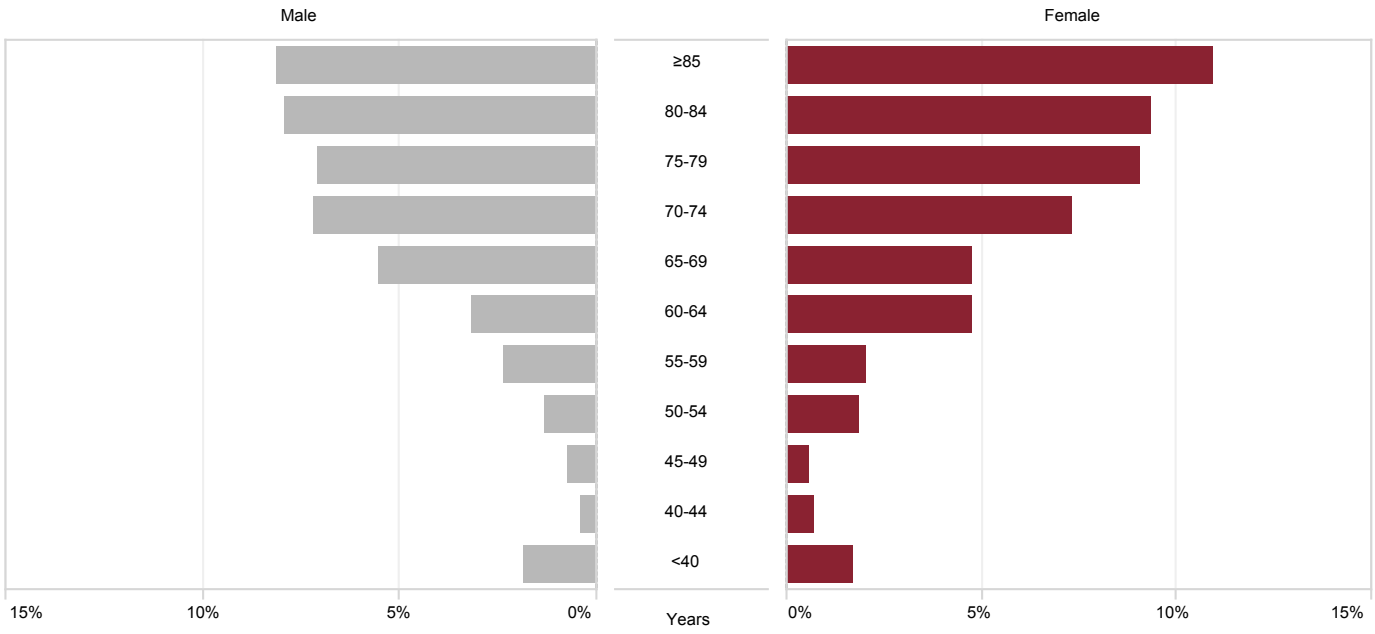
* Heart failure with reduced ejection fraction (LVEF <50%)

† Heart failure with preserved ejection fraction (LVEF ≥50%)



% of total with HFrEF (n=5,122)

Figure 6: Proportion of HFrEF referrals by gender and age group



% of total with HFpEF (n=920)

Figure 7: Proportion of HFpEF referrals by gender and age group

5.5 Summary of patient characteristics

A summary of patient characteristics from all referrals to an HFSS are shown below.

Table 14: Summary of patient characteristics

Characteristic	Summary
Participating HFSS	21
New referrals	6,326
Referrals from South East Queensland	77.8%
Referral source:	
Inpatient	62.9%
Outpatient	24.1%
Another HFSS	11.7%
Primary care	1.3%
Age (median years):	
All (median, range by service)	69 (59–79) years
Male vs. Female	68 vs. 71 years
Indigenous vs. non-Indigenous	57 vs. 70 years
HFrEF* vs. HFpEF†	67 vs. 77 years
Age group:	
75 years and over	34.0%
Males	65.9%
Aboriginal and Torres Strait Islander patients	5.5%
Heart failure phenotype:	
HFrEF*	81.0%
HFpEF†	14.5%
Primary right HF	2.5%
Unsure/unknown	2.0%

* Heart failure with reduced ejection fraction (LVEF ‹50%)

† Heart failure with preserved ejection fraction (LVEF ≥50%)

6 Clinical indicators

The number of clinical indicators is limited so that data entry is sustainable and part of routine clinical practice. The six clinical indicators selected are shown in Table 15.

The target benchmark for all indicators was set at 80%, except for 6b (beta blocker titration to clinical guideline target dose at six months) where the benchmark was set at 50%. The lower benchmark of 50% acknowledges that target doses derived from clinical trials may be inappropriate in clinical practice where patients are often older with greater disease severity and associated comorbidities compared to patients recruited to large drug trials.[51]

Table 15: Clinical process indicators

Indicator #	Process measures
1	**Timely follow-up and first clinical review** 1a) First clinical review within two weeks for inpatient referrals 1b) First clinical review within four weeks for non acute referrals
2	**Left ventricular ejection fraction (LVEF) assessed within 2 years of referral to HFSS**
3	**Prescription of angiotensin-converting-enzyme inhibitor (ACEI), angiotensin II receptor blockers (ARB) or angiotensin receptor neprilysin inhibitor (ARNI) for HFrEF** 3a) Prescription at time of hospital discharge (inpatient referrals) 3b)Prescription at time of first clinical review (all referrals)
4	**Prescription of guideline recommended beta blockers (bisoprolol, carvedilol, metoprolol sustained release or nebivolol) for HFrEF** 4a) Prescription at time of hospital discharge (inpatient referrals) 4b) Prescription at time of first clinical review (all referrals)
5	**Prescription of mineralocorticoid receptor antagonists (MRA) for patients with HFrEF** 5a) Prescription at time of hospital discharge (inpatient referrals) 5b) Prescription at time of first clinical review (all referrals)
6	**Beta blocker review and titration** 6a) Titration review conducted within 6 months of first clinical review 6b) Guideline target dose achieved at time of titration review 6c) Either target or maximum dose achieved at time of titration review

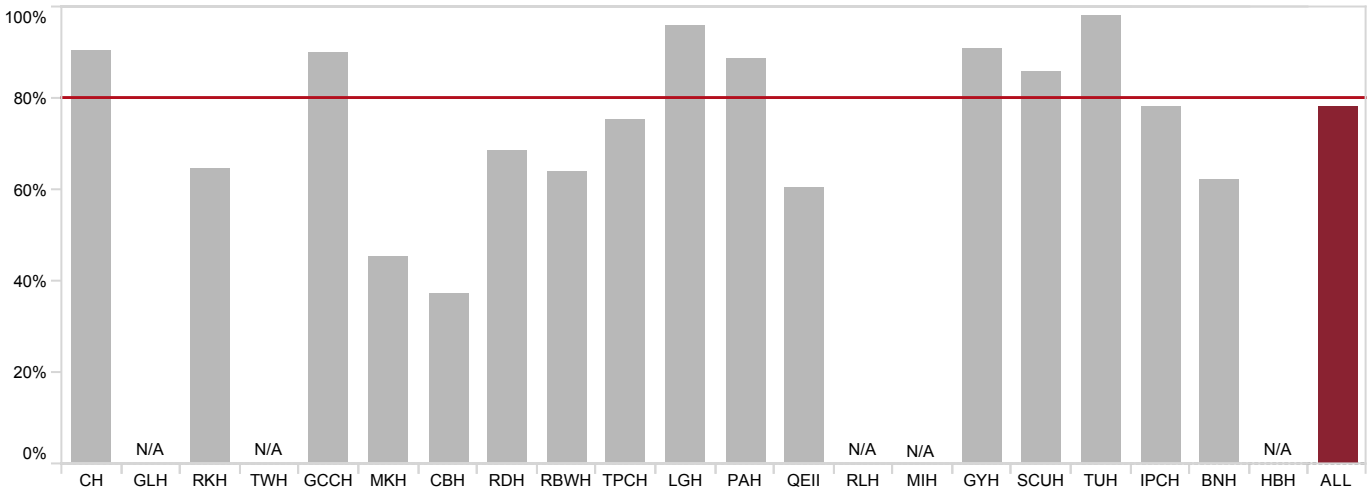
6.1 First clinical review

The HFSS review is defined as a clinical (rather than administrative) intervention and can be conducted face to face (clinic, gym or home visit) or virtually (phone, videoconference). Patients were excluded if they died, were referred to another HFSS, declined follow-up or could not be contacted.

1a First clinical review by Heart Failure Support Service within two weeks of hospital discharge (for inpatient referrals)

Early post discharge follow-up is recommended for patients with HF to monitor symptoms, provide education and support self-management principles. The review timeframe chosen for this intervention is within two weeks of hospital discharge or date of referral after recent hospitalisation.

Of the 3,978 patients referred from an acute setting, 78% received a clinical review by an HFSS within two weeks of hospital discharge. Variation in performance was observed between services and is demonstrated in the figure below.



