Queensland Health

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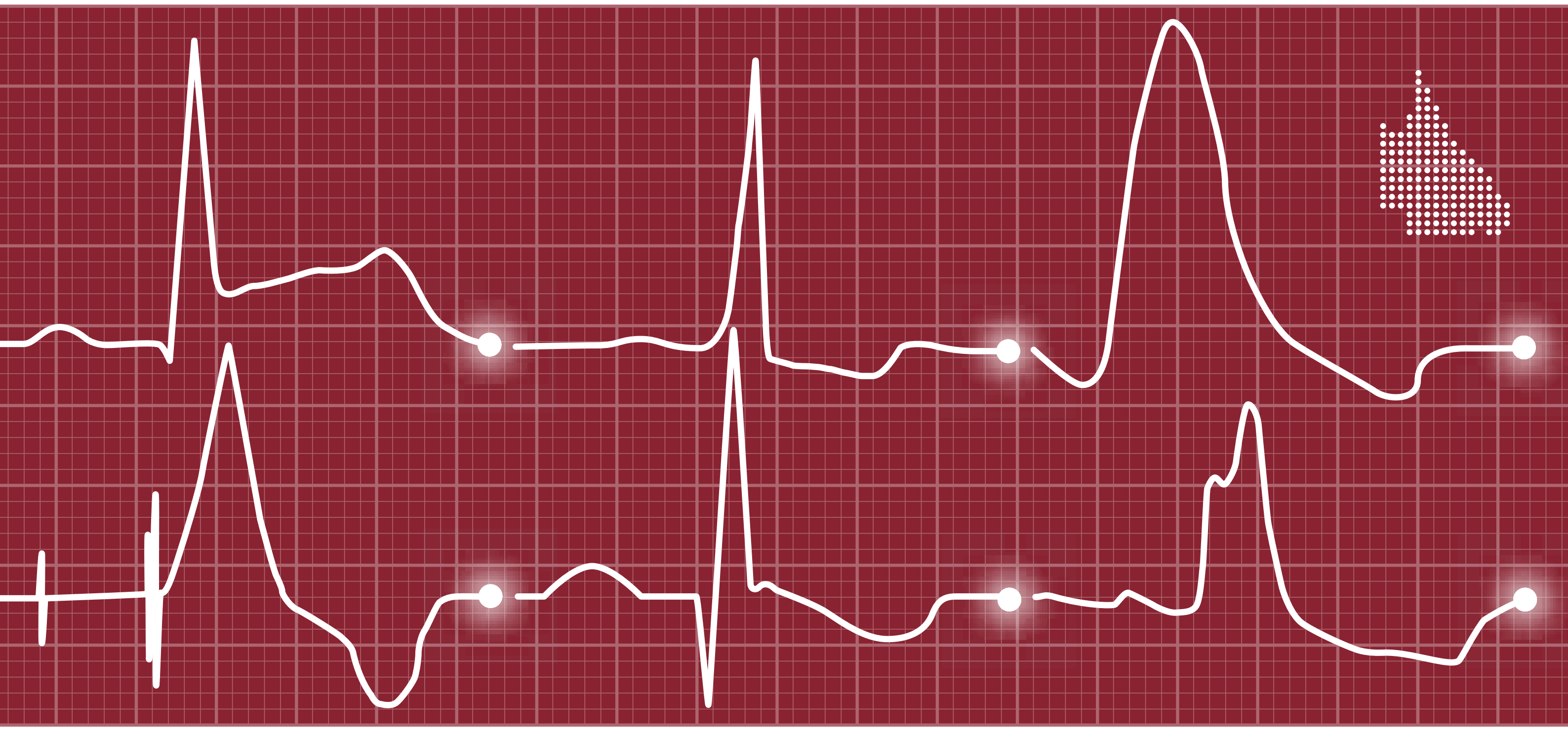
Queensland Cardiac Clinical Network

Queensland Cardiac Outcomes Registry

2022 Annual Report



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Queensland Government

Queensland Cardiac Outcomes Registry 2022 Annual Report

Published by the State of Queensland (Queensland Health), December 2023

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1 Message from the Queensland Cardiac Clinical Network Chair

It is with great pleasure that we present the Annual Report of the Queensland Cardiac Outcomes Registry. This report serves as a testament to the relentless pursuit of excellence in cardiovascular care within the Queensland region. The data, analyses, and insights presented here reflect the collective efforts of our passionate team, whose commitment to improving patient outcomes remains unwavering.

