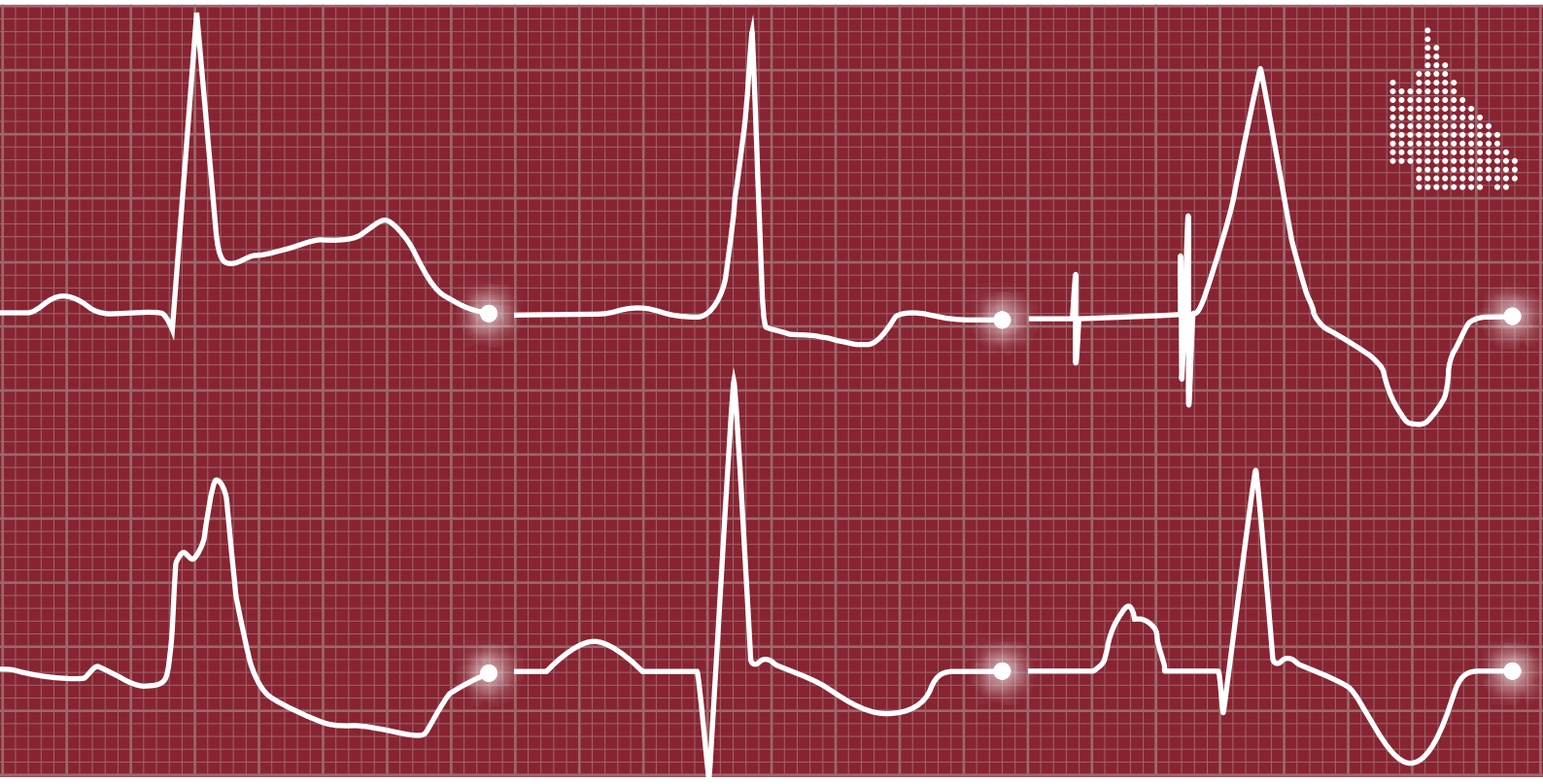
Statewide Cardiac Clinical Network

Queensland Cardiac Outcomes Registry

2019 Annual Report



Improvement | Transparency | Patient Safety | Clinician Leadership | Innovation

Queensland Government

Queensland Cardiac Outcomes Registry
2019 Annual Report

Published by the State of Queensland
(Queensland Health), December 2020

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clinicalexcellence.qld.gov.au/priority-areas/clinician-engagement/statewide-clinical-networks/cardiac

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1 Message from the SCCN Chair

We are pleased to present the 2019 Queensland Cardiac Outcomes Registry (QCOR) Annual Report, which marks five years of publication. Yet again, the Report documents the world-class quality of care offered by practitioners within the Queensland public health system. The QCOR program is driven by the passion of Queensland's clinicians to not only report on the quality, performance and outcomes of cardiac services delivered to Queenslanders, but to enable and provide a comprehensive platform to directly support frontline cardiac services and be a driving force for continuous improvement. The result has been collaboration on a statewide scale, with QCOR directly supporting the efforts of hundreds of clinicians across often incredible distances.

The breadth of QCOR is highlighted by the development of a new module to support cardiac outreach services, starting with the Far North Queensland outreach unit in late 2019. Outreach services are an important part of delivering quality care to patients for whom cardiac care is less accessible, due to their remoteness from traditional facility-based services. This initial reporting will be expanded as additional units are established or come online over following years. This Report also shines a spotlight on the new partnership between QCOR and the Queensland Rheumatic Heart Disease (RHD) Registry. Despite being in its infancy, this collaboration has already led to the identification and development of specialised care plans for almost two hundred Queenslanders suffering from RHD. These are outcomes which are seldom linked to traditional research-focused registries and reflect a far greater vision at the core of this clinician-led initiative.

Clinical quality has again continued to be a focus of this report, with several new clinical indicators having been added to these audits for the new year to align with ever-changing international guidelines for the management and treatment of patients. As such, the registry continues to evolve and clinical indicators across all areas of interest will continue to be reviewed and expand accordingly over future years. It is yet again reassuring to see performance of Queensland services strong when compared to these often optimistic benchmarks and targets.

Investment in the collection of clinical data is now recognised as a valuable means of returning on investment and identifying areas of efficiency that subsequently enable cost savings and redirection of health funding to areas of need or emerging clinical technologies. QCOR data has underpinned bulk purchase arrangements and continues to demonstrate the ability to negotiate strongly with industry via commercial processes and ensure that each health funding dollar is spent wisely and carefully. Future processes now have the potential to increase in scope which will drive further financial realisation on investment that compound and grow over time.

The tireless work of Queensland cardiac clinicians and administrative staff must be recognised, not only for delivering high quality clinical outcomes but for their engagement, understanding and enthusiasm for quality clinical processes that are supported by quality data, and we look forward to future expansion that seeks to apply a similar scope and high standard of reporting to echocardiography and structural heart disease.

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

2 Introduction

The Queensland Cardiac Outcomes Registry (QCOR) is an ever-evolving clinical registry and quality program established by the Statewide Cardiac Clinical Network (SCCN) 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 improve patient care and support quality improvement activities 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 SCCN 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.

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 Marcus Prior, Informatics Analyst
Dr Ian Smith, PhD, Biostatistician
Mr William Vollbon, Manager*
Mr Michael Mallouhi, Clinical Analyst
Ms Bianca Sexton, Project Manager
Mr Karl Wortmann, Application Developer

* Principal contact officer/QCOR program lead

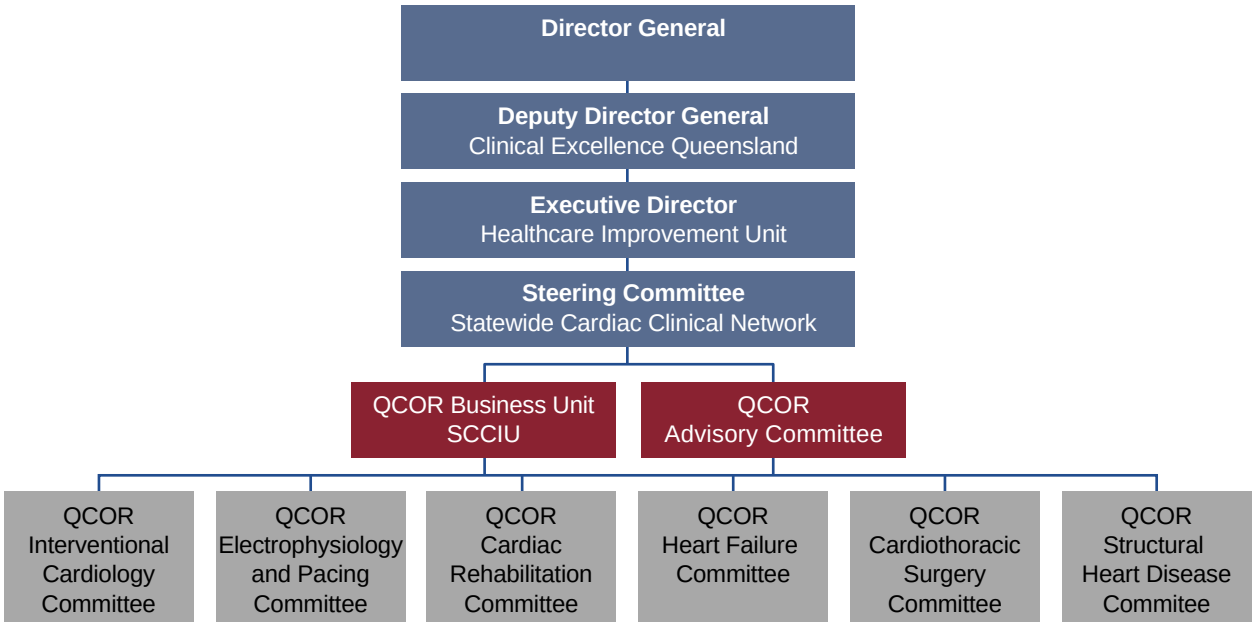
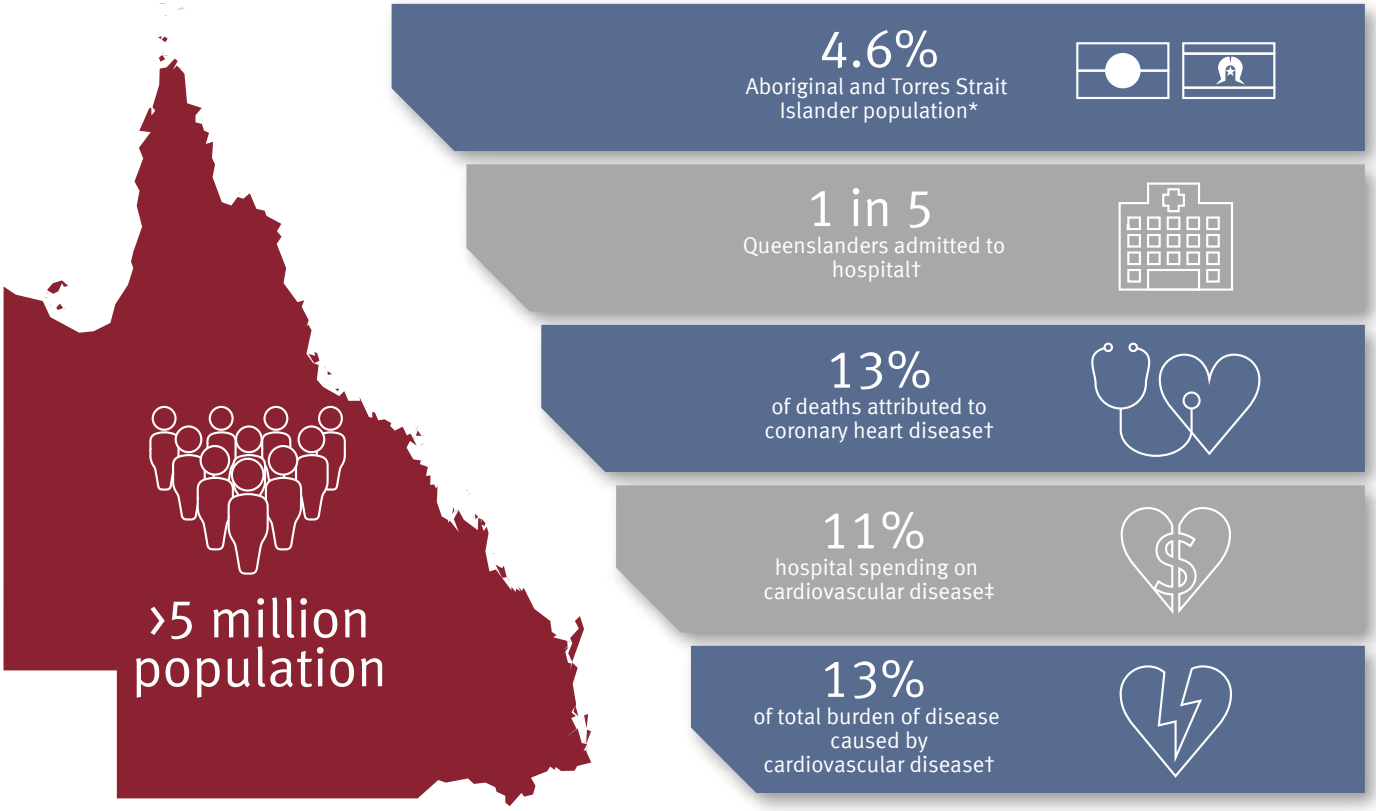


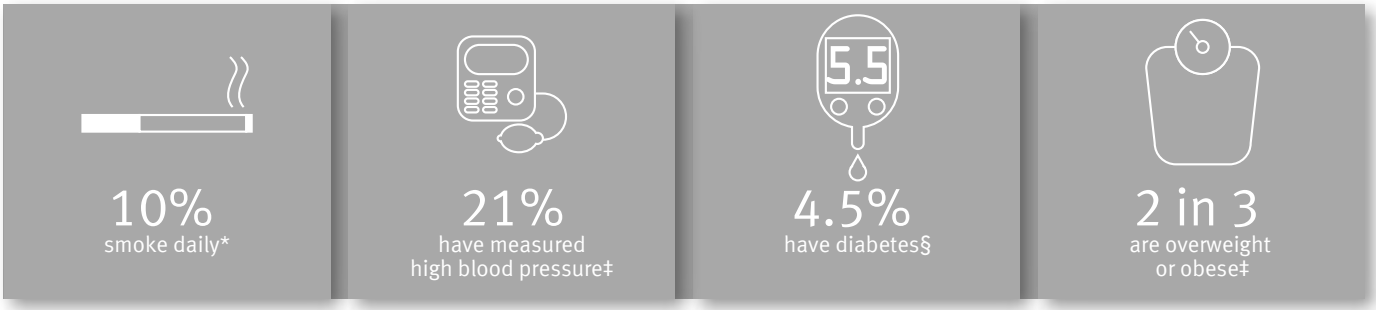
Figure 1: Governance structure

Queensland Cardiac Outcomes Registry

The Health of Queenslanders



Comorbidities



Mortality

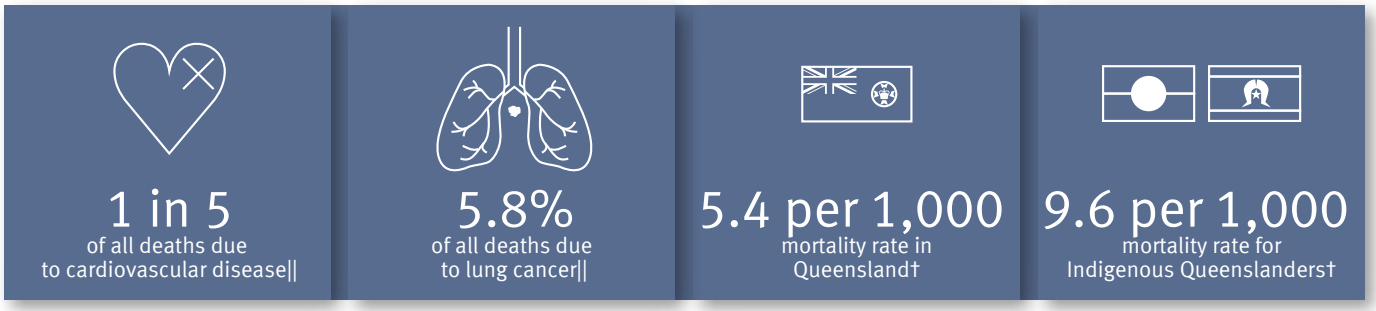


Figure 2: QCOR 2019 infographic

* Australian Bureau of Statistics. (2018). *Estimates of Aboriginal and Torres Strait Islander Australians*, June 2016. Cat. no 3238.055001. ABS: Canberra.

† 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 Bureau of Statistics. (2019). *Deaths, Australia, 2018*. Cat. no. 3302.0. ABS: Canberra.

2019 Activity at a Glance

What's New?

- Rheumatic heart disease, cardiac outreach and ECG Flash spotlights
- Expanded thrombolysis for STEMI analysis
- Cardiac surgery EuroSCORE II risk adjustment analysis
- Cardiac surgery remoteness investigation
- New timely non-acute assessments cardiac rehabilitation indicator
- New mineralocorticoid antagonist prescription heart failure indicator

Interventional Cardiology

5,002
percutaneous coronary interventions

477
structural heart disease interventions

249
transcatheter aortic valve replacements

15,615
all coronary procedures

Cardiothoracic Surgery

2,622
adult cardiac surgeries

1,042
adult thoracic surgeries

Electrophysiology & Pacing

4,654
electrophysiology and pacing procedures

3,189
cardiac implantable electronic device procedures

Heart Failure Support Services

5,304
heart failure support services referrals

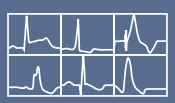
Cardiac Rehabilitation

11,547
cardiac rehabilitation referrals

Rheumatic Heart Disease

179
unknown RHD patients identified

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

92%
of patients referred to a heart failure support service on an ACEI, ARB or ARNI at discharge

94%
of cardiac rehabilitation referrals within 3 days of discharge

1.0%
mortality rate for coronary artery bypass surgery at 30 days

QCOR Yearly Trends

Interventional Cardiology

15,615
cases in 2019
– up from 15,293 in 2017

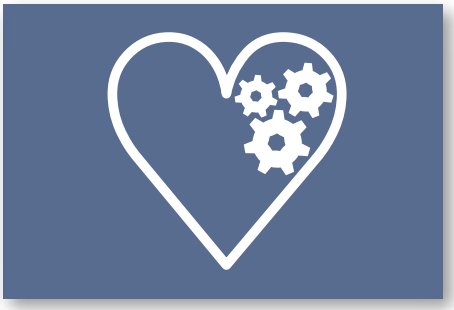
5,002
PCI cases in 2019
– up from 4,867 in 2018

3 minute
improvement in median time to reperfusion for STEMI PCI from 2017 to 2019

8%
increase in primary PCI cases meeting 90 minute target for timely reperfusion – 2017 to 2019

Cardiothoracic Surgery

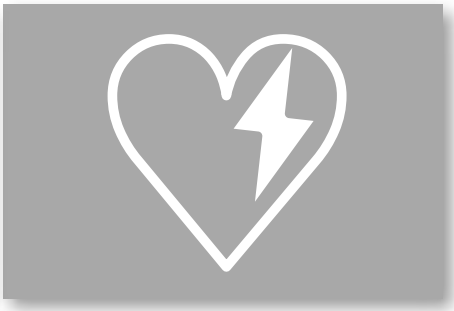
11%
increase in cardiac surgery cases
– 2017 to 2019



23%
increase in thoracic surgery cases
– 2018 to 2019

Electrophysiology & Pacing

4,654
cases in 2019
– up from 4,474 in 2018



22%
increase in complex EP cases
– 2018 to 2019

Outpatient Support Services

23,000+
cardiac rehabilitation referrals
– 2018 and 2019

17%
increase in new heart failure support services referrals
– 2017 to 2019

3 Acknowledgements

This collaborative report was produced by the SCCIU, audit lead for QCOR for and on behalf of the Statewide 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, Townsville University Hospital
- Dr Niranjan Gaikwad, The Prince Charles Hospital
- Dr Paul Garrahy, Princess Alexandra Hospital
- Dr Christopher Hammett, Royal Brisbane & Women's Hospital
- A/Prof Richard Lim, Princess Alexandra Hospital
- Dr Rohan Poulter, Sunshine Coast University Hospital
- A/Prof Atifur Rahman, Gold Coast University Hospital
- Dr Shantisagar Vaidya, Mackay Base Hospital
- Dr Gregory Starmer, Cairns Hospital (Chair)

QCOR Cardiothoracic Surgery Committee

- Dr Anil Prabhu, The Prince Charles Hospital
- Dr Pallav Shah, Townsville University Hospital
- Dr Andrie Stroebel, Gold Coast University Hospital
- Dr Morgan Windsor, Metro North Hospital and Health Service
- 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 Jacqueline Cairns, Cairns Hospital
- Ms Yvonne Martin, Chronic Disease Brisbane South
- Dr Johanne Neill, Ipswich Hospital
- Ms Samara Phillips, Statewide Cardiac Rehabilitation Coordinator
- Ms Madonna Prenzler, West Moreton Hospital and Health Service
- Ms Deborah Snow, Gold Coast Hospital and Health Service
- Ms Natalie Thomas, South West Hospital and Health Service
- Mr Gary Bennett, Health Contact Centre (Chair)

Statewide Cardiac Clinical Informatics Unit

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

QCOR Electrophysiology and Pacing Committee

- 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
- Ms Sanja Doneva, Princess Alexandra Hospital
- Mr Nathan Engstrom, Townsville University Hospital
- A/Prof John Hill, Princess Alexandra Hospital
- Dr Bobby John, Townsville University Hospital
- Dr Paul Martin, Royal Brisbane & Women's Hospital
- Ms Sonya Naumann, Royal Brisbane & Women's Hospital
- Dr Kevin Ng, Cairns Hospital
- Dr Robert Park, Gold Coast University Hospital

QCOR Heart Failure Support Services Committee

- Mr Ben Shea, Ipswich Hospital
- Ms Angie Sutcliffe, Cairns Hospital
- Ms Tina Ha, Princess Alexandra Hospital
- Ms Helen Hannan, Rockhampton Hospital
- Ms Annabel Hickey, Statewide Heart Failure Services Coordinator
- Dr Rita Hwang, PhD, Princess Alexandra Hospital
- Dr Kevin Ng, Cairns Hospital
- Ms Robyn Peters, Princess Alexandra Hospital
- Ms Serena Rofail, Royal Brisbane & Women's Hospital
- Dr Yee Weng Wong, The Prince Charles Hospital
- A/Prof John Atherton, Royal Brisbane & Women's Hospital (Chair)

Queensland Ambulance Service

- Dr Tan Doan, PhD
- Mr Brett Rogers

4 Executive summary

This report comprises an account for cases performed in the eight cardiac catheterisation laboratories (CCL) and nine electrophysiology and pacing (EP) facilities, along with five cardiothoracic surgery units operating across Queensland public hospitals in 2019. Referrals to the 21 heart failure support and 57 cardiac rehabilitation services for the management of heart disease have also been included in this Audit.

- 15,615 diagnostic or interventional cases were performed across the eight public CCL facilities in Queensland hospitals. Percutaneous coronary intervention (PCI) was performed in 5,002 of these cases.
- Patient outcomes following PCI remain encouraging. The 30 day mortality rate following PCI was 2.2%, and of the 108 deaths observed, 77% were classed as either salvage or emergency PCI.
- When analysing the ST segment elevation myocardial infarction (STEMI) patient cohort, the median time from first diagnostic electrocardiograph (ECG) to reperfusion and arrival at PCI facility to reperfusion was observed at 83 minutes and 42 minutes.
- Across the four sites with a cardiac surgery unit, a total of 2,622 cases were performed including 1,567 coronary artery bypass grafting (CABG) and 1,104 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.
- Approximately 4% of all cardiac surgical patients resided in remote or very remote Australia.
- Patients in Outer Regional and Remote/Very Remote areas were two to four times more likely to have a postoperative length of stay >14 days (Outer Regional: OR 2.02, p<0.01), Remote/Very Remote: OR 4.05, p <0.001).
- Patients residing outside of a Major City of Australia had a higher likelihood of having a length of stay <6 days (Inner Regional: OR 1.61 p=0.009, Outer Regional: OR 1.45 p=0.044).
- A total of 1,042 thoracic surgery cases were performed across the five public hospitals providing thoracic surgery services in 2019. Almost a quarter (24%) of surgeries followed a preoperative diagnosis of primary lung cancer, whereas pleural disease accounted for nearly a third of all cases (32%).
- At the nine public Electrophysiology and Pacing (EP) sites, a total of 4,654 cases were performed, which included 3,189 cardiac device procedures and 1,058 electrophysiology procedures. This year's EP Audit sees the addition of Toowoomba Hospital, which began direct entry in November 2019.
- The EP clinical indicator audit identified a median wait time of 81 days for complex ablation procedures, and 32 days for elective implantable cardioverter defibrillator (ICD) implants. Meanwhile the median wait time for a standard ablation procedure was 117 days.
- There was a total of 11,547 referrals to one of the 57 public cardiac rehabilitation (CR) services in 2019. Almost three quarters of referrals (74%) followed an admission at a public hospital in Queensland.
- The vast majority of referrals to CR were created within three days of the patient being discharged from hospital (94%), while over half of patients went on to complete an initial assessment by CR within 28 days of discharge (56%). This performance measure is consistent with the data observed in 2018.
- There were 5,304 new referrals to a heart failure support service in 2019. Clinical indicator benchmarks were achieved for timely follow-up of referrals and appropriate medication prescriptions as per clinical guidelines for all medications except mineralocorticoid receptor antagonists.

5 Cardiac Outreach Spotlight

The development and implementation of the QCOR Cardiac Outreach module is an initiative of the Statewide Cardiac Clinical Network in partnership with the Healthcare Improvement Unit and the Health Minister's 'Rapid Results Program'.

People living in rural and remote locations (such as North Queensland) and Aboriginal and Torres Strait Islander people are admitted to hospital for cardiac related conditions at two to three times the rate of the broader Queensland population*. Equitable access to health care across Queensland can be a challenge due to its vast size and dispersed population, which can require patients to travel significant distances to access cardiac care. Furthermore, due to the vast distances this patient cohort need to travel to access tertiary care, their healthcare journey is often fragmented contributing to poorer access and health outcomes. The foundation of this model is based on a coordinated approach which supports the patient journey by linking to services. Through the outreach model, patients in a remote setting can access support from a team of practitioners much closer to home including a specialist cardiologist, cardiac scientists, nurses and health workers.

As well as seeing a cardiologist for initial consultation, review or follow-up, patients attending a cardiac outreach clinic can have specialised tests such as echocardiograms and stress tests, as well as the potential for referral to tertiary care for more complex procedures. Close links with other Queensland Health outpatient services such as cardiac rehabilitation programs or heart failure support services are also an advantage of this model of care. These services are further supplemented by telehealth and remote cardiac testing capabilities.

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 Cardiac Outreach	Cairns Hospital	November 2019
Townsville and North West Queensland Cardiac Outreach	Townsville University Hospital	January 2020
Princess Alexandra Hospital Cardiac Outreach	Princess Alexandra Hospital	July 2020
Toowoomba Hospital Cardiac Outreach	Toowoomba Hospital	August 2020
Ipswich Hospital Cardiac Outreach	Ipswich Hospital	November 2020

* Australian Commission on Safety and Quality in Health Care (ACSQHC) and Australian Institute of Health and Welfare. (2017). The second Australian atlas of healthcare variation. Sydney: ACSQHC.

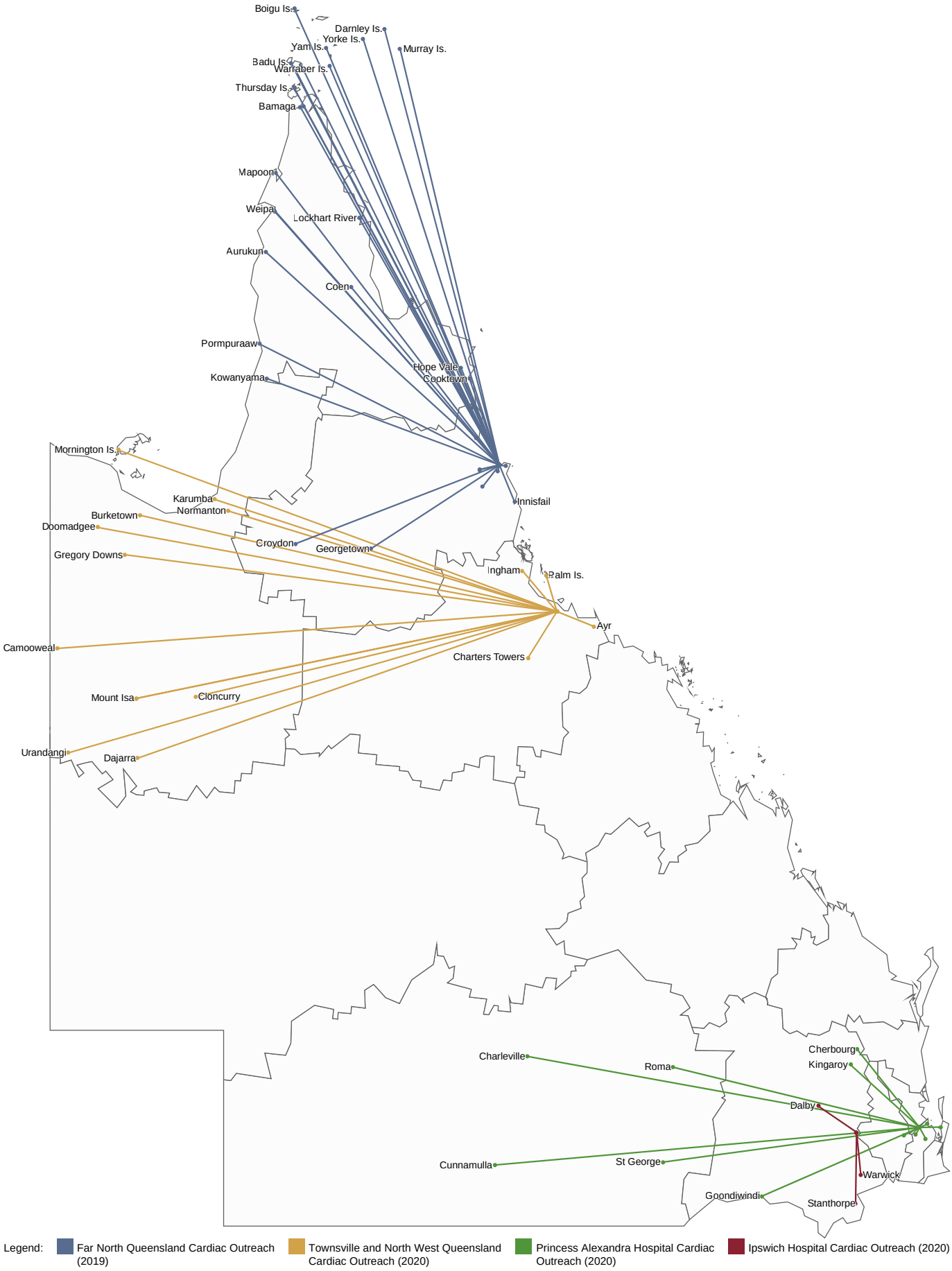


Figure 3: Cardiac outreach hub and spoke locations

6 ECG Flash Spotlight

ECG Flash, a Statewide Cardiac Clinical Network initiative, aims to give rural and remote clinicians 24/7 access to urgent specialist cardiology advice. When a patient presents at emergency and an ECG is taken, the system lets clinicians send time critical, difficult-to-interpret ECGs straight to an on call cardiologist for rapid analysis. The on call cardiologist receives a digital copy of the ECG to review and will call the treating clinician back to provide treatment advice. ECG Flash has been implemented to use a hub and spoke model of care where larger facilities with specialist staff cardiologists act as the hub to smaller regional and remote centres.

Regional and remote sites (spoke sites) use a digitally enabled ECG cart which automatically transmits all ECGs taken to an enterprise clinical data storage application. This digital storage solution for ECGs is available at each site and from there clinicians can selectively transmit time critical, difficult-to-interpret ECGs directly to the on call cardiologist at their referring tertiary hospital (hub site). They are also able to access ECGs taken at other participating hospitals within their HHS, allowing them to have access to patients' ECGs across multiple facilities.

In 2019, there were 30 rural sites utilising the ECG Flash solution and they sent 252 ECGs through to five receiving cardiology departments.

Implementation at an additional 51 rural sites and 3 hub sites is planned for 2020. Further use of ECG Flash data to complement existing QCOR data collections will be the focus for future work.

Table 2: ECG Flash – participating hub sites

ECG Flash hub	Commenced date	Number of spoke sites 2019	Number of spoke sites 2020
Princess Alexandra Hospital	August 2018	9	9
Cairns Hospital	September 2018	10	19
Mackay Base Hospital	February 2019	7	7
Townsville University Hospital	June 2019	4	6
Bundaberg Hospital	February 2020	–	8

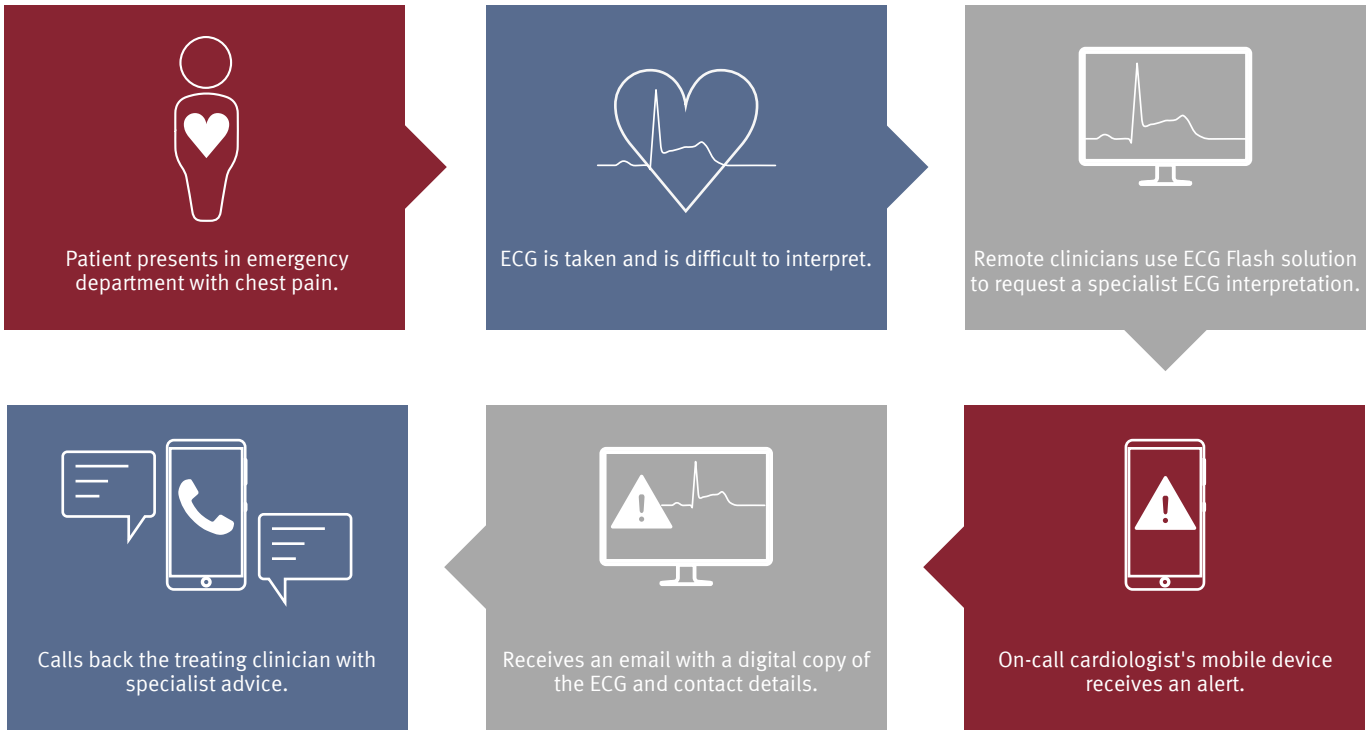


Figure 4: ECG Flash process flow

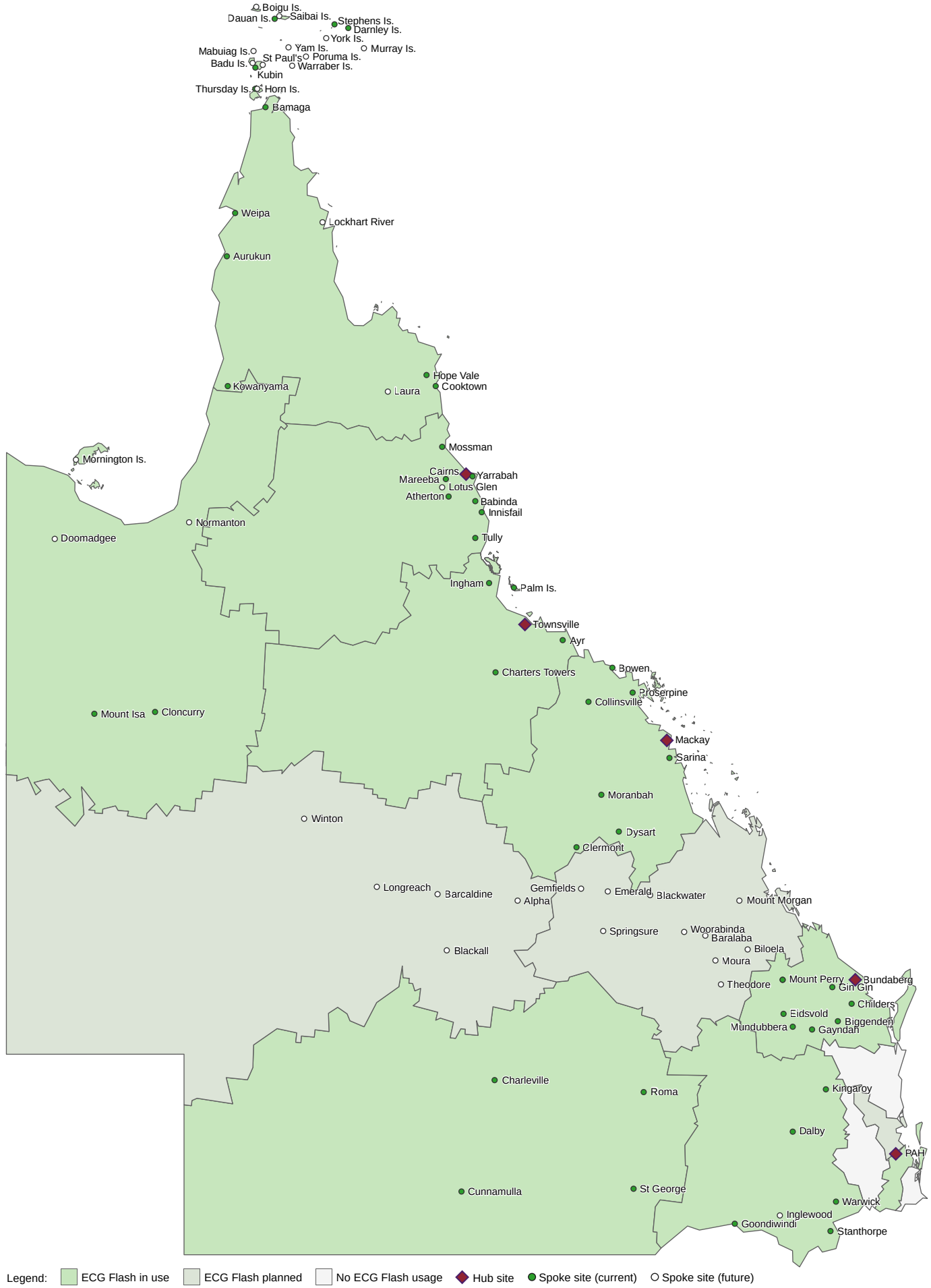


Figure 5: ECG Flash hub and spoke locations as at November 2020

7 RHD Spotlight

7.1 Background

The Queensland rheumatic heart disease register and control program (RHD Program) was established in 2009 to address rheumatic heart disease (RHD) as the leading cause of cardiovascular disparity between Aboriginal and Torres Strait Islander peoples and Australians of other descent. The program supports existing healthcare services with client care by maintaining a skilled health workforce, promoting culturally appropriate care, supporting education and health promotion for patients and communities, and working with patients and primary health care staff to optimise timely delivery of secondary prophylaxis.

The program further advocates for and supports activities aimed at preventing, identifying, managing and treating acute rheumatic fever (ARF) and RHD, and promotes primordial, primary and secondary prevention aimed at preventing initial episodes of ARF and development of RHD. This includes the development and distribution of ARF/RHD education and health promotion-focused resources such as client and family educational material to improve health literacy, and information on diversionary therapy aids and reward/incentive products.

Additional strategies are being undertaken to enhance the quality of support the program provides including, creation and distribution of reports for outreach clinics, HHS, service providers and health service planning managers. Individual client information and clinical advice is being provided to healthcare providers including, diagnostic criteria, notification process, treatment and follow-up requirements (point of care information).

The World Health Organization recommends a coordinated, public health approach in areas where there are substantial populations with ARF or RHD. The Australian Guideline for prevention, diagnosis and management of ARF and RHD (3rd edition)* states that 'Comprehensive RHD control programs which span action in the social and environmental determinants of health and primary and secondary prevention of ARF, can provide an effective approach to reducing the burden of RHD.' It is with this structure and suggested methodology that the Queensland RHD Program has been established.

7.2 The disease

ARF is an acute illness causing a generalised, autoimmune inflammatory response following repeated exposure to and infection with Group A Streptococcal bacteria. The inflammatory response occurs predominantly in the heart, joints, brain and skin. Clients typically present with a history of a sore throat and/or infected skin sores, pain and swelling in one or more joints, fever, malaise, a skin rash, chorea (jerky, uncoordinated movements of the hands, feet, tongue and face) and sometimes chest pain. Clinical investigations may identify prolonged atrioventricular junctional arrhythmias on an electrocardiogram, a heart murmur or carditis.

Once the initial acute illness has resolved, ARF leaves no lasting damage to the joints or skin however, any remaining damage to the brain can cause ongoing mental health and neurological issues. Similarly, anatomical changes occur affecting the heart valves with the ensuing clinical sequalae known as RHD. Repeated episodes of ARF inevitably lead to the development or worsening of RHD.

Severe RHD usually requires surgical intervention in the form of valve repair and/or replacement. Individuals receiving mechanical valves require lifelong anticoagulation. Every year, RHD kills people and devastates lives, particularly those of young Aboriginal and Torres Strait Islander Queenslanders. The disease process begins with symptoms as modest as a sore throat or skin infection which can be easily treated with common antibiotics, however if left untreated, it can lead to stroke and valve disease requiring cardiac surgery, often in an adolescent population. Efforts to prevent ARF and RHD currently centre on primary prevention (of the sore throat or skin infection), and secondary prevention via delivery of secondary prophylactic antibiotics to prevent recurrent episodes.

7.3 Disease demographics

Across Australia, sustained improvements to the conditions in which we are born, grow, live and work have permanently reduced the rates of preventable infectious diseases. Unfortunately, this progress is inequitable and Aboriginal and Torres Strait Islander people have not benefitted from the same improvements in health and living outcomes as the rest of Australia. Household disadvantage, poor-quality living conditions, poverty and overcrowding all contribute to health inequalities in at-risk populations.

ARF and RHD are diseases that exemplify the 'gap' between Aboriginal and Torres Strait Islander peoples and Australians of other descent. In 2017, there was a rate of 111 ARF cases per 100,000 Aboriginal and Torres Strait Islander Australians whereas for Australians of other descent the rate was 1 per 100,000. (Australian Institute of Health and Welfare (AIHW) 2019).† Between the ages of 5 years to 24 years, Aboriginal and Torres Strait Islander peoples are three times more likely to die from RHD than Australians of other descent.

7.4 The costs of ARF and RHD

Eliminating RHD means preventing all new cases of ARF. Preventing ARF is as simple as early diagnosis and treatment of a Streptococcal infection. This cost is negligible in comparison to the long term management of what would become chronic disease.

ARF and RHD contribute to increased death and disability in Queensland. RHD accrues early in life, with 20% of people on the Queensland RHD Register under 18 years of age and 26% of all ARF and RHD clients having had or will require valvular surgery.

The estimated financial costs of ARF and RHD diagnosis and management are outlined in Table 1.‡

Table 3: Costs of diagnosis and management of ARF and RHD

	Child $	Adult $
Management of Acute disease requiring hospitalisation		
ARF – Inpatient	12,075	12,912
RHD – Non-Surgical	11,798	9,787
RHD – Surgical	74,915	72,042
ARF/RHD Management (per year)		
ARF with/without mild RHD	2,048	2,048
Severe RHD	3,920	3,920

7.5 Disease prevention

Interventions to eradicate ARF and RHD in Australia require strategies that target the underlying economic, social and environmental conditions. These are structural and health system considerations that include moving away from a silo-based culture and transitioning towards functional multiagency, multidisciplinary teams. By actioning disparities in the environmental, social, cultural and economic determinants of health, primary and secondary prevention strategies for ARF and RHD can be developed. These then lend themselves to effective tertiary care which provides clients with high-quality medical and surgical management of their RHD.

* RHD Australia (ARF/RHD writing group) (2020). *The 2020 Australian guideline for prevention, diagnosis and management of acute rheumatic fever and rheumatic heart disease* (3rd edition). Retrieved from https://www.rhdaustralia.org.au/arf-rhd-guideline

† Australian Institute of Health and Welfare (2020). *Acute rheumatic fever and rheumatic heart disease in Australia, 2014–2018.* Retrieved from https://www.aihw.gov.au/reports/heart-stroke-vascular-diseases/acute-rheumatic-fever/contents/summary

‡ Wyber, R., Noonan, K., Halkon, C., Enkel, S., Ralph, A., … Carapetis, J. (2020.). *The RHD Endgame Strategy: A Snapshot. The blueprint to eliminate rheumatic heart disease in Australia by 2031*. Perth: The END RHD Centre of Research Excellence, Telethon Kids Institute

7.6 Queensland RHD Program and QCOR

In September 2018, RHD became a notifiable condition in Queensland. Since April 2019, QCOR and the RHD program have collaborated to enhance the reporting of all RHD-identified echocardiograms to the RHD register for Cairns, Townsville, Mackay and Rockhampton hospitals. Interaction between the RHD Register and QCOR acts as a supporting notification mechanism, assisting to identify those patients who have not previously been or were escalated for notification of RHD at the time of their clinical encounter.

Through QCOR, reporting of positive RHD findings by echocardiography has resulted in 172 previously unknown clients with RHD being added to the Register.

Table 4: QCOR echocardiography module RHD notifications

	Positive RHD findings n	Unknown RHD clients identified n
Cairns	494	66
Townsville	150	62
Mackay	47	26
Rockhampton	28	18
Total	**719**	**172**

Through the QCOR cardiac surgery RHD notification reports, seven previously unknown clients requiring surgery for their RHD have been added to the RHD register since October 2019.

Table 5: QCOR cardiac surgery module RHD notifications

	Positive RHD findings n	Unknown RHD clients identified n
Statewide cardiac surgery	14	7

8 Facility profiles

8.1 Cairns Hospital

Figure 6: 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

8.2 Townsville University Hospital

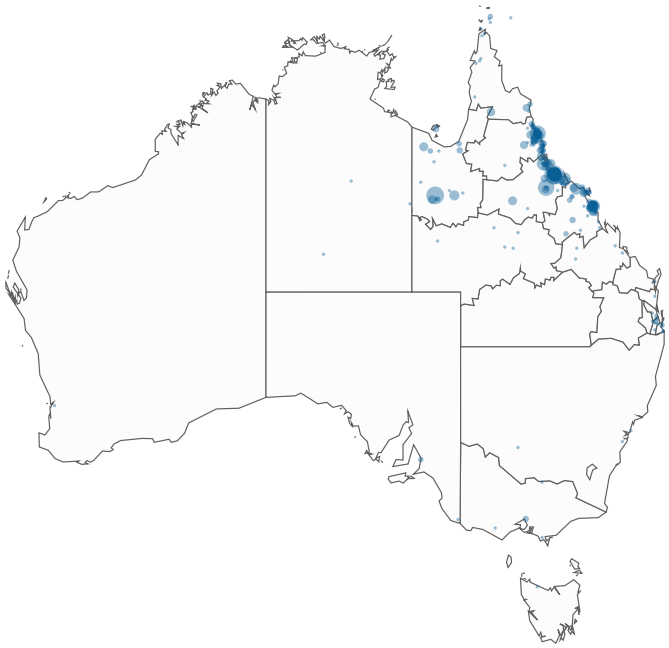


Figure 7: Townsville University Hospital

- 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

8.3 Mackay Base Hospital

Figure 8: 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

Figure 9: 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

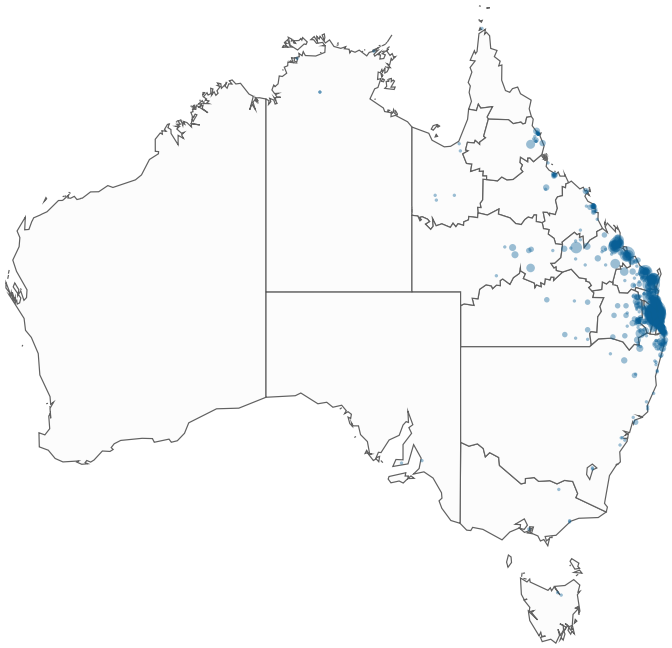


Figure 10: The Prince Charles Hospital

- 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

8.6 Royal Brisbane & Women's Hospital

Figure 11: 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

8.7 Princess Alexandra Hospital

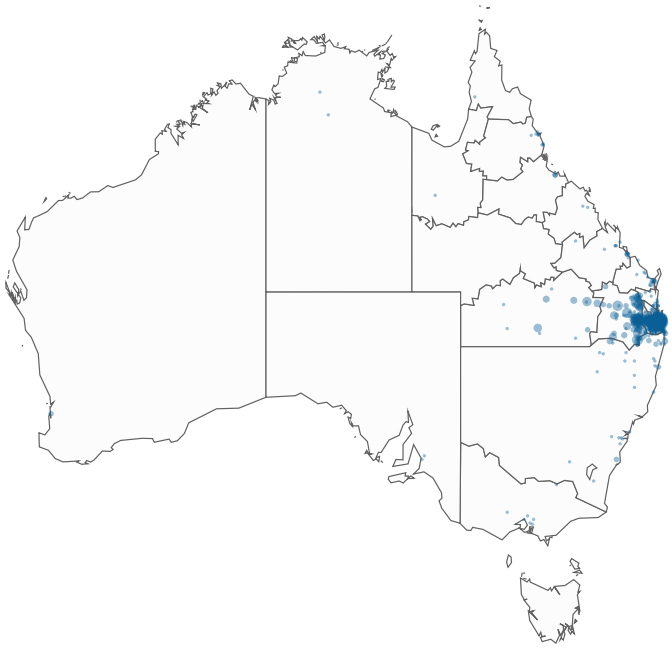


Figure 12: Princess Alexandra Hospital

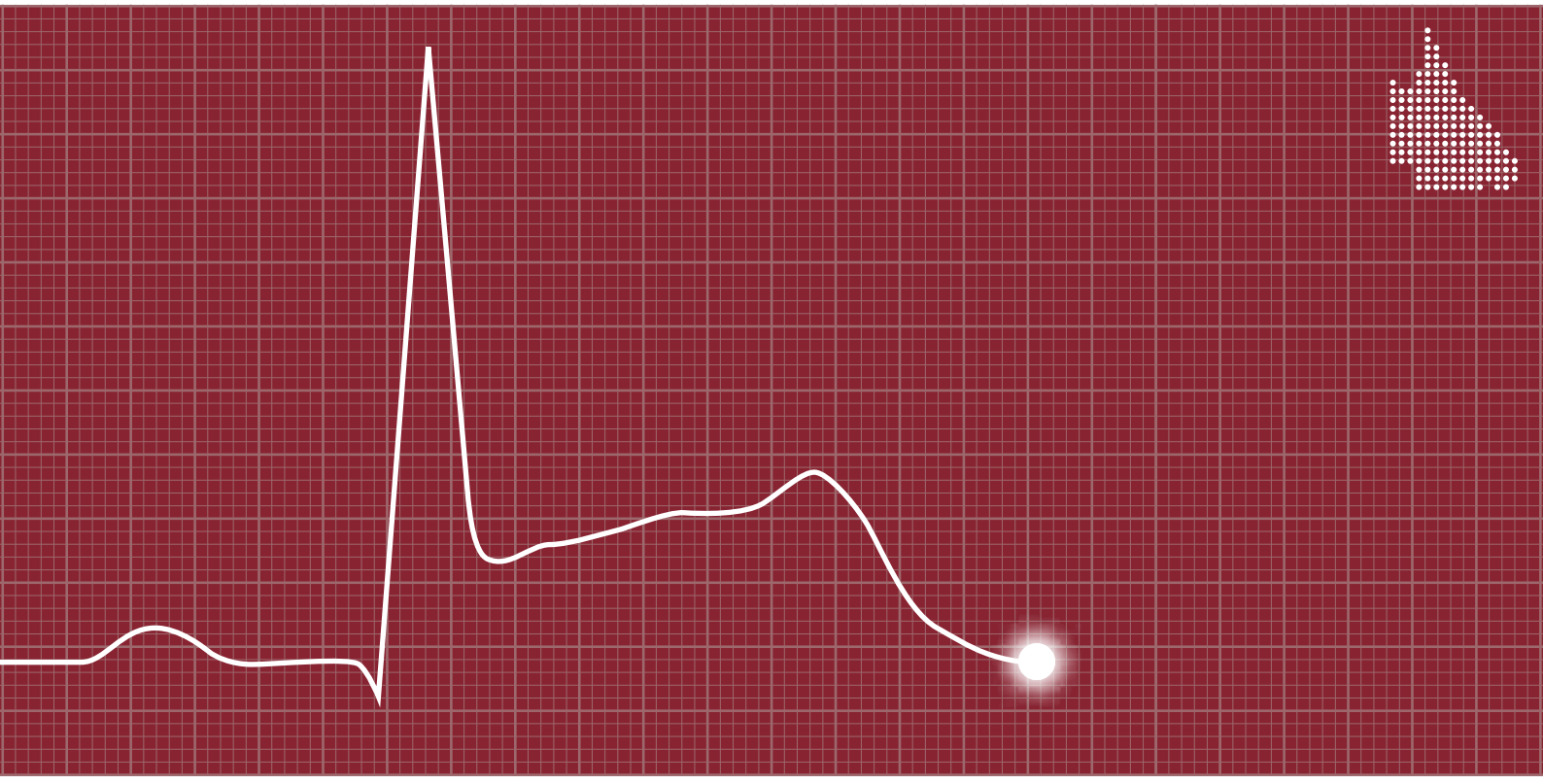
- Referral hospital for Metro South and South West Hospital and Health Services, serving a population of approximately 1,000,000
- Public tertiary level invasive cardiac services provided at the Princess Alexandra Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural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

8.8 Gold Coast University Hospital

Figure 13: 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

With the publication of the 2019 QCOR Interventional Cardiology Audit amidst probably the most significant global health event that any of us will encounter during our professional lifetime, I reflected on the challenges 2020 presented and the composed, yet purposeful and systematic manner, in which my colleagues from around the state united and planned, with the objective being the preservation of high quality cardiac care to those who needed it.

QCOR evolved from a similar desire from clinicians around Queensland to use high quality data to improve systems of care, process, and ultimately, outcomes. In 2014, a relatively modest Queensland Interventional Cardiology Audit was published, and from this, it is both pleasing and reassuring to present the 2019 Interventional Cardiology Report, with expanding data from all eight public Cardiac Catheter laboratories across Queensland. The goal of this report remains the same, to use data to improve outcomes for patients.

The 2019 Report provides in more in-depth analysis of the acute myocardial infarct (STEMI) population, in particular, initial treatment with thrombolysis rather than primary coronary intervention. This data provides an important link in this time-critical disease, and therefore further opportunity to reduce the time it takes to achieve a successful outcome. In many cases, this treatment is provided by the Queensland Ambulance Service paramedics with whom we work closely, and it is important to acknowledge their significant contribution to this body of work.

This report also again highlights the over-representation of Aboriginal and Torres Strait Islander peoples receiving cardiac procedures in Queensland, and sadly, also portrays a significant (11 year) age gap between Indigenous and non-Indigenous patients requiring procedural cardiac care.

The vast majority of patients were non-elective, that is, inpatients requiring cardiac care immediately or prior to discharge. This reflects the highly acute nature of the cardiac disease burden treated in Queensland's public hospitals, and the hospital care was generally prompt, of high quality, and amongst the safest in the world.

The last two years have also seen further development of the National Cardiac Registry (NCR). This takes the form of a "federated" model with state based registries, such as QCOR, responsible for producing a common dataset to contribute to the NCR. QCOR has been an active participant in this evolution, providing the NCR with key pilot analyses. We look forward to the next phase in maturation of this important concept.

Finally, I am reminded of a quote – "without data, you are just another person with an opinion", and I would like to acknowledge the exhaustive effort of the entire SCCIU team, under difficult circumstances this year, for their ongoing dedication to synthesising, analysing, and publishing cardiac data upon which we, as clinicians, can continue to provide high quality cardiac care to Queenslanders.

Dr Greg Starmer
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 2019.

Key findings include:

- 15,615 diagnostic coronary or interventional cases were performed across the eight cardiac catheterisation laboratory facilities in Queensland public hospitals, including 5,002 PCI cases.
- 76% of all PCI patients residing in Queensland had a place of residence within 50 km of the nearest PCI capable facility, while 11% of patients resided more than 150 km from the nearest facility.
- A large proportion of PCI patients (77%) were classed as having an unhealthy body mass index over 25 kg/m^2.
- The proportion of patients identified as Aboriginal and Torres Strait Islander (7.1%) 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 11 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.
- Drug eluting stents were used in 98% of cases, ranging from 95% to 100% across sites.
- There were 1,488 PCI cases following presentation with ST elevation myocardial infarction (STEMI), of which 53% were managed by primary PCI.
- There was a total of 498 thrombolysed STEMIs presenting for angiography, for whom the median time from first diagnostic ECG to the administration of thrombolysis was 35 minutes. The median time from thrombolysis to coronary angiography was 22 hours, with 52% 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 73 minutes to 98 minutes across sites).
- Median hospital door-to-device time for STEMI patients presenting within six hours of symptom onset was 42 minutes (range 37 minutes to 64 minutes across sites).
- PCI for non-ST elevation myocardial infarction (NSTEMI) represented 30% of all cases, with the median time to angiography of 60 hours. Patients presenting to a non-PCI capable facility have a median wait time to coronary angiography of 34 hours longer than those who present directly to a PCI capable facility (76 hours vs. 42 hours).
- Mortality within 30 days following PCI was 2.2% (108 deaths). Of these 108 deaths, 76% were classed as either salvage or emergency PCI.
- Of all cases, 0.72% recorded a major intra-procedural complication. Coronary artery perforation (0.52%) accounted for the majority of these events.
- Radiation doses were found to be under the high dose threshold in 99% of PCI cases across all sites and 99.6% of other coronary procedures.

3 Participating sites

There were eight public hospitals which offered cardiac catheter laboratory (CCL) services across both Metropolitan and regional Queensland.

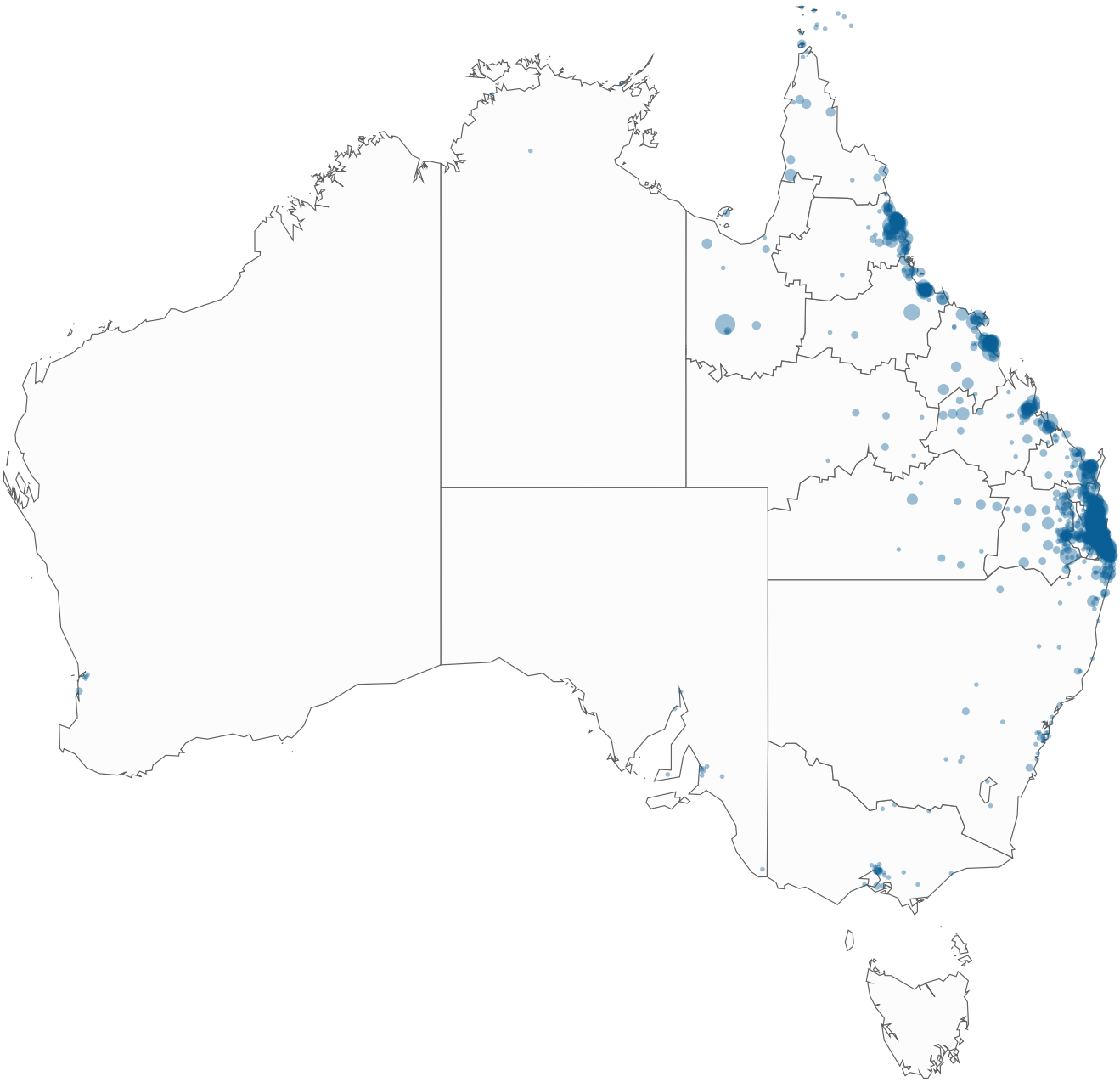


Figure 1: Statewide PCI cases by patient place of usual residence (by residential postcode)

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

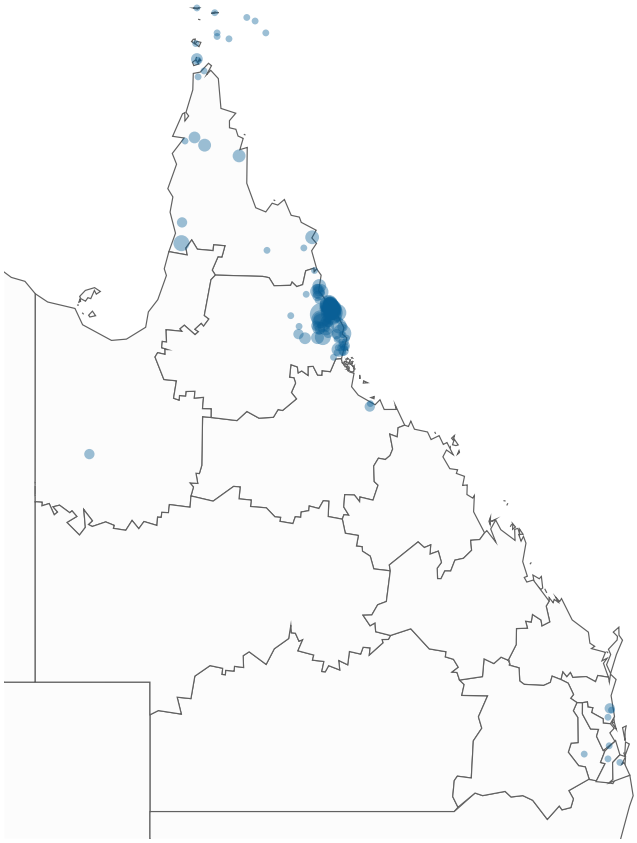


Figure 2: Cairns Hospital

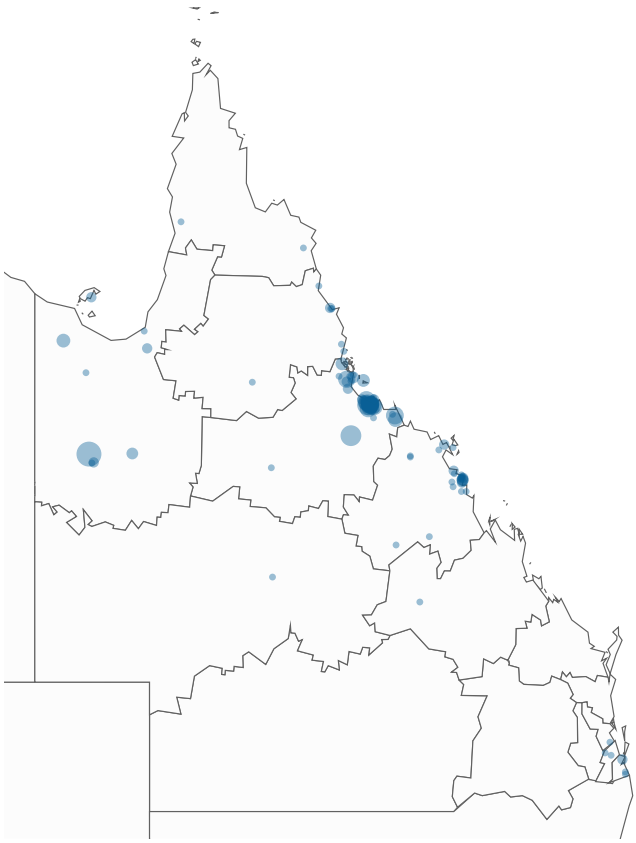


Figure 3: Townsville University Hospital

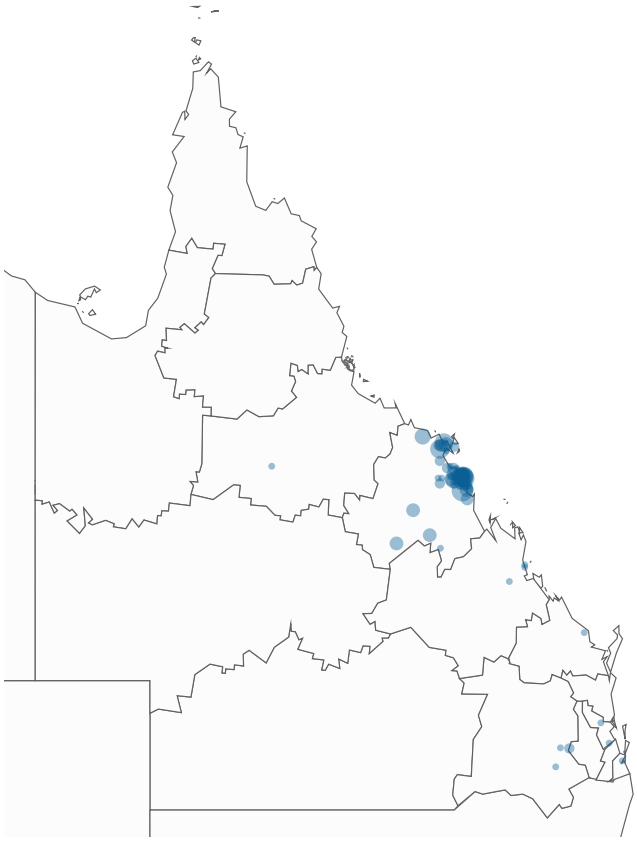


Figure 4: Mackay Base Hospital

Figure 5: Sunshine Coast University Hospital

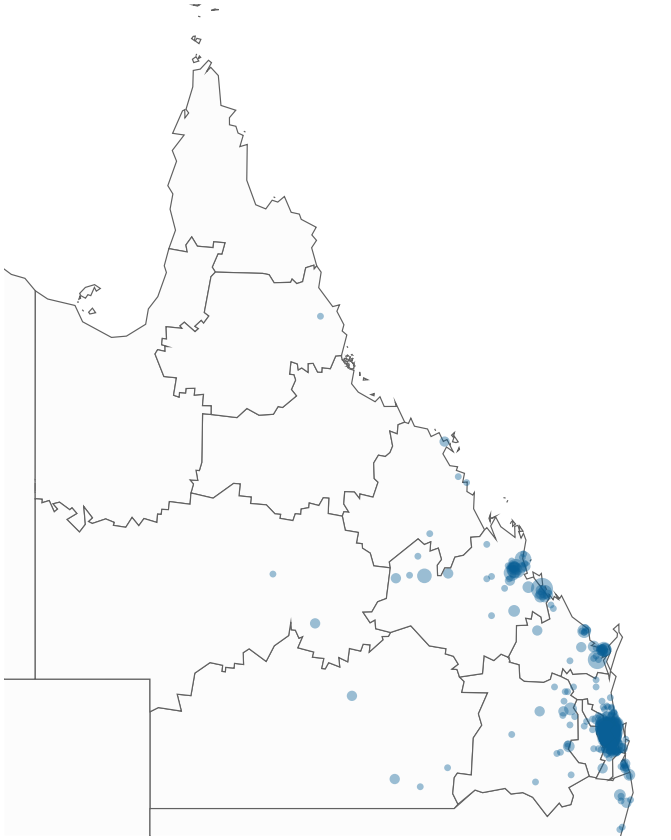


Figure 6: The Prince Charles Hospital

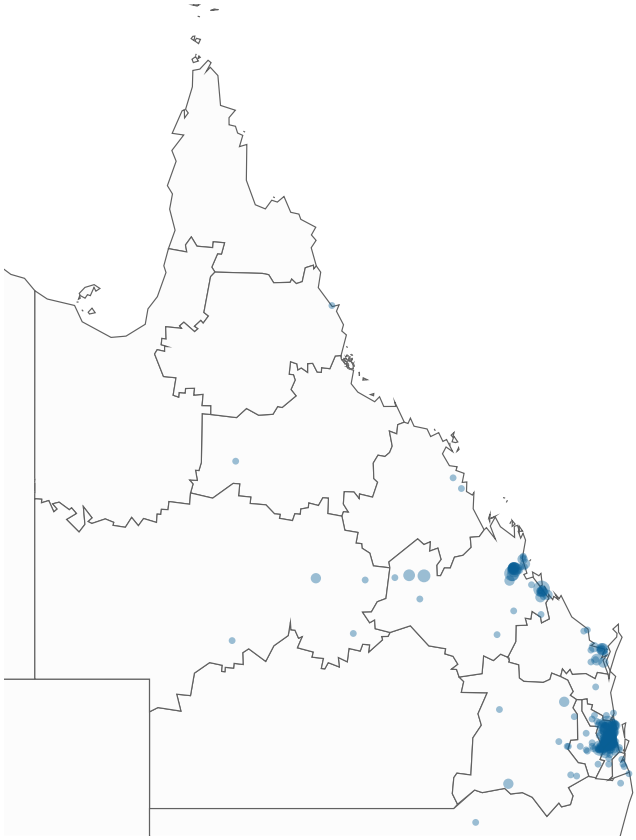


Figure 7: Royal Brisbane & Women's Hospital

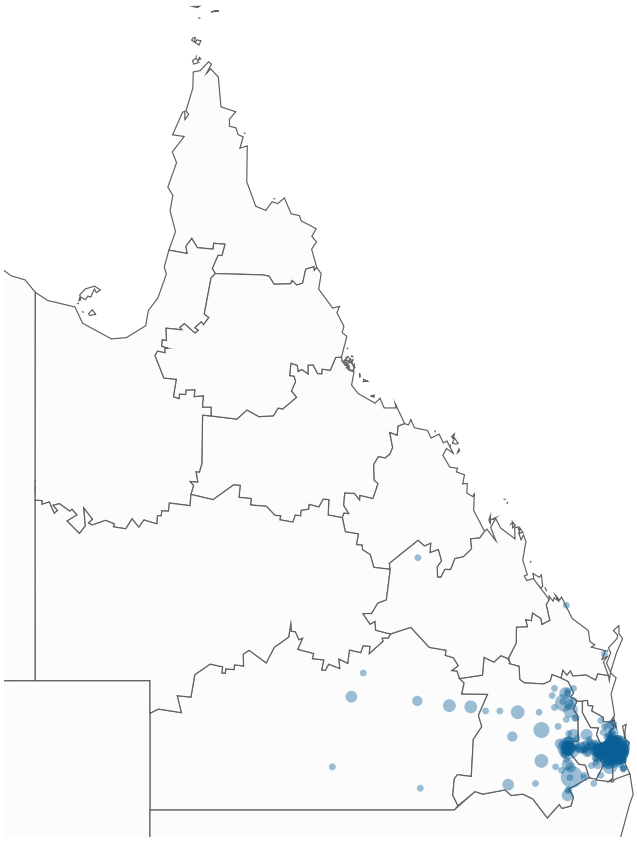


Figure 8: Princess Alexandra Hospital

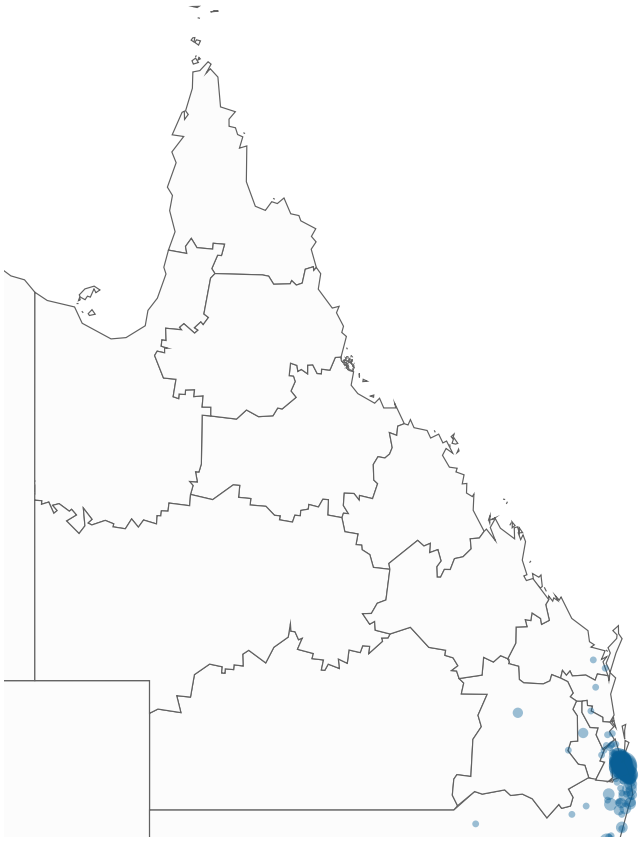


Figure 9: Gold Coast University Hospital

4 Total coronary cases

A total of 15,615 coronary cases were performed across the eight contributing cardiac catheterisation sites, with 5,002 patients (32%) undergoing a percutaneous coronary intervention (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 477 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.

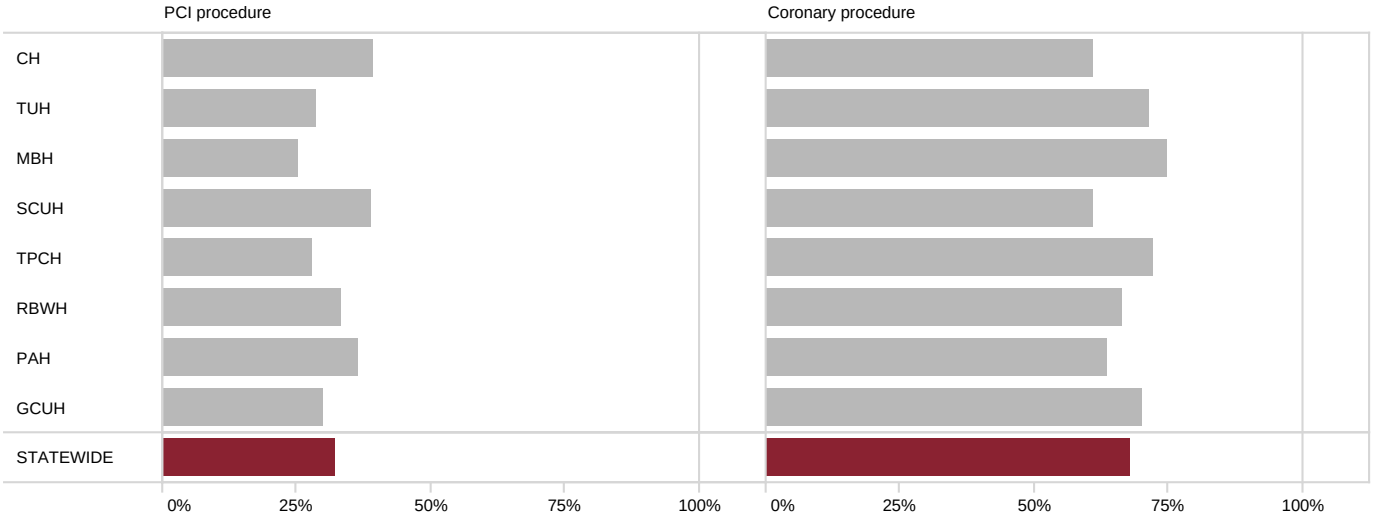


Figure 10: Proportion of cases by procedure category

Table 2: Total cases by procedure category

Site	PCI procedure* n (%)	Other coronary procedure† n (%)	Total coronary cases n
CH	535 (39.2)	829 (60.8)	1,364
TUH	372 (28.6)	928 (71.4)	1,300
MBH	291 (25.0)	871 (75.0)	1,162
SCUH	579 (38.9)	908 (61.1)	1,487
TPCH	1,078 (27.8)	2,794 (72.2)	3,872
RBWH	427 (33.5)	848 (66.5)	1,275
PAH	1,024 (36.3)	1,799 (63.7)	2,823
GCUH	696 (29.8)	1,636 (70.2)	2,332
STATEWIDE	**5,002 (32.0)**	**10,613 (68.0)**	**15,615**

* Includes balloon angioplasty, coronary stenting, PTCRA/atherectomy 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 non-ST elevation myocardial infarction (NSTEMI), while ST elevation myocardial infarction (STEMI) cases represented 12% of all cases, and 30% 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%). Almost two thirds of PCI procedures undertaken were categorised as either STEMI or NSTEMI (60%).

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	158 (11.6)	350 (25.7)	856 (62.8)
TUH	120 (9.2)	240 (18.5)	940 (72.3)
MBH	73 (6.3)	135 (11.6)	954 (82.1)
SCUH	290 (19.5)	330 (22.2)	867 (58.3)
TPCH	341 (8.8)	648 (16.7)	2,883 (74.5)
RBWH	139 (10.9)	333 (26.1)	803 (63.0)
PAH	503 (17.8)	808 (28.6)	1,512 (53.6)
GCUH	243 (10.4)	341 (14.6)	1,748 (75.0)
STATEWIDE	**1,867 (12.0)**	**3,185 (20.4)**	**10,563 (67.6)**

Table 4: PCI cases by clinical presentation category

Site	STEMI n (%)	NSTEMI n (%)	Other n (%)
CH	124 (23.2)	202 (37.8)	209 (39.1)
TUH	93 (25.0)	94 (25.3)	185 (49.7)
MBH	58 (19.9)	60 (20.6)	173 (59.5)
SCUH	232 (40.1)	147 (25.4)	200 (34.5)
TPCH	280 (26.0)	294 (27.3)	504 (46.8)
RBWH	106 (24.8)	173 (40.5)	148 (34.7)
PAH	385 (37.6)	374 (36.5)	265 (25.9)
GCUH	210 (30.2)	157 (22.6)	329 (47.3)
STATEWIDE	**1,488 (29.7)**	**1,501 (30.0)**	**2,013 (40.3)**

4.2 Place of residence

The vast majority of PCI patients (95%) had a usual place of residence within Queensland, with a smaller proportion originating from interstate (4%) and overseas (1%). For the Gold Coast University Hospital, over one fifth of PCI patients (21%) originated from outside of Queensland.