N/A: Eligible referrals <20

Figure 8: Inpatients who received first HFSS clinical review within two weeks of hospital discharge

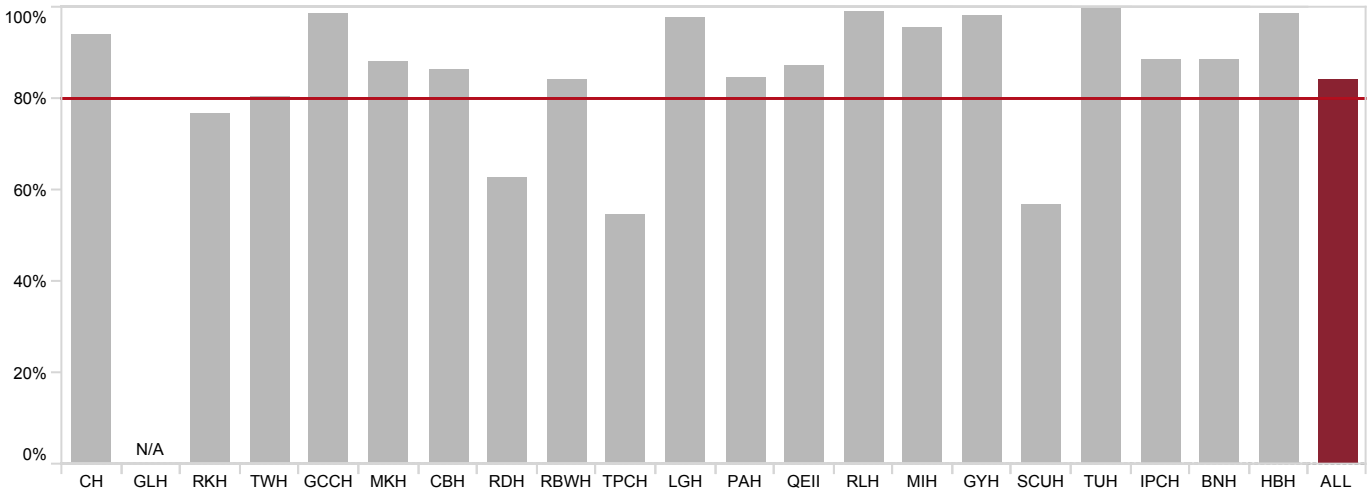
Table 16: Inclusion details for clinical indicator 1a: Inpatients receiving first HFSS clinical review within two weeks of hospital discharge

	n	%
Eligible for analysis	2,660	
Achieved benchmark	2,081	78.2
Benchmark not achieved	579	21.8
Ineligible	1,317	
Referred to another HFSS	681	
Patient could not be contacted, lives out of area or repeated failure to attend	140	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	139	
Patient declined service	133	
HF no longer prime issue (palliative care, high care nursing home etc.)	85	
Patient deceased	46	
Our service is at capacity workload	14	
Other reason	79	
Missing data	1	
Total inpatient referrals	**3,978**	

1b First Heart Failure Support Service clinical review within four weeks for non acute referrals

For non acute referrals, clinical follow-up should be within four weeks of the referral date.

Referrals for 2,348 patients came from non acute services, of which 84% of the cases eligible for analysis received a clinical review within four weeks of referral. Variation in performance amongst services was observed and is outlined below.



N/A: Eligible referrals <20

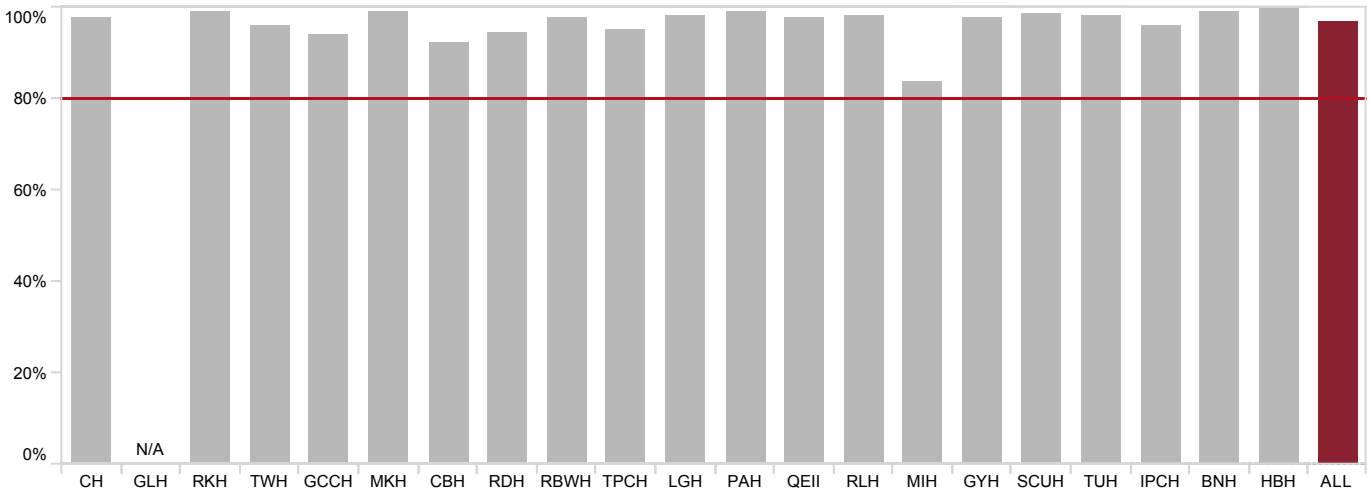
Figure 9: Proportion of non acute patients who received first HFSS clinical review within four weeks of referral

Table 17: Inclusion details for clinical indicator 1b: Non acute patients receiving first HFSS clinical review within four weeks of referral

	n	%
Eligible for analysis	2,024	
Achieved benchmark	1,703	84.1
Benchmark not achieved	321	15.9
Ineligible	319	
Referred to another HFSS	98	
Patient could not be contacted, lives out of area or repeated failure to attend	73	
Patient declined service	55	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	17	
Patient deceased	15	
HF no longer prime issue (palliative care, high care nursing home etc.)	14	
Our service is at capacity workload	4	
Other reason	43	
Missing data	5	
Total non acute patients	**2,348**	

6.2 Left ventricular ejection fraction (LVEF) assessed within two years of referral to HFSS

Australian clinical guidelines recommend that all patients with heart failure should have an assessment of left ventricular function.[52] In 97% of cases, LVEF was assessed within two years of referral to an HFSS. Little variation in performance was observed and is demonstrated in the analysis below.



N/A: Eligible referrals <20

Figure 10: Proportion of all patients who had LVEF assessed within two years of referral to HFSS

Table 18: Inclusion details for clinical indicator 2: Patients who had LVEF assessed within two years of referral

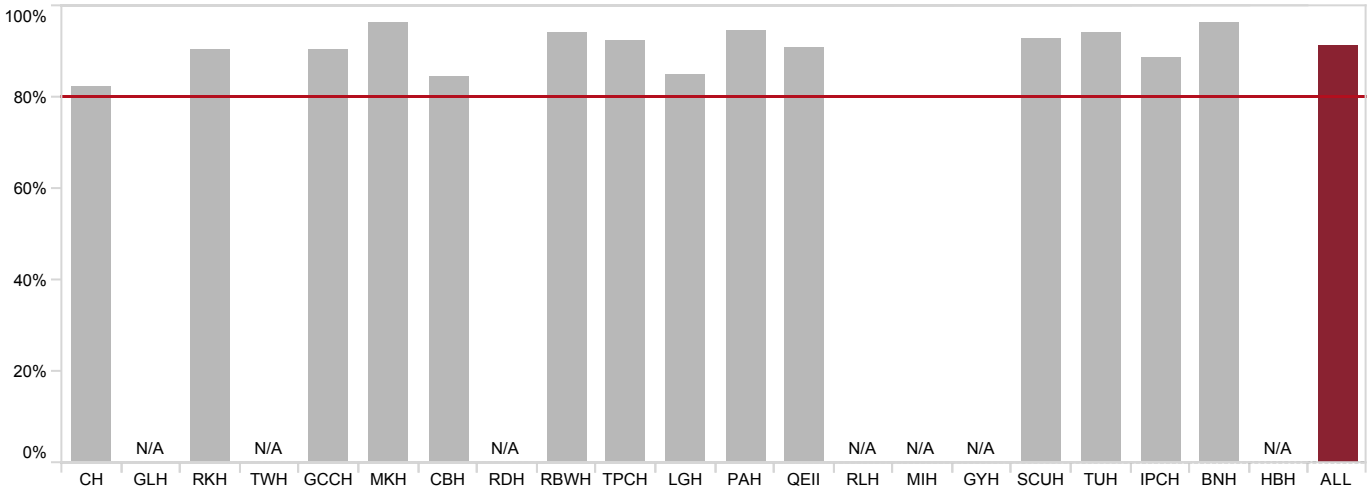
	n	%
Eligible for analysis	6,325	
Achieved benchmark	6,119	96.7
Benchmark not achieved	206	3.3
Ineligible	N/A	
Missing data	1	
Total referrals	**6,326**	

6.3 Prescription of ACEI, ARB or ARNI for patients with HFrEF

Angiotensin-converting-enzyme inhibitor (ACEI), angiotensin II receptor blockers (ARB) or angiotensin receptor neprilysin inhibitor (ARNI) have been shown to reduce mortality and morbidity in patients with HFrEF and are recommended for all patients unless contraindicated or not tolerated.[52]

3a ACEI, ARB or ARNI prescription for HFrEF at hospital discharge

Prescription benchmarks for ACEI, ARB or ARNI therapy on hospital discharge was met for 91% of eligible patients. Of these patients there were 75% of patients who were prescribed ARNI and the remaining 25% an ACEI/ARB.