QCOR remains one of the most comprehensive clinician-led clinical registries in the country, incorporating modules reporting on interventional cardiology, cardiac surgery, thoracic surgery, electrophysiology and pacing, cardiac rehabilitation and heart failure support services. Through rigorous data collection, innovative research endeavours, and collaborative efforts, we have made significant strides in enhancing patient outcomes, advancing medical knowledge, and fostering a healthier future for our community.

We continue to keenly await the delivery of a contemporary statewide cardiovascular information system for diagnostic and interventional cardiology and echocardiography. Following a successful procurement process, the platform for a forward-thinking, all-encompassing solution has been laid and throughout the process to date, the collegiality and cooperation of cardiac clinicians throughout the state has once again been exemplified.

In the era of expanding datasets and advanced analytics, our commitment will be to translating the knowledge gained from this program into information supporting patient safety and quality initiatives. We are looking forward to expanded capability for data collection and analysis to become part of real-time care delivery, recognising always the patient as the focus of our efforts. We trust that this report will serve as a valuable for knowledge exchange, and ultimately, better cardiovascular outcomes for our community.

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

2 Acknowledgements

This collaborative report was produced by the SCCIU, audit lead for QCOR for and on behalf of the 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 Yohan Chacko, Ipswich Hospital
- Dr Christopher Hammett, Royal Brisbane & Women's Hospital
- Dr Dale Murdoch, The Prince Charles Hospital
- A/Prof Atifur Rahman, Gold Coast University Hospital
- Dr Sam Sidharta, Rockhampton Hospital
- Dr Yash Singbal, Princess Alexandra Hospital
- Dr Gregory Starmer, Cairns Hospital
- Dr Michael Zhang, Mackay Base Hospital
- Dr Rohan Poulter, Sunshine Coast University Hospital (Chair)

QCOR Cardiothoracic Surgery Committee

- Dr Manish Mathew, Townsville University Hospital
- Dr Rishendran Naidoo, Metro North Hospital and Health Service
- Dr Anil Prabhu, The Prince Charles Hospital
- Dr Andrie Stroebel, Gold Coast University Hospital
- Dr Christopher Cole, Princess Alexandra Hospital (Chair)

QCOR Electrophysiology and Pacing Committee

- Dr Naresh Dayananda, Sunshine Coast University Hospital
- A/Prof John Hill, Princess Alexandra Hospital
- Dr Paul Martin, Royal Brisbane & Women's Hospital
- Dr Caleb Mengel, Toowoomba Hospital
- Dr Sachin Nayyar, Townsville University Hospital
- Dr Kevin Ng, Cairns Hospital
- Dr Robert Park, Gold Coast University Hospital
- Dr Russell Denman, The Prince Charles Hospital (Chair)

QCOR Cardiac Rehabilitation Committee

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

QCOR Heart Failure Support Services Committee

- Ms Melanie Burgess, Ipswich Hospital
- Dr Wandy Chan, The Prince Charles Hospital
- Ms Deepali Gupta, Queen Elizabeth II Hospital
- Ms Annabel Hickey, Statewide Heart Failure Services Coordinator
- Dr Rita Hwang, PhD, Princess Alexandra Hospital
- Ms Sophie Lloyd, Royal Brisbane & Women's Hospital
- Ms Menaka Louis, Gold Coast Hospital and Health Service
- Ms Kellie Mikkelsen, Redcliffe Hospital
- Ms Melissa Moore, Townsville University Hospital
- Ms Rachelle Mulligan, Princess Alexandra Hospital
- Ms Louvaine Wilson, Toowoomba Hospital
- Prof John Atherton, Royal Brisbane & Women's Hospital (Chair)

Statewide Cardiac Clinical Informatics Unit

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

Queensland Ambulance Service

- Dr Tan Doan, PhD

3 Introduction

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

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

Goals and mission

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

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

The SCCIU team consists of:

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

* Principal contact officer/QCOR program lead

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

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

QCOR manages the Cardiothoracic Surgery Quality Assurance Committee which has been formed under Part 5 of the *Hospital and Health Boards Regulation 2023* to facilitate the participation of clinicians and administrators responsible for the management and delivery of cardiac services. This group enables the peer review of safety and quality of the cardiothoracic services delivered in Queensland and guides any service improvement activities that may be required.