Patients came from a wide geographical area with a large proportion of patients residing on the Eastern Seaboard. More than half of all patients were seen inside their local Hospital and Health Service (HHS). Of those patients residing in Queensland, the majority (76%) 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	97.4	86.1	1.5	1.1
TUH	97.3	70.5	1.6	1.1
MBH	97.9	93.8	1.0	1.0
SCUH	95.9	69.4	3.1	1.0
TPCH	97.8	66.8	2.0	0.2
RBWH	94.6	48.2	2.4	3.1
PAH	97.4	61.2	1.4	1.3
GCUH	78.7	75.8	20.0	1.3
STATEWIDE	**94.5**	**69.6**	**4.4**	**1.1**

Excludes missing data (0.2%)

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	67.8	22.8	9.5
TUH	64.4	19.7	15.8
MBH	69.2	19.9	10.8
SCUH	68.3	22.9	8.8
TPCH	77.3	6.9	15.7
RBWH	67.3	8.0	24.8
PAH	78.1	16.9	5.0
GCUH	99.3	0.5	0.2
STATEWIDE	**75.6**	**13.8**	**10.6**

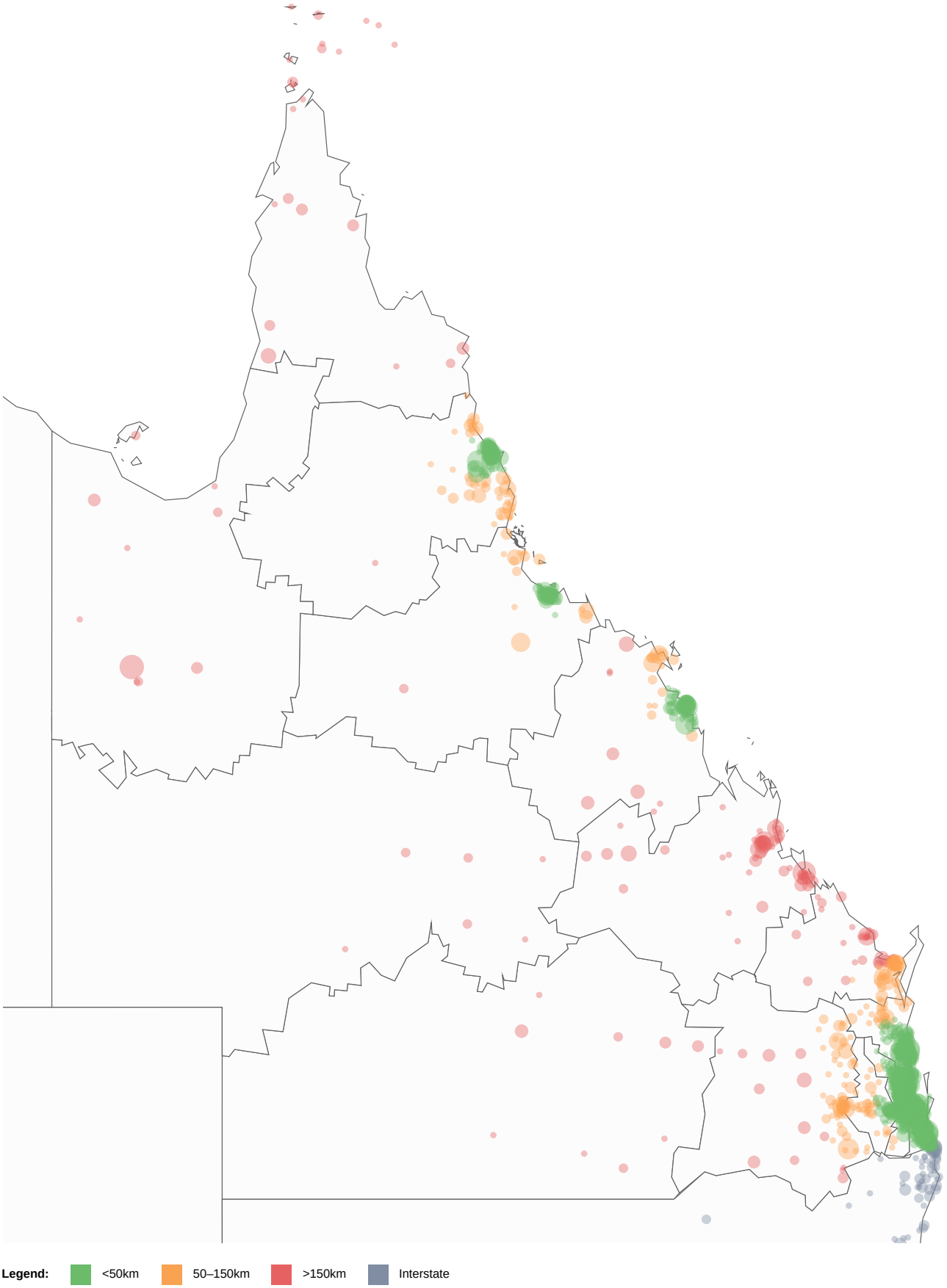


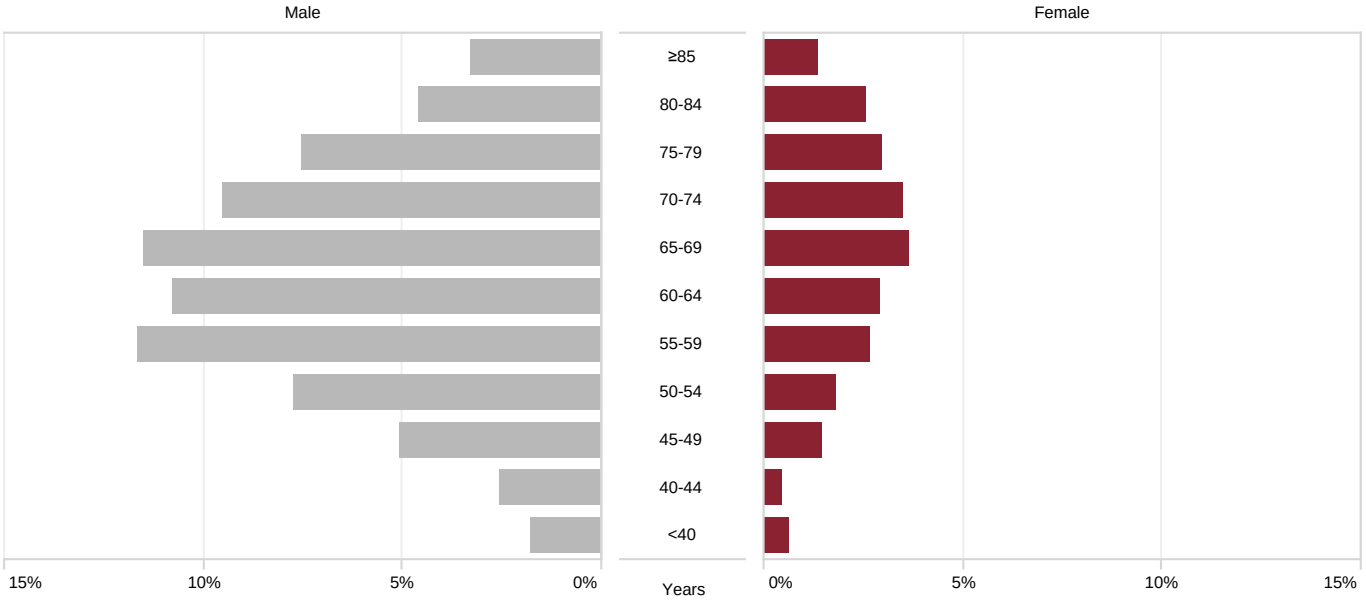
Figure 11: Queensland PCI cases by distance to nearest public PCI facility

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 59 years to 68 years across sites.

The majority of patients were male (76%), 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=5,002)

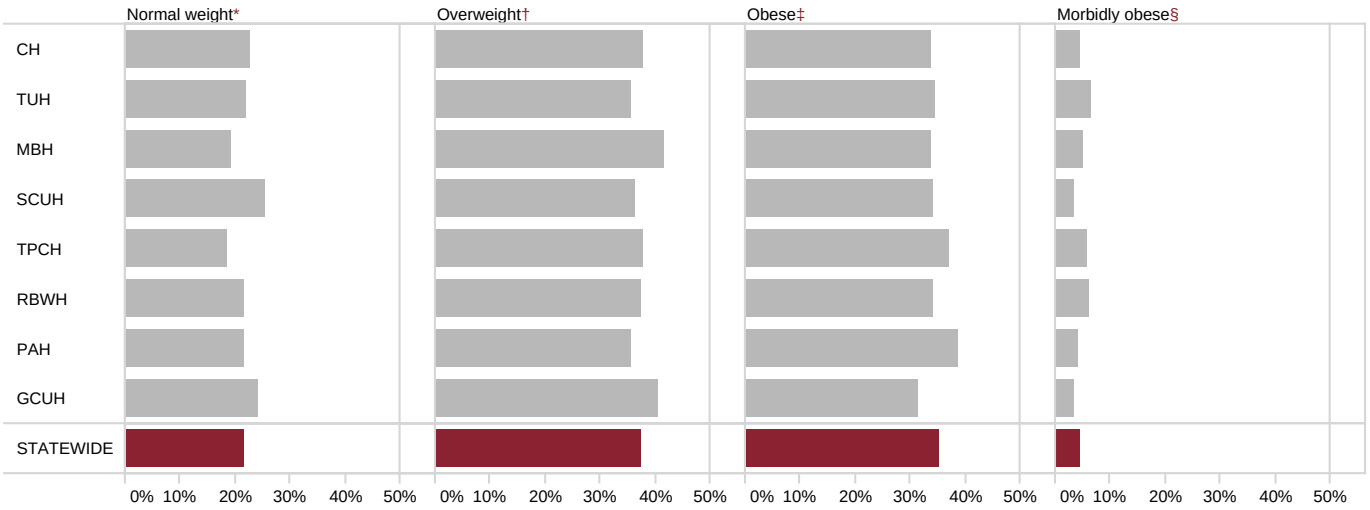
Figure 12: Proportion of all PCI cases by gender and age group

Table 7: Median PCI patient age by gender and site

Site	Male years	Female years	All years
CH	63	61	63
TUH	59	60	59
MBH	65	65	65
SCUH	67	72	68
TPCH	66	70	67
RBWH	64	69	65
PAH	62	65	63
GCUH	64	70	66
STATEWIDE	**64**	**68**	**65**

5.2 Body mass index

Patients across all sites displayed similar trends for body mass index (BMI), with less than one quarter of patients (22%) in the normal BMI range and 38%, 35% and 5% 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 (0.3%)

* 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 13: 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	8 (1.5)	120 (22.6)	201 (37.8)	179 (33.6)	24 (4.5)
TUH	6 (1.6)	81 (22.0)	130 (35.3)	127 (34.5)	24 (6.5)
MBH	3 (1.0)	56 (19.3)	120 (41.4)	97 (33.4)	14 (4.8)
SCUH	5 (0.9)	147 (25.4)	210 (36.3)	197 (34.1)	19 (3.3)
TPCH	11 (1.0)	200 (18.6)	406 (37.7)	399 (37.0)	61 (5.7)
RBWH	4 (0.9)	92 (21.6)	159 (37.3)	145 (34.0)	26 (6.1)
PAH	5 (0.5)	218 (21.4)	363 (35.6)	391 (38.4)	42 (4.1)
GCUH	7 (1.0)	167 (24.0)	282 (40.5)	217 (31.2)	23 (3.3)
STATEWIDE	**49 (1.0)**	**1,081 (21.7)**	**1,871 (37.5)**	**1,752 (35.1)**	**233 (4.7)**

Excludes missing/invalid data (0.3%)

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, 26% and TUH, 16%) is reflective of the resident population within these areas and should be noted for service provision and planning.

The proportion of identified Aboriginal and Torres Strait Islander patients requiring a PCI procedure across all sites (7.1%) exceeds the estimated proportion of Aboriginal and Torres Strait Islander people within Queensland (4.6%).[2]

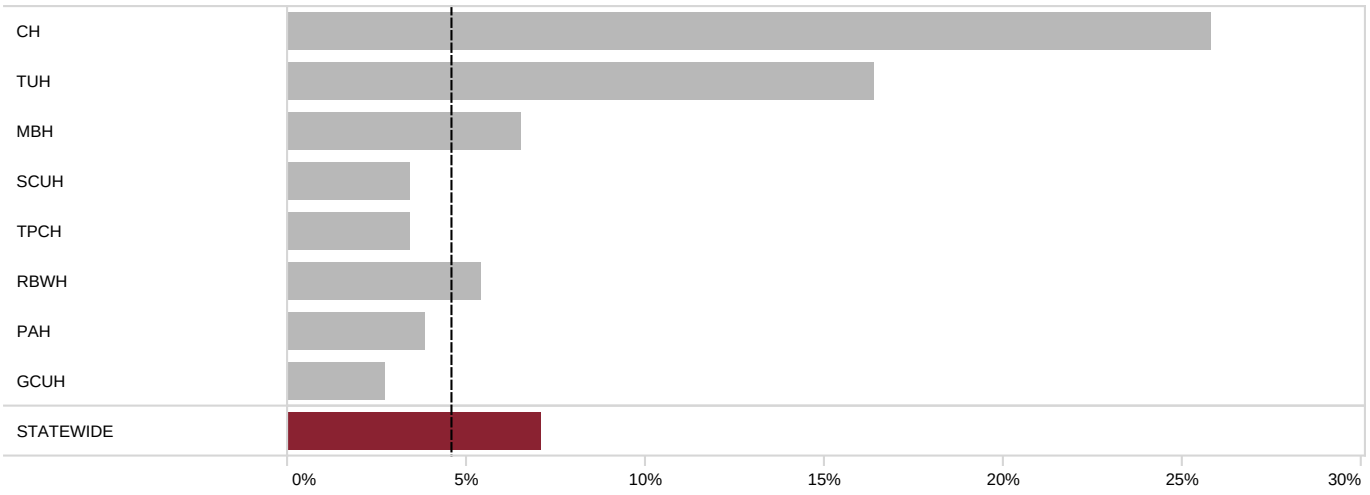


Figure 14: Proportion of all PCI cases by identified Aboriginal and Torres Strait Islander status

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. 66 years).

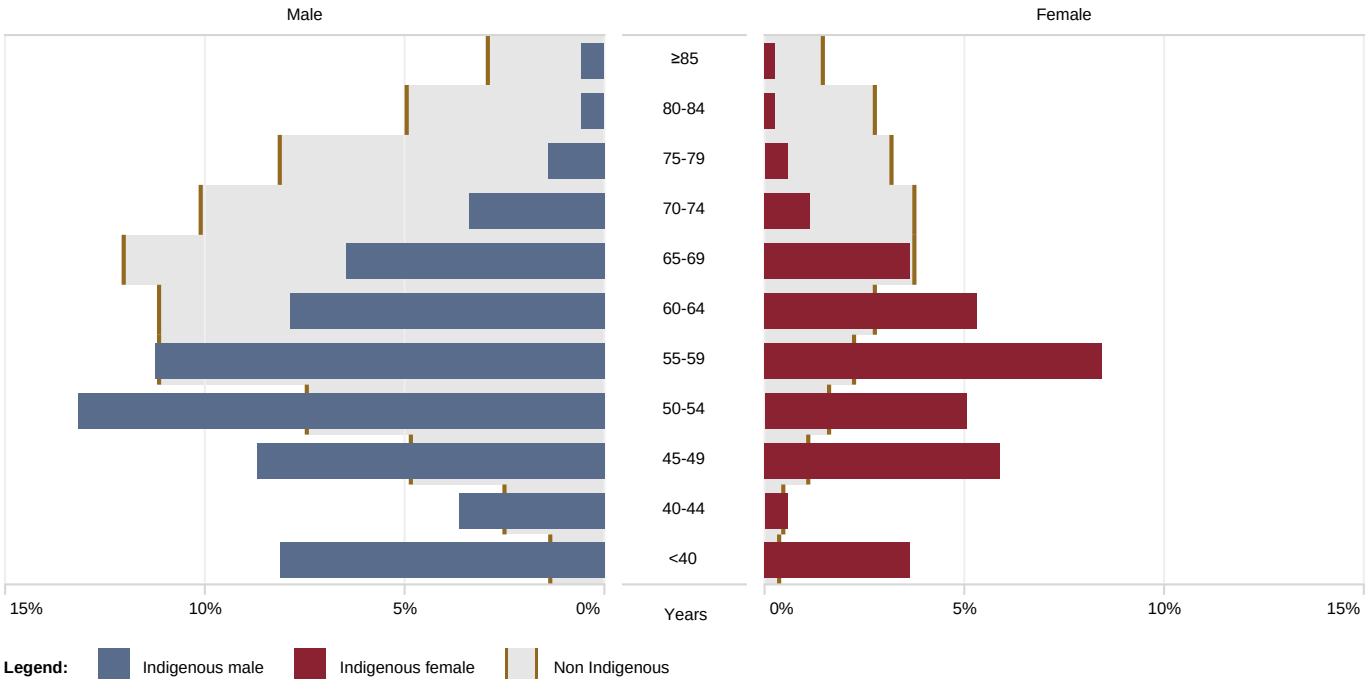


Figure 15: Proportion of all PCI cases by age group and Indigenous status

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

	Male years	Female years	All years
Aboriginal and Torres Strait Islander	54	57	55
Non Aboriginal and Torres Strait Islander	65	69	66
ALL	**64**	**68**	**65**

6 Care and treatment of PCI patients

6.1 Admission status

There were 5,002 PCI procedures performed in 2019 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]

For the 2019 cohort, 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, with CH and RBWH performing approximately 3% of their PCI cases in these exceptional and highly complex clinical scenarios.

The application of the newly developed salvage definition to the 2019 patient cohort saw a slight rise in salvage case numbers compared to the 2018 audit (n=64, 1.3%). Thus, the modestly higher proportion of salvage cases noted during this audit period was to be expected.

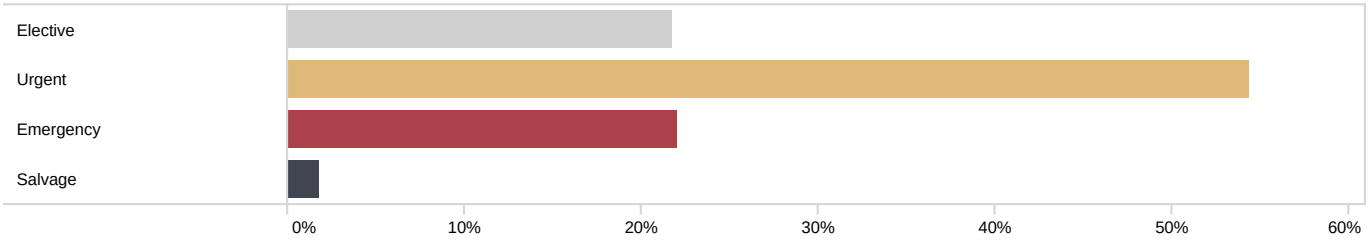


Figure 16: Proportion of all PCI cases by admission status

Table 11: PCI cases by site and admission status

	Elective n (%)	Urgent n (%)	Emergent n (%)	Salvage n (%)
CH	142 (26.5)	300 (56.1)	77 (14.4)	16 (3.0)
TUH	89 (23.9)	217 (58.3)	64 (17.2)	2 (0.5)
MBH	109 (37.2)	141 (48.1)	43 (14.7)	0 (0.0)
SCUH	95 (16.4)	328 (56.6)	149 (25.7)	7 (1.2)
TPCH	303 (28.1)	511 (47.4)	246 (22.8)	18 (1.7)
RBWH	61 (14.3)	269 (63.0)	81 (19.0)	16 (3.7)
PAH	148 (14.5)	607 (59.3)	258 (25.2)	11 (1.1)
GCUH	147 (21.1)	346 (49.7)	186 (26.7)	17 (2.4)
STATEWIDE	**1,094 (21.9)**	**2,719 (54.3)**	**1,104 (22.1)**	**87 (1.7)**

6.2 Access route

6.2.1 All PCI cases

The majority of PCI cases (93%) used a single access route, with 73% of all cases being via the radial approach and 34% 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 (41% to 94%).

Table 12: PCI access route by site

Site	Total PCI cases n	Radial approach %	Femoral approach %	Other approach %
CH	535	77.8	29.2	0.6
TUH	372	73.4	29.0	0.5
MBH	291	83.8	20.6	0.0
SCUH	579	93.8	10.9	1.0
TPCH	1,078	79.3	32.0	0.7
RBWH	427	79.4	32.1	0.2
PAH	1,024	41.4	62.5	0.3
GCUH	696	82.2	26.1	0.0
STATEWIDE	**5,002**	**73.3**	**33.8**	**0.5**

Totals >100% due to multiple access sites

Table 13: PCI total access routes by site

Site	Single approach %	Multiple approaches %
CH	92.5	7.5
TUH	97.0	3.0
MBH	95.5	4.5
SCUH	94.5	5.5
TPCH	88.4	11.6
RBWH	88.3	11.7
PAH	96.0	4.0
GCUH	91.7	8.3
STATEWIDE	**92.6**	**7.4**

There was minimal difference observed in the overall cohort when the STEMI presenting within six hours of symptom onset cohort was examined. However, individual site proportions varied with some sites opting to utilise the femoral approach more frequently and vice versa.

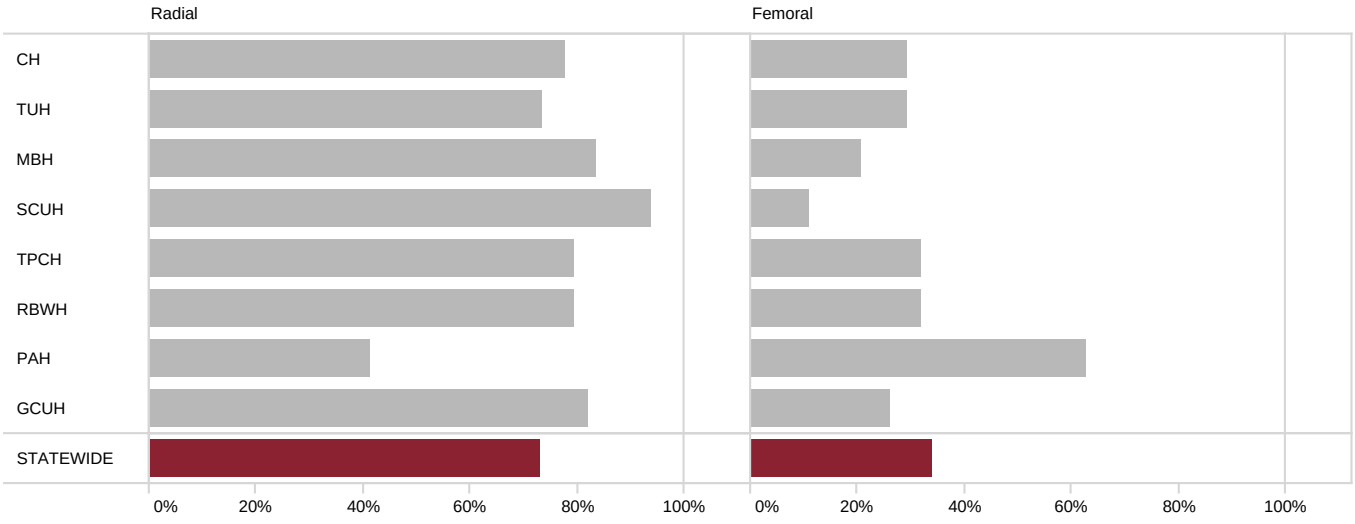


Figure 17: Proportion of PCI cases using radial and femoral access routes by site

6.2.2 Access route for STEMI presenting within six hours of symptom onset

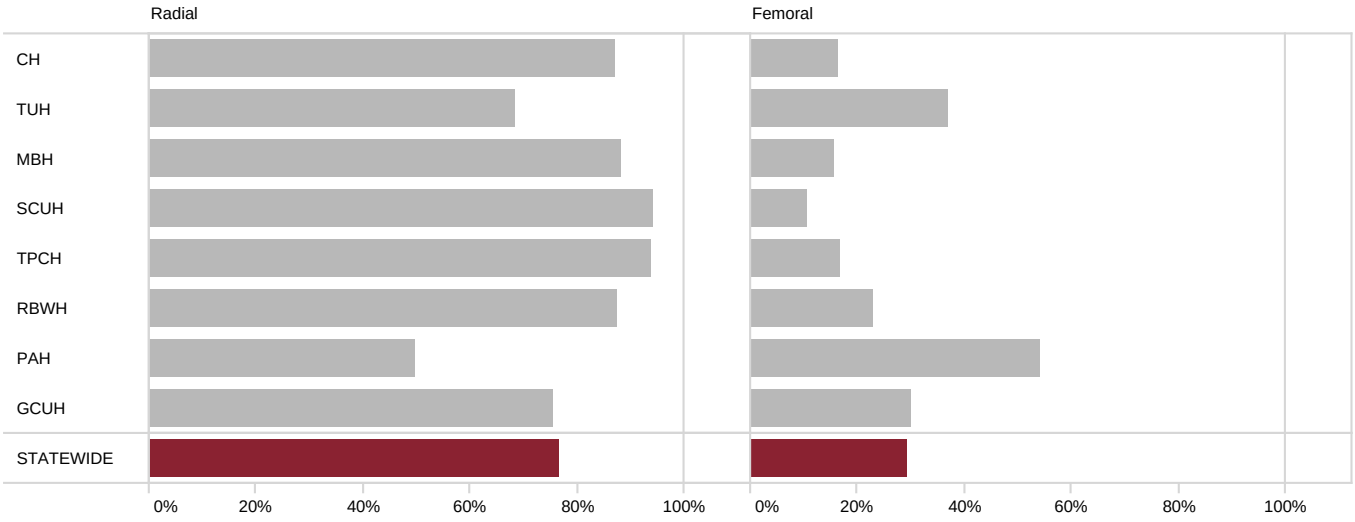


Figure 18: Proportion of STEMI presenting within six hours PCI cases using radial and femoral access routes by site

6.3 Vessels treated

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

Of the vessels treated, 43% of cases involved the left anterior descending coronary artery (LAD), followed by the right coronary artery (RCA) at 38%, the circumflex coronary artery (LCx) at 24% and the left main coronary artery (LMCA) at 3%.

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

Table 14: Grafts and vessels treated by site

Site	LAD %	LMCA %	LCx %	RCA %	Graft %
CH	43.4	1.9	23.4	33.5	5.0
TUH	42.7	2.2	22.6	33.1	5.6
MBH	44.7	1.7	24.6	32.1	2.7
SCUH	45.6	5.0	28.2	36.4	2.9
TPCH	45.8	4.2	23.7	39.9	3.2
RBWH	43.6	1.9	26.2	38.4	2.6
PAH	43.6	3.1	25.0	38.8	2.2
GCUH	44.1	1.9	20.4	40.4	3.3
STATEWIDE	**44.3**	**3.0**	**24.2**	**37.5**	**3.3**

Table 15: Total native vessels treated by site

Site	Single vessel n (%)	Two vessel n (%)	Three vessel n (%)
CH	475 (93.5)	30 (5.9)	3 (0.6)
TUH	332 (94.6)	18 (5.1)	1 (0.3)
MBH	266 (94.0)	17 (6.0)	0 (0.0)
SCUH	476 (84.7)	69 (12.3)	17 (3.0)
TPCH	883 (84.7)	146 (14.0)	14 (1.3)
RBWH	371 (89.2)	42 (10.1)	3 (0.7)
PAH	885 (88.4)	105 (10.5)	11 (1.1)
GCUH	608 (90.3)	59 (8.8)	6 (0.9)
STATEWIDE	**4,296 (88.8)**	**486 (10.0)**	**55 (1.1)**

Excludes any graft PCI (n=165)

Table 16: Grafts treated by site

Site	Graft only n (%)	Graft and one native vessel n (%)
CH	25 (92.6)	2 (7.4)
TUH	20 (95.2)	1 (4.8)
MBH	8 (100.0)	0 (0.0)
SCUH	14 (82.4)	3 (17.6)
TPCH	29 (82.9)	6 (17.1)
RBWH	11 (100.0)	0 (0.0)
PAH	22 (95.7)	1 (4.3)
GCUH	23 (100.0)	0 (0.0)
STATEWIDE	**152 (92.1)**	**13 (7.9)**

6.4 Stent type

There were four different stent types utilised in coronary artery PCI – drug-eluting stents (DES), bare metal stents (BMS), bioresorbable vascular scaffolds (BVS) and covered stents.

Across all centres, there was an average of 1.5 stents used for each of the 4,658 PCI cases involving stent deployment. DES were used in 98% of cases, with some sites using DES exclusively. The proportion of cases utilising DES has increased from previous years (93% and 85% in 2018 and 2017 respectively).

BMS were used in 2% of cases and a BVS or covered stent was used in less than 1% of cases. The remaining 344 PCI cases did not involve stent deployment.

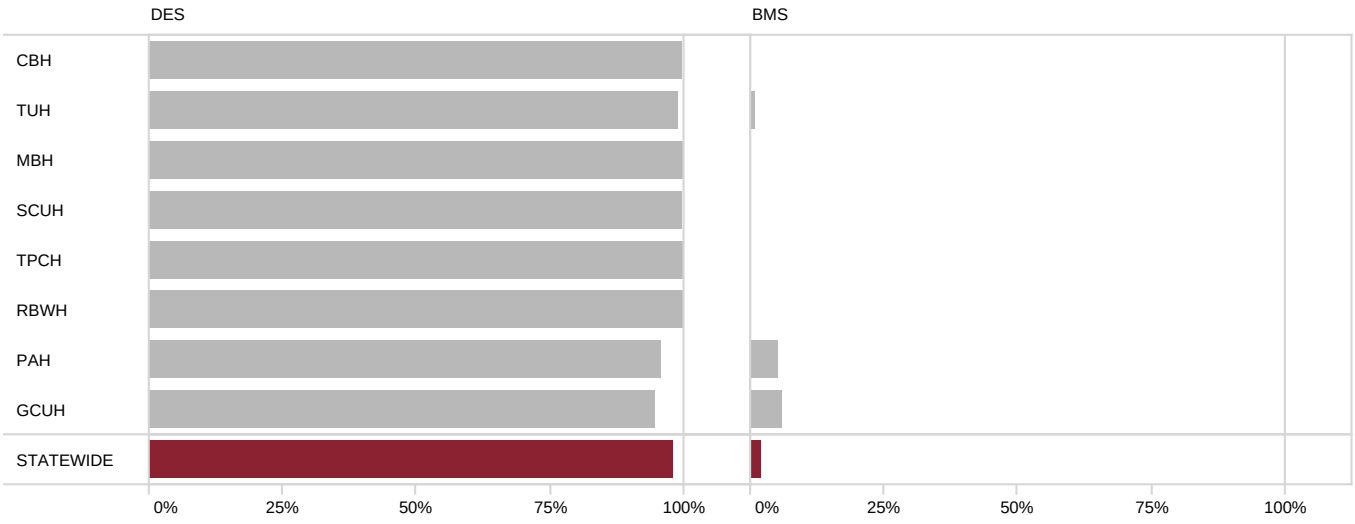


Figure 19: Proportion of stenting cases using DES and BMS

Table 17: PCI cases including at least one stent deployed by site and stent type

	Total cases n	DES %	BMS %	BVS %	Covered stent %	Stents per case mean
CH	461	94.4	0.0	5.4	0.2	1.5
TUH	338	98.8	0.9	0.0	0.3	1.4
MBH	257	100.0	0.0	0.0	0.0	1.3
SCUH	550	99.8	0.0	0.0	0.4	1.7
TPCH	1,006	100.0	0.0	0.0	0.6	1.5
RBWH	407	100.0	0.0	0.0	0.0	1.5
PAH	991	95.8	4.9	0.0	0.1	1.6
GCUH	648	94.8	5.9	0.0	0.3	1.4
STATEWIDE	**4,658**	**97.7**	**1.9**	**0.5**	**0.3**	**1.5**

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 1,488 documented STEMI PCI cases, with over half (53%) presenting as primary PCI cases and 11% presenting after 12 hours (late presenters).

Almost one quarter (24%) of patients had received thrombolysis (lysis) 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 lysis n (%)	Rescue PCI (failed lysis) n (%)
CH	17 (13.7)	55 (44.4)	6 (4.8)	15 (12.1)	23 (18.5)	8 (6.5)
TUH	7 (7.5)	35 (37.6)	4 (4.3)	14 (15.1)	23 (24.7)	10 (10.8)
MBH	2 (3.4)	26 (44.8)	2 (3.4)	8 (13.8)	14 (24.1)	6 (10.3)
SCUH	29 (12.5)	87 (37.5)	18 (7.8)	20 (8.6)	62 (26.7)	16 (6.9)
TPCH	39 (13.9)	130 (46.4)	28 (10.0)	42 (15.0)	35 (12.5)	6 (2.1)
RBWH	12 (11.3)	57 (53.8)	5 (4.7)	11 (10.4)	14 (13.2)	7 (6.6)
PAH	50 (13.0)	176 (45.7)	15 (3.9)	32 (8.3)	86 (22.3)	26 (6.8)
GCUH	23 (11.0)	134 (63.8)	14 (6.7)	14 (6.7)	19 (9.0)	6 (2.9)
STATEWIDE	**179 (12.0)**	**700 (47.0)**	**92 (6.2)**	**156 (10.5)**	**276 (18.5)**	**85 (5.7)**

6.5.2 First medical contact

Most patients with STEMI presented via the Queensland Ambulance Service (QAS) (70%), 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 15% respectively). The remaining 6% presented to other health facilities such as GP clinics, community health centres or any other outpatient setting.

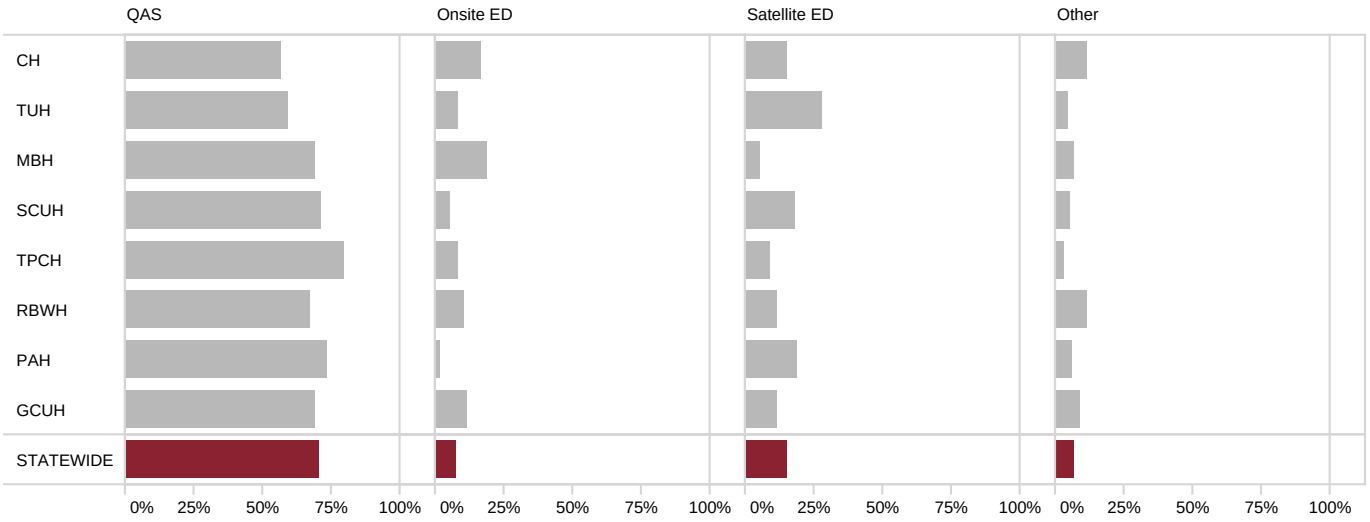


Figure 20: Proportion of STEMI cases by first medical contact

6.5.3 Admission pathway

After first medical contact, 66% of STEMI PCI patients were admitted directly to the treating centre.

As expected, admission pathway varied considerably by STEMI presentation. For lysed and rescue PCI, there were 82% and 73% admitted via interhospital transfer respectively, whereas a large proportion (94%) of the STEMI presenting within six hours of symptom onset cohort presented directly to a PCI facility.

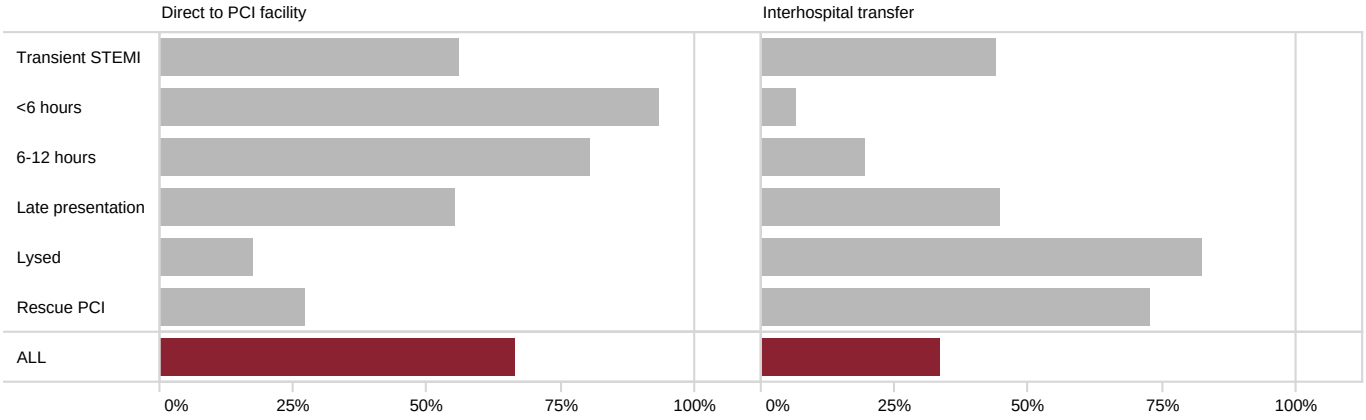


Figure 21: Proportion of STEMI cases by admission pathway and clinical presentation

6.5.4 Thrombolysed patients

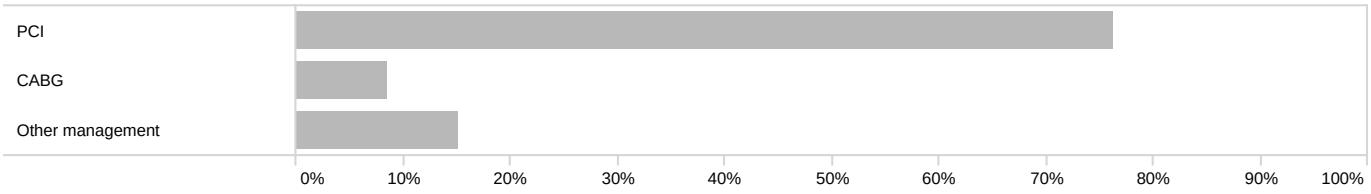
As mentioned above, the method of reperfusion depends on many factors which together determine the treatment method most appropriate for the particular presentation.

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 498 thrombolysed STEMI presentations with the majority (73%) receiving a PCI, which increased to 77% when accounting for subsequent staged interventions within 90 days (Table 20). A smaller proportion (9%) went on to receive coronary artery bypass graft surgery (CABG) at a Queensland Health facility within 90 days.

Table 19: Total lysed STEMI cases by tertiary cardiac centre

Site	Total lysed STEMIs n	Receiving a PCI n (%)	Proportion of all PCI cases %
CH	44	31 (70.5)	5.8
TUH	44	33 (75.0)	8.9
MBH	28	20 (71.4)	6.8
SCUH	111	78 (70.3)	13.5
TPCH	52	41 (78.8)	3.8
RBWH	32	21 (65.6)	4.9
PAH	154	112 (72.7)	10.9
GCUH	33	25 (75.8)	3.6
STATEWIDE	**498**	**361 (72.5)**	**7.2**



PCI and CABG revascularisation not displayed (0.2%)

Figure 22: Proportion of lysed patients by clinical management

Table 20: Total lysed patients by revascularisation method within 90 days

	PCI %	CABG %	PCI + CABG %	Other management* %
CH	72.1	14.0	0.0	14.0
TUH	78.6	7.1	0.0	14.3
MBH	84.6	0.0	0.0	15.4
SCUH	75.7	7.2	0.0	17.1
TPCH	76.9	7.7	1.9	13.5
RBWH	71.0	3.2	0.0	25.8
PAH	76.9	12.2	0.0	10.9
GCUH	75.8	3.0	0.0	21.2
ALL	**76.3**	**8.5**	**0.2**	**15.1**

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

Overall, there were 498 lysed STEMI patients who reached a public hospital CCL site in 2019. Substantially improved data quality this year sees 75% of this cohort eligible for analysis compared to 54% in 2018.

Reassuringly, the median time from FdECG to thrombolysis was similar across the patients receiving pre-hospital thrombolysis by QAS and the patients who presented directly to the thrombolysis facility (34 minutes vs. 36 minutes).

The patients in the other thrombolysis group took a median of 79 minutes from FdECG to thrombolysis. This included a median 41 minute travel component, representative of the time taken to arrive at the thrombolysis facility.

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 lysed STEMI cases by thrombolysis administration pathway

	Total lysed STEMIs n	Total analysed n	Median FdECG to thrombolysis minutes	Interquartile range minutes
QAS pre-hospital thrombolysis	168	160	33.5	26–43
Presented and lysed at ED	179	130	31	22–50
Other pre-hospital thrombolysis*	10	0	N/A	N/A
All others†	141	83	70	36–100
ALL	**498**	**373**	**35**	**25–55**

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

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

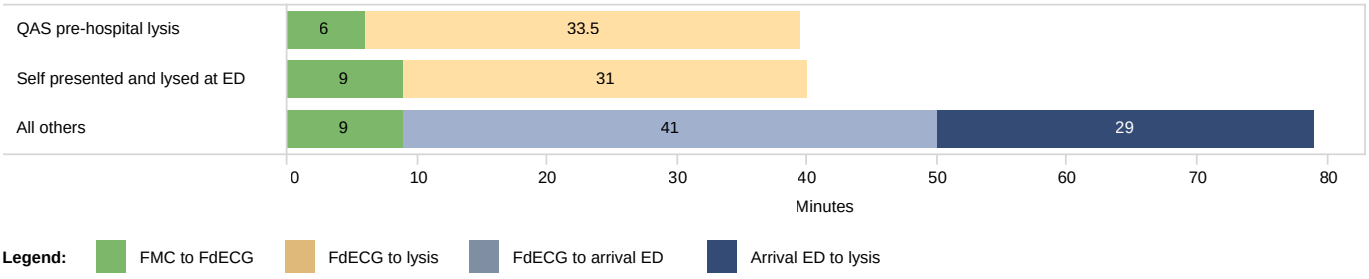


Figure 23: Time delays to thrombolysis therapy by administration pathway

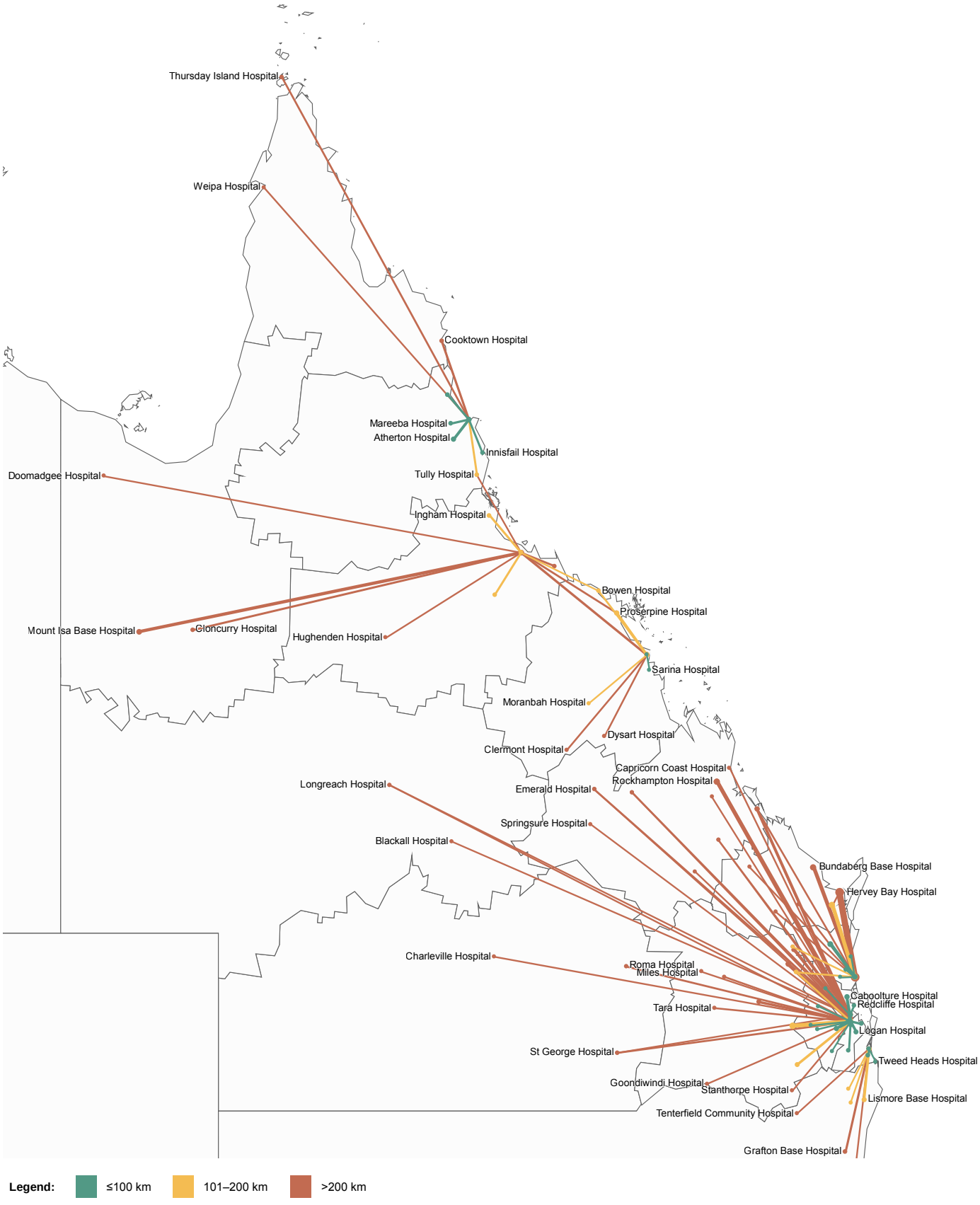


Figure 24: Thrombolysed STEMI interhospital transfers by estimated distance to transfer

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

Approximately one quarter (28%) of lysed STEMI patients were not indicated for pre-hospital thrombolysis. Most commonly, these patients had been located within close proximity to a hospital (46%). A smaller proportion were contraindicated for pre-hospital thrombolysis due to advanced age (›75 years) (18%), significant other comorbidity or complex clinical presentation (Table 23).

For the cohort of thrombolysed patients, the median time to angiography was 22 hours post thrombolysis with 52% of patients undergoing coronary angiography within 24 hours. The unadjusted all-cause mortality rate within 30 days for STEMI patients receiving thrombolysis is 2.2%.

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

	n (%)
Close proximity to hospital	63 (46.0)
Patient age (›75 years)	25 (18.2)
Hypertensive	13 (9.5)
No consistent ST elevation	9 (6.6)
Prolonged pain duration ›6 hours	6 (4.4)
Patient pain free	5 (3.6)
GCS* ‹15	4 (2.9)
CPR ›10 minutes	3 (2.2)
Head trauma	2 (1.5)
Suspected aortic dissection	1 (0.7)
Blood clotting disorder	1 (0.7)
Recent surgery	1 (0.7)
Other	4 (2.9)
ALL	**137 (100.0)**

Excludes missing data (n=4)

* 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	44	44	21	7–31	52.3
TUH	44	34	22	5–52	40.9
MBH	28	26	16	7–25	67.9
SCUH	111	108	19	6–28	66.7
TPCH	52	30	24	12–32	32.7
RBWH	32	28	22	10–31	46.9
PAH	154	153	25	10–44	48.7
GCUH	33	26	14	5–24	54.5
STATEWIDE	**498**	**449**	**22**	**7–35**	**52.0**

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

	Total cases n	Total salvage n (%)	In lab death n	In hospital death n	Total mortality n (%)
Lysed	413	6 (1.5)	1	3	4 (1.0)
Rescue PCI	85	6 (7.1)	1	8	7 (8.2)
ALL	**498**	**12 (2.4)**	**2**	**9**	**11 (2.2)**

6.6 NSTEMI presentations

Of all PCI and coronary cases performed in CCLs during 2019, there were 3,185 coded with a procedural indication of NSTEMI. These cases accounted for 30% of all PCI cases across all centres, with site variation ranging from 21% to 41%. These figures are similar across the previous 2018 cohort of patients.

Of patients presenting with NSTEMI, 47% were revascularised via PCI, which increased to 51% when accounting for staged interventions within 90 days of index presentation (Table 27). A further 16% 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	350	202 (57.7)	37.8
TUH	240	94 (39.2)	25.3
MBH	135	60 (44.4)	20.5
SCUH	330	147 (44.5)	25.4
TPCH	648	294 (45.4)	27.3
RBWH	333	173 (52.0)	40.5
PAH	808	374 (46.3)	36.5
GCUH	341	157 (46.0)	22.6
STATEWIDE	**3,185**	**1,501 (47.1)**	**30.0**

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

Site	PCI revascularisation %	CABG revascularisation %	PCI + CABG revascularisation %	Other management* %
CH	62.0	14.7	1.3	22.0
TUH	43.9	13.2	0.4	42.5
MBH	49.2	10.6	0.0	40.2
SCUH	49.7	16.8	0.6	32.9
TPCH	48.4	13.0	0.3	38.2
RBWH	57.5	10.2	0.3	31.9
PAH	50.1	21.3	0.3	28.3
GCUH	49.4	12.7	0.0	37.9
STATEWIDE	**51.2**	**15.2**	**0.4**	**33.2**

* 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 (54% and 46% 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 this Audit.

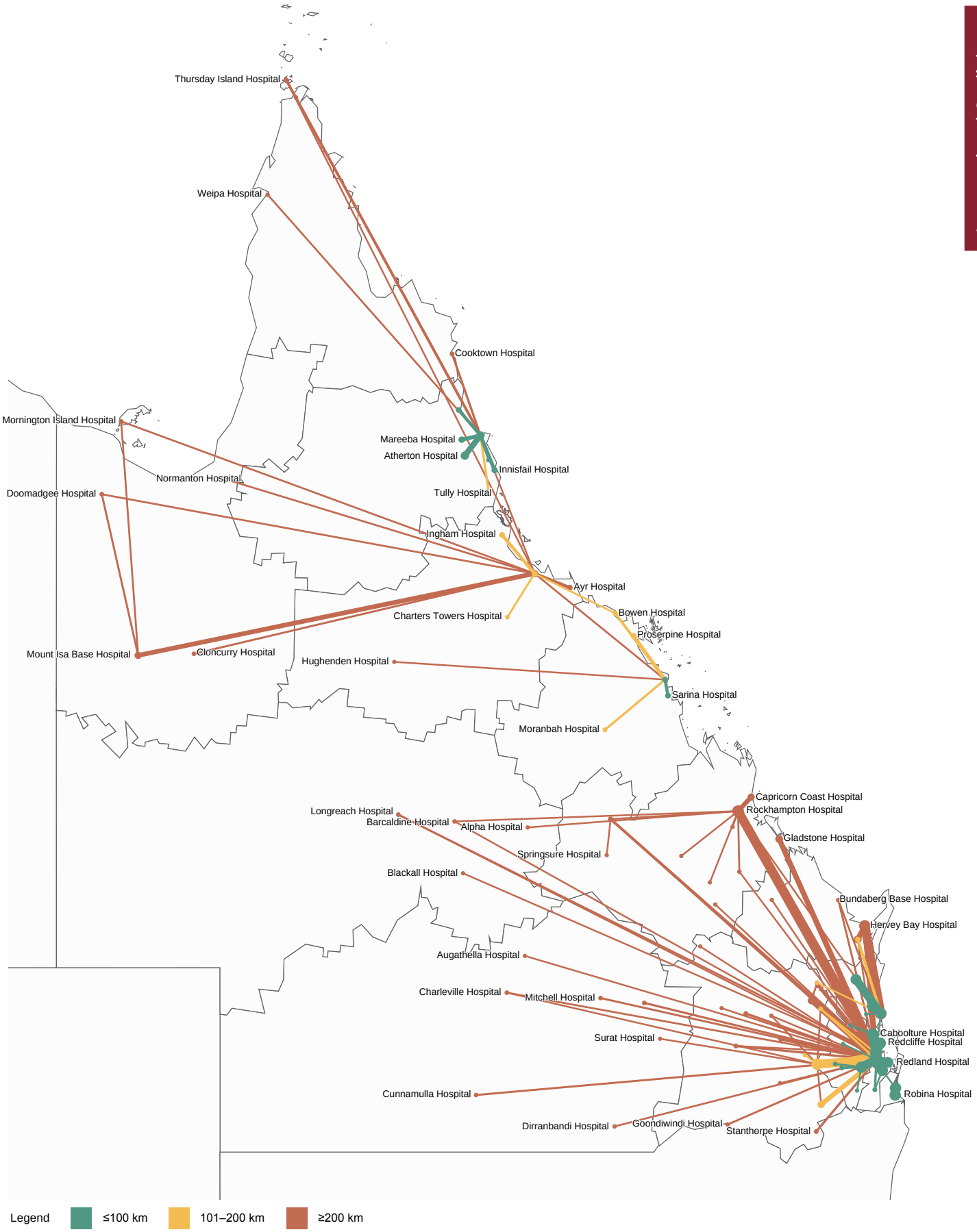
Considerable variation was observed between sites, with the proportion of interhospital transfers for NSTEMI ranging from 35% to 72%, largely explained by catchment area. Where higher volumes and larger median distances to PCI centres exist, it is reasonable to expect that the proportion of cases meeting targets would be smaller. Table 29 and Figure 25 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	218 (62.3)	132 (37.7)
TUH	155 (64.6)	85 (35.4)
MBH	85 (63.0)	50 (37.0)
SCUH	146 (44.2)	184 (55.8)
TPCH	336 (51.9)	312 (48.1)
RBWH	103 (30.9)	230 (69.1)
PAH	229 (28.3)	579 (71.7)
GCUH	198 (58.1)	143 (41.9)
STATEWIDE	**1,470 (46.2)**	**1,715 (53.8)**

Table 29: NSTEMI interhospital transfers by estimated distance to transfer

Site	Total analysed n	Median kilometres	Interquartile range kilometres
CH	99	93	75–93
TUH	61	779	199–901
MBH	38	125	36–191
SCUH	156	93	30–209
TPCH	257	82	39–535
RBWH	201	281	45–611
PAH	466	40	24–122
GCUH	78	17	17–17
STATEWIDE	**1,356**	**90**	**27–240**



Excludes interstate transfers due to incomplete referring facility data

Figure 25: NSTEMI interhospital transfers by estimated distance to transfer

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 2019 was 2.2%. This result compares favourably with the 30 day mortality rate of 2.8% presented by the British Cardiovascular Interventional Society (BCIS) in their review of PCI outcomes for the 2014 calendar year (chosen as the comparator as BCIS reports in subsequent years have given in-hospital rather than 30 day mortality).[5]

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 48% 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	535	0 (0.0)	5 (1.7)	2 (2.6)	8 (50.0)	15 (2.8)
TUH	372	0 (0.0)	1 (0.5)	2 (3.1)	1 (50.0)	4 (1.1)
MBH	291	0 (0.0)	1 (0.7)	1 (2.3)	–	2 (0.7)
SCUH	579	0 (0.0)	4 (1.2)	8 (5.4)	5 (71.4)	17 (2.9)
TPCH	1,078	0 (0.0)	5 (1.0)	8 (3.3)	9 (50.0)	22 (2.0)
RBWH	427	0 (0.0)	4 (1.5)	1 (1.2)	8 (50.0)	13 (3.0)
PAH	1,024	0 (0.0)	3 (0.5)	13 (5)	4 (36.4)	20 (2.0)
GCUH	696	0 (0.0)	3 (0.9)	5 (2.7)	7 (41.2)	15 (2.2)
STATEWIDE	**5,002**	**0 (0.0)**	**26 (1.0)**	**40 (3.6)**	**42 (48.3)**	**108 (2.2)**

Figure 26 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.[6] 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 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 0.0%–3.7% 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 27 presents the observed and expected mortality rates excluding salvage.

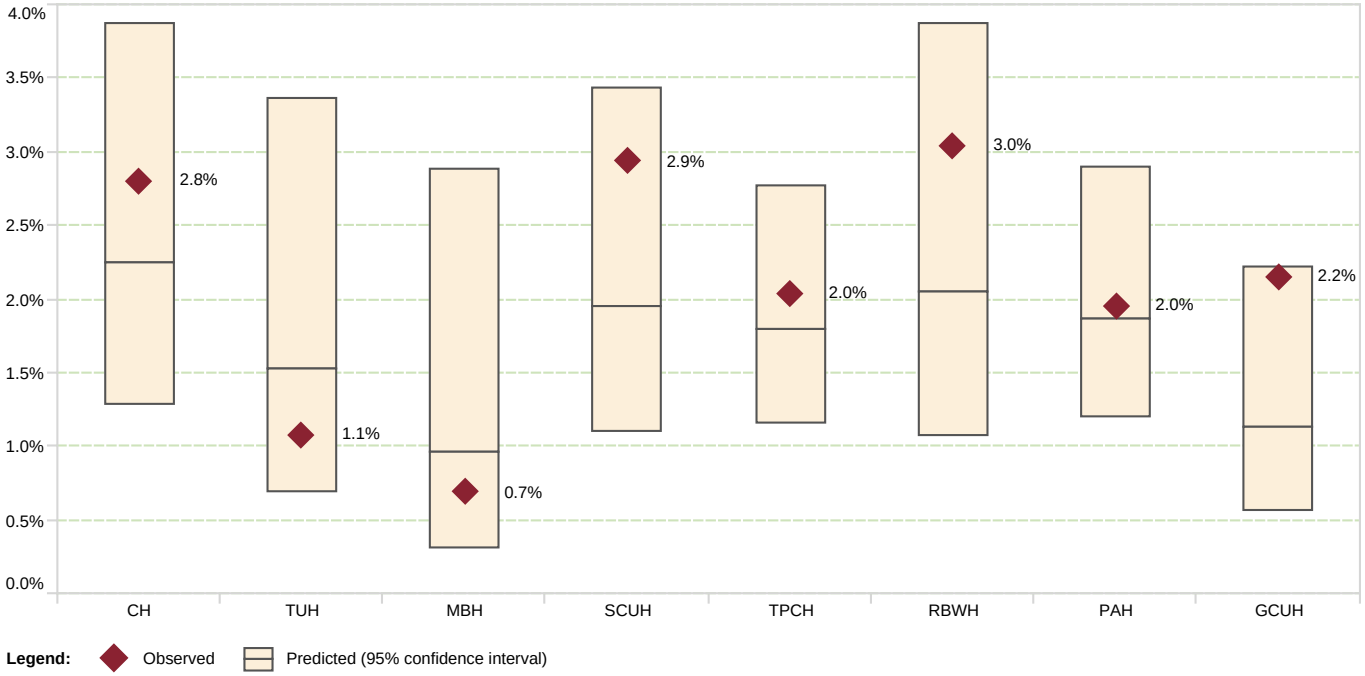
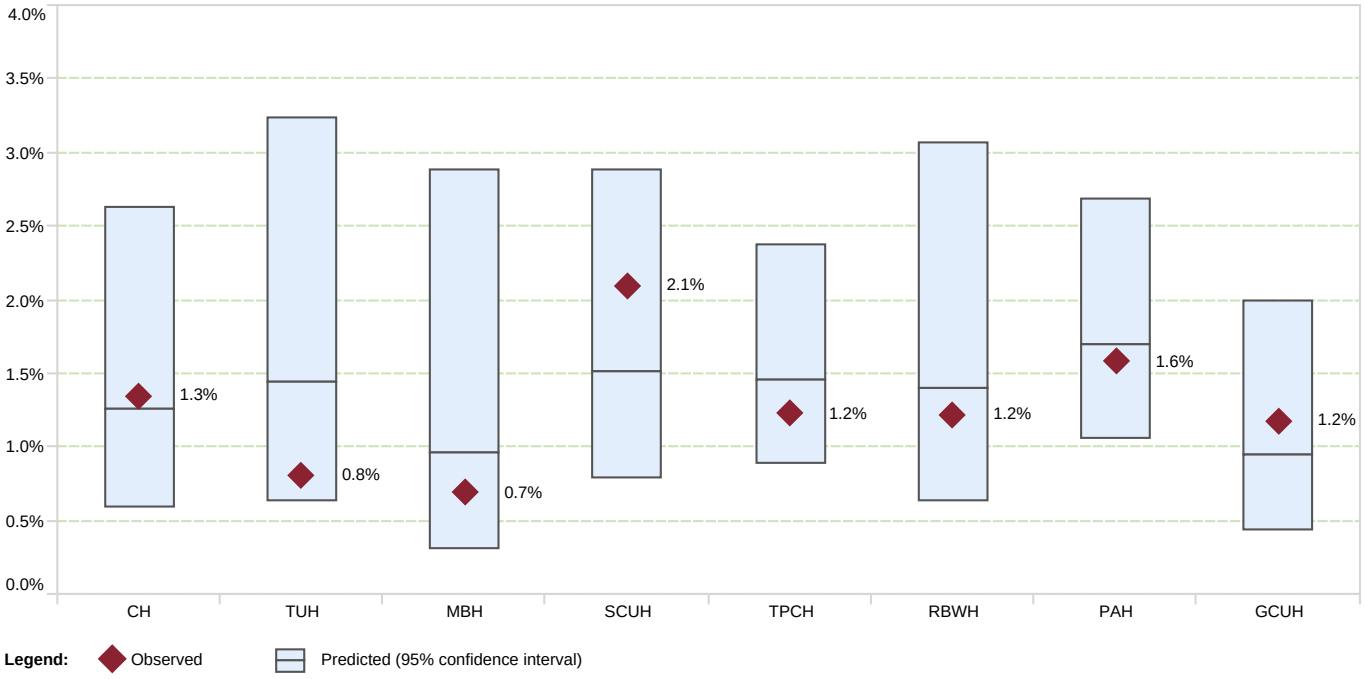


Figure 26: Comparison of observed and predicted mortality rates by site

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[8]. 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=87)

Figure 27: 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 1,867 documented STEMI cases in 2019, 1,488 cases (80%) 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 1.7% to 4.0% between participating centres with a statewide rate of 2.9%. Of these 1,429 patients analysed, a total of 42 mortalities were identified with the majority (79%) 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	2	1	110	3 (2.7)
TUH	0	2	0	91	2 (2.2)
MBH	0	1	0	58	1 (1.7)
SCUH	0	7	2	226	9 (4.0)
TPCH	0	8	1	270	9 (3.3)
RBWH	0	1	1	97	2 (2.1)
PAH	0	9	1	375	10 (2.7)
GCUH	1	3	2	202	6 (3.0)
STATEWIDE	**1**	**33**	**8**	**1,429**	**42 (2.9)**

* Excluding salvage cases (n=59)

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 3.2%.

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	1	46	1 (2.2)
TUH	0	2	0	34	2 (5.9)
MBH	0	1	0	26	1 (3.8)
SCUH	0	0	1	84	1 (1.2)
TPCH	0	4	0	124	4 (3.2)
RBWH	0	1	0	53	1 (1.9)
PAH	0	7	1	172	8 (4.7)
GCUH	1	2	0	127	3 (2.4)
STATEWIDE	**1**	**17**	**3**	**666**	**21 (3.2)**

* Excluding salvage cases (n=34)

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[9]. 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 84% 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.

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

Site	Total cases n	Proportion of total cases %
CH	9	1.7
TUH	6	1.6
MBH	4	1.4
SCUH	11	1.9
TPCH	18	1.7
RBWH	10	2.3
PAH	40	3.9
GCUH	22	3.2
STATEWIDE	**120**	**2.4**

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	**120**	**4**	**14**	**1**	**19 (15.8)**

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 first diagnostic ECG (FdECG)-to-device time as an important modifiable and objective measure of overall STEMI system performance.[10]

Both the European and American STEMI guidelines recommend a target FdECG-to-device time less than 90 minutes.[10,11] 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 cardiac catheter laboratory, 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

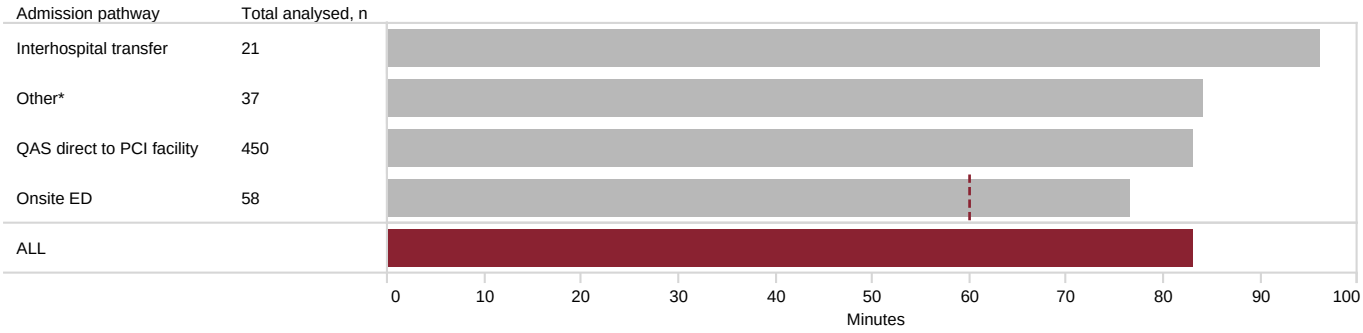
Time	Definition
First diagnostic ECG	First diagnostic ECG refers to the timestamp when the ECG shows ST-segment elevation (or equivalent) and can be regarded as time zero in the therapeutic pathway. The interpretation of the first diagnostic ECG may be undertaken by ambulance personnel, general practitioners 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) 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)[12]

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

In total, there were 700 STEMI primary PCI cases presenting within six hours of symptom onset. Of these, there were 134 cases which had been excluded per the criteria in Table 37 leaving 566 cases which are eligible for the following analysis.

As observed in previous annual reports, there was considerable variation in time from first diagnostic ECG to reperfusion depending on the admission pathway to the treating facility, ranging from 96 minutes to 58 minutes for interhospital transfers and PCI facility on site ED respectively.



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

Figure 28: 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	34
Out-of-hospital arrest	33
Thrombolysis contraindicated	21
Previous coronary artery bypass graft surgery	12
Significant comorbidities/frailty	12
Unsuccessful PCI	10
Intubation	6
Shock/acute pulmonary oedema	4
Missing data	2
Total ineligible	**134**

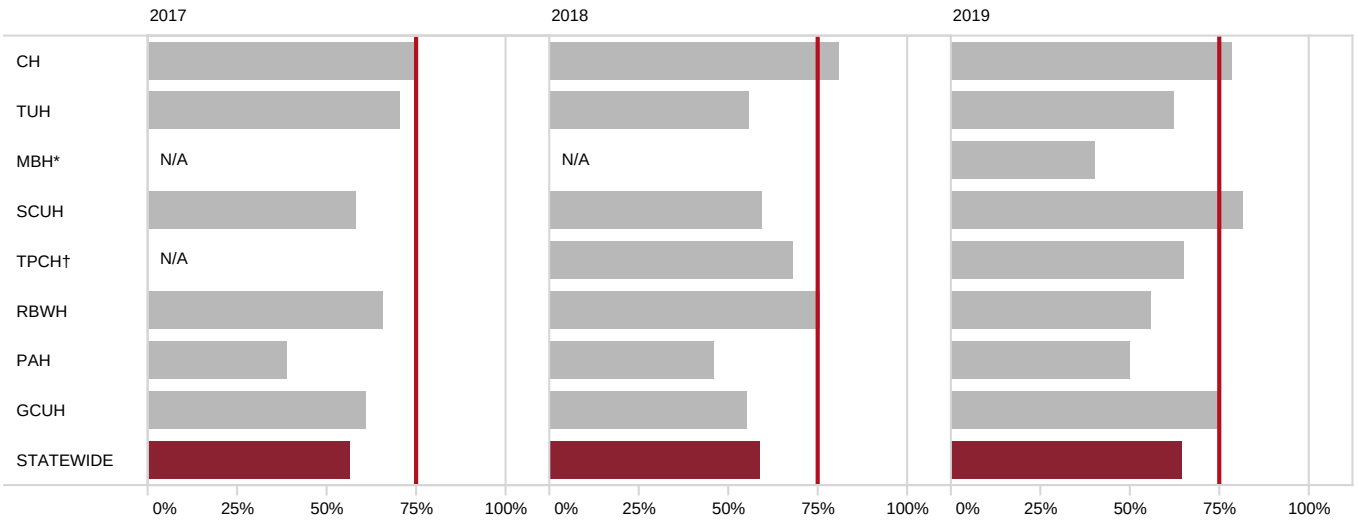
7.2.1 Time from first diagnostic ECG to first device

The all-site median time from first diagnostic ECG to reperfusion was 83 minutes, with median individual site times ranging from 73 minutes to 98 minutes. These results indicate that overall Queensland public facilities are approaching the ambitious benchmark of 90 minutes from time of first diagnostic ECG to first device. However, only 65% of patients analysed receive timely reperfusion per current guidelines (FdECG to reperfusion)[11], 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	42	73	63–89	78.6
TUH	35	24	75	70–118	62.5
MBH	26	25	98	79–125	40.0
SCUH	87	66	79	68–86	81.8
TPCH	130	113	84	75–99	65.5
RBWH	57	50	85	68–101	56.0
PAH	176	134	91	75–106	50.0
GCUH	134	112	79	68–90	75.0
STATEWIDE	**700**	**566**	**83**	**71–99**	**64.5**



* MBH results are not displayed for 2017 and 2018 due to less than 20 cases for analysis

† TPCH data collection extended to include first diagnostic ECG timestamps in 2018

Figure 29: Proportion of STEMI cases (presenting within six hours of symptom onset) where time from first diagnostic ECG to reperfusion met 90 min target, 2017–2019

7.2.1.1 Pre-hospital notification processes

The QAS has a well-established process for the management of STEMI in the pre hospital setting. All QAS paramedics are skilled in STEMI identification and pre-hospital reperfusion treatment. Advanced Care Paramedics (ACPs) are trained in 12-lead ECG acquisition and interpretation, decision-supported direct referral for pPCI, and decision supported administration of pre-hospital fibrinolysis. Critical Care Paramedics (CCPs) are authorised to perform direct pPCI referral and pre-hospital thrombolysis administration autonomously.

On recognition of prehospital STEMI that may be eligible for pPCI, paramedics utilise a dedicated telephone line to make direct contact with the on-call interventional cardiologist at the receiving PCI hospital to refer the patient. A pre-hospital treatment plan is agreed upon and, if pPCI is appropriate, the CCL is activated.

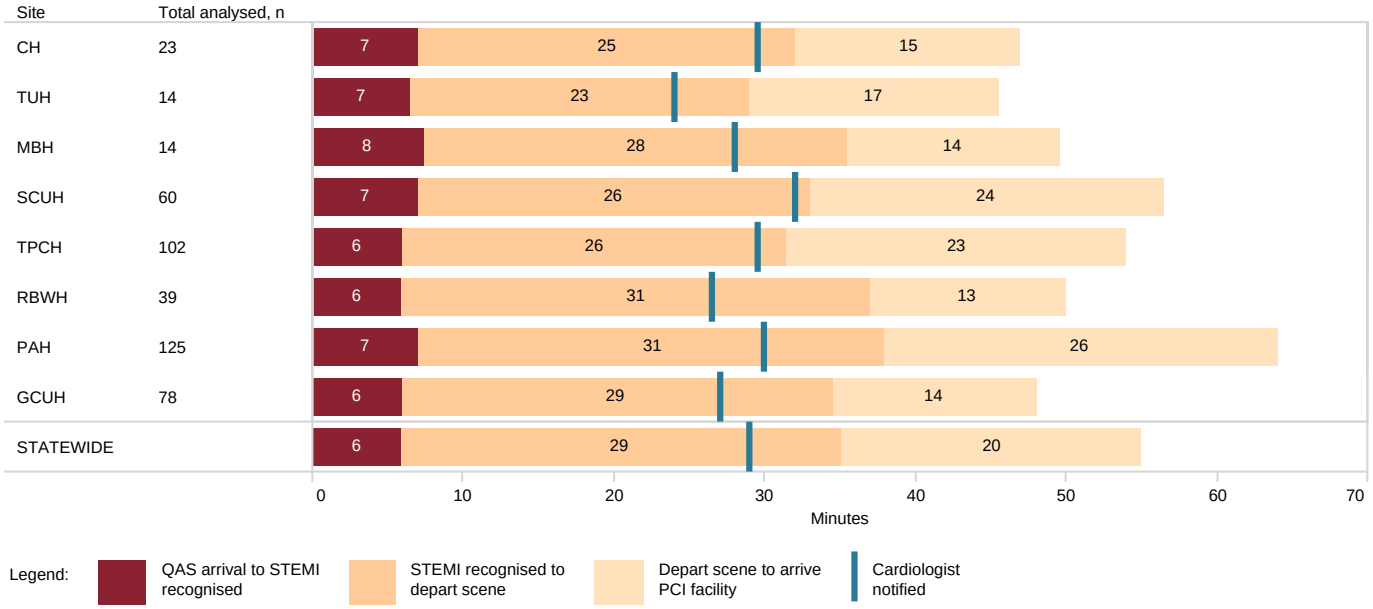


Figure 30: STEMI presenting within six hours of symptom onset pre-hospital component breakdown – QAS direct to PCI facility

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.

Although differing processes may explain some variation, this would appear to have minimal impact. When exploring door-to-device times in the following section, all sites were similar in the time taken to treat patients once they arrived at the PCI capable facility.

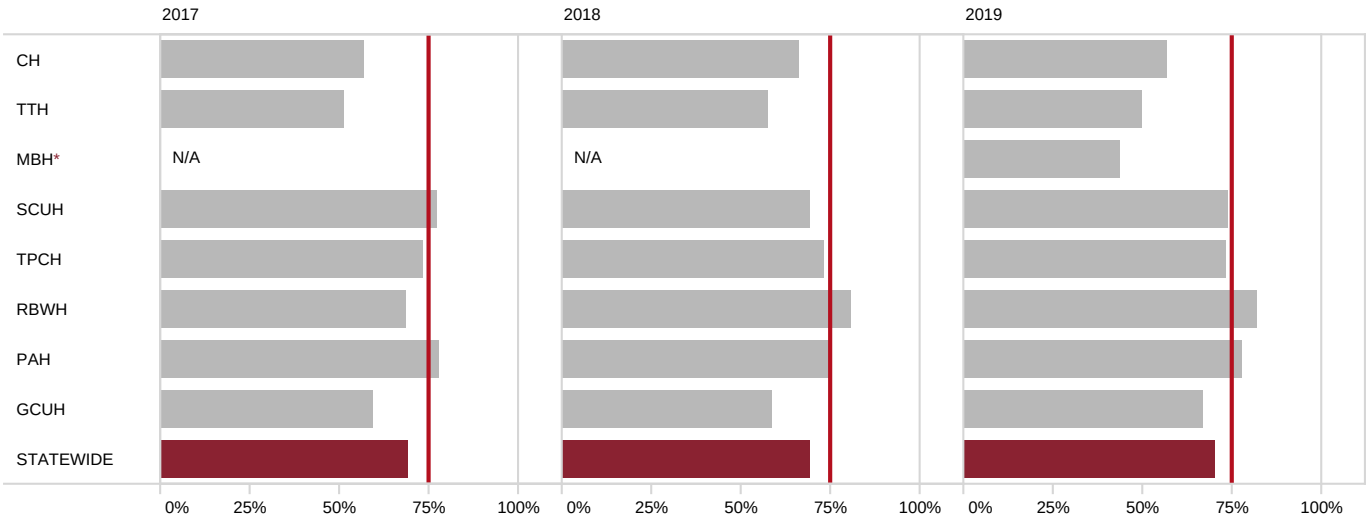
7.2.2 Time from arrival PCI capable facility to first device

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.[10,11]

Results demonstrate that for over two thirds of cases (71%), participating PCI facilities are meeting a target door-to-device time of less than 60 minutes, with an overall statewide median time of 42 minutes (ranging from 37 minutes to 64 minutes across sites).

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	42	54	31–80	57.1
TUH	35	24	59	32–88	50.0
MBH	26	25	64	40–104	44.0
SCUH	87	66	38	29–62	74.2
TPCH	130	113	39	29–61	73.5
RBWH	57	50	43	29–57	82.0
PAH	176	134	37	27–55	78.4
GCUH	134	112	45	32–79	67.0
STATEWIDE	**700**	**566**	**42**	**29–69**	**70.7**



* MBH results are not displayed for 2017 and 2018 due to less than 20 cases for analysis

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, 2017–2019

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.[13]

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 achieving this target is the time taken to transfer patients from non PCI capable facilities to the accepting PCI centre. Multiple reasons for delays include capacity constraints and patient transfer logistics in a large geographic area. Many of these factors are more complicated to improve than changes in practice or departmental efficiency. Overall, the figures for 2017 and 2018 (when high sensitivity troponin assays were increasingly used) are broadly similar, suggesting only a minor impact on clinicians' approach to truly high-risk cases.

Table 40 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 40: NSTEMI time to angiography – cases excluded from analysis

	n
Planned or staged PCI	153
Admitted with an unrelated principal diagnosis	148
Transferred from an interstate hospital	55
Coronary angiography not performed at index admission	41
Transferred from a private hospital	36
Stable non admitted patients transferred directly to lab for planned angiography	12
Incomplete data	94
Total ineligible	**539**

Patients presenting directly to a PCI capable facility had a median wait to coronary angiography time of 42 hours and were more likely to have angiography performed within the target timeframe of 72 hours compared with interhospital transfers (74% vs. 46%).

For direct presenters, the wide range of 20 hours to 73 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 2018, there was for direct presenters (Table 41) a modest increase in analysable NSTEMI cases (1,290 vs. 1,227) and a similar proportion meeting target (74%). While for interhospital transfers (Table 42), there was an increase in analysable cases (1,356 vs. 1,251) and slight reduction in the proportion meeting target (46% vs. 50%).

Table 41: Time to angiography – direct to PCI facility

SITE	Total cases n	Total analysed n	Median hours	Interquartile range hours	Met 72 hour target %
CH	218	178	63	27–107	55.6
TUH	155	141	46	24–68	75.9
MBH	85	78	37	17–57	87.2
SCUH	146	133	43	21–67	78.2
TPCH	336	303	31	16–65	80.5
RBWH	103	82	28	19–57	82.9
PAH	229	191	46	20–83	69.6
GCUH	198	184	43	22–77	72.8
STATEWIDE	**1,470**	**1,290**	**42**	**20–73**	**74.2**

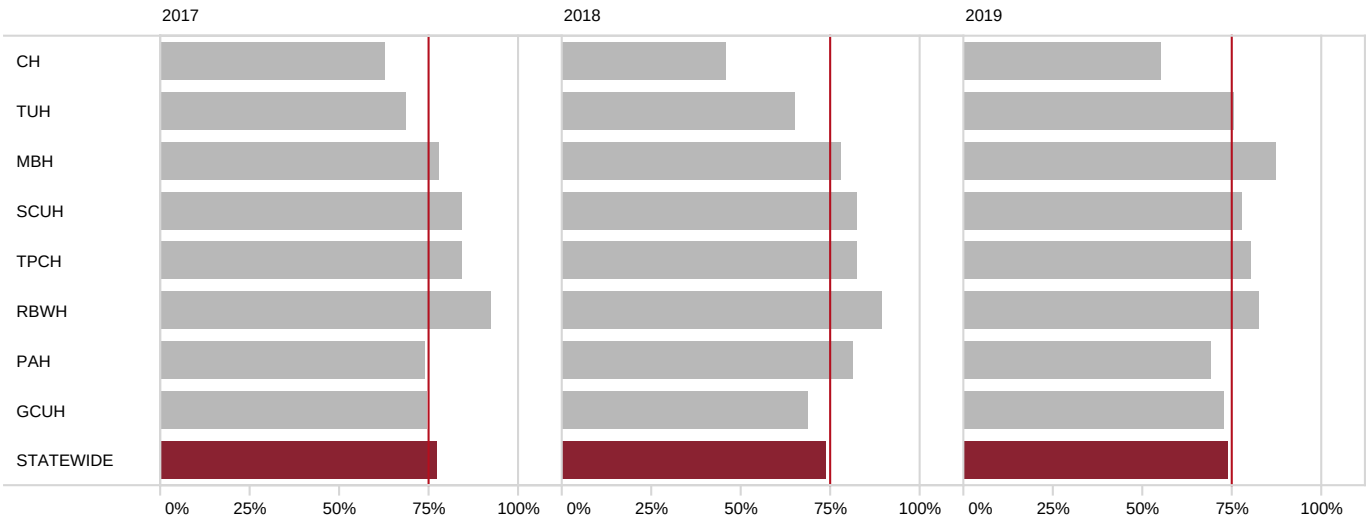


Figure 32: Proportion of NSTEMI direct presenters receiving angiography within 72 hours, 2017–2019

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.