N/A: Eligible referrals ‹20

Figure 11: Proportion of patients who were on ACEI, ARB or ARNI at time of hospital discharge

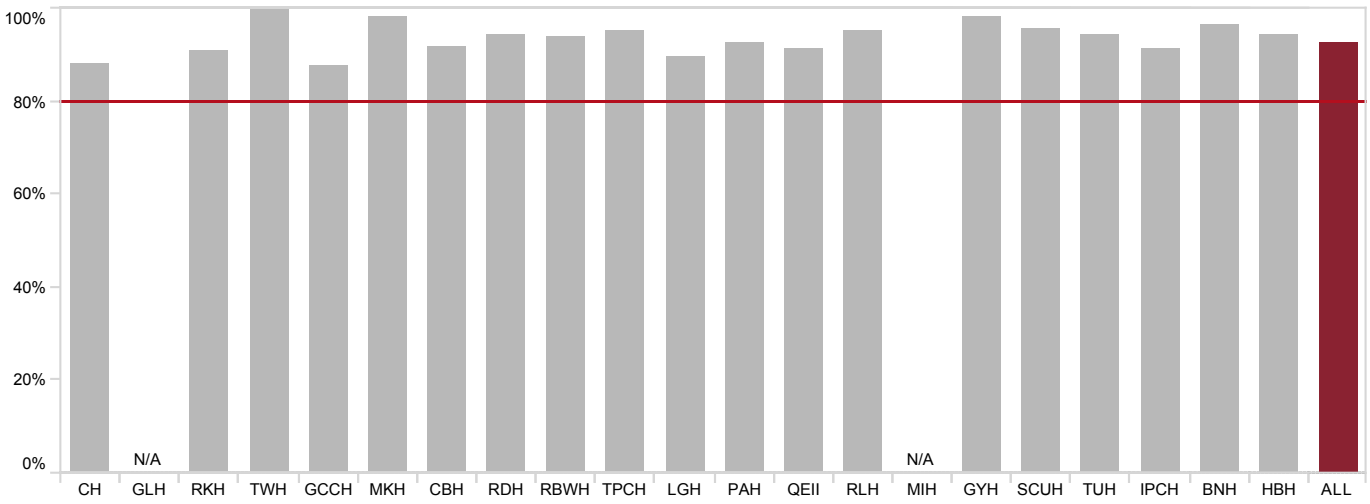
Table 19: Inclusion details for clinical indicator 3a: Inpatients on ACEI, ARB or ARNI at time of hospital discharge

	n	%
Eligible for analysis	2,943	
Achieved benchmark	2,684	91.2
Benchmark not achieved	259	8.8
Ineligible		
Documented contraindication*	170	
Incomplete data	3	
Total inpatient referrals analysed	**3,116**	

* Adverse reaction to ACEI/ARB or ARNI, palliative intent to treatment, pregnancy, eGFR ‹30mL/min/1.73m^2, severe aortic stenosis, renal artery stenosis, serum potassium ›5.5 mmol/L, symptomatic hypotension

3b ACEI, ARB or ARNI prescription for HFrEF at time of first HFSS clinical review

At the time of first clinical review, the target for prescription of ACEI, ARB or ARNI was met for 93% of eligible patients. Of these patients there were 70% of patients who were prescribed ARNI and the remaining 30% an ACEI/ARB.



N/A: Eligible referrals <20

Figure 12: Proportion of patients on ACEI, ARB or ARNI at time of first clinical review by site

Table 20: Inclusion details for clinical indicator 3b: Patients on ACEI, ARB or ARNI at first clinical review

	n	%
Eligible for analysis	3,630	
Achieved benchmark	3,365	92.7
Benchmark not achieved	265	7.3
Ineligible		
Documented contraindication*	168	
Incomplete data	6	
Total referrals analysed	**3,804**	

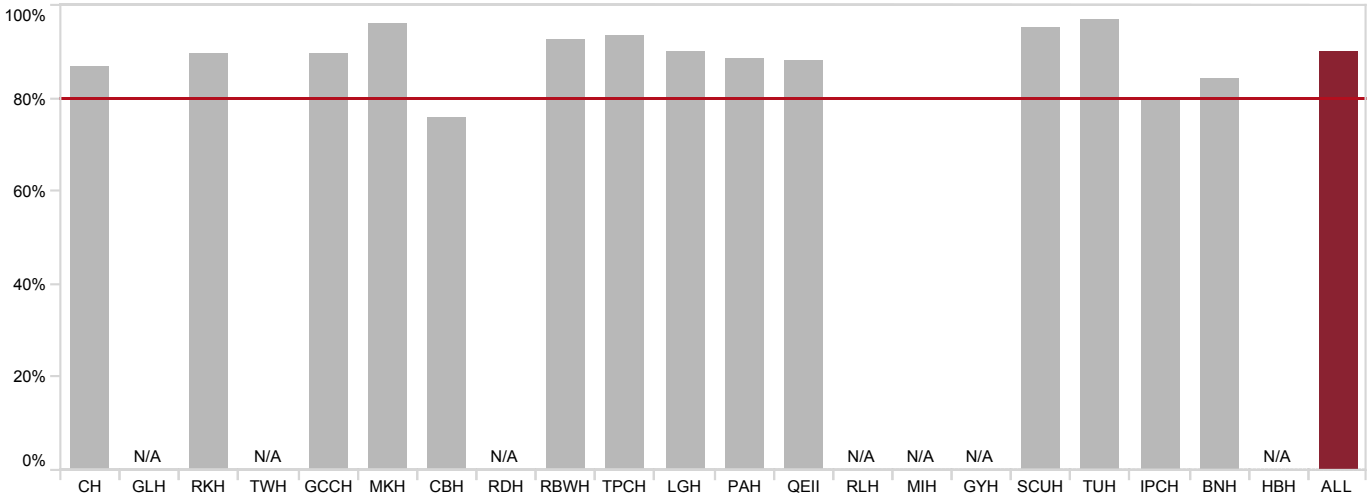
* Adverse reaction to ACEI/ARB or ARNI, palliative intent to treatment, pregnancy, eGFR <30mL/min/1.73m^2, severe aortic stenosis, renal artery stenosis, serum potassium >5.5 mmol/L, symptomatic hypotension

6.4 Prescription of guideline recommended beta blockers for HFrEF

Guideline recommended beta blockers have been shown to reduce mortality and morbidity in patients with HFrEF and are recommended for all patients unless contraindicated or not tolerated.[52,53] Guideline recommended beta blockers include bisoprolol, carvedilol, metoprolol sustained release or nebivolol. Results pertain only to these beta blocker medications.

4a Beta blocker prescription for HFrEF at time of hospital discharge

At hospital discharge, 90% of eligible patients were prescribed guideline recommended beta blockers. Of these patients there were 84%, 9%, 5% and 2% of patients who were prescribed bisoprolol, metoprolol sustained release, carvedilol, and nebivolol respectively.



N/A: Eligible referrals <20

Figure 13: Proportion of patients on guideline recommended beta blocker at hospital discharge by site

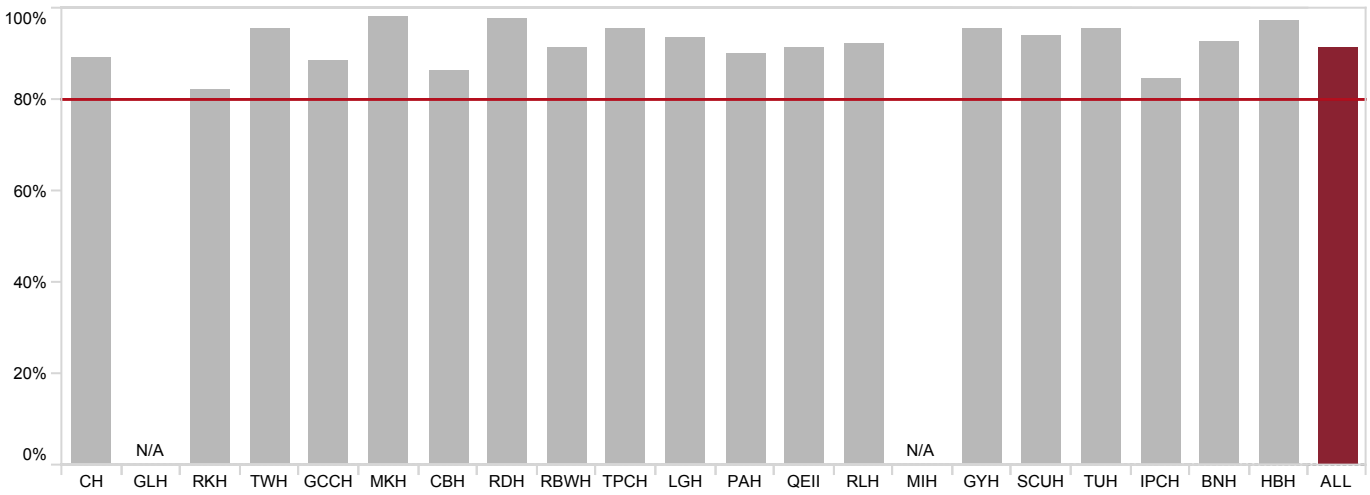
Table 21: Inclusion details for clinical indicator 4a: Patients on guideline recommended beta blocker at hospital discharge

	n	%
Eligible for analysis	3,028	
Achieved benchmark	2,728	90.1
Benchmark not achieved	300	9.9
Ineligible		
Documented contraindication*	85	
Incomplete data	3	
Total inpatient referrals analysed	**3,116**	

* Adverse reaction to beta blocker, palliative intent to treatment, pregnancy, bradycardia (HR <50bpm), symptomatic hypotension, severe COPD, asthma/reversible airways disease

4b Beta blocker prescription for HFrEF at time of first HFSS clinical review

At the first clinical review, 92% of eligible referrals to HFSS were reported to be on a guideline recommended beta blocker. Of these patients there were 82%, 9%, 6% and 3% of patients who were prescribed bisoprolol, metoprolol sustained release, carvedilol, and nebivolol respectively.