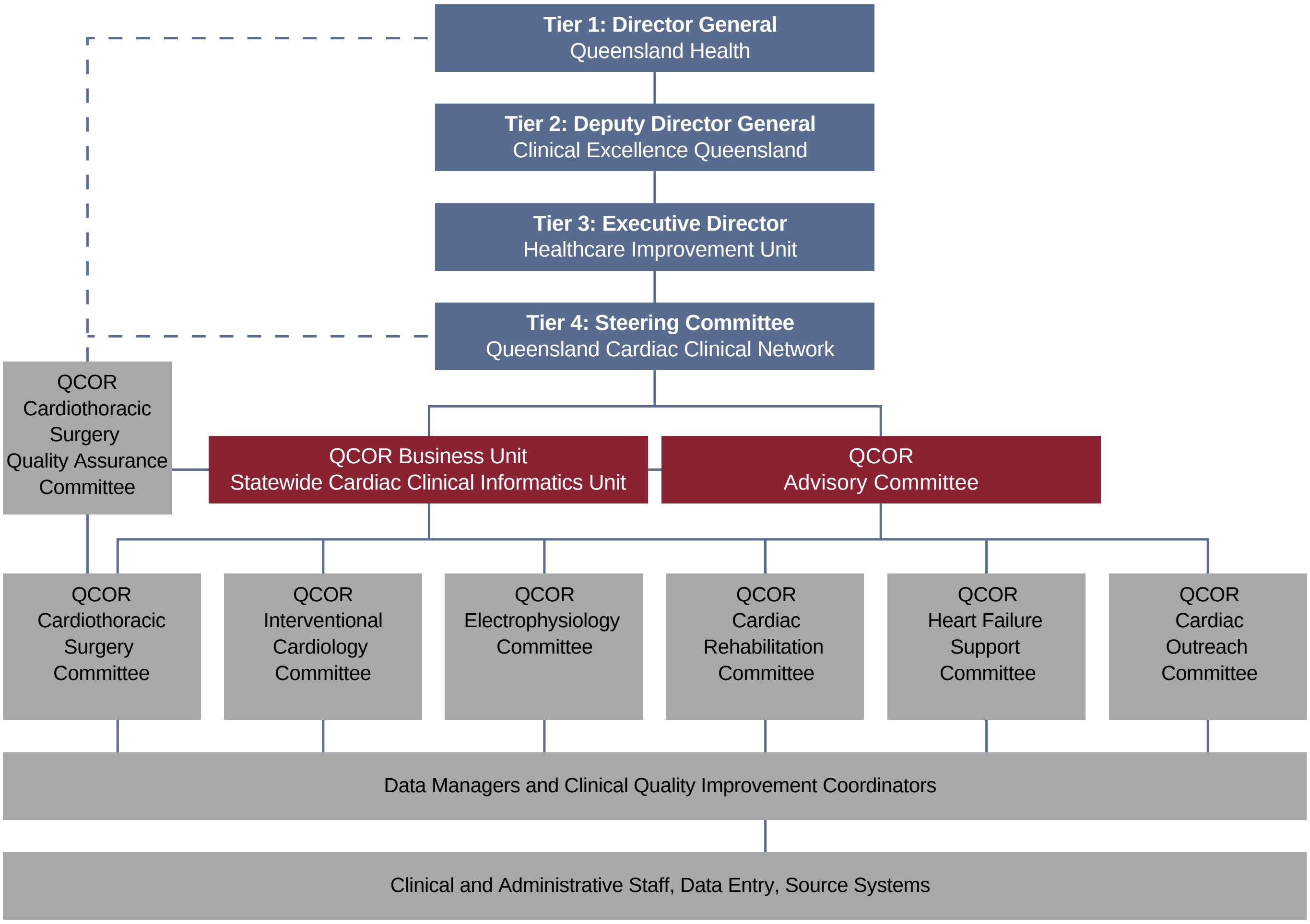


Figure 1: Governance structure

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

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

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

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

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