Table 42: Time to angiography – interhospital transfers

Site	Total cases n	Total analysed n	Median hours	Interquartile range hours	Met 72 hour target %
CH	132	99	88	57–124	38.4
TUH	85	61	67	39–96	55.7
MBH	50	38	39	25–64	78.9
SCUH	184	156	48	29–71	76.9
TPCH	312	257	98	57–157	34.6
RBWH	230	201	89	54–122	38.3
PAH	579	466	83	50–125	40.3
GCUH	143	78	65	41–93	65.4
STATEWIDE	**1,715**	**1,356**	**76**	**45–121**	**46.2**

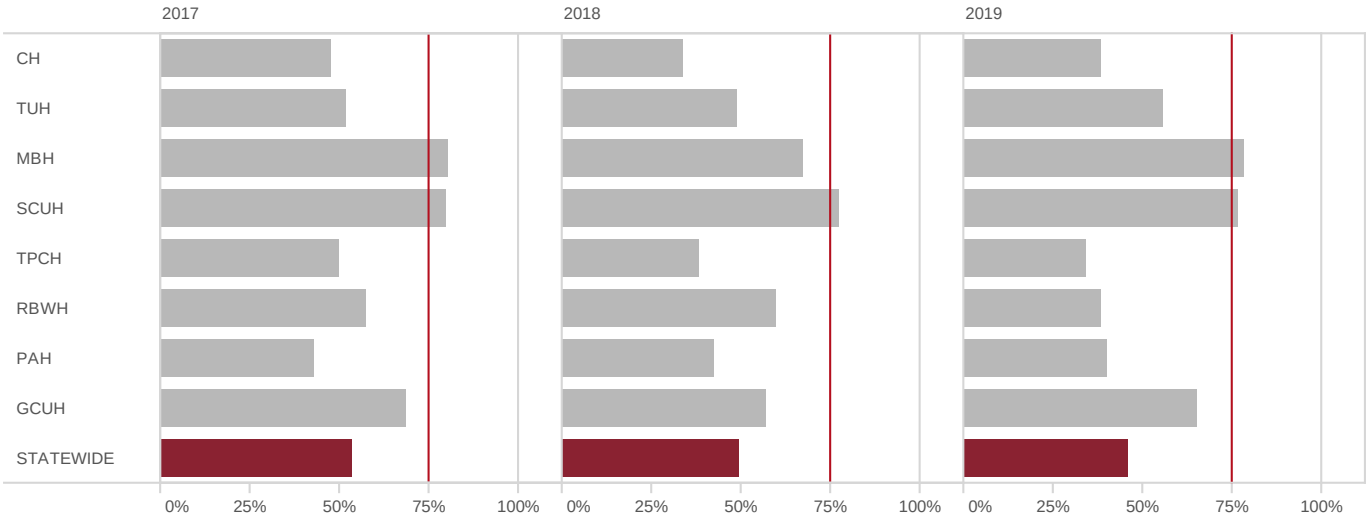


Figure 33: Proportion of NSTEMI interhospital transfers receiving angiography within 72 hours, 2017–2019

Of the 3,185 total NSTEMI cases, 54% were interhospital transfers and 48% received PCI. The median time to angiography with or without PCI was 60 hours.

Table 43: 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	350	277	37.7	72	37–117	49.5
TUH	240	202	35.4	48	27–83	69.8
MBH	135	116	37.0	38	19–58	84.5
SCUH	330	289	55.8	45	25–70	77.5
TPCH	648	560	48.1	59	24–109	59.5
RBWH	333	283	69.1	71	36–114	51.2
PAH	808	657	71.7	73	42–116	48.9
GCUH	341	262	41.9	48	25–82	70.6
STATEWIDE	**3,185**	**2,646**	**53.8**	**60**	**30–99**	**59.9**

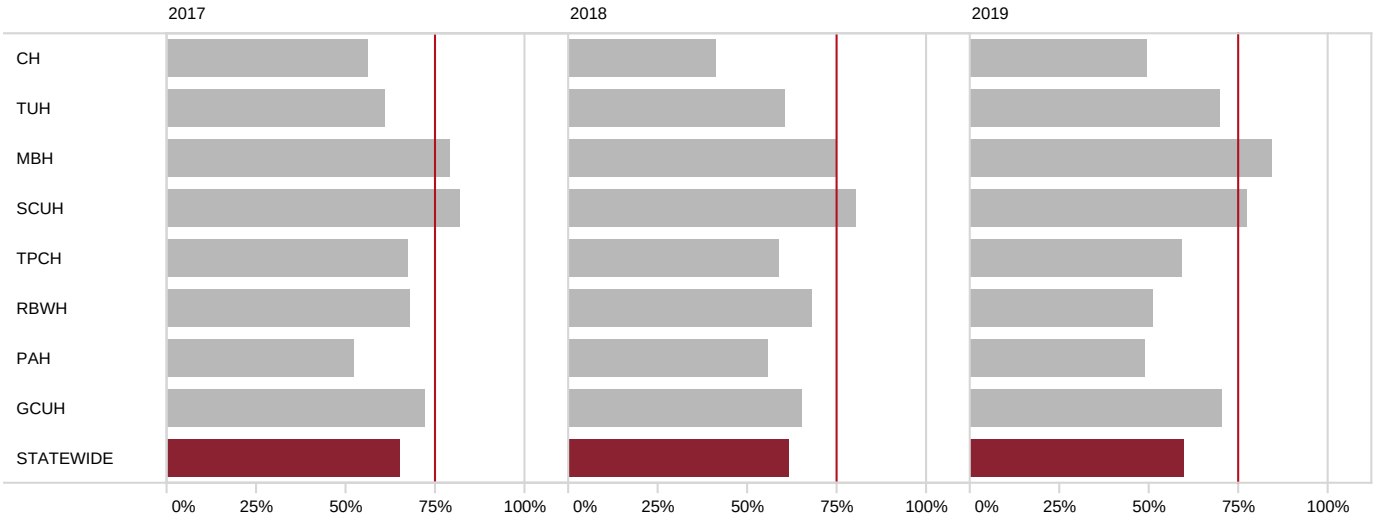


Figure 34: Proportion of NSTEMI cases meeting time to angiography target of 72 hours, 2017–2019

7.4 Major procedural complications

This quality indicator examines in-lab intra-procedural complications. In 2019, 36 cases (0.72%) 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.

The numbers of reported events remain low, rendering further comment difficult other than to state that it is reassuring.

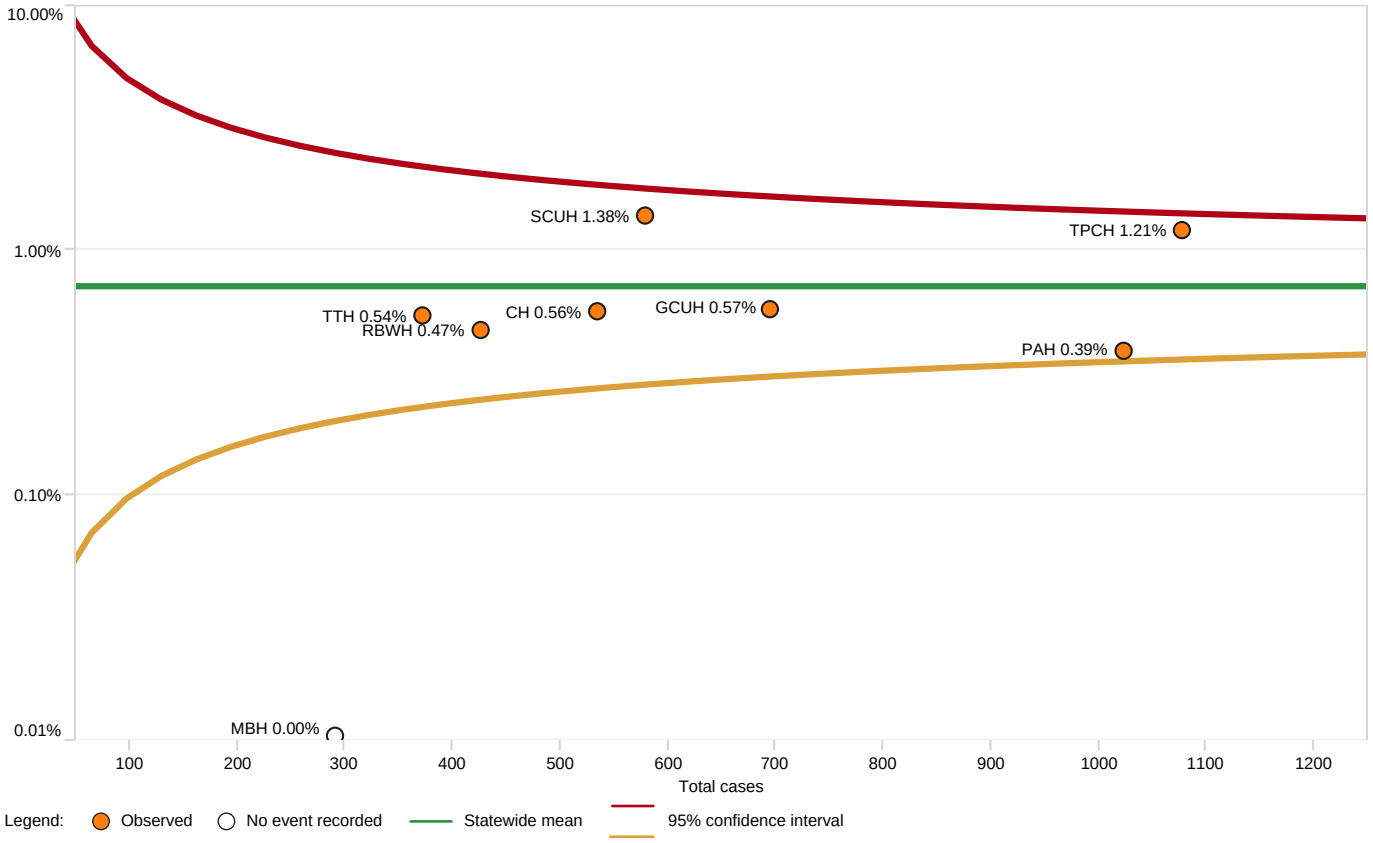


Figure 35: Proportion of PCI cases with immediate major procedure complication by site

Table 44: All PCI cases by immediate major procedural complication type

Complication type	Case n	%
Major intra-procedural complication	**36**	**0.72**
Coronary artery perforation	26	0.52
Tamponade	5	0.10
CVA	2	0.04
In-lab death*	2	0.04
Emergency CABG	1	0.02
No immediate major procedural complication	4,965	99.28
Total	**5,002**	

* Excluding salvage deaths

7.5 Safe radiation doses

Staff and patients are exposed to ionising radiation during the majority of all procedures performed in the cardiac catheter laboratory. Whilst ionising radiation is known to cause both delayed and immediate effects, the probability of effect is thought to be dose related.

Fortunately, conservative thresholds are applied and monitored throughout Queensland. 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.

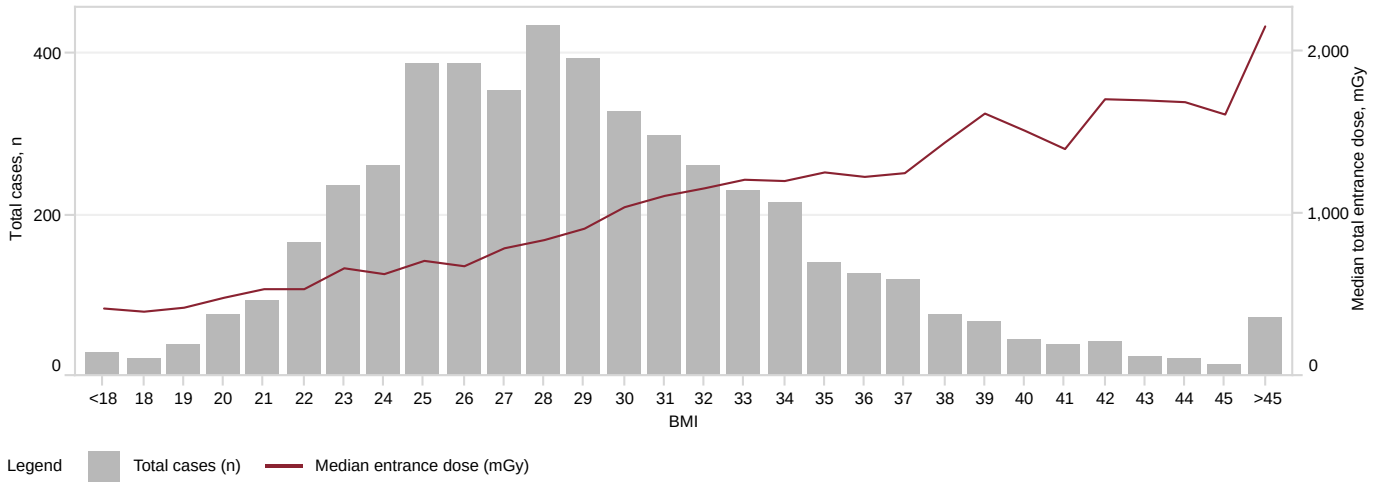


Figure 36: All coronary and PCI procedures median total entrance dose by body mass index

Table 45: Proportion of cases meeting the safe dose threshold by case type

Site	PCI procedures %	Other coronary procedures %
CH	99.6	99.7
TUH	98.4	99.5
MBH	100.0	100.0
SCUH	98.8	99.5
TPCH	99.2	99.7
RBWH	99.5	99.8
PAH	97.8	99.2
GCUH	99.9	99.9
STATEWIDE	**99.0**	**99.6**

8 Conclusions

This year's Interventional Cardiology Audit has once again expanded in scope and driven forward quality improvement activities across the state. With the expanded analysis of patients receiving thrombolysis, new insight can be gained relating to patient outcomes in this cohort. The contribution of the QAS has been invaluable in getting to this point and we look forward to ongoing future collaboration.

Year on year improvements have been made with a three minute improvement in the time from first diagnostic ECG to reperfusion for patients undergoing PCI for STEMI from 2017–2019. Similarly, there has been an 8% increase in the number of patients reaching the 90 minute reperfusion target time for primary PCI since 2017. QCOR data has enabled individual departments to monitor their own progress with this metric to initiate changes to internal processes.

The addition of an out-of-hospital cardiac arrest analysis has shown sobering but reassuring mortality rates for this extremely unwell patient group who, on presentation, have an extremely guarded prognosis.

The introduction of a new definition for salvage PCI in this year's report saw a modest increase in the number of patients categorised this way. By removing these patients from mortality analysis, better clarity of PCI safety is gained. It is encouraging to see that even with this change in definition that overall rates appear steady when compared to previous years.

Work can still be done to explore alternate or locally developed risk adjustment models for those patients undergoing PCI. This has been a goal for some time, and with improved access to other datasets and the increasingly high quality data from within QCOR, this goal is becoming more achievable than ever.

Structural heart disease interventions continue to increase in volume across the state, in particular, TAVR. With a new application nearing completion and implementation, the level of data available for analysis will be unprecedented. By embedding this new application within the established workflow for these complex interventions, clinical, as well as data collection benefits can be realised.

The role of QCOR data has once again exceeded the analysis performed in this Report. Through partnership with other Queensland Health divisions, PCI data which relates to device usage has enabled significant cost savings to date, and established a platform for continued cost efficiencies to be realised.

Further to work in expanding data collection and analysis, QCOR has also been actively involved in establishing and contributing to national registries though working closely with the newly established National Cardiac Registry (NCR). The NCR is a Commonwealth funded clinical quality registry which operates using a federated model where each state-based registry acts as the conduit for contributing data. This initiative is being followed closely by Queensland cardiac clinicians with the hope that it can provide valuable functions that have quality assurance at their crux. We look forward to future involvement in the design and direction of this new clinical quality registry for PCI.

9 Supplement: Structural heart disease

This year's structural heart disease (SHD) supplement contains data for procedures including cardiac defect closures and transcatheter aortic valve replacement (TAVR) procedures, among others, that took place in the seven Queensland public hospital cardiac catheterisation laboratories.

A new bespoke QCOR module for SHD interventions, led by clinicians throughout its development, will be deployed across most public sites offering such procedures in Queensland through 2021. The QCOR SHD module has been developed to provide a procedural reporting solution for the point of care in addition to capturing case data for registry purposes. The new module allows data to be recorded across the patient journey, from the preoperative phase up to one year post discharge, and will provide a platform to enable seamless participation in national quality and patient safety registries.

The new module will streamline participation of Queensland public facilities in the Australasian Cardiac Outcomes Registry transcatheter aortic valve implantation registry, which forms the basis for institution and operator credentialing within Australia.

The QCOR SHD sub-committee and the Statewide Cardiac Clinical Network continue to work towards extending registry participation to private healthcare facilities in the future.

9.1 Participating sites

A total of 477 SHD interventions were performed across the seven Queensland public cardiac catheterisation laboratories. Two thirds (68%) of cases were valvular interventions including percutaneous valve replacement and valvuloplasty procedures.

Table 1: Total SHD cases by participating site

Site	Total cases n	Device closure* n (%)	Valvular intervention† n (%)	Other‡ n (%)
CH	19	16 (84.2)	2 (10.5)	1 (5.3)
TUH	25	10 (40.0)	15 (60.0)	–
SCUH	21	12 (57.1)	9 (42.9)	–
TPCH	248	31 (12.5)	207 (83.5)	10 (4.0)
RBWH	21	17 (81.0)	4 (19.0)	–
PAH	88	29 (33.0)	57 (64.8)	2 (2.3)
GCUH	55	22 (40.0)	31 (56.4)	2 (3.6)
STATEWIDE	**477**	**137 (28.7)**	**325 (68.1)**	**15 (3.1)**

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

† Percutaneous valve replacement and valvuloplasty

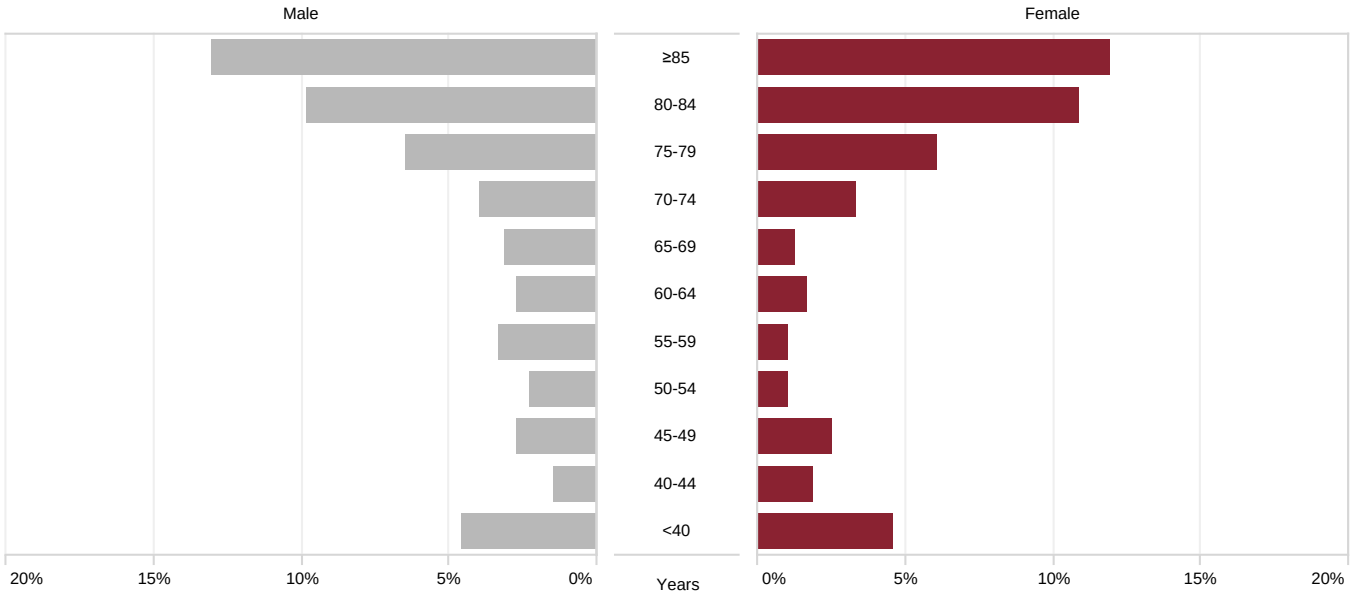
‡ Myocardial septal ablation and renal denervation

9.2 Patient characteristics

9.2.1 Age and gender

Patients undergoing an SHD intervention were distributed between genders at 54% male and 46% female. One quarter 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 83 years compared to 49 years for device closure procedures.



% of total (n=477)

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

Table 2: Median age by gender and procedure category

	Male years	Female years	All years
Device closures	50	46	49
Valvular intervention	83	83	83
Other	70	70	70
ALL	**77**	**80**	**79**

9.3 Care and treatment of SHD patients

9.3.1 Device closures

There was a total of 137 device closures performed across the seven participating centres. The majority of device closure procedures were for the correction of a patent foramen ovale (PFO), followed by atrial septal defect (ASD), at 73% and 17% of case volumes respectively.

Table 3: Device closure procedures by participating site

Site	Total cases n	PFO* n (%)	ASD† n (%)	PDA‡ n (%)	LAA§ n (%)	Para-valvular leak n (%)	Other‖ n (%)
CH	16	16 (100.0)	–	–	–	–	–
TUH	10	7 (70.0)	–	–	–	2 (20.0)	1 (10.0)
SCUH	12	10 (83.3)	1 (8.3)	1 (8.3)	–	–	–
TPCH	31	16 (51.6)	5 (16.1)	1 (3.2)	6 (19.4)	2 (6.5)	1 (3.2)
RBWH	17	15 (88.2)	2 (11.8)	–	–	–	–
PAH	29	16 (55.2)	13 (44.8)	–	–	–	–
GCUH	22	20 (90.9)	2 (9.1)	–	–	–	–
STATEWIDE	**137**	**100 (73.0)**	**23 (16.8)**	**2 (1.5)**	**6 (4.4)**	**4 (2.9)**	**2 (1.5)**

* Patent foramen ovale

† Atrial septal defect

‡ Patent ductus arteriosus

§ Left atrial appendage

‖ Includes closure of cardiac collateral vessel and arteriovenous malformation

9.3.2 Valvular interventions

The total number of valvular interventions performed across the seven participating sites was 325, comprising of transcatheter valvuloplasty (Table 6) and transcatheter valve replacement (Table 7) procedures.

The aortic valve was the most common valve requiring intervention, accounting for 91% of overall cases.

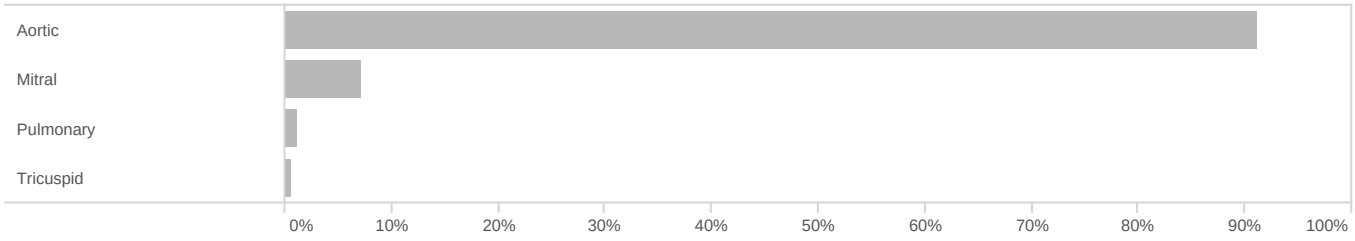


Figure 2: Proportion of all transcatheter valvular interventions by valve type

Table 4: Transcatheter valvular interventions by cardiac valve

Site	Total cases n	Aortic n (%)	Mitral n (%)	Pulmonary n (%)	Tricuspid n (%)
CH	2	2 (100.0)	–	–	–
TUH	15	15 (100.0)	–	–	–
SCUH	9	9 (100.0)	–	–	–
TPCH	207	178 (86.0)	23 (11.1)	4 (1.9)	2 (1.0)
RBWH	4	4 (100.0)	–	–	–
PAH	57	57 (100.0)	–	–	–
GCUH	31	31 (100.0)	–	–	–
STATEWIDE	**325**	**296 (91.1)**	**23 (7.1)**	**4 (1.2)**	**2 (0.6)**

Table 5: Transcatheter valvular interventions by type

Site	Total cases n	Transcatheter valvuloplasty n (%)	Transcatheter valve replacement n (%)
CH	2	2 (100.0)	–
TUH	15	2 (13.3)	13 (86.7)
SCUH	9	9 (100.0)	–
TPCH	207	41 (19.8)	166 (80.2)
RBWH	4	4 (100.0)	–
PAH	57	3 (5.3)	54 (94.7)
GCUH	31	5 (16.1)	26 (83.9)
STATEWIDE	**325**	**66 (20.3)**	**259 (79.7)**

Transcatheter valve replacement procedures constitute a relatively new and highly sophisticated approach to treating patients with conditions often otherwise reliant on conventional cardiac surgery. There were four sites which offered transcatheter valve replacement procedures in 2019, while the number of procedures performed by those sites (n=259) was increased considerably from the previous year (n=151).

Table 6: Transcatheter valvuloplasty procedures

Site	Balloon aortic valvuloplasty n (%)	Mitral leaflet clip n (%)	Balloon tricuspid valvuloplasty n (%)
CH	2 (100.0)	–	–
TUH	2 (100.0)	–	–
SCUH	9 (100.0)	–	–
TPCH	22 (53.7)	18 (43.9)	1 (2.4)
RBWH	4 (100.0)	–	–
PAH	3 (100.0)	–	–
GCUH	5 (100.0)	–	–
STATEWIDE	**47 (71.2)**	**18 (26.9)**	**1 (1.5)**

Table 7: Transcatheter valve replacement procedures

Site	TAVR* n (%)	TMVR† n (%)	TTVR‡ n (%)	TPVR§ n (%)
TUH	13 (100.0)	–	–	–
TPCH	156 (94.0)	5 (3.0)	1 (0.6)	4 (2.4)
PAH	54 (100.0)	–	–	–
GCUH	26 (100.0)	–	–	–
STATEWIDE	**249 (96.1)**	**5 (1.9)**	**1 (0.4)**	**4 (1.6)**

* Transcatheter aortic valve replacement/implantation

† Transcatheter mitral valve replacement

‡ Transcatheter tricuspid valve replacement

§ Transcatheter pulmonary valve replacement

Table 8: Other structural heart disease interventions

Site	Myocardial septal ablation n (%)	Renal denervation n (%)
CH	–	1 (100.0)
TPCH	–	10 (100.0)
PAH	2 (100.0)	–
GCUH	–	2 (100.0)
STATEWIDE	**2 (13.3)**	**13 (86.7)**

9.4 Patient outcomes

9.4.1 All-cause 30 day mortality

Across the seven public cardiac catheter labs in Queensland offering SHD intervention, the all-cause unadjusted 30 day mortality rate was 2.7%.

Table 9: 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	19	0 (0.0)	1 (50.0)	0 (0.0)	1 (5.3)
TUH	25	0 (0.0)	0 (0.0)	–	0 (0.0)
SCUH	21	0 (0.0)	0 (0.0)	–	0 (0.0)
TPCH	248	1 (3.2)	9 (4.3)	0 (0.0)	10 (4.0)
RBWH	21	0 (0.0)	0 (0.0)	–	0 (0.0)
PAH	88	0 (0.0)	1 (1.8)	0 (0.0)	1 (1.4)
GCUH	55	0 (0.0)	1 (3.2)	0 (0.0)	1 (2.0)
STATEWIDE	**477**	**1 (0.7)**	**12 (3.7)**	**0 (0.0)**	**13 (2.7)**

9.4.2 All TAVR cases

2019 cases

Of the four sites performing TAVR in 2019, the overall all-cause unadjusted mortality rate within 30 days of the procedure was 2.0%.

Table 10: All-cause unadjusted 30 day mortality post TAVR by site

Site	Total cases n	30 day mortality n (%)
TUH	13	0 (0.0)
TPCH	156	5 (3.2)
PAH	54	0 (0.0)
GCUH	26	0 (0.0)
STATEWIDE	**249**	**5 (2.0)**

2018 and 2017 cases

Of the four sites performing TAVR in 2018, the overall all-cause unadjusted mortality rate within 30 days of the procedure was 1.4%, and 9.5% at 365 days. For the three sites performing TAVR in 2017, the overall all-cause unadjusted mortality rate at two years post procedure was 18.8%.

These figures should be interpreted with caution as many of the patients within this cohort were of advanced age at the time of their procedure and were also likely to have been unsuitable for surgical valve replacement due to comorbidities and risk factors.

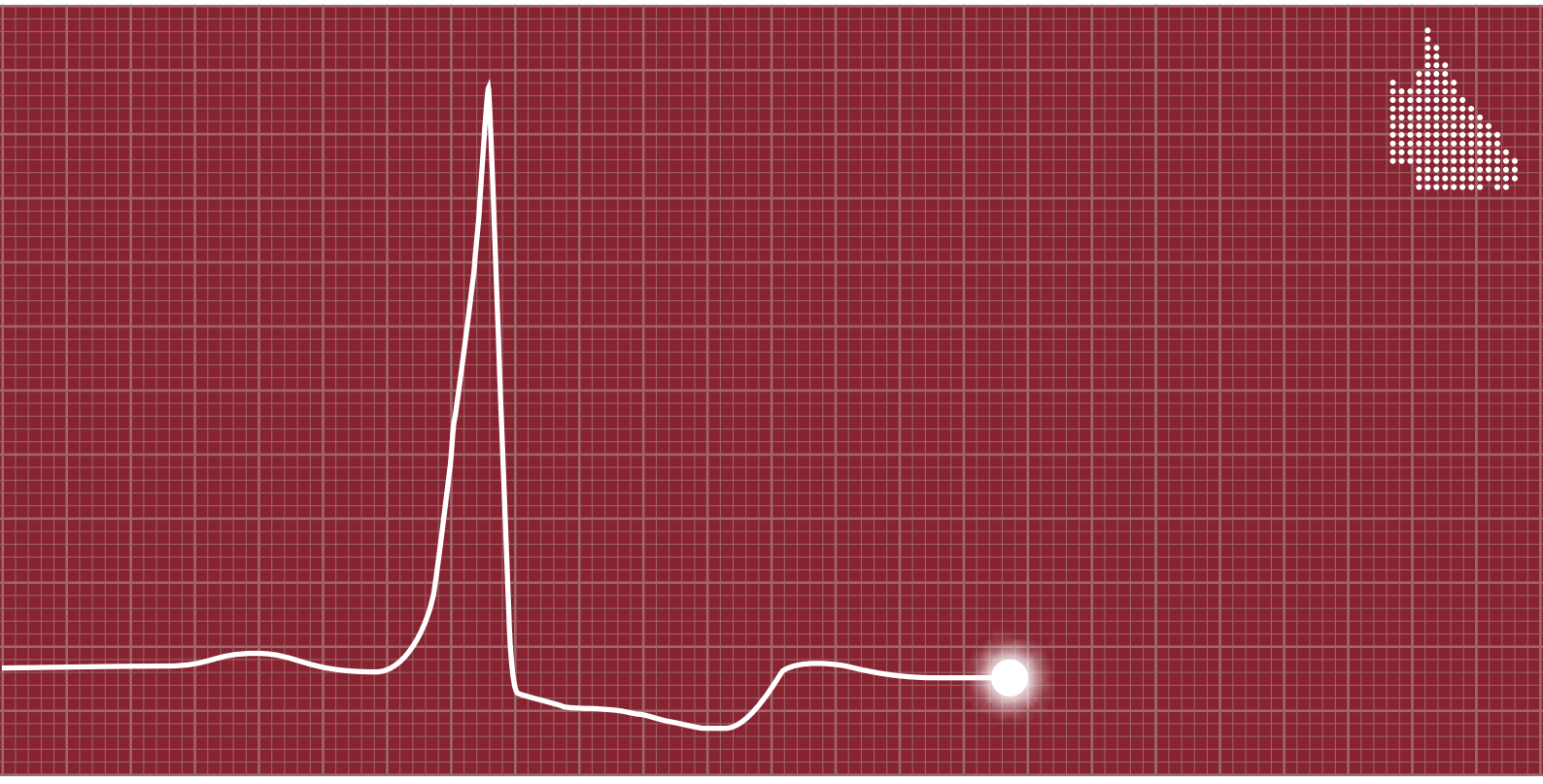
Table 11: All-cause unadjusted 30 day and 1 year mortality post TAVR by site (2018 cohort)

Site	Total cases n	30 day mortality n (%)	1 year mortality n (%)
TUH	3	0 (0.0)	0 (0.0)
TPCH	93	1 (1.1)	8 (8.6)
PAH	33	1 (3.0)	5 (15.2)
GCUH	19	0 (0.0)	1 (5.3)
STATEWIDE	**148**	**2 (1.4)**	**14 (9.5)**

Table 12: All-cause unadjusted mortality up to 2 years post TAVR by site (2017 cohort)

Site	Total cases n	30 day mortality n (%)	1 year mortality n (%)	2 year mortality n (%)
TPCH	103	4 (3.9)	15 (14.6)	21 (20.4)
PAH	21	0 (0.0)	2 (9.5)	3 (14.3)
GCUH	4	0 (0.0)	0 (0.0)	0 (0.0)
STATEWIDE	**128**	**4 (3.1)**	**17 (13.3)**	**24 (18.8)**

Cardiothoracic Surgery Audit



1 Message from the QCOR Cardiothoracic Steering Committee Chair

Undergoing cardiac surgery can be the last stage of a long journey from health, to disease, to diagnosis, to catheter based treatment, and finally to major surgical treatment. Assessing the safety and quality of this final stage of treatment starts with stopping to back at the journey our patients have taken. A thoughtful reader of this audit will see how the journey unfolds for most patients. Most commonly patients are in their seventh decade of life, overweight and obese with the resulting diseases of hypertension and dyslipidaemia. The need for surgery is most often urgent, demonstrating that after decades of missed opportunity for prevention, patients suddenly develop a pattern of disease that if not treated with urgency results in a threat to their life. The significant rate of urgent and emergency surgery reflects the story of poorly controlled risk factors presenting in a sudden fashion requiring urgent intervention. This decades long public health disaster caused by the confluence of environmental and physiologic factors that results in obesity, metabolic syndromes, and the associated diseases is demonstrated in this audit, being that the surgical treatment of the end result of obesity related disease is clearly the bulk of the need for cardiac surgery. Primary prevention and public health failures result in highly invasive resource consuming treatments such as cardiac surgery.

The audit process is iterative and results in the addition of data points that clarify the conditions treated and the measurements of performance. The addition of data points for calculation of the EuroSCORE II and self-administered recreational intravenous drug use related to intracardiac infections are examples of the iterations in the data set that are changes in this report.

The safety and performance of cardiac surgery is again shown to be better than is predicted by risk calculators. Across Queensland, those who undergo cardiac surgery have a less than expected rate of complications and death. Surgery is being performed at a high level. Deep sternal wound infection continues at the same rate and hence has the same fixed relationship to the risk score as in previous years.

The length of stay analysis again shows that there are more patients who stay longer than two weeks than expected from risk scores. Comparison with an American risk score is probably the source of this finding given that geography and health system structure may influence this result. None of these factors differ markedly between Queensland and generalised United States data. The supplemental report was triggered by these observations. This finds that the length of stay greater than two weeks is explained by distance from hospitals, which is not unexpected. Interestingly, the length of stay for those not within major cities but in inner and outer regional areas was less than expected, perhaps a reflection that distances of several hundred kilometres are not particularly prohibitive to discharge for most Queenslanders. However, the analysis did show that Very Remote Australia and the Major Cities of Australia are very different places, the extremes of health system experiences for Queenslanders. Younger, mostly Aboriginal patients residing in Very Remote Australia requiring cardiac surgery have to travel distances equivalent to the entire length of the United Kingdom to undergo surgery, surgery that is usually urgent. The findings of low rates of salvage cases in Remote Australia reflects the inability to overcome distance in the most critical of emergencies, rather than the absence of conditions that require salvage in regional and remote areas. This is the very definition of the tyranny of distance to which some Queenslanders will become victims. However, pleasingly, overall, distance does not have a negative factor in patients' experience of their cardiac surgical journey.

I once again thank my fellow committee members whose participation reflects their ongoing concern in the quality of the care that we provide Queenslanders.

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 2019.

Key findings include:

- The number of surgeries performed across the four public adult cardiac surgery units in Queensland were 2,622.
- The majority of patients were aged between 61 years and 80 years of age (61%) with a median age of 66 years old.
- Approximately three quarters of patients were male (72%).
- 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 6.9%, and had a wide variation between sites with 23% of patients in Townsville identifying as Aboriginal and Torres Strait Islander.
- The majority of patients had high blood pressure (66%) or a history of high cholesterol (61%). Half of all patients presented with both of these risk factors combined.
- Almost one third of patients (29%) were reported to be diabetic at the time of their operation, increasing to 39% of all patients undergoing coronary artery bypass grafting (CABG).
- Over a quarter (28%) of patients had an element of left ventricular systolic dysfunction.
- Over half (58%) of all cases were elective admissions with 14% of elective patients being admitted on the day of surgery.
- In 2019, 1,567 patients had a CABG procedure, the majority (92%) of patients had multi-vessel disease.
- There were 294 patients who underwent aortic surgery, with 78% undergoing ascending aorta replacement.
- Among the 1,104 patients undergoing valve surgery in 2019, the most common interventions performed were replacement of the aortic valve (68%) or mitral valve (17%).
- Degenerative valve disease (56%) was the primary pathology for patients undergoing valve intervention.
- Major morbidities were evaluated using Society of Thoracic Surgeons (STS) models with most results demonstrating that the observed rate of adverse events is within expectations. The exception is the rate of deep sternal wound infection for CABG which was outside the expected range.
- The mortality rate after surgery is either within the expected range or significantly less than expected, depending on the risk model used to evaluate this outcome.

3 Participating sites

Queenslanders were served by four public cardiac surgery units that were spread across Metropolitan and regional locations. Each unit entered data directly into the QCOR cardiac surgery database application.

Patients came from a wide geographical area, with most patients residing close to the 7,000 kilometre stretch of eastern coastline.

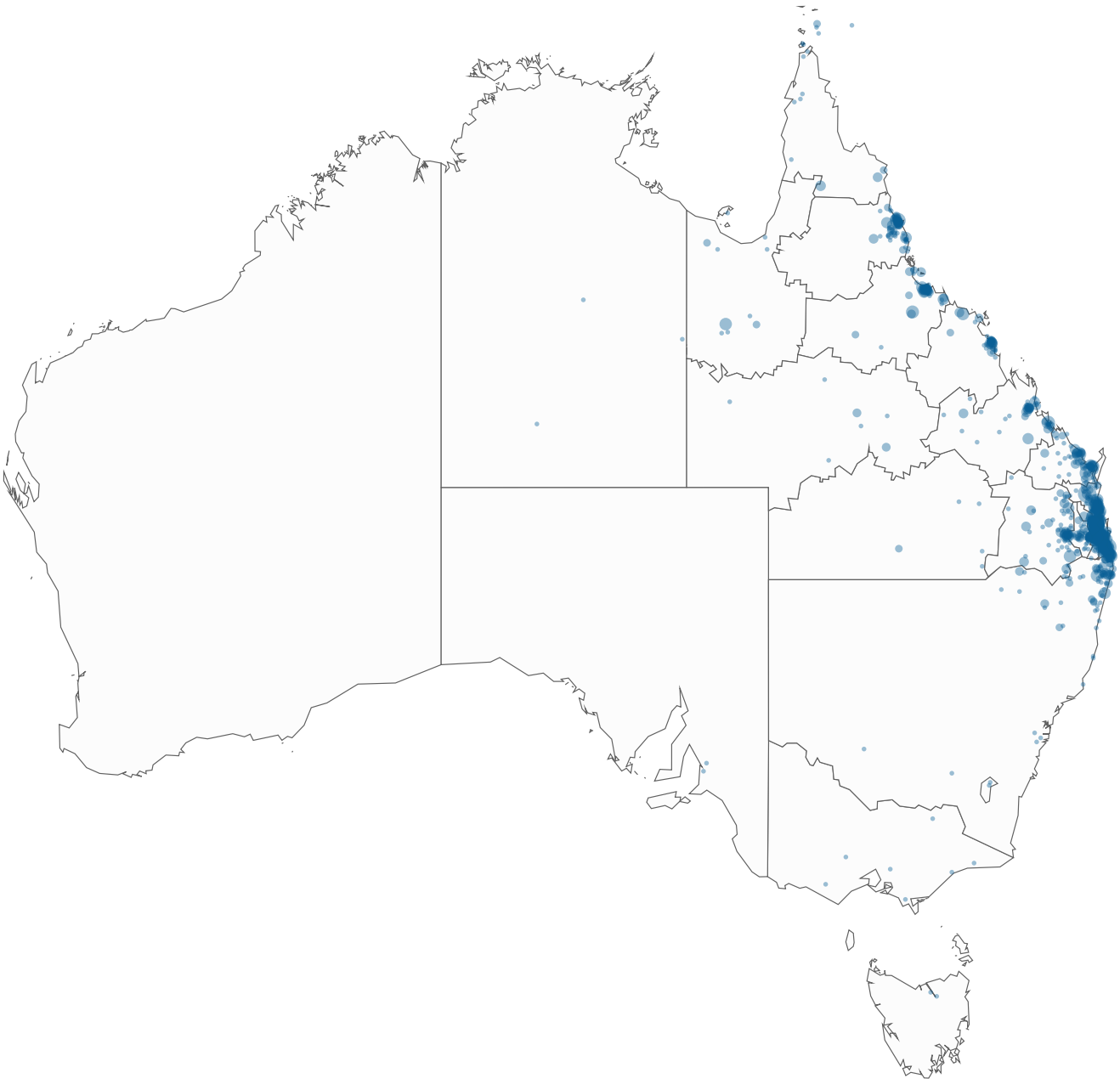


Figure 1: Cardiac surgery cases by residential postcode

Table 1: Participating sites

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

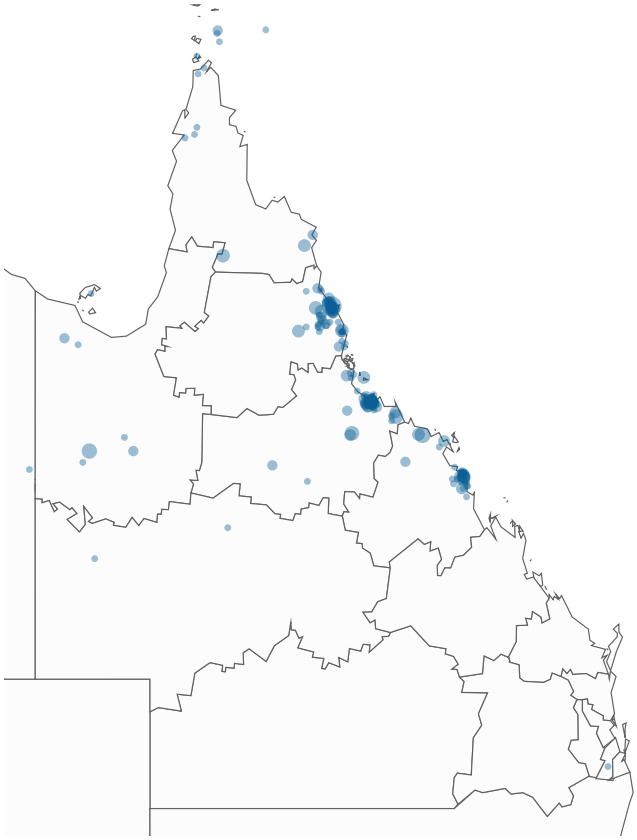


Figure 2: Townsville University Hospital

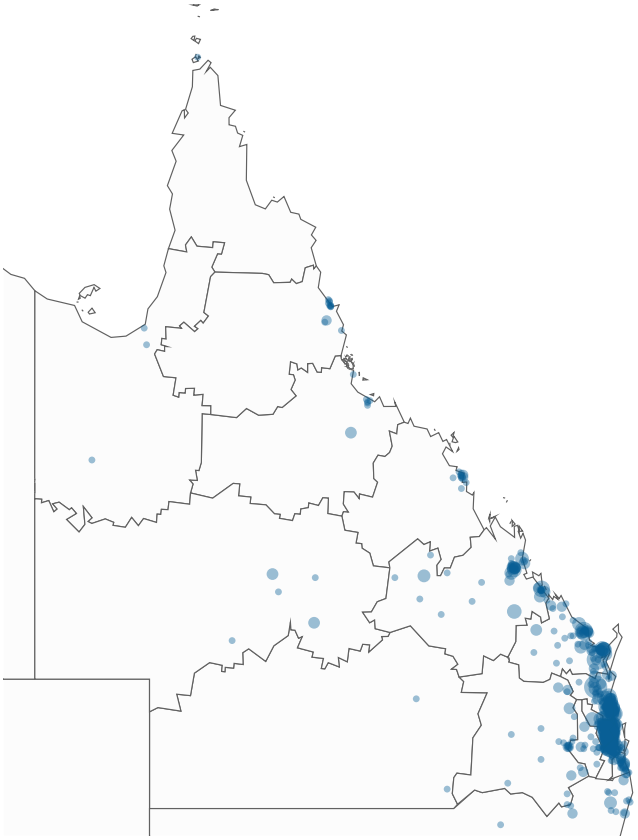


Figure 3: The Prince Charles Hospital

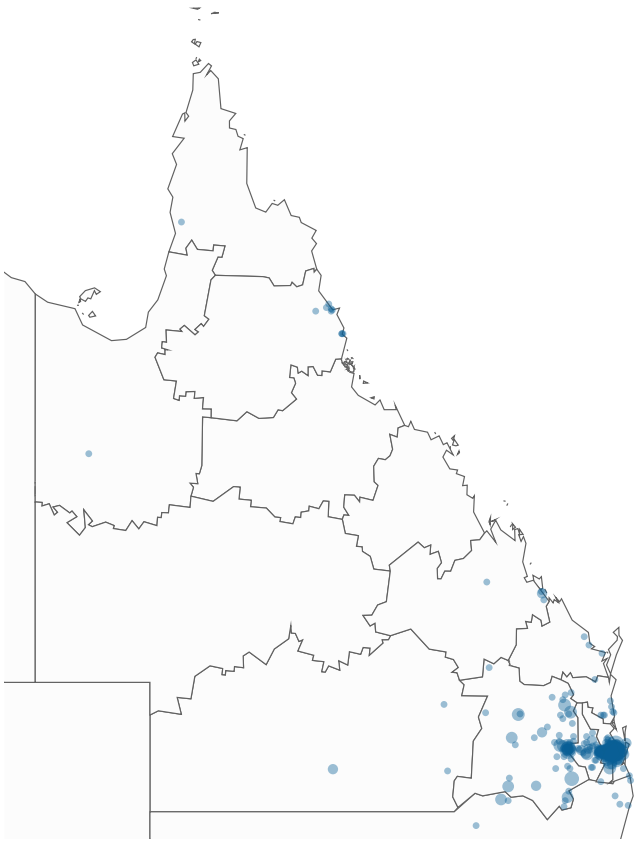


Figure 4: Princess Alexandra Hospital

Figure 5: Gold Coast University Hospital

4 Case totals

4.1 Total surgeries

The total number of cardiac surgical procedures performed at the four public hospitals participating in the QCOR database was 2,622. Each of the procedure combinations included in those cases have been allocated to a cardiac surgery procedure category for the purpose of this report.

Table 2: Procedure counts and surgery category

Procedure combination	Count	Category*
CABG	1,284	ANY CABG
CABG + other cardiac procedure	29	
CABG + other non-cardiac procedure	9	
CABG + aortic procedure	8	
CABG + other cardiac procedure + other non-cardiac procedure	1	
CABG + valve	193	CABG + VALVE
CABG + valve + aortic procedure	27	
CABG + valve + other cardiac procedure	15	
CABG + valve + aortic procedure + other cardiac procedure	1	
Valve procedure†	586	VALVE
Valve + aortic procedure	194	
Valve + other cardiac procedure	72	
Valve + aortic procedure + other cardiac procedure	12	
Valve + other non-cardiac procedure	3	
Valve + aortic procedure + other non-cardiac procedure	1	
Other cardiac procedure	125	OTHER
Aortic procedure	45	
Other cardiac procedure + other non-cardiac procedure	11	
Aortic procedure + other non-cardiac procedure	3	
Aortic procedure + other cardiac procedure	3	
ALL	**2,622**	

* Category procedure combination allocated

† Includes TAVR procedures (n=134)

4.2 Cases by category

Nearly two thirds (60%) of all cardiac surgery procedures involved coronary artery bypass grafting (CABG). Of these, 9% involved a simultaneous CABG and valve procedure.

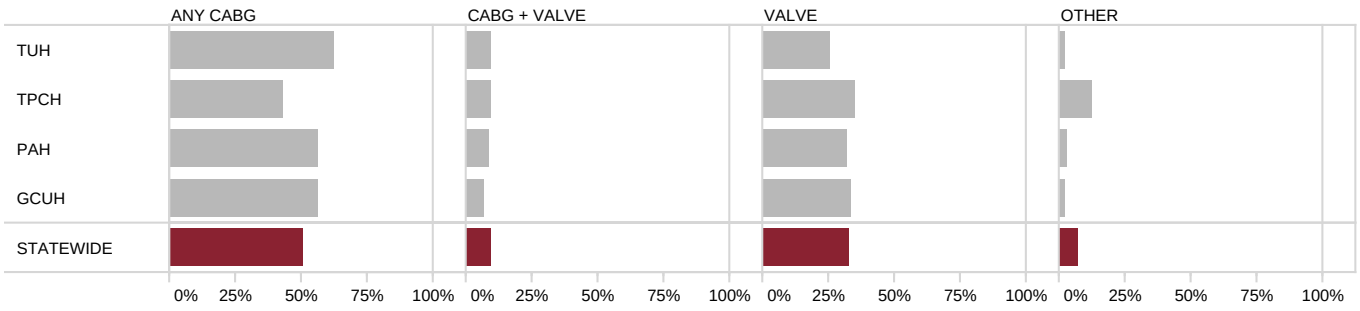


Figure 6: Proportion of cases by site and surgery category

Table 3: Proportion of cases by surgery category

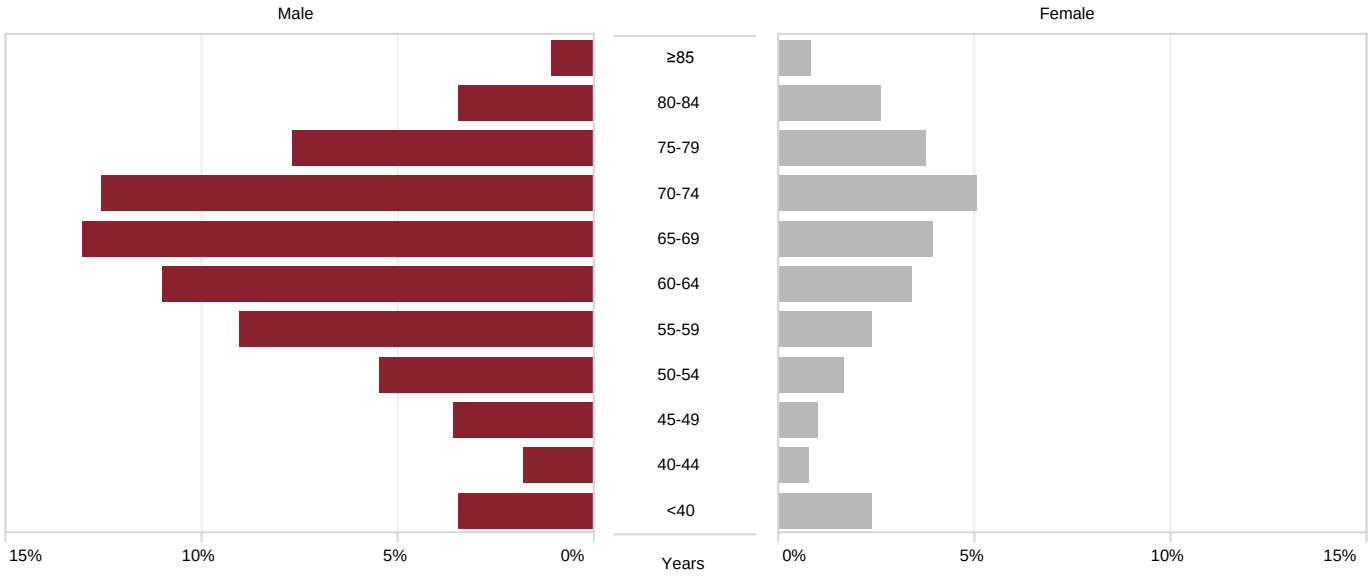
SITE	Total cases n	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)
TUH	363	226 (62.3)	34 (9.4)	95 (26.2)	8 (2.2)
TPCH	1,235	527 (42.7)	119 (9.6)	439 (35.5)	15 (12.1)
PAH	653	368 (56.4)	57 (8.7)	208 (31.9)	20 (3.1)
GCUH	371	210 (56.6)	26 (7.0)	126 (34.0)	9 (2.4)
STATEWIDE	**2,622**	**1,331 (50.8)**	**236 (9.0)**	**868 (33.1)**	**187 (7.1)**

5 Patient characteristics

5.1 Age and gender

Age is an important risk factor for developing cardiovascular disease. Almost two thirds of patients were aged between 61 years and 80 years of age (61%). The male cohort of 65 years to 69 years accounted for the largest proportion of cases (13% of all cases or 18% of males). Approximately 8% of cases were performed on patients younger than 45 years of age.

The median age of all patients undergoing cardiac surgery was 66 years of age. The median age of both males and females undergoing cardiac surgery was 66 years and 68 years respectively.



% of total (n=2,622)

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	1,331	65	67	66
CABG + VALVE	236	70	72	70
VALVE	868	66	69	68
OTHER	187	52	52	52
ALL	**2,622**	**66**	**68**	**66**

Overall, around three quarters of patients were male (72%), with the largest proportion of females represented in the valve (38%) and other cardiac surgery (49%) categories. This reflects the increased risk of coronary artery disease in men.

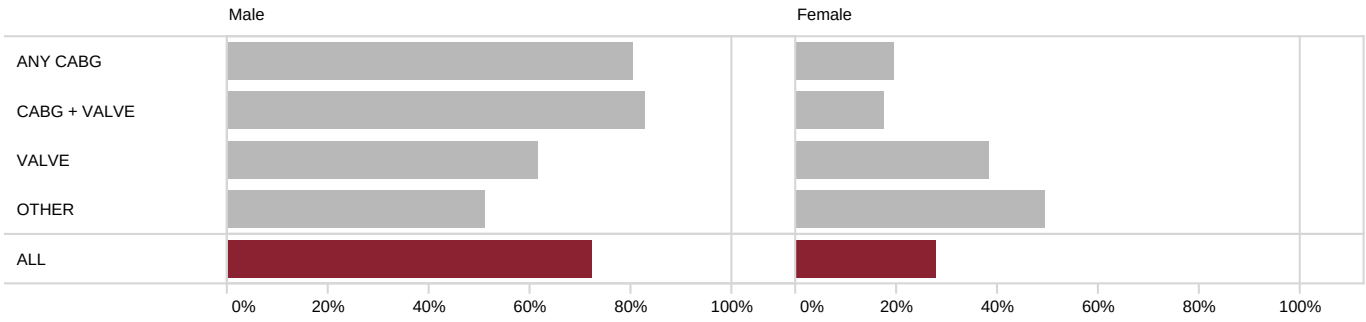
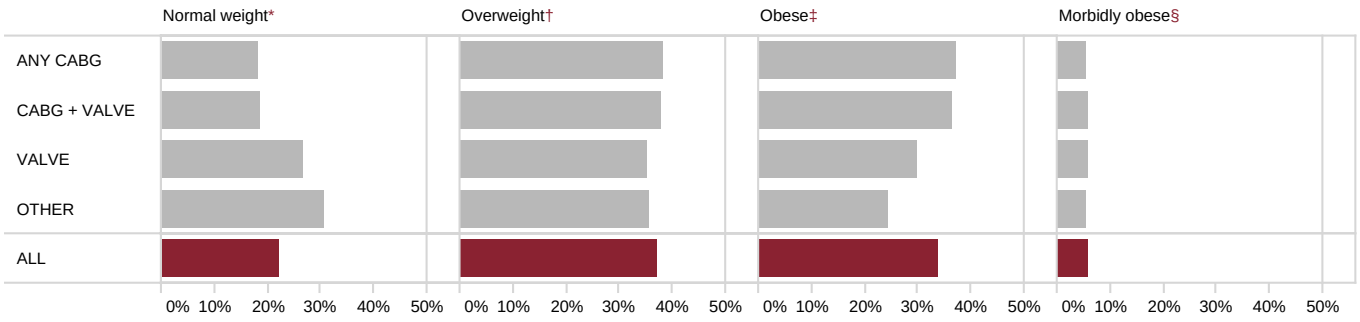


Figure 8: Proportion of cases by gender and surgery category

5.2 Body mass index

Less than one quarter (22%) of cardiac surgery patients had a healthy body mass index (BMI), while patients having a BMI category of overweight, obese or morbidly obese represented over three quarters of cardiac surgery patients (77%).

Just over one quarter (27%) 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 approximately 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	6 (0.5)	245 (18.4)	512 (38.5)	496 (37.3)	72 (5.4)
CABG + VALVE	2 (0.8)	44 (18.6)	90 (38.1)	86 (36.4)	14 (5.9)
VALVE	18 (2.1)	231 (26.6)	306 (35.3)	260 (30.0)	52 (6.0)
OTHER	7 (3.7)	57 (30.5)	67 (35.6)	46 (24.5)	10 (5.3)
ALL	**33 (1.3)**	**577 (22.0)**	**975 (37.2)**	**888 (33.9)**	**148 (5.6)**

Excludes missing data (‹0.1%)

5.3 Aboriginal and Torres Strait Islander status

Coronary heart disease has complex causes and multiple risk factors, one of which is ethnicity. Ethnicity is an important determinant of the development of cardiovascular disease. It is recognised that the Aboriginal and Torres Strait Islander population have a higher incidence and prevalence of coronary artery disease than other ethnicities.[1]

Overall, the proportion of identified Aboriginal and Torres Strait Islander patients undergoing cardiac surgery was 6.9%. This proportion is larger than the estimated 4.6% of the overall Queensland population that Aboriginal and Torres Strait Islander people account for.[2]

Almost one quarter (23%) of patients undergoing cardiac surgery at TUH identified as Aboriginal and Torres Strait Islander.

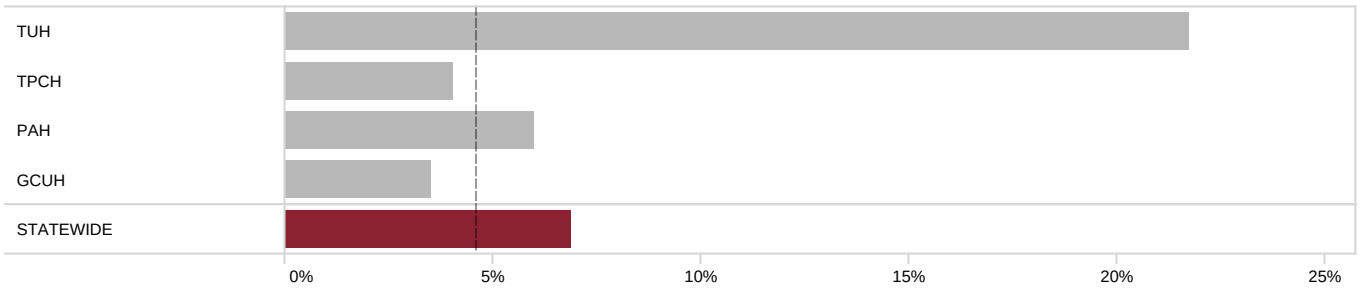


Figure 10: Proportion of all cardiac surgical cases by identified Aboriginal and Torres Strait Islander status and site

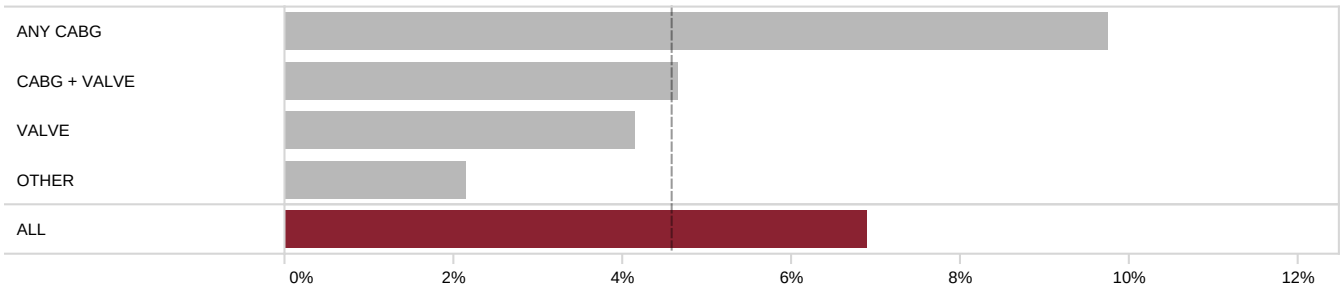
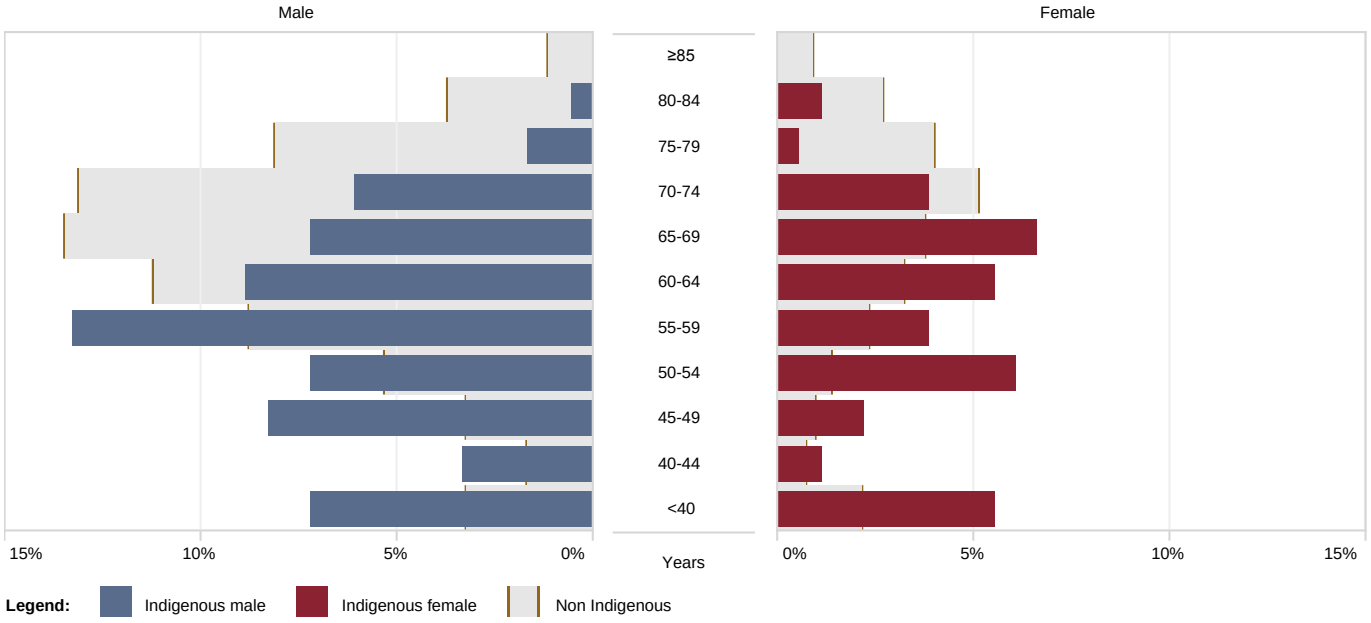


Figure 11: Proportion of cases by identified Aboriginal and Torres Strait Islander status and surgery category

The median age for Aboriginal and Torres Strait Islander Queenslanders undergoing cardiac surgery was 58 years, whereas the median age of other patients was 67 years of age (Figure 12).



% of total Aboriginal and Torres Strait Islander (n=181) vs. total non-Indigenous (n=2,441)

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

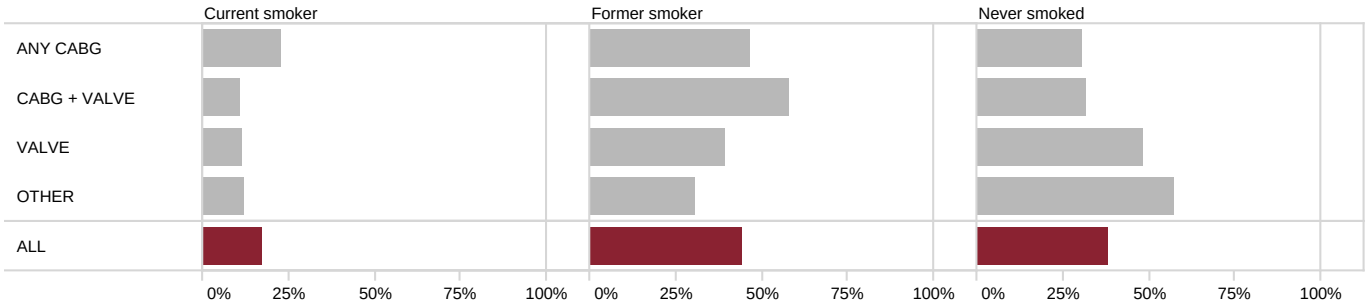
Table 6: Median patient age by gender and Indigenous status

	Male years	Female years	All years
Aboriginal and Torres Strait Islander	59	57	58
Non Aboriginal and Torres Strait Islander	69	66	67
ALL	**68**	**66**	**66**

6 Risk factor profile

6.1 Smoking history

Overall, 61% of patients had a history of tobacco use including 17% current smokers (defined as smoking within 30 days of the procedure) and 44% former smokers. Of the remaining patients, 39% reported never having smoked.



Unknown smoking status not displayed (‹1.0%)

Figure 13: Proportion of cases by smoking status and surgery category

6.2 Diabetes

Overall, 29% of all cardiac surgical patients were reported as diabetic. The prevalence of diabetes was highest in the CABG patient group (39%).

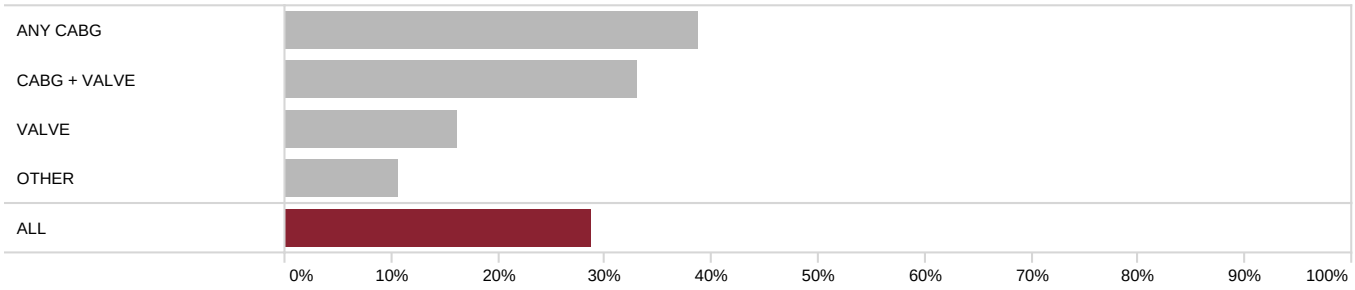


Figure 14: Proportion of cases by diabetes status and surgery category

6.3 Hypertension

Hypertension, defined as receiving antihypertensive medications at the time of surgery, was present in 66% of patients with considerable variation by surgery type (range 34% to 80%).

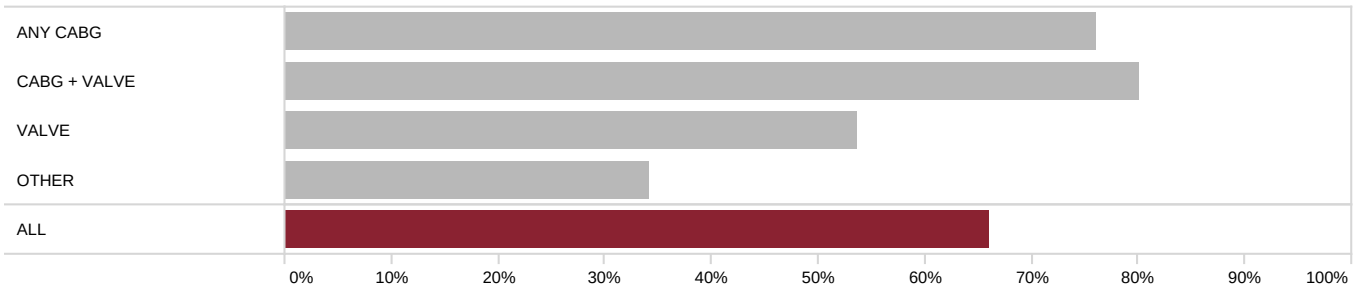


Figure 15: Proportion of cases by hypertension status and surgery category

6.4 Hypercholesterolaemia

Overall, 61% of patients had a documented history of hypercholesterolaemia, ranging from 78% in the CABG category to 23% in the other surgery category.

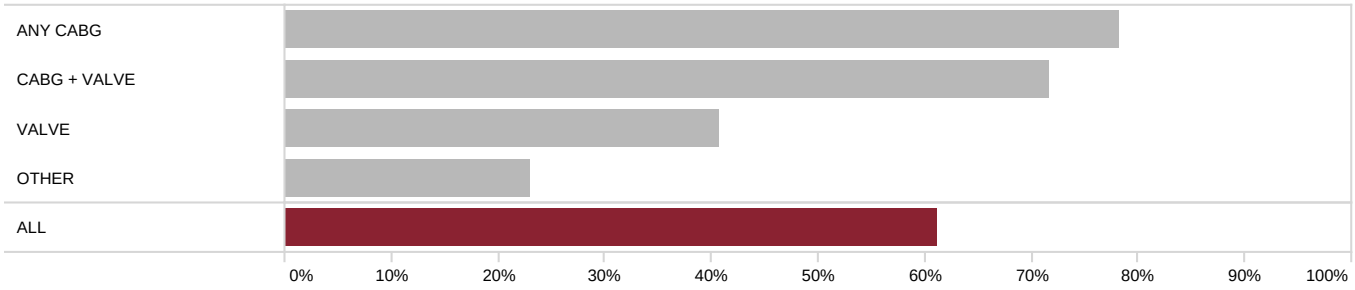
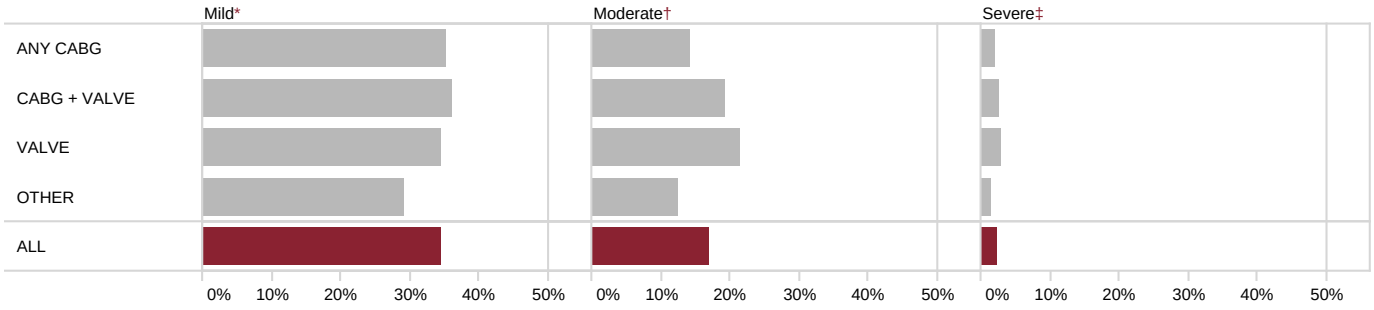


Figure 16: Proportion of cases by statin therapy status and surgery category

6.5 Renal impairment

Over half (54%) of all patients were identified as having impaired renal function (eGFR ≤89 mL/min/1.73 m²) at the time of their surgery. Of these, approximately 60% of patients undergoing CABG and valve surgery had documented renal impairment.



* eGFR 60–89 mL/min/1.73 m²

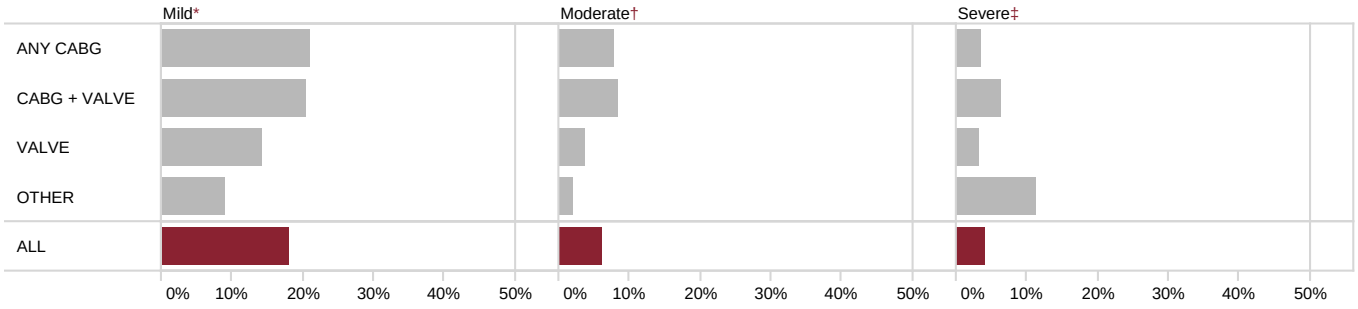
† eGFR 30–59 mL/min/1.73 m²

‡ eGFR <30 mL/min/1.73 m²

Figure 17: Proportion of cases by renal impairment status and surgery category

6.6 Left ventricular dysfunction

Over a quarter (28%) of patients were classed as having an impaired left ventricular ejection fraction (LVEF), including 18% with mild LV dysfunction (LVEF between 40% to 50%), 6% with moderate LV dysfunction (LVEF between 30% to 39%) and 4% with severe LV dysfunction (LVEF less than 30%).



* LVEF 40–49%

† LVEF 30–39%

‡ LVEF ‹30%

Figure 18: Proportion of cases by LV dysfunction category and surgery category

6.7 Infective endocarditis

There were 105 cases of infective endocarditis (IE) that required cardiac surgical intervention. Of these, nearly three-quarters (n=74) were active infections at the time of surgery.

Native valve endocarditis was noted in 72% of active infections, with prosthetic valve involvement in 11%.

Table 7: Infective endocarditis status

Endocarditis status	n (%)
Active	74 (70.5)
Treated	31 (29.5)
Total	**105 (100.0)**

Table 8: Active infective endocarditis by site of infection

Active endocarditis site	n (%)
Native valve	53 (71.6)
Aortic root	13 (17.6)
Prosthetic valve	5 (6.8)
Prosthetic valve + pacemaker	2 (2.7)
Prosthetic valve + aortic root	1 (1.4)
Pacemaker	2 (2.6)
Total	**74 (100.0)**

6.7.1 Organism

Almost half (46%) of all active IE cases were identified as a methicillin susceptible Staphylococcus aureus (MSSA) infection, while the responsible organism was unidentified in 11% of cases.

Table 9: Identified organism in active IE cases

Active organism	n (%)
MSSA*	34 (45.9)
Streptococcus	11 (14.9)
Staphylococcus (other)	8 (10.8)
Enterococcus	3 (4.1)
Propionibacterium	3 (4.1)
Other	7 (9.5)
Unknown/unidentified	8 (10.8)
Total	**74 (100.0)**

* Methicillin susceptible Staphylococcus aureus

6.7.2 Intravenous drug use

Almost one in five (18%) of all active infective endocarditis cases were linked to a history of intravenous drug use (IVDU), of which over half were current intravenous drug users.

Table 10: Proportion of intravenous drug use associated with active IE

IVDU history	n (%)
Current IVDU (≤3 months)	7 (9.5)
Previous IVDU (›3 months)	6 (8.1)
No history of IVDU	54 (73.0)
Unknown	7 (9.5)
Total	**74 (100.0)**

6.8 Summary of risk factors

The development of coronary artery disease is dependent on several background variables and risk factors. Analysis of risk factors and surgical categories has found a number of combinations of risk factors that have a greater representation in some categories, thus reflecting the complex medical history of many patients.

Table 11: Summary of risk factors by surgery category

	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)	ALL n (%)
BMI ≥30 kg/m²	568 (42.7)	100 (42.4)	312 (36.0)	56 (29.8)	1,036 (39.5)
Current smoker	291 (21.9)	24 (10.2)	96 (11.1)	21 (11.2)	432 (16.5)
Diabetes	516 (38.8)	78 (33.1)	141 (16.3)	20 (10.6)	755 (28.8)
eGFR 60–89 mL/min/1.73 m²	466 (35.0)	85 (36.0)	299 (34.4)	54 (28.9)	904 (34.5)
eGFR 30–59 mL/min/1.73 m²	189 (14.2)	46 (19.5)	186 (21.5)	23 (12.3)	444 (16.9)
eGFR <30 mL/min/1.73 m²	29 (2.2)	6 (2.5)	26 (3.0)	3 (1.6)	64 (2.4)
Former smoker	604 (45.4)	132 (55.9)	330 (38.1)	54 (28.7)	1,120 (42.7)
Hypertension	1,013 (76.1)	189 (80.1)	465 (53.6)	64 (34.0)	1,731 (66.0)
Hypercholesterolaemia	1,040 (78.1)	169 (71.6)	353 (40.7)	43 (23.0)	1,605 (61.2)
Infective endocarditis	0 (0.0)	7 (3.0)	93 (10.7)	5 (2.7)	105 (4.0)
LVEF 40–50%	281 (21.1)	48 (20.3)	124 (14.3)	17 (9.0)	470 (17.9)
LVEF 30–39%	105 (7.9)	20 (8.5)	34 (3.9)	4 (2.1)	163 (6.2)
LVEF <30%	47 (3.5)	15 (6.4)	27 (3.4)	21 (11.2)	110 (4.2)

Table 12: Summary of combined risk factors by surgery category

	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)	ALL n (%)
Hypertension + hypercholesterolaemia	867 (65.1)	142 (60.2)	262 (30.2)	31 (16.6)	1,302 (49.7)
Current/former smoker + hypertension	692 (52.0)	126 (53.4)	230 (26.5)	32 (17.1)	1,080 (41.2)
Current/former smoker + hypertension + hypercholesterolaemia	599 (45.0)	97 (41.1)	135 (15.6)	17 (910)	848 (32.3)
BMI ≥30 kg/m² + hypercholesterolaemia	463 (34.8)	70 (29.7)	149 (17.2)	16 (8.5)	698 (26.6)
Diabetes + hypertension + hypercholesterolaemia	387 (29.1)	54 (22.9)	77 (8.9)	7 (3.7)	525 (20.0)
Diabetes + eGFR ≤89 mL/min/1.73 kg/m²	248 (18.6)	40 (16.9)	93 (10.7)	9 (4.8)	390 (14.9)
Current/former smoker + BMI ≥30 kg/m² + diabetes	179 (13.4)	27 (11.4)	45 (5.2)	4 (2.1)	255 (9.7)
BMI ≥30 kg/m² + diabetes	276 (20.7)	42 (17.8)	81 (9.3)	9 (4.8)	408 (15.6)

7 Care and treatment of patients

7.1 Admission status

Elective, urgent or emergent status varied widely between the various categories of surgeries. Most CABG cases were performed as urgent cases, whilst emergencies were predominately CABG followed by aortic surgery, in particular correction of aortic dissection.

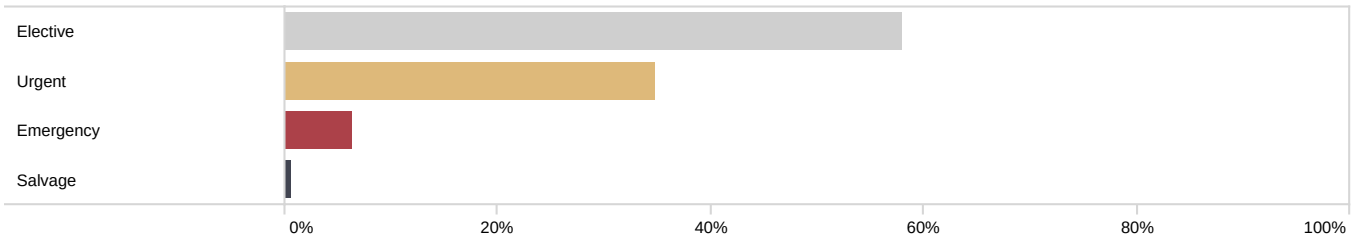


Figure 19: Proportion of cases by admission status

Table 13: Cases by admission status and surgery category

	Elective n (%)	Urgent n (%)	Emergency n (%)	Salvage n (%)
ANY CABG	568 (42.7)	696 (52.3)	57 (4.3)	10 (0.8)
CABG + VALVE	156 (66.1)	73 (30.9)	7 (3.0)	–
VALVE	702 (80.9)	127 (14.6)	37 (4.3)	2 (0.2)
OTHER	97 (51.9)	17 (9.1)	68 (36.4)	5 (2.7)
ALL	**1,523 (58.1)**	**913 (34.8)**	**169 (6.4)**	**17 (0.6)**

7.2 Day of surgery admission

Day of surgery admission (DOSA) rates accounted for 14% of all elective cases, with some variation observed across most surgery categories.