N/A: Eligible referrals <20

Figure 14: Proportion of patients on guideline recommended beta blocker therapy at first clinical review by site

Table 22: Inclusion details for clinical indicator 4b: Patients on guideline recommended beta blocker at first clinical review

	n	%
Eligible for analysis	3,715	
Achieved benchmark	3,401	91.5
Benchmark not achieved	314	8.5
Ineligible		
Documented contraindication*	83	
Incomplete data	6	
Total referrals analysed	**3,804**	

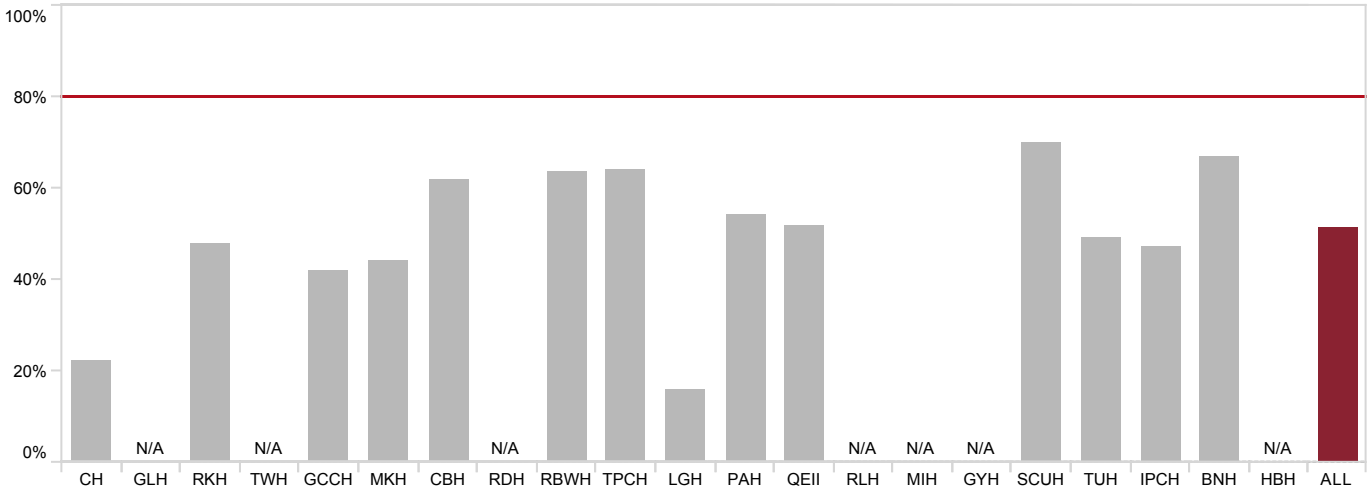
* Adverse reaction to beta blocker, palliative intent to treatment, pregnancy, bradycardia (HR <50bpm), symptomatic hypotension, severe COPD, asthma/reversible airways disease

6.5 Prescription of mineralocorticoid receptor antagonists (MRA) for patients with HFrEF

Guideline recommended mineralocorticoid receptor antagonists have been shown to reduce mortality and morbidity in patients with HFrEF and are recommended for all patients unless contraindicated or not tolerated.[52,53] Guideline recommended MRAs include eplerenone and spironolactone. All sites were below the benchmark.

5a Prescription of MRA for HFrEF at time of hospital discharge

At the time of discharge from hospital, 51% of eligible patients referred to an HFSS were prescribed an MRA. Of these patients there were 82% were prescribed spironolactone and 18% of patients who were prescribed eplerenone.



N/A: Eligible referrals <20

Figure 15: Proportion of patients on guideline recommended MRA at hospital discharge by site

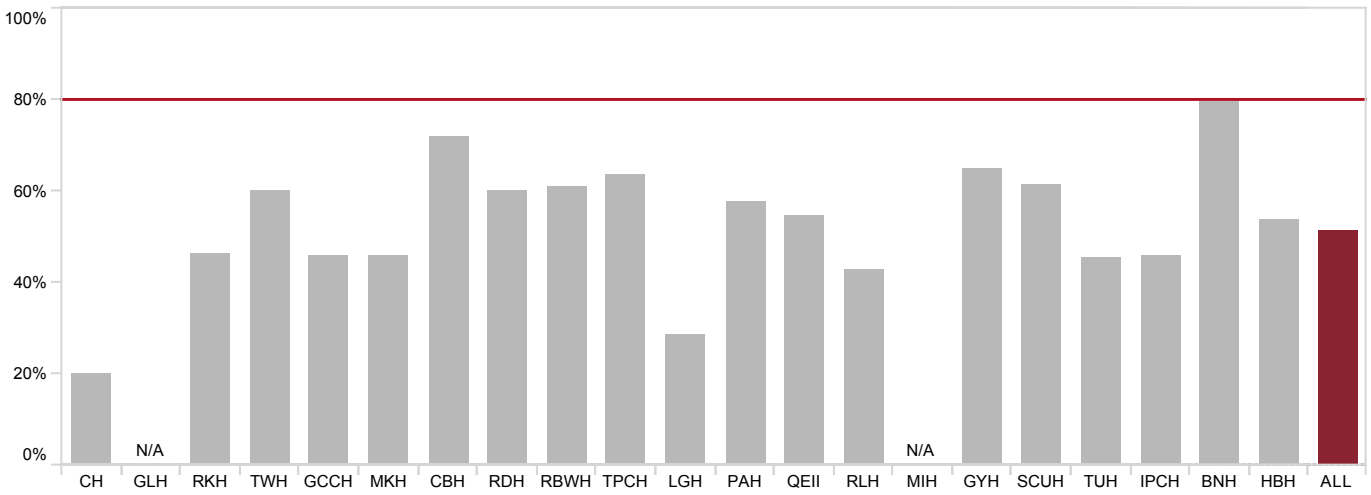
Table 23: Inclusion details for clinical indicator 5a: Patients on guideline recommended MRA at hospital discharge

	n	%
Eligible for analysis	2,805	
Achieved benchmark	1,443	51.4
Benchmark not achieved	1,362	48.6
Ineligible		
Documented contraindication*	308	
Missing data	3	
Total inpatient referrals analysed	**3,116**	

* Adverse reaction to MRA, palliative intent to treatment, serum potassium >5 mmol/L, pregnancy, eGFR <30mL/min/1.73m^2, previous gynaecomastia, Addison's disease, symptomatic hypotension or LVEF returned to >50%

5b Prescription of MRA for HFrEF at time of first HFSS clinical review

At the time of first clinical review, 51% of eligible referrals to an HFSS were reported to be on a guideline recommended MRA. Of these patients there were 85% were prescribed spironolactone and 15% of patients who were prescribed eplerenone. All sites were below the benchmark.



N/A: Eligible referrals <20

Figure 16: Proportion of patients on guideline recommended MRA at first clinical review site

Table 24: Inclusion details for clinical indicator 5b: Patients on guideline recommended MRA at first clinical review

	n	%
Eligible for analysis	3,441	
Achieved benchmark	1,767	51.4
Benchmark not achieved	1,674	48.6
Ineligible		
Documented contraindication*	357	
Missing data	6	
Total referrals analysed	**3,804**	

* Adverse reaction to MRA, palliative intent to treatment, serum potassium >5 mmol/L, pregnancy, eGFR <30mL/min/1.73m^2, previous gynaecomastia, Addison's disease, symptomatic hypotension or LVEF returned to >50%

6.6 Beta blocker titration

This indicator looks at the progress of titration of guideline recommended beta blockers at six months following hospital discharge or when deactivated from the HFSS, whichever is sooner. The timeframe is taken from the first clinical review by HFSS (usually at four weeks from referral or hospital discharge).