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

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

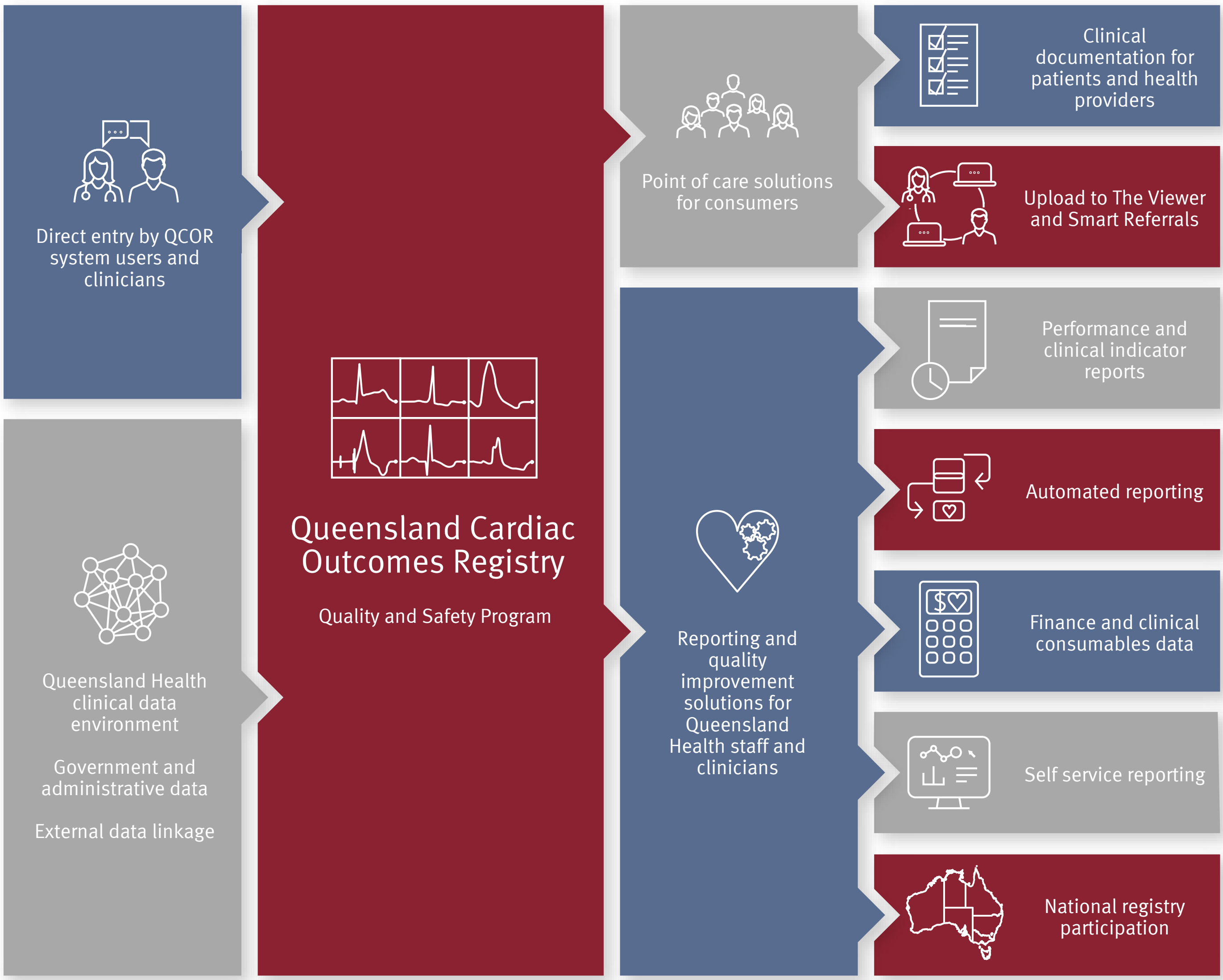


Figure 2: QCOR data flow

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

Queensland Cardiac Outcomes Registry

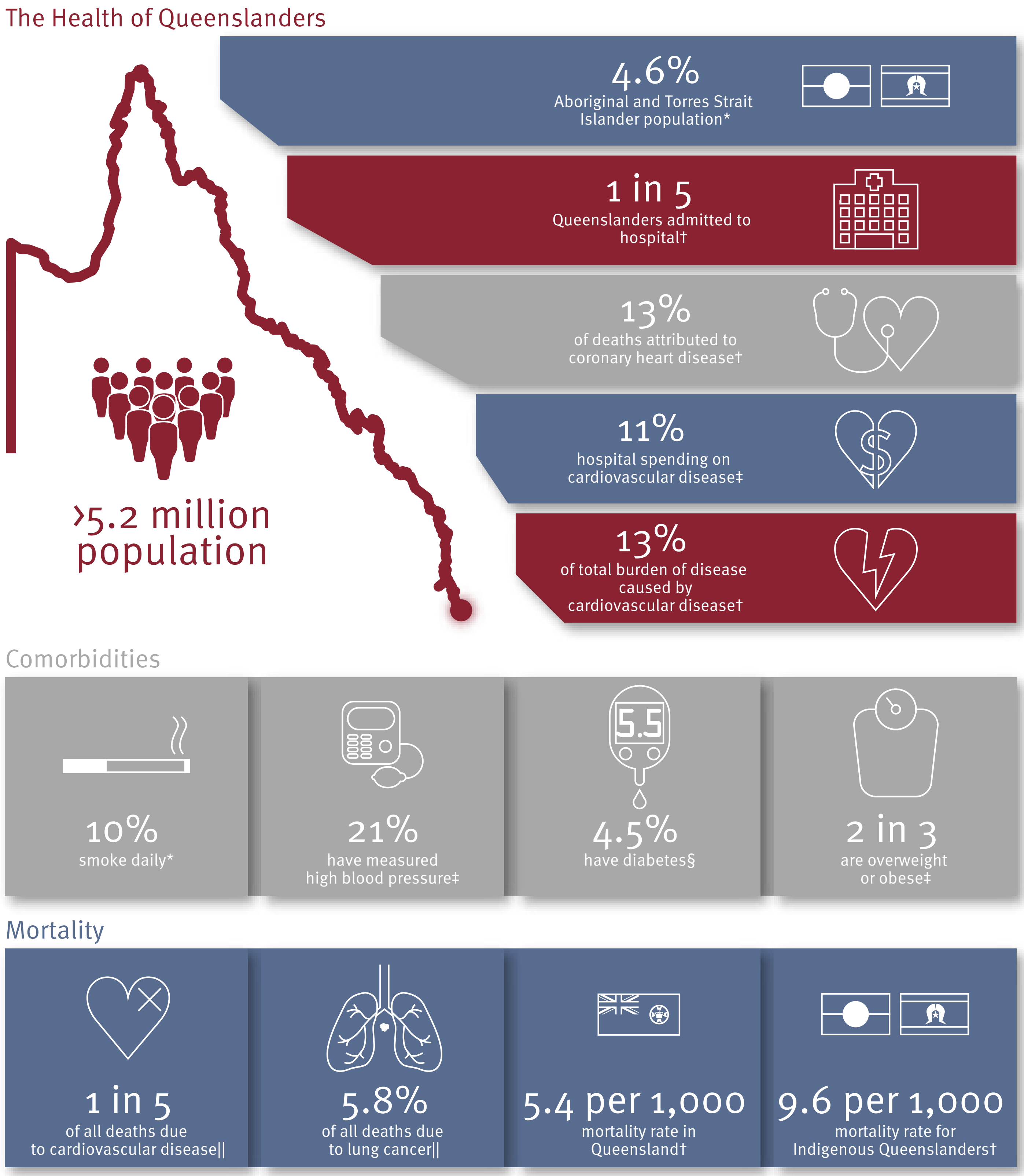


Figure 3: QCOR 2022 infographic

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

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

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

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

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

2022 Activity at a Glance

What's New?