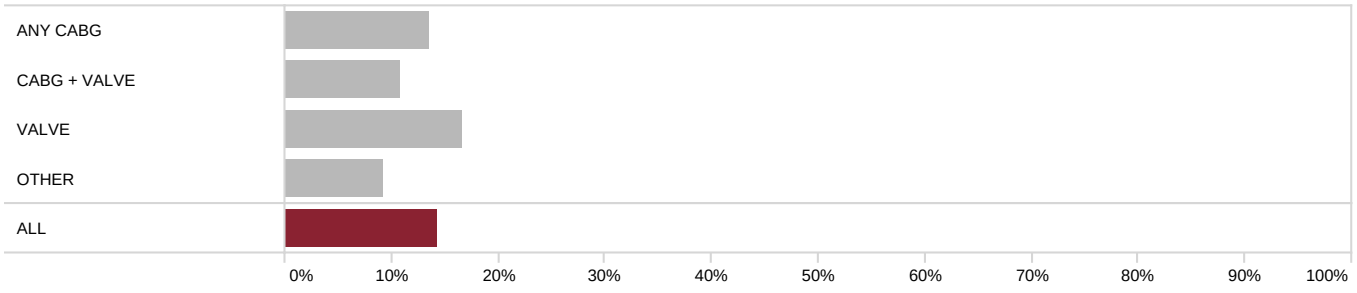


Figure 20: Proportion of elective cases for DOSA cases by surgery category

Table 14: DOSA cases by surgery category

	Total elective cases n	DOSA cases n (%)
ANY CABG	568	77 (13.6)
CABG + VALVE	156	17 (10.9)
VALVE	702	116 (16.5)
OTHER	97	9 (9.3)
ALL	**1,523**	**219 (14.4)**

7.3 Coronary artery bypass grafting

7.3.1 Number of diseased vessels

There were 1,567 CABG procedures performed across all sites. The majority (92%) had multi-vessel disease.

When CABG was performed in conjunction with a valve procedure, 67% of patients had multi-vessel disease compared to 96% when CABG surgery was performed without a valve intervention.

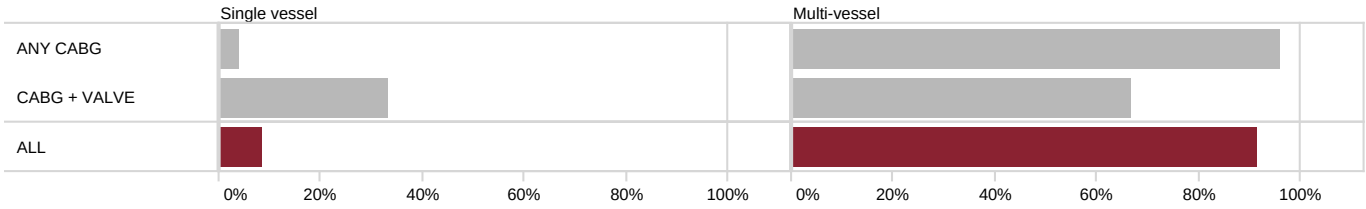


Figure 21: Number of diseased vessels

Table 15: Number of diseased vessels

	Single vessel n (%)	Multi-vessel n (%)	Total n (%)
ANY CABG	54 (4.1)	1,277 (95.9)	1,331 (100.0)
CABG + VALVE	78 (33.2)	158 (66.9)	236 (100.0)
ALL	**132 (8.4)**	**1,435 (91.6)**	**1,567 (100.0)**

Excludes missing data/not applicable (n=6)

7.3.2 Number of grafts

Overall, the average CABG procedure required 2.7 grafts. In multi vessel CABG, the mean number of grafts utilised was 2.9.

Table 16: Number of grafts by number of diseased vessels

	Single vessel mean	Multi vessel mean	Multi vessel median	Total mean
ANY CABG	1.3	2.9	3	2.9
CABG + VALVE	1.1	2.3	2	1.9
ALL	**1.2**	**2.9**	**3**	**2.7**

7.3.3 Conduits used

In CABG, including surgeries involving valvular intervention, the most common form of revascularisation required the use of a combination of an arterial and vein graft (72%). Total arterial revascularisation occurred in 18% of cases.

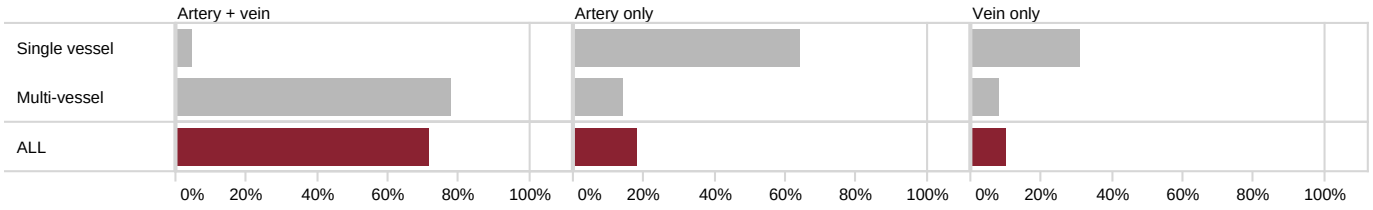


Figure 22: Proportion of diseased vessels by conduits used

Table 17: Conduits used by number of diseased vessels

	Artery + vein n (%)	Artery only n (%)	Vein only n (%)
Single vessel	6 (4.5)	85 (64.4)	41 (31.1)
Multi-vessel	1,121 (78.1)	198 (13.8)	116 (8.1)
ALL	**1,127 (71.9)**	**283 (18.1)**	**157 (10.0)**

7.3.4 Off-pump CABG

Overall, 2% of isolated CABG operations were performed off-pump.

Table 18: Off-pump CABG

	Total cases n	Off-pump n (%)
Isolated CABG	1,284	26 (2.0)

7.3.5 Y or T grafts

Approximately 6% of all CABG surgeries included 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	1,331	80 (6.0)
CABG + VALVE	236	7 (3.0)
ALL	**1,567**	**87 (5.6)**

7.4 Aortic surgery

There were a total of 294 cases that included a procedure involving the aorta (not including procedures conducted on the aortic valve). Aortic aneurysm was the primary reason for aortic surgery (53%).

Most aortic surgery procedures included replacement of the ascending aorta in isolation (60%), while surgery to replace both the ascending aorta and aortic arch accounted for 11% of cases.

Aortoplasty involving patch repair was performed in approximately 18% of aortic surgery cases.

Table 20: Aortic surgery by procedure type

Aortic surgery type	n (%)
Replacement	225 (76.5)
Ascending aorta	176 (59.9)
Ascending + aortic arch	32 (10.9)
Ascending aorta + aortic arch + descending aorta	8 (2.7)
Descending aorta	5 (1.7)
Aortic arch	4 (1.4)
Aortoplasty	56 (19.0)
Patch repair	43 (14.6)
Direct aortoplasty	13 (4.4)
Aortoplasty and replacement	12 (4.1)
Patch repair + ascending aorta	7 (2.4)
Patch repair + ascending aorta + aortic arch	3 (1.0)
Direct aortoplasty + ascending aorta	2 (0.7)
Direct aortoplasty + ascending aorta + aortic arch	1 (0.3)
ALL	**294 (100.0)**

7.4.1 Aortic pathology

Table 21: Aortic surgery cases by pathology type

Aortic pathology type	n (%)
Aortic aneurysm	156 (53.1)
Aortic dissection (≤2 weeks)	50 (17.0)
Calcification	28 (9.5)
Aortic abscess	10 (3.4)
Aortic dissection (>2 weeks)	5 (1.7)
Other	45 (15.3)
ALL	**294 (100.0)**

7.5 Valve surgery

There were 1,104 valve surgery procedures performed at the participating sites during 2019.

The aortic valve was the most commonly operated on valve either with or without other valves (69%). Isolated mitral valve surgery was the next most common valvular surgery (23%).

Overall, 11% of valve operations performed comprised of intervention to multiple valves.

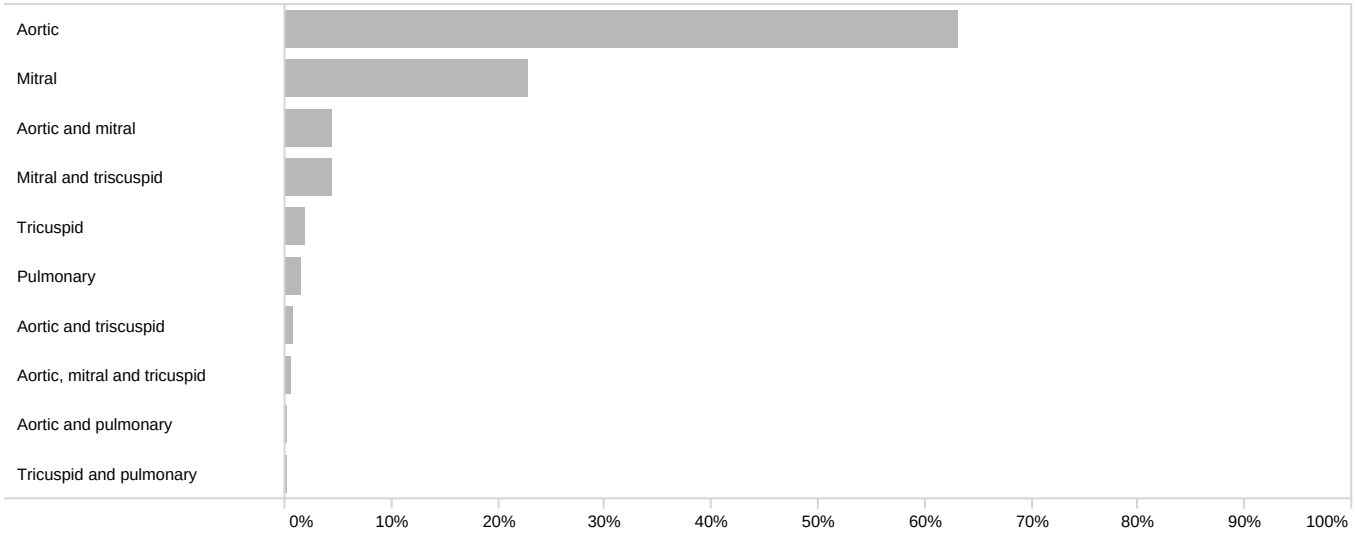


Figure 23: Proportion of valve surgery cases by valve

Table 22: Valve surgery cases by valve

Type of valve surgery	n (%)
Aortic	697 (63.1)
Mitral	251 (22.7)
Aortic and mitral	50 (4.5)
Mitral and tricuspid	48 (4.3)
Tricuspid	22 (2.0)
Pulmonary	16 (1.4)
Aortic and tricuspid	9 (0.8)
Aortic, mitral and tricuspid	7 (0.6)
Aortic and pulmonary	2 (0.2)
Tricuspid and pulmonary	2 (0.2)
ALL	**1,104 (100.0)**

7.5.1 Valve pathology

The most common valve pathology across all valve types was a degenerative cause (56%) and accounted for more than half of all aortic (61%) and mitral (52%) valve procedures.

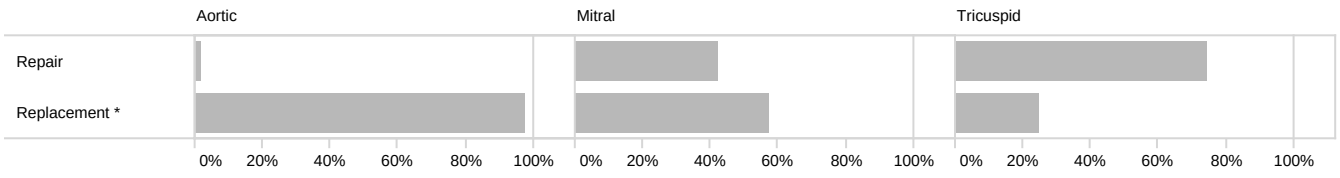
Table 23: Valve pathology by valve type

	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Degenerative	464 (60.7)	186 (52.2)	38 (43.2)	–	688 (56.0)
Congenital	121 (15.8)	6 (1.7)	6 (6.8)	14 (70.0)	147 (12.0)
Infection	42 (5.5)	42 (11.8)	9 (10.2)	2 (10.0)	95 (7.7)
Rheumatic	18 (2.4)	37 (10.4)	8 (9.1)	–	63 (5.1)
Prosthesis failure	28 (3.7)	22 (6.2)	–	2 (10.0)	52 (4.2)
Dissection	34 (4.5)	–	–	–	34 (2.8)
Ischaemic	–	21 (5.9)	–	–	21 (1.7)
Annuloaortic ectasia	16 (2.1)	–	–	–	16 (1.3)
Functional	–	–	13 (14.8)	–	13 (1.1)
Peri-prosthetic leak	3 (0.4)	–	–	1 (5.0)	4 (0.3)
Failed prior repair	–	–	3 (3.4)	–	3 (0.2)
Iatrogenic	1 (0.1)	–	–	–	1 (0.1)
Other	38 (5.0)	42 (11.8)	11 (12.5)	1 (5.0)	92 (7.5)
ALL	**765 (100.0)**	**356 (100.0)**	**88 (100.0)**	**20 (100.0)**	**1,229 (100.0)**

7.5.2 Types of valve surgery

The majority of valve surgery cases involved aortic valve intervention (62%).

The most common aortic valve procedure was replacement surgery (98%), with the remainder involving valve repair. Similarly, for the mitral valve, replacement was more frequent than repair (54% vs. 46%).



* Aortic replacement category includes transcatheter aortic valve replacement (TAVR) cases involving CTS.

Figure 24: Valve surgery category by valve

Table 24: Valve surgery category by valve type

Surgery category	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Repair	14 (1.8)	164 (46.1)	72 (81.8)	1 (5.0)	251 (20.4)
Replacement	751 (98.2)*	192 (53.9)	16 (18.2)	19 (95.0)	978 (79.6)
Inspection only	–	–	–	–	–
ALL	**765 (100.0)**	**356 (100.0)**	**88 (100.0)**	**20 (100.0)**	**1,229 (100.0)**

* Includes TAVR procedure involving CTS (n=134)

Transcatheter aortic valve replacement (TAVR)

A TAVR procedure is often a combined effort of a multidisciplinary heart team involving both interventional cardiologists and cardiac surgeons, among other specialties. Despite the varied role of the surgeon in the heart team, over half (54%) of all TAVR were performed with a cardiac surgeon involved in the procedure.

It should be noted that the reported number of TAVR cases within this Audit reflects those where a cardiothoracic surgeon was present during the procedure. As such, it does not represent the total number of these surgeries performed in Queensland public hospitals in 2019.

Further detail regarding all TAVR procedures performed in a Queensland public hospital are included in the structural heart disease supplement to the interventional cardiology chapter 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	156	41 (26.3)
PAH	54	54 (100.0)
GCUH	26	26 (100.0)
STATEWIDE	**249**	**134 (54.0)**

7.5.3 Valve repair surgery

The most common form of valve repair surgery was repair/reconstruction with annuloplasty (80%) followed by annuloplasty only (10%). Mitral valve repair/reconstruction with annuloplasty was the most common individual valve repair surgery comprising 57% of overall valve repair surgery.

Table 26: Valve repair surgery by valve type

	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Repair/reconstruction with annuloplasty	–	142 (86.6)	57 (79.2)	–	199 (79.3)
Annuloplasty only	–	14 (8.5)	12 (16.7)	–	26 (10.4)
Repair/reconstruction without annuloplasty	–	5 (3.0)	3 (4.2)	–	8 (3.2)
Root reconstruction with valve sparing	7 (50.0)	–	–	–	7 (2.7)
Resuspension of aortic valve	6 (42.9)	–	–	–	6 (2.4)
Repair paravalvular leak	–	1 (0.6)	–	1 (100.0)	2 (0.8)
Tumour tissue removal	1 (7.1)	1 (0.6)	–	–	2 (0.8)
Alfieri suture	–	1 (0.6)	–	–	1 (0.4)
ALL	**14 (100.0)**	**164 (100.0)**	**72 (100.0)**	**1 (100.0)**	**251 (100.0)**

7.5.4 Valve replacement surgery

Aortic valve replacement accounted for the majority of valve replacement surgeries (76%), which included 134 TAVR procedures and 120 aortic root reconstruction surgeries utilising a valved conduit.

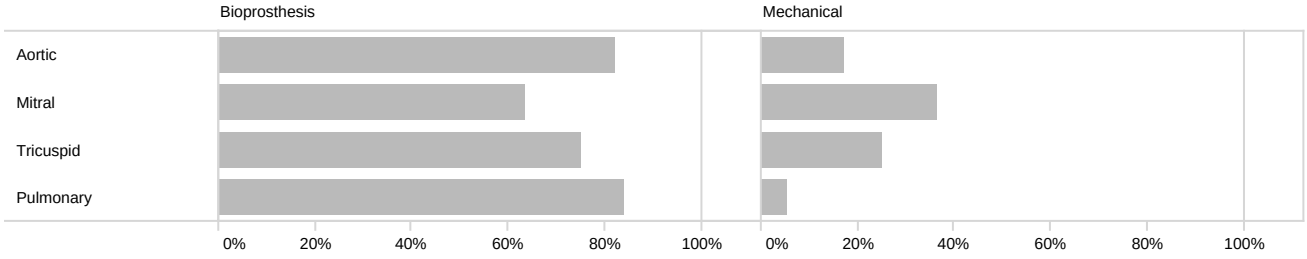
Table 27: Valve replacement surgery by valve type

Surgery type	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Replacement	497 (66.2)	192 (100.0)	16 (100.0)	19 (100.0)	724 (74.0)
TAVR	134 (15.7)	–	–	–	134 (13.7)
Root reconstruction with valve conduit	120 (16.0)	–	–	–	120 (12.3)
ALL	**751 (100.0)**	**192 (100.0)**	**16 (100.0)**	**19 (100.0)**	**978 (100.0)**

Prosthesis type

The most common form of valve prostheses used across all valve types were biological (78%). Mechanical prostheses were used in 21% of cases with a greater proportion represented in mitral valve replacement surgeries.

Porcine-derived aortic valve prostheses accounted for the largest proportion of all valves used, representing 36% of all aortic valve prostheses and 55% of the total valvular prostheses used.



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

Figure 25: 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	349 (46.5)	17 (8.9)	0 (0.0)	2 (10.5)	368 (37.6)
Biological – porcine	267 (35.6)	105 (54.7)	12 (75.0)	14 (73.7)	398 (40.7)
Mechanical	131 (17.4)	70 (36.5)	4 (25.0)	1 (5.3)	206 (21.1)
Homograft/allograft	3 (0.4)	0 (0.0)	0 (0.0)	2 (10.5)	5 (0.5)
Autograft	1 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.1)
ALL	**751 (100.0)**	**192 (100.0)**	**16 (100.0)**	**19 (100.0)**	**978 (100.0)**

7.6 Other cardiac surgery

The most common forms of other cardiac surgery were atrial septal defect repair (10%), followed by left atrial appendage closure (9%). Approximately 8% of other surgeries were classified as various other cardiac surgery.

Table 29: Other cardiac procedures

Procedure	n (%)
Atrial septal defect repair	37 (10.8)
Left atrial appendage closure	31 (9.1)
Atrial arrhythmia surgery	29 (8.5)
Other congenital	28 (8.2)
LVOT† myectomy for HOCM‡	26 (7.6)
BSSLTx*	23 (6.7)
Cardiac tumour	20 (5.8)
Ventricular septal defect repair	15 (4.4)
Cardiac transplant	14 (4.1)
ECMO‖ procedure	11 (3.2)
VAD§ procedure	10 (2.9)
Permanent LV epicardial lead	9 (2.6)
PPM procedure	8 (2.3)
LV aneurysm repair	7 (2.0)
Lung resection	6 (1.8)
Patent foramen ovale repair	5 (1.5)
Single lung transplant	5 (1.5)
Septal myectomy	5 (1.5)
Other myectomy	5 (1.5)
Cardiac trauma	4 (1.2)
Pulmonary thrombo-endarterectomy	4 (1.2)
Pericardiectomy	3 (0.9)
PAPVD# repair	3 (0.9)
Coronary artery endarterectomy	2 (0.6)
Cardiopulmonary transplant	2 (0.6)
Pericardial effusion drainage	2 (0.6)
Other cardiac	28 (8.2)
ALL	**342 (100.0)**

* Bilateral sequential single lung transplantation

† Left ventricular outflow tract

‡ Hypertrophic obstructive cardiomyopathy

§ 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 (65%). However, as the urgency of operations increased, so too did the requirement for red blood cells (RBC) and non-red blood cells (NRBC). Three quarters (75%) of all emergency cases utilised at least one blood product.

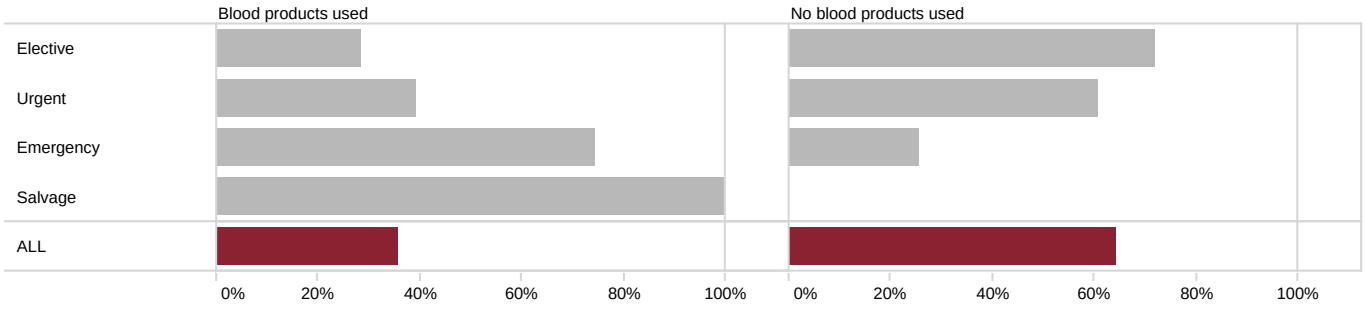


Figure 26: Blood products used by admission status

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	149 (9.8)	161 (10.6)	119 (7.8)	1,094 (71.8)
Urgent	137 (15.0)	146 (16.0)	76 (8.3)	554 (60.7)
Emergency	78 (46.2)	24 (14.2)	24 (14.2)	43 (25.4)
Salvage	13 (76.5)	4 (23.5)	0 (0.0)	0 (0.0)
ALL	**377 (14.4)**	**335 (12.8)**	**219 (8.4)**	**1,691 (64.5)**

8 Outcomes

Measures of outcomes in this cardiac surgery report comprise of factors that effect 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

Risk adjustment models are a commonly employed method of estimating patient outcomes based on patient-specific comorbidities and clinical factors known at the time of surgery. This statistical analysis enables the adjustment of risk for individual patients, attempting to correct for patients who may be undergoing surgery in a critical pre-operative state e.g. cardiogenic shock as opposed to an elective procedure in a patient with limited comorbid factors.

Risk scores in cardiac surgery are established from large patient cohorts and are usually relevant for a particular period in time, and in a particular geographical area.

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. In this 2019 cohort, EuroSCORE II is reported for the first time.

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 postoperative risk of complications (morbidity).

The risk prediction models used in evaluating the 2019 clinical outcomes for cardiac surgical cases are:

- EuroSCORE[14]
- EuroSCORE II[15]
- ANZSCTS General Score[16]
- AusSCORE[17]
- STS Score (mortality and morbidity)[18, 19, 20]

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[14], EuroSCORE II[15], and ANZSCTS General Score[16] can be applied to evaluate deaths for all types of cardiac surgical cases, whereas the AusSCORE model[17] 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.

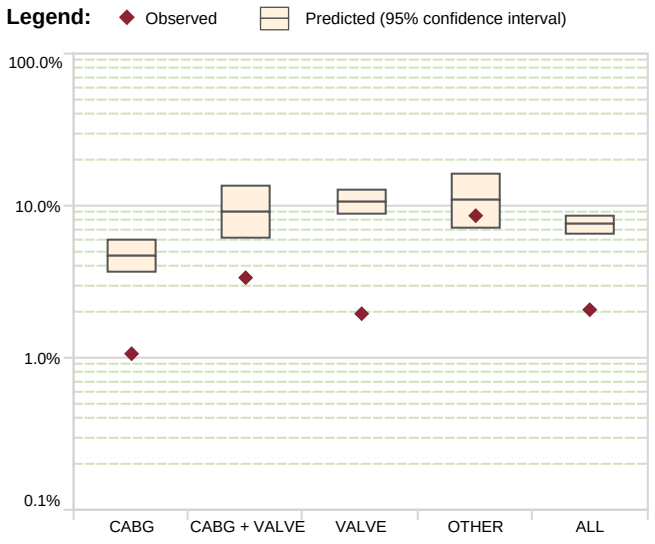


Figure 27: EuroSCORE

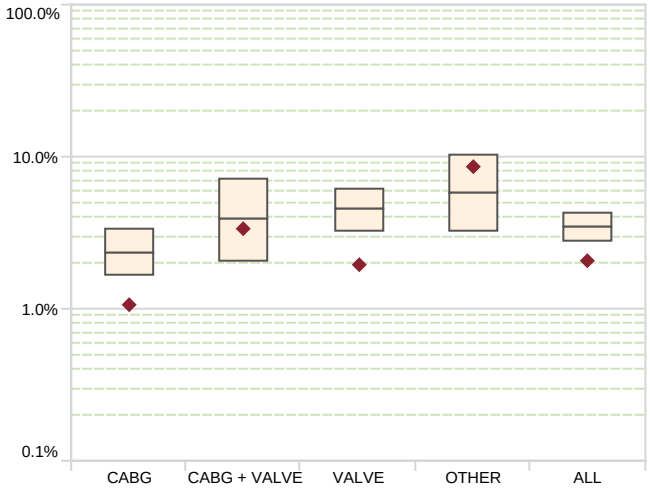


Figure 28: EuroSCORE II

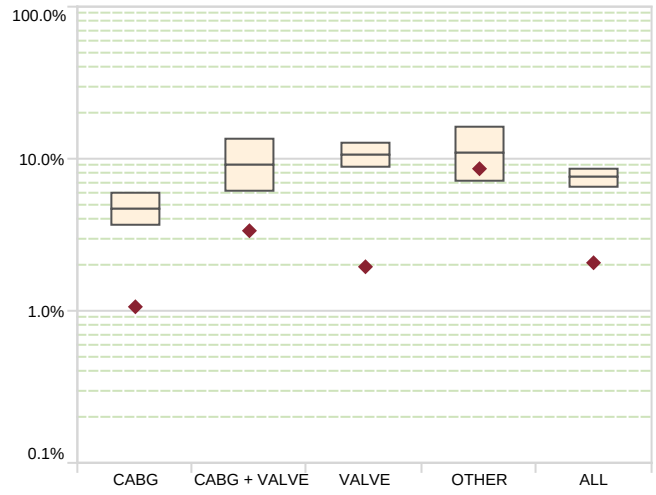


Figure 29: ANZSCTS (General Score)

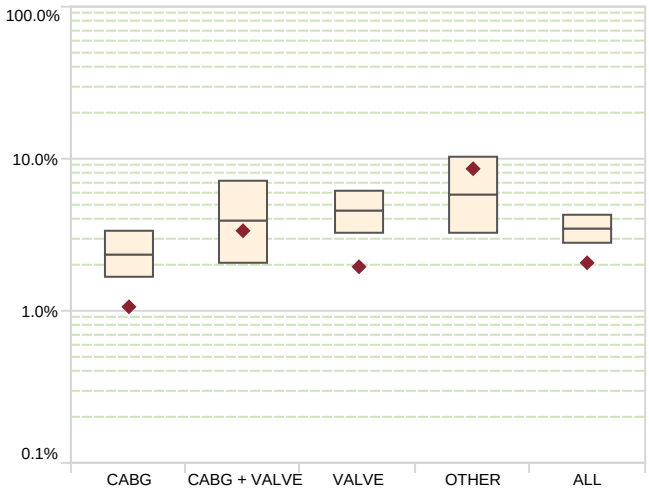


Figure 30: STS (death)

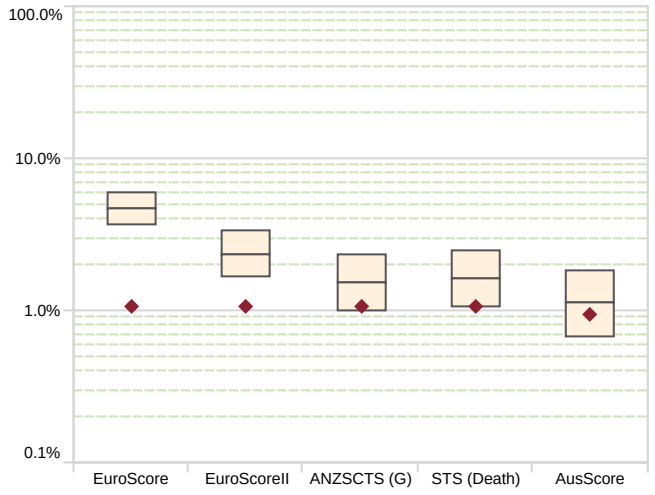


Figure 31: CABG

8.1.2 Morbidity

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

The aggregated morbidities chart (Figure 37) 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 exception continues to be deep sternal wound infection (DSWI) in CABG cases and the All category, where the rate appears be higher than predicted.

As the definition of DSWI includes reopening and debridement of the wound site, a flow-on consequence of this event is the higher than expected rate of reoperations in CABG cases.

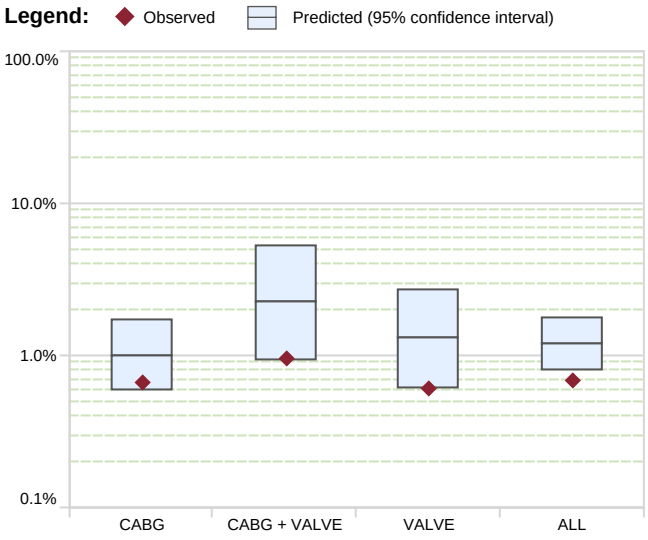


Figure 32: Cerebrovascular accident

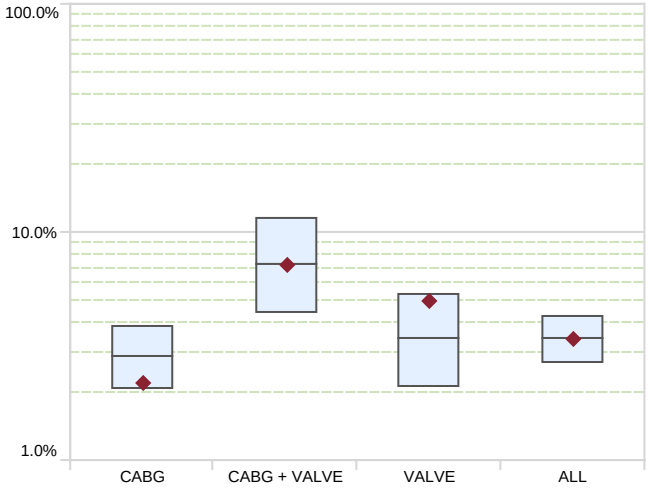


Figure 33: Renal failure

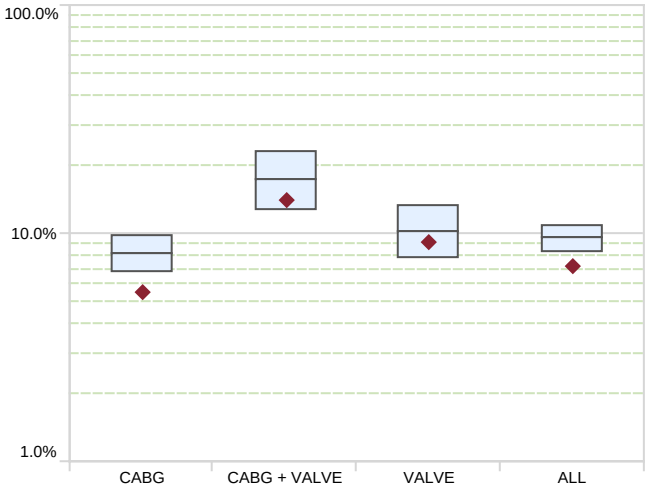


Figure 34: Ventilation >24 hours

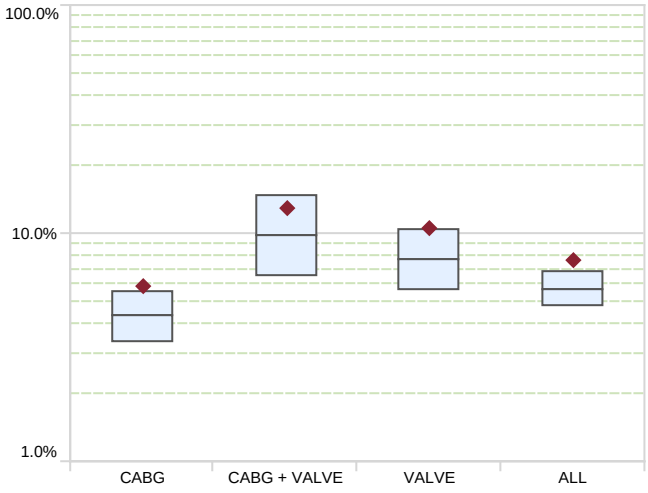


Figure 35: Reoperation

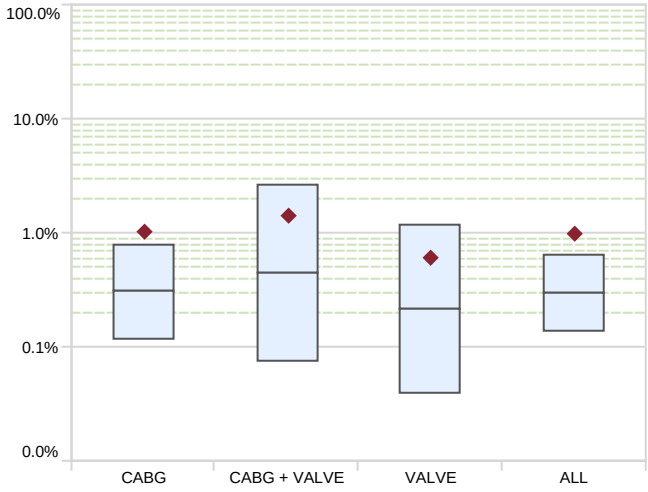


Figure 36: Deep sternal infection

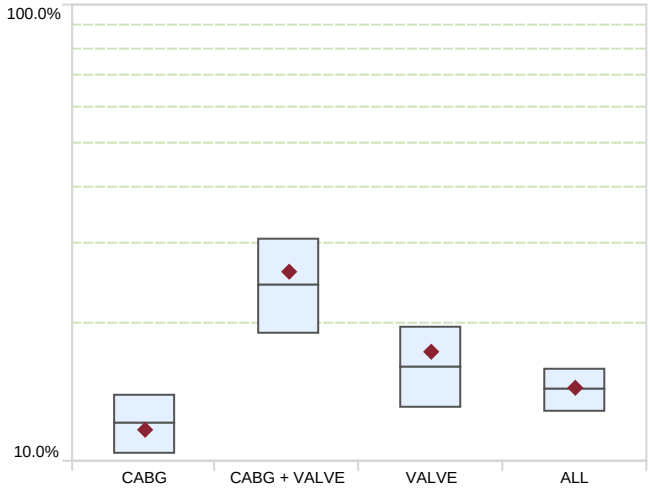


Figure 37: Major morbidity

8.1.3 Measures of process

The following graphs assesses 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 larger than expected. Further investigation is needed to delineate whether this measure is prolonged due to institutional processes or factors relating to patient care.

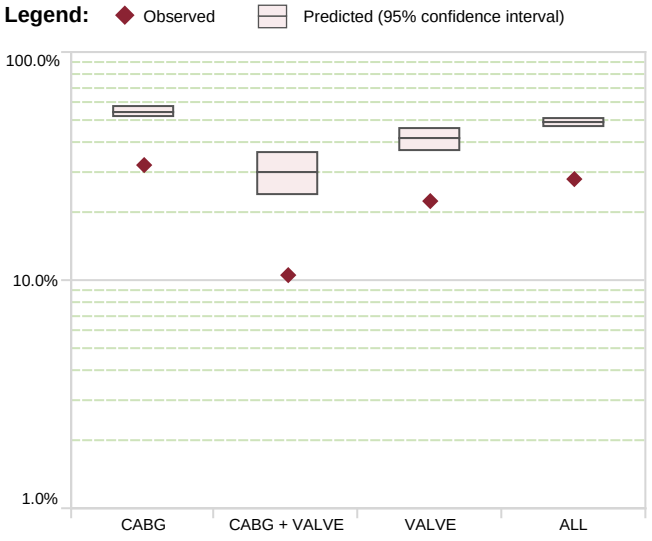


Figure 38: LOS ‹6 days

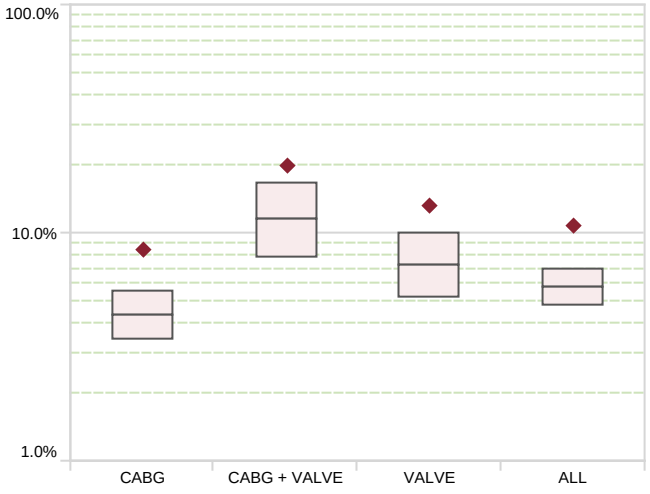


Figure 39: LOS ›14 days

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. It is used to describe the prognosis of the patient cohort that has experienced a postoperative 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 CABG cases is statistically better than predicted and the rate for valve, and combined CABG and valve cases is within the expected range.

In summary, processes set-up to deal with adverse events appear to be functioning at or better than the expected level.

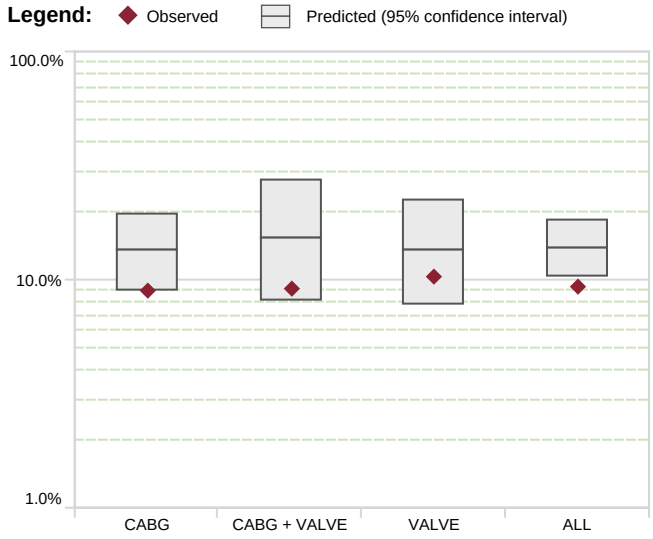


Figure 40: Failure to rescue

9 Conclusions

This is the fourth report to examine cardiac surgery outcomes for Queensland and once again highlights that cardiac surgery is being performed in Queensland to high levels of safety, with better than expected results when compared to American, European and Australian risk scores. While the bulk of surgery is acute coronary surgery, the remaining surgeries involve a wide array of procedures. The teams and systems that perform cardiac surgery are functioning well for Queenslanders.

Deep sternal wound infection for isolated CABG continues to be encountered at a higher than expected rate based on risk scores. This in turn is reflected in results for the overall cohort. As discussed in previous reports, this appears to be a persistent finding. Further work to investigate what elements may predict DSWI and whether any form of risk factor modification is possible prior to surgery to alleviate this elevated rate is clearly warranted.

Surgical aortic valve replacement case volume has reduced over the past three years however there has been a commensurate increase in the numbers of transcatheter valvular procedures. Evolving clinical guidelines for utilisation of transcatheter replacement as opposed to traditional surgical approach as well as an increasing appreciation of the operational benefits in terms of length of stay will continue to see increasing volumes of these procedures.

The addition of the EuroSCORE II risk prediction model and expanded examination of infective endocarditis in this year's report reflects the advantages and responsiveness of QCOR as a bespoke registry guided by the specific needs of Queensland clinicians. We look forward to further opportunities to expand on these analyses in future reports.

Expansion of the data analysis project in Queensland cardiac surgery will, in future, seek to include the publication of data from the Queensland Children's Hospital. Our paediatric cardiac surgical colleagues are leading the drive across Australia and New Zealand to establish a registry in which performance in paediatric cardiac surgery can be assessed. This project has been undertaken so far without direct involvement from QCOR. Preliminary collaboration reflects willingness for open disclosure and accountability for their results. Our aim is to support their efforts to establish Australia and New Zealand wide benchmarking for paediatric cardiac surgery.

10 Supplement: Cardiac surgery and geography

This report seeks to identify any relationship between the amount of time spent in hospital after cardiac surgery and the geographic remoteness of the patient's place of usual residence. The focus is on patients who have undergone cardiac surgery at one of the four public cardiothoracic surgery units located in Queensland between the years of 2017 and 2019.

With a land area of 1.7 million square kilometres, Queensland is Australia's second-largest state and home to a widely-dispersed population of approximately five million people. Queensland is the most decentralised of all mainland Australian states, with (36%) of Queenslanders residing in regional or remote areas. The population is most heavily concentrated along the Eastern Seaboard and 7,000 kilometre stretch of Queensland Pacific coastline.

For the outcomes analysis, the two primary outcomes of interest had been postoperative length of stay (LOS) less than six days and LOS greater than 14 days. The secondary outcome of interest was to examine any effect of geographic remoteness on subsequent rehospitalisation within 30 days of surgery. The six and 14 day cut-offs had been selected to align with the STS measures which have been used elsewhere in the document.

Patients were classed into a remoteness area based on the Australian Statistical Geography Standard[21], using their postcode and suburb combination. The estimated distance travelled for surgery was based on the direct, point-to-point distance (excluding driving time). Data linkage with Queensland Hospital Admitted Patient Data Collection was used to identify additional time spent in a public hospital postoperatively outside of the participating cardiac surgery unit.

Table 1: Queensland and Australian total estimated resident population by remoteness area

Remoteness area	Queensland n (%)	Australia n (%)
Major Cities of Australia	3,282,614 (64.4)	18,320,373 (72.2)
Inner Regional Australia	991,155 (19.5)	4,499,741 (17.7)
Outer Regional Australia	694,038 (13.6)	2,054,693 (8.1)
Remote Australia	71,900 (1.4)	290,431 (1.1)
Very Remote Australia	54,803 (1.1)	200,333 (0.8)
Total	**5,094,510 (100.0)**	**25,365,571 (100.0)**

Australian Bureau of Statistics. Regional Population Growth 2018-19, March 2020. Cat No 3218.0. Accessed November 2020

The majority of Queensland's population reside in areas classed as Major Cities of Australia (64%) with approximately one-fifth (20%) residing in Inner Regional areas. As expected, the proportion residing in Regional, Remote and Very Remote areas of Queensland demonstrates a stepwise decrease as distance to the Metropolitan area increases (Table 1).

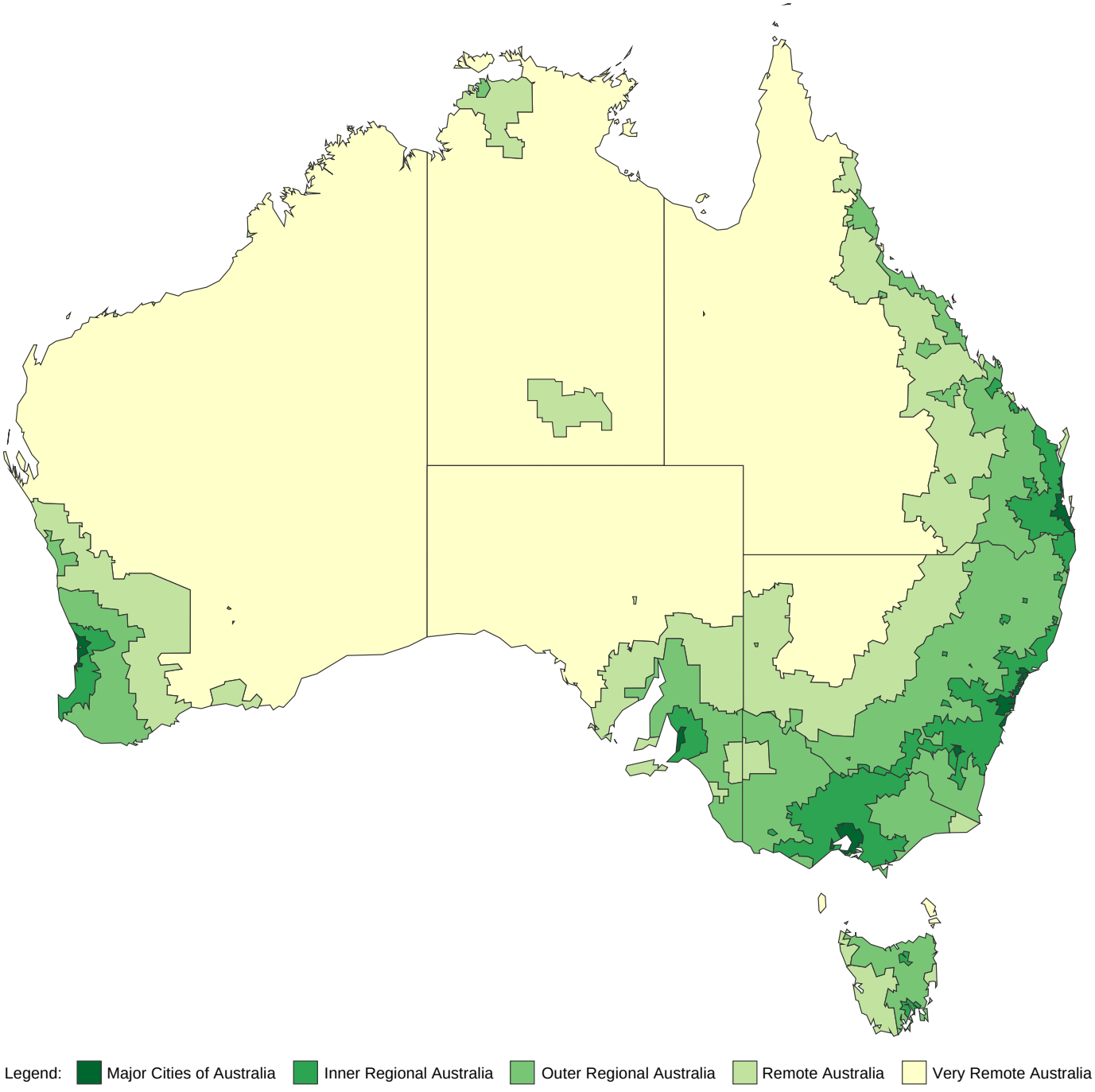


Figure 1: Australian Statistical Geography Standard remoteness areas

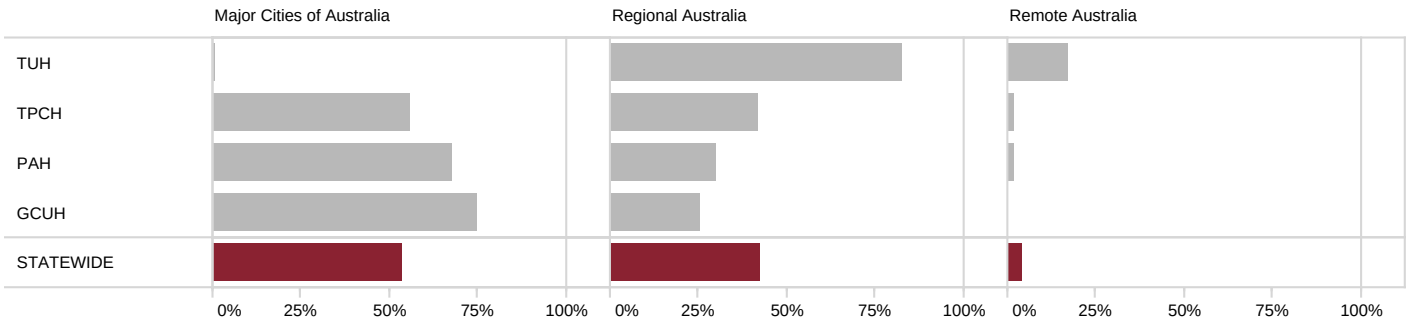
TUH treated the largest proportion of patients residing in Remote and Very Remote parts of Queensland (6% and 12% respectively). This contrasts with GCUH whose patient cohort resided predominantly (75%) within the Major Cities area. Of the overall patient cohort, 54% of patients lived in a Major City with 2.5% from a Very Remote location. This finding is consistent with an overall trend where patients undergoing cardiac surgery who reside in a Regional or Remote location are overrepresented when compared to their background population proportion.

As expected, median distances travelled by patients increased as their remoteness area moved further from Major Cities. The median estimated travel distance for those Queenslanders residing in Very Remote areas (787 km) is in stark contrast to those living in a Major City (18 km).

Table 2: Cardiac surgery cases by remoteness area and treating facility (2017–2019)

	Total cases n	Major Cities of Australia n (%)	Inner Regional Australia n (%)	Outer Regional Australia n (%)	Remote Australia n (%)	Very Remote Australia n (%)
TUH	1,063	5 (0.5)	114 (10.7)	761 (71.6)	58 (5.5)	125 (11.8)
TPCH	3,413	1,913 (56.1)	1,233 (36.1)	200 (5.9)	29 (0.8)	38 (1.1)
PAH	1,820	1,232 (67.7)	423 (23.2)	129 (7.1)	19 (1.0)	17 (0.9)
GCUH	1,019	762 (74.8)	231 (22.7)	26 (2.6)	–	–
STATEWIDE	**7,315**	**3,912 (53.5)**	**2,001 (27.4)**	**1,116 (15.3)**	**106 (1.4)**	**180 (2.5)**

Excludes missing postcode, no fixed abode, and overseas patients (0.5%)



Excludes missing postcode, no fixed abode, and overseas patients (0.5%)

Figure 2: Cardiac surgery cases by remoteness area and treating facility (2017–2019)

Table 3: Estimated distance travelled by remoteness area (2017–2019)

Remoteness area	Total cases n	Median kilometres	Interquartile range kilometres
Major Cities of Australia	3,912	18	9–30
Inner Regional Australia	2,001	156	95–287
Outer Regional Australia	1,116	252	73–298
Remote Australia	106	390	132–491
Very Remote Australia	180	787	690–959
Total	**7,315**	**37**	**15–182**

Excludes missing postcode, no fixed abode, and overseas patients (0.5%)

10.1 Patient characteristics

There were minimal differences in gender proportions observed when examined by remoteness area. Males were more likely to undergo cardiac surgery in all remoteness areas with the highest proportion of females represented in the Remote Australia area. As the remoteness of the area increased, there was a stepwise increase in the proportion of identified Aboriginal and Torres Strait Islander patients. There was a nine-year difference in median age observed between patients residing in Major Cities compared to those in Very Remote areas (66 years vs. 57 years).

Table 4: Patient characteristics by remoteness area (2017–2019)

	Major Cities of Australia n (%)	Inner Regional Australia n (%)	Outer Regional Australia n (%)	Remote Australia n (%)	Very Remote Australia n (%)	ALL n (%)
Gender						
Male	2,865 (73.2)	1,486 (74.3)	800 (71.7)	70 (66.0)	130 (72.2)	5,351 (73.2)
Female	1,047 (26.8)	515 (25.7)	316 (28.3)	36 (34.0)	50 (27.8)	1,964 (26.8)
Age group (years)						
<40	245 (6.3)	85 (4.2)	56 (5.0)	9 (8.5)	26 (14.4)	421 (5.8)
40–49	323 (8.3)	111 (5.5)	89 (8.0)	8 (7.5)	29 (16.1)	560 (7.7)
50–59	726 (18.6)	353 (17.6)	235 (21.1)	25 (23.6)	49 (27.2)	1,388 (19.0)
60–69	1,197 (30.6)	649 (32.4)	326 (29.2)	36 (34.0)	44 (24.4)	2,252 (30.8)
70–79	1,112 (28.4)	612 (30.6)	319 (28.6)	25 (23.6)	27 (15.0)	2,095 (28.6)
≥80	309 (7.9)	191 (9.5)	91 (8.2)	3 (2.8)	5 (2.8)	599 (8.2)
Aboriginal and Torres Strait Islander status						
Indigenous	110 (2.8)	108 (5.4)	145 (13.0)	36 (34.0)	99 (55.0)	498 (6.8)
Non-Indigenous	3,802 (97.2)	1,893 (94.6)	971 (87.0)	70 (66.0)	81 (45.0)	6,817 (93.2)
Total	**61 (100.0)**	**1,098 (100.0)**	**1,750 (100.0)**	**1,630 (100.0)**	**206 (100.0)**	**4,745 (100.0)**

Excludes missing postcode, no fixed abode, and overseas patients (0.5%)

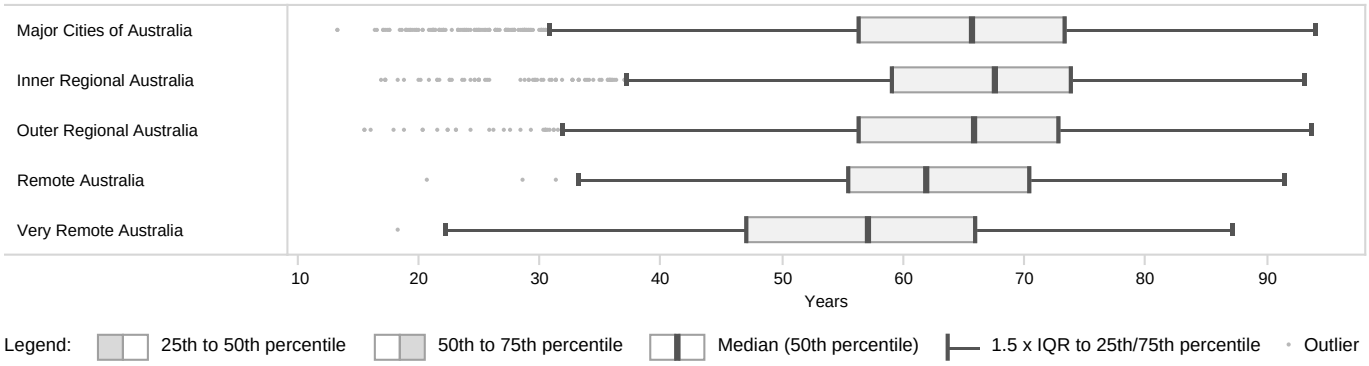


Figure 3: Patient age distribution by remoteness area (2017–2019 cohort)

Table 5: Median age by gender and remoteness area (2017–2019 cohort)

Remoteness area	Male years	Female years	ALL years
Major Cities of Australia	67	66	66
Inner Regional Australia	68	68	68
Outer Regional Australia	66	66	66
Remote Australia	62	62	62
Very Remote Australia	57	57	57
Total	**67**	**66**	**66**

Excludes missing postcode, no fixed abode, and overseas patients (0.5%)

10.2 Risk factors and comorbidities

As residential remoteness area progresses to becoming more remote, so too does the incidence of risk factors and comorbidities. There was an appreciable difference in the proportions of patients with higher BMI, current smoking status, diabetes, hypertension and statin usage between the Major Cities and Very Remote areas.

Table 6: Risk factors and comorbidities by remoteness area (2017–2019)

	Major Cities of Australia n (%)	Inner Regional Australia n (%)	Outer Regional Australia n (%)	Remote Australia n (%)	Very Remote Australia n (%)	ALL n (%)
BMI ≥30 kg/m²	1,498 (38.3)	793 (39.6)	441 (39.5)	44 (41.5)	80 (44.4)	2,856 (39.0)
Current smoker	603 (15.4)	314 (15.7)	223 (20.0)	24 (22.6)	65 (36.1)	1,229 (16.8)
Former smoker	1,590 (40.6)	932 (46.6)	481 (43.1)	43 (40.6)	59 (32.8)	3,105 (42.4)
Diabetes	1,021 (26.1)	560 (28.0)	332 (29.7)	34 (32.1)	89 (49.4)	2,036 (27.8)
Hypertension	2,560 (65.4)	1,365 (68.2)	778 (69.7)	74 (69.8)	131 (72.8)	4,908 (67.1)
Statin therapy	2,390 (61.1)	1,295 (64.7)	700 (62.7)	70 (66.0)	125 (69.4)	4,580 (62.6)
Infective endocarditis	172 (4.4)	83 (4.1)	46 (4.1)	4 (3.8)	6 (3.3)	311 (4.3)
Mild renal dysfunction*	1,313 (33.6)	717 (35.8)	369 (33.1)	37 (34.9)	35 (19.4)	2,471 (33.8)
Moderate renal dysfunction†	696 (17.8)	355 (17.7)	178 (15.9)	11 (10.4)	26 (14.4)	1,266 (17.3)
Severe renal dysfunction‡	91 (2.3)	47 (2.3)	37 (3.3)	6 (5.7)	9 (5.0)	190 (2.6)
LVEF 40–50%	723 (18.5)	354 (17.7)	212 (19.0)	21 (19.8)	33 (18.3)	1,343 (18.4)
LVEF 30–39%	258 (6.6)	127 (6.3)	72 (6.5)	17 (16.0)	20 (11.1)	494 (6.8)
LVEF <30%	185 (4.7)	83 (4.1)	43 (3.9)	5 (4.7)	7 (3.9)	323 (4.4)

* eGFR 60–89 mL/min/1.73m²

† eGFR 30–59 mL/min/1.73m²

‡ eGFR <30 mL/min/1.73m²

10.3 Care and treatment of patients

There was a greater proportion of patients undergoing CABG in the Very Remote Australia area when compared to others, which suggests a higher rate of coronary artery disease as a specific medical pathology in this cohort. Salvage cases were more often encountered in patients residing in the Major Cities area, which likely owes to the high-risk nature of this presentation category. Elective day of surgery admission rates were also markedly different across remoteness areas (Table 7).

Table 7: Treatment characteristics by remoteness area (2017–2019)

	Major Cities of Australia n (%)	Inner Regional Australia n (%)	Outer Regional Australia n (%)	Remote Australia n (%)	Very Remote Australia n (%)	ALL n (%)
Surgery category						
ANY CABG	1,950 (49.8)	989 (49.4)	567 (50.8)	53 (50.0)	108 (60.0)	3,667 (50.1)
CABG + VALVE	357 (9.1)	216 (10.8)	112 (10.0)	14 (13.2)	21 (11.7)	720 (9.8)
VALVE	1,268 (32.4)	661 (33.0)	372 (33.3)	32 (30.2)	43 (23.9)	2,376 (32.5)
OTHER	337 (8.6)	135 (6.7)	65 (5.8)	7 (6.6)	8 (4.4)	552 (7.5)
Isolated CABG						
	1,880 (48.1)	955 (47.7)	540 (48.4)	51 (48.1)	103 (57.2)	3,529 (48.2)
Admission status						
Elective	2,225 (56.9)	1,100 (55.0)	624 (55.9)	62 (58.5)	107 (59.4)	4,118 (56.3)
Urgent	1,338 (34.2)	781 (39.0)	445 (39.9)	39 (36.8)	67 (37.2)	2,670 (36.5)
Emergency	325 (8.3)	118 (5.9)	43 (3.9)	4 (3.8)	6 (3.3)	496 (6.8)
Salvage	24 (0.6)	2 (0.1)	4 (0.4)	1 (0.9)	0 (0.0)	31 (0.4)
Elective day of surgery admission						
	453 (20.4)	49 (4.5)	78 (12.5)	5 (8.1)	10 (9.3)	595 (14.4)
Discharge method						
Home/usual residence	3,703 (94.7)	1,852 (92.6)	1,038 (93.0)	98 (92.5)	168 (93.3)	6,859 (93.8)
Other*	209 (5.3)	149 (7.4)	78 (7.0)	8 (7.5)	12 (6.7)	456 (6.2)
Total	**3,912 (100.0)**	**2,001 (100.0)**	**1,116 (100.0)**	**106 (100.0)**	**180 (100.0)**	**7,315 (100.0)**

Excludes missing postcode, no fixed abode, and overseas patients (0.5%)

* Includes transfer to a private/interstate hospital, in-hospital mortality, nursing home or other health care accommodation

10.4 Patient outcomes

This section examines the association of patient remoteness on postoperative length of stay and rehospitalisation within 30 days. For the purpose of this analysis, relative odds ratios (OR) have been derived to compare outcomes across categories while controlling for clinical risk factors and in hospital complications/major morbidities.

Cases were excluded from the outcomes analysis where the postcode data were missing, for patients with no fixed place of residence or residing overseas, or where the patient had died during their hospital visit.

10.4.1 Postoperative length of stay

After adjusting for clinical characteristics and other procedural factors, the analysis 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. Patients in Outer Regional and Remote/Very Remote areas were two to four times more likely to spend additional time in hospital. (Outer Regional: OR 2.02, p<0.01, Remote/ Very Remote: OR 4.05, p <0.001).

Paradoxically, it was also found that when adjusted for clinical characteristics and procedural factors, patients residing in an Inner Regional and Outer Regional area had a higher likelihood of having a length of stay <6 days (Inner Regional: OR 1.61 p=0.009, Outer Regional: OR 1.45 p=0.044). Though it may seem likely that patients who reside further from their centre of treatment would be discharged to other care arrangements to ensure access to appropriate support, review of postoperative discharge destinations (Table 6) shows only a small proportion of patients within each geographic area who were not discharged to their usual place of residence. Further investigation may identify differences in practice with respect to these patients.

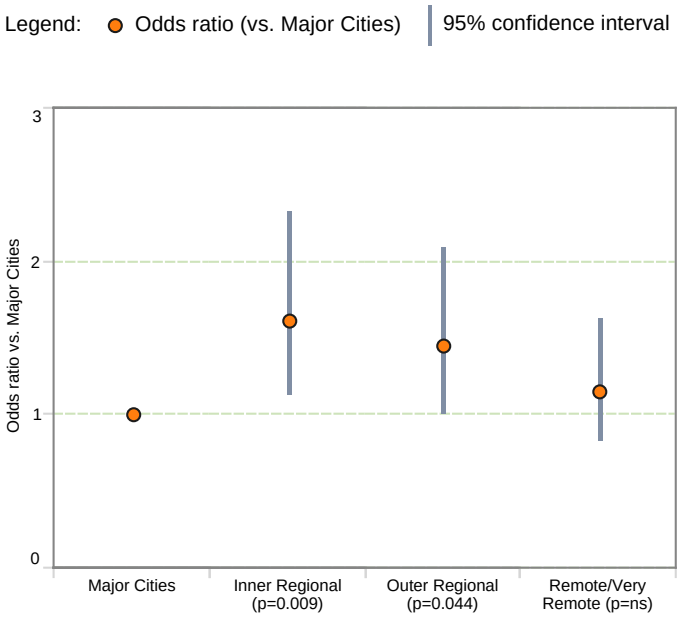


Figure 4: Standardised incidence of postoperative LOS less than six days by remoteness area (2017–2019)

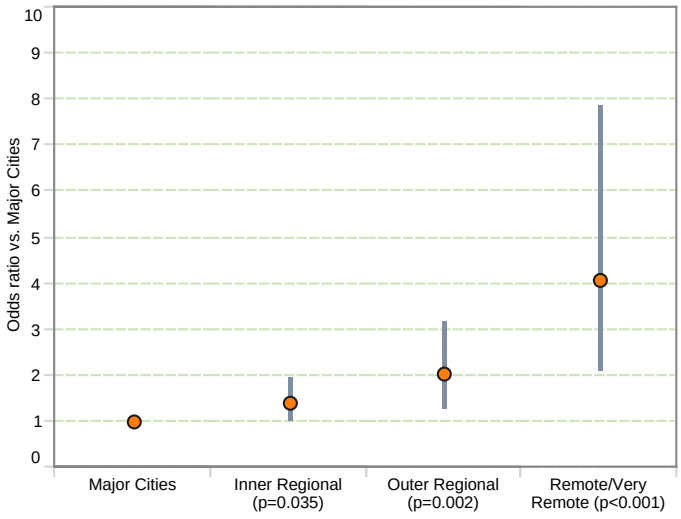


Figure 5: Standardised incidence of postoperative LOS greater than 14 days by remoteness area (2017–2019)

Table 8: Standardised incidence of overall LOS less than six days and greater than 14 days by remoteness area (2017–2019)

	Major Cities of Australia*	Inner Regional OR (p value)	Outer Regional OR (p value)	Remote/Very Remote OR (p value)
Post operative LOS <6 days	1.00	1.61 (p=0.009)	1.45 (p=0.044)	1.16 (p>0.05)
Post operative LOS >14 days	1.00	1.40 (p=0.035)	2.02 (p=0.002)	4.05 (p<0.001)

* Used as reference/baseline for comparison across categories

10.4.2 Rehospitalisation within 30 days of surgery

In examining all-cause rehospitalisation within 30 days of surgery, there was minor variation observed when the patient remoteness areas were individually compared against the Major Cities area. Patients in Inner Regional and Outer Regional areas had a slightly lower overall 30 day rehospitalisation rate compared to patients located more closely towards the Greater Brisbane area (Inner Regional: OR 0.75, p<0.001, Outer Regional: OR 0.73, p=0.026).

This lower rate of 30 day rehospitalisation for patients in Inner Regional and Outer Regional areas may be associated with the increased rate of LOS>14 days for these patients. This could be attributable to patients who had required staged or subsequent procedures being retained in hospital for longer in the first instance, thereby leading to a reduced incidence of subsequent rehospitalisation.

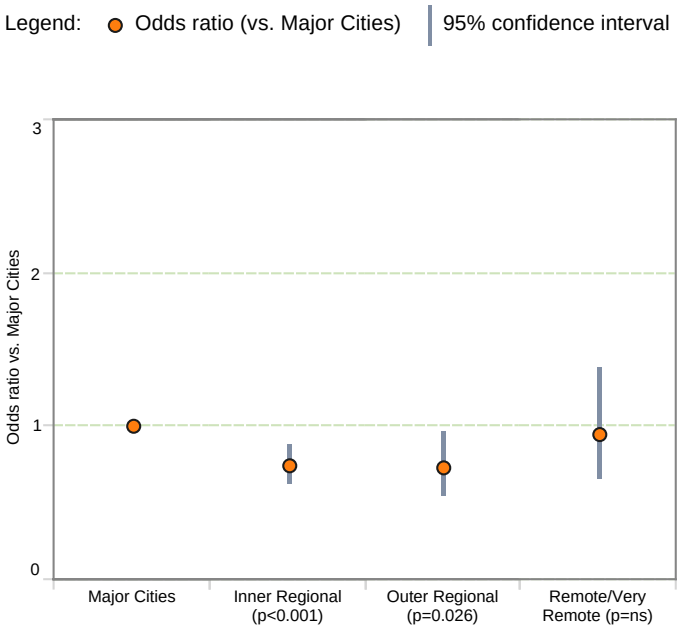


Figure 6: Standardised incidence of rehospitalisation within 30 days of surgery by remoteness area (2017–2019)

Table 9: Standardised incidence of rehospitalisation within 30 days of surgery by remoteness area (2017–2019)

	Major Cities of Australia*	Inner Regional OR (p value)	Outer Regional OR (p value)	Remote/Very Remote OR (p value)
Rehospitalisation within 30 days of surgery	1.00	0.75 (p<0.001)	0.73 (p=0.026)	0.95 (p>0.05)

* Used as reference/baseline for comparison across categories

10.5 Discussion

For patients attending surgery from a remote setting, it is clear that great distances may be involved in travelling to the nearest cardiac surgery unit for treatment. While these patients were in the minority, there are some clearly appreciable variations relating to patient risk profile and outcomes concerning time spent in hospital post-surgery.

Patients presenting from Remote and Very Remote areas (62 years and 57 years respectively) had a median age which was considerably younger than the median age of patients residing in the Major Cities area (66 years), which is suggestive of earlier onset of disease. As the residential remoteness area increased, so too did the incidence of preventable, lifestyle-related risk factors such as current smoking and obesity, which suggests poorer health literacy. From the Very Remote area, there was also a greater proportion of patients undergoing CABG (60% of patients, compared to 50% of overall patients) suggesting a higher rate of coronary artery disease as a specific pathology for this cohort.

Detailed analysis of patient outcomes identified that those patients residing in Outer Regional and Remote/Very Remote settings are two to four times more likely to spend greater than 14 days in hospital postoperatively. A lower incidence of 30 day rehospitalisation for patients residing in Inner Regional and Outer Regional areas was also noted. This may be reflective of care planning for patients residing in close proximity to the surgical hospital versus patients with a more distant place of residence. Counterintuitively, the analysis also showed that patients from Outer Regional and Remote areas were more likely to stay less than 6 days postoperatively. As this is not reflected in a higher rate of rehospitalisation for these areas, it is reassuring that this suggests Queensland practitioners are correctly selecting those patients eligible for discharge within 6 days. Further analysis may be needed to be able to better predict when a short stay is more likely based on risk factors, comorbidities and clinical status at presentation.

Access to tertiary care for all Queenslanders continues to be a focus for the public health system and these findings reflect the sometimes dichotomous scenarios that are frequently encountered by treating clinicians. Given that most cardiac surgical sites are often limited by intensive care and bed capacity, these findings are important to note for health system, operational and scheduling considerations as well as for the tailoring of treatment for individuals to ensure the best possible care for each patient. The increased proportion of Aboriginal and Torres Strait Islander patients presenting from regional and remote areas is likely reflective of the resident population within these areas and worth highlighting in terms of health service planning and provision.

Part B: Thoracic Surgery

1 Message from the Chair

This is the second annual audit of Thoracic Surgery in Queensland and is part of a wider Australia and New Zealand push to establish data registries, risk scores, and key performance indicators for Thoracic Surgery. Queensland leads the way in publishing statewide data for Thoracic Surgery.

Again reading the report, one sees the focus is on lung cancer, and its most modifiable risk factor, cigarette smoking. The rate of current smoking in the thoracic surgery cohort is nearly twice that of the general population, indicating once again the contribution of cigarette smoking to cancer. The outcomes for patients who can receive surgery for their lung cancer are dramatically better than those who are inoperable. The prevention of lung cancer, and after that, the discovery of cancers at a resectable stage are the two most important factors in improving the survival from lung cancer. This disease pattern means that thoracic surgery has a more elective pattern than cardiac surgery.

The analysis of performance in thoracic surgery is not as mature as in cardiac surgery. The mortality rate in the entire cohort was exceptionally low at 0.7%, meaning that mortality itself is not a reliable performance indicator. This mortality rate is exceptional when compared to published data, and needs further investigation and discussion. Whether this is a reflection of high quality performance or a conservative ethos is not an immediate conclusion, and needs to be taken in the context of the alternative treatments for lung cancer. This discussion is held elsewhere in the analysis of lung cancer care performance overall by different reporting groups. The morbidity rate is perhaps falsely high, in that it includes air leak between three and seven days, which is the most common scenario labelled as a morbidity but is not universally considered a marker in thoracic surgery. What is to be considered a morbidity that reflects quality in surgery in thoracic surgery is still for significant discussion and refinement by the committee.

The rate of previous thoracic surgery is of interest and is perhaps a future supplemental report. Patterns in the repeat intervention may give insights into how the approach to treatment can be changed.

Dr Christopher Cole
Chair
QCOR Cardiothoracic Surgery Committee

2 Key findings

This Thoracic Surgery Audit describes baseline demographics, risk factors, surgeries performed, outcomes and subsequent investigations for 2019.

Key findings include:

- There were 1,042 thoracic surgical cases entered for 2019 across the five public thoracic surgery units in Queensland.
- The median age of patients undergoing thoracic surgery was 61 years of age, with 21% of patients aged under 40 years of age.
- Almost one third of patients (32%) 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 (62%), including 4% classed as morbidly obese.
- The proportion of Aboriginal and Torres Strait Islander patients undergoing thoracic surgery was 4.7% of the total cohort.
- Most operations were performed for preoperative diagnoses of primary lung cancer (24%) or pleural disease (32%), while some other cancer or non-cancer diagnosis had been recorded in 18% and 26% of cases respectively.
- Two thirds of patients had some smoking history, including 23% who were current smokers at the time of surgery.
- Elective procedures accounted for 70% of the total surgeries performed, while 6% of cases were emergency operations. Of elective cases, 52% were performed on a day of surgery admission pathway.
- Lobectomy (84%) and lymph node sampling (65%) were the most common procedures performed on patients with a preoperative diagnosis of primary lung cancer.
- Approximately 7% of all cases required a blood product transfusion.
- The median length of stay (LOS) for thoracic surgery patients was 7 days. Patients with a preoperative diagnosis of pleural disease tended to stay longer with a median LOS of 11 days.
- There were 155 cases having one or more new major morbidities recorded post procedure. Prolonged air leak between three and seven days (18%) and reoperation (17%) were the most common reasons for major morbidity.
- Unadjusted all-cause mortality at 30 days was 0.7%, increasing to 1.5% at 90 days.

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.

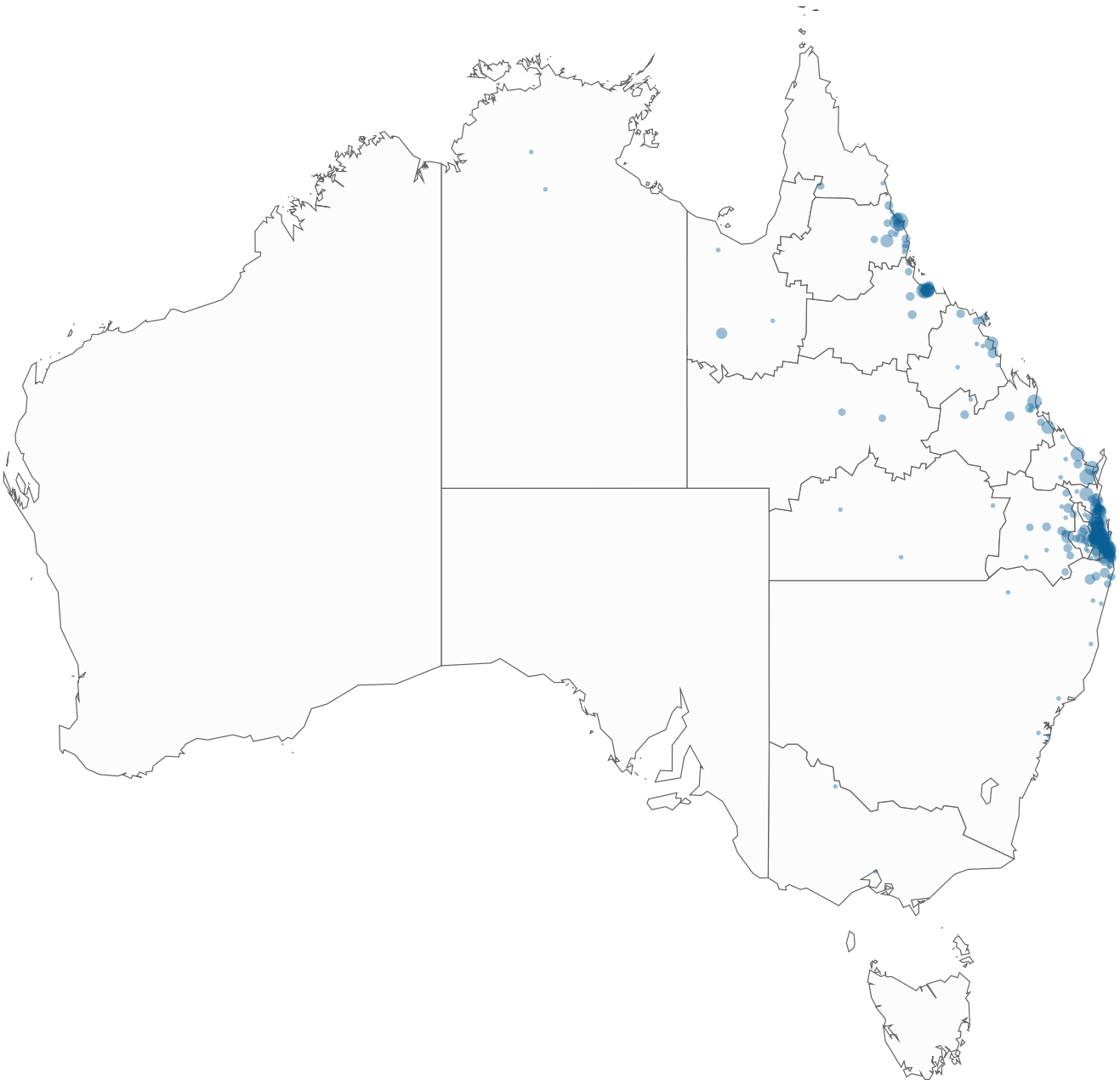


Figure 1: Thoracic surgery cases by residential postcode

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

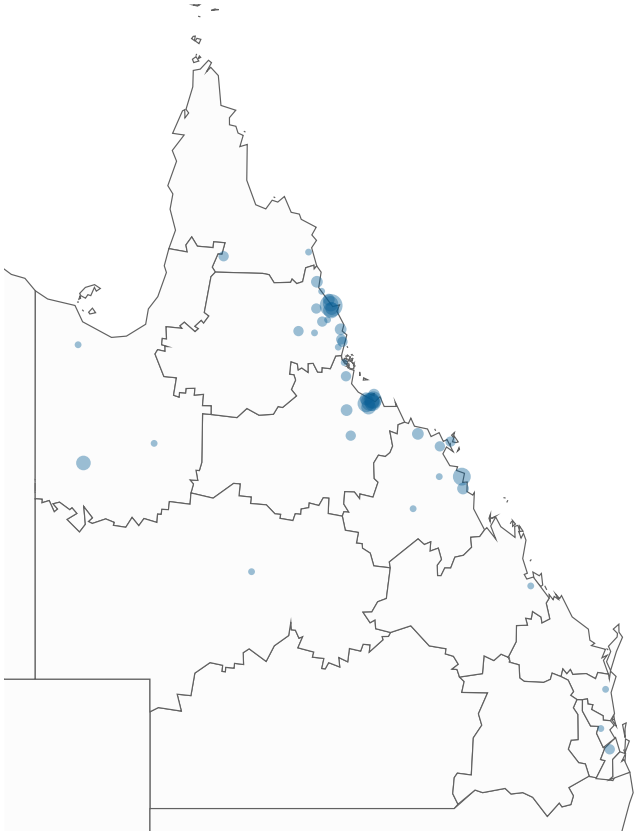


Figure 2: Townsville University Hospital

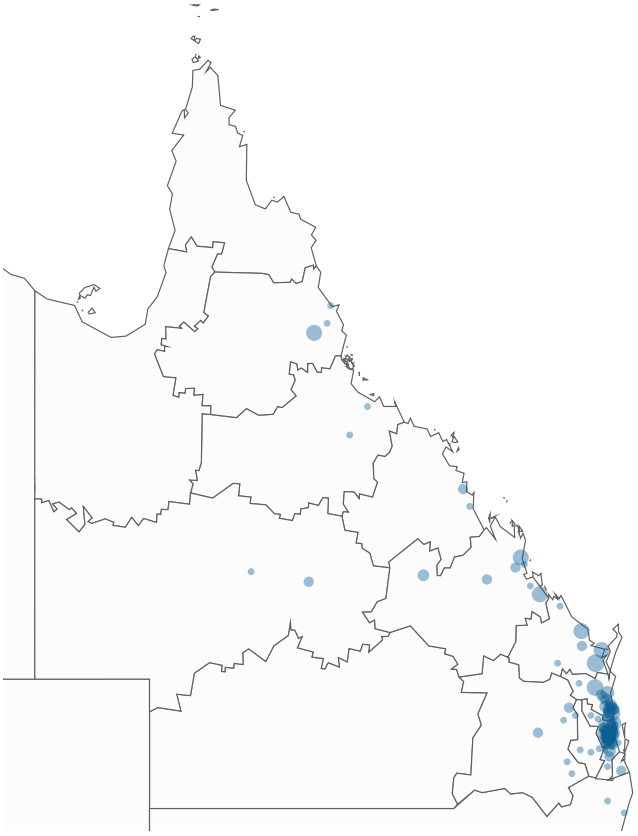


Figure 3: The Prince Charles Hospital

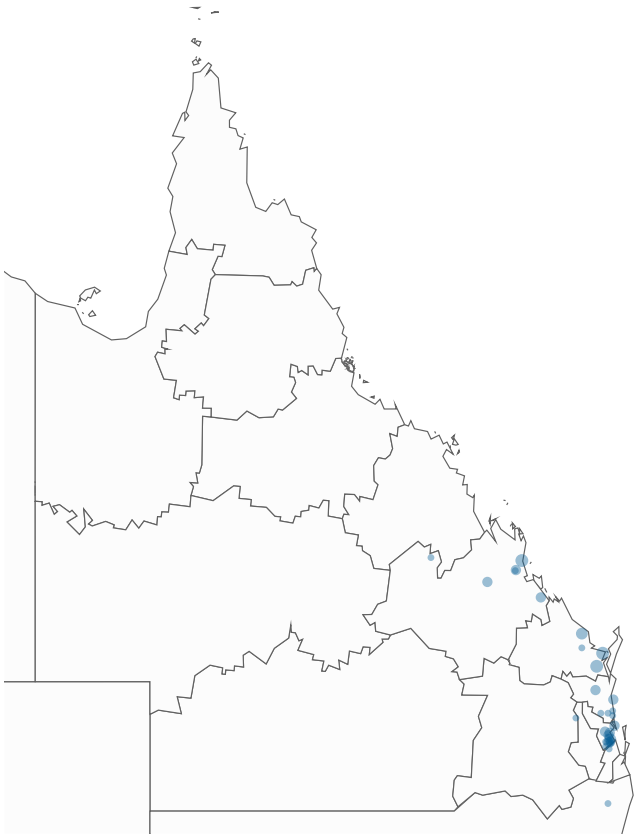


Figure 4: Royal Brisbane & Women's Hospital

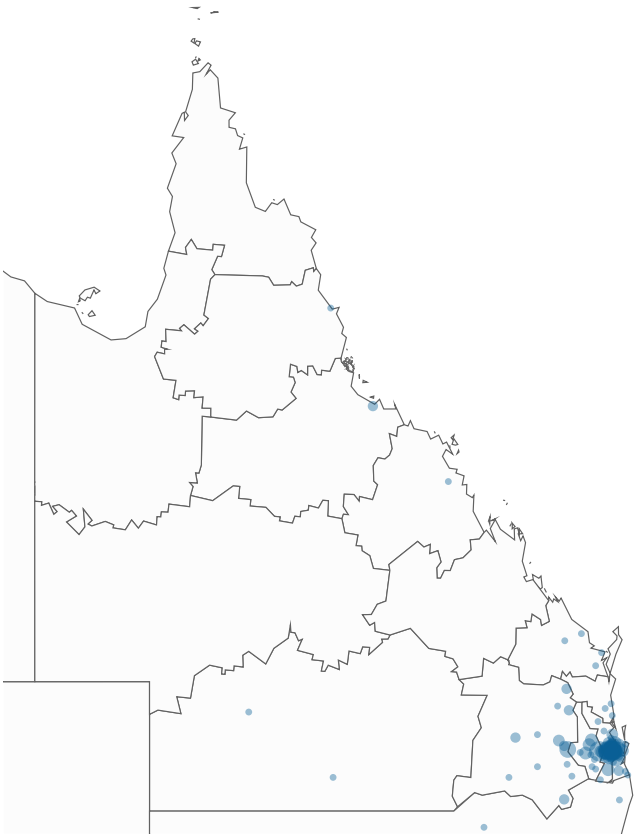


Figure 5: Princess Alexandra Hospital

Figure 6: Gold Coast University Hospital

4 Case totals

4.1 Total surgeries

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

Of the 1,042 cases performed across the five public thoracic surgery units in Queensland, many patients (42%) presented with a preoperative diagnosis including some form of cancer. Diagnosis of primary lung cancer accounted for 24% and 18% had another cancer diagnosis.