The indicator measures three components of beta blocker titration at six months, including:

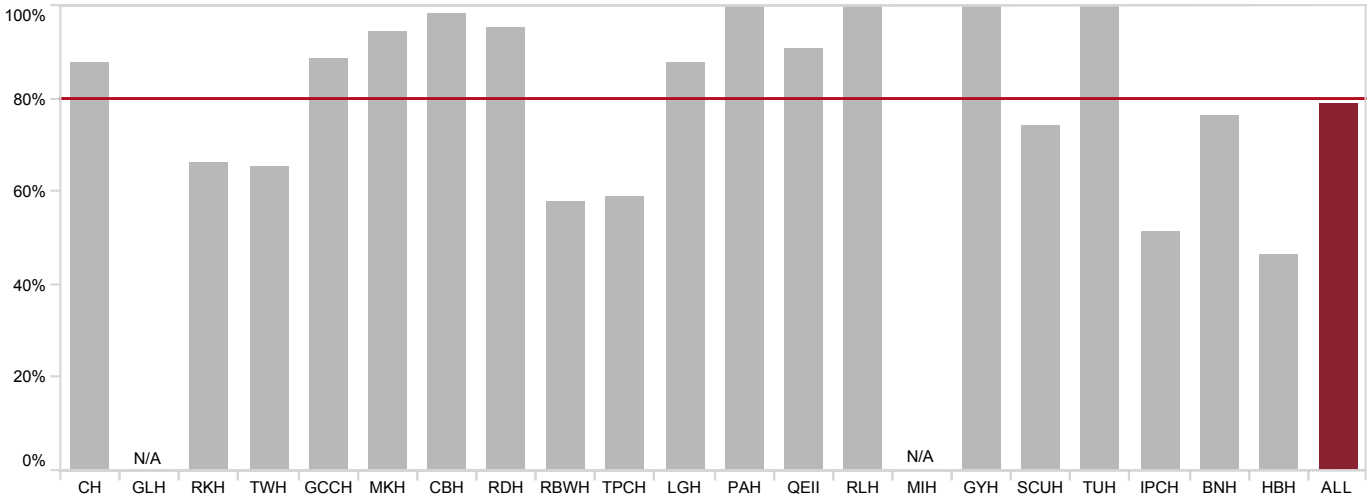
a) Review of titration status undertaken,

b) Achievement of target dose, and

c) Achievement of target or maximum tolerated dose.

6a Beta blocker titration review conducted within six months of first HFSS clinical review

At six months from referral or at the time of deactivation from the HFSS (whichever was sooner), 79% of patients received a beta blocker titration review which is below the benchmark. Variation in performance amongst services was observed and is demonstrated in the figure below.



N/A: Eligible referrals <20

Figure 17: Proportion of patients who had a beta blocker titration review conducted within six months by site

Table 25: Inclusion details for clinical indicator 6a: Patients who had a beta blocker titration review within six months

	n	%
Eligible for analysis	1,984	
Achieved benchmark	1,569	79.1
Benchmark not achieved	415	20.9
Ineligible	1,644	
Patient on target dose at the time of referral	892	
Patient could not be contacted, lives out of area or repeated failure to attend	146	
Patient declined service	113	
Referred to another HFSS	69	
HF no longer prime issue (palliative care, high care nursing home etc.)	65	
Patient deceased	59	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	40	
Documented contraindication*	30	
Medical follow-up only (GP, private or public physician)	20	
Patient on maximum tolerated dose	3	
Other reason	207	
Incomplete data	44	
Total analysed	**3,672**	

* Adverse reaction to beta blocker, palliative intent to treatment, pregnancy, bradycardia (HR <50bpm), symptomatic hypotension, severe COPD, asthma/reversible airways disease

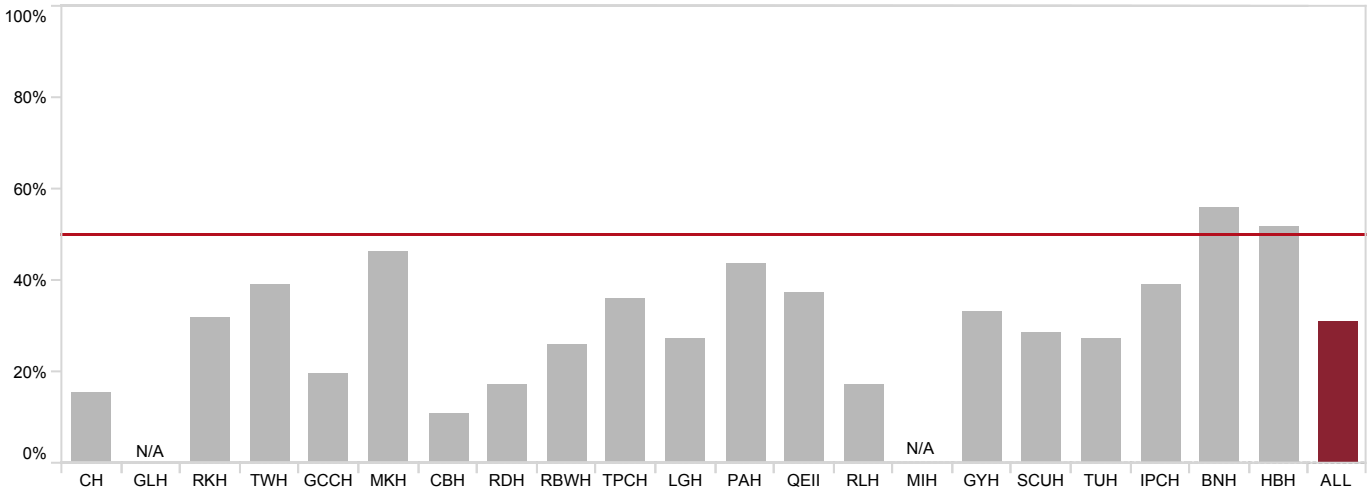
6b Beta blocker clinical guideline target dose achieved at time of titration review

The benchmark for target dose beta blocker titration was set lower than the other indicators at 50%. This lower benchmark is to accommodate differences in patients recruited to clinical trials compared to patients presenting in clinical practice who are older with more comorbidities.

Guideline recommended target dose was achieved for 31% of referrals within six months or at deactivation, with only two sites exceeding the benchmark (see Figure 18).

Daily target doses are:

- Carvedilol 50–100 mg
- Metoprolol sustained release 190 mg
- Bisoprolol 10 mg
- Nebivolol 10 mg



N/A: Eligible referrals <20

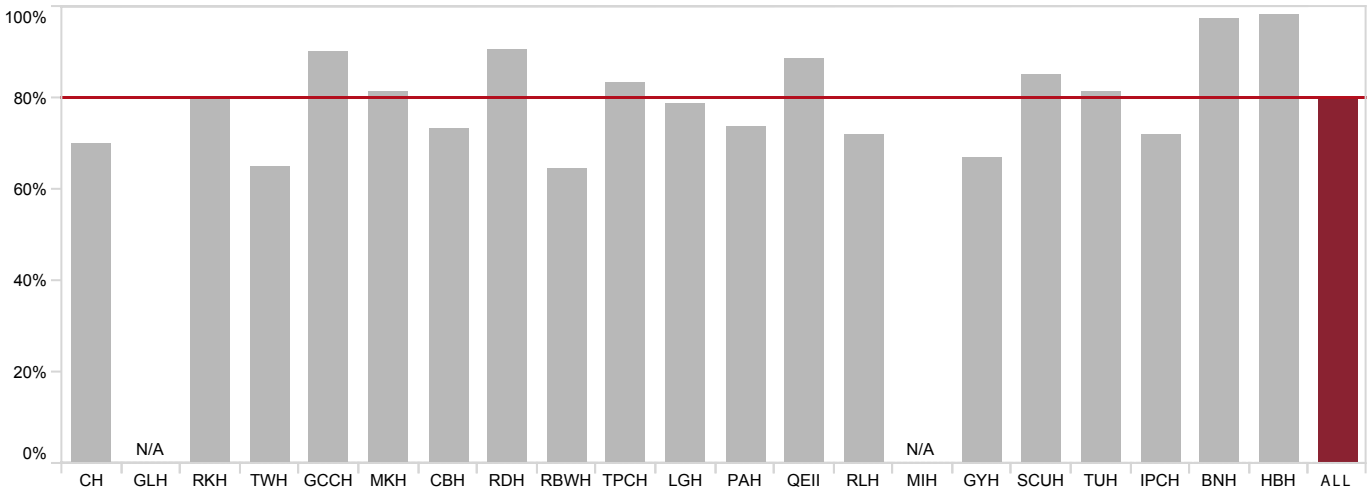
Figure 18: Proportion of patients who achieved target beta blocker dose at time of titration review by site

Table 26: Inclusion details for clinical indicator 6b: Patients who achieved target beta blocker dose at time of titration review

	n	%
Eligible for analysis	1,984	
Achieved benchmark	612	30.8
Benchmark not achieved	1,372	69.2
Ineligible	N/A	
Total titration reviews conducted	**1,984**	

6c Beta blocker titration clinical guideline target or maximum tolerated dose achieved at time of titration review

Maximum tolerated dose of beta blockers is based on a clinical judgement balancing the harm and benefit of up-titration. The proportion of patients reaching the target dose or maximum tolerated dose of guideline recommended beta blocker medication by the time of the titration review was 80%.