- Cardiac Surgery health equity spotlight
- Cardiac Rehabiliation expanded outcomes audit
- Heart Failure Support Services SGLT2 inhibitor indicator
- Interventional Cardiology adjunct devices review

Interventional Cardiology

4,818 percutaneous coronary interventions

617 structural heart disease interventions

335 transcatheter aortic valve replacements

14,769 total coronary procedures

Cardiothoracic Surgery

2,230 adult cardiac surgeries

918 adult thoracic surgeries

Electrophysiology & Pacing

5,305 electrophysiology and pacing procedures

3,611 cardiac implantable electronic device procedures

Heart Failure Support Services

6,438 heart failure support services referrals

Cardiac Rehabilitation

9,317 cardiac rehabilitation referrals

Paediatric Cardiac Surgery

292 paediatric cardiac surgeries

Clinical Indicator Progress

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

0.2% 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

92% of cardiac rehabilitation referrals within 3 days of discharge

1.5% mortality rate for coronary artery bypass surgery at 30 days

4 Publications in 2022

Adams, C., Sawhney, G., & Singh, K. (2022). Comparing pharmacotherapy in MINOCA versus medically managed obstructive acute coronary syndrome. *Heart and Vessels*, 1-6.

Aprile, G., Dermedgoglou, A., Powaloski, P., Nguyen, S., Brazzale, A., & Starmer, G. (2022). Five-Year Outcomes of a Structural Heart Program in a Regional Hospital Without On-Site Cardiac Surgical Support. *Heart, Lung and Circulation, 31*, S335-S336.

Aprile, G., Dermedgoglou, A., Starmer, G., & Ng, K. (2022). Outcomes of Invasive Electrophysiology Studies With Both Radiofrequency and Cryoablation in a Regional Centre Without On-site Cardiac Surgery Support: A Single Centre Experience. *Heart, Lung and Circulation, 31*, S125.

Aprile, G., Dermedgoglou, A., Jhaveri, U., Singbal, Y., Moore, P., Kyranis, S., & Cox, S. (2022). Safety and Feasibility of Day Case PCI in a Cardiac Catheter Laboratory in a Queensland Tertiary Hospital. Heart, Lung and Circulation, 31, S351.

Baldini, M., Rutstein, A., & Morris, N. (2022). Getting to the Heart of Genomics: Mainstreaming Cardiology Genomics in Queensland. *Heart, Lung and Circulation, 31*, S3.

Dermedgoglou, A., Aprile, G., Starmer, G., Preston, S., Nucifora, J., Saireddy, R., & Brazzale, A. (2022). The Use of Rotational Atherectomy in a Non-Surgical Centre in Far North Queensland: Evaluating Safety Outcomes. *Heart, Lung and Circulation, 31*, S358.

Doan, T. N., Prior, M., Vollbon, W., Rogers, B., Rashford, S., & Bosley, E. (2022). Survival after resuscitated out-of-hospital cardiac arrest in patients with paramedic-identified ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention. *Prehospital Emergency Care, 26*(6), 764-771.

Malhotra, G., & Stewart, P. (2022). Outcomes of rotational atherectomy in three Large Queensland centres without onsite cardiac surgical backup in a contemporary patient cohort–a 9-year experience. *Heart, Lung and Circulation, 31*, S346.

Phillips, S., Vollbon, W., & Kidby, K. (2022). Implementation of a System-Wide, Data-Driven Approach to Improving Cardiac Rehabilitation in Queensland. *Heart, Lung and Circulation, 31*, S296-S297.

Phillips, S., Vollbon, W., Kidby, K., & Thomas, E. E. (2022). Improving Cardiac Rehabilitation in Queensland: A Whole of System, Data-Driven Approach Over the Past 10 Years. *Heart, Lung and Circulation, 31*(12), 1568-1572.

Phillips, S., Mahoney, A., Adsett, J., & El-Ansary, D. (2022). Management and Rehabilitation Post Median Sternotomy in Queensland. *Heart, Lung and Circulation, 31*, S297.

Savage, M., Murdoch, D., Ranasinghe, I., & Raffel, O. (2022). Sex Differences in Time to Reperfusion and Mortality in ST-Segment Elevation Myocardial Infarction (STEMI): Insights From the Queensland Cardiac Outcomes Registry (QCOR). *Heart, Lung and Circulation, 31*, S351.

Savage, M., Murdoch, D., Ranasinghe, I., & Raffel, O. (2022). Pre-Hospital Activation of ST-Segment Elevation Myocardial Infarction (STEMI): Insights From the Queensland Cardiac Outcomes Registry (QCOR). *Heart, Lung and Circulation, 31*, S348.