Non-cancer diagnoses accounted for 58% of the overall cases, including pleural disease (32%) or other non-cancer indication (26%).

Table 2: Cases by site and preoperative diagnosis category

SITE	Total n	Primary lung cancer n (%)	Other cancer* n (%)	Pleural disease† n (%)	Other‡ n (%)
TUH	175	34 (19.4)	65 (37.1)	35 (20.0)	41 (23.4)
TPCH	302	75 (24.8)	25 (8.3)	112 (37.1)	90 (29.8)
RBWH	57	20 (35.1)	13 (22.8)	11 (19.3)	13 (22.8)
PAH	306	72 (23.5)	50 (16.3)	107 (35.0)	77 (25.2)
GCUH	202	44 (21.8)	39 (19.3)	68 (33.7)	51 (25.2)
STATEWIDE	**1,042**	**245 (23.5)**	**192 (18.4)**	**333 (32.0)**	**272 (26.1)**

* 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

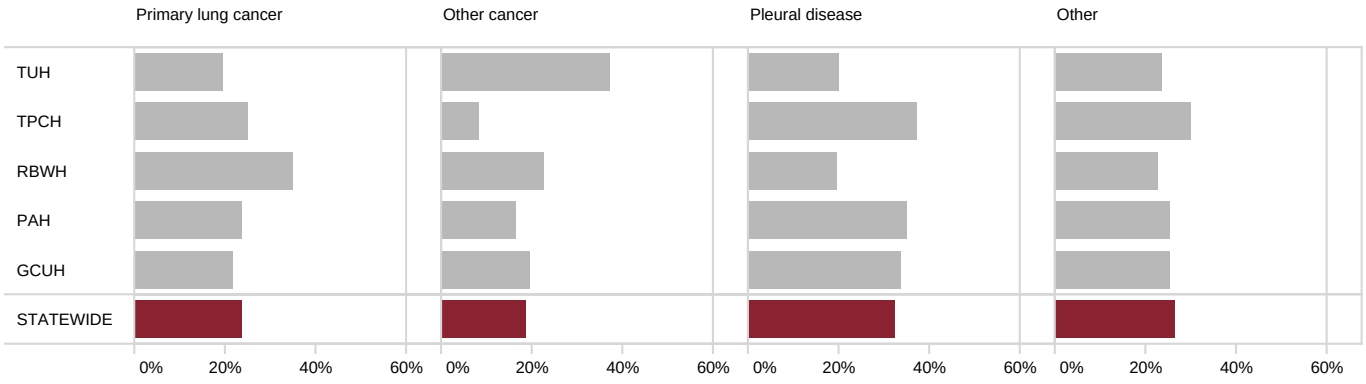


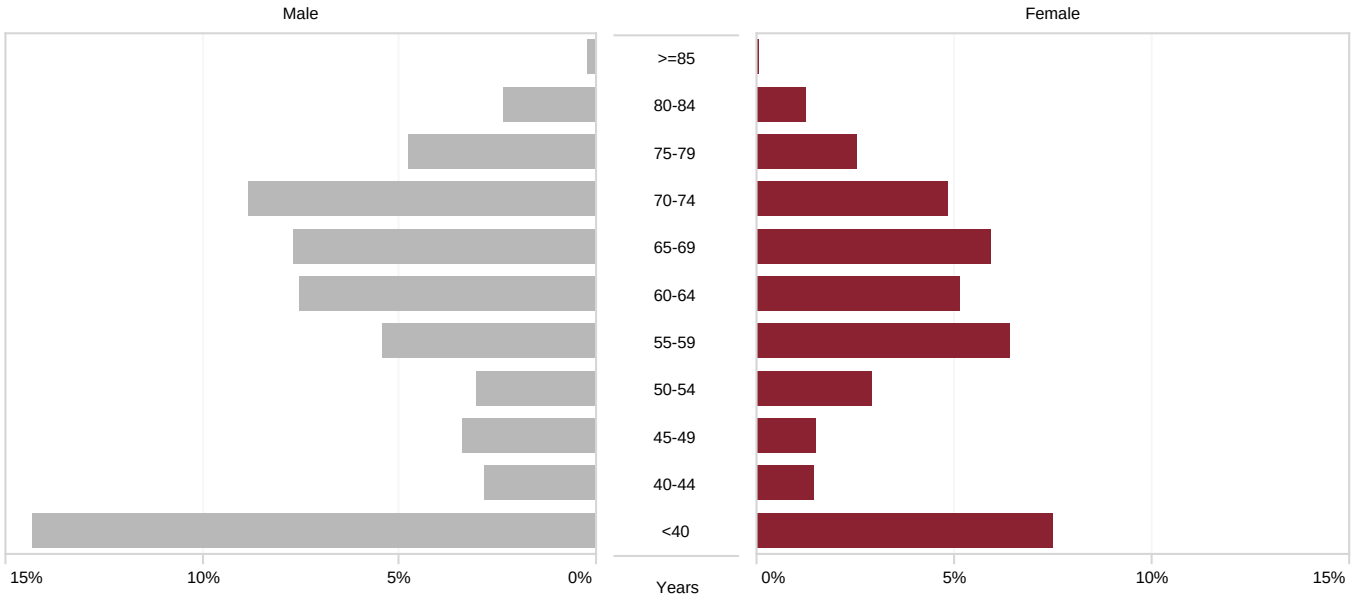
Figure 7: Proportion of cases by site and preoperative diagnosis category

5 Patient characteristics

5.1 Age and gender

The median age for thoracic surgical patients was 61 years, while more than one in five (21%) patients were less than 40 years of age.

Whilst the majority of patients were male (60%), distribution of cases between genders were similar among patients with a preoperative cancer diagnosis (53% and 47% for males and females respectively). Patients with pleural disease were more commonly male (72%).



% of total (n=1,042)

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

Table 3: Median age by gender and preoperative diagnosis category

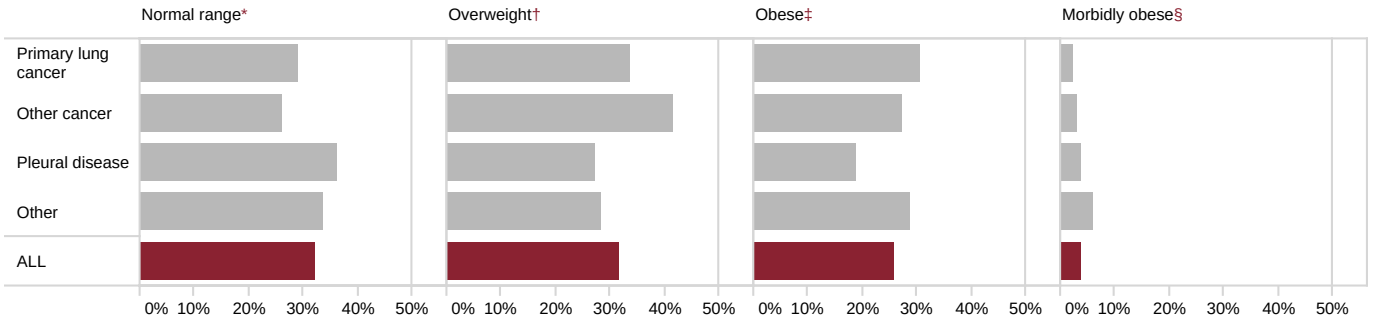
Preoperative diagnosis	Male	Female years	ALL years
Primary lung cancer	68	68	68
Other cancer	66	59	63
Pleural disease	47	45	47
Other	58	59	59
ALL	**61**	**60**	**61**

Table 4: Proportion of cases by gender and preoperative diagnosis category

Preoperative diagnosis	Male n (%)	Female n (%)
Primary lung cancer	131 (53.5)	114 (46.5)
Other cancer	104 (54.2)	88 (45.8)
Pleural disease	239 (71.8)	94 (28.2)
Other	154 (56.6)	118 (43.4)
ALL	**628 (60.3)**	**414 (39.7)**

5.2 Body mass index

The majority of thoracic surgery patients (62%) were classed as overweight or obese, while 32% of patients had a body mass index (BMI) classed within the normal range. Approximately 6% of patients were classed as underweight.



Underweight category (BMI <18.5 kg/m^2) is not displayed (6.2%)

Excludes missing data (0.6%)

* 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 preoperative diagnosis categories

Table 5: BMI category by preoperative diagnosis category

Preoperative diagnosis	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Morbidly obese n (%)
Primary lung cancer	8 (3.3)	71 (29.3)	82 (33.9)	75 (31.0)	6 (2.5)
Other cancer	4 (2.1)	50 (26.0)	80 (41.7)	52 (27.1)	6 (3.1)
Pleural disease	42 (12.7)	121 (36.7)	91 (27.6)	63 (19.1)	13 (3.9)
Other	10 (3.7)	91 (33.5)	77 (28.3)	78 (28.7)	16 (5.9)
ALL	**64 (6.2)**	**333 (32.1)**	**330 (31.9)**	**268 (25.9)**	**41 (4.0)**

Excludes missing data (0.6%)

5.3 Aboriginal and Torres Strait Islander status

The overall proportion of identified Aboriginal and Torres Strait Islander patients undergoing thoracic surgery was 4.7%.

Table 6: Aboriginal and Torres Strait Islander status by preoperative diagnosis category

Preoperative diagnosis	Indigenous n (%)	Non-Indigenous n (%)
Primary lung cancer	7 (2.9)	238 (97.1)
Other cancer	12 (6.3)	179 (93.7)
Pleural disease	23 (6.9)	310 (93.1)
Other	7 (2.6)	265 (97.4)
ALL	**49 (4.7)**	**992 (95.3)**

Excludes missing data (0.1%)

6 Risk factors and comorbidities

6.1 Smoking history

Nearly a quarter of patients (23%) were current smokers (defined as smoking within 30 days prior to surgery), while 43% of patients had a smoking history recorded. Only 26% of patients were identified as having never smoked. In 8% of cases, smoking status was unknown.

There was considerable variation for patients in the primary lung cancer category, where the majority (84%) were recorded as either current or former smokers.

Table 7: Smoking history by preoperative diagnosis category

Preoperative diagnosis	Current smoker n (%)	Former smoker n (%)	Never smoked n (%)	Unknown n (%)
Primary lung cancer	52 (21.2)	153 (62.4)	37 (15.1)	3 (1.2)
Other cancer	41 (21.4)	88 (45.8)	59 (30.7)	4 (2.1)
Pleural disease	105 (31.5)	103 (30.9)	83 (24.9)	42 (12.6)
Other	46 (16.9)	101 (37.1)	89 (32.7)	36 (13.2)
ALL	**244 (23.4)**	**445 (42.7)**	**268 (25.7)**	**85 (8.2)**

6.2 Respiratory disease

The majority of patients (72%) did not have respiratory disease, while over one quarter (27%) were recorded as having mild or moderate respiratory disease.

Table 8: Respiratory disease according to preoperative diagnosis category

Preoperative diagnosis	Mild* n (%)	Moderate† n (%)	Severe‡ n (%)
Primary lung cancer	38 (16.1)	48 (20.3)	1 (0.4)
Other cancer	23 (12.6)	14 (7.7)	3 (1.6)
Pleural disease	35 (10.8)	43 (13.2)	4 (1.2)
Other	32 (12.2)	49 (18.6)	2 (0.8)
ALL	**128 (12.7)**	**154 (15.3)**	**10 (1.0)**

Excludes missing data (3.4%)

* 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, or pO_2 on room air ‹60 mmHg or pCO2 on room air ›50 mmHg

6.3 Diabetes

There were 12% of thoracic surgery patients recorded as having diabetes. The incidence of diabetes was similar across preoperative diagnosis categories, ranging from 11% in the other category to 15% in the primary lung cancer cohort.

Table 9: Diabetes status by preoperative diagnosis category

Preoperative diagnosis	Diabetes n (%)	No diabetes n (%)
Primary lung cancer	36 (14.7)	209 (85.3)
Other cancer	25 (13.0)	167 (87.0)
Pleural disease	38 (11.4)	295 (88.6)
Other	30 (11.0)	242 (89.0)
ALL	**129 (12.4)**	**913 (87.6)**

6.4 Coronary artery disease

Overall, 9% of thoracic surgery patients were identified as having a prior diagnosis of coronary artery disease (CAD), while 2.2% of the cohort had an unknown CAD history.

Table 10: Coronary artery disease status by preoperative diagnosis category

Preoperative diagnosis	CAD n (%)	No CAD n (%)	Unknown n (%)
Primary lung cancer	29 (12.1)	202 (84.2)	9 (3.8)
Other cancer	17 (9.0)	166 (88.3)	5 (2.7)
Pleural disease	24 (7.3)	296 (90.2)	8 (2.4)
Other	23 (8.6)	243 (91.0)	1 (0.4)
ALL	**93 (9.1)**	**907 (88.7)**	**23 (2.2)**

Excludes missing data (1.8%)

6.5 Renal function

Over one quarter (28%) 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 preoperative diagnosis category

Preoperative diagnosis	Normal* n (%)	Mild† n (%)	Moderate‡ n (%)	Severe§ n (%)
Primary lung cancer	99 (41.8)	104 (43.9)	33 (13.9)	1 (0.4)
Other cancer	99 (52.9)	68 (36.4)	17 (9.1)	3 (1.6)
Pleural disease	234 (72.4)	49 (15.2)	35 (10.8)	5 (1.5)
Other	164 (64.8)	57 (22.5)	28 (11.1)	4 (1.6)
ALL	**596 (59.6)**	**278 (27.8)**	**113 (11.3)**	**13 (1.3)**

Excludes missing data (4.0%)

* 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 4% of patients were described as having cerebrovascular disease. Of these patients, 3% were characterised by a reversible neurological deficit with a complete return of function within 72 hours. Less than 1% exhibited residual symptoms greater than 72 hours post onset.

Table 12: Cerebrovascular disease type by preoperative diagnosis category

Preoperative diagnosis	Reversible* n (%)	Irreversible† n (%)	No n (%)
Primary lung cancer	9 (3.7)	–	236 (96.3)
Other cancer	5 (2.6)	3 (1.6)	184 (95.8)
Pleural disease	8 (2.4)	3 (0.9)	322 (96.7)
Other	6 (2.2)	3 (1.1)	263 (96.7)
ALL	**28 (2.7)**	**9 (0.9)**	**1,005 (96.4)**

* Typically includes transient ischaemic attack

† Typically includes cerebrovascular accident

6.7 Peripheral vascular disease

The prevalence of peripheral vascular disease was 4% in patients undergoing thoracic surgery.

Table 13: Peripheral vascular disease status by preoperative diagnosis category

Preoperative diagnosis	Yes n (%)	No n (%)
Primary lung cancer	6 (2.5)	236 (97.5)
Other cancer	9 (5.1)	167 (94.9)
Pleural disease	14 (4.2)	317 (95.8)
Other	11 (3.8)	282 (96.2)
ALL	**40 (3.8)**	**1,002 (96.2)**

6.8 Previous interventions

6.8.1 Previous thoracic surgery

There were 12% of patients who underwent prior thoracic surgery, ranging from 6% in the primary lung cancer group to 16% in the pleural disease category.

Table 14: Previous thoracic surgery by preoperative diagnosis category

Preoperative diagnosis	Yes n (%)	No n (%)
Primary lung cancer	26 (10.7)	218 (89.3)
Other cancer	10 (5.4)	176 (94.6)
Pleural disease	53 (16.1)	277 (83.9)
Other	29 (10.9)	237 (89.1)
ALL	**118 (11.5)**	**908 (88.5)**

Excludes missing data (1.5%)

6.8.2 Previous pulmonary resection

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

Table 15: Previous pulmonary resection surgery by preoperative diagnosis category

Preoperative diagnosis	Yes n (%)	No n (%)
Primary lung cancer	13 (5.3)	230 (94.7)
Other cancer	7 (3.7)	184 (96.3)
Pleural disease	27 (8.2)	304 (91.8)
Other	13 (4.9)	253 (95.1)
ALL	**60 (5.8)**	**971 (94.2)**

Excludes missing data (1.1%)

7 Care and treatment of patients

7.1 Admission status

Approximately three quarters of all cases (70%) were classed as elective, while emergency admissions accounted for only 6% of cases.

A preoperative diagnosis of pleural disease was noted in 73% of all emergency cases and 74% of all urgent cases.

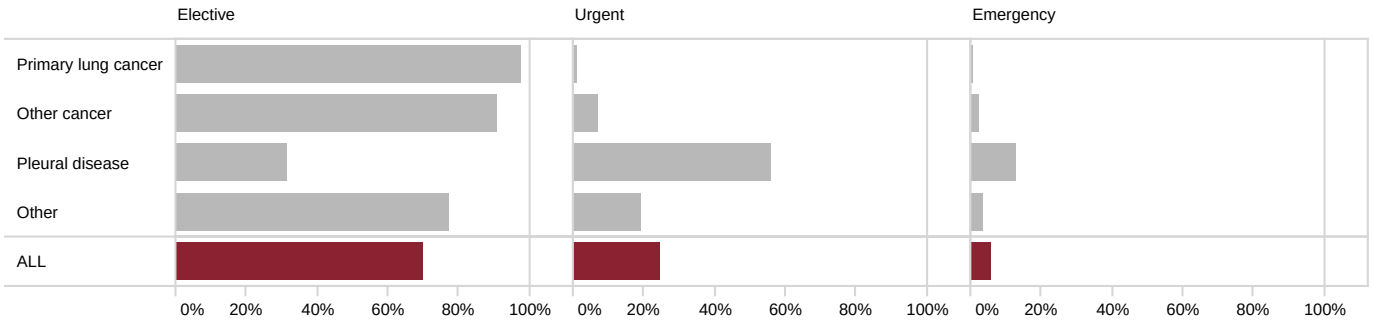


Figure 10: Admission status by preoperative diagnosis category

Table 16: Admission status by preoperative diagnosis category

	Elective n (%)	Urgent n (%)	Emergency n (%)	All n
Primary lung cancer	240 (98.0)	3 (1.2)	2 (0.8)	245
Other cancer	175 (91.1)	13 (6.8)	4 (2.1)	192
Pleural disease	104 (31.2)	186 (55.9)	43 (12.9)	333
Other	211 (77.6)	52 (19.1)	9 (3.3)	272
STATEWIDE	**730 (70.1)**	**254 (24.4)**	**58 (5.6)**	**1,042**

7.1.1 Elective day of surgery admissions

Of the 730 elective cases, 52% were recorded as day of surgery admissions (DOSA).

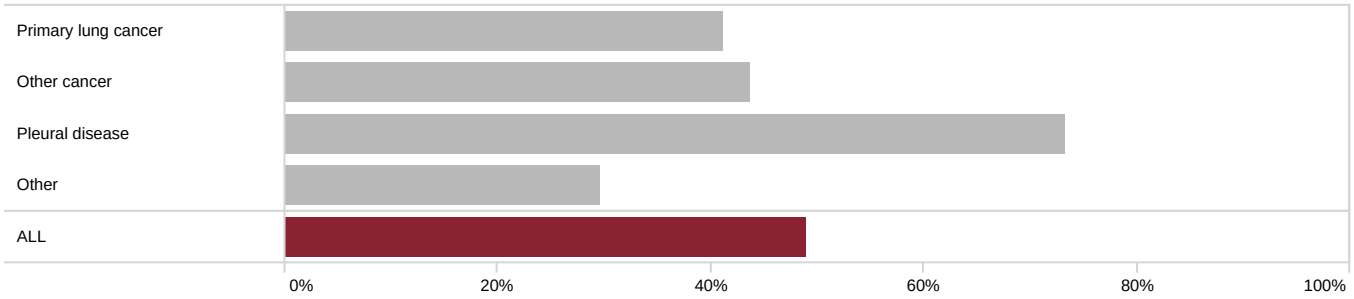
Table 17: Day of surgery admissions by preoperative diagnosis category

Preoperative diagnosis	DOSA n (%)
Primary lung cancer	118 (49.2)
Other cancer	106 (60.6)
Pleural disease	43 (41.3)
Other	110 (52.1)
ALL	**377 (51.6)**

7.2 Surgical technique

7.2.1 Video-assisted thoracic surgery

Overall, 49% of cases utilised video-assisted thoracic surgery (VATS), including 73% of cases in the pleural disease category. Of procedures undertaken through VATS, 38% utilised 3 ports for the operation.



Excludes missing data (1.2%)

Figure 11: Proportion of cases utilising VATS by preoperative diagnosis category

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

Preoperative diagnosis	1 port n (%)	2 ports n (%)	3 ports n (%)	≥4 ports n (%)
Primary lung cancer	33 (33.7)	33 (33.7)	32 (32.7)	–
Other cancer	38 (46.3)	22 (26.8)	22 (26.8)	–
Pleural disease	58 (23.8)	82 (33.6)	102 (41.8)	2 (0.8)
Other	15 (18.8)	26 (32.5)	33 (41.3)	6 (7.5)
ALL	**144 (28.6)**	**163 (32.3)**	**189 (37.5)**	**8 (1.6)**

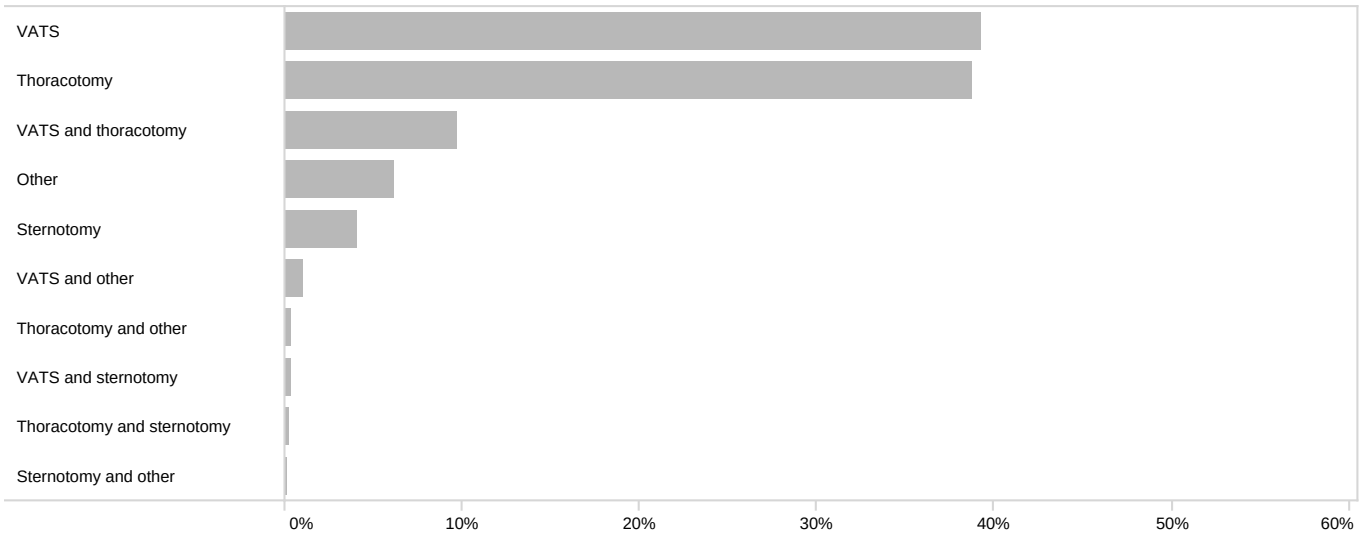
Excludes missing data (1.2%)

7.2.2 Incision type

Approximately 40% of all surgeries were solely video assisted, while 39% 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 (54%), VATS only (28%), or VATS and thoracotomy (13%).

Use of sternotomy accounted for 5% of overall cases.



Excludes missing data (4.0%)

Figure 12: Proportion of all cases by incision type

Table 19: Incision type by preoperative diagnosis category

Incision type	Primary lung cancer n (%)	Other cancer n (%)	Pleural disease n (%)	Other n (%)	All n (%)
VATS	57 (23.7)	67 (35.8)	212 (64.0)	57 (23.7)	393 (39.3)
Thoracotomy	138 (57.3)	94 (50.3)	78 (23.6)	78 (32.4)	388 (38.8)
VATS and thoracotomy	40 (16.6)	14 (7.5)	26 (7.9)	18 (7.5)	98 (9.8)
Other	3 (1.2)	5 (2.7)	5 (1.5)	48 (19.9)	61 (6.1)
Sternotomy	2 (0.8)	3 (1.6)	2 (0.6)	34 (14.1)	41 (4.1)
VATS and other	1 (0.4)	1 (0.5)	4 (1.2)	4 (1.7)	10 (1.0)
Thoracotomy and other	–	2 (1.1)	1 (0.3)	–	3 (0.3)
VATS and sternotomy	–	–	2 (0.6)	1 (0.4)	3 (0.3)
Thoracotomy and sternotomy	–	1 (0.5)	1 (0.3)	–	2 (0.2)
Sternotomy and other	–	–	–	1 (0.4)	1 (0.1)
ALL	**241 (100.0)**	**187 (100.0)**	**331 (100.0)**	**241 (100.0)**	**1,000 (100.0)**

Excludes missing data (4.0%)

7.3 Surgery types

The most common procedure performed on patients with a preoperative diagnosis of primary lung cancer was a lobectomy (84%).

Wedge resection (37%) and lobectomy (35%) were the most common procedures in the other cancer cohort, while pleural disease was most commonly treated with pleurodesis (38%).

It is important to note that the procedures outlined in this section are frequently undertaken in combination.

Table 20: Surgical procedures for primary lung cancer

	n (%)
Lobectomy	206 (84.1)
Lymph node sampling	158 (64.5)
Bronchoscopy	48 (19.6)
Wedge resection	28 (11.4)
Lymph node dissection	26 (10.6)
Pneumonectomy	10 (4.1)
Pleural biopsy	10 (4.1)
Pleurodesis	7 (2.9)
Bilobectomy	7 (2.9)
Segmentectomy	4 (1.6)
Pleural drainage	4 (1.6)
Stent – trachea	2 (0.8)
Decortication	2 (0.8)
Chest wall resection	2 (0.8)
Chest wall biopsy	2 (0.8)
Rib resection	1 (0.4)
Diaphragm resection/reconstruction	1 (0.4)
ORIF* ribs	1 (0.4)
Open biopsy	1 (0.4)
Chest wall reconstruction	1 (0.4)
Other	6 (2.4)
Total	**245 (100.0)**

* Open reduction internal fixation

Table 21: Surgical procedures for other cancer

	n (%)
Wedge resection	71 (37.0)
Lobectomy	67 (34.9)
Lymph node sampling	51 (26.6)
Pleural biopsy	26 (13.5)
Pleurodesis	25 (13.0)
Bronchoscopy	21 (10.9)
Pleural drainage	18 (9.4)
Lymph node dissection	11 (5.7)
Decortication	9 (4.7)
Mediastinoscopy	5 (2.6)
Chest wall resection	4 (2.1)
Mediastinal biopsy	4 (2.1)
Resection mediastinal mass	4 (2.1)
Segmentectomy	4 (2.1)
Chest wall reconstruction	3 (1.6)
Lung biopsy	3 (1.6)
Pericardial window	3 (1.6)
Open biopsy	2 (1.0)
Pneumonectomy	2 (1.0)
Diaphragm resection/reconstruction	2 (1.0)
Bilobectomy	1 (0.5)
Other	8 (4.2)
Total	**192 (100.0)**

Table 22: Surgical procedures for pleural disease

	n (%)
Pleurodesis	126 (37.8)
Decortication	112 (33.6)
Pleural drainage	93 (27.9)
Wedge resection	85 (25.5)
Pleural biopsy	62 (18.6)
Bronchoscopy	35 (10.5)
ORIF* ribs	27 (8.1)
Bullectomy	21 (6.3)
Clot evacuation	19 (5.7)
Washout	19 (5.7)
Lobectomy	4 (1.2)
Lymph node sampling	3 (0.9)
Pericardial window	3 (0.9)
Air leak control	2 (0.6)
Diaphragm plication	2 (0.6)
Rib resection	2 (0.6)
Chyle leak control	1 (0.3)
Lung biopsy	1 (0.3)
Lung volume reduction	1 (0.3)
Nuss bar	1 (0.3)
Open biopsy	1 (0.3)
Blebectomy	1 (0.3)
Pneumonectomy	1 (0.3)
Diaphragm resection/reconstruction	1 (0.3)
Segmentectomy	1 (0.3)
Other	36 (10.8)
Total	**333 (100.0)**

* Open reduction internal fixation

Table 23: Surgical procedures for all other surgeries

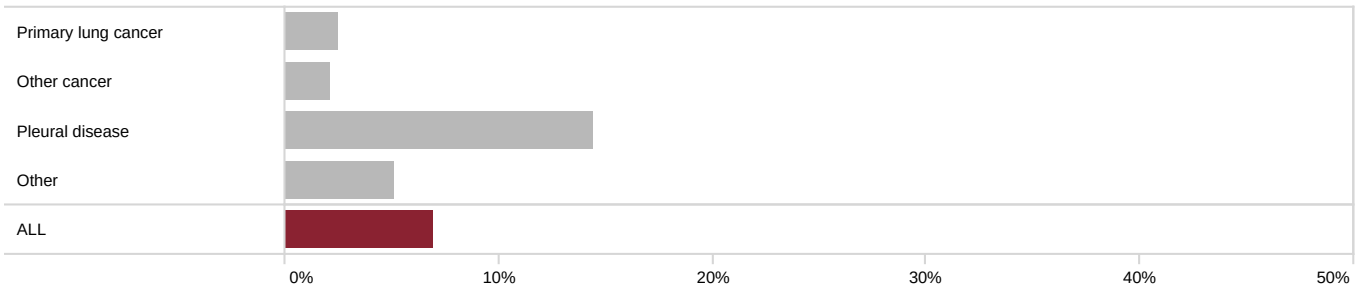
	n (%)
Lobectomy	42 (15.4)
Bronchoscopy	36 (13.2)
Wedge resection	29 (10.7)
Lymph node sampling	25 (9.2)
ORIF* ribs	21 (7.7)
Mediastinoscopy	20 (7.4)
Thymectomy	20 (7.4)
Chest wall reconstruction	15 (5.5)
Resection mediastinal mass	11 (4.0)
Rib resection	11 (4.0)
Nuss bar	10 (3.7)
Mediastinal biopsy	9 (3.3)
Chest wall resection	8 (2.9)
Sympathectomy	8 (2.9)
Open biopsy	7 (2.6)
Other – xiphoid excision	6 (2.2)
Pericardial window	6 (2.2)
Diaphragm plication	5 (1.8)
APC† laser procedure	4 (1.5)
Hernia repair	4 (1.5)
Muscle flap	4 (1.5)
Pacing procedure	4 (1.5)
Removal of foreign body	4 (1.5)
Removal of sternal wires	4 (1.5)
Bullectomy	3 (1.1)
Chest wall debridement	3 (1.1)
Lung biopsy	3 (1.1)
Bilobectomy	2 (0.7)
Bronchial repair	2 (0.7)
Chest wall biopsy	2 (0.7)
Decortication	2 (0.7)
Lung volume reduction	2 (0.7)
Lymph node dissection	2 (0.7)
Mediastinotomy	2 (0.7)
Pectus repair	2 (0.7)
Tracheal repair	2 (0.7)
Tracheal resection	2 (0.7)
Other	44 (16.2)
Total	**270 (100.0)**

* Open reduction internal fixation

† Argon plasma coagulation

7.4 Blood product usage

Approximately 7% of all thoracic surgical cases required blood product usage. Just under 2% of patients were transfused with both red blood cell (RBC) and non-red blood cell products (NRBC). Nearly 15% of patients diagnosed with pleural disease required some blood product transfusion.



Excludes missing data (0.1%)

Figure 13: Proportion of cases requiring blood product transfusion

Table 24: Blood product types used by preoperative diagnosis category

Preoperative diagnosis	RBC and NRBC n (%)	RBC only n (%)	NRBC only n (%)	No blood products used n (%)
Primary lung cancer	2 (0.8)	3 (1.2)	1 (0.4)	238 (97.5)
Other cancer	–	4 (2.1)	–	188 (97.9)
Pleural disease	14 (4.2)	33 (9.9)	1 (0.3)	285 (85.6)
Other	4 (1.5)	8 (2.9)	2 (0.7)	258 (94.9)
ALL	**20 (1.9)**	**48 (4.6)**	**4 (0.4)**	**969 (93.1)**

Excludes missing data (0.1%)

8 Clinical outcomes

8.1 Length of stay

The median length of stay for thoracic surgery patients was seven days, ranging from five days to twelve days across preoperative diagnosis categories.

Table 25: Length of stay by preoperative diagnosis category

Preoperative diagnosis	Median days	Interquartile range days
Primary lung cancer	6	4–8
Other cancer	5	3–9
Pleural disease	11	7–18
Other	5	3–10
ALL	**7**	**4–12**

8.2 Major morbidity

There were 155 cases (15%) having one or more new major morbidities recorded post procedure. The incidence rate of major morbidity ranged from 22% in the primary lung cancer group to 7% in the other cancer category.

Prolonged air leak greater than seven days accounted for 26% of the total major morbidities experienced by patients undergoing thoracic surgery.

Table 26: New major morbidity by diagnosis category

Preoperative diagnosis	Yes n (%)	No n (%)
Primary lung cancer	54 (22.0)	191 (78.0)
Other cancer	13 (6.8)	179 (93.2)
Pleural disease	60 (18.0)	273 (82.0)
Other	28 (10.3)	244 (89.7)
ALL	**155 (14.9)**	**887 (85.1)**

Excludes missing data (2.4%)

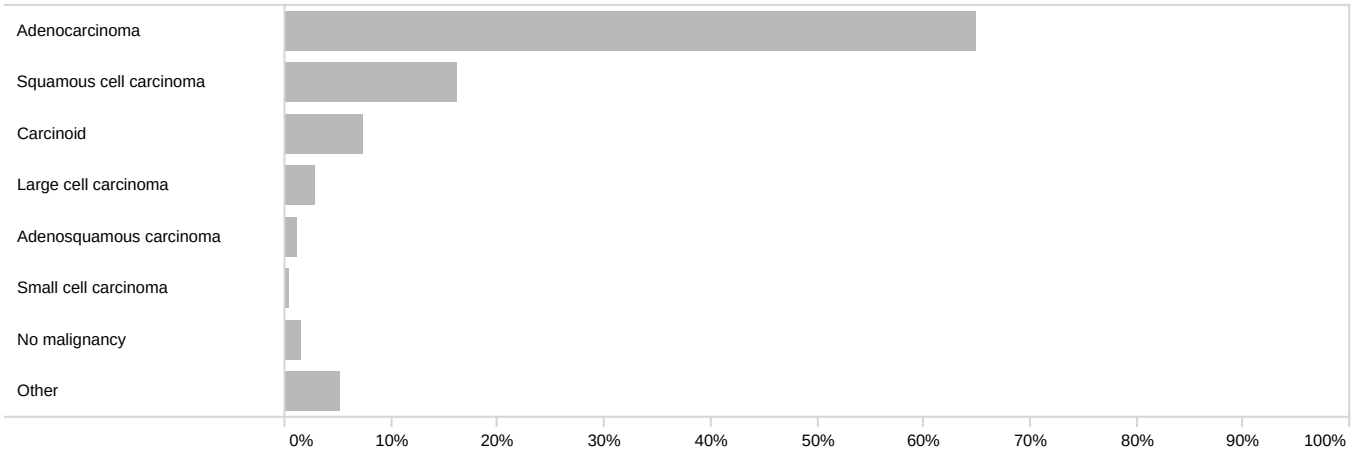
Table 27: Type of major morbidity

Major morbidity type	n (%)
Air leak (3–7 days)	41 (18.2)
Reoperation	39 (17.3)
Atrial fibrillation	32 (14.2)
Air leak (>7 days)	21 (9.3)
Wound infection	19 (8.4)
Pneumonia	15 (6.7)
Bronchopleural fistula	5 (2.2)
Pulmonary embolism	2 (0.9)
Cerebrovascular accident – reversible	1 (0.4)
Other major morbidity	50 (22.2)
ALL	**225 (100.0)**

8.3 Primary lung cancer outcomes

8.3.1 Final histopathology

In patients with a preoperative suspicion of primary lung malignancy, adenocarcinoma (65%) was the most common lung cancer according to final histopathology, followed by squamous cell carcinoma (16%).



Excludes missing data (3.2%)

Figure 14: Proportion of primary lung cancer cases by final histopathology

Table 28: Final histopathology results for primary lung malignancy

Histopathology	n (%)
Adenocarcinoma	159 (64.9)
Squamous cell carcinoma	40 (16.3)
Carcinoid	18 (7.3)
Large cell carcinoma	7 (2.9)
Adenosquamous carcinoma	3 (1.2)
Small cell carcinoma	1 (0.4)
No malignancy	4 (1.6)
Other	13 (5.3)
ALL	**245 (100.0)**

8.3.2 Stage classification

The tumour-node-metastasis (TNM)[22] 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.

The most common postoperative pathological TNM classification for primary lung malignancy was a grade Ib tumour (23%), followed by Ia2 (22%). A stage IV cancer (1.6%) is the least likely malignancy to proceed to surgery when compared with other cancer stages.

Table 29: Primary lung malignancy by preoperative clinical classification

Clinical staging classification	n (%)
Ia1	9 (3.7)
Ia2	55 (22.4)
Ia3	35 (14.3)
Ib	34 (13.9)
IIa	12 (4.9)
IIb	36 (14.7)
IIIa	16 (6.5)
IIIb	2 (0.8)
IVa	3 (1.2)
IVb	1 (0.4)
Missing data	42 (17.1)
Total	**245 (100.0)**

Table 30: Primary lung malignancy by postoperative pathological classification

Pathological classification	n (%)
Ia1	5 (2.0)
Ia2	52 (21.2)
Ia3	26 (10.6)
Ib	55 (22.4)
IIa	12 (4.9)
IIb	36 (14.7)
IIIa	28 (11.4)
IIIb	6 (2.4)
IVa	11 (4.5)
IVb	1 (0.4)
No malignancy	4 (1.6)
Missing data	9 (3.7)
Total	**245 (100.0)**

8.4 Unadjusted all-cause mortality

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 5% of lung cancers are postoperatively classified as stage IV, which is associated with an inherently high short-term mortality rate. The unadjusted all-cause mortality rate within 30 days of all thoracic surgery was 0.7%, increasing to 1.5% 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 a small patient numbers.

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

Category	Total cases n	Death in 30 days n (%)	Death in 90 days n (%)
Primary lung cancer	245	0 (0.0)	4 (1.6)
Other cancer	192	1 (0.5)	5 (2.6)
Pleural disease	333	5 (1.5)	6 (1.8)
Other	272	1 (0.4)	1 (0.4)
ALL	**1,042**	**7 (0.7)**	**16 (1.5)**

9 Conclusions

This is the second report to provide a detailed examination of procedures performed and the characteristics of patients treated by the five Queensland public thoracic surgical units. Within thoracic surgery, the committee has continued to encourage data quality and completeness which is reflected in a considerable reduction in missing data as well as an increase in the overall number of reported cases. This is now a more comprehensive overview of the often-varied role of thoracic surgeons working within Queensland public facilities.

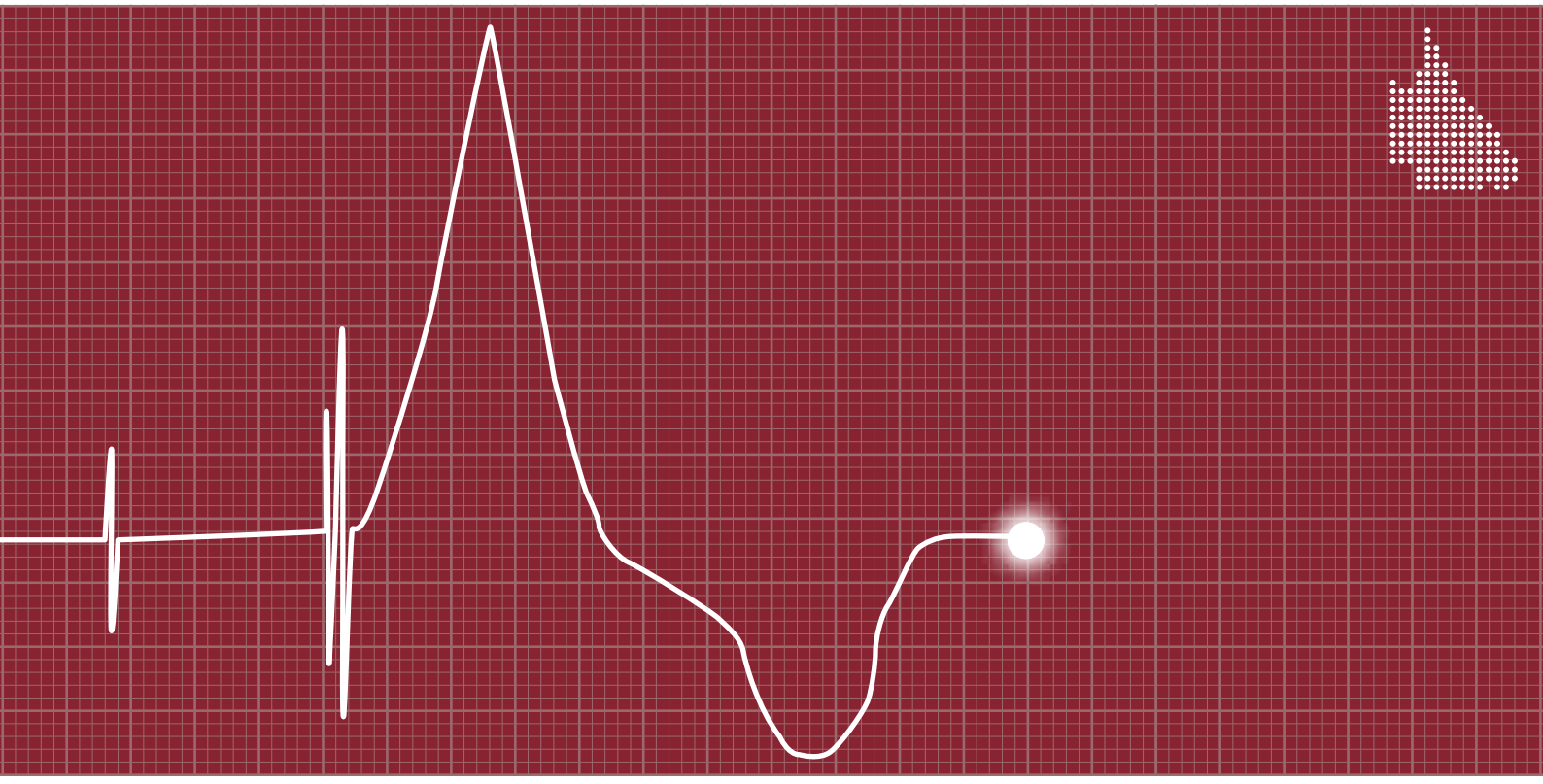
Thoracic surgery is being performed at very safe levels with regards to patient survival in the immediate postoperative period. There is a wide spectrum of conditions and treatments with a marked variation in resource consumption as measured by the length of stay and morbidity dependent on condition. Further development of what is to be targeted with regards to performance is the future work of the committee.

Through the expanded analysis within this Report, we are now able to include quality data for pre-operative clinical staging of primary lung cancer. This will be an area for future expansion of reporting as investigation of clinical vs. pathological staging advances. All surgical units should be commended on their efforts in ensuring this increased level of data quality and are encouraged to sustain these efforts.

The future for the reporting of patient outcomes for patients undergoing thoracic surgery is encouraging and Queensland clinicians look forward to initiatives that seek to establish a comprehensive quality and safety program for all thoracic surgeries in Australia.

Discussions are also underway to expand the scope of the QCOR Thoracic Surgery module and tailor the data collection towards the specific requirements of paediatric patients. Though the differences for these patients compared to the adult population are well known, the advantage of QCOR as distinct from other registries is that it provides the ability to cater towards emerging requirements such as these.

Electrophysiology and Pacing Audit



1 Introduction

This 2019 QCOR Electrophysiology and Pacing Audit builds on the foundations of work performed in earlier years to document the activity and quality of electrophysiology and pacing work performed across the state. The content of this report relates to procedures and interventions that ultimately enhance the quality of life and reduce the burden of disease for the community. It seeks to examine the experience of Queenslanders who undergo these procedures and ensure that public hospital electrophysiology and pacing services are functioning safely.

The report characterises the patients that have been treated, the often complex and chronic diseases they face, and the procedures they have had. Sometimes these are multiple, owing to the nature of the pathology and status of the patient. As the background population continues to age and the incidence of cardiovascular diseases such as atrial fibrillation and heart failure, so too does the need for more complex treatment and a highly trained and specialised workforce. Commensurate with this increase in procedural complexity is an increase in time taken to complete this work, which negatively affects wait times. Again, it is noted that long wait times point to clear deficiencies in service provision, and these are often longstanding and increasing. Without further resources to attempt to alleviate these confounding issues, case volumes will likely continue to stay steady with services at saturation point.

QCOR data has again assisted with securing competitive market arrangements for implantable devices with the effect of ensuring all funding for these invaluable services is spent in the most efficacious way possible. Further processes of this kind are hoped to expand on this work.

As the QCOR dataset continues to increase in size and scope, so too does the ability to follow patient cohorts over time and investigate their interactions with the health care system. Intra-registry linkage with other QCOR data collections presents opportunities, especially in the heart failure cohort. Further work will enhance the breadth of reporting and quality assurance activities that is possible from this dataset. The efforts of clinicians in compiling this quality data must be acknowledged.

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 2019.

Key findings include:

- Across Queensland, nine public sites contributed to the registry with eight sites contributing a complete year of data. Toowoomba Hospital began direct data entry in November 2019.
- Of the 4,654 electrophysiology and pacing cases, 3,189 were device procedures and 1,058 were electrophysiology procedures.
- The majority of all patients were aged over 60 years (70%) with a median age of 69 years.
- The overall proportion of Aboriginal and Torres Strait Islander patients was 3.9%.
- The vast majority of patients (73%) were classed as having an unhealthy body mass index (BMI) of greater than 30 kg/m^2.
- High-urgency procedures that are clinically indicated within 30 days accounted for the majority of procedures (57%).
- Outpatient procedures accounted for 53% of all cases.
- Complex electrophysiology procedures which utilise three-dimensional mapping technology involve pulmonary vein isolation or ventricular arrhythmias, and accounted for 64% of this case cohort.
- Radiofrequency ablation was the energy source utilised in the vast majority of ablation cases (88%).
- Atrial flutter, pulmonary vein isolation (atrial fibrillation) and atrioventricular node re-entry tachycardia ablations accounted for 72% of all ablation cases.
- The reported complication rate for all device procedures was 1.3%, while electrophysiology procedures had a 1.1% complication rate.
- The statewide median wait time for complex ablation was 65 days with 79% of cases meeting the 180 day benchmark.
- There was a 0.3% procedural tamponade rate reported for all cases.
- The 12 month device system loss rate due to infection was 0.7%.

3 Participating sites

There were nine public electrophysiology and pacing units spread across Metropolitan and regional Queensland. Eight of these entered data directly into the Queensland Cardiac Outcomes Registry (QCOR) electrophysiology and pacing application. The ninth site, Toowoomba Hospital, began direct entry in November 2019.

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

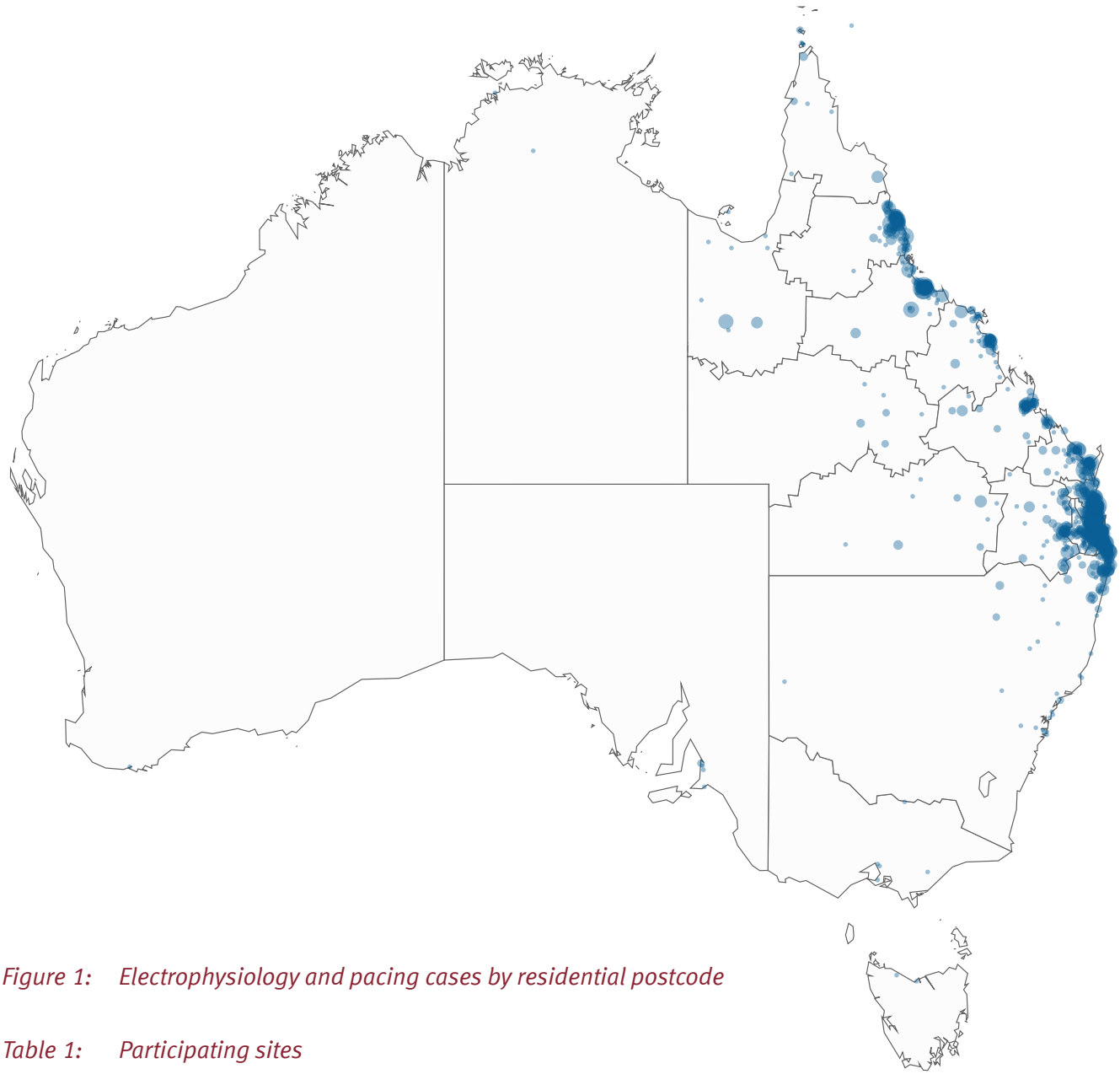


Figure 1: Electrophysiology and pacing cases by residential postcode

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
GCUH	Gold Coast University Hospital
TWH	Toowoomba Hospital

Toowoomba Hospital commenced data entry 6 November 2019

Figure 2: Cairns Hospital

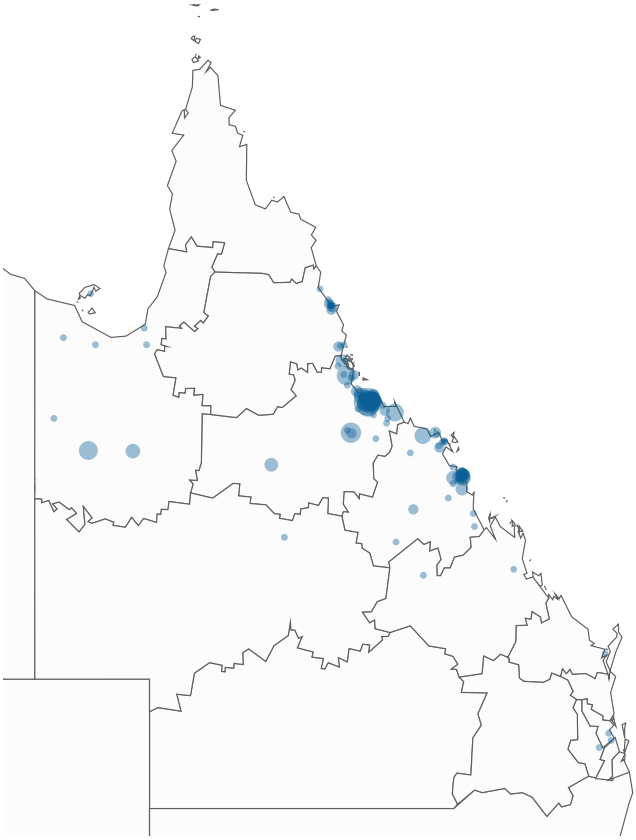


Figure 3: Townsville University Hospital

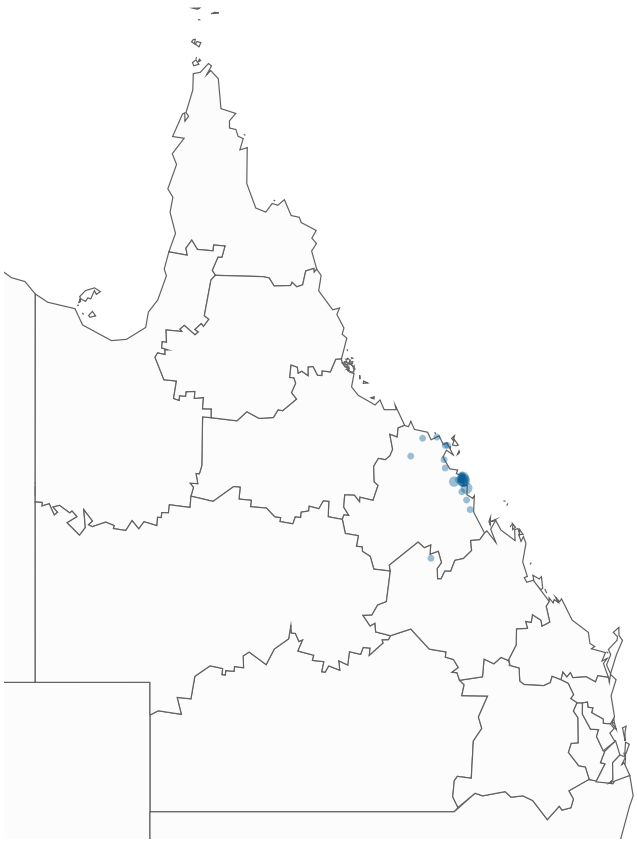


Figure 4: Mackay Base Hospital

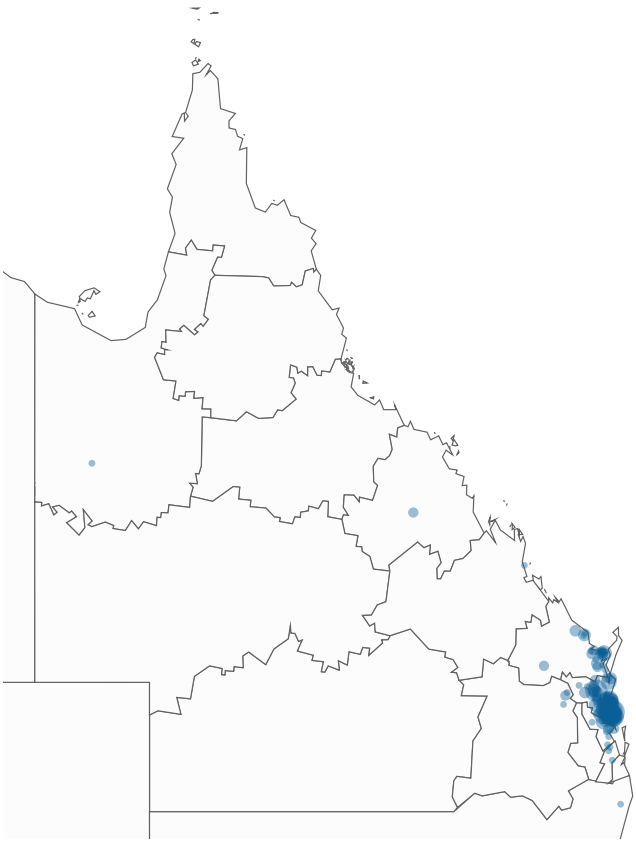


Figure 5: Sunshine Coast University Hospital

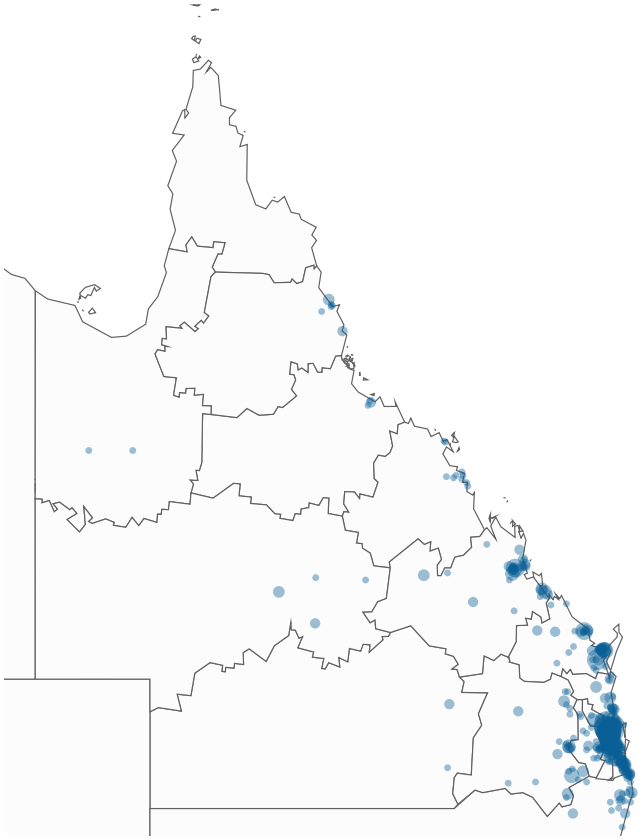


Figure 6: The Prince Charles Hospital

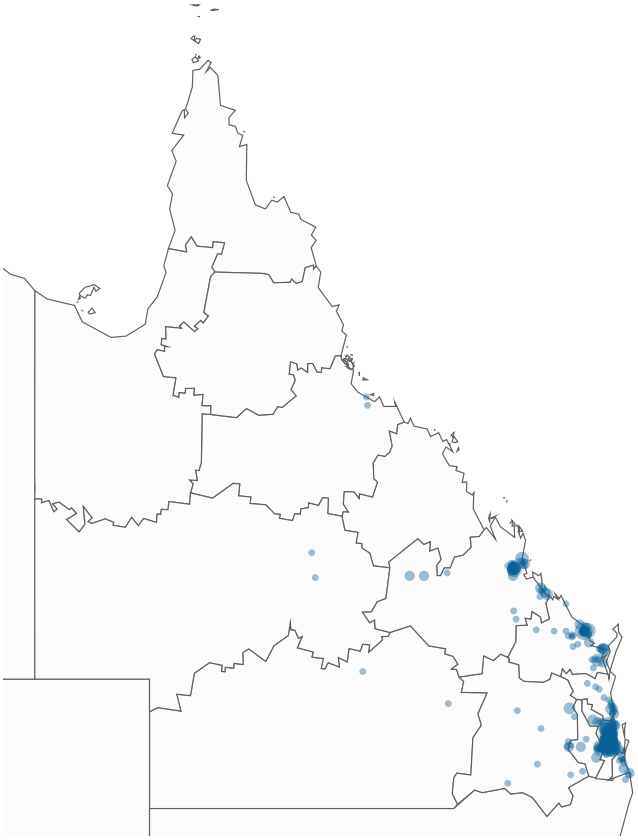


Figure 7: Royal Brisbane & Women's Hospital

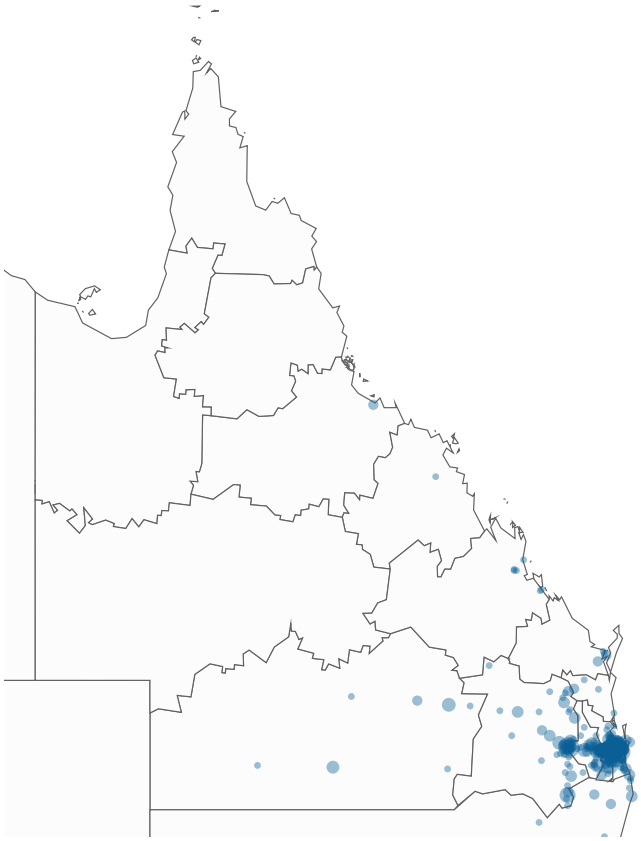


Figure 8: Princess Alexandra Hospital

Figure 9: Gold Coast University Hospital

4 Case totals

4.1 Case volume

There were 4,654 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	3,146 (67.6)
Cardiac device procedure + EP study		19 (0.4)
Cardiac device procedure + other procedure		15 (0.3)
Cardiac device procedure + EP study + ablation		4 (0.1)
Cardiac device procedure + cardioversion		3 (0.1)
Cardiac device procedure + drug challenge		1 (<0.1)
Cardiac device procedure + EP study + drug challenge		1 (<0.1)
EP study + ablation	EP	866 (18.6)
EP study		136 (2.9)
EP study + ablation + cardioversion		38 (0.8)
EP study + drug challenge		6 (0.1)
EP study + cardioversion		5 (0.1)
EP study + ablation + other procedure		4 (0.1)
EP study + ablation + cardioversion + other procedure		2 (<0.1)
EP study + other procedure		1 (<0.1)
Cardioversion	Other	360 (7.7)
Other procedure		24 (0.5)
Drug challenge		21 (0.5)
Cardioversion + other procedure		2 (<0.1)
ALL		**4,654 (100.0)**

Case totals do not reflect all activity due to incomplete year of data acquisition

4.2 Cases by category

The majority of cases performed were cardiac device procedures accounting for over two thirds (69%) of documented procedures. The remainder of cases were electrophysiology and ablation procedures (23%), with the remainder categorised as 'other' procedures (9%).

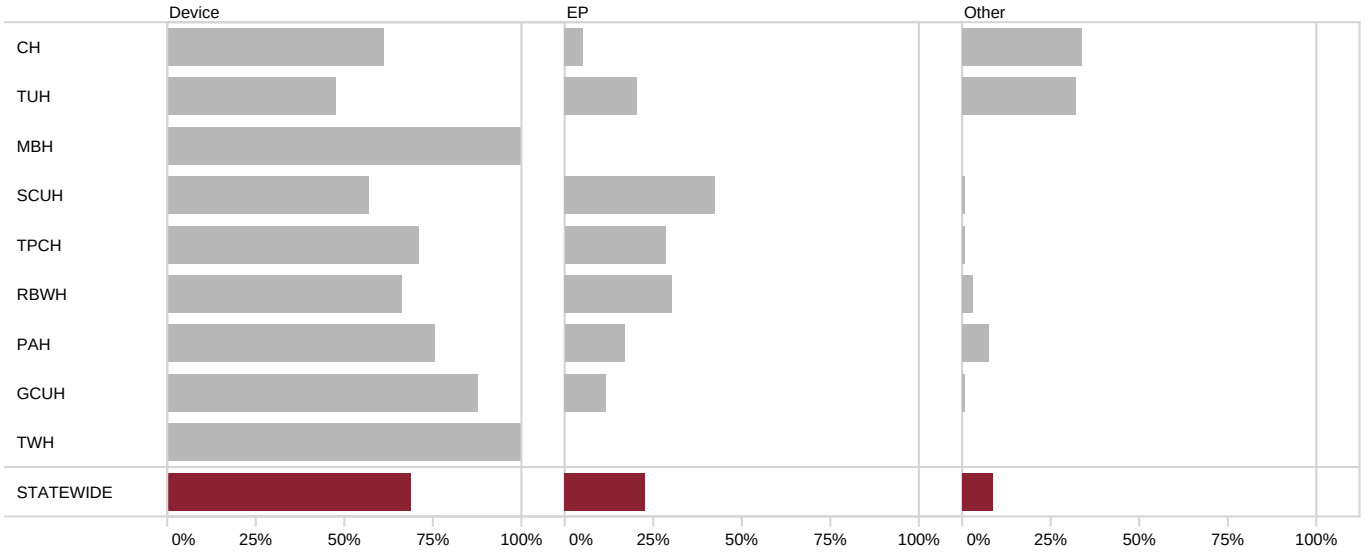


Figure 10: Proportion of cases by site and category

Table 3: Cases by case category

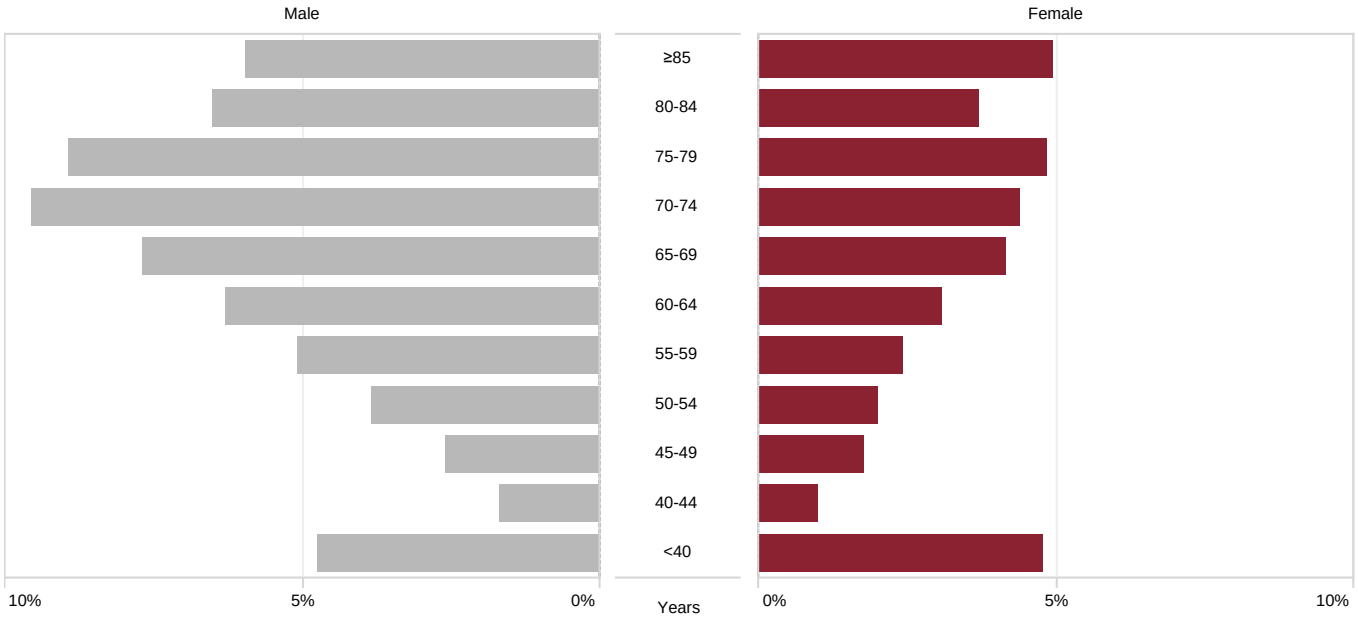
Site	Device n (%)	EP n (%)	Other n (%)	Total n (%)
CH	257 (8.1)	21 (2.0)	143 (35.1)	421 (9.0)
TUH	248 (7.8)	105 (9.9)	168 (41.3)	522 (11.2)
MBH	37 (1.2)	–	–	37 (0.8)
SCUH	305 (9.6)	227 (21.5)	4 (1.0)	536 (11.5)
TPCH	839 (26.3)	336 (31.8)	7 (1.7)	1182 (25.4)
RBWH	342 (10.7)	156 (14.7)	16 (3.9)	514 (11.0)
PAH	672 (21.1)	150 (14.2)	68 (16.7)	890 (19.1)
TWH	8 (0.3)	–	–	8 (0.2)
GCUH	481 (15.1)	63 (6.0)	1 (0.2)	545 (11.7)
STATEWIDE	**3,189 (68.5)**	**1,058 (22.7)**	**407 (8.8)**	**4,654 (100.0)**

5 Patient characteristics

5.1 Age and gender

Age is an important risk factor for developing cardiovascular disease. The majority of patients were aged 60 years and above (70%). The median age of the overall electrophysiology and pacing patient cohort was 69 years of age.

The median age of males and females was 69 years. Patient age differed greatly by procedure category with the median age of patients undergoing electrophysiology procedures being 58 years compared to 73 years for cardiac device procedures.



% of total (n=4,654)

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

Table 4: Median age by gender and case category

	Total cases n	Male years	Female years	ALL years
Device	3,189	72	74	73
EP	1,058	60	54	58
Other	407	64	69	66
ALL	**4,654**	**69**	**69**	**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 (43%).

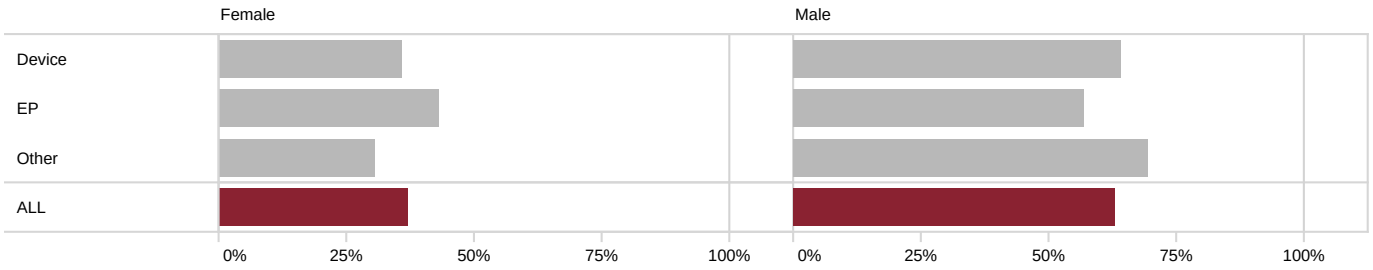


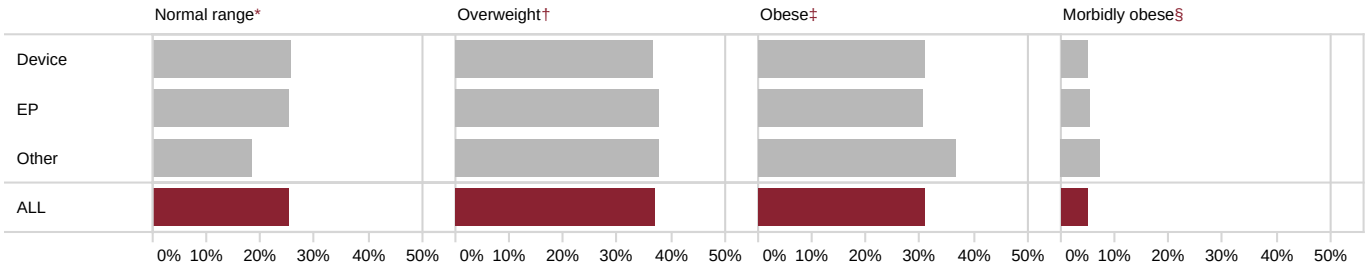
Figure 12: Proportion of cases by gender and category

Table 5: Proportion of cases by gender and category

	Total cases n	Male n (%)	Female n (%)
Device	3,189	2,040 (64.0)	1,149 (36.0)
EP	1,058	603 (57.0)	455 (43.0)
Other	407	282 (69.3)	125 (30.7)
ALL	**4,654**	**2,925 (62.8)**	**1,729 (37.2)**

5.2 Body mass index

Patients classed as having a body mass index (BMI) category of overweight (37%), obese (31%) or morbidly obese (5%) represented almost three quarters of all electrophysiology and pacing patients. Patients classed as underweight represented 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 13: 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 3.9%. 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 sites seeing a larger proportion of Aboriginal and Torres Strait Islander patients (Figure 14).

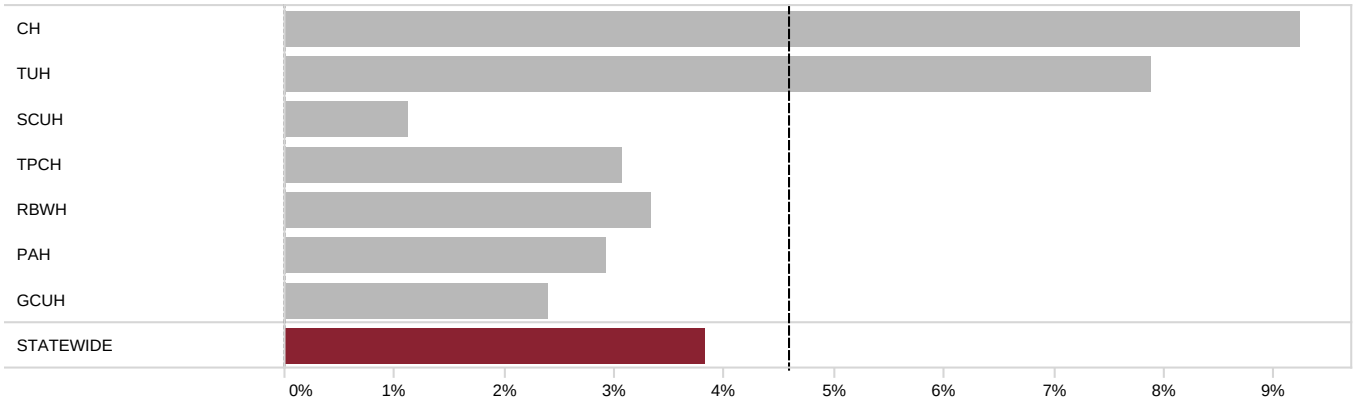


Figure 14: Proportion of cases by identified Aboriginal and Torres Strait Islander status and site

6 Risk factors and comorbidities

Heart rhythm disorders can affect any individual, though they are more commonly developed in those who have other cardiac disease. Risk factors that may increase an individual's likelihood of developing a heart rhythm disorder are outlined below. Hypertension and a history of atrial arrhythmia are the most common comorbidities documented. There are also notable differences between some risk factors and comorbidities within the device and EP categories.

Table 6: Risk factor incidence by case category

	Device %	EP %	Other %	All %
Anticoagulation	22.3	28.3	28.5	24.1
Atrial arrhythmia history	26.3	31.9	31.5	28.0
Coronary artery disease	26.7	13.9	6.1	22.0
Diabetes	18.9	8.0	3.9	15.1
Dyslipidaemia	31.8	16.8	13.3	26.8
Family history of sudden cardiac death	4.1	2.9	2.7	3.7
Heart failure	12.9	5.7	8.4	10.8
Hypertension	43.5	25.1	16.2	37.0
Other cardiovascular disease or co-morbidity	4.1	3.2	3.9	3.9
Smoking history	27.9	22.2	10.4	25.1
Valvular heart disease	18.2	10.7	8.6	15.7

7 Care and treatment of patients

7.1 Urgency category

Urgency categories are based on the time frame which the procedure is clinically indicated. Categorisation is judged by the individual treating clinician.

Across the state, category one cases formed the majority of procedures undertaken. Urgency category ranged widely between sites with category one cases varying from 37% to 100%. Further disparity was noted within category three, with these cases accounting for 1% to 36% of case volumes by site.