N/A: Eligible referrals <20

Figure 19: Proportion of patients who achieved target beta blocker dose or maximum tolerated dose at time of titration review

Table 27: Inclusion details for clinical indicator 6c: Patients who achieved target or maximum tolerated beta blocker dose at time of titration review

	n	%
Eligible for analysis	1,984	
Achieved benchmark	1,588	80.0
Benchmark not achieved	396	20.0
Ineligible	N/A	
Total titration reviews conducted	**1,984**	

6.7 Summary of clinical indicators

Table 28: Summary of clinical process indicator performance by site

	Clinical indicator achievement (%)											
HFSS	**1a**	**1b**	**2**	**3a**	**3b**	**4a**	**4b**	**5a**	**5b**	**6a**	**6b**	**6c**
Cairns Hospital	91	94	98	82	88	87	89	23	20	88	16	70
Gladstone Hospital	–	–	–	–	–	–	–	–	–	–	–	–
Rockhampton Hospital	65	77	99	91	91	89	82	48	46	66	32	80
Toowoomba Hospital	–	81	96	–	100	–	95	–	60	65	39	65
Gold Coast Community Health	90	99	94	91	88	90	89	42	46	89	20	90
Mackay Base Hospital	45	88	99	96	98	96	98	44	46	94	46	82
Caboolture Hospital	37	86	92	84	92	76	86	62	72	98	11	73
Redcliffe Hospital	69	63	95	–	94	–	98	–	60	95	17	90
Royal Brisbane & Women's Hospital	64	84	98	94	94	93	91	64	61	58	26	65
The Prince Charles Hospital	76	55	95	92	95	93	96	64	64	59	36	83
Logan Hospital	96	98	98	85	89	90	94	16	28	88	27	79
Princess Alexandra Hospital	89	85	99	95	93	89	90	54	58	100	44	74
Queen Elizabeth II Hospital	60	87	98	91	91	88	91	52	55	91	38	89
Redland Hospital	–	99	98	–	95	–	92	–	43	100	17	72
Mt Isa Hospital	–	96	84	–	–	–	–	–	–	–	–	–
Gympie Hospital	91	98	98	–	98	–	95	–	65	100	33	67
Sunshine Coast University Hospital	86	57	98	93	96	95	94	70	62	74	29	85
Townsville Hospital	98	100	98	94	94	97	96	49	45	100	27	81
Ipswich Community Health	78	89	96	89	91	80	84	47	46	51	39	72
Bundaberg Hospital	62	89	99	96	96	84	93	67	80	77	56	97
Hervey Bay Hospital	–	99	100	–	94	–	97	–	54	47	52	98
Statewide	**78**	**84**	**97**	**91**	**93**	**90**	**92**	**51**	**51**	**79**	**31**	**80**

Legend:

1a Follow-up of acute patients within two weeks (Benchmark: 80%)

1b Follow-up of non acute patients within four weeks (Benchmark: 80%)

2 Assessment of left ventricular ejection fraction within two years (Benchmark: 80%)

3a ACEI, ARB or ARNI prescription at hospital discharge (Benchmark: 80%)

3b ACEI, ARB or ARNI prescription at first clinical review (Benchmark: 80%)

4a Guideline recommended beta blocker prescription at hospital discharge (Benchmark: 80%)

4b Guideline recommended beta blocker prescription at first clinical review (Benchmark: 80%)

5a Guideline recommended MRA prescription at hospital discharge (Benchmark: 80%)

5b Guideline recommended MRA prescription at first clinical review (Benchmark: 80%)

6a Beta blocker titration status review at six months post referral (Benchmark: 80%)

6b Beta blockers achievement of guideline recommended target dose (Benchmark: 50%)

6c Beta blockers achievement of guideline recommended target dose or maximum tolerated dose (Benchmark: 80%)

7 Patient outcomes

Chronic heart failure is associated with recurrent hospitalisation and increased mortality. Support from multidisciplinary HF disease management programmes (such as an HFSS) and adherence to recommended therapies are associated with improved outcomes.

7.1 Methods

This analysis used the previously reported 2020 patient cohort to examine the early (30 day) and one year clinical outcomes (rehospitalisation and mortality) among patients referred to HFSS. This was performed using data linkage with the Queensland Hospital Admitted Patient Data Collection (QHAPDC) and Queensland Registry of Births, Deaths and Marriages.

For this report, only HFSS referrals initiated during an inpatient encounter for 2020 were included. The earliest admission of the calendar year was considered the index admission (which may not be the first time that a patient has been hospitalised with heart failure).

Eligibility criteria for the mortality and readmission analysis cohort were applied at the time of the index admission. The eligibility status for days alive and out of hospital (DAOH) analysis was reviewed at all subsequent admissions over 12 months to exclude patients who were transferred to private hospitals or interstate.

The patient outcome indicators of interest are summarised in Table 29. Survival curves were constructed using the Kaplan–Meier method and cumulative incidence function was used to estimate the risk of all-cause and HF-related rehospitalisation to account for the competing risk of death.

DAOH was calculated to reflect the burden of recurrent hospitalisation, hospital length of stay and death, and was expressed as both median values, interquartile range, and mean values. Categorical variables were summarised as frequencies and percentages.

Table 29: Patient outcome indicators

Indicator #	Measure
1	All-cause mortality within one year after index hospitalisation discharge
2	Rehospitalisation within one year after index hospitalisation discharge a) All-cause rehospitalisation b) Heart failure rehospitalisation*
3	Composite of all-cause hospitalisation or all-cause mortality within one year after index hospitalisation discharge
4	Days alive and out of hospital within one year of index hospital discharge date

* ICD10AM codes: E87.7, I13.0, I13.2, I25.5, I42.0, I42.1, I42.2, I42.5, I42.6, I42.7, I42.8, I42.9, I46.0, I46.1, I46.9, I50, J81, J90, R18, R57.0, R60.1

7.2 Findings

There were 3,782 inpatient referrals of which 96% were successfully linked with the QHAPDC data. There were 464 patients who were ineligible for readmission and mortality analysis for the reasons shown in Table 30. A further 22 patients (0.6%) did not have complete follow up over one year to allow DAOH to be calculated.

Table 30: Eligibility criteria for patient outcome indicators

	n	%
Total 2020 inpatient referrals	**3,782**	**100.0**
Ineligible at index admission		
Duplicate patient record	172	4.5
Died during index admission	14	0.4
Not a Queensland resident	61	1.6
Transferred to private hospital	29	0.8
Index admission is not overnight	25	0.7
No linkage data available	162	4.3
Included in readmission and mortality analysis	**3,319**	**87.7**
Ineligible at subsequent admission over 1 year		
Transferred to private hospital	22	0.6
Included in days alive and out of hospital analysis	**3,297**	**87.2**

7.2.1 All-cause mortality

Among patients referred to HFSS during an inpatient encounter, the 30 day and one year unadjusted all-cause mortality rates were 1.4% and 11.4%. The Kaplan-Meier survival analyses below (Figures 20 to 22) suggest that older age was associated with increased mortality rates at all time points and particularly at 12 months.

Table 31: Cumulative all-cause unadjusted mortality rate from 30 to 365 days after discharge

	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Total deaths identified	45 (1.4)	111 (3.3)	210 (6.3)	379 (11.4)
Died during subsequent admission*	27 (0.8)	70 (2.1)	129 (3.9)	221 (6.7)
All other deaths	18 (0.5)	41 (1.2)	81 (2.4)	158 (4.8)
Total at risk	**3,274 (98.6)**	**3,208 (96.7)**	**3,109 (93.7)**	**2,940 (88.6)**

* Data available for Queensland public hospitals only

Table 32: Cumulative all-cause unadjusted mortality by patient characteristic

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,196	32 (1.5)	76 (3.5)	142 (6.5)	257 (11.7)
Female	1,123	13 (1.2)	35 (3.1)	68 (6.1)	122 (10.9)
Age group					
<65 years	1,273	9 (0.7)	18 (1.4)	35 (2.7)	66 (5.2)
65–74 years	836	11 (1.3)	30 (3.6)	53 (6.3)	96 (11.5)
≥75 years	1,210	25 (2.1)	63 (5.2)	122 (10.1)	217 (17.9)
Heart failure phenotype					
HFrEF	2,619	35 (1.3)	86 (3.3)	147 (5.6)	268 (10.2)
HFpEF	637	8 (1.3)	21 (3.3)	55 (8.6)	98 (15.4)
Missing/unsure	63	2 (3.2)	4 (6.3)	8 (12.7)	13 (20.6)
All	**3,319**	**45 (1.4)**	**111 (3.3)**	**210 (6.3)**	**379 (11.4)**