Sen, J., Pires, D., De Sa, A., Ascher, D., Wahi, S., & Marwick, T. (2022). Phenotyping patients with aortic stenosis using cluster analysis to determine mortality and suitability for transcatheter aortic valve replacement. *European Heart Journal, 43*(Supplement_2), ehac544-1627.

Sen, J., Pires, D., de Sá, A., Ascher, D., Wahi, S., & Marwick, T. (2022). Use of Cluster Analysis to Characterise Aortic Stenosis Phenotypes with Treatable and Untreatable Risk. *Heart, Lung and Circulation, 31*, S44-S45.

Seton, N., Anderson, S., Power, A., Ball, Z., Divi, S., Su, H., & Starmer, G. (2022). Gender and Ethnic Differences in Morbidity and Coronary Revascularisation Rates Amongst Young Australians in Far North Queensland. *Heart, Lung and Circulation, 31*, S53.

Seton, N., Power, A., Anderson, S., Divi, S., Ball, Z., Su, H., & Starmer, G. (2022). Gender and Ethnic Differences in Length of Stay Post Coronary Angiography in Far North Queensland. *Heart, Lung and Circulation, 31*, S281-S282.

Sharma, N., Brazzale, A., & Starmer, G. (2022). Structural Interventional Cardiology in FNQ–Beginning of a New Era. A Retrospective Review of all the PFO Closures and Its Complications Versus Success Rate in Preventing the Future Stroke Risk. *Heart, Lung and Circulation, 31*, S229.

Sharma, N., Saireddy, R., & Starmer, G. (2022). Retrospective Review of STEMI Presentation to Cairns Hospital and Impact of Transit Time on Long Term Cardiac Mortality of Outreach Community Patients. *Heart, Lung and Circulation, 31*, S226.

5 Executive summary

This report comprises an account for cases performed in the nine cardiac catheterisation laboratories (CCL), nine electrophysiology and pacing (EP) facilities, and five cardiothoracic surgery units operating across Queensland public hospitals in 2022. All referrals to heart failure support (HFSS) and cardiac rehabilitation (CR) services have also been included in this Annual Report.

- 14,864 diagnostic or interventional cases were performed across the nine public CCL facilities in Queensland hospitals. Percutaneous coronary intervention (PCI) was performed in 4,818 of these cases.
- Patient outcomes following PCI remain encouraging. The 30 day all-cause mortality rate following PCI was 2.2%, and of the 107 deaths observed, 70% 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 was 85 minutes, while the median time from arrival at PCI facility to reperfusion was measured at 42 minutes.
- For STEMI presenting within six hours of symptom onset the median time from arrival at PCI facility to reperfusion was 35 minutes for cases performed in working hours (8am to 6pm, Monday to Friday, excluding public holidays), while cases occurring out of hours had a median time of 48 minutes.
- There were 617 structural heart interventions performed across participating CCL facilities. This included 430 transcatheter valve procedures, of which 335 were transcatheter aortic valve replacement procedures. The unadjusted all-cause 30 day mortality rate for all SHD interventions was 1.6%.
- Across the four sites with a cardiac surgery unit, a total of 2,230 cases were performed including 1,045 coronary artery bypass grafting (CABG) procedures, 802 valve procedures, and 201 CABG and valve procedures.
- The observed rates for cardiac surgery mortality and morbidity are either within the expected range or better than expected depending on the risk model used to evaluate these outcomes. This is consistent with the results of previous Audits.
- Across the period of July 2017 to June 2022 1,340 children underwent cardiac surgery, including 269 children in 2022.
- There were 1,492 paediatric cardiac surgical procedures performed from July 2017 to June 2022, either with or without cardiopulmonary bypass (1,140 and 352 procedures respectively).
- Thirty day mortality after paediatric cardiac surgery was observed at 0.7% between July 2017 to June 2022.
- A total of 918 thoracic surgery (TS) cases were performed across the five public hospitals providing TS services in 2022. Over one quarter (28%) of surgeries followed a surgical indication of primary lung cancer, while pleural disease also accounted for 28% all cases.
- The unadjusted all-cause 30 day mortality rate following TS was 1.0%, increasing to 2.6% at 90 days post surgery.
- At the nine public EP sites, a total of 5,305 cases were performed, which included 3,611 cardiac device procedures and 1,286 cardiac electrophysiology procedures.
- The EP clinical indicator audit identified a median wait time of 88 days for complex ablation procedures, and 21 days for elective implantable cardioverter defibrillator (ICD) implants. The median wait time for a standard ablation procedure was 99 days.
- There was a total of 9,317 referrals to public CR services in 2022. Almost three quarters of referrals (72%) followed an admission at a public hospital in Queensland.
- Over two thirds (69%) of CR referrals proceeded to pre assessment by a CR service. The most common reason this did not take place was that the patient declined or was not interested.
- The majority (92%) of referrals to CR were created within three days of the patient being discharged from hospital, while over half (58%) of patients went on to complete an initial assessment by CR within 28 days of discharge.
- There were 6,438 new referrals to a HFSS in 2022, with 62% originating from an inpatient setting.
- Upon discharge from hospital, the prescription of an ACEI/ARB or ARNI, beta blocker, MRA or SGLT2 inhibitor for heart failure with reduced ejection fraction (HFrEF) were measured at 92%, 91%, 58% and 38% respectively.
- At the time of first clinical review, benchmark rates were achieved for prescription of ACEI/ARB or ARNI and beta blocker for HFrEF patients (93% and 92% respectively).
- Beta blocker titration to clinical guideline target or maximum tolerated dose was achieved by time of titration review in 72% of HFrEF patients.