Table 7: Proportion of all cases by urgency category and site

	Total cases n	Category 1* n (%)	Category 2† n (%)	Category 3‡ n (%)
CH	421	332 (78.9)	72 (17.1)	6 (1.4)
TUH	521	193 (37.0)	62 (11.9)	6 (1.2)
MBH	37	16 (43.2)	19 (51.4)	2 (5.4)
SCUH	536	176 (32.8)	199 (37.1)	111 (20.7)
TPCH	1,182	812 (68.7)	284 (24.0)	84 (7.1)
RBWH	514	238 (46.3)	92 (17.9)	184 (35.8)
PAH	890	403 (45.3)	345 (38.8)	140 (15.7)
TWH	8	8 (100.0)	–	–
GCUH	545	458 (84.0)	70 (12.8)	15 (2.8)
STATEWIDE	**4,654**	**2,636 (56.6)**	**1,143 (24.6)**	**548 (11.8)**

Includes missing data 7.1%

* Procedures that are clinically indicated within 30 days

† Procedures that are clinically indicated within 90 days

‡ Procedures that are clinically indicated within 365 days

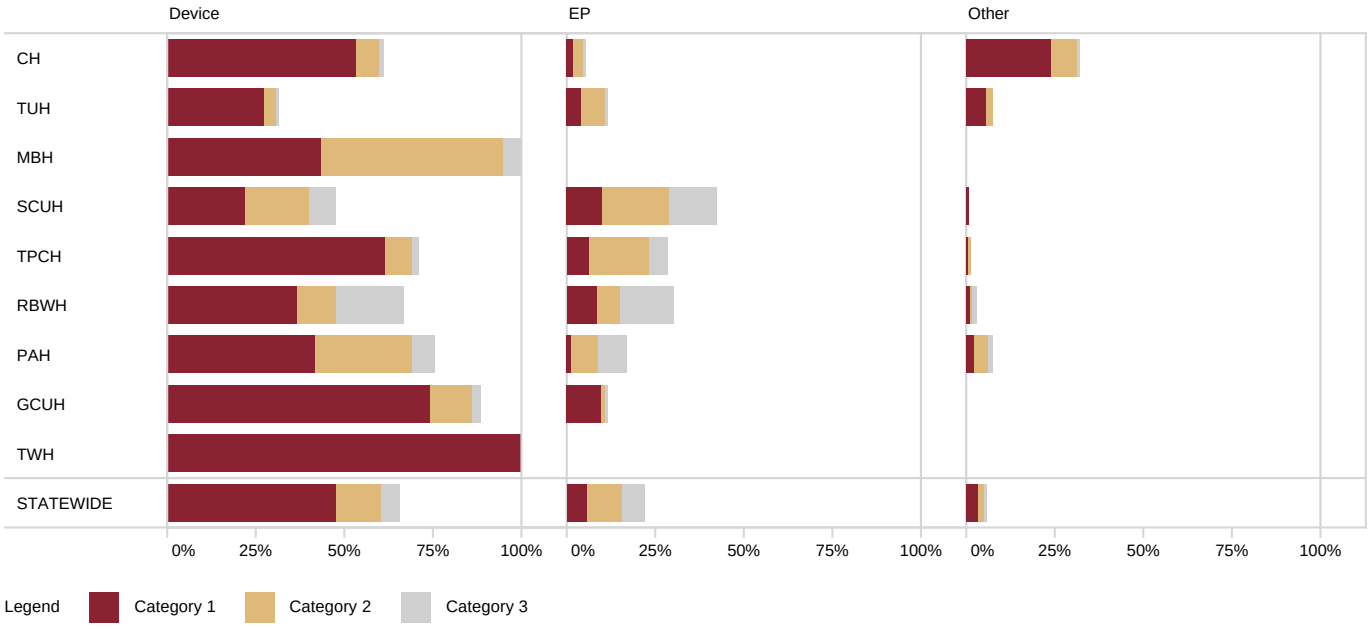
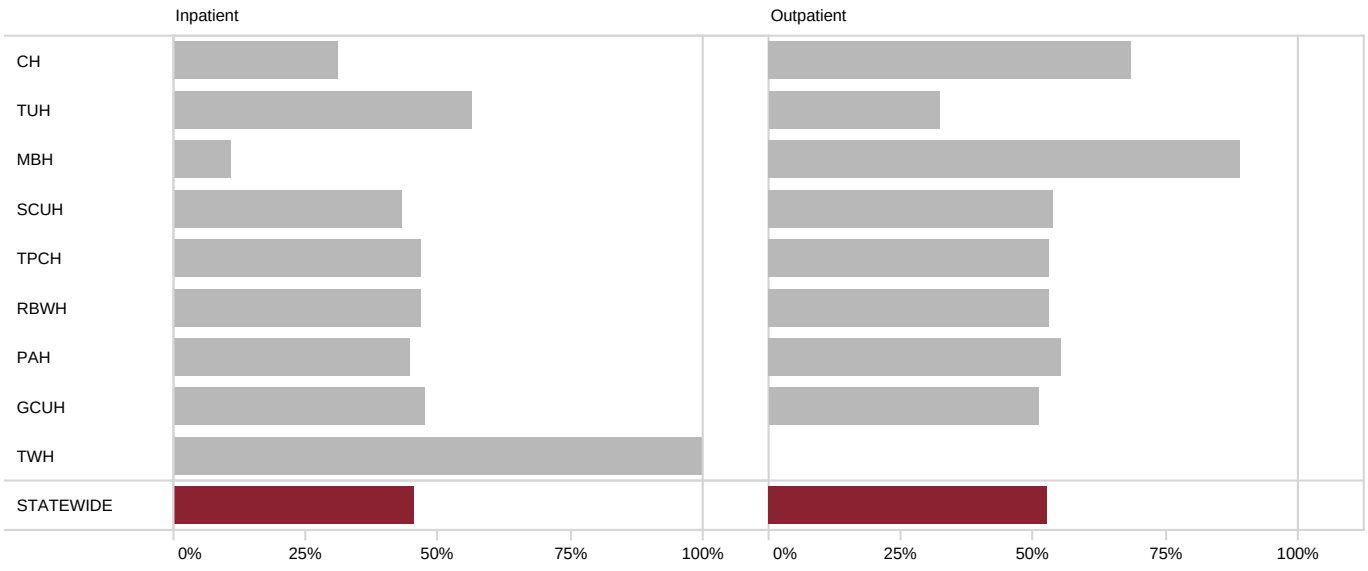


Figure 15: Proportion of all cases by urgency category, procedure category and site

7.2 Admission source

The majority of all cases were performed on patients classed as outpatients (53%). Inpatient cases accounted for 45% of cases and non-admitted, interhospital transfers made up less than 1% of all case volume.



Non-admitted interhospital transfers not displayed (<1%)

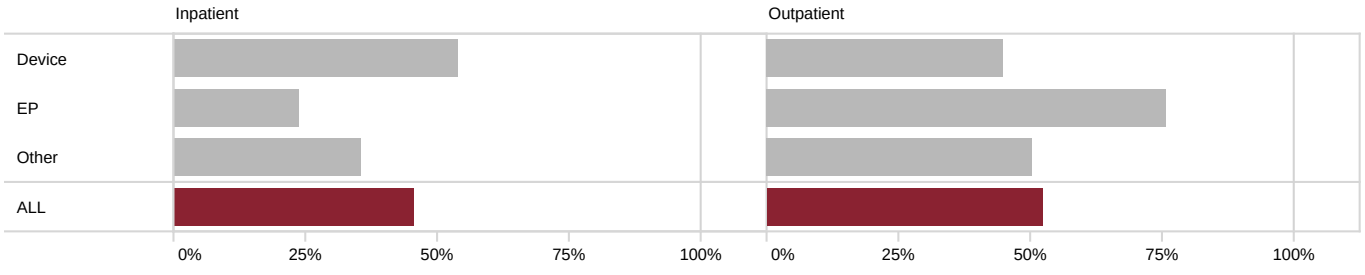
Includes missing data (1.7%)

Figure 16: Admission source by site

Table 8: Admission source by site

	Total cases n*	Inpatient n (%)	Outpatient n (%)	Non-admitted interhospital transfer n (%)
CH	421	131 (31.1)	288 (68.4)	2 (0.5)
TUH	521	294 (56.3)	168 (32.2)	–
MBH	37	4 (10.8)	33 (89.2)	–
SCUH	539	232 (43.3)	288 (53.7)	–
TPCH	1,182	554 (46.9)	627 (53.0)	1 (0.1)
RBWH	514	240 (46.7)	272 (52.9)	2 (0.4)
PAH	890	397 (44.6)	491 (55.2)	1 (0.1)
TWH	8	8 (100.0)	–	–
GCUH	549	258 (47.3)	278 (51.0)	8 (1.5)
STATEWIDE	**4,654**	**2,445 (52.5)**	**2,118 (45.5)**	**14 (0.3)**

* Includes missing data (1.7%)



Non-admitted interhospital transfers not displayed (<1%)

Includes missing data (1.7%)

Figure 17: Admission source by case category

7.3 Admission source and urgency category

Category one procedures accounted for the highest proportion of inpatient and outpatient cases. There was a marked increase in proportions for inpatient procedures with category one cases accounting for over three quarters of cases (86%). Outpatient procedures demonstrated a more even distribution across the three categories.

Table 9: Outpatient cases by urgency category

Outpatient site	Total cases n*	Category 1 n (%)	Category 2 n (%)	Category 3 n (%)
CH	288	203 (70.5)	70 (24.3)	5 (1.7)
TUH	168	50 (29.8)	38 (22.6)	5 (3.0)
MBH	33	13 (39.4)	18 (54.5)	2 (6.1)
SCUH	290	34 (11.8)	136 (47.2)	102 (35.4)
TPCH	627	280 (44.7)	267 (42.6)	78 (12.4)
RBWH	272	23 (8.5)	77 (28.3)	172 (63.2)
PAH	491	82 (16.7)	297 (60.5)	112 (22.8)
GCUH	278	230 (82.7)	34 (12.2)	13 (4.7)
STATEWIDE	**2,445**	**915 (37.4)**	**937 (38.3)**	**489 (20.0)**

* Includes missing data (4.3%)

Table 10: Inpatient cases by urgency category

Inpatient site	Total cases n*	Category 1 n (%)	Category 2 n (%)	Category 3 n (%)
CH	131	127 (96.9)	2 (1.5)	1 (0.8)
TUH	294	142 (48.3)	24 (8.2)	1 (0.3)
MBH	4	3 (75.0)	1 (25.0)	–
SCUH	232	142 (61.2)	63 (27.2)	8 (3.4)
TPCH	554	532 (96.0)	17 (3.1)	5 (0.9)
RBWH	240	213 (88.8)	15 (6.3)	12 (5.0)
PAH	397	320 (80.6)	48 (12.1)	28 (7.1)
TWH	8	8 (100.0)	–	–
GCUH	258	219 (84.9)	36 (14.0)	2 (0.8)
STATEWIDE	**2,118**	**1,706 (80.5)**	**206 (9.7)**	**57 (2.7)**

* Includes missing data (7.0%)

7.4 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 11: 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*	98	137	4	172	409	129	416	7	280
ICD procedure*	52	49	4	43	122	72	99	–	91
Loop recorder implant/explant	82	14	28	40	80	82	51	–	45
BiV ICD procedure*	10	21	–	20	68	25	40	–	21
Lead revision/replacement/pocket revision	6	4	–	9	19	11	16	–	25
Device explant	3	2	–	3	77	1	5	–	8
BiV pacemaker procedure*	3	13	–	14	33	11	11	–	3
Temporary pacing system	2	2	1	4	8	5	16	1	3
Leadless pacemaker implant	1	6	–	–	14	5	4	–	5
Defibrillation threshold testing	–	–	–	–	6	1	13	–	–
Insertion of epicardial pacing system	–	–	–	–	2	–	–	–	–
Insertion of epicardial lead	–	–	–	–	–	–	1	–	–
ALL	**257**	**248**	**37**	**305**	**838**	**342**	**672**	**8**	**481**

* Includes implant/generator change/upgrade

7.5 Electrophysiology studies/ablations

Electrophysiology studies including radiofrequency ablation were the most common individual procedure performed across all sites, ranging from 62% of case volume at SCUH to 79% at TUH.

Table 12: Electrophysiology study/ablation types by site

Site	Procedure type	Case n (%)
CH	Radiofrequency ablation	16 (72.7)
	Electrophysiology study	6 (27.3)
TUH	Radiofrequency ablation	85 (79.4)
	Cryotherapy ablation	10 (9.3)
	Electrophysiology study	10 (9.3)
	Radiofrequency and cryotherapy ablation	2 (1.9)
SCUH	Radiofrequency ablation	142 (62.3)
	Cryotherapy ablation	52 (22.8)
	Electrophysiology study	30 (13.2)
	Radiofrequency and cryotherapy ablation	3 (1.3)
	Cryotherapy ablation and drug challenge	1 (0.4)
TPCH	Radiofrequency ablation	265 (77.0)
	Electrophysiology study	43 (12.5)
	Cryotherapy ablation	30 (8.7)
	Electrophysiology study and drug challenge	6 (1.7)
RBWH	Radiofrequency ablation	122 (75.3)
	Electrophysiology study	24 (14.8)
	Cryotherapy ablation	14 (8.6)
	Radiofrequency and cryotherapy ablation	2 (1.2)
PAH	Radiofrequency ablation	121 (78.6)
	Electrophysiology study	27 (17.5)
	Cryotherapy ablation	5 (3.2)
	Electrophysiology study and drug challenge	1 (0.6)
GCUH	Radiofrequency ablation	46 (70.8)
	Electrophysiology study	19 (29.2)
STATEWIDE		**1,082**

7.5.1 Standard vs. complex electrophysiology

Complex electrophysiology cases involving three-dimensional mapping technology, ventricular arrhythmias or pulmonary vein isolation accounted for 64% of all electrophysiology cases.

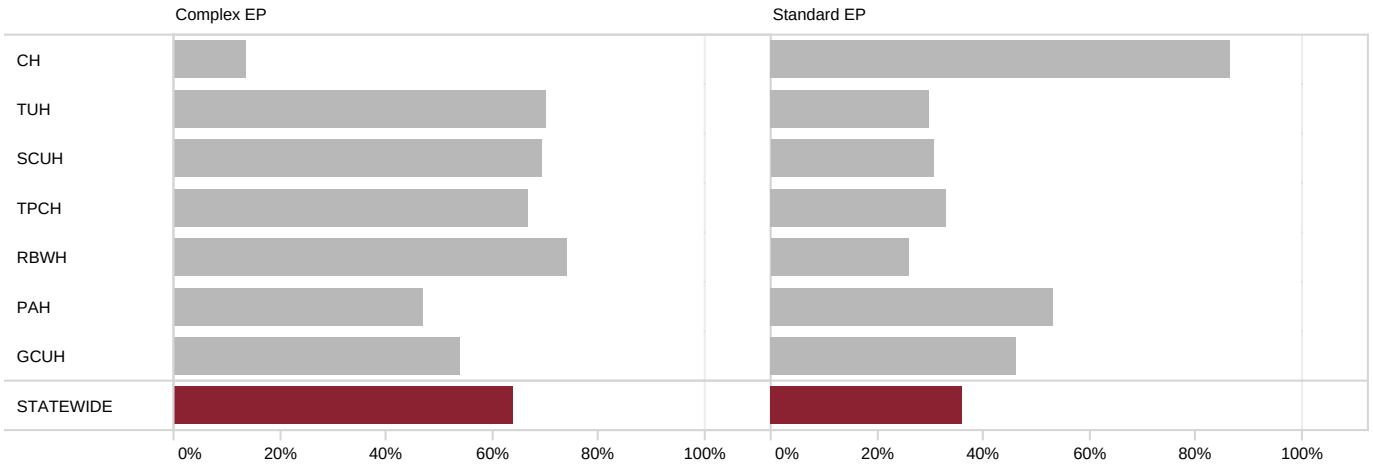


Figure 18: Complexity of electrophysiology procedures by site

Table 13: Proportion of standard and complex electrophysiology procedures by site

Site	Procedure type	Total n	Complex EP n	Standard EP n
CH	Radiofrequency ablation	16	–	16
	Electrophysiology study	6	3	3
TUH	Radiofrequency ablation	85	59	26
	Cryotherapy ablation	10	10	–
	Electrophysiology study	10	4	6
	Radiofrequency and cryotherapy ablation	2	2	–
SCUH	Radiofrequency ablation	142	95	47
	Electrophysiology study	30	17	13
	Cryotherapy ablation	52	43	9
	Radiofrequency and cryotherapy ablation	3	3	–
	Cryotherapy ablation with drug challenge	1	–	1
TPCH	Radiofrequency ablation	265	172	93
	Electrophysiology study	43	26	17
	Cryotherapy ablation	30	29	1
	Electrophysiology study with drug challenge	6	3	3
RBWH	Radiofrequency ablation	122	96	26
	Electrophysiology study	24	10	14
	Cryotherapy ablation	14	14	–
	Radiofrequency and cryotherapy ablation	2	–	2
PAH	Radiofrequency ablation	121	63	58
	Electrophysiology study	27	9	18
	Cryotherapy ablation	5	–	5
	Electrophysiology study with drug challenge	1	–	1
GCUH	Radiofrequency ablation	46	27	19
	Electrophysiology study	19	8	11
STATEWIDE		**1,082**	**693**	**389**

7.5.2 Three-dimensional mapping system

The total proportion of electrophysiology cases utilising three-dimensional mapping systems across sites, and distribution across vendors is shown in Table 14. Two vendors accounted for 75% of all three-dimensional mapping systems used.

Table 14: Three-dimensional mapping system type by site

	Total cases n	Vendor 1 n (%)	Vendor 2 n (%)	Vendor 3 n (%)	Vendor 3 + other n (%)
TUH	67	34 (50.7)	32 (47.8)	–	1 (1.5)
SCUH	126	1 (0.8)	46 (36.5)	79 (62.7)	–
TPCH	191	27 (14.1)	163 (85.3)	1 (0.5)	–
RBWH	103	8 (7.8)	95 (92.2)	–	–
PAH	66	32 (48.5)	34 (51.5)	–	–
GCUH	31	22 (71.0)	9 (29.0)	–	–
STATEWIDE	**584**	**124 (21.2)**	**379 (64.9)**	**80 (13.7)**	**1 (0.2)**

7.6 Ablation type

Radiofrequency ablation is the principal method across all sites, with 87% of all cases utilising this energy. There was variation in the proportionate use between sites with some more likely to use multiple types which is possibly a function of equipment availability. A small proportion of cases (1%) utilised two energy types.

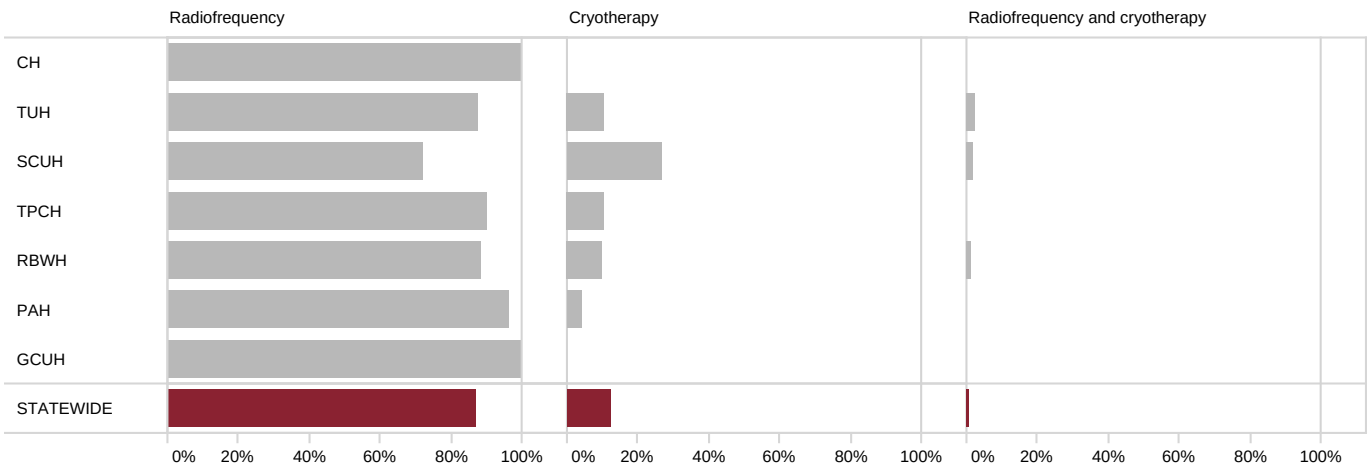


Figure 19: Proportion of case by ablation type and site

Table 15: Ablation type by site

	Total cases n	Radiofrequency n (%)	Cryotherapy n (%)	Radiofrequency + cryotherapy n (%)
CH	16	16 (100.0)	–	–
TUH	97	85 (87.6)	10 (10.3)	2 (2.1)
SCUH	198	142 (71.7)	53 (26.8)	3 (1.5)
TPCH	294	264 (89.8)	30 (10.2)	–
RBWH	138	122 (88.4)	14 (10.1)	2 (1.4)
PAH	126	121 (96.0)	5 (4.0)	–
GCUH	45	45 (100.0)	–	–
STATEWIDE	**914**	**795 (87.0)**	**112 (12.2)**	**7 (0.8)**

7.6.1 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) (23%) and atrial flutter (17%).

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, two thirds of patients undergoing pulmonary vein isolation were male which contrasts with the AVNRT cohort which is predominately a female group. These details are further expanded in Table 16.

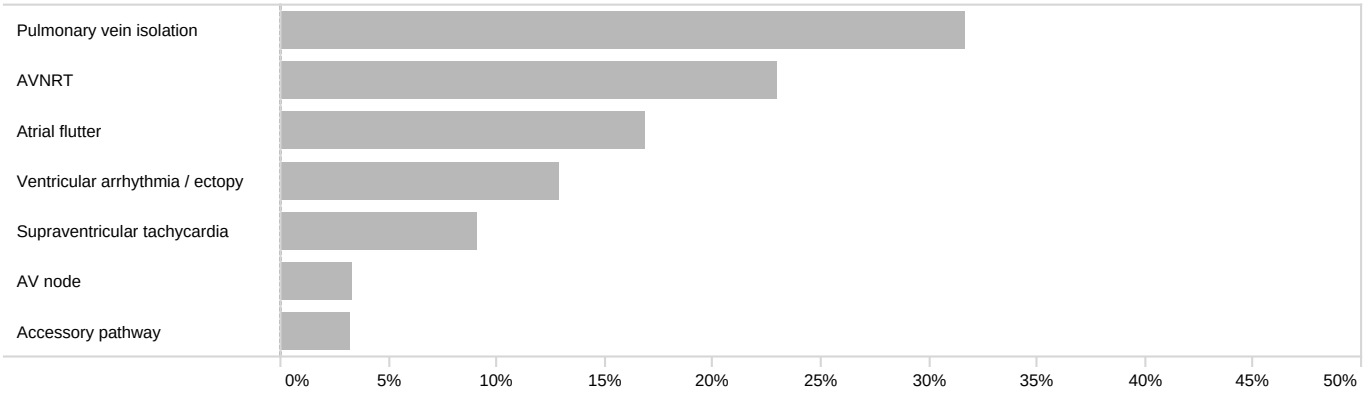


Figure 20: Proportion of arrhythmias ablated

Table 16: Median age and gender by ablation type

Ablation type	Gender	Total cases n (%)	Median age years
Pulmonary vein isolation	Male	192 (66.2)	59
	Female	98 (33.8)	63
AVNRT	Male	65 (31.0)	59
	Female	145 (69.0)	50
Atrial flutter ablation	Male	116 (75.3)	67
	Female	38 (24.7)	64
Ventricular arrhythmia/ectopy ablation	Male	77 (65.3)	68
	Female	41 (34.7)	49
Supraventricular tachycardia	Male	37 (44.6)	37
	Female	46 (55.4)	30
AV node	Male	12 (40.0)	72
	Female	18 (60.0)	74
Accessory pathway	Male	17 (58.6)	29
	Female	12 (41.4)	25
ALL		**914 (100.0)**	**59**

Table 17: Arrhythmia type by site

Site	Ablation type	Count n (%)
CH	AVNRT	8 (0.9)
	Atrial flutter ablation	6 (0.7)
	AV node	2 (0.2)
TUH	AVNRT	28 (3.1)
	Pulmonary vein isolation	25 (2.7)
	Ventricular arrhythmia/ectopy ablation	23 (2.5)
	Atrial flutter ablation	10 (1.1)
	Supraventricular tachycardia	6 (0.7)
	Accessory pathway	4 (0.4)
	AV node	1 (0.1)
SCUH	Pulmonary vein isolation	89 (9.8)
	Atrial flutter ablation	46 (5.0)
	AVNRT	32 (3.5)
	Ventricular arrhythmia/ectopy ablation	12 (1.3)
	Accessory pathway	8 (0.9)
	AV node	7 (0.8)
	Supraventricular tachycardia	4 (0.4)
TPCH	Pulmonary vein isolation	80 (8.8)
	AVNRT	76 (8.3)
	Ventricular arrhythmia/ectopy ablation	57 (6.2)
	Atrial flutter ablation	32 (3.5)
	Supraventricular tachycardia	31 (3.4)
	AV node	11 (1.2)
	Accessory pathway	7 (0.8)
RBWH	Pulmonary vein isolation	43 (4.7)
	Atrial flutter ablation	34 (3.7)
	AVNRT	21 (2.3)
	Supraventricular tachycardia	21 (2.3)
	Ventricular arrhythmia/ectopy ablation	13 (1.4)
	Accessory pathway	3 (0.3)
	AV node	3 (0.3)
PAH	Pulmonary vein isolation	41 (4.5)
	AVNRT	41 (4.5)
	Atrial flutter ablation	14 (1.5)
	Supraventricular tachycardia	13 (1.4)
	Ventricular arrhythmia/ectopy ablation	8 (0.9)
	Accessory pathway	5 (0.5)
	AV node	4 (0.4)
GCUH	Pulmonary vein isolation	12 (1.3)
	Atrial flutter ablation	12 (1.3)
	Supraventricular tachycardia	8 (0.9)
	Ventricular arrhythmia/ectopy ablation	5 (0.5)
	AVNRT	4 (0.4)
	Accessory pathway	2 (0.2)
	AV node	2 (0.2)
STATEWIDE		**914**

7.7 Other procedures

The most common other procedure was cardioversion (89%). 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 18: Other procedures

	Total n	Cardioversion n (%)	Drug challenge n (%)	Other procedure n (%)
CH	143	131 (91.6)	6 (4.2)	6 (4.2)
TUH	168	155 (92.3)	4 (2.4)	9 (5.4)
SCUH	4	–	2 (50.0)	2 (50.0)
TPCH	7	3 (42.9)	1 (14.3)	3 (42.9)
RBWH	16	8 (50.0)	5 (31.3)	3 (18.8)
PAH	68	65 (95.6)	3 (4.4)	–
GCUH	1	–	–	1 (100.0)
STATEWIDE	**407**	**362 (88.9)**	**21 (5.2)**	**24 (5.9)**

8 Procedural complications

Lead complications were the most frequently encountered complication for device procedures, and pericardial effusions were the most commonly observed complication across electrophysiology procedures. 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 in Tables 19 and 20 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 1.3%, while electrophysiology procedures had a 1.1% complication rate.

Table 19: Cardiac device procedure complications

Procedure type	Complication	Total n (%)
Pacemaker implant/generator change	Lead complication	5 (0.2)
	Haemodynamic instability	3 (<0.1)
	Coronary sinus dissection	3 (<0.1)
	Other	3 (<0.1)
	Pericardial effusion with tamponade	2 (<0.1)
	Vascular injury	2 (<0.1)
	Pericardial effusion without tamponade	1 (<0.1)
	Pneumothorax	1 (<0.1)
ICD implant/generator change/upgrade	Other	3 (<0.1)
	Coronary sinus dissection	1 (<0.1)
	Pericardial effusion with tamponade	1 (<0.1)
	Lead complication	1 (<0.1)
BIV ICD implant/generator change/upgrade	Coronary sinus dissection	3 (<0.1)
	Conduction block	1 (<0.1)
	Haematoma	1 (<0.1)
	Pericardial effusion with tamponade	1 (<0.1)
Lead revision/replacement/pocket revision	Lead complication	1 (<0.1)
	Cardiac arrest	1 (<0.1)
	Other	1 (<0.1)
BiV pacemaker implant/generator change/upgrade	Pericardial effusion without tamponade	1 (<0.1)
Device explant	Vascular injury	2 (<0.1)
	Pericardial effusion with tamponade	1 (<0.1)
	Lead complication	1 (<0.1)
ALL		**40 (1.3)**

Table 20: Electrophysiology procedure complications by study type and complexity

Procedure type	Complexity	Complication	Total n (%)
Electrophysiology study	Standard EP	Vascular injury	1 (<0.1)
	Complex EP	Haematoma	1 (<0.1)
Radiofrequency ablation	Standard EP	Atrial arrhythmia requiring DCCV	1 (<0.1)
		Vascular injury	1 (<0.1)
		Pericardial effusion without tamponade	1 (<0.1)
		Conduction block	1 (<0.1)
	Complex EP	Vascular injury	1 (<0.1)
		Conduction block	1 (<0.1)
		Haematuria	1 (<0.1)
		Pericardial effusion without tamponade	1 (<0.1)
Cryotherapy ablation	Complex EP	Phrenic nerve injury	2 (<0.1)
ALL			**12 (1.1)**

9 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. Usually, rate-based indicators 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 Committee are outlined in Table 21.

Table 21: 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

9.1 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 performed on patients classed as elective (procedures 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.

9.1.1 Elective pacemaker

Examination of the waiting time for elective pacemaker procedures is below. Of the 193 cases with complete data, the median wait time was 21 days.

Table 22: Elective pacemaker wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
STATEWIDE	335	193	21	3–169

9.1.2 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 23: Elective ICD wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
STATEWIDE	234	130	32	14–267	45.4

9.1.3 Standard ablation

Waiting times for standard ablation procedures are presented below. Of the 182 cases eligible for analysis, the median wait time was 117 days. More than one quarter of patients had a wait time of 159 days or more.

Table 24: Elective standard ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
STATEWIDE	251	182	117	44–737

9.1.4 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 65 days was observed, with a large interquartile range demonstrating there are a number of patients with considerably long waits.

Table 25: Elective complex ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
STATEWIDE	457	364	65	25–681	78.6

9.2 Procedural tamponade rates

Cardiac tamponade is a known complication of cardiac device and electrophysiology procedures. This indicator examines the rate of procedural pericardial tamponade. 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 26: Procedural tamponade analysis

Procedure category	Total cases analysed n	Procedural tamponade observed n	Procedural tamponade rate %
Device	3,189	7	0.2
EP	1,058	6	0.6
ALL	**4,247**	**13**	**0.3**

9.3 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 2018 calendar year.

The analysis showed 41 cases (1.9%) where reintervention was required within 12 months of the index procedure. Higher rates of reintervention were noted in the biventricular device category which may reflect the greater complexity of these systems.

These results compare favourably with international cohorts, where observed dislodgement rates for pacemaker system implants vary from 1.0 to 2.7%.[23]

Table 27: Reintervention due to lead dislodgement analysis

	Cases analysed n	Atrial lead n	Ventricular lead n	12 month lead dislodgement n	12 month lead dislodgement rate %
Pacemaker implant	1,510	16	19	35	2.3
Any BiV implant	234	1	4	5	2.1
ICD implant	435	1	0	1	0.2
Eligible 2018 device cases	**2,179**	**18**	**23**	**41**	**1.9**

9.4 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 0.7% system loss rate was observed at 12 months post procedure, which is reassuring when compared to international literature which suggests infection rates necessitating explant of approximately 2.4%.[24]

Table 28: Rehospitalisation with device loss analysis

	Cases analysed n	12 month system loss due to infection n	12 month system loss rate %
Eligible 2018 device cases	2,642	19	0.7

9.5 12 month all-cause mortality for cardiac device procedures

The rate of 12 month all-cause mortality is examined for patients with cardiac devices procedures in 2018. It is important to note that patients undergoing these procedures are often of an advanced age, have advanced symptomatology (advanced heart failure in patients with biventricular pacing) and often have multiple comorbidities and risk factors.

Table 29: 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	290	15	5.2	70	57–88
ICD procedure	599	17	2.8	68	61–85
Pacemaker procedures	2,232	129	5.8	82	74–97
All 2018 device cases	**3,121**	**161**	**5.2**	**79**	**70–97**

10 Conclusions

This 2019 QCOR Annual Report has built on the significant advances in the analytic capacity for electrophysiology and pacing. Improvement and enhancement in the reporting of clinical quality indicators relevant to clinical practice and have also examined further the unmet demand for ablation procedures in Queensland. This is exemplified through considerable wait times for diagnosis and intervention.

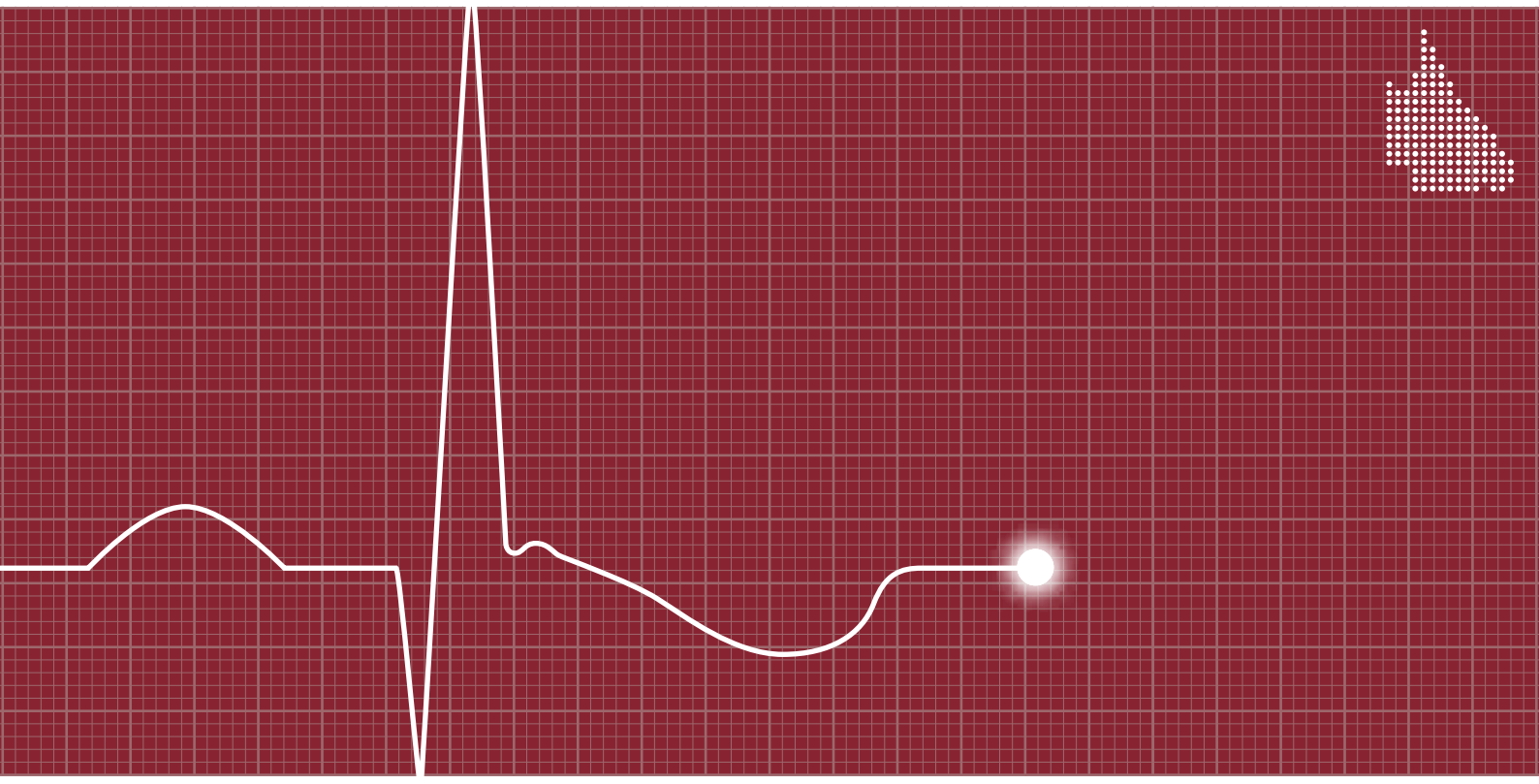
While overall case volumes have remained essentially unchanged from previous years, a 12% increase in the proportion of cases categorised as complex electrophysiology (52% vs. 64%) has been noted since the 2018 Audit. Pulmonary vein isolation remains the most frequently performed ablation procedure while increases in the case volumes of ventricular arrhythmia ablation were also noted. There was a corresponding increase in the usage of three-dimensional mapping systems use, which further underlines the intricacy of the work undertaken at Queensland public EP units. It is once again reassuring to see that aggregated performance for device loss and lead dislodgement compare favourably to internationally reported rates.

Secondary use of QCOR data has also supported the implementation of more cost-effective procurement framework for implantable devices, resulting in significant cost-savings, and allowing funding to be redirected to other areas of need. It is also reassuring that QCOR data has been applied to the prospective service planning and capability discussions within Queensland Health. Without this critical contextualised information provided by QCOR, informed guidance and decision-making would be considerably limited.

With continued clinical input and focus, QCOR data and reporting will be able to inform clinicians not only of performance and quality but offering as well unprecedented levels of insight into electrophysiology and pacing service capacity and throughput rarely available to clinicians both nationally and internationally. Indeed, the current level of detail contained within this registry stands Queensland in good stead for future use and as a case study for what is possible with an engaged clinical group.

These initiatives have underscored the importance of quality data capture and the indispensable nature of clinical input to inform useful and relevant reporting. With a further focus on data completeness and integrity, it is anticipated that the power of the QCOR electrophysiology registry will grow to underpin service provision and delivery of quality clinical care for the people of Queensland.

Cardiac Rehabilitation Audit



Cardiac Rehabilitation

1 Message from the QCOR Cardiac Rehabilitation Committee Chair

The 2019 Annual Report offers detailed insight into key aspects of cardiac rehabilitation (CR) across the state of Queensland, with a record 57 public CR sites participating. It includes information on referral trends, patient demographics, the patient journey, and their outcomes. Each year, the data collected builds a picture that will guide improvements in CR service delivery around the state. With CR known to save lives, reduce avoidable hospital admissions and improve the quality of life for those that participate, this increasing pool of data also offers invaluable research opportunities for those with a passion for CR.

With new analysis and data collections available for this Report, we are now able to further investigate the cohort of patients who decline CR at the time of their admission. This has the potential to enable clinicians to better identify those who may benefit from alternate rehabilitation programs or education to increase the reach and effectiveness of services.

With an aim of every client who would benefit from CR receiving CR, identifying system-wide barriers will go some way to achieving this goal. There can be significant variation in the content delivered, as well as the number of sessions and duration of CR services. In the future, the module will allow greater visibility into the different models of care currently in place and their outcomes. This will offer opportunities to continually learn from successful service models and to incorporate models of excellence more broadly.

Continual development of the technical infrastructure associated with CR services has made all associated documentation available to clinicians within The Viewer. This in turn has allowed for greater collaboration with treating teams and primary care. Further development opportunities also include the collection of data regarding physical assessments and possible collaboration with other outpatient support services.

I would like to acknowledge the efforts of clinicians around the state in contributing to this dataset and strongly encourage any sites not yet contributing to add their data to this statewide collective.

Mr Gary Bennett
Chair
QCOR Cardiac Rehabilitation Committee

2 Key findings

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

- There were 57 public CR sites that contributed data to QCOR.
- A total of 11,547 referrals were made to public CR sites across Queensland.
- Approximately 74% of all referrals originated from an inpatient setting, while 14% of referrals originated from outside of Queensland Health.
- Male patients accounted for 69% of all referrals to CR.
- The median age of all 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 (56 years) and patients of other descent (67 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.
- Of all referrals, there were 65% of patients who completed the initial CR pre assessment. The most common reasons that the pre assessment did not take place was that the patient declined, had been uncontactable or failed to attend the appointment.
- 41% of patients who completed a pre assessment continued CR to the completion of a post assessment.
- Overall, 66% of referrals had a pre assessment diagnosis of ischaemic heart disease.
- The most common procedure undergone by patients who attended a CR pre assessment was a percutaneous coronary intervention, which had been performed for 39% of patients. There were 18% of patients who had undergone coronary artery bypass grafting.
- At pre assessment, 80% of patients were classed as having an unhealthy body mass index (BMI) including 36% classed as overweight, 38% obese and 6% morbidly obese.
- Only 36% 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 94% of cases.
- A timely overall journey occurred in 56% of cases (Queensland Health inpatients referred within 3 days of discharge and assessed by CR program within 28 days of discharge).
- 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	2017	2018	2019
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*	–	✓	✓
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	✓	✓	✓
HSQ‡	COACH Program	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	✓	✓	✓
Metro South	PAH Heart Recovery Program	Princess Alexandra Hospital	✓	✓	✓
	Bayside CR Program	Redland	✓	✓	✓
	Brisbane South Heart Smart	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	○	◑	◑
	Ayr Health Service	Ayr	○	○	○
	Hughenden CR Program	Hughenden	○	○	○
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 2018

† New service commencing in 2019

‡ Health Support Queensland

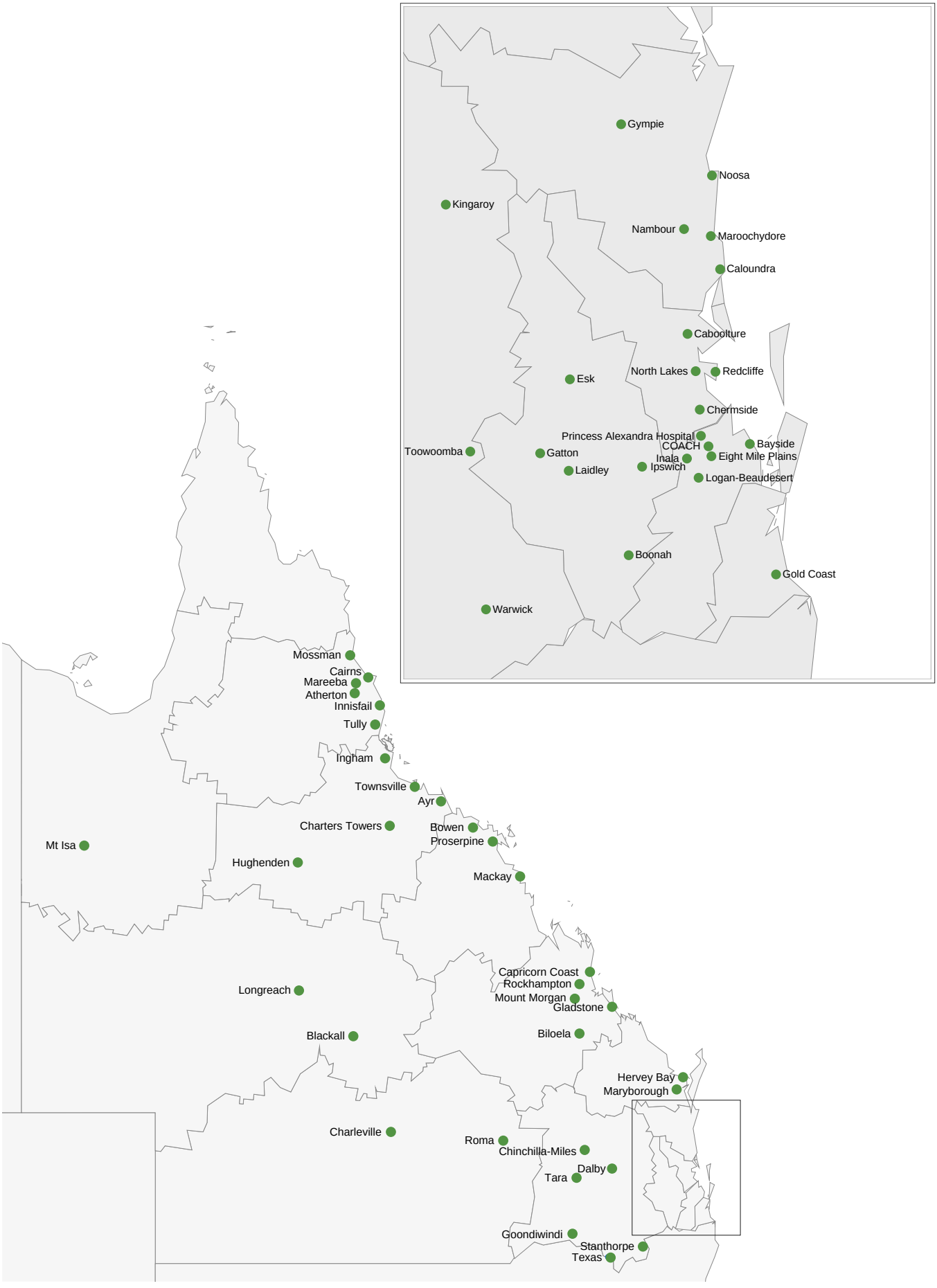


Figure 1: Map of Queensland public CR sites

4 Total referrals

4.1 Statewide

The volume of cardiac rehabilitation (CR) referrals entered into QCOR expanded through 2019 to include an additional 11,547 new referrals for the year. This brings the overall total to almost 30,000 referrals since the system was first launched and CR data collection commenced in July 2017 (Figure 2). Clinicians at 57 Queensland CR sites have incorporated QCOR into their daily practices, with most sites directly entering data into QCOR at the time of assessment. A number of sites that are delivering public outpatient CR, but not contributing to the database, remain a focus for engagement and involvement.

An enhanced QCOR module delivered in April 2020 allowed for an increased level of detail to be recorded in cases where the patient declined or was unsuitable to participate in CR for whatever reason. In this current reporting, a limiting factor has been that these referrals, due to their inherent unsuitability for CR, were not always entered into the QCOR CR module. It is hoped this more recent change will increase the availability of data, allowing these cases to be examined in more detail in future reports.

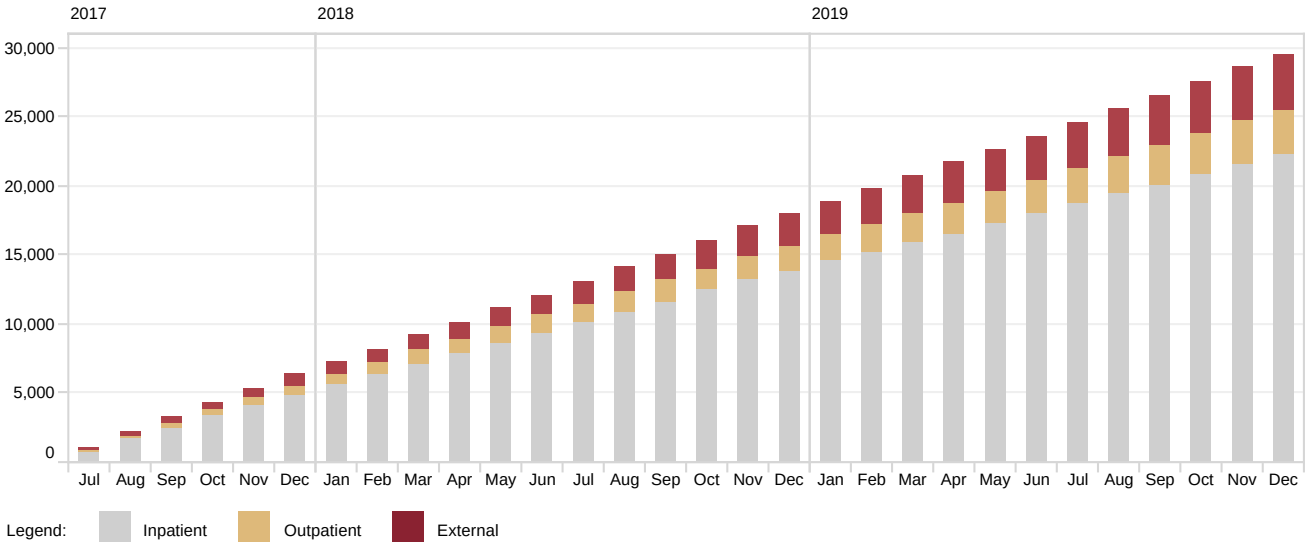


Figure 2: Cumulative total CR referrals by month, 2017–2019

Table 2: Total referrals by admission source, 2017–2019

Referral origin	2017 %	2018 %	2019 %
Inpatient	78.0	76.5	73.9
Outpatient	9.6	10.0	12.1
Non Queensland Health	12.5	13.5	14.1

Figure 3 represents the distribution of CR referrals by the patient's usual place of residence. Patients were located across a wide geographical area with the majority residing in population centres along the eastern seaboard.

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. While some sites leverage QCOR to maintain a record of overall referral volumes, others utilise different processes and as such may not represent phase one activity which does not lead to a referral to a public CR program.

Half of all patients were residing in major cities, and the remainder in regional and remote areas of Queensland. This is reflective of the decentralised distribution of the population within the state.

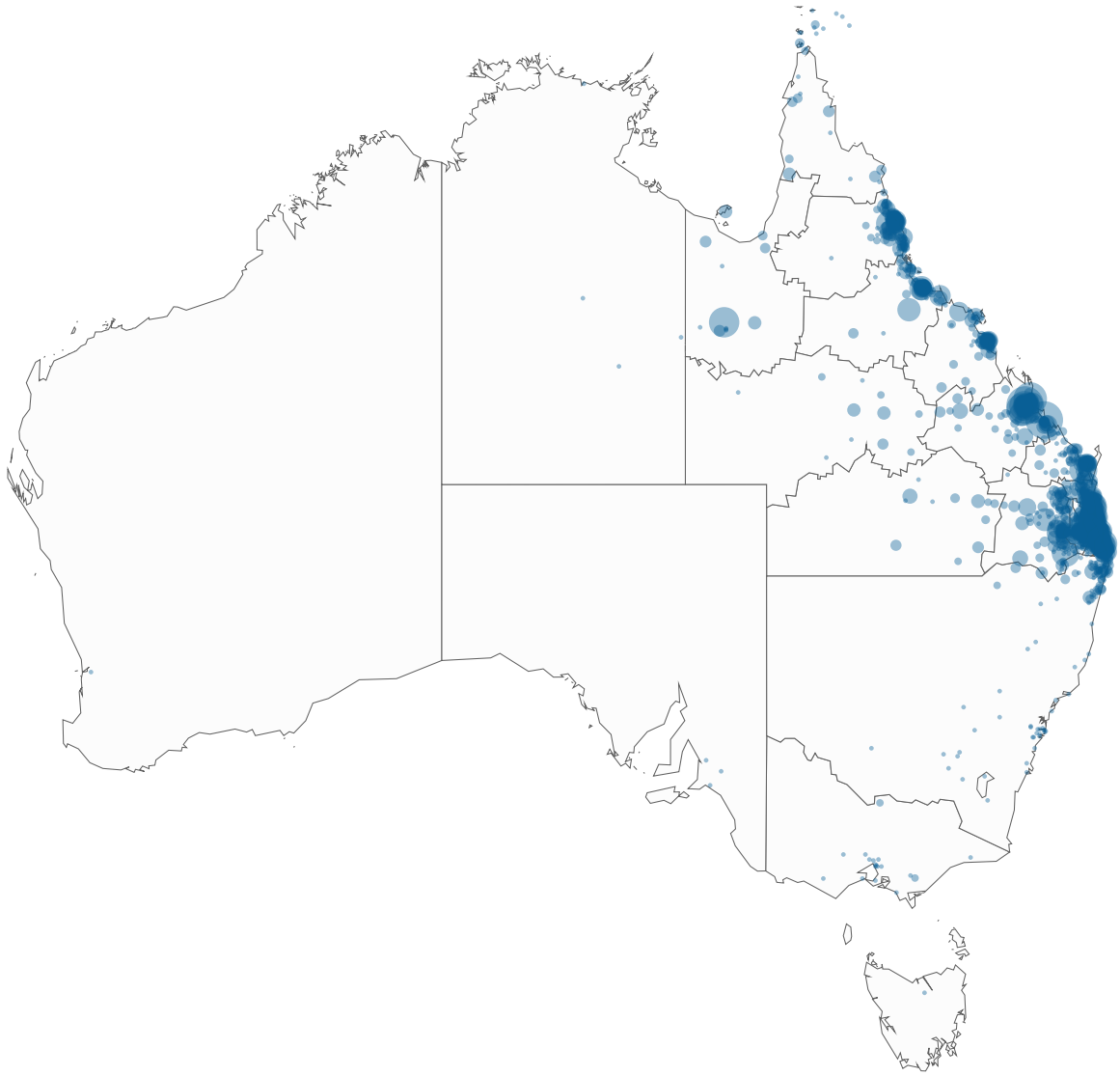


Figure 3: CR referrals by residential postcode

Table 3: CR referrals by remoteness classification

Remoteness area*	%
Major Cities of Australia	50.5
Inner Regional Australia	29.1
Outer Regional Australia	17.2
Remote Australia	1.0
Very Remote Australia	2.2
ALL	**100.0**

Excludes missing data (0.6%)

* Classified by Australian Statistical Geography Standard remoteness area

4.2 Origin of referrals

The majority of referrals (74%) 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 0% to 27%. This suggests not all sites are entering details for patients referred from general practitioners, private hospitals or external specialists.

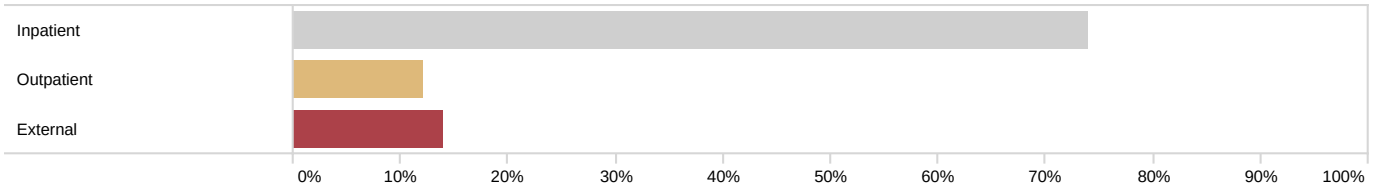


Figure 4: Proportion of referrals by referral source

Table 4: Referral sources by outpatient program HHS

HHS/division	Total referrals n	Inpatient* n (%)	Outpatient* n (%)	External n (%)
Cairns and Hinterland	864	710 (82.2)	83 (9.6)	71 (8.2)
Central Queensland	1,200	690 (57.5)	238 (19.8)	272 (22.7)
Central West	23	11 (47.8)	12 (52.2)	–
Darling Downs	562	389 (69.2)	78 (13.9)	95 (16.9)
Gold Coast	1,456	1,199 (82.3)	185 (12.7)	72 (4.9)
Health Support Queensland	1,238	1,060 (85.6)	149 (12.0)	29 (2.3)
Mackay	277	203 (73.3)	65 (23.5)	9 (3.2)
Metro North	1,449	1,011 (69.8)	138 (9.5)	300 (20.7)
Metro South	1,869	1,253 (67.0)	108 (5.8)	508 (27.2)
North West	89	48 (53.9)	39 (43.8)	2 (2.2)
South West	40	26 (65.0)	12 (30.0)	2 (5.0)
Sunshine Coast	926	809 (87.4)	48 (5.2)	69 (7.5)
Townsville	534	419 (78.5)	114 (21.3)	1 (0.2)
West Moreton	717	456 (63.6)	70 (9.8)	191 (26.6)
Wide Bay	303	247 (81.5)	54 (17.8)	2 (0.7)
Statewide	**11,547**	**8,531 (73.9)**	**1,393 (12.1)**	**1,623 (14.1)**

* Includes referrals from a Queensland Health public hospital

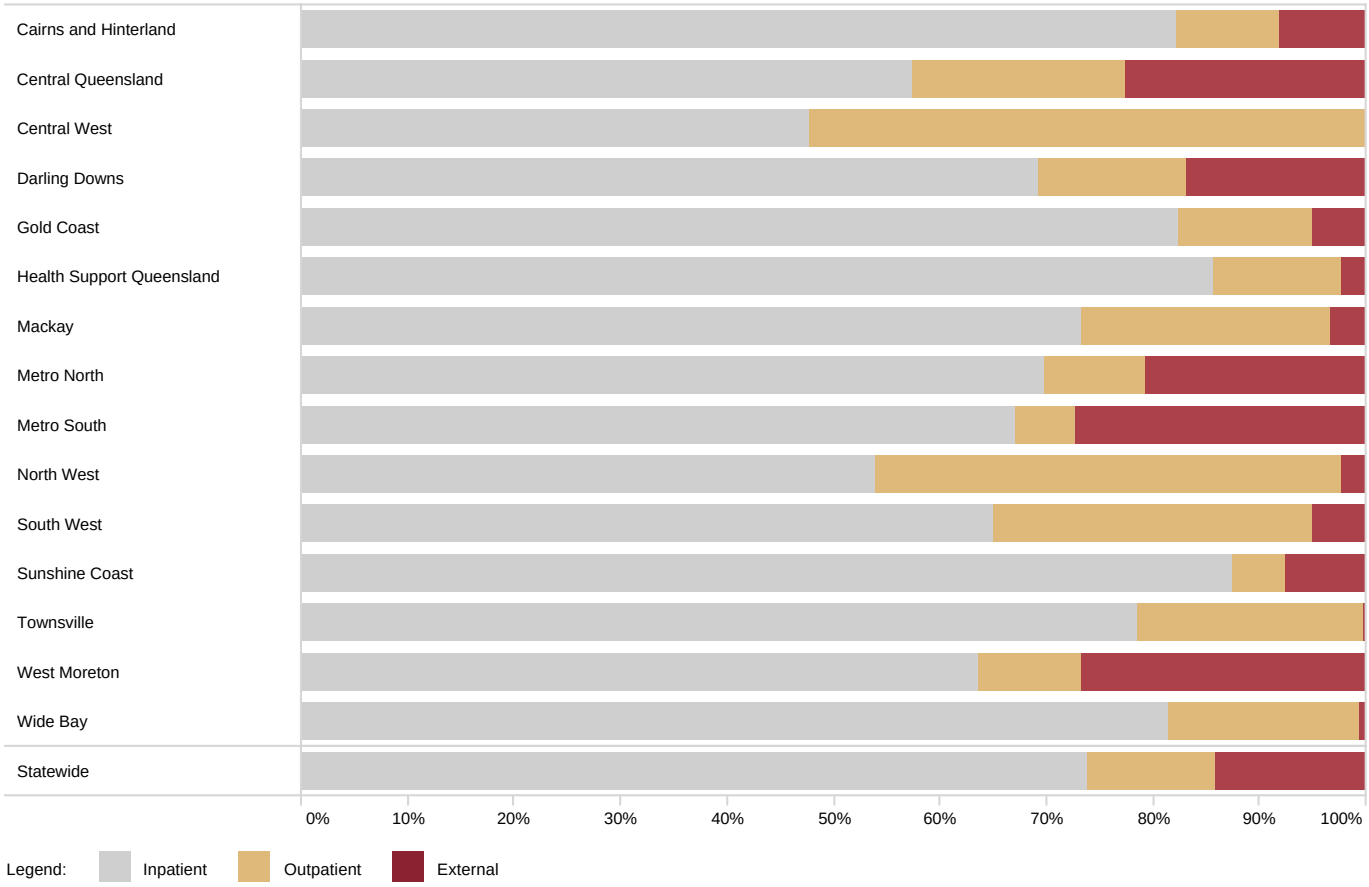


Figure 5: Proportion of referrals by referral source and outpatient program HHS

4.3 Inpatient referrals

For referrals originating from an inpatient setting, the largest referrer was Metro North HHS which accounted for approximately one quarter (26%) of referrals, while Metro South HHS received the largest volume of inpatient referrals (15%).

Table 5: CR inpatient referrals by source and destination HHS

HHS/organisation	Outgoing inpatient referrals n (%)	Incoming inpatient referrals n (%)
Cairns and Hinterland	628 (7.4)	710 (8.3)
Central Queensland	501 (5.9)	690 (8.1)
Central West	–	11 (0.1)
Darling Downs	115 (1.3)	389 (4.6)
Gold Coast	1,206 (14.1)	1,199 (14.1)
Health Support Queensland	–	1,060 (12.4)
Mackay	183 (2.1)	203 (2.4)
Mater Health Services	75 (0.9)	–
Metro North	2,174 (25.5)	1,011 (11.8)
Metro South	1,838 (21.5)	1,253 (14.7)
North West	–	48 (0.6)
South West	–	26 (0.3)
Sunshine Coast	793 (9.3)	809 (9.5)
Townsville	808 (9.5)	419 (4.9)
West Moreton	170 (2.0)	456 (5.3)
Wide Bay	40 (0.5)	247 (2.9)
Statewide	**8,531 (100.0)**	**8,531 (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 Health Support Queensland provides an outpatient (telephone based) service only.

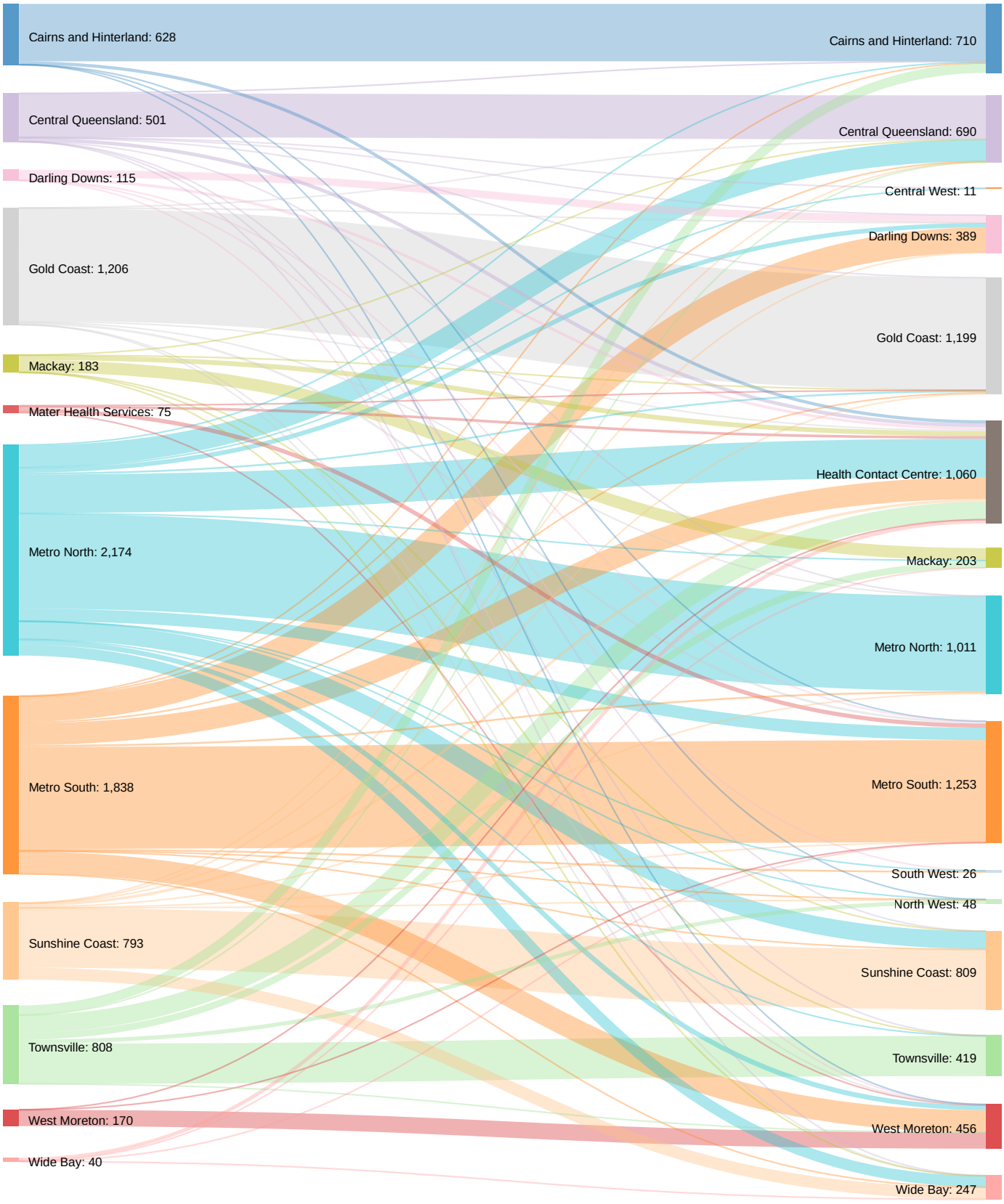


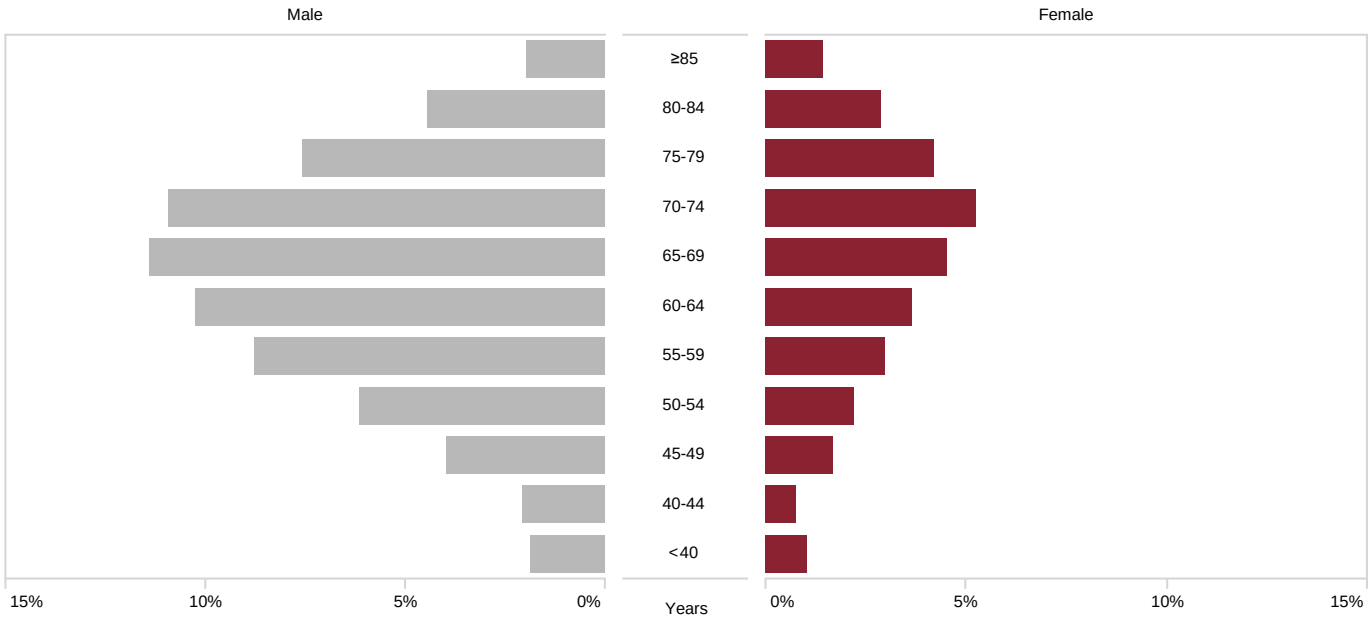
Figure 6: CR inpatient referrals by source and destination HHS

5 Patient characteristics

5.1 Age and gender

Development of cardiovascular disease is related to age. Overall, 69% of patients were male and 31% female. The age distribution of referrals was similar for genders, though the median age for males was slightly lower than for females (66 years vs. 68 years). These results have been very similar since the initial 2017 report.

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



% of total referrals (n=11,547)

Figure 7: Referrals by patient gender and age group

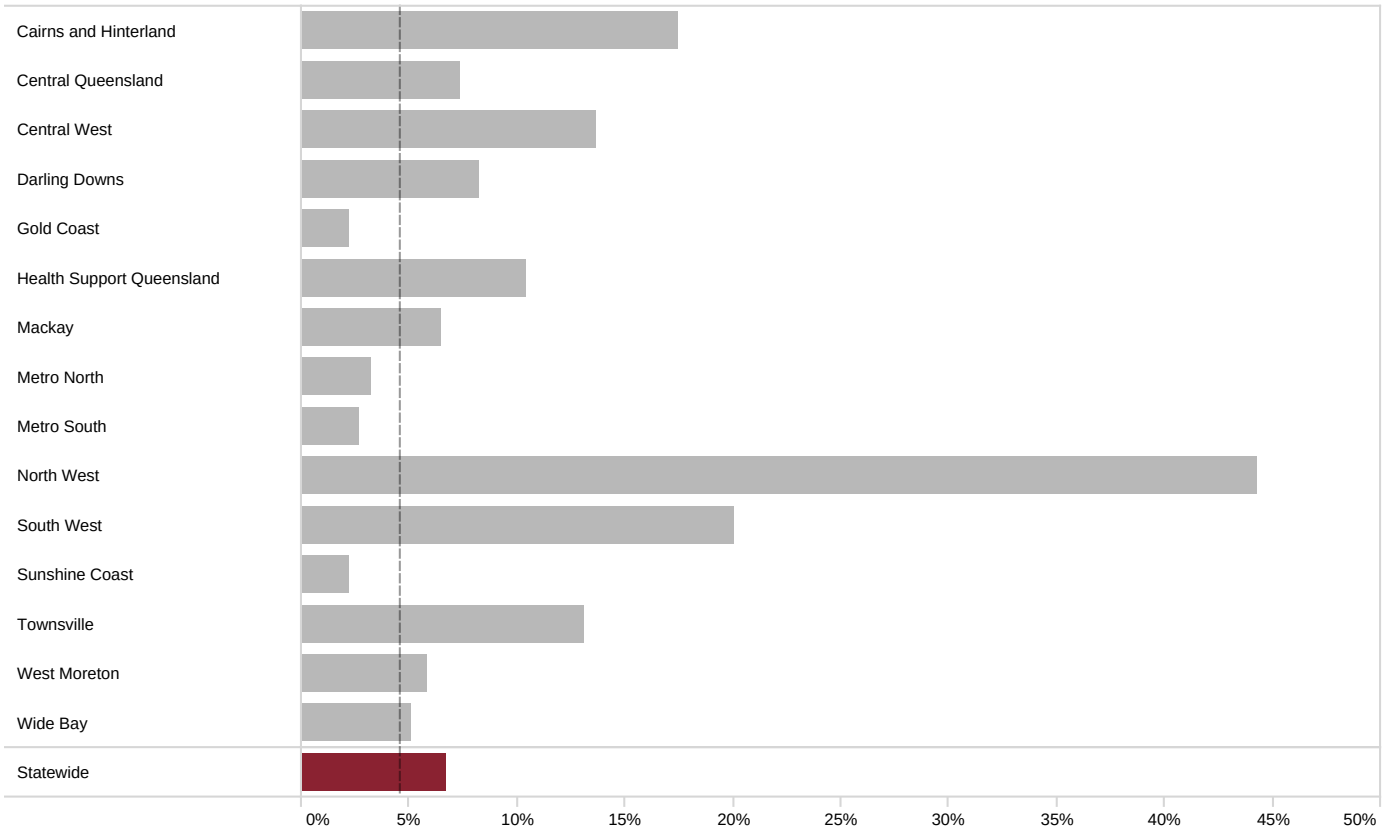
Table 6: Median patient age by gender and HHS

Outpatient HHS/division	Male years	Female years	ALL years
Cairns and Hinterland	65	66	65
Central Queensland	67	70	68
Central West	60	66	60
Darling Downs	67	68	67
Gold Coast	67	70	67
Health Support Queensland	64	67	64
Mackay	63	63	63
Metro North	67	70	68
Metro South	65	68	66
North West	58	58	58
South West	67	64	66
Sunshine Coast	68	71	69
Townsville	64	63	63
West Moreton	65	66	65
Wide Bay	69	69	69
Statewide	**66**	**68**	**66**

5.2 Aboriginal and Torres Strait Islander status

Ethnicity is an important determinant in the development of cardiovascular disease. It is recognised that the Aboriginal and Torres Strait Islander population has a higher incidence and prevalence of coronary artery disease. 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 people's population in Queensland is 4.6%.

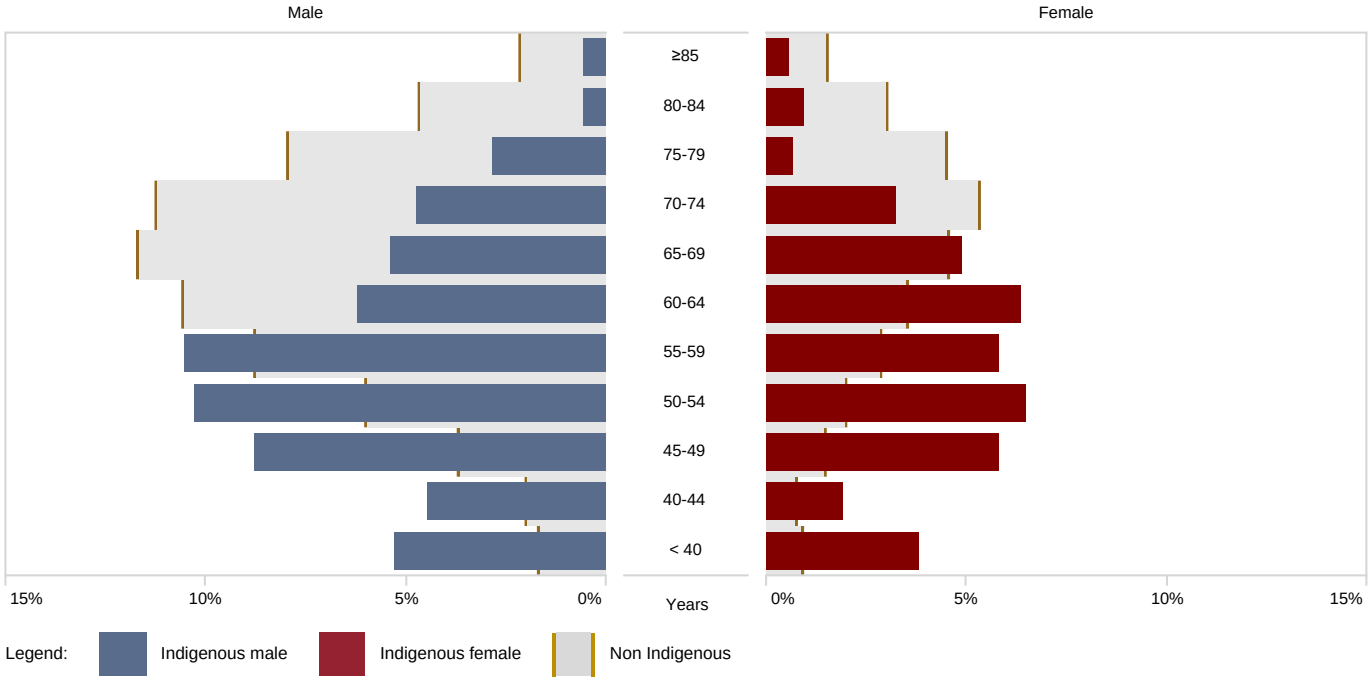
Larger proportions of Aboriginal and Torres Strait Islander patients were referred to CR programs in northern and western HHSs. Cairns and Hinterland, Central West, North West, South West and Townsville HHSs all reported more than 12% of patients identifying as Aboriginal and Torres Strait Islander.



Excludes missing data (3.4%)

Figure 8: 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 (56 years vs. 67 years respectively). This suggests the presence of a cardiovascular disease gap compared to Australians of other descent.



Excludes missing data (3.4%)

Figure 9: Proportion of all CR referrals by age group and Indigenous status

Table 7: Patient age by gender and Indigenous status

	Male years	Female years	All years
Aboriginal and Torres Strait Islander	55	57	56
Non Aboriginal and Torres Strait Islander	66	69	67
ALL	**66**	**68**	**66**

Excludes missing data 3.4%

6 Program participation

6.1 Pre assessment stage

The assessment of a patient by 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.

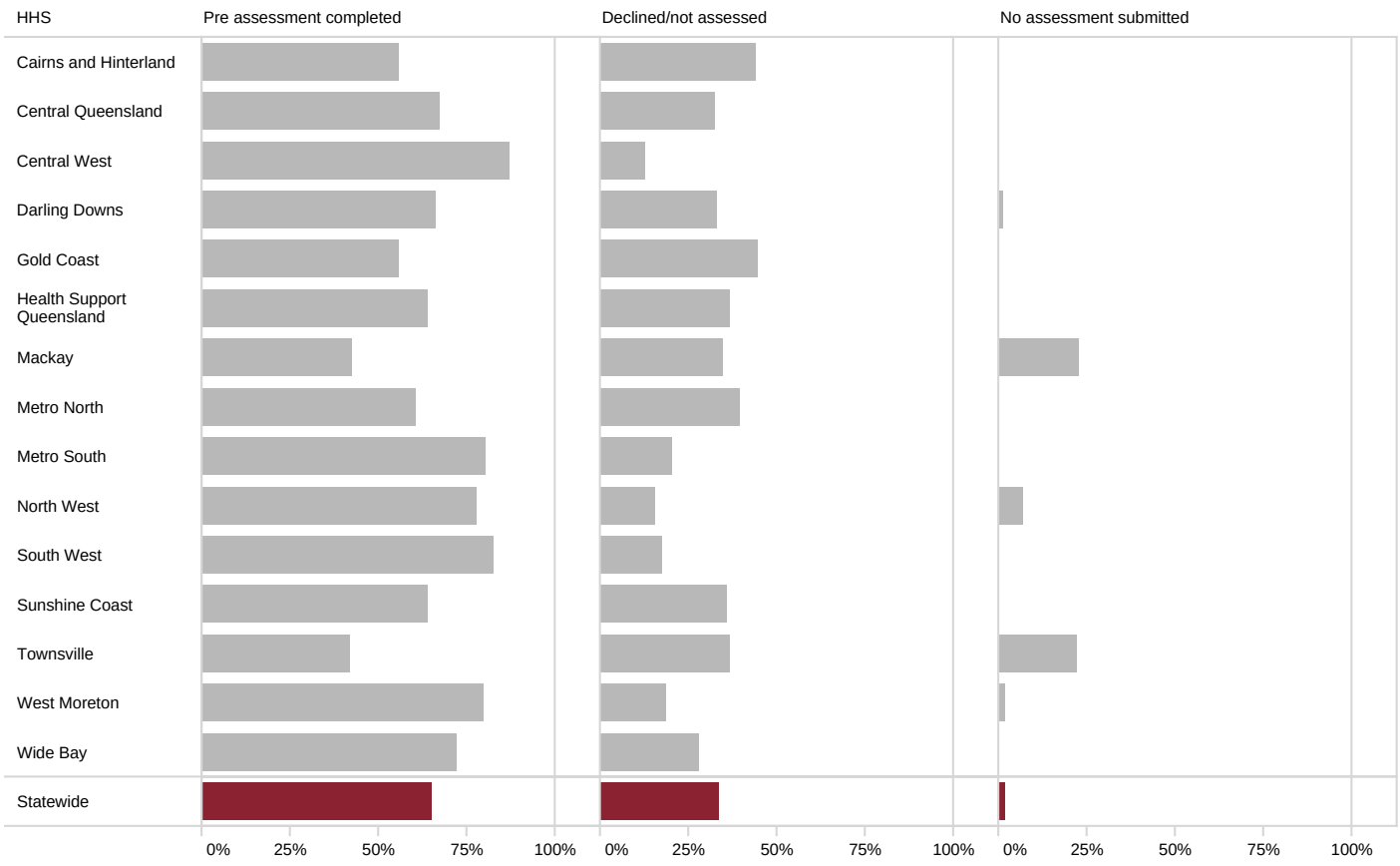
An assessment by outpatient CR is generally conducted in two stages which occur before and after a patient attends the specialist CR program. These stages are referred to as the pre assessment and post assessment. The pre assessment signifies the successful uptake and recruitment of a patient onto the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

The proportion of total referrals which proceeded to a pre assessment within any timeframe was 65%. It should be noted this is a very 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 discussed later in the report.

Table 8: 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	481 (55.7)	383 (44.3)	–
Central Queensland	808 (67.3)	392 (32.7)	–
Central West	20 (87.0)	3 (13.0)	–
Darling Downs	370 (65.8)	185 (32.9)	7 (1.2)
Gold Coast	810 (55.6)	646 (44.4)*	–
Health Support Queensland	787 (63.6)	451 (36.4)	–
Mackay	118 (42.6)	97 (35.0)	62 (22.4)
Metro North	877 (60.5)	572 (39.5)	–
Metro South	1,495 (80.0)	374 (20.0)	–
North West	69 (77.5)	14 (15.7)	6 (6.7)
South West	33 (82.5)	7 (17.5)	–
Sunshine Coast	591 (63.8)	335 (36.2)	–
Townsville	223 (41.8)	194 (36.3)	117 (21.9)
West Moreton	570 (79.5)	134 (18.7)	13 (1.8)
Wide Bay	218 (71.9)	85 (28.1)	–
Statewide	**7,470 (64.7)**	**3,872 (33.5)**	**205 (1.8)**

* Total for Gold Coast HHS includes 21% of referrals for patients residing interstate, who are typically referred for CR outside of Queensland Health



Total for Gold Coast HHS includes 21% of referrals for patients residing interstate

Figure 10: Proportion of CR referrals proceeding to pre assessment by outpatient HHS/division

6.2 Post assessment stage

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. Of 7,470 completed pre assessments, 41% proceeded to post assessment.

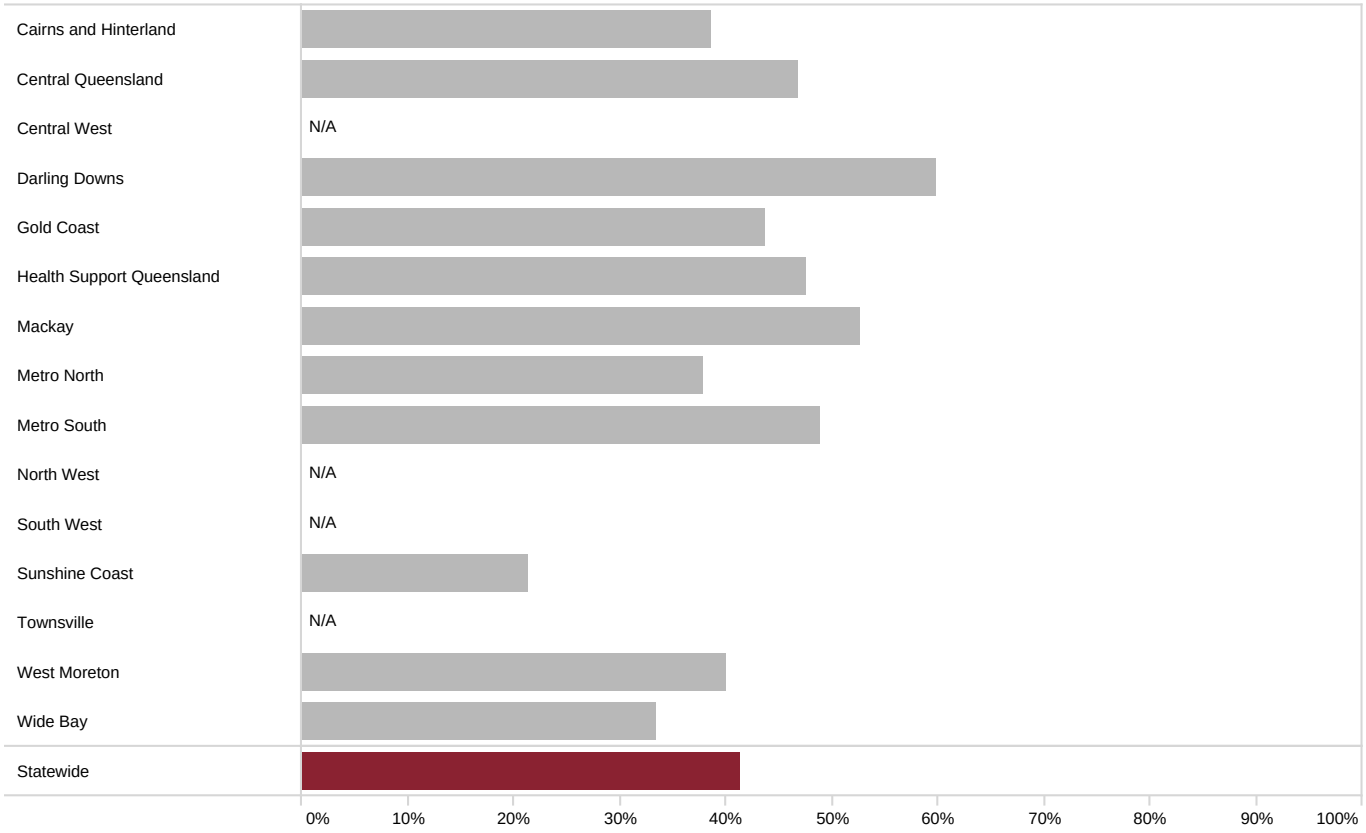
Completion rates and median time delays from post assessment to pre assessment varied considerably by HHSs. The median time from pre assessment to post assessment was 80 days, ranging from 48 days to 163 days across outpatient HHSs. There was considerable variation in the proportion of cases where a post assessment was completed, indicating practices towards post assessment completion and data entry vary considerably 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.