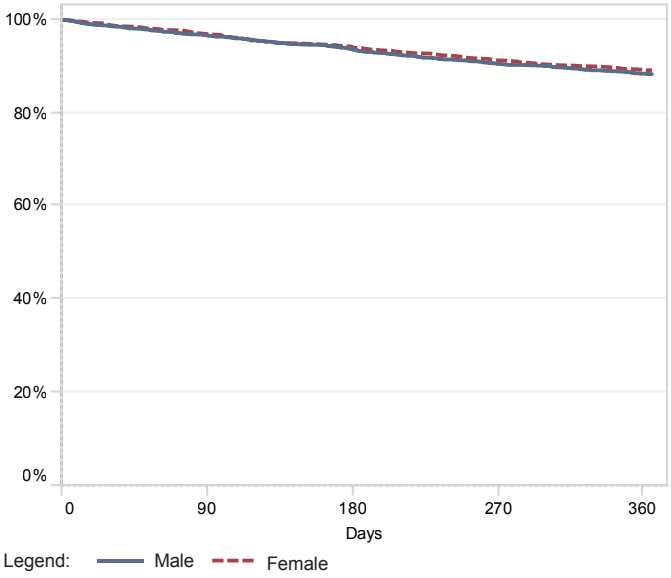


Figure 20: Heart failure survival by gender

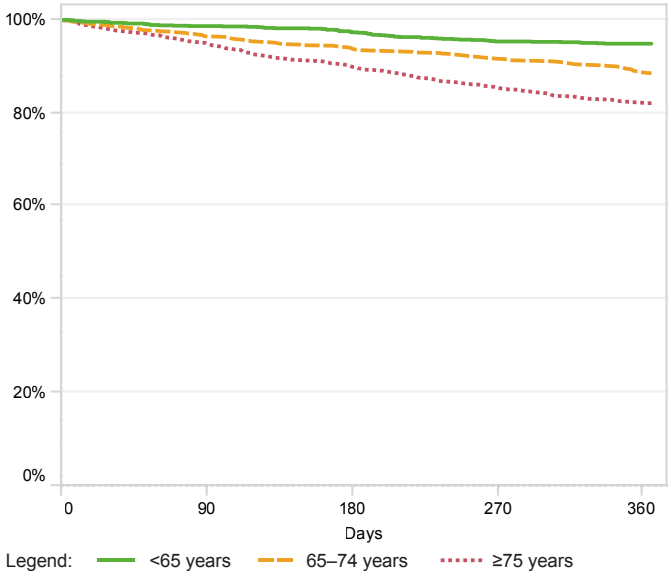


Figure 21: Heart failure survival by age group

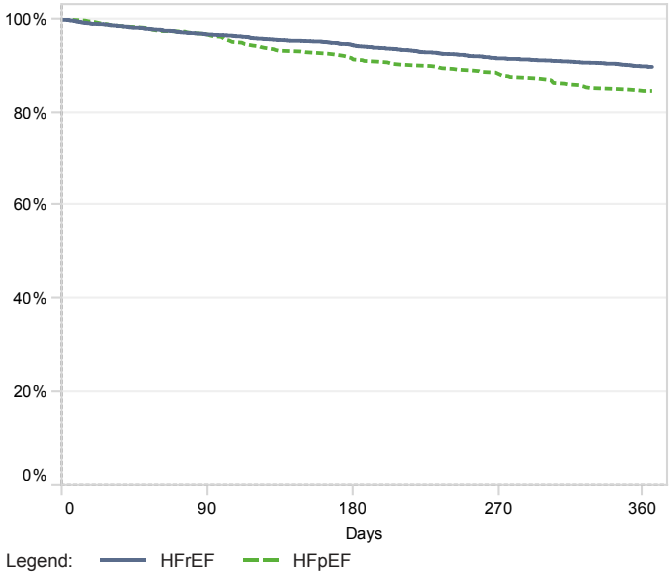


Figure 22: Heart failure survival by phenotype

7.2.2 All-cause and heart failure rehospitalisation

Cumulative incidence curves for all-cause and HF hospitalisation are shown in Figures 23 and 24. Of the 3,319 eligible patients referred to HFSS during 2020, the unadjusted rate of all-cause hospitalisation was 17.2% at 30 days, increasing to 52.8% at one year. Hospitalisations relating to HF (as identified by discharge diagnosis coding) were 5.8% and 20.7% at 30 days and one year respectively.

The overall risk of hospitalisation or death within 12 months post the index admission was 53.8% (Figure 25). More than one quarter of patients referred to an HFSS were rehospitalised at least twice in the subsequent 12 months (Table 33).

Table 33: Number of rehospitalisations per patient in the year post initial discharge

Total in one year	All-cause n (%)	Heart failure n (%)
0	1,604 (48.3)	2,678 (80.7)
1	823 (24.8)	412 (12.4)
2	366 (11.0)	125 (3.8)
3	219 (6.6)	62 (1.9)
4	127 (3.8)	21 (0.6)
≥5	180 (5.4)	21 (0.6)

Table 34: Cumulative incidence of all-cause rehospitalisation from 30 to 365 days post discharge

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,196	374 (17.1)	642 (29.5)	839 (38.8)	1,101 (51.2)
Female	1,123	195 (17.5)	341 (30.7)	466 (42.1)	614 (55.9)
Age group					
<65 years	1,273	192 (15.1)	328 (25.9)	428 (33.8)	554 (43.9)
65–74 years	836	131 (15.8)	227 (27.6)	312 (38.1)	417 (51.4)
≥75 years	1,210	246 (20.4)	428 (35.9)	565 (47.8)	744 (63.4)
Heart failure phenotype					
HFrEF	2,619	432 (16.6)	726 (28)	973 (37.6)	1,281 (49.8)
HFpEF	637	124 (19.6)	231 (36.7)	303 (48.9)	398 (64.5)
Missing/unsure	63	13 (21.0)	26 (42.6)	29 (47.5)	36 (60.0)
All	**3,319**	**569 (17.2)**	**983 (29.9)**	**1,305 (39.9)**	**1,715 (52.8)**

Table 35: Cumulative incidence of heart failure rehospitalisation from 30 to 365 days post discharge

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,196	128 (5.9)	219 (10.2)	290 (13.8)	397 (19.4)
Female	1,123	61 (5.5)	132 (12)	170 (15.7)	244 (23.2)
Age group					
<65 years	1273	59 (4.7)	112 (8.9)	128 (10.2)	176 (14.3)
65–74 years	836	44 (5.3)	72 (8.9)	102 (12.8)	145 (18.8)
≥75 years	1,210	86 (7.2)	167 (14.3)	230 (20.2)	320 (29.4)
Heart failure phenotype					
HFrEF	2,619	138 (5.3)	237 (9.3)	317 (12.5)	444 (18.1)
HFpEF	637	46 (7.3)	100 (16.1)	129 (21.5)	180 (30.9)
Missing/unsure	63	5 (8.1)	14 (23)	14 (23.7)	17 (29.8)
All	**3,319**	**189 (5.8)**	**351 (10.8)**	**460 (14.4)**	**641 (20.7)**

Table 36: Cumulative incidence of all-cause rehospitalisation or death from 30 to 365 days post discharge

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,196	384 (17.5)	665 (30.3)	873 (39.8)	1,147 (52.2)
Female	1,123	202 (18.0)	354 (31.5)	483 (43.0)	638 (56.8)
Age group					
<65 years	1,273	196 (15.4)	334 (26.2)	435 (34.2)	564 (44.3)
65–74 years	836	137 (16.4)	240 (28.7)	329 (39.4)	441 (52.8)
≥75 years	1,210	253 (20.9)	445 (36.8)	592 (48.9)	780 (64.5)
Heart failure phenotype					
HFrEF	2,619	444 (17.0)	752 (28.7)	1,005 (38.4)	1,328 (50.7)
HFpEF	637	128 (20.1)	239 (37.5)	320 (50.2)	418 (65.6)
Missing/unsure	63	14 (22.2)	28 (44.4)	31 (49.2)	39 (61.9)
All	**3,319**	**586 (17.7)**	**1,019 (30.7)**	**1,356 (40.9)**	**1,785 (53.8)**

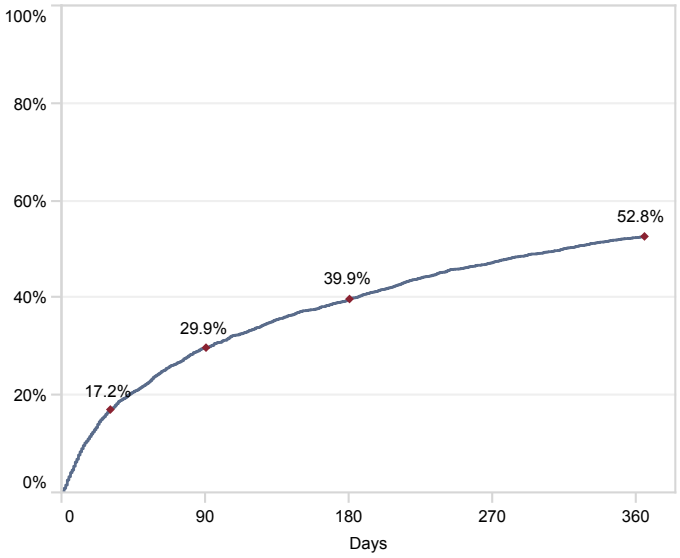


Figure 23: Cumulative incidence of all-cause rehospitalisation

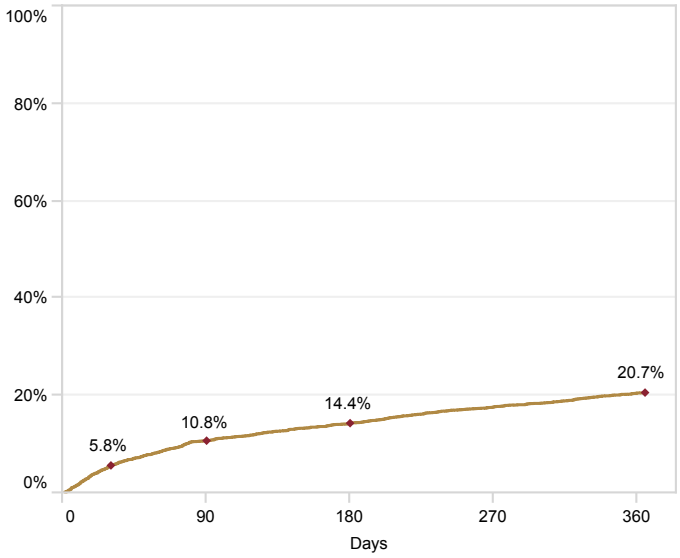


Figure 24: Cumulative incidence of heart failure rehospitalisation

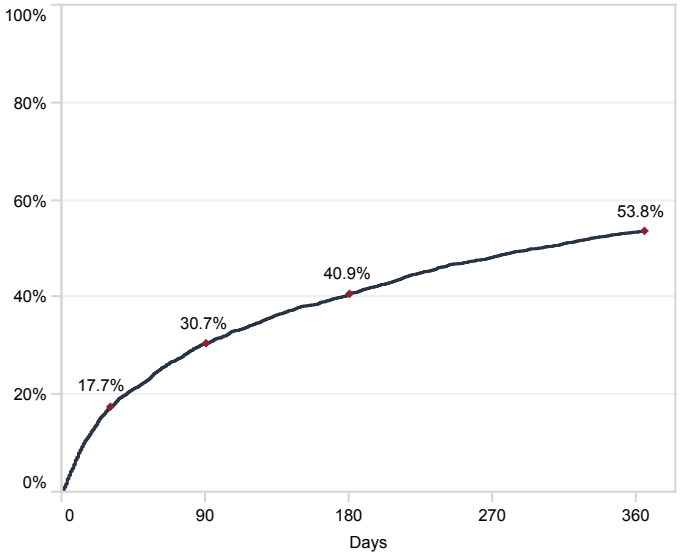


Figure 25: Cumulative incidence of all-cause rehospitalisation or death

7.2.3 Days alive and out of hospital

Days alive and out of hospital (DAOH) incorporates mortality and all hospitalisations (including length of hospital stay) within one year of discharge. This single measure demonstrates the post discharge time alive and not in hospital as a combined measure.

Almost 47% of patients survived more than a year without rehospitalisation, with a median of 364 days for the whole group. The mean days alive and out of hospital was 334.2, which equates to 101,548 days lost due to death or hospitalisation over 12 months in 3,297 patients.

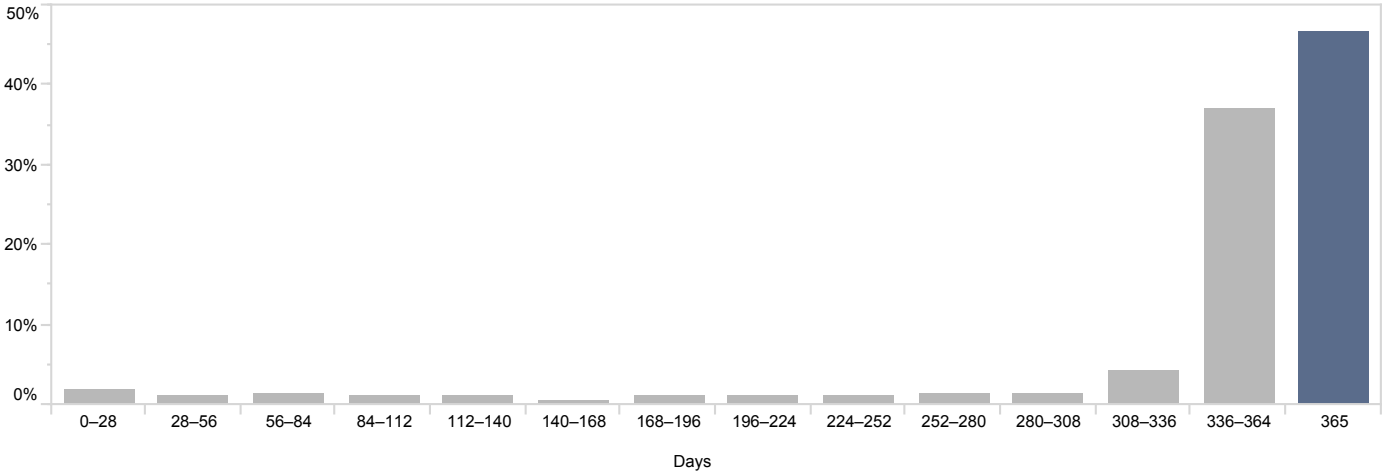
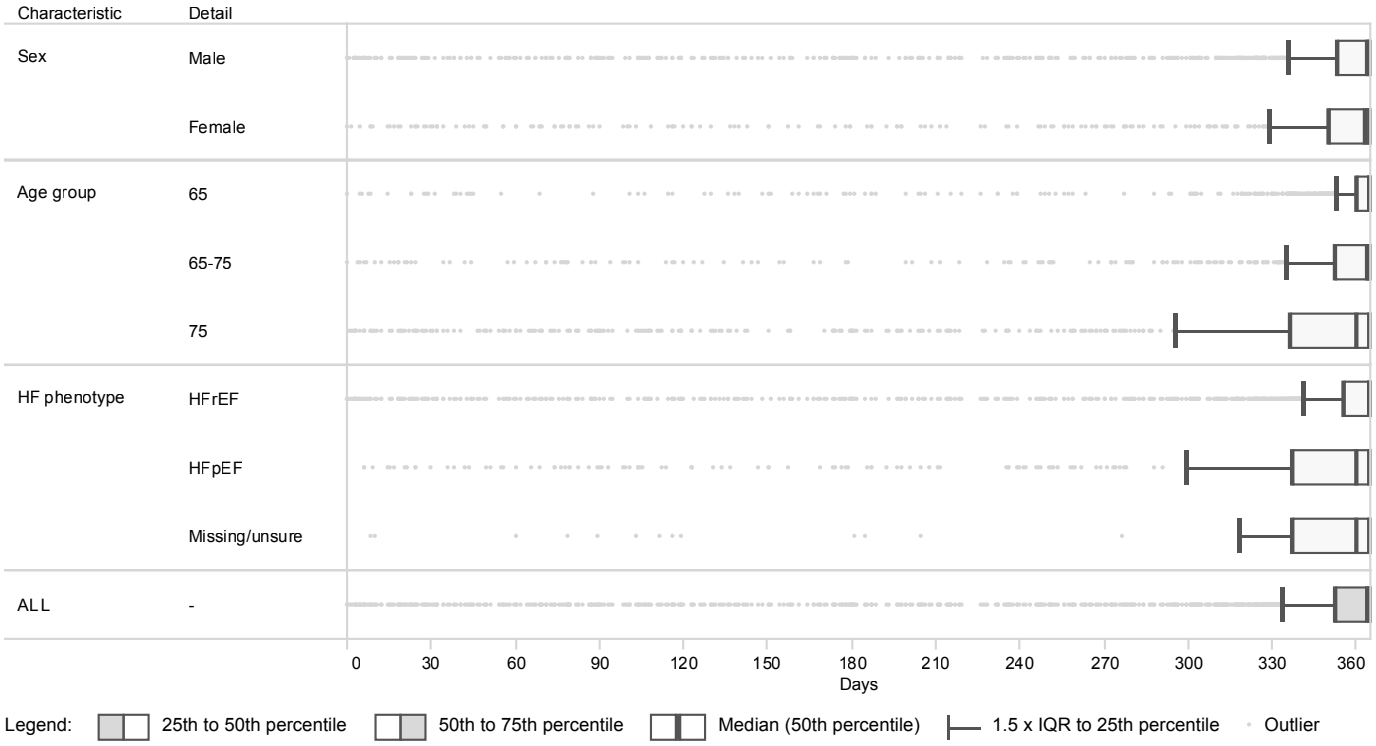


Figure 26: Days alive and out of hospital within one year after hospital discharge

Table 37: Days alive and out of hospital within one year of discharge by patient characteristic

Characteristic	Detail	n	Mean days	Median (IQR) days
Sex	Male	2,192	334.0	364 (353–365)
	Female	1,105	334.6	364 (351–365)
Age group	<65	1,273	348.2	365 (360–365)
	65–74	834	336.2	364 (353–365)
	≥75	1,190	317.8	361 (337–365)
HF phenotype	HFrEF	2,608	337.3	365 (356–365)
	HFpEF	626	323.7	360 (337–365)
	Missing/unsure	63	309.1	360 (337–365)
All		**3,297**	**334.2**	**364 (352–365)**

The box and whisker plots in Figure 27 illustrate the distribution of DAOH for different characteristics. The median DAOH is close to 365 days for most categories (the box shows the middle 50% of scores). The whiskers stretching to the left illustrate that many patients spent subsequent time in hospital or died. The DAOH was much lower for patients who were over 75 years old.



Mean, median and interquartile range (IQR) are given in days

Figure 27: Days alive and out of hospital within one year of discharge by patient characteristic

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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

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