It is important to note that the data reported in this section uses a minimum 90 day window for post assessment completion, which may skew results for sites using longer program timeframes.

Table 9: Total post assessments completed by HHS

Outpatient HHS/division	Post assessment completed n (%)	Median time to post assessment days
Cairns and Hinterland	186 (38.7)	74
Central Queensland	378 (46.8)	74
Central West	5 (25.0)	N/A
Darling Downs	221 (59.7)	56
Gold Coast	354 (43.7)	67
Health Support Queensland	375 (47.6)	163
Mackay	62 (52.5)	81
Metro North	332 (37.9)	120
Metro South	731 (48.9)	74
North West	14 (20.3)	N/A
South West	7 (21.2)	N/A
Sunshine Coast	126 (21.3)	125
Townsville	4 (1.8)	N/A
West Moreton	228 (40.0)	66
Wide Bay	73 (33.5)	48
Statewide	**3,096 (41.4)**	**80**

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



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

Figure 11: Proportion of CR assessments proceeding to post assessment

6.3 Program outcomes

The following sections 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 include 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, and specific model of care employed by the CR program may result in limited data from which conclusions can be drawn. This is a focus for future reporting methods and enhancements in data collection.

Table 10: 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

6.3.1 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. With increased availability of enterprise Queensland Health data collections, it is hoped that future analyses can address this current limitation.

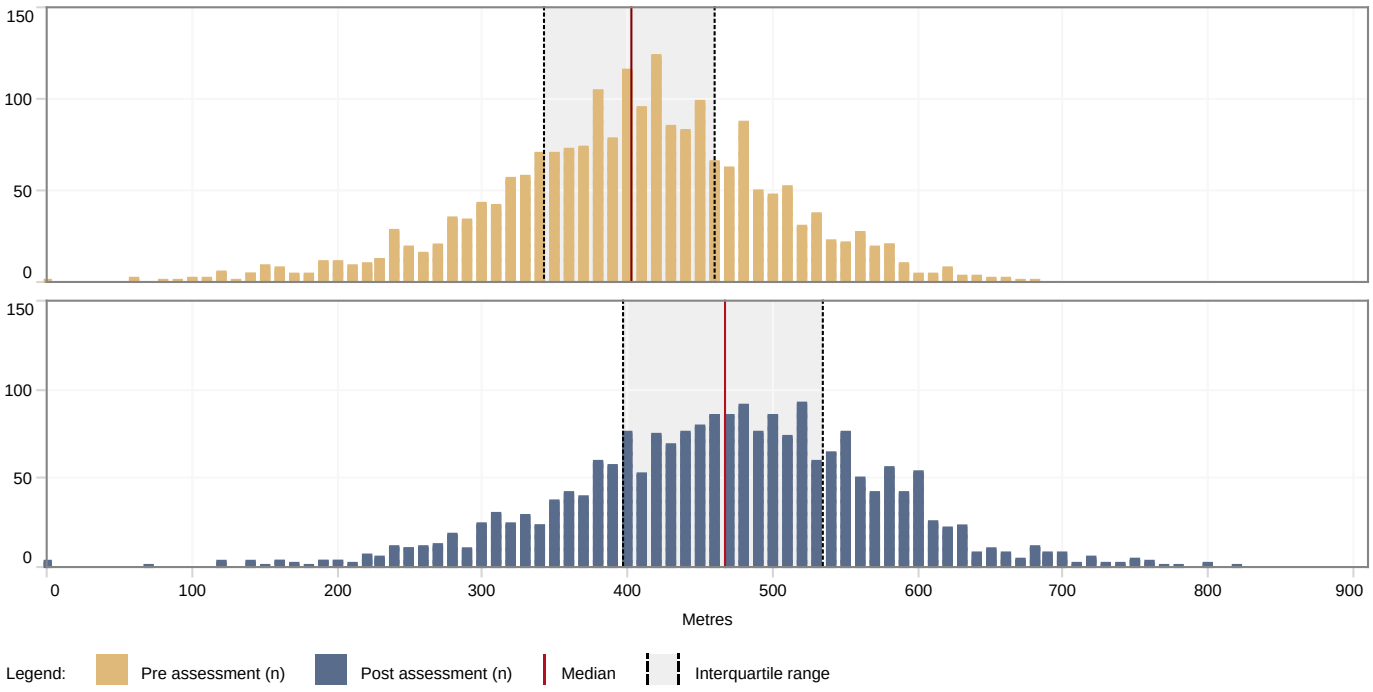
Table 11: Summary of lipid values

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Total cholesterol (mmol/L)	326	4.8 ± 1.4	3.9 ± 1.0	-0.9 ± 1.4
Triglycerides (mmol/L)	306	1.8 ± 1.3	1.5 ± 0.8	-0.4 ± 1.1
HDL-C (mmol/L)	283	1.1 ± 0.4	1.1 ± 0.3	0.0 ± 0.3
LDL-C (mmol/L)	273	2.8 ± 1.2	2.0 ± 0.8	-0.8 ± 1.2

6.3.2 Six minute walk test

A functional measure is indicated prior to implementing an exercise program in order to determine exercise prescription and measure improvement. 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.[25]

There were 2,109 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 (75%) patients demonstrated an improvement in 6MWT, with 57% showing an increase of greater than 50 metres (Table 13).



Results rounded to 10 metres

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

Table 12: 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)	2,109	398.6 ± 94.5	463.6 ± 107.3	65.1 ± 64.2

Table 13: Change in six minute walk test results

	n (%)
Improved ≥50 metres	1,201 (56.9)
Improved 26–49 metres	391 (18.5)
No change (±25 metres)	425 (20.2)
Worsened >25 metres	92 (4.4)
ALL	**2,109 (100.0)**

6.3.3 Patient reported outcome measures

Patient Health Questionnaire

The CR assessment often includes a brief screening for anxiety and depressive disorders, both of which are significant risk factors for patients suffering coronary artery disease 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.[26] 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 with categories of high psychological distress being scored 9–12 points and mild psychological distress scoring between 3–5 points. A score of 0–2 points suggests minimal depression and anxiety.

A total of 2,760 paired data were available for analysis. Almost one third of patients (30%) demonstrated an improved PHQ-4 score at post assessment.

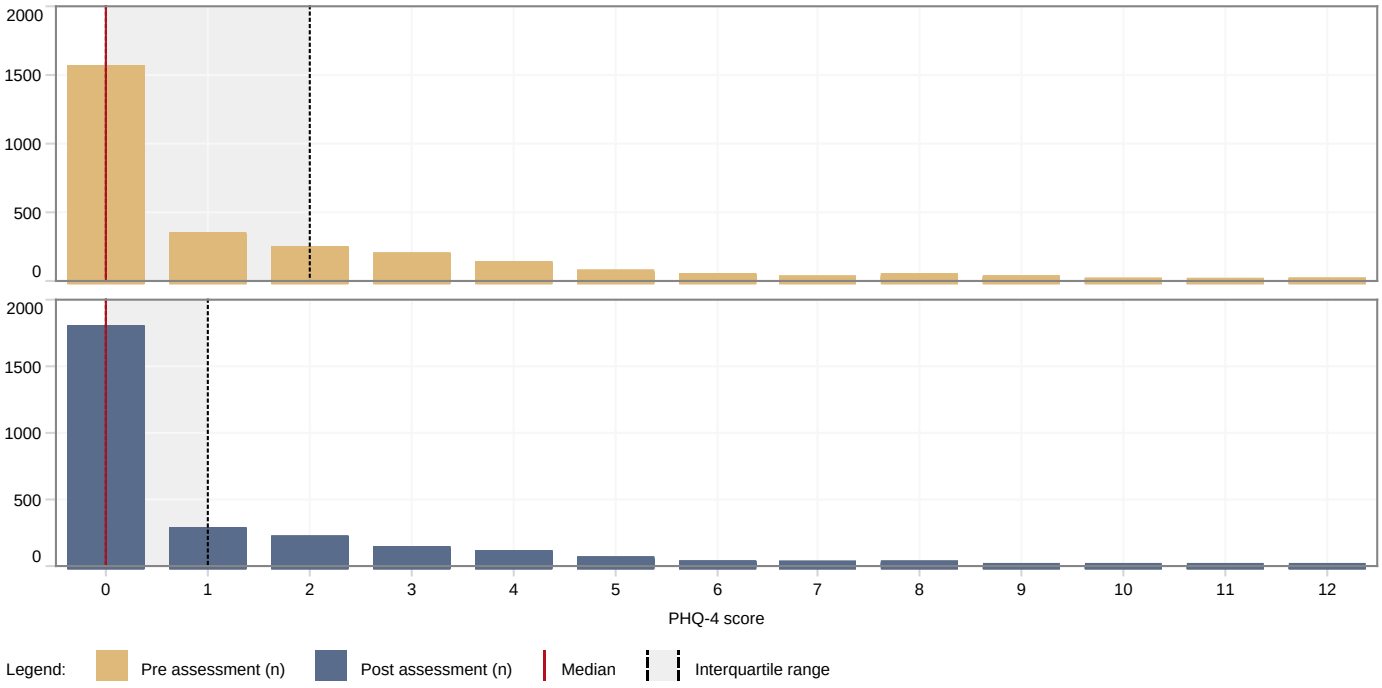


Figure 13: Comparison of pre assessment and post assessment PHQ-4 results

Table 14: 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)	2,760	0.6 ± 1.2	0.5 ± 1.0	-0.1 ± 1.2
Anxiety score (GAD-2)	2,760	0.8 ± 1.4	0.6 ± 1.2	-0.2 ± 1.3
Overall score	**2,760**	**1.4 ± 2.3**	**1.1 ± 2.0**	**-0.4 ± 2.1**

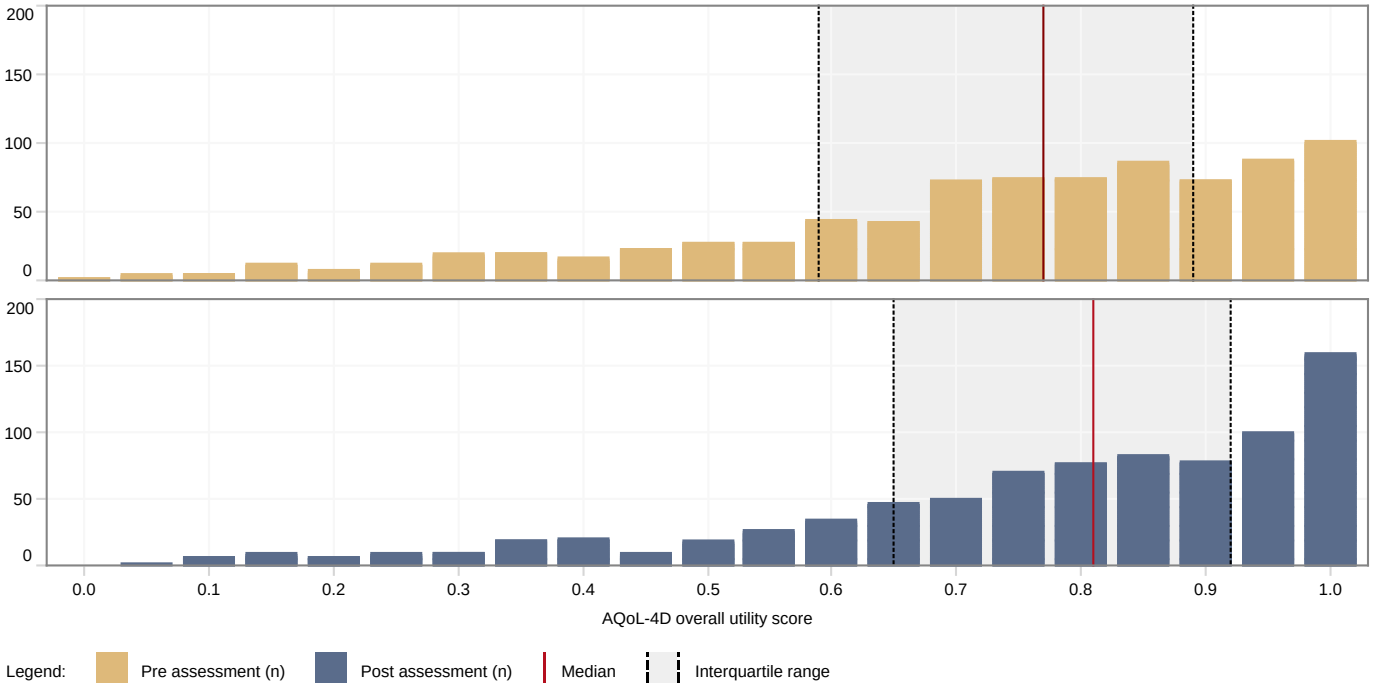
Table 15: Change in PHQ-4 results

	n (%)
Any improvement	833 (30.2)
No change	1,439 (52.1)
Any worse result	48 (17.7)
ALL	**2,760 (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. AQoL-4D utility scores range 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 834 records available at the pre and post CR timeframes, the mean overall pre assessment AQoL-4D utility score was 0.71 which compares similarly to expected results for patients with a cardiovascular diagnosis.[27] This utility score improved to 0.76 at the post assessment stage, where 55% of patients demonstrated an improved overall utility score after CR intervention (Table 16 and Table 17).



Results rounded to 0.05 utility score

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

Table 16: Summary of AQoL-4D results

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Independent living	834	0.91 ± 0.16	0.94 ± 0.13	0.03 ± 0.16
Relationships	834	0.9 ± 0.17	0.91 ± 0.16	0.01 ± 0.17
Senses	834	0.94 ± 0.09	0.93 ± 0.09	‹0.01 ± 0.10
Mental health	834	0.89 ± 0.12	0.91 ± 0.10	0.02 ± 0.13
Overall score	**834**	**0.71 ± 0.23**	**0.76 ± 0.22**	**0.04 ± 0.23**

Table 17: Change in AQoL-4D results

	n (%)
Any improvement	454 (54.4)
No change	72 (8.6)
Any worse result	308 (36.9)
ALL	**834 (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 provides a gauge to whether the CR practitioner may need to apply the more detailed AQoL-4D assessment to better understand the status and needs of the individual patient.

Paired data on the condensed QOL survey were available for 1,839 assessments.

Self reported health

Over 40% of patients reported a health status of very good or excellent at post assessment, compared with 16% at the pre assessment phase. Overall, half of patients (54%) reported a feeling of improved health. Reductions in the numbers of patients reporting fair or poor health were observed with only 2% of patients reporting poor health at post assessment.

Decreases in self reported health status were reported by 9% 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.

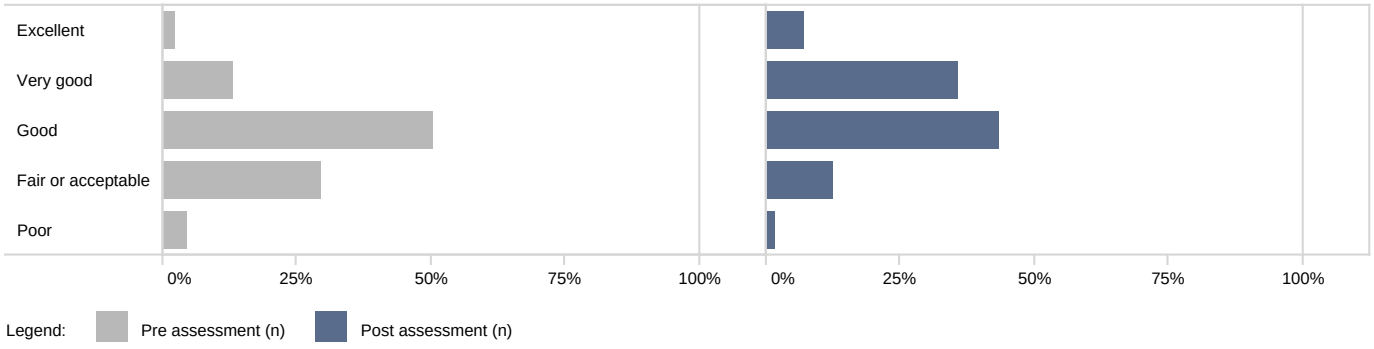


Figure 15: Comparison of patient reported health status at pre and post assessment

Table 18: Change in patient reported health status at pre and post assessment

	n (%)
Any improvement	986 (53.6)
No change	693 (37.7)
Any worse result	160 (8.7)
ALL	**1,839 (100.0)**

Self reported mood

Over half of patients (54%) reported an improved mood compared to the pre assessment stage. The proportion of patients reporting excellent mood scores at post assessment increased from 4% to 14%, while those with very good mood scores increased from 16% to 34%.

There were 11% of patients who reported a decrease in mood, however it is reassuring to see that overall, there was a decrease in the proportion of patients who reported fair or poor mood.

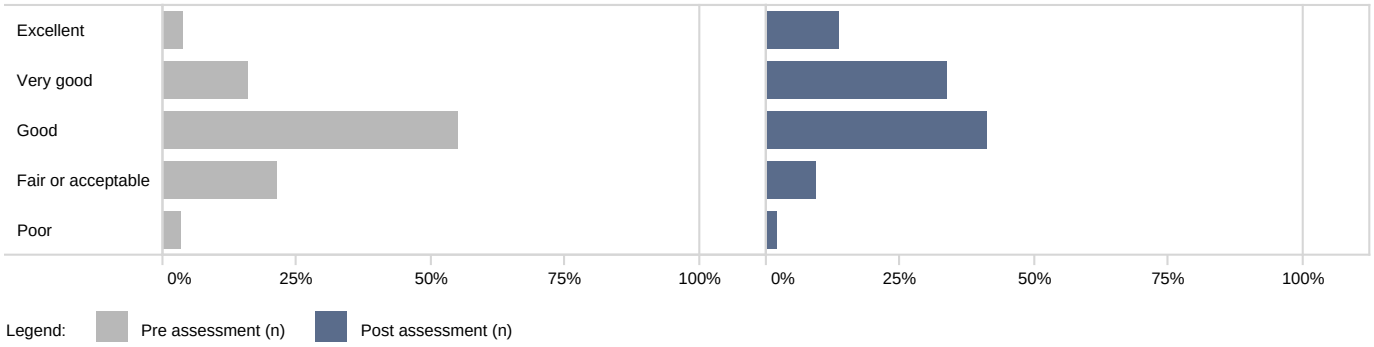


Figure 16: Patient reported change in fitness at post assessment

Table 19: Patient reported change in fitness at post assessment

	n (%)
Any improvement	961 (52.3)
No change	676 (36.8)
Any worse result	202 (11.0)
ALL	**1839 (100.0)**

Self reported fitness

When asked to compare fitness levels in the six months prior to completing a cardiac rehabilitation program, over 50% of patients reported that their fitness improved. Decreases in fitness were reported by 18% of patients. This finding may warrant further investigation to explore the clinical background of these patients as there may be various factors contributing to their reported decrease in fitness.

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

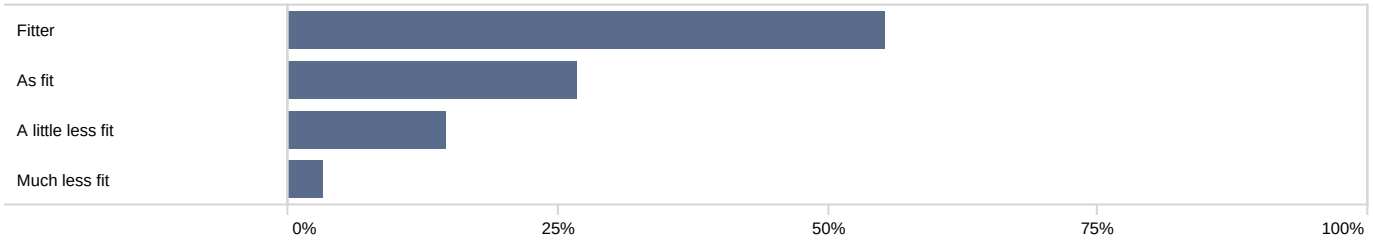


Figure 17: Comparison of patient reported fitness at pre and post assessment

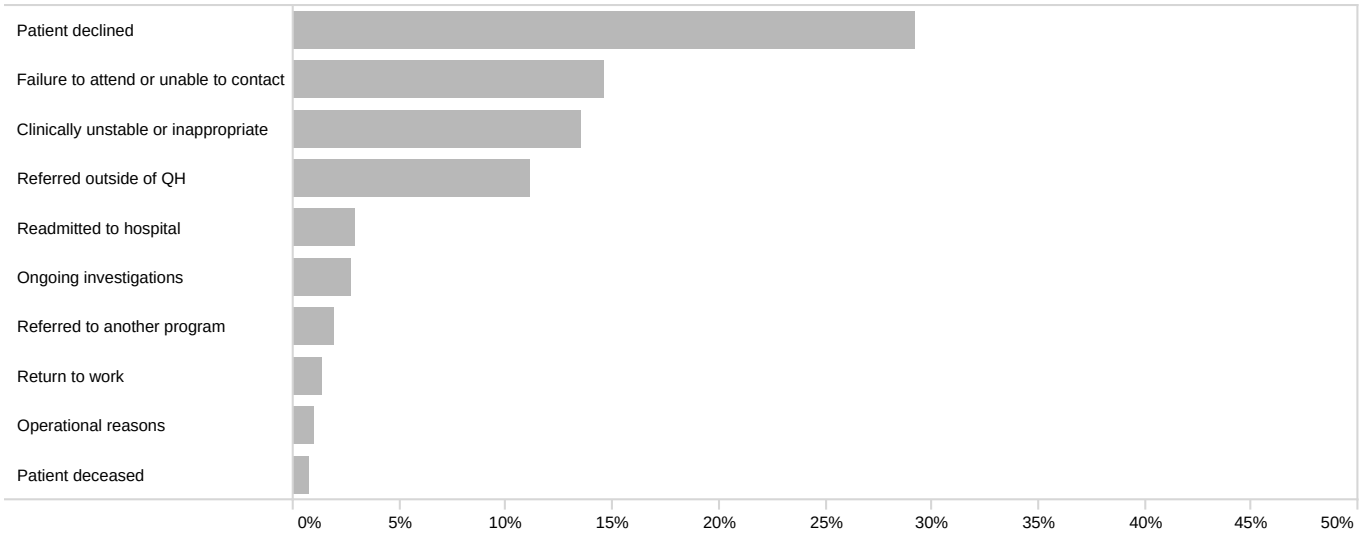
Table 20: Change in patient reported fitness at pre and post assessment

	n (%)
Fitter	1,017 (55.3)
As fit	492 (26.8)
A little less fit	268 (14.6)
Much less fit	62 (3.4)
ALL	**1,839 (100.0)**

6.4 Failure to participate

There are many reasons a patient may not participate in a CR program. In this cohort, the most common reasons for not participating in a CR program were that patients had declined (29%), had been uncontactable or failed to attend (15%), or were medically inappropriate to proceed (14%).

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.



Not displaying other reasons (21%)

Figure 18: Reasons for no pre assessment being conducted

7 Clinical presentation

7.1 Diagnosis

Patients attending a CR pre assessment have been grouped into a diagnosis category for the following analysis based on information provided on the referral to CR. The majority of assessments (66%) followed a previous diagnosis of ischaemic heart disease (IHD).

Table 21: Pre assessments by diagnosis category

Diagnosis category	n	%
Ischaemic heart disease*	4,930	66.0
Valvular disease	635	8.5
Other†	1,905	25.5
ALL	**7,470**	**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 referral to CR was PCI, which had been documented for 39% of all referrals and approximately half (52%) of referrals for patients with IHD.

There were 11% of cases where the most recent procedure had not been identified. These cases can be attributed to missing data, or to patients presenting and subsequently being conservatively managed thus having no procedure applicable.

Table 22: 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	2,570 (52.1)	5 (0.8)	315 (16.5)	2,890 (38.7)
Coronary angiogram	854 (17.3)	20 (3.1)	328 (17.2)	1,202 (16.1)
CABG	811 (16.5)	13 (2.0)	318 (16.7)	1,142 (15.3)
Valve procedure	16 (0.3)	485 (76.4)	91 (4.8)	592 (7.9)
CABG + valve procedure	64 (1.3)	67 (10.6)	35 (1.8)	166 (2.2)
Device procedure	16 (0.3)	1 (0.2)	119 (6.2)	136 (1.8)
Other	66 (1.3)	14 (2.2)	177 (9.3)	257 (3.4)
Not specified	533 (10.8)	30 (4.7)	522 (27.4)	1,085 (14.5)

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, 13% of patients were identified as current smokers (defined as smoking within 30 days), while 50% were classed as former smokers. Only one third of patients met the physical activity guidelines for their age and were sufficiently active. Furthermore, 20% of patients were classed as inactive, which is defined as only undertaking activities associated with daily living. Similarly, less than one quarter (20%) of patients were identified as having a BMI within the normal range.

Overall, 27% of patients had diabetes as a comorbidity with considerable variation observed between diagnosis categories, ranging from 18% for valvular disease to 28% in the IHD and other diagnosis categories. More than half of patients (63%) were identified as having hypertension.

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.

Abnormal cholesterol levels for patients with known cardiovascular disease include measures of:

- Total cholesterol >4.0mmol/L
- HDL <1.0mmol/L
- LDL >2.0mmol/L
- Triglycerides >2.0mmol/L.[28]

Heart failure and LV dysfunction

Overall, there were 15% of patients assessed by outpatient CR who were documented as having heart failure. Of the patients documented to have heart failure, 85% were classed as having a reduced ejection fraction (LVEF <50%). Of these, 32% had mild LV dysfunction, 35% with moderate LV dysfunction and 19% with severe LV dysfunction. The remainder (15%) were documented as having heart failure associated with a preserved ejection fraction (LVEF ≥50%).

Table 23: Summary of risk factors by diagnosis category

Risk factor	Ischaemic heart disease %	Valvular disease %	Other %	ALL %
Abnormal cholesterol	96.0	65.8	82.0	89.8
Activity level				
Sufficiently active	36.5	38.0	33.6	35.8
Insufficiently active	43.9	40.9	44.0	43.7
Inactive	19.6	21.1	22.5	20.5
Body mass index				
Normal range*	18.7	27.9	19.7	19.7
Overweight†	37.1	35.0	34.3	36.2
Obese‡	38.5	32.7	37.3	37.7
Morbidly obese§	5.0	3.3	8.0	5.6
Diabetes	27.9	18.4	27.5	27.0
Family history of CVD‖	49.1	32.8	47.7	47.4
Heart failure	12.2	14.7	21.8	14.8
Heart failure, LVEF				
Preserved function#	8.9	33.3	19.6	14.8
Mild dysfunction**	37.4	22.6	25.3	31.8
Moderate dysfunction††	38.6	26.2	31.0	34.8
Severe dysfunction‡‡	15.1	17.9	24.2	18.6
History of depression	27.9	23.7	31.7	28.5
Hypertension	62.8	55.7	66.4	63.1
Smoking status				
Current smoker§§	14.9	5.1	9.1	12.6
Former smoker	50.4	48.6	50.1	50.2
Never smoked	34.7	46.4	40.9	37.3

% from total complete data per case category

* 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

‖ Cardiovascular disease

\# LVEF ≥50%

** LVEF 40–49%

†† LVEF 30–39%

‡‡ LVEF ‹30%

§§ Within 30 days

7.4 Current medications

Over three quarters of patients were being treated with aspirin (82%) 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, which is consistent with the different disease processes.

Table 24: Current medications by diagnosis category

Medications	IHD %	Valvular disease %	Other %	ALL %
Aspirin	89.7	62.0	68.0	81.8
ACEI/ARB	65.0	41.9	54.1	60.2
Antiplatelet	64.5	9.3	28.7	50.7
Anticoagulant	16.3	45.7	24.8	21.0
Beta blocker	66.2	47.9	60.3	63.1
Diabetic medications	22.1	15.5	22.6	21.7
Dual antiplatelet	60.0	6.6	23.2	46.1
Lipid lowering	91.1	57.4	73.7	83.8
Sublingual nitrate	60.4	5.7	23.8	46.5
Other	65.1	79.1	77.0	69.3

8 Clinical indicators

The CR clinical indicator program has been focused towards the timely referral and uptake to CR for admitted patients being discharged from public hospitals. This requires collaboration between the acute and outpatient services, each having their own targets (clinical indicator 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.

Since the previous report, the QCOR CR Committee has established a new clinical indicator (clinical indicator 2b) examining the proportion of patients who were referred from other settings and had an initial CR assessment completed within 28 days of the referral date. This indicator was developed to help ensure timely services are being provided to all clients, regardless of referral source or clinical history.

Table 25: 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

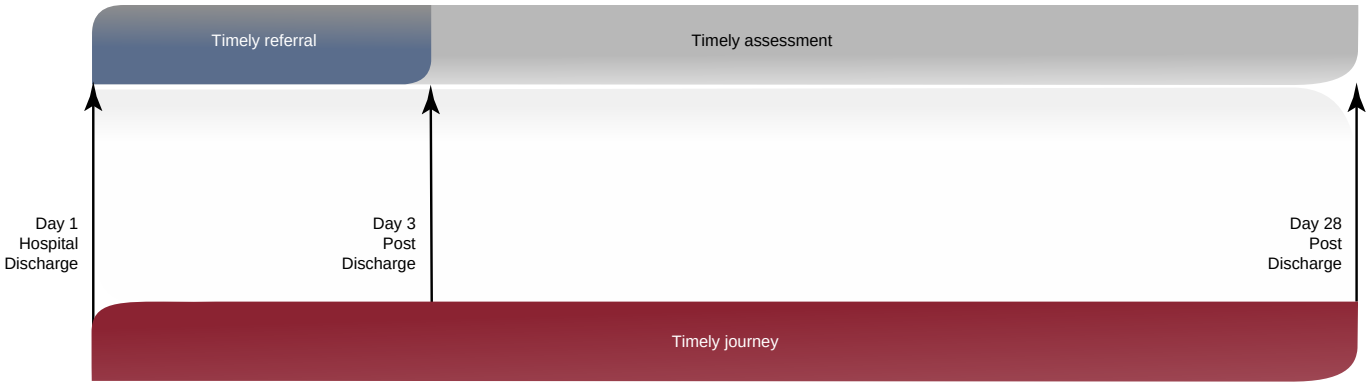


Figure 19: Timely referral, assessment and overall journey for inpatient referrals

8.1.1 Timely referral

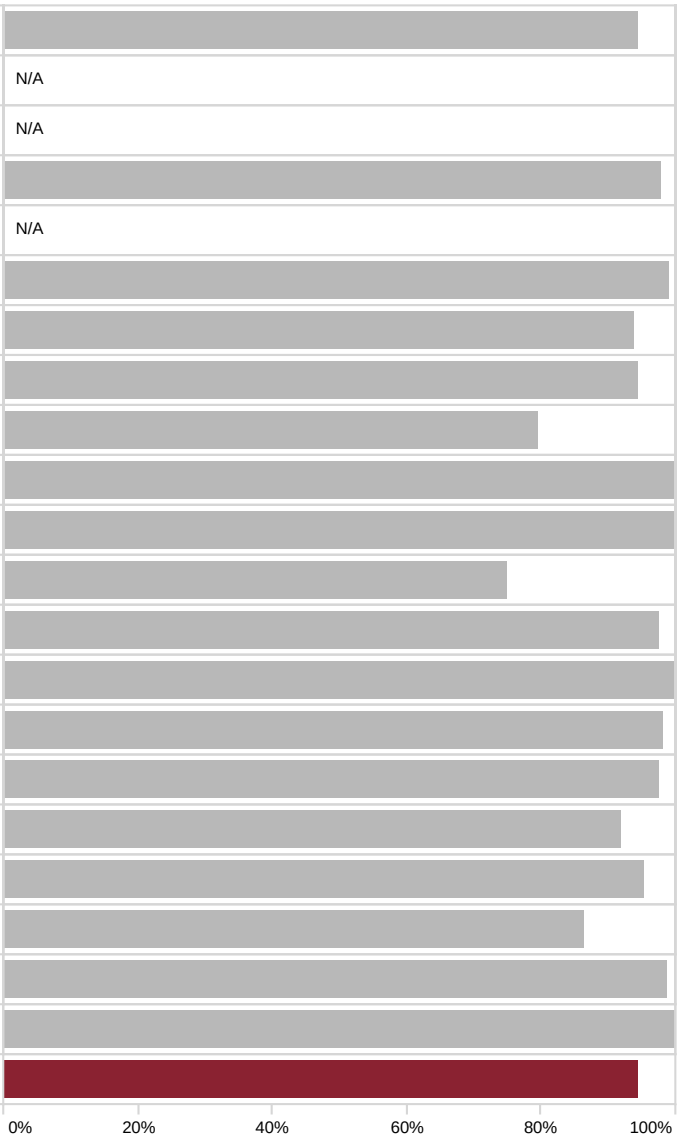
This indicator examines the proportion of inpatient referrals to CR originating from a public hospital which had been provided to the CR program in a timely manner. This requires the referral to be submitted to the outpatient program within three days of the patient being discharged from hospital.

Overall, performance is high with 94% of referrals contributed to QCOR being submitted within three days of discharge.

Table 26: Timely referrals by referring HHS

Referring HHS/organisation	Total inpatient referrals n	Total eligible for analysis n	Target met n (%)
Cairns and Hinterland	628	617	582 (94.3)
Central Queensland	501	457	445 (97.4)
Darling Downs	115	114	113 (99.1)
Gold Coast	1,206	1,191	1,117 (93.8)
Mackay	183	175	165 (94.3)
Mater Health Services	75	73	58 (79.5)
Metro North	2,174	2,156	2,016 (93.5)
Metro South	1,838	1,837	1,799 (97.9)
Sunshine Coast	793	742	707 (95.3)
Townsville	808	784	678 (86.5)
West Moreton	170	169	167 (98.8)
Wide Bay	40	39	39 (100.0)
Statewide	**8,531**	**8,354**	**7,886 (94.4)**

Referred by HHS	Referred by hospital	Total analysed, n
Cairns and Hinterland	Cairns Hospital	617
Central Queensland	Gladstone Hospital	15
	Mount Morgan Hospital	1
	Rockhampton Hospital	441
Darling Downs	Dalby Hospital	1
	Toowoomba Hospital	113
Gold Coast	Gold Cost University Hospital	1,191
Mackay	Mackay Base Hospital	175
Mater Health Services	Mater Hospital Brisbane	73
Metro North	Caboolture Hospital	173
	Redcliffe Hospital	73
	Royal Brisbane & Women's Hospital	408
	The Prince Charles Hospital	1,502
Metro South	Logan Hospital	69
	Princess Alexandra Hospital	1,681
	Queen Elizabeth II Jubilee Hospital	38
	Redland Hospital	49
Sunshine Coast	Sunshine Coast University Hospital	742
Townsville	Townsville University Hospital	784
West Moreton	Ipswich Hospital	169
Wide Bay	Bundaberg Base Hospital	39
Statewide		



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

Figure 20: Timely referrals by referring hospital

8.1.2 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 27. The exclusions are applied where information is available and has been documented in the application.

Overall, more than half of all patients (59%) are being assessed in a timely manner, however there was some variation across health services.

Table 27: Summary of referrals ineligible for timely assessment clinical indicator – inpatients

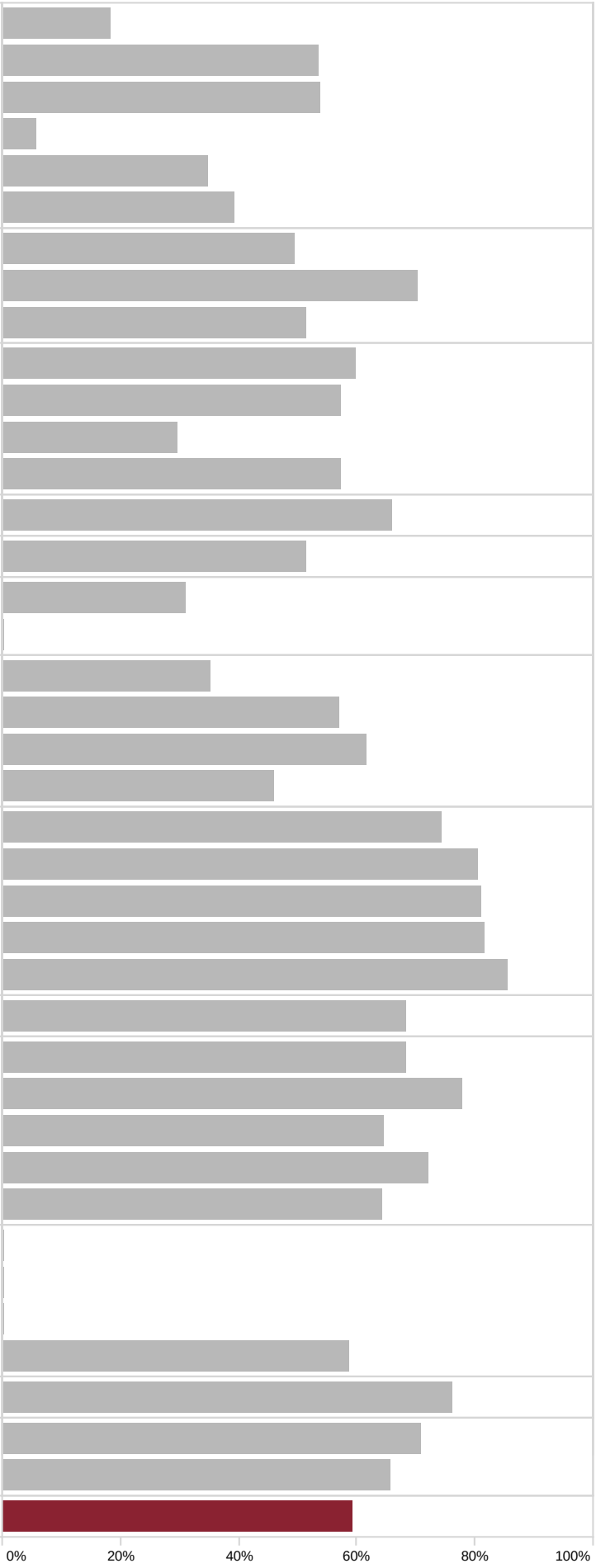
Summary	n
Not referred within three days of discharge	423
Referred outside of Queensland Health	369
Same day admission	177
Clinically unstable/inappropriate	126
Patient accepted onto existing program	94
Patient readmitted to hospital	94
Patient deceased	28
Total ineligible	**1,311**

Table 28: 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	710	595	274 (46.1)
Central Queensland	690	577	308 (53.4)
Central West	11	9	N/A
Darling Downs	389	355	142 (40.0)
Gold Coast	1,199	813	536 (65.9)
Health Support Queensland	1,060	872	449 (51.5)
Mackay	203	157	34 (21.7)
Metro North	1,011	943	469 (49.7)
Metro South	1,253	1,192	961 (80.6)
North West	48	38	26 (68.4)
South West	26	24	10 (41.7)
Sunshine Coast	809	673	464 (68.9)
Townsville	419	349	143 (41.0)
West Moreton	456	413	315 (76.3)
Wide Bay	247	210	146 (69.5)
Statewide	**8,531**	**7,220**	**4,284 (59.3)**

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

Outpatient HHS	Outpatient program	Total analysed, n
Cairns and Hinterland	Atherton	64
	Cairns	498
	Innisfail	45
	Mareeba	40
	Mossman	27
	Tully	25
Central Queensland	Capricorn Coast	108
	Gladstone	105
	Rockhampton	400
Darling Downs	Dalby-Tara	27
	Kingaroy	74
	Toowoomba	193
	Warwick	54
Gold Coast	Gold Coast	1,184
Health Support Queensland	COACH	1,043
Mackay	Mackay	148
	Proserpine	36
Metro North	Caboolture	317
	Chermside	294
	North Lakes	248
	Redcliffe	142
Metro South	Bayside	286
	Eight Mile Plains	160
	Inala	82
	Logan-Beaudesert	467
	Princess Alexandra Hospital	254
North West	Mt Isa	46
Sunshine Coast	Caloundra	196
	Gympie	123
	Maroochydore	196
	Nambour	139
	Noosa	112
Townsville	Ayr	39
	Charters Towers	26
	Ingham	37
	Townsville	296
West Moreton	Ipswich	455
Wide Bay	Hervey Bay	152
	Maryborough	86
Statewide		



Sites with ‹20 referrals for analysis not displayed

Figure 21: Timely assessment by outpatient program – inpatients

8.1.3 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 29: Summary of referrals ineligible for timely assessment clinical indicator – non acute patients

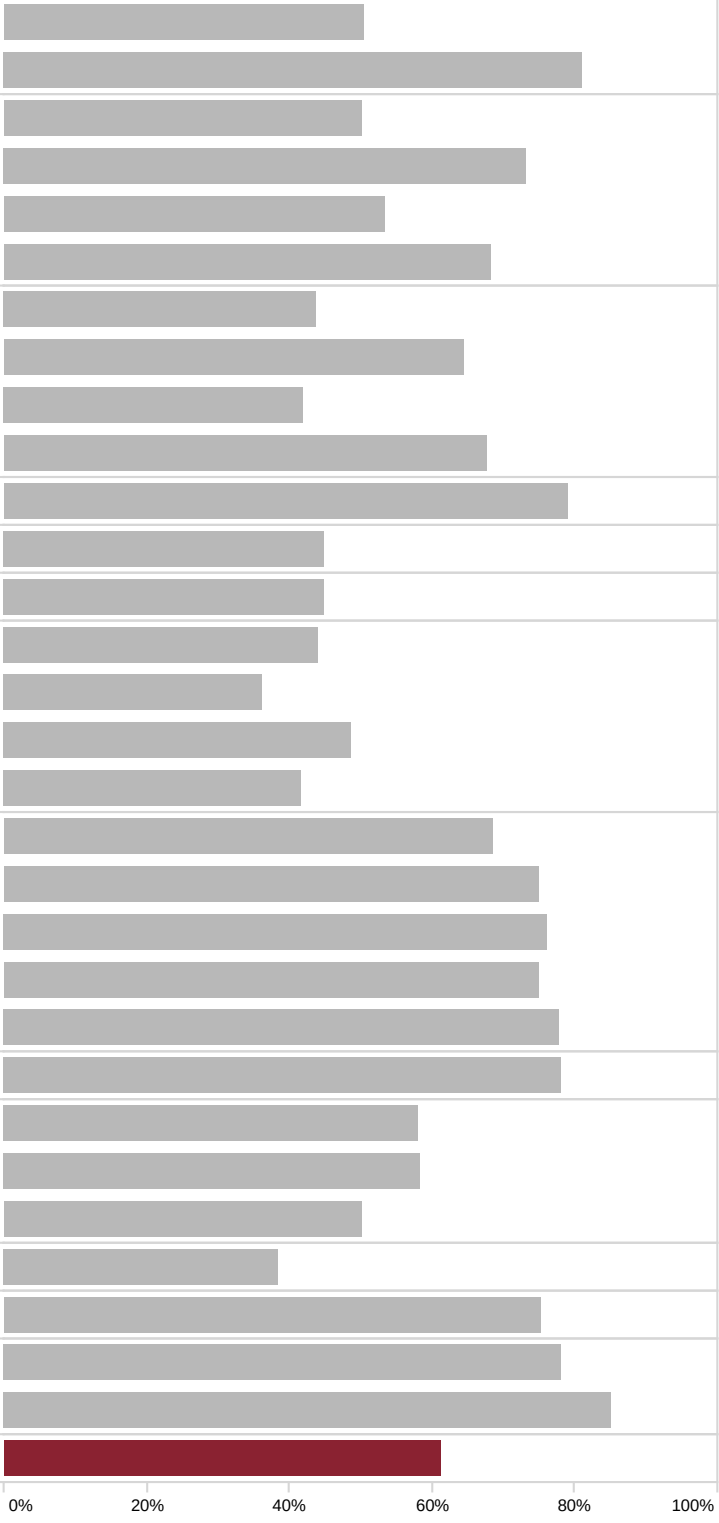
Summary	n
Referred outside of Queensland Health	62
Patient accepted onto existing program	24
Patient readmitted to hospital	19
Clinically unstable/inappropriate	18
Patient deceased	3
Total ineligible	**126**

Table 30: 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	154	153	80 (52.3)
Central Queensland	510	497	321 (64.6)
Central West	12	11	N/A
Darling Downs	173	171	96 (56.1)
Gold Coast	257	215	170 (79.1)
Health Support Queensland	178	158	71 (44.9)
Mackay	74	68	26 (38.2)
Metro North	438	432	190 (44.0)
Metro South	616	603	438 (72.6)
North West	41	41	32 (78.0)
South West	14	12	N/A
Sunshine Coast	117	104	57 (54.8)
Townsville	115	112	32 (28.6)
West Moreton	261	258	194 (75.2)
Wide Bay	56	55	45 (81.8)
Statewide	**3,016**	**2,890**	**1,770 (61.2)**

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

Outpatient HHS	Outpatient program	Total analysed, n
Cairns and Hinterland	Cairns	89
	Innisfail	21
Central Queensland	Capricorn Coast	94
	Gladstone	134
	Mount Morgan Cardiac Rehabilitation	45
	Rockhampton	221
Darling Downs	Dalby-Tara	32
	Kingaroy	31
	Toowoomba	50
	Warwick	34
Gold Coast	Gold Coast	215
Health Support Queensland	COACH	158
Mackay	Mackay	58
Metro North	Caboolture	125
	Chermside	72
	North Lakes	156
	Redcliffe	79
Metro South	Bayside	231
	Eight Mile Plains	136
	Inala	21
	Logan-Beaudesert	188
	Princess Alexandra Hospital	27
North West	Mt Isa	41
Sunshine Coast	Caloundra	31
	Gympie	24
	Maroochydore	24
Townsville	Townsville	83
West Moreton	Ipswich	258
Wide Bay	Hervey Bay	32
	Maryborough	20
Statewide		



Sites with <20 referrals for analysis not displayed

Figure 22: Timely assessment by outpatient program – non acute patients

8.1.4 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 31. 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 against both participating services.

Table 31: Summary of referrals ineligible for timely journey clinical indicator – inpatients

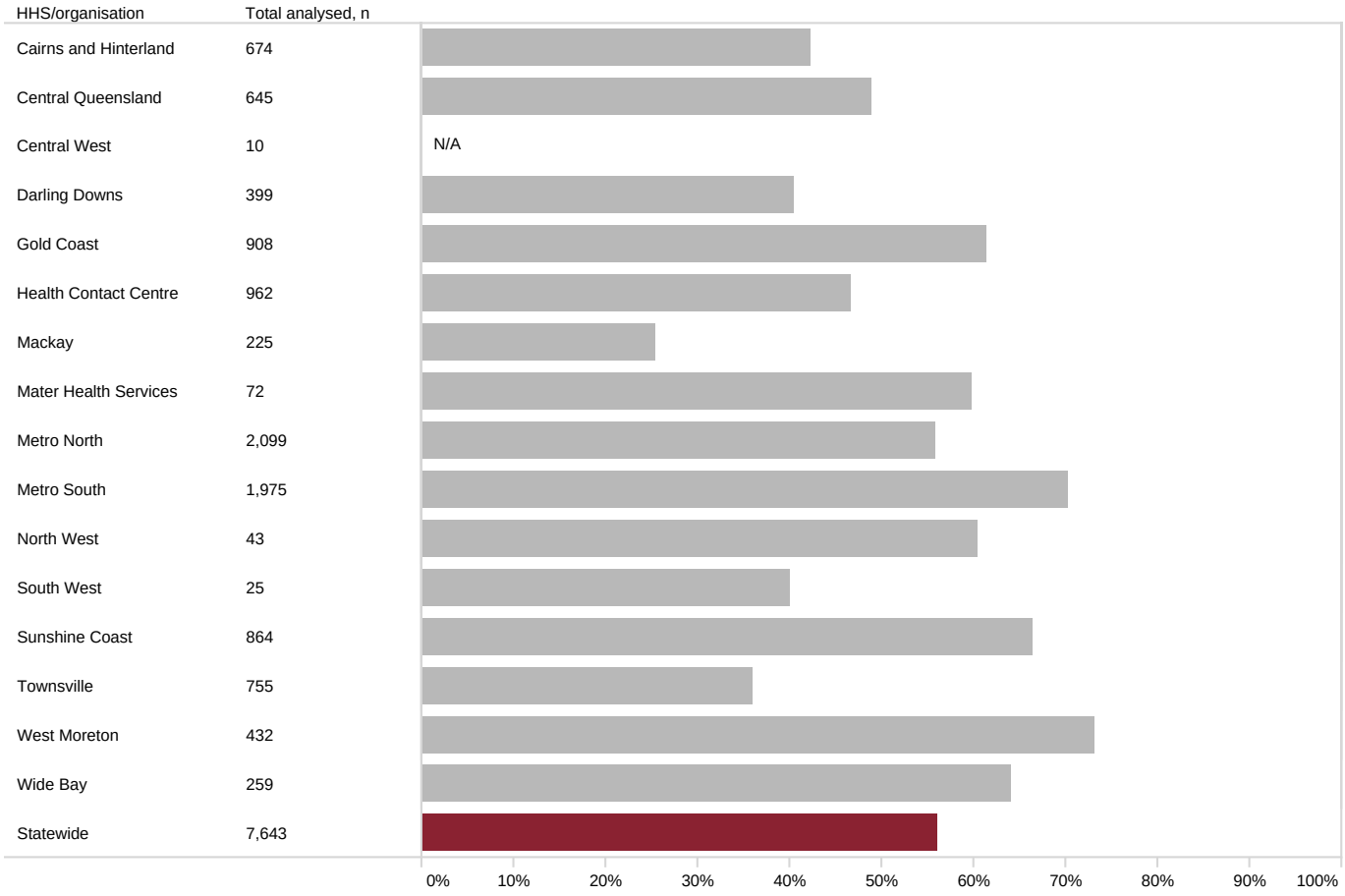
Summary	n
Referred outside of Queensland Health	369
Same day admission	177
Clinically unstable/inappropriate	126
Patient accepted onto existing program	94
Patient readmitted to hospital	94
Patient deceased	28
Total ineligible	**888**

Table 32: 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	747	674	285 (42.3)
Central Queensland	739	645	316 (49.0)
Central West	11	10	N/A
Darling Downs	426	399	161 (40.4)
Gold Coast	1,247	908	557 (61.3)
Health Support Queensland	1,060	962	449 (46.7)
Mackay	261	225	57 (25.3)
Mater Health Services	75	72	43 (59.7)
Metro North	2,209	2,099	1,172 (55.8)
Metro South	2,041	1,975	1,386 (70.2)
North West	48	43	26 (60.5)
South West	26	25	10 (40.0)
Sunshine Coast	988	864	575 (66.6)
Townsville	814	755	272 (36.0)
West Moreton	459	432	316 (73.1)
Wide Bay	286	259	166 (64.1)
Statewide	**8,531**	**7,643**	**4,284 (56.1)**

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

* Includes both incoming and outgoing referrals



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

Figure 23: Timely journey indicator by participating HHS – inpatients

9 Declined referrals

An ongoing initiative has been to further define the subset of patients who did not uptake CR for whatever reason, with the aim to increase the level of detail available to describe the barriers to participation. The cohort of patients who had elected not participate in CR have been examined with an aim to identify common themes and opportunities to improve patient participation rates.

This does not include, for example, patients who did not attend CR due to being medically unsuitable to participate.

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.

9.1 Age and gender

Patients most likely to decline CR participation are males aged 65 years to 69 years (12%). The largest group of females to decline CR were aged in the 70 years to 74 years category (6%). Patients who declined were older than patients who had taken up CR (70 years vs. 66 years).

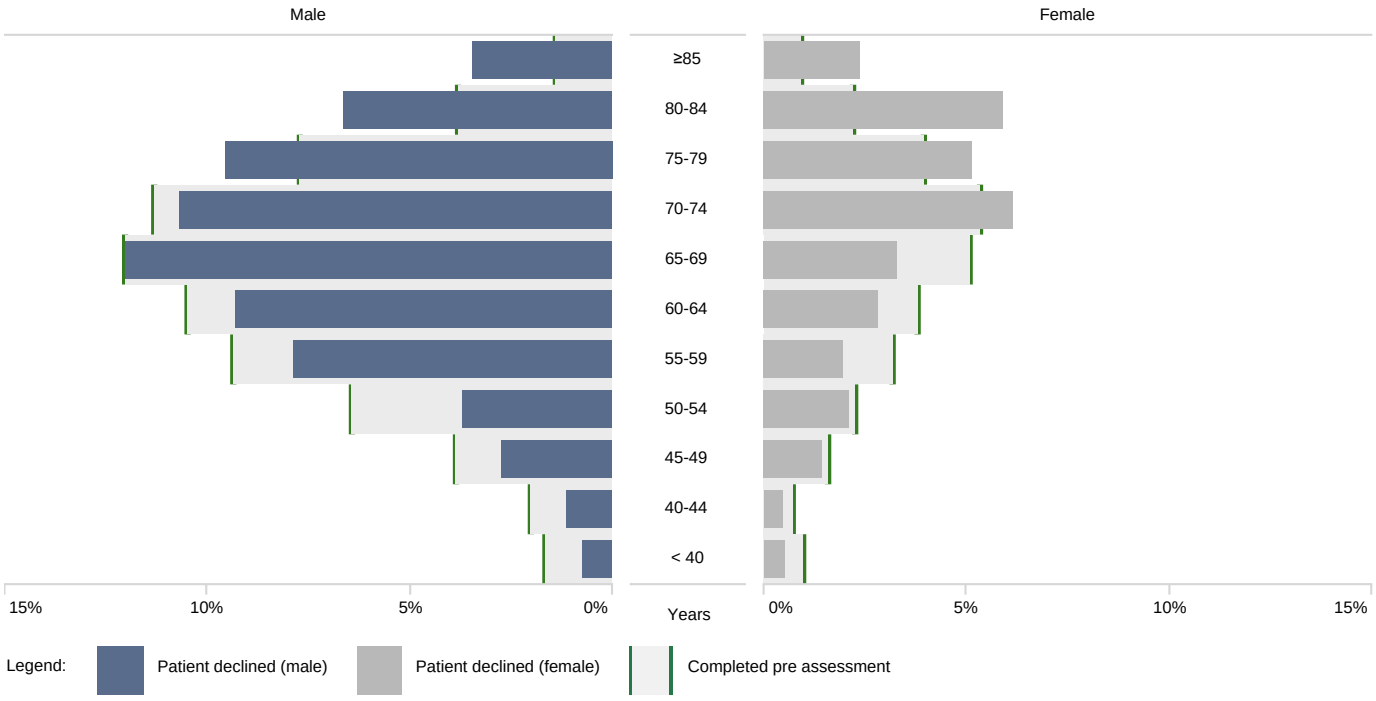


Figure 24: Patient CR program participation status by age group and gender

Table 33: Patient age (years) by program participation status

	Male Median (IQR)	Female Median (IQR)	ALL Median (IQR)
Patient declined	68 (61–76)	73 (63–80)	70 (61–78)
Fully assessed	65 (57–73)	68 (58–74)	66 (57–73)

Table 34: Patient gender by program participation status

Gender	Completed pre assessment n (%)	Patient declined n (%)
Male	5,225 (69.9)	767 (67.8)
Female	2,245 (30.1)	364 (32.2)

9.2 Diagnosis category

Of the patients who declined, 41% had a diagnosis of ischaemic heart disease and 4% valvular disease, while the majority (55%) had some other diagnosis.

By comparison, patients who had completed initial assessment via CR more highly represented by ischaemic heart disease and valvular heart disease (66% and 9% respectively).

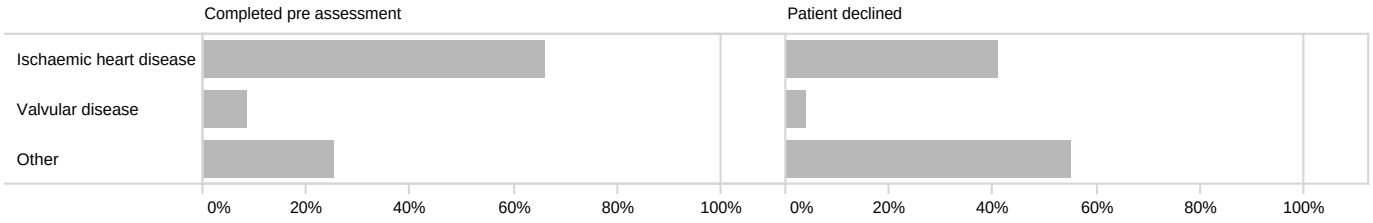


Figure 25: Proportion of cases by diagnosis category and program participation status

Table 35: Diagnosis category by program participation status

Diagnosis category	Completed pre assessment n (%)	Patient declined n (%)
Ischaemic heart disease	4,930 (66.0)	465 (41.1)
Valvular disease	635 (8.5)	44 (3.9)
Other	1,905 (25.5)	622 (55.0)
ALL	**7,470 (100.0)**	**1,131 (100.0)**

9.3 Most recent procedure

Overall, 22% of patients that elected not to participate in CR were recorded as having undergone PCI, while approximately 8% had undergone CABG (with or without a concomitant valve procedure). Almost half of patients (47%) who declined CR had no recent procedure specified. Care should be taken, however, when interpreting these findings as this data element is not always completed at the time of referral. Therefore, it may not fully represent the preceding patient medical history.

For the cohort that proceeded to assessment, their most recent procedure was more closely related to their participation status. This data suggests that patients who went on to uptake a CR program may be more likely to have undergone an invasive cardiac procedure prior to referral.

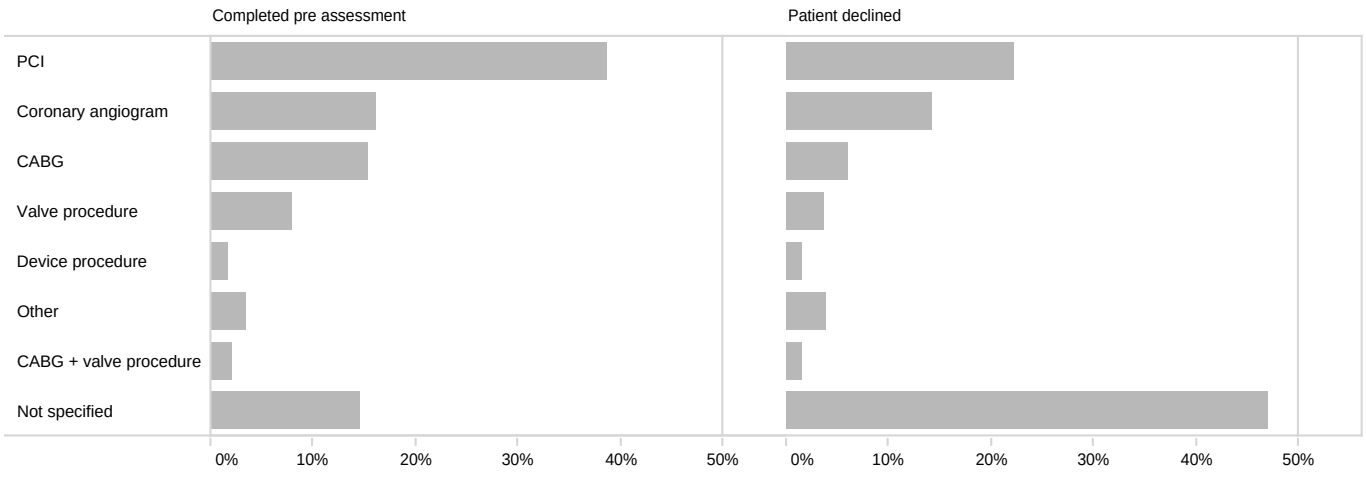


Figure 26: Proportion of cases by most recent procedure and program participation status

Table 36: Most recent procedure by program participation status

Most recent procedure	Completed pre assessment n (%)	Patient declined n (%)
PCI	2,890 (38.7)	250 (22.1)
Coronary angiogram	1,202 (16.1)	161 (14.2)
CABG	1,142 (15.3)	68 (6.0)
Valve procedure	592 (7.9)	41 (3.6)
CABG + valve procedure	166 (2.2)	18 (1.6)
Device procedure	136 (1.8)	18 (1.6)
Other	257 (3.4)	43 (3.8)
Not specified	1,085 (14.5)	532 (47.0)
ALL	**7,470 (100.0)**	**1,131 (100.0)**

9.4 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.

Table 37: Remoteness classification by program participation status

Remoteness area*	Completed pre assessment %	Patient declined %
Major Cities of Australia	54.2	45.4
Inner Regional Australia	29.0	28.5
Outer Regional Australia	13.8	23.0
Remote Australia	0.8	1.9
Very Remote Australia	2.2	1.2
ALL	**100.0**	**100.0**

Excludes missing data (0.5%)

* Classified by Australian Statistical Geography Standard remoteness area

10 Conclusions

This year's report reflects the effort and dedication of clinicians across 57 Queensland CR sites incorporating QCOR into their daily practice, including the addition of two newly established sites during the year.

Almost all sites offering public CR services in Queensland are directly entering data into QCOR at the time of assessment. Whilst a goal of the QCOR committee is for all sites to enter data into QCOR, it must be recognised that the vast level of collaboration and collegiality that has already been established through this endeavour is unprecedented for CR services in the state.

The evolution of the QCOR application over time has allowed increased detail for all CR activity, including inpatient phase one activity. One future focus of this Audit will be those patients who decline CR in the initial stages, with an exploration of the barriers and reasons for non-participation to occur.

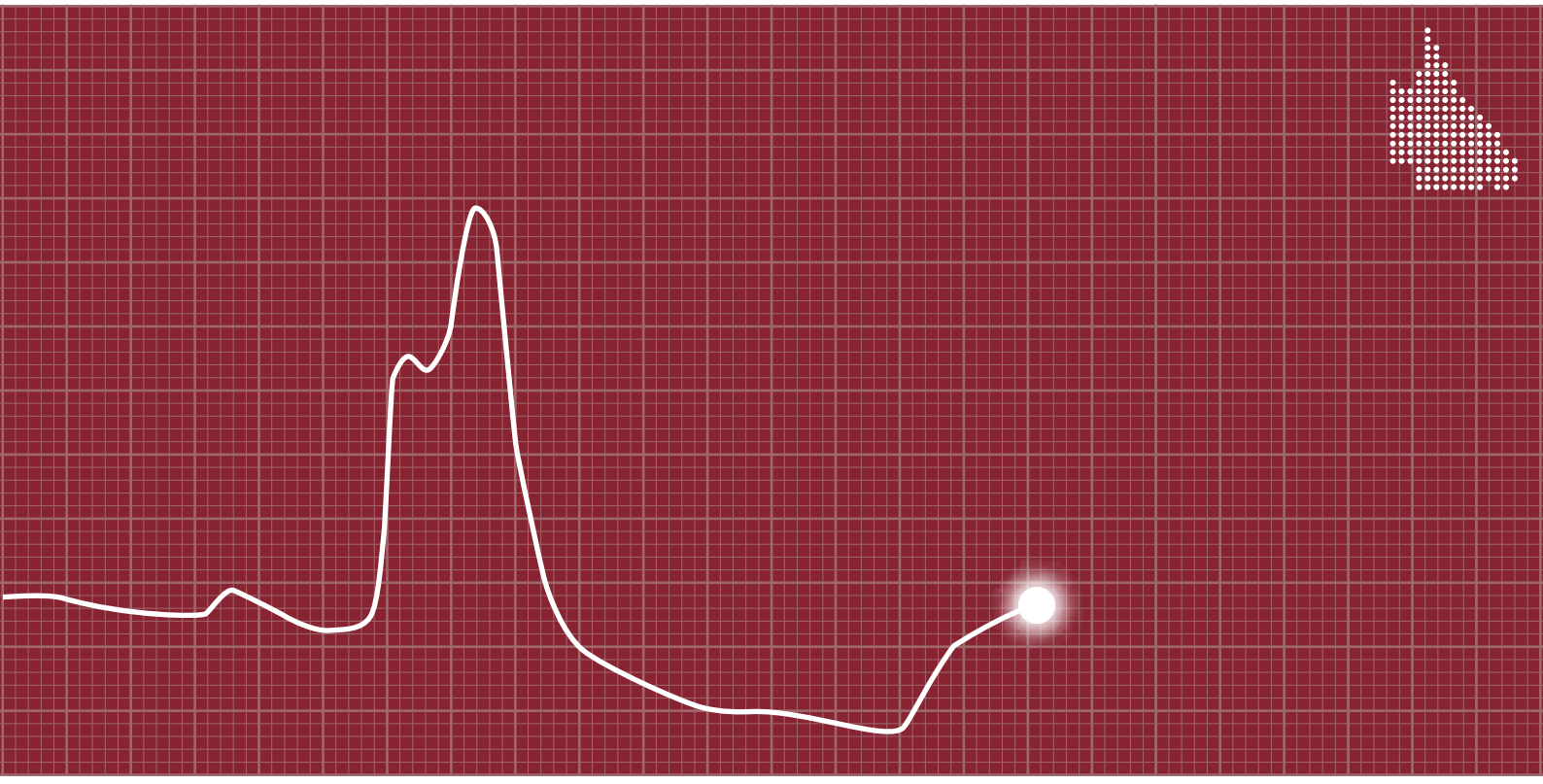
The clinical quality indicator program for CR services continues to drive improvement with the journey of the patient and their experience at the forefront of all focus. By expanding on the formal Hospital and Health Service performance measure, the QCOR committee has moved to measure outcomes across all areas in CR.

Patient reported measures within this Audit show improvement in outcomes and quality of life which is reassuring for all staff that they're making a consistent and measurable difference to the lives of patients affected by cardiovascular disease. With further expansion and enhancement of the dataset, as well as a focus on in and out-of-hospital processes and reporting, there is room for further improvement and sophistication to be realised in this space.

Further enhancements of the QCOR application have improved collaboration between sites and primary carers with multiple forms of CR documentation now available in Queensland Health's 'The Viewer' platform. Primary care is known to be an important determinant of outcomes and hospital avoidance post-discharge and it is hoped with this greater level of visibility of CR interactions that patient care can be improved not only in hospital but long after discharge.

The future of CR services in Queensland Health holds great promise but would not be possible without the dedication and engagement of health professionals working day in day out to improve the lives of their fellow Queenslanders. By embracing this enthusiasm and drive for improvement there will no doubt be many more opportunities to effect change and excellence in the future.

Heart Failure Support Services Audit



1 Message from the Heart Failure Steering Committee Chair

Since 2016, data collected by the QCOR Heart Failure module have helped to inform clinical practice for patients referred to multidisciplinary heart failure support services across the state. Patients living with chronic heart failure are at the centre of our attempts to understand and improve our practice so that they can live longer with a better quality of life and stay safely out of hospital.

The Audit monitors patient demographics, and measures performance against a range of clinical indicators ranging from referral times to several pharmacological prescribing and titration practices. Outcome measures include rehospitalisations, survival and time alive out of hospital.

This year we have included a new indicator for the prescribing of mineralocorticoid receptor antagonists (MRAs). MRAs represent the third arm of guideline-directed medical therapy for heart failure with a reduced ejection fraction (HFrEF). The recommended medications used in combination have been shown to substantially reduce mortality and morbidity in patients with HFrEF than when used in isolation.

Once again, I would like to thank all the clinicians who enter data as part of their everyday clinical practice, the Statewide Cardiac Clinical Informatics Unit, and especially acknowledge the patients themselves.

Associate Professor John Atherton
Chair
QCOR Heart Failure Support Services Committee

2 Key findings

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

The majority of the 5,304 referrals were male (69%), non-Indigenous (95.3%), referred to South East Queensland HFSS (81%), from an inpatient setting (66%) and diagnosed with HFrEF (81.4%).

The median age of referrals was 69 years old with male patients presenting younger than females (68 years vs. 73 years respectively). Aboriginal and Torres Strait Islander peoples represented a younger cohort compared with non-Indigenous patients (58 years vs. 70 years respectively), and HFrEF patients are younger than HFpEF patients (68 years vs. 76 years respectively). Patients aged 80 years or older represented over 20% of total cases.

Clinical indicator performance

Most indicators met benchmarks at a statewide level except for prescription of mineralocorticoid receptor antagonists for HFrEF (clinical indicator 5a and 5b) and the review and titration of beta blockers (clinical indicator 6a, 6b and 6c).

There is variation in practice with many of the 21 HFSS below benchmarks for clinical indicators 1a (follow-up of inpatient referrals in two weeks) and 6a, 6b and 6c (beta blocker review and titration).

Prescription rates of guideline directed medications met benchmarks for all sites except for MRA (clinical indicator 5) which was uniformly below benchmarks.

Table 1: Summary of statewide clinical indicator performance

#	Clinical indicator	% referrals
1a	Follow-up of acute patients within 2 weeks	78.8
1b	Follow-up of non-acute patients within 4 weeks	82.4*
2	Assessment of left ventricular ejection fraction within 2 years	96.3*
3a	ACEI/ARB or ARNI† prescription at hospital discharge	91.7*
3b	ACEI/ARB or ARNI† at first clinical review	90.2*
4a	Beta blocker‡ prescription at hospital discharge	89.0*
4b	Beta blocker‡ prescription at first clinical review	91.3*
5a	Prescription of MRA§ for HFrEF at time of hospital discharge	44.6
5b	Prescription of MRA§ for HFREF at time of first HFSS clinical review	42.9
6a	Beta blocker‡ titration status review at six months post referral	66.8
6b	Beta blocker‡ achievement of guideline recommended target	34.7
6c	Beta blocker‡ achievement of guideline recommended target dose or maximum tolerated dose	74.9

* 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 to allow for 12 month follow-up from the index hospitalisation. Key findings are summarised in Table 2.

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

#	Measures post index hospitalisation*	30 days	1 year
1	All-cause mortality	1.6%	13.5%
2	a) All-cause rehospitalisation	17.8%	54.5%
	b) Heart failure rehospitalisation	5.8%	22.7%
3	Composite all-cause hospitalisation or all-cause mortality	18.4%	55.5%
4	Days alive and out-of-hospital†	N/A	363.7 median days‡

* Commences from date of discharge for index admission

† A single measure of mortality, readmissions and length of stay

‡ Approximately 55% of patients had additional time in hospital

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 1 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
	Mater Adult Hospital, Brisbane	MTHB
	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 University Hospital	TUH
West Moreton	Ipswich Community Health	IPCH
Wide Bay	Bundaberg Hospital	BNH
	Hervey Bay Hospital (includes Maryborough)	HBH

* Not participating in the 2019 audit

Figure 1: Heart Failure Support Service (HFSS) locations

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

Hospital and Health Service	Facility	HFSS disciplines				Modes of service (telephone + ...)				
		Nurse	NP†	Pharm*	Physio or AEP#	In-patient	Nurse or MD clinics	Home visits	Rehab programs	Medical mentor‡
Cairns and Hinterland	CH	Y	Y	–	Y	Y	Y	Y	Y	Y
Central Queensland	GLH	Y	–	–	Y	Y	–	–	Y	Video clinic
	RKH	Y	Y	Y	Y	Y	Y	–	Y	Y
Darling Downs	TWH	Y	–	Y	R	–	Y	Y	–	Y
Gold Coast	GCCH	Y	–	Y	Y	Y	Y	Y	Y	Y
Mackay	MBH	Y	–	–	Y	Y	Y	–	Y	Y
Metro North	CBH	Y	–	Y	–	–	Y	–	–	Y
	RDH	Limited service available 2019				–	–	–	–	–
	RBWH	Y	–	Y	Y	Y	Y	–	Y	Y
	TPCH	Y	Y	Y	Y	Y	Y	–	Y	Y
Metro South	LGH	Y	Y	Y	Y	Y	Y	Y	Y	Y
	MTHB	Y	Y	–	R	Y	Y	Y	–	Y
	PAH	Y	Y	Y	Y	Y	Y	Y	Y	Y
	QEII	Y	Y	Y	R	Y	Y	Y	–	Y
	RLH	Y	Y	–	Y	Y	Y	Y	Y	Y
North West	MIH	Y	Y	Y	R	Y	Y	Y	–	Outreach
Sunshine Coast	GYH	Y	–	–	–	Y	Y	Y	–	Y
	SCUH	Y	Y	–	R	Y	Y	Y	–	Y
Townsville	TUH	Y	Y	Y	R	Y	Y	Y	–	Y
West Moreton	IPCH	Y	Y	Y	Y	Y	Y	Y	Y	Y
Wide Bay	BNH	Y	–	–	R	–	Y	–	–	Y
	HBH	Y	Y	–	Y	Y	Y	Y	Y	Video clinic
Statewide		100%	59%	50%	82%	77%	95%	68%	59%	100%

* Nurse practitioner who can prescribe medications

† Pharmacist

§ The HFSS has a cardiologist or general physician mentor

‡ Physiotherapist or accredited exercise physiologist

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

4 New referrals

There were 5,304 new referrals reported by the 21 participating HFSS, with Metropolitan sites comprising 55% of all referrals.

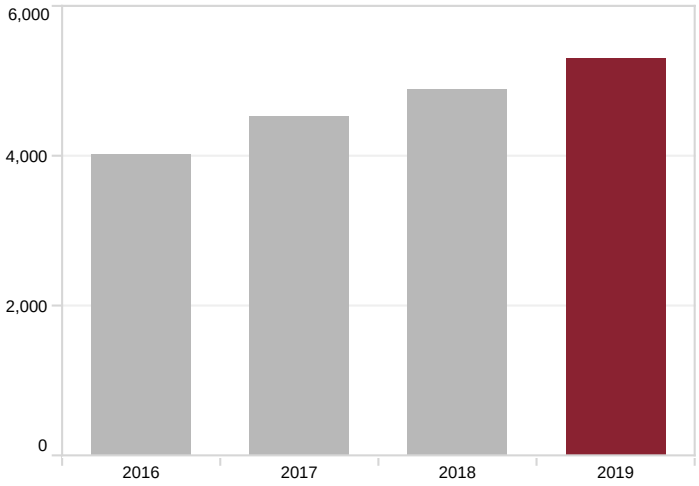


Figure 2: Total yearly HF referrals, 2016–2019

4.1 Location of referrals

Table 5: Distribution of new referrals by HFSS location

Referrals per HHS	n (%)	Referrals per facility in each HHS	n (%)
Cairns and Hinterland	127 (2.4)	Cairns Hospital	127 (2.4)
Central Queensland	224 (4.2)	Gladstone Hospital	23 (0.4)
		Rockhampton Hospital	201 (3.8)
Darling Downs	80 (1.5)	Toowoomba Hospital	80 (1.5)
Gold Coast	497 (9.4)	Gold Coast Community Health	497 (9.4)
Mackay	122 (2.3)	Mackay Base Hospital	122 (2.3)
Metro North	1,454 (27.4)	Caboolture Hospital	104 (2.0)
		Royal Brisbane & Women's Hospital	445 (8.4)
		The Prince Charles Hospital	905 (17.1)
Metro South	1,460 (27.5)	Logan Hospital	382 (7.2)
		Mater Adult Hospital	71 (1.3)
		Princess Alexandra Hospital	708 (13.3)
		Queen Elizabeth II Hospital	117 (2.2)
		Redland Hospital	182 (3.4)
North West	36 (0.7)	Mt Isa Hospital	36 (0.7)
Sunshine Coast	527 (9.9)	Gympie Hospital	102 (1.9)
		Sunshine Coast University Hospital	425 (8.0)
Townsville	259 (4.9)	Townsville University Hospital	259 (4.9)
West Moreton	345 (6.5)	Ipswich Community Health	345 (6.5)
Wide Bay	173 (3.3)	Bundaberg Hospital	97 (1.8)
		Hervey Bay Hospital	76 (1.4)
Statewide			**5,304 (100.0)**

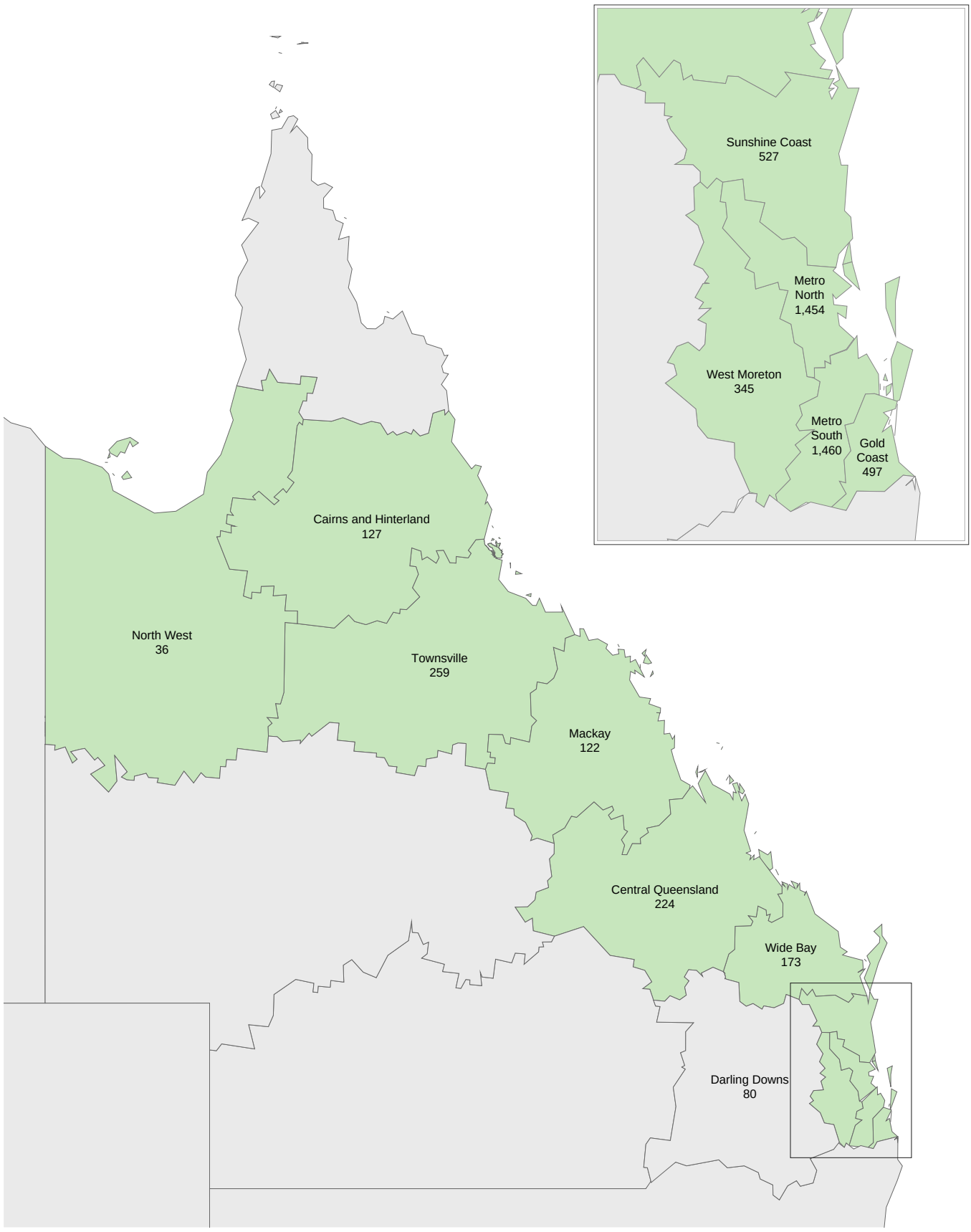


Figure 3: Regional distribution of new referrals

4.2 Referral source

Most referrals originated from an inpatient setting (66%), with smaller proportions originating from an outpatient setting (24%) or as a transfer from another service (8%).

Few referrals came directly from primary care (2%), which is expected as most referrals flow to specialty outpatient clinics for diagnosis and treatment optimisation prior to referral to an HFSS.

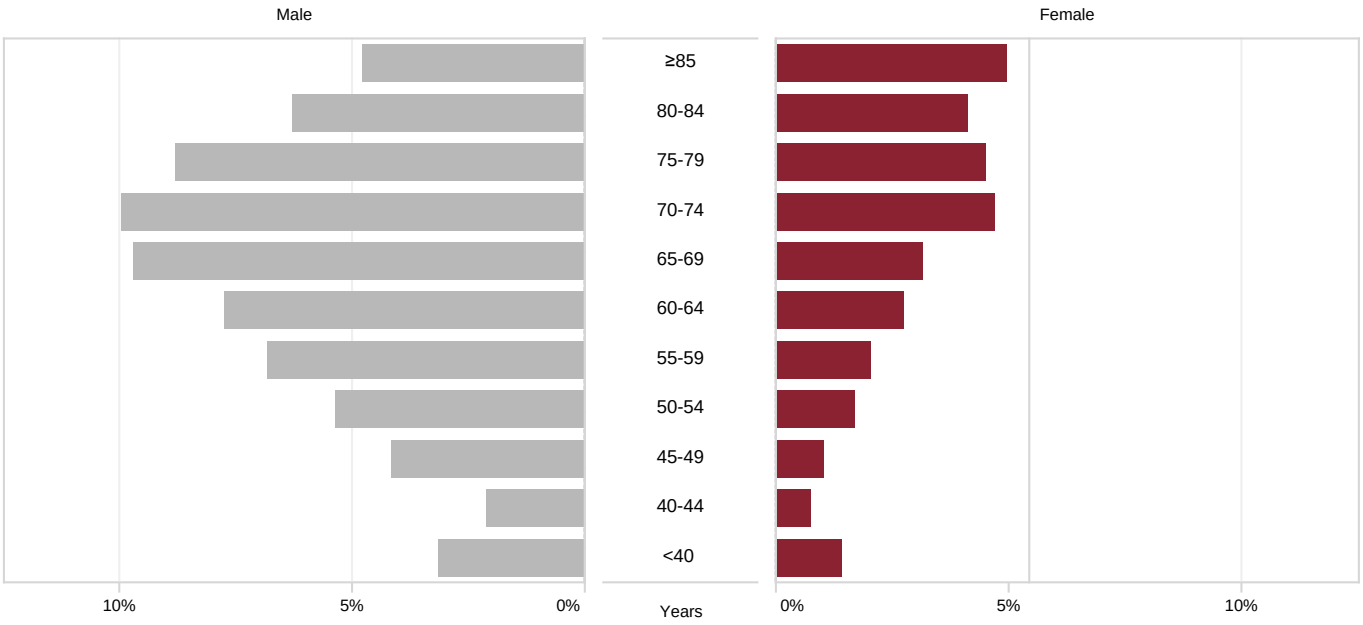
Table 6: Source of HFSS referral

HHS	HFSS	Inpatient n (%)	Outpatient n (%)	Another HFSS n (%)	Primary care n (%)
Cairns and Hinterland	Cairns Hospital	78 (61.4)	49 (38.6)	–	–
Central Queensland	Gladstone Hospital	11 (47.8)	–	9 (39.1)	3 (13.0)
	Rockhampton Hospital	97 (48.3)	80 (39.8)	5 (2.5)	19 (9.5)
Darling Downs	Toowoomba Hospital	1 (1.2)	79 (98.8)	–	–
Gold Coast	Gold Coast Community Health	333 (67.0)	115 (23.1)	23 (4.6)	26 (5.2)
Mackay	Mackay Base Hospital	24 (19.7)	97 (79.5)	1 (0.8)	–
Metro North	Caboolture Hospital	16 (15.4)	46 (44.2)	2 (1.9)	40 (38.5)
	Royal Brisbane & Women's Hospital	326 (73.3)	113 (25.4)	6 (1.3)	–
	The Prince Charles Hospital	733 (81.0)	168 (18.6)	4 (0.4)	–
Metro South	Logan Hospital	230 (60.2)	50 (13.1)	98 (25.7)	4 (1.0)
	Mater Adult Hospital	59 (83.1)	12 (16.9)	–	–
	Princess Alexandra Hospital	664 (93.8)	34 (4.8)	10 (1.4)	–
	Queen Elizabeth II Hospital	78 (66.7)	29 (24.8)	10 (8.5)	–
	Redland Hospital	49 (26.9)	57 (31.3)	74 (40.7)	2 (1.1)
North West	Mt Isa Hospital	7 (19.4)	27 (75.0)	1 (2.8)	1 (2.8)
Sunshine Coast	Gympie Hospital	50 (49.0)	11 (10.8)	39 (38.2)	2 (2.0)
	Sunshine Coast University Hospital	358 (84.2)	51 (12.0)	16 (3.8)	–
Townsville	Townsville University Hospital	152 (58.7)	107 (41.3)	–	–
West Moreton	Ipswich Community Health	155 (44.9)	132 (38.3)	53 (15.4)	5 (1.4)
Wide Bay	Bundaberg Hospital	59 (60.8)	11 (11.3)	20 (20.6)	7 (7.2)
	Hervey Bay Hospital	10 (13.2)	18 (23.7)	47 (61.8)	1 (1.3)
Statewide		**3,490 (65.8)**	**1,286 (24.2)**	**418 (7.9)**	**110 (2.1)**

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 (73 years) was five years older than men. One third of patients (33%) were 75 years of age and older.



% of total (n=5,304)

Figure 4: Proportion of referrals to HFSS by gender and age group

Table 7: Median age (years) of referrals by gender

HHS	HFSS	Male years	Female years	ALL years
Cairns and Hinterland	Cairns Hospital	62	62	62
Central Queensland	Gladstone Hospital	70	75	72
	Rockhampton Hospital	68	73	69
Darling Downs	Toowoomba Hospital	66	68	67
Gold Coast	Gold Coast Community Health	69	76	71
Mackay	Mackay Base Hospital	65	71	66
Metro North	Caboolture Hospital	74	72	73
	Royal Brisbane & Women's Hospital	68	76	70
	The Prince Charles Hospital	68	74	71
Metro South	Logan Hospital	65	73	67
	Mater Adult Hospital	69	75	72
	Princess Alexandra Hospital	68	73	69
	Queen Elizabeth II Hospital	65	77	71
	Redland Hospital	69	75	71
North West	Mt Isa Hospital	57	56	57
Sunshine Coast	Gympie Hospital	73	75	74
	Sunshine Coast University Hospital	68	74	71
Townsville	Townsville University Hospital	66	64	66
West Moreton	Ipswich Community Health	66	67	67
Wide Bay	Bundaberg Hospital	67)	73	68
	Hervey Bay Hospital	72	76	74
Statewide		**68**	**73**	**69**

5.2 Gender

The majority of patients were male (69%), ranging from 53% to 79% across participating sites.

Table 8: Number and proportion of referrals to HFSS by gender

HHS	HFSS	Male n (%)	Female n (%)
Cairns and Hinterland	Cairns Hospital	94 (74.0)	33 (26.0)
Central Queensland	Gladstone Hospital	15 (65.2)	8 (34.8)
	Rockhampton Hospital	143 (71.1)	58 (28.9)
Darling Downs	Toowoomba Hospital	62 (77.5)	18 (22.5)
Gold Coast	Gold Coast Community Health	363 (73.0)	134 (27.0)
Mackay	Mackay Base Hospital	96 (78.7)	26 (21.3)
Metro North	Caboolture Hospital	73 (70.2)	31 (29.8)
	Royal Brisbane & Women's Hospital	313 (70.3)	132 (29.7)
	The Prince Charles Hospital	587 (64.9)	318 (35.1)
Metro South	Logan Hospital	266 (69.6)	116 (30.4)
	Mater Adult Hospital	45 (63.4)	26 (36.6)
	Princess Alexandra Hospital	515 (72.7)	193 (27.3)
	Queen Elizabeth II Hospital	73 (62.4)	44 (37.6)
	Redland Hospital	130 (71.4)	52 (28.6)
North West	Mt Isa Hospital	19 (52.8)	17 (47.2)
Sunshine Coast	Gympie Hospital	68 (66.7)	34 (33.3)
	Sunshine Coast University Hospital	284 (66.8)	141 (33.2)
Townsville	Townsville University Hospital	178 (68.7)	81 (31.3)
West Moreton	Ipswich Community Health	214 (62.0)	131 (38.0)
Wide Bay	Bundaberg Hospital	75 (77.3)	22 (22.7)
	Hervey Bay Hospital	48 (63.2)	28 (36.8)
Statewide		**3,661 (69.0)**	**1,643 (31.0)**

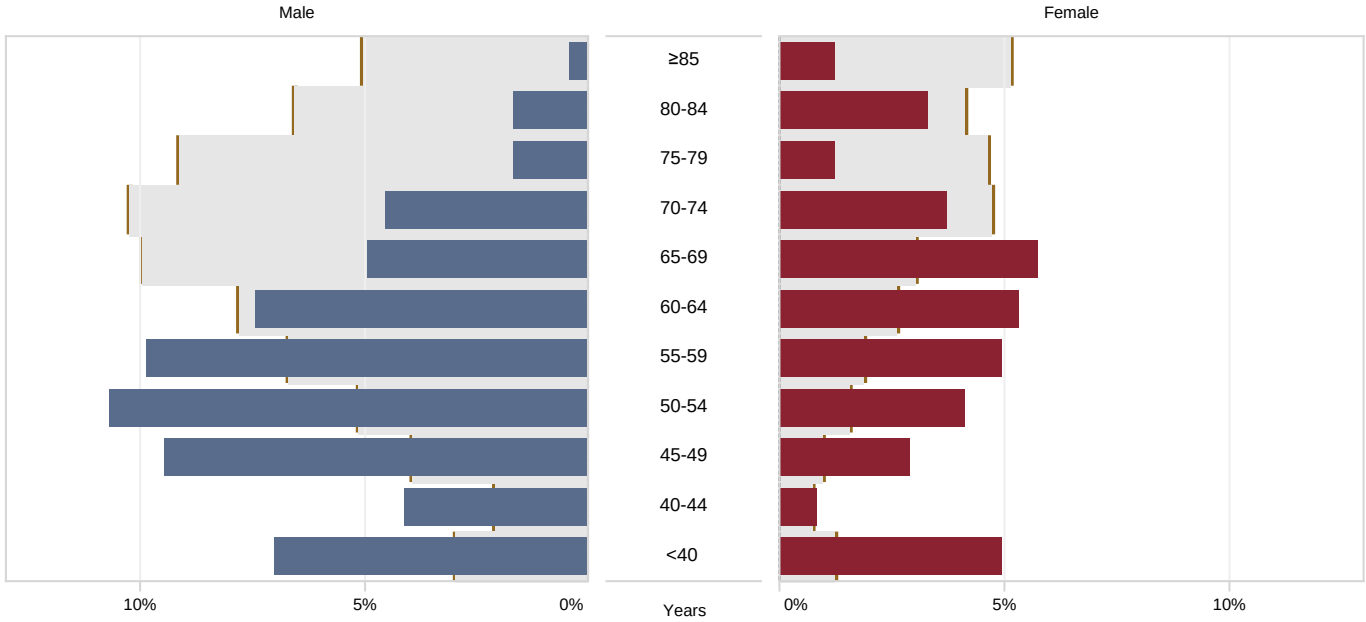
5.3 Aboriginal and Torres Strait Islander status

Patients of identified Aboriginal and Torres Strait Islander status made up 4.6% of all referrals. The number of referrals (243) was consistent with the previous year (258). Aboriginal and Torres Strait Islander patients were significantly younger than other Queenslanders. Table 9 shows that the proportion of Aboriginal and Torres Strait Islander patient referrals was highest in Mt Isa (47%), followed by Cairns (22%) and Townsville (11%).

A smaller proportion of total referrals (42%) of all Aboriginal and Torres Strait Islander patients were referred to facilities in the Greater Brisbane area (Metro North HHS or Metro South HHS).

Table 9: Proportion of site referrals identified as Aboriginal and Torres Strait Islander

HHS	Facility	Indigenous n (%)	Non-Indigenous n (%)	Not stated / unknown n (%)
Cairns and Hinterland	Cairns Hospital	28 (22.0)	99 (78.0)	–
Central Queensland	Gladstone Hospital	–	23 (100.0)	–
	Rockhampton Hospital	16 (8.0)	185 (92.0)	–
Darling Downs	Toowoomba Hospital	7 (8.8)	73 (91.3)	–
Gold Coast	Gold Coast Community Health	5 (1.0)	491 (98.8)	1 (0.2)
Mackay	Mackay Base Hospital	11 (9.0)	111 (91.0)	–
Metro North	Caboolture Hospital	1 (1.0)	103 (99.0)	–
	Royal Brisbane & Women's Hospital	14 (3.1)	431 (96.9)	–
	The Prince Charles Hospital	27 (3.0)	878 (97.0)	–
Metro South	Logan Hospital	22 (5.8)	360 (94.2)	–
	Mater Adult Hospital	3 (4.2)	64 (90.1)	4 (5.6)
	Princess Alexandra Hospital	26 (3.7)	682 (96.3)	–
	Queen Elizabeth II Hospital	2 (1.7)	115 (98.3)	–
	Redland Hospital	8 (4.4)	174 (95.6)	–
North West	Mt Isa Hospital	17 (47.2)	19 (52.8)	–
Sunshine Coast	Gympie Hospital	2 (2.0)	100 (98.0)	–
	Sunshine Coast University Hospital	6 (1.4)	419 (98.6)	–
Townsville	Townsville University Hospital	28 (10.8)	231 (89.2)	–
West Moreton	Ipswich Community Health	10 (2.9)	334 (96.8)	1 (0.3)
Wide Bay	Bundaberg Hospital	7 (7.2)	90 (92.8)	–
	Hervey Bay Hospital	3 (3.9)	73 (96.1)	–
Statewide		**243 (4.6)**	**5,055 (95.3)**	**6 (0.1)**



% of total Indigenous (n=243) vs. total non-Indigenous (n=5,055). Excludes missing data (0.1%)

Figure 5: Proportion of all referrals by age group and Indigenous status

Table 10: Median patient age by gender and Indigenous status

HHS	Total referrals n	Male years	Female years	ALL years
Aboriginal and Torres Strait Islander	243	54	61	58
Non-Aboriginal and Torres Strait Islander	5,055	68	74	70
ALL	**5,298**	**68**	**73**	**69**

Excludes missing data (0.1%)

5.4 Classification of heart failure by left ventricular ejection fraction

Patients were classified as predominately HFrEF, heart failure with preserved ejection fraction (HFpEF) or primary right heart failure. HFrEF was defined as a left ventricular ejection fraction (EF) less than 50% at time of diagnosis. The EF may return to normal for some patients but still require ongoing medications to manage HFrEF.[29] HFrEF was attributed to 81% of patients in the 2019 cohort. The table below shows the rates of different HF phenotypes.

Many patients with HFrEF were males (73%), with a median age of nine years younger than for HFpEF patients (68 years vs 77 years respectively). There were similar numbers of men and women making up patients with HFpEF (males 47.9% vs. females 52.1%).

Table 11: Proportion of patients by heart failure type

HHS	HFSS	HFrEF* n (%)	HFpEF† n (%)	Primary right HF n (%)	Unsure/ Unknown n (%)
Cairns and Hinterland	Cairns Hospital	125 (98.4)	1 (0.8)	1 (0.8)	–
Central Queensland	Gladstone Hospital	19 (82.6)	3 (13.0)	1 (4.3)	–
	Rockhampton Hospital	156 (77.6)	35 (17.4)	6 (3.0)	4 (2.0)
Darling Downs	Toowoomba Hospital	60 (75.0)	4 (5.0)	–	16 (20.0)
Gold Coast	Gold Coast Community Health	388 (78.1)	81 (16.3)	17 (3.4)	11 (2.2)
Mackay	Mackay Base Hospital	116 (95.1)	4 (3.3)	1 (0.8)	1 (0.8)
Metro North	Caboolture Hospital	75 (72.1)	20 (19.2)	1 (1.0)	8 (7.7)
	Royal Brisbane & Women's Hospital	371 (83.4)	65 (14.6)	5 (1.1)	4 (0.9)
	The Prince Charles Hospital	658 (72.7)	182 (20.1)	36 (4.0)	29 (3.2)
Metro South	Logan Hospital	324 (84.8)	42 (11.0)	13 (3.4)	3 (0.8)
	Mater Adult Hospital	55 (77.5)	12 (16.9)	–	4 (5.6)
	Princess Alexandra Hospital	633 (89.4)	54 (7.6)	20 (2.8)	1 (0.1)
	Queen Elizabeth II Hospital	90 (76.9)	21 (17.9)	3 (2.6)	3 (2.6)
	Redland Hospital	145 (79.7)	24 (13.2)	7 (3.8)	6 (3.3)
North West	Mt Isa Hospital	35 (97.2)	–	–	1 (2.8)
Sunshine Coast	Gympie Hospital	58 (56.9)	30 (29.4)	11 (10.8)	3 (2.9)
	Sunshine Coast University Hospital	364 (85.6)	46 (10.8)	7 (1.6)	8 (1.9)
Townsville	Townsville University Hospital	238 (91.9)	14 (5.4)	2 (0.8)	5 (1.9)
West Moreton	Ipswich Community Health	261 (75.7)	51 (14.8)	21 (6.1)	12 (3.5)
Wide Bay	Bundaberg Hospital	83 (85.6)	8 (8.2)	2 (2.1)	4 (4.1)
	Hervey Bay Hospital	64 (84.2)	7 (9.2)	5 (6.6)	–
Statewide		**4,318 (81.4)**	**704 (13.3)**	**159 (3.0)**	**123 (2.3)**

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

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

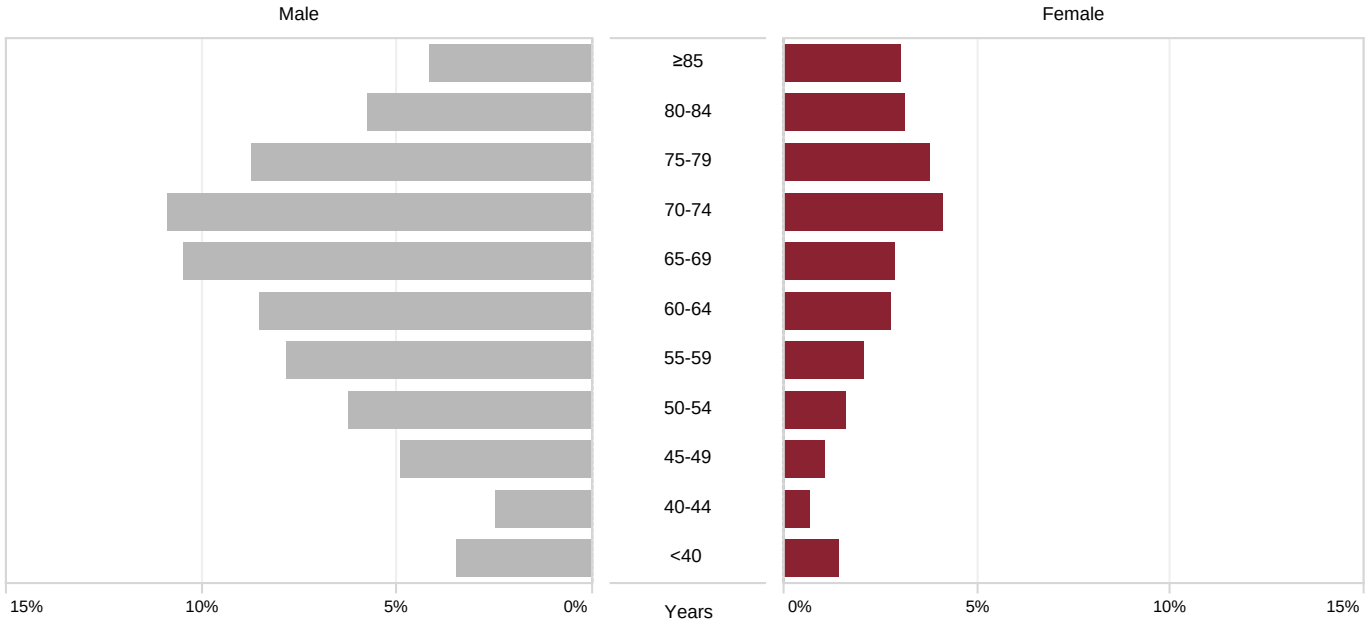
Table 12: Summary of patient age, gender and Indigenous status by type of heart failure

	HFrEF*	HFpEF†	Primary right HF
Number	4,318	704	159
Age (median years)	68	77	73
% male	73.4	47.9	52.8
% Aboriginal and Torres Strait Islander	5.1	1.8	5.0

Excludes unsure/unknown HF phenotype (2.3%)

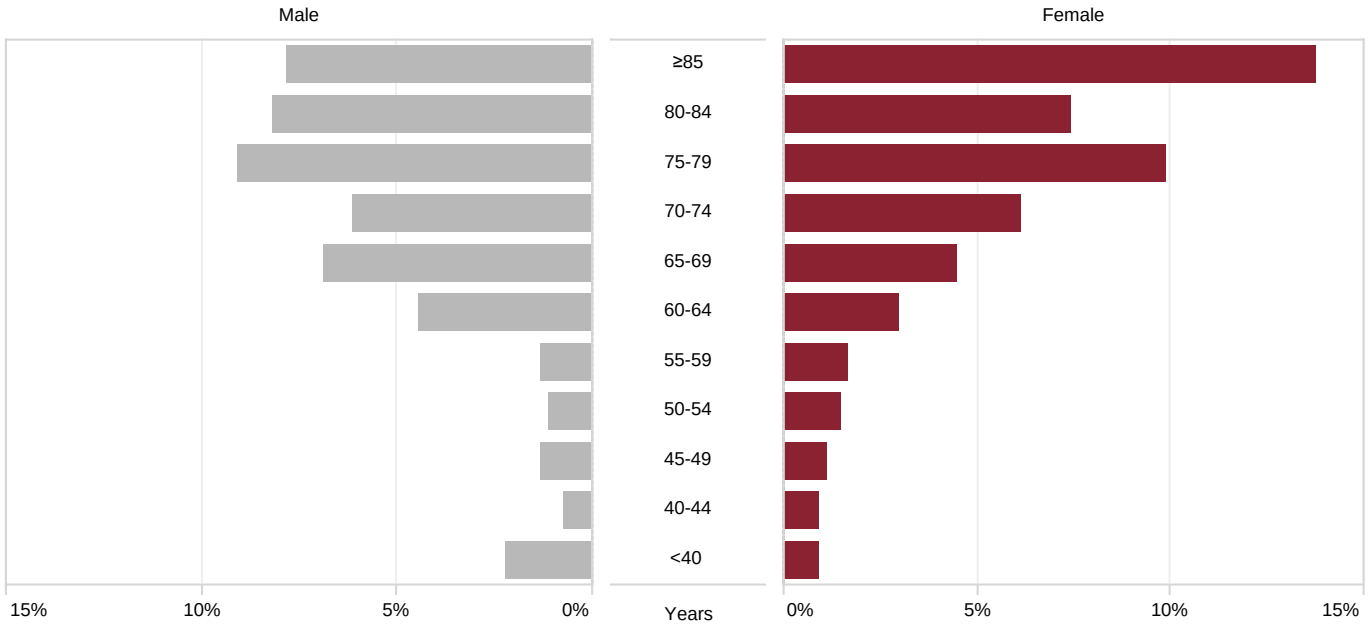
* Heart failure with reduced ejection fraction (LVEF <50%)

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



% of total with HFrEF (n=4,318)

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



% of total with HFpEF (n=704)

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 13: Summary of patient characteristics

Characteristic	Summary
Participating HFSS	21
New referrals	5,304
Referrals from South East Queensland	80.8%
Referral source:	
Inpatient	65.8%
Outpatient	24.2%
Another HFSS	7.9%
Primary care	2.1%
Age (median years):	
All (median, range by service)	69 (62–74) years
Male vs. Female	68 vs. 72 years
Indigenous vs. non-Indigenous	58 vs. 69 years
HFrEF*vs. HFpEF†	68 vs. 77 years
Age group:	
80 years and over	20.2%
Males	69.0%
Aboriginal and Torres Strait Islander patients	4.6%
HFrEF*	81.4%
HFpEF†	13.3%
Primary right HF	3.0%
Uncertain diagnosis	2.3%

* 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 14.

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.[30]

Table 14: 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

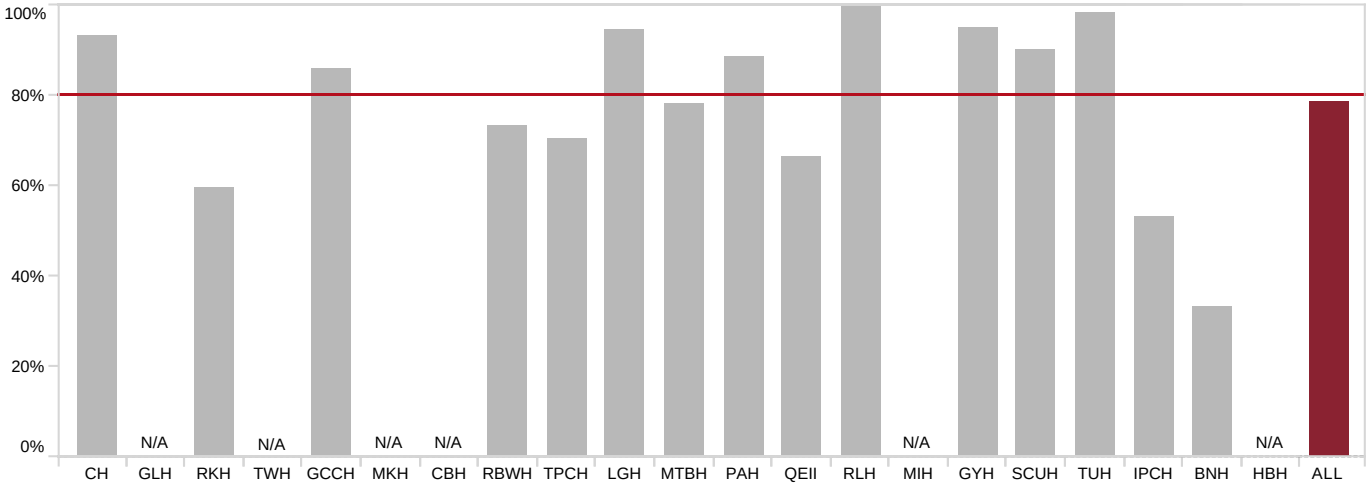
6.1 First clinical review

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 or date of referral if after 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 appropriate review timeframe chosen for this intervention was within two weeks of hospital discharge or date of referral after recent hospitalisation.

Of the 3,490 patients referred from an acute setting, 79% received a clinical review by an HFSS within two weeks of hospital discharge.



N/A: Eligible referrals <20

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

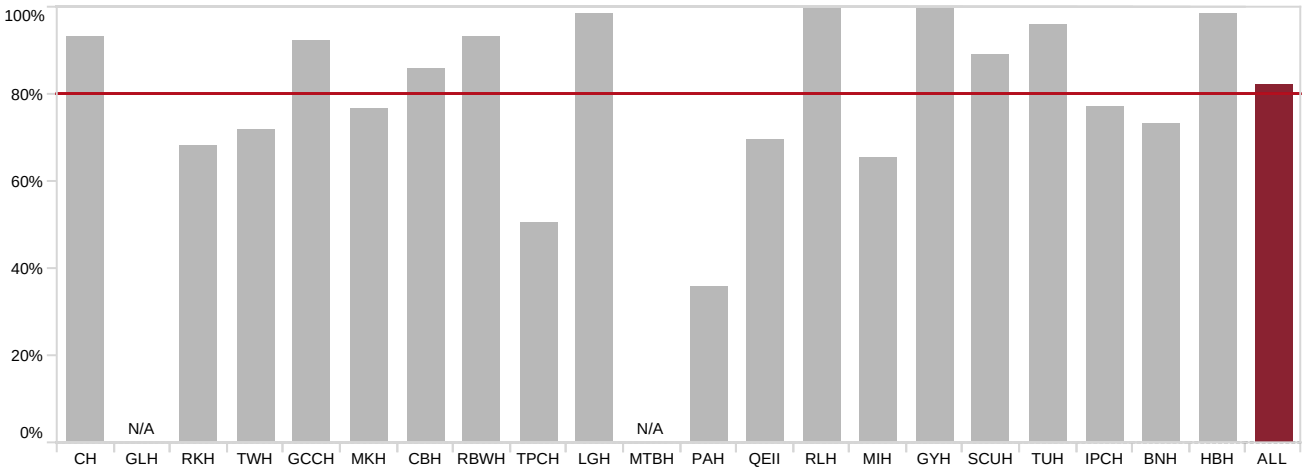
Table 15: Inclusion details for clinical indicator 1a: Inpatients receiving first HFSS clinical review within two weeks of hospital discharge

	n	%
Eligible for analysis	2,288	
Achieved benchmark	1,804	78.8
Benchmark not achieved	484	21.2
Ineligible	1,202	
Referred to another HFSS	603	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	175	
Patient could not be contacted, lives out of area or repeated failure to attend	146	
Patient declined service	121	
HF no longer prime issue (palliative care, high care nursing home etc.)	72	
Patient deceased	51	
Medical follow-up only (GP, private or public physician)	23	
Other reason	11	
Total inpatient referrals	**3,490**	

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

For non-acute patients, the Statewide HF Steering Committee determined four weeks following referral to be the recommended timeframe for first clinical review.

Referrals for 1,814 patients came from non-acute services, of which 82% received a clinical review within four weeks of referral.



N/A: Eligible referrals <20

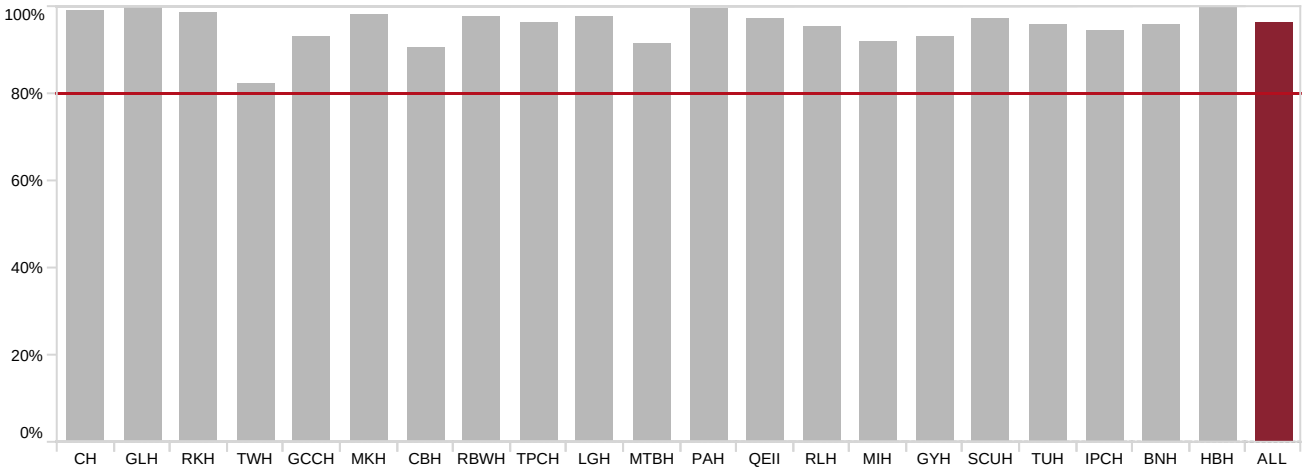
Figure 9: Proportion of non-acute patients who received first HFSS clinical review within four weeks of referral

Table 16: Inclusion details for clinical indicator 1b: Non-acute patients receiving first HFSS clinical review within four weeks of referral

	n	%
Eligible for analysis	1,594	
Achieved benchmark	1,314	82.4
Benchmark not achieved	280	17.6
Ineligible	220	
Patient could not be contacted, lives out of area or repeated failure to attend	72	
Patient declined service	60	
Referred to another HFSS	46	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	15	
HF no longer prime issue (palliative care, high care nursing home etc.)	10	
Patient deceased	5	
Medical follow-up only (GP, private or public physician)	4	
Other reason	8	
Total non-acute patients	**1,814**	

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.[29] In 96% of cases, LVEF was assessed within two years of referral to an HFSS.



N/A: Eligible referrals <20

Figure 10: Proportion of all patients who had LVEF assessed within two years of referral to HFSS

Table 17: Inclusion details for clinical indicator 2: Patients who had LVEF assessed within two years of referral

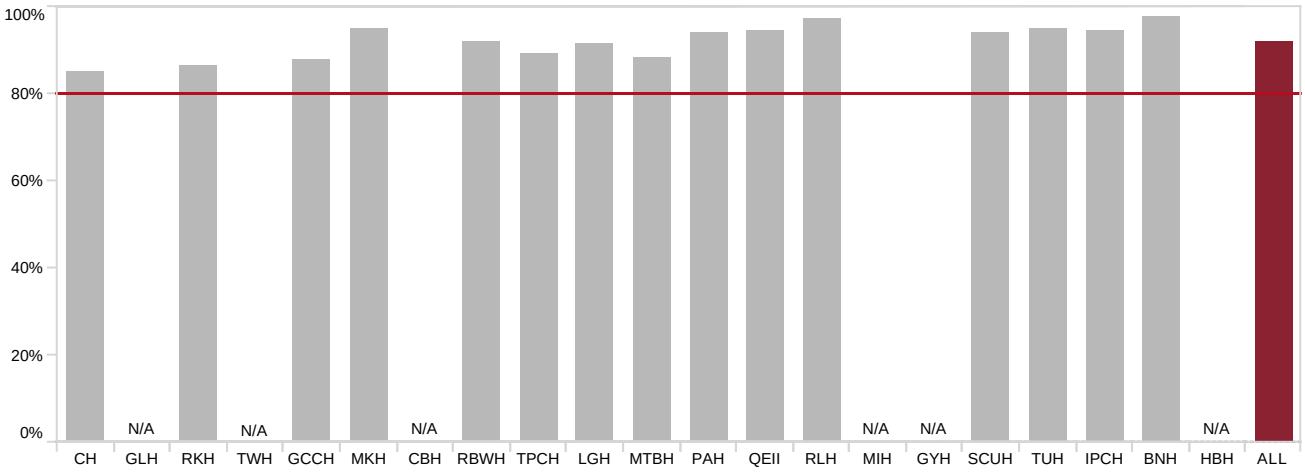
	n	%
Eligible for analysis	5,304	
Achieved benchmark	5,109	96.3
Benchmark not achieved	195	3.7
Ineligible	N/A	
Total referrals	**5,304**	

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 symptomatic patients unless contraindicated or not tolerated.

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 92% of patients.



N/A: Eligible referrals <20

Figure 11: Proportion of patients who were on ACEI, ARB or ARNI at time of hospital discharge

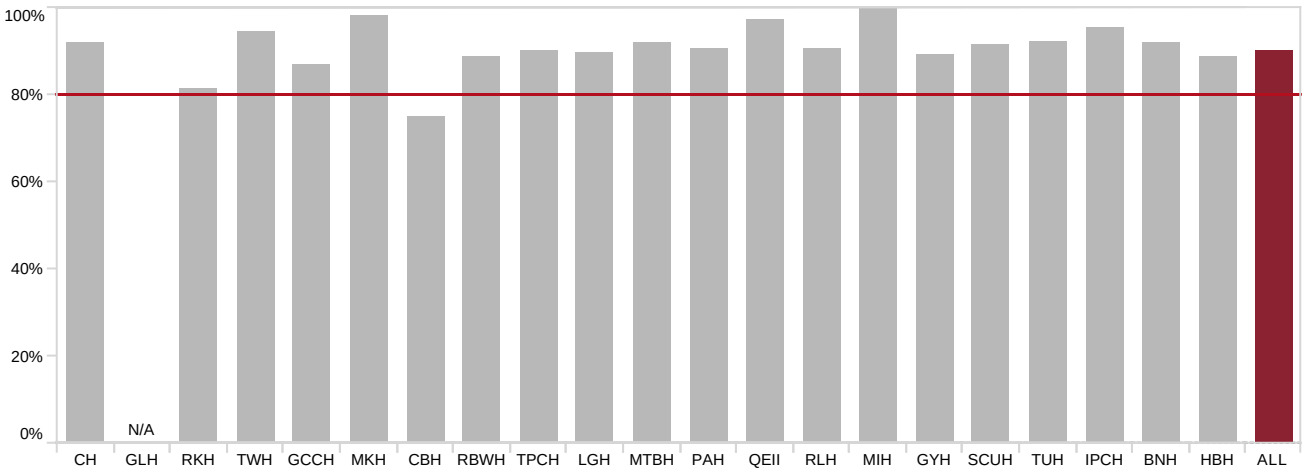
Table 18: Inclusion details for clinical indicator 3a: Inpatients on ACEI, ARB or ARNI at time of hospital discharge

	n	%
Eligible for analysis	2,626	
Achieved benchmark	2,409	91.7
Benchmark not achieved	217	8.3
Ineligible		
Documented contraindication*	158	
Total inpatient referrals analysed	**2,784**	

* 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 90% of patients.



N/A: Eligible referrals ‹20

Figure 12: Proportion of patients on ACEI, ARB or ARNI at time of first clinical review by site

Table 19: Inclusion details for clinical indicator 3b: Patients on ACEI, ARB or ARNI at first clinical review

	n	%
Eligible for analysis	3,102	
Achieved benchmark	2,797	90.2
Benchmark not achieved	305	9.8
Ineligible	1,482	
Referred to another HFSS	649	
Patient could not be contacted, lives out of area or repeated failure to attend	218	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	190	
Patient declined service	181	
HF no longer prime issue (palliative care, high care nursing home etc.)	82	
Documented contraindication*	60	
Patient deceased	56	
Medical follow-up only (GP, private or public physician)	27	
Other reason	19	
Total referrals	**4,584**	

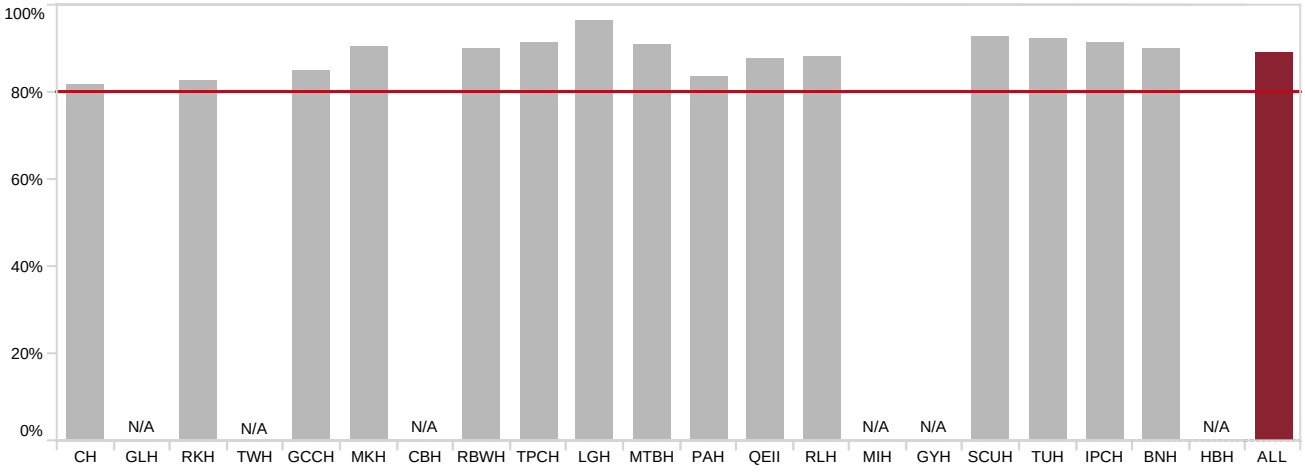
* Adverse reaction to ACEI/ARB or ARNI, palliative intent to treatment, pregnancy, eGFR ‹30mL/min/1.73m^2, severe aortic stenosis, renal artery stenosis, serum potassium ›5.5 mmol/L, symptomatic hypotension.

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 symptomatic patients unless contraindicated or not tolerated.[29] 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, 89% of patients were prescribed guideline recommended beta blockers.



N/A: Eligible referrals <20

Figure 13: Proportion of patients on guideline recommended beta blocker at hospital discharge by site

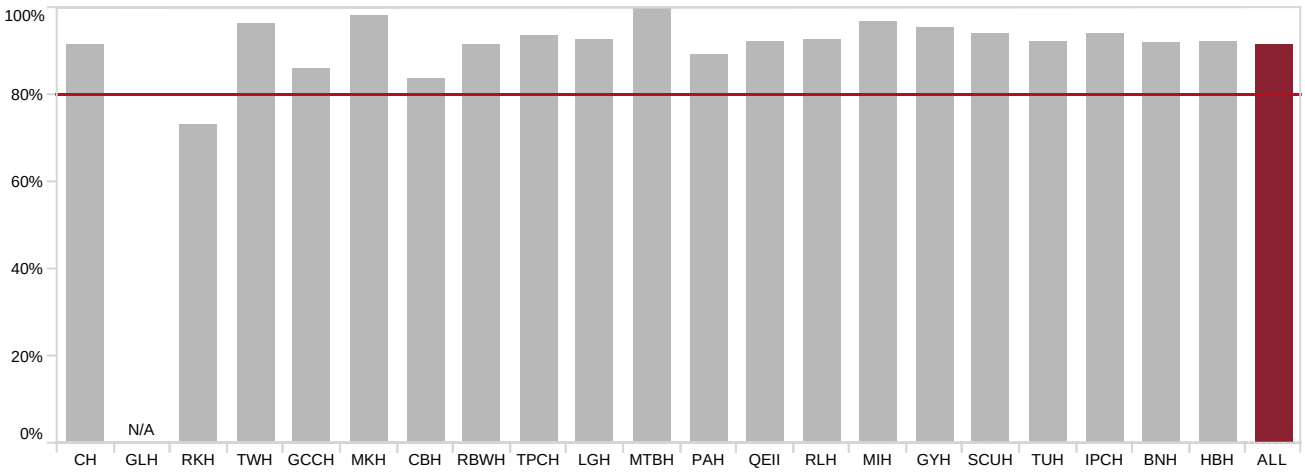
Table 20: Inclusion details for clinical indicator 4a: Patients on guideline recommended beta blocker at hospital discharge

	n	%
Eligible for analysis	2,716	
Achieved benchmark	2,418	89.0
Benchmark not achieved	298	11.0
Ineligible		
Documented contraindication*	68	
Total inpatient referrals analysed	**2,784**	

* 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, 91% of referrals to HFSS were reported to be on a guideline recommended beta blocker.



N/A: Eligible referrals <20

Figure 14: Proportion of patients on guideline recommended beta blocker therapy at first clinical review by site

Table 21: Inclusion details for clinical indicator 4b: Patients on guideline recommended beta blocker at first clinical review

	n	%
Eligible for analysis	3,085	
Achieved benchmark	2,817	91.3
Benchmark not achieved	268	8.7
Ineligible	1,498	
Referred to another HFSS	649	
Patient could not be contacted, lives out of area or repeated failure to attend	218	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	190	
Patient declined service	181	
HF no longer prime issue (palliative care, high care nursing home etc.)	82	
Documented contraindication*	76	
Patient deceased	56	
Medical follow-up only (GP, private or public physician)	27	
Other reason	19	
Incomplete data	1	
Total referrals analysed	**4,584**	

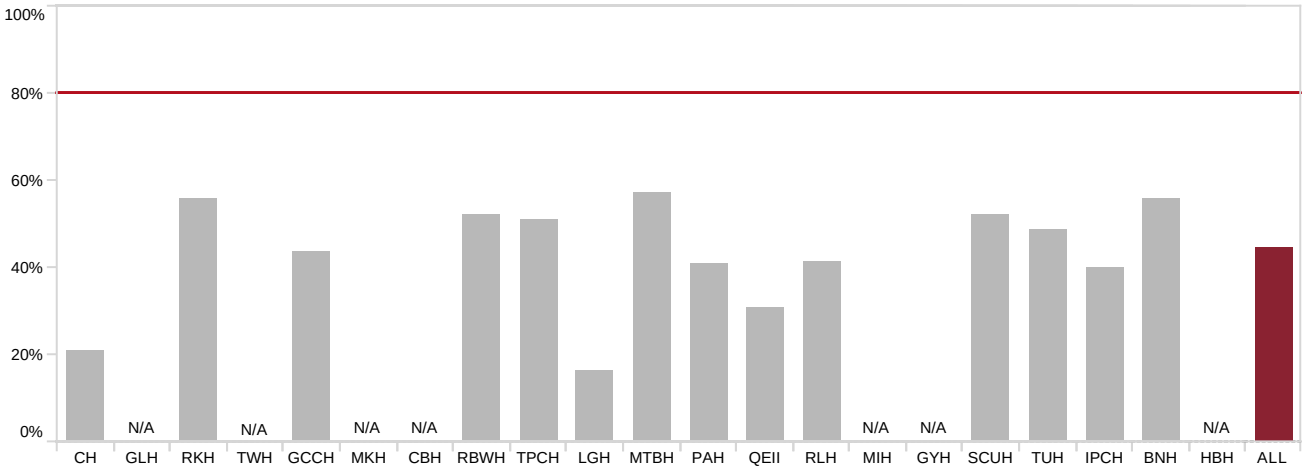
* Adverse reaction to beta blocker, palliative intent to treatment, pregnancy, bradycardia (HR <50bpm), symptomatic hypotension, severe COPD, asthma/reversible airways disease

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 symptomatic patients unless contraindicated or not tolerated.[29] 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, 45% of patients referred to an HFSS were prescribed an MRA.



N/A: Eligible referrals ‹20

Figure 15: Proportion of patients on guideline recommended MRA at hospital discharge by site

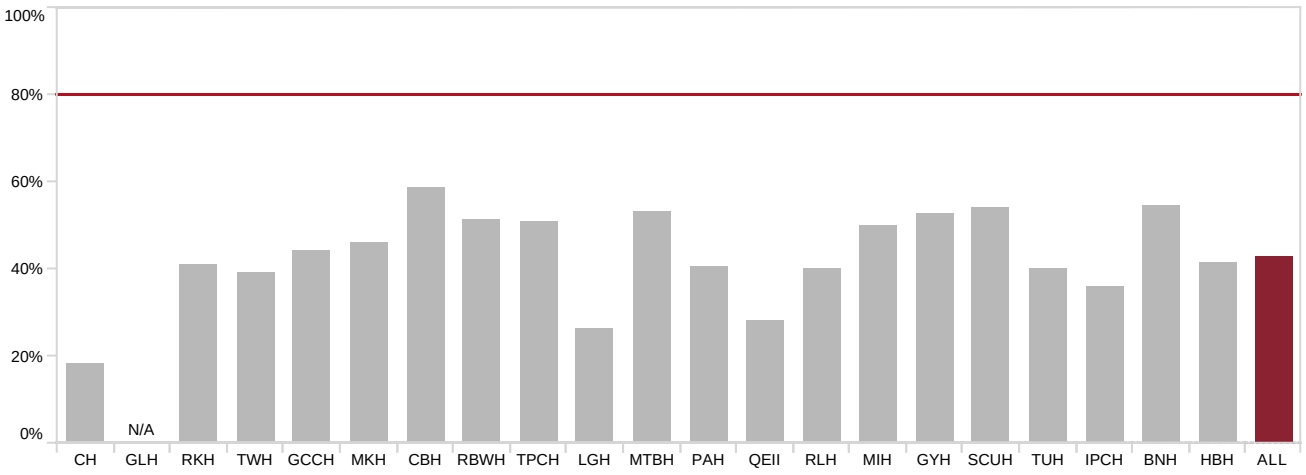
Table 22: Inclusion details for clinical indicator 5a: Patients on guideline recommended MRA at hospital discharge

	n	%
Eligible for analysis	2,448	
Achieved benchmark	1,091	44.6
Benchmark not achieved	1,357	55.4
Ineligible		
Documented contraindication*	336	
Total inpatient referrals analysed	**2,784**	

* Adverse reaction to MRA, palliative intent to treatment, serum potassium ›5 mmol/L, pregnancy, eGFR ‹30mL/min/1.73m², 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, 43% of referrals to an HFSS were reported to be on a guideline recommended MRA. 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 23: Inclusion details for clinical indicator 5b: Patients on guideline recommended MRA at first clinical review

	n	%
Eligible for analysis	2,810	
Achieved benchmark	1,205	42.9
Benchmark not achieved	1,605	57.1
Ineligible	1,774	
Referred to another HFSS	646	
Documented contraindication*	352	
Patient could not be contacted, lives out of area or repeated failure to attend	203	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	187	
Patient declined service	178	
HF no longer prime issue (palliative care, high care nursing home etc.)	73	
Patient deceased	55	
Medical follow-up only (GP, private or public physician)	12	
Total referrals analysed	**4,584**	

* 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 time frame 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:

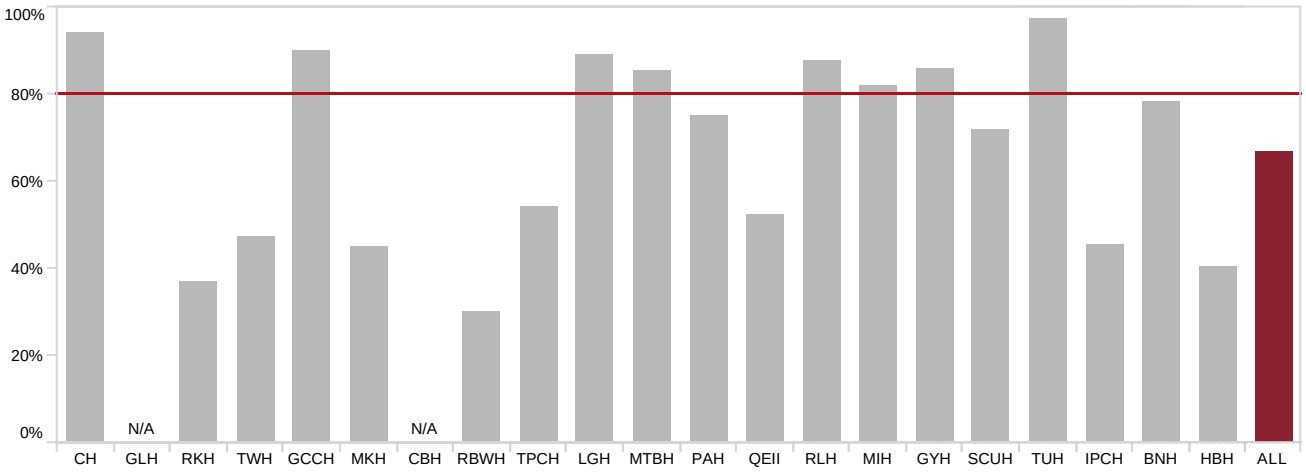
a) Review of titration status undertaken,

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), 67% of patients received a beta-blocker titration review which is below the benchmark.



N/A: Eligible referrals <20

Figure 17: Proportion of patients who had a beta blocker titration review conducted within six months by site

Table 24: Inclusion details for clinical indicator 6a: Patients who had a beta blocker titration review within six months

	n	%
Eligible for analysis	1,687	
Achieved benchmark	1,127	66.8
Benchmark not achieved	560	33.2
Ineligible	1,405	
Patient on target dose at the time of referral	681	
Patient could not be contacted, lives out of area or repeated failure to attend	116	
Documented contraindication*	109	
Patient declined service	105	
Patient deceased	78	
Referred to another HFSS	77	
Medical follow-up only (GP, private or public physician)	76	
HF no longer prime issue (palliative care, high care nursing home etc.)	36	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	23	
HFSS is at capacity workload	15	
Patient on max tolerated dose	6	
Other reason	83	
Incomplete data	44	
Total analysed	**3,136**	

* Adverse reaction to beta blocker, palliative intent to treatment, pregnancy, bradycardia (HR ‹50bpm), symptomatic hypotension, severe COPD, asthma/reversible airways disease

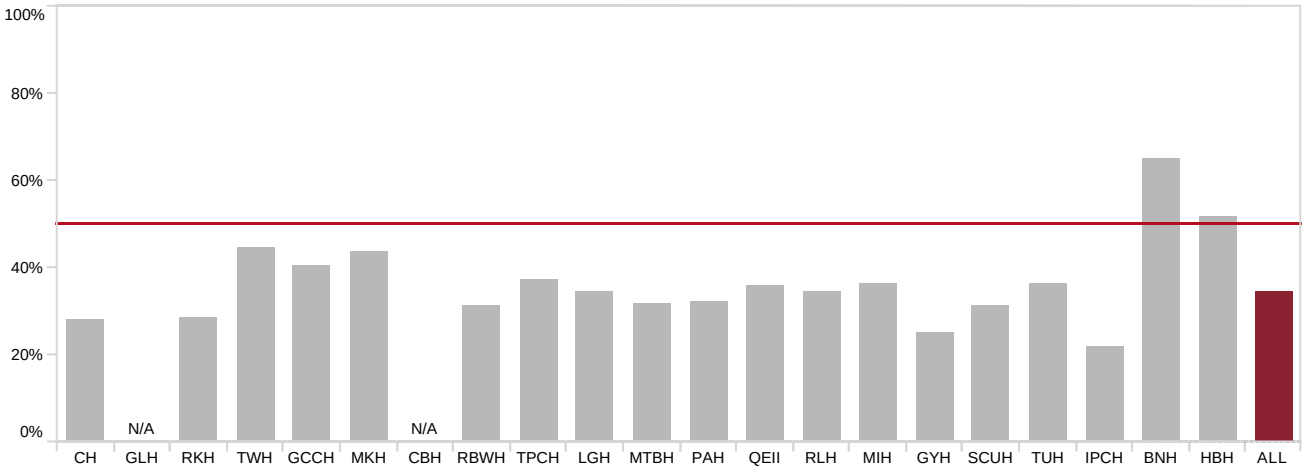
6b Beta blocker clinical guideline target dose achieved at time of titration review

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 35% 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

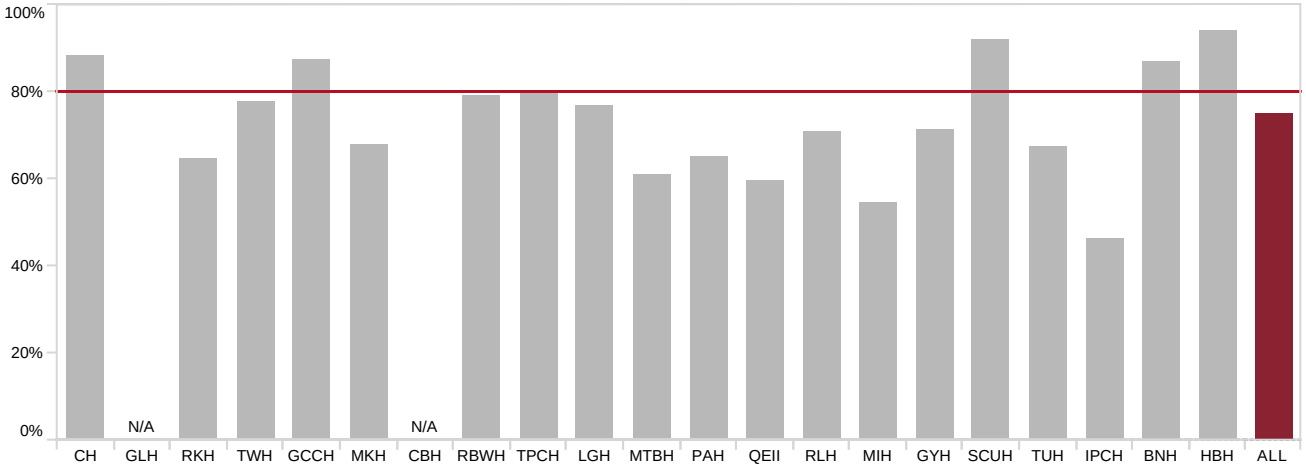
Figure 18: Proportion of patients who achieved target beta blocker dose at time of titration review by site

Table 25: Inclusion details for clinical indicator 6b: Patients who achieved target beta blocker dose at time of titration review

	n	%
Eligible for analysis	1,687	
Achieved benchmark	585	34.7
Benchmark not achieved	1,102	65.3
Ineligible	N/A	
Total titration reviews conducted	**1,687**	

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 medical judgement balancing the harm and benefit of up-titration. The number of patients reaching the target dose or maximum tolerated dose of guideline recommended beta blocker medication by the time of the titration review was 75% (below the benchmark).



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 26: 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	1,687	
Achieved benchmark	1,264	74.9
Benchmark not achieved	423	25.1
Ineligible	N/A	
Total titration reviews conducted	**1,687**	

6.7 Summary of clinical indicators

Table 27: Summary of clinical process indicator performance by site

	Clinical indicator achievement (%)											
Facility	**1a**	**1b**	**2**	**3a**	**3b**	**4a**	**4b**	**5a**	**5b**	**6a**	**6b**	**6c**
Cairns Hospital	93	93	99	85	92	82	92	21	18	98	25	93
Gladstone Hospital	–	–	100	–	–	–	–	–	–	–	–	–
Rockhampton Hospital	59	69	99	87	82	83	73	56	41	27	35	78
Toowoomba Hospital	–	72	83	–	95	–	96	–	39	–	–	–
Gold Coast Community Health	86	92	93	88	87	85	86	44	44	96	46	90
Mackay Base Hospital	–	77	98	95	98	91	98	–	46	87	52	83
Caboolture Hospital	–	86	90	–	75	–	84	–	59	–	–	–
Royal Brisbane & Women's Hospital	73	93	98	92	89	90	91	52	51	42	46	80
The Prince Charles Hospital	70	50	96	89	90	92	94	51	51	80	42	81
Logan Hospital	95	99	98	92	89	96	93	17	26	96	36	79
Mater Adult Hospital	78	–	92	88	92	91	100	58	53	100	17	50
Princess Alexandra Hospital	89	36	99	94	91	84	89	41	41	96	37	71
Queen Elizabeth II Hospital	66	69	97	95	97	88	93	31	28	–	–	–
Redland Hospital	100	100	96	97	90	88	93	41	40	83	45	90
Mt Isa Hospital	–	65	92	–	100	–	97	–	50	–	–	–
Gympie Hospital	95	100	93	–	89	–	96	–	53	83	22	74
Sunshine Coast University Hospital	90	89	97	94	91	93	94	52	54	89	29	94
Townsville University Hospital	98	96	96	95	93	92	93	49	40	100	37	71
Ipswich Community Health	53	77	94	94	96	91	94	40	36	57	24	57
Bundaberg Hospital	33	73	96	98	92	90	92	56	55	82	64	91
Hervey Bay Hospital	–	99	100	–	89	–	92	–	41	63	46	96
Statewide	**79**	**82**	**96**	**92**	**90**	**89**	**91**	**45**	**43**	**67**	**32**	**72**

Legend:

1a Follow-up of acute patients within 2 weeks (Benchmark: 80%)

1b Follow-up of non-acute patients within 4 weeks (Benchmark: 80%)

2 Assessment of left ventricular ejection fraction within 2 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

Heart failure hospitalisations are 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 2018 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 2018 were included. Where patients had multiple referrals to an HFSS during this period, 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 28. 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 re-hospitalisation 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 with 25th and 75th percentiles as well as mean values. Categorical variables were summarised as frequencies and percentages.

Table 28: 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 3,413 inpatient referrals of which 96% were successfully linked with the QHAPDC data. There were 339 patients who were ineligible for readmission and mortality analysis for the reasons shown in Table 29. A further 52 patients (1.5%) did not have complete follow up over one year to allow DAOH to be calculated.

Table 29: Eligibility criteria for patient outcome indicators

	n	%
Total 2018 inpatient referrals	**3,413**	**100.0**
Ineligible at index admission		
Duplicate patient record	166	4.9
Died during index admission	25	0.7
Not a Queensland resident	88	2.6
Index admission is not overnight	31	0.9
Transferred to private hospital	29	0.8
No linkage data available	136	4.0
Included in readmission and mortality analysis	**2,938**	**86.1**
Ineligible at subsequent admission over 1 year		
Transferred to private hospital	50	1.5
Moved outside of Queensland	2	‹0.1
Included in days alive and out-of-hospital analysis	**2,886**	**84.6**

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 1.6% and 13.5%. 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 30: 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	48 (1.6)	149 (5.1)	268 (9.1)	397 (13.5)
Died during subsequent admission*	31 (1.1)	98 (3.3)	169 (5.8)	244 (8.3)
All other deaths	17 (0.6)	51 (1.7)	99 (3.4)	153 (5.2)
Total at risk	**2,890 (98.4)**	**2,789 (94.9)**	**2,670 (90.9)**	**2,541 (86.5)**

* Data available for Queensland public hospitals only

Table 31: 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	1,942	33 (1.7)	99 (5.1)	175 (9.0)	267 (13.7)
Female	996	15 (1.5)	50 (5.0)	93 (9.3)	130 (13.1)
Age group					
<65 years	1,077	7 (0.6)	24 (2.2)	52 (4.8)	75 (7.0)
65–74 years	771	9 (1.2)	38 (4.9)	61 (7.9)	93 (12.1)
≥75 years	1,090	32 (2.9)	87 (8.0)	155 (14.2)	229 (21.0)
Heart failure phenotype					
HFrEF	2,311	31 (1.3)	100 (4.3)	186 (8.0)	280 (12.1)
HFpEF	533	13 (2.4)	41 (7.7)	65 (12.2)	96 (18.0)
Missing/unsure	94	4 (4.3)	8 (8.5)	17 (18.1)	21 (22.3)

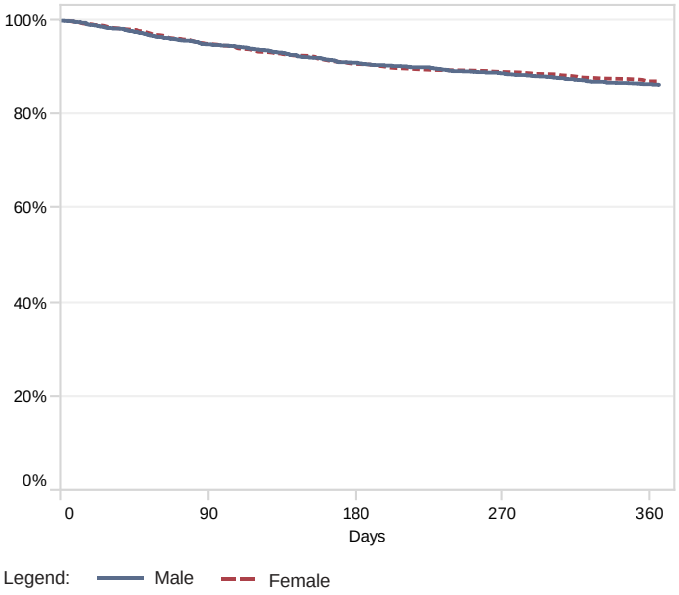


Figure 20: Heart failure survival by gender

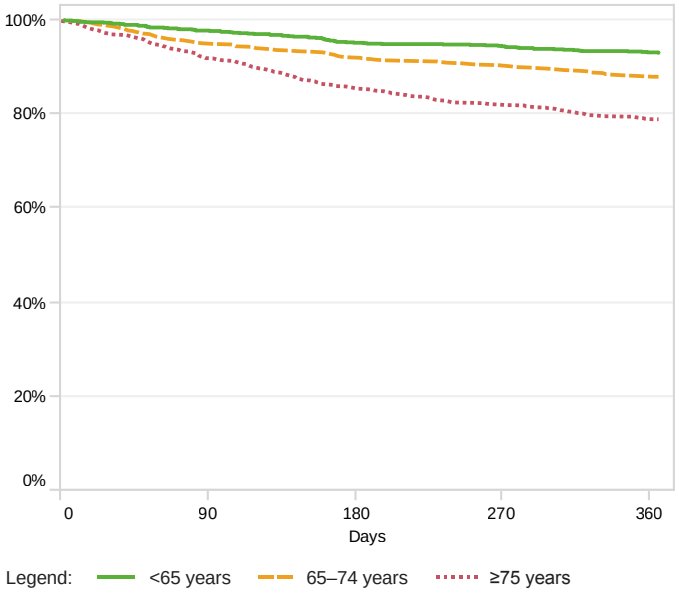


Figure 21: Heart failure survival by age group

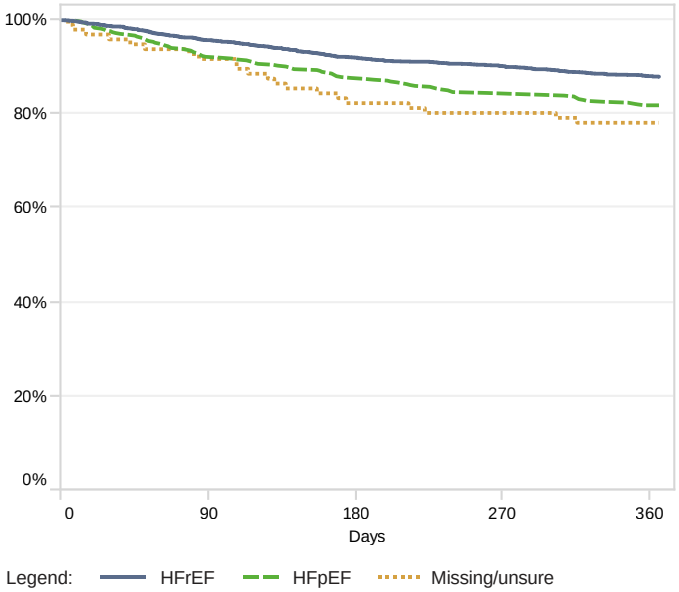


Figure 22: Heart failure survival by phenotype

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 2,938 eligible patients referred to HFSS during 2018, the unadjusted rate of all-cause hospitalisation was 17.8% at 30 days, increasing to 54.5% at one year. Hospitalisations relating to HF (as identified by discharge diagnosis coding) were 5.8% and 22.7% at 30 days and one year respectively.

The overall risk of hospitalisation or death within 12 months post the index admission was 55.5% (Figure 25). Almost a third of patients referred to an HFSS were rehospitalised at least two times in the subsequent 12 months (Table 32).

Table 32: Number of rehospitalisations per patient in the year post initial discharge

Total in one year	All-cause n (%)	Heart failure n (%)
0	1,371 (46.7)	2,324 (79.1)
1	697 (23.7)	390 (13.3)
2	385 (13.1)	133 (4.5)
3	193 (6.6)	43 (1.5)
4	120 (4.1)	25 (0.9)
≥5	172 (5.9)	23 (0.8)

Table 33: 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	1,942	334 (17.4)	616 (32.3)	802 (42.2)	1,013 (53.5)
Female	996	186 (18.8)	338 (34.2)	443 (45.2)	555 (56.7)
Age group					
<65 years	1,077	153 (14.3)	285 (26.8)	361 (34.2)	476 (45.1)
65–74 years	771	147 (19.1)	258 (33.7)	335 (43.9)	420 (55.4)
≥75 years	1,090	220 (20.4)	411 (38.5)	549 (51.7)	672 (63.4)
Heart failure phenotype					
HFrEF	2,311	386 (16.8)	691 (30.3)	910 (40.1)	1,158 (51.2)
HFpEF	533	116 (21.9)	225 (42.7)	285 (54.2)	352 (67.0)
Missing/unsure	94	18 (19.6)	38 (42.2)	50 (56.8)	58 (65.9)
ALL	**2,938**	**520 (17.8)**	**954 (32.9)**	**1,245 (43.2)**	**1,568 (54.5)**

Table 34: 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	1942	109 (5.7)	218 (11.6)	288 (15.8)	397 (22.2)
Female	996	60 (6.1)	123 (12.8)	166 (17.7)	217 (23.6)
Age group					
<65 years	1,077	43 (4.0)	90 (8.5)	115 (11.1)	170 (16.5)
65–74 years	771	53 (6.9)	84 (11.2)	112 (15.3)	157 (21.7)
≥75 years	1,090	73 (6.8)	167 (16.2)	227 (22.9)	287 (30.1)
Heart failure phenotype					
HFrEF	2,311	122 (5.3)	239 (10.7)	306 (14.0)	425 (19.9)
HFpEF	533	40 (7.6)	85 (16.6)	123 (24.7)	161 (33.2)
Missing/unsure	94	7 (7.8)	17 (19.5)	25 (29.8)	28 (33.7)
ALL	**2,938**	**169 (5.8)**	**341 (12)**	**454 (16.4)**	**614 (22.7)**

Table 35: 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	1,942	351 (18.1)	648 (33.4)	843 (43.4)	1,060 (54.6)
Female	996	191 (19.2)	347 (34.8)	458 (46.0)	572 (57.4)
Age group					
<65 years	1,077	159 (14.8)	298 (27.7)	381 (35.4)	497 (46.1)
65–74 years	771	150 (19.5)	264 (34.2)	343 (44.5)	433 (56.2)
≥75 years	1,090	233 (21.4)	433 (39.7)	577 (52.9)	702 (64.4)
Heart failure phenotype					
HFrEF	2,311	402 (17.4)	722 (31.2)	953 (41.2)	1,208 (52.3)
HFpEF	533	120 (22.5)	231 (43.3)	292 (54.8)	360 (67.5)
Missing/unsure	94	20 (21.3)	42 (44.7)	56 (59.6)	64 (68.1)
ALL	**2,938**	**542 (18.4)**	**995 (33.9)**	**1,301 (44.3)**	**1,632 (55.5)**

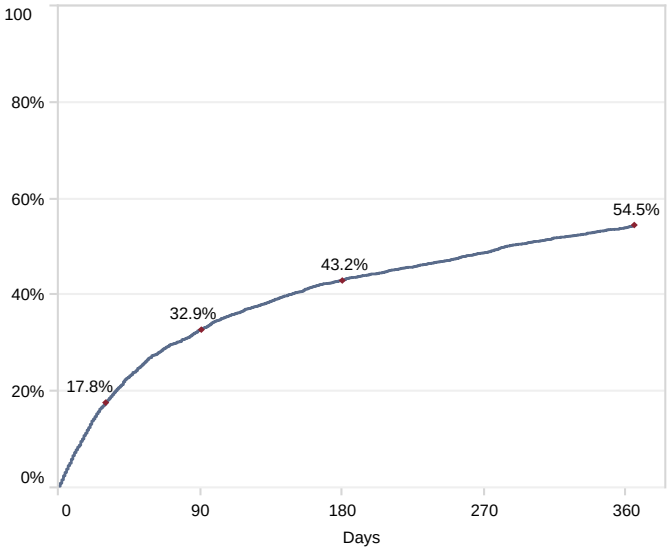


Figure 23: Cumulative incidence of all-cause rehospitalisation

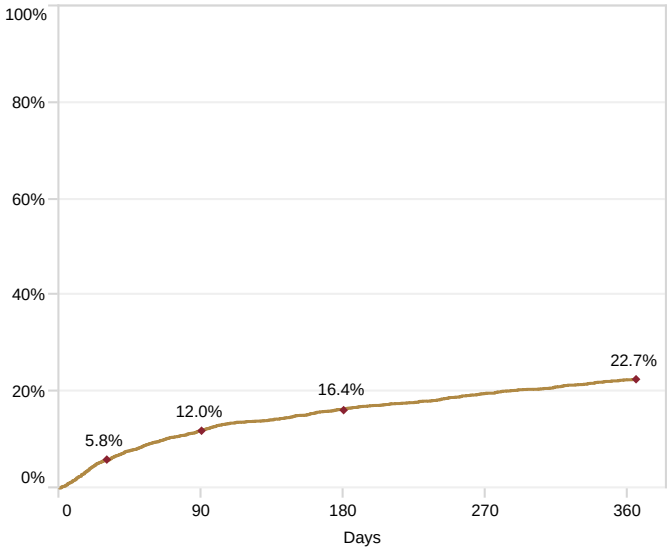


Figure 24: Cumulative incidence of heart failure rehospitalisation

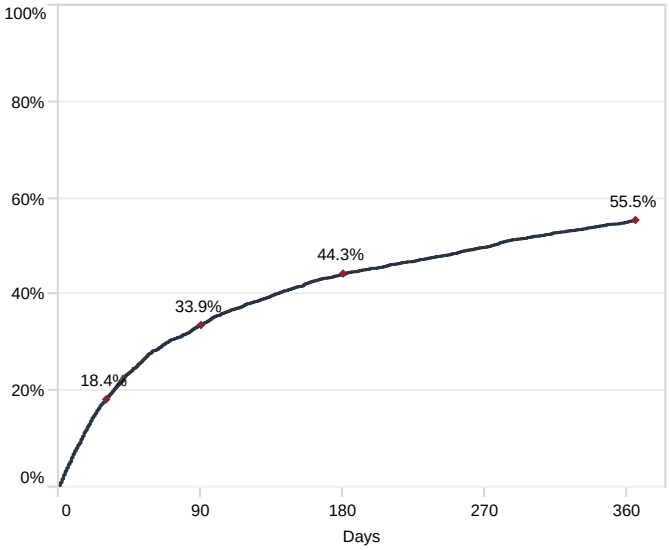


Figure 25: Cumulative incidence of all-cause rehospitalisation or death

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 43% of patients survived more than a year without rehospitalisation, with a median of 363 days for the whole group. The mean days alive and out-of-hospital was 327.2, which equates to almost 110,000 days lost due to death or hospitalisation over 12 months in 2,886 patients.

The box and whisker plots in Figure 27 illustrate the distribution of DAOH for different characteristics. The median of the data 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.

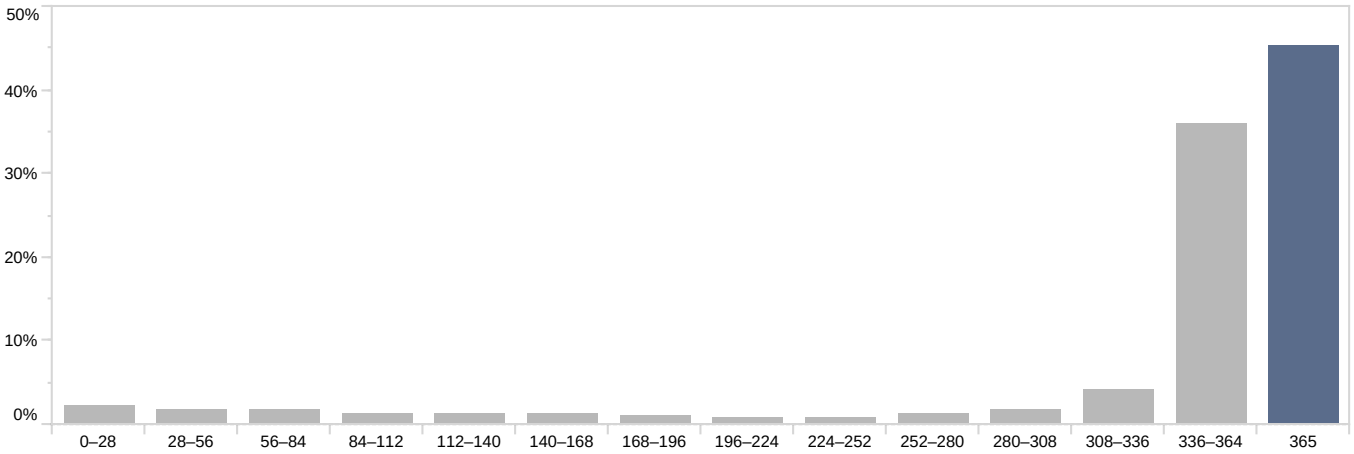
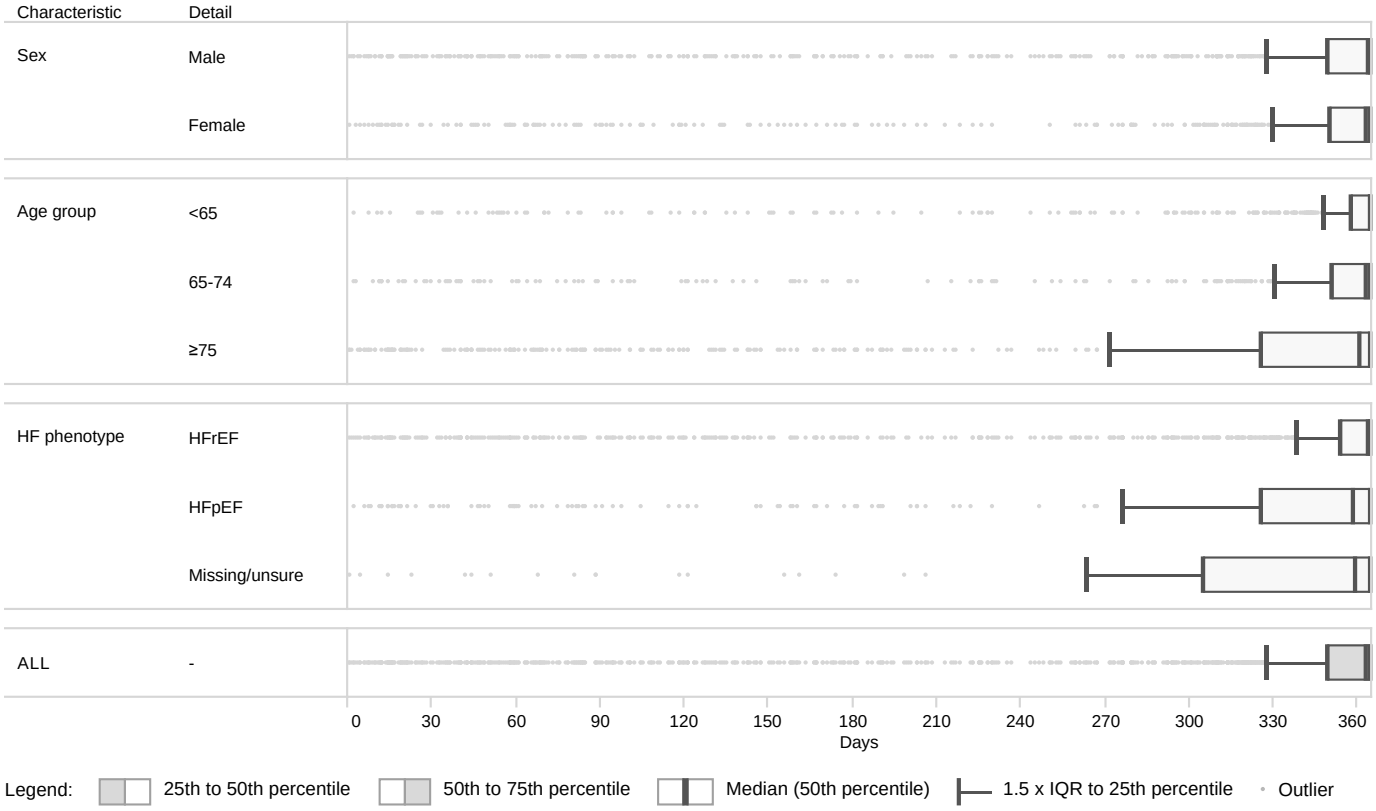


Figure 26: Days alive and out-of-hospital within one year after hospital discharge

Table 36: Days alive and out-of-hospital within one year of discharge by patient characteristic

Characteristic	Detail	n	Mean	Median (IQR)
Sex	Male	1,909	326.8	364.0 (350–365)
	Female	977	328.1	363.4 (351–365)
Age group	<65	1,068	342.8	365.0 (358–365)
	65–74	755	330.7	363.3 (351–365)
	≥75	1,063	309.2	360.8 (326–365)
HF phenotype	HFrEF	2,271	331.5	364.3 (354–365)
	HFpEF	522	313.2	358.9 (326–365)
	Missing/unsure	93	302.2	359.7 (306–365)
Statewide		**2,886**	**327.2**	**363.7 (350–365)**



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

8 Conclusions

The 2019 report collected information on 5,304 newly referred patients to 21 HFSSs across Queensland, a 9% increase from the previous year. Aboriginal and Torres Strait Islander Queenslanders make up 4.6% of referrals and had a median age 12 years younger than patients of other descent.

As with previous reports, most referrals to HFSS are for patients with HFrEF, even though evidence suggests that patients with HFpEF also benefit from support. Barriers to referring patients with HFpEF and right heart failure could be the limited evidence base for specific medical therapies, the older age of patients with HFpEF, reduced capacity to identify patients on general medicine wards and limited resources to grow caseloads.

Prescribing practices for ACEI/ARB or ARNIs and beta blockers have remained consistently high over the four years. Titration of beta blockers to target dose continues to be low at 32% (benchmark is 50%). This percentage is only for those patients who had their betablocker reviewed by the HFSS (67%). Monitoring and keeping track of titration is difficult over months when there may be no regular contact with a patient. When a GP or private cardiologist is managing titration, obtaining dose information is time consuming for the HFSS. Despite the difficulties in tracking patients in the community for several months, the current dataset is rich and one of the few registries routinely collecting titration information post discharge.

This year we introduced the measurement of MRA prescription which confirmed our observations that prescribing for eligible patients is low (45% at hospital discharge and 43% at first clinical follow-up; well below the benchmark of 80%). This is an area that could benefit from extensive promotion among clinical staff.

Patient outcomes (rehospitalisation, survival and DAOH) were collected on inpatient referrals from the previous year to allow for reporting of outcomes at 12 months post the index admission (n=3,413). The burden of the disease remains high with rehospitalisation or death rates of 34% and 56% at 6 and 12 months respectively. HFpEF continues to have a higher unadjusted mortality rate than HFrEF.

Future plans include refining the data collection to include data such as comorbidities and phenotyping, to allow for risk adjusted outcomes to be reported, and capturing information related to other therapies including sodium–glucose co-transporter-2 inhibitors and exercise prescription. New fields were added to the database midway through 2019 to recording rates of cardiac implantable electronic devices use in patients referred to a HFSS. These new fields will be investigated for 2020 reporting, once a complete annual data set is available. Work is also in progress to improve the user functionality of the QCOR Heart Failure module and provide functionality to assist in patient referral management.

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Glossary

6MWT	Six Minute Walk Test
ACC	American College of Cardiology
ACEI	Angiotensin Converting Enzyme Inhibitor
ACP	Advanced Care Paramedic
ACS	Acute Coronary Syndromes
AEP	Accredited Exercise Physiologist
ANZSCTS	Australian and New Zealand Society of Cardiac and Thoracic Surgeons
APC	Argon Plasma Coagulation
AQoL	Assessment of Quality of Life
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
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
FdECG	First Diagnostic Electrocardiograph
FTR	Failure to Rescue
GAD	Generalized Anxiety Disorder
GCCH	Gold Coast Community Health
GCUH	Gold Coast University Hospital
GLH	Gladstone Hospital
GP	General Practitioner
GYH	Gympie Hospital
HBH	Hervey Bay Hospital (includes Maryborough)
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
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
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
NOAC	Non Vitamin K Antagonist Oral Anticoagulants
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
QAS	Queensland Ambulance Service
QCOR	Queensland Cardiac Outcomes Registry
QEII	Queen Elizabeth II Jubilee Hospital
QHAPDC	Queensland Hospital Admitted Patient Data Collection
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
SCCN	Statewide Cardiac Clinical Network
SCUH	Sunshine Coast University Hospital
SHD	Structural Heart Disease
STEMI	ST-Elevation Myocardial Infarction
STS	Society of Thoracic Surgery
TAVR	Transcatheter Aortic Valve Replacement
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
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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