6 Facility profiles

6.1 Cairns Hospital

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

6.2 Townsville University Hospital

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

6.3 Mackay Base Hospital

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

6.4 Sunshine Coast University Hospital

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

6.5 The Prince Charles Hospital

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

6.6 Royal Brisbane & Women's Hospital

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

6.7 Queensland Children's Hospital

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

6.8 Princess Alexandra Hospital

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

6.9 Toowoomba Hospital

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

6.10 Ipswich Hospital

- Referral hub for West Moreton Hospital and Health Service. Ipswich Hospital provides health services to more than 320,000 people across the Somerset, Scenic Rim, Lockyer Valley and Ipswich communities.
- Public invasive cardiac services provided at the Ipswich Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
- Networked cardiac services outreach hub for West Moreton Hospital and Health Service

6.11 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

7 Spotlight: Cardiac Outreach

The Networked Cardiac Services (NCS) program is an integrated model of care for the delivery of cardiac services to regional and remote areas of Queensland, underpinned by building regional capability and organisational accountability. Implementation of the NCS program has been directed at improving key metrics identified as critical to the success of Cardiac Outreach services across Queensland.

The NCS program has been adopted by five Hospital and Health Services (HHSs) since its inception in 2019. Significant support has been provided by Queensland Health and the Queensland Cardiac Clinical Network, along with key regional stakeholders.

Areas targeted for improvement by the NCS program include:

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

Improve access, equity, quality, safety, and efficiency

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

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

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

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

- **Coordination and integration**

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

- **Evidence, evaluation, and improvement**

  Evidence-based care informed by data.

- **Technology**

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

- **Sustainable funding and resources**

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

- **Governance and accountability**

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

- **Harness existing investments and programs**

  For exponential benefits and efficiency.

Since 2019, five HHSs have progressively implemented the NCS program while business cases have been approved for the remaining sites. Funding for the remaining stages is yet to be identified.

The purpose-built QCOR Outreach Module offers a foundation for cardiac outreach care coordination across the health landscape and provides a reporting platform which allows an unprecedented amount of information to be available for an area otherwise characterised by relative paucity of data.

The QCOR Outreach Module provides Queensland Health practitioners with:

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

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

Table 1: QCOR cardiac outreach module – participating outreach units

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

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

Future directions for NCS include the collation of the different models of care in use and analysis of how experiences in various hubs may be transferable to other Hospital and Health Services. With the addition of a NCS centric performance measure which monitors access to care via the number of patients receiving their initial specialist outpatient appointment within the clinically recommended time. With these measures available NCS will continue to improve in its goals to provide appropriate specialist cardiac care to all Queenslanders regardless of where they live.

Table 2: Practitioner roles provided for outreach services

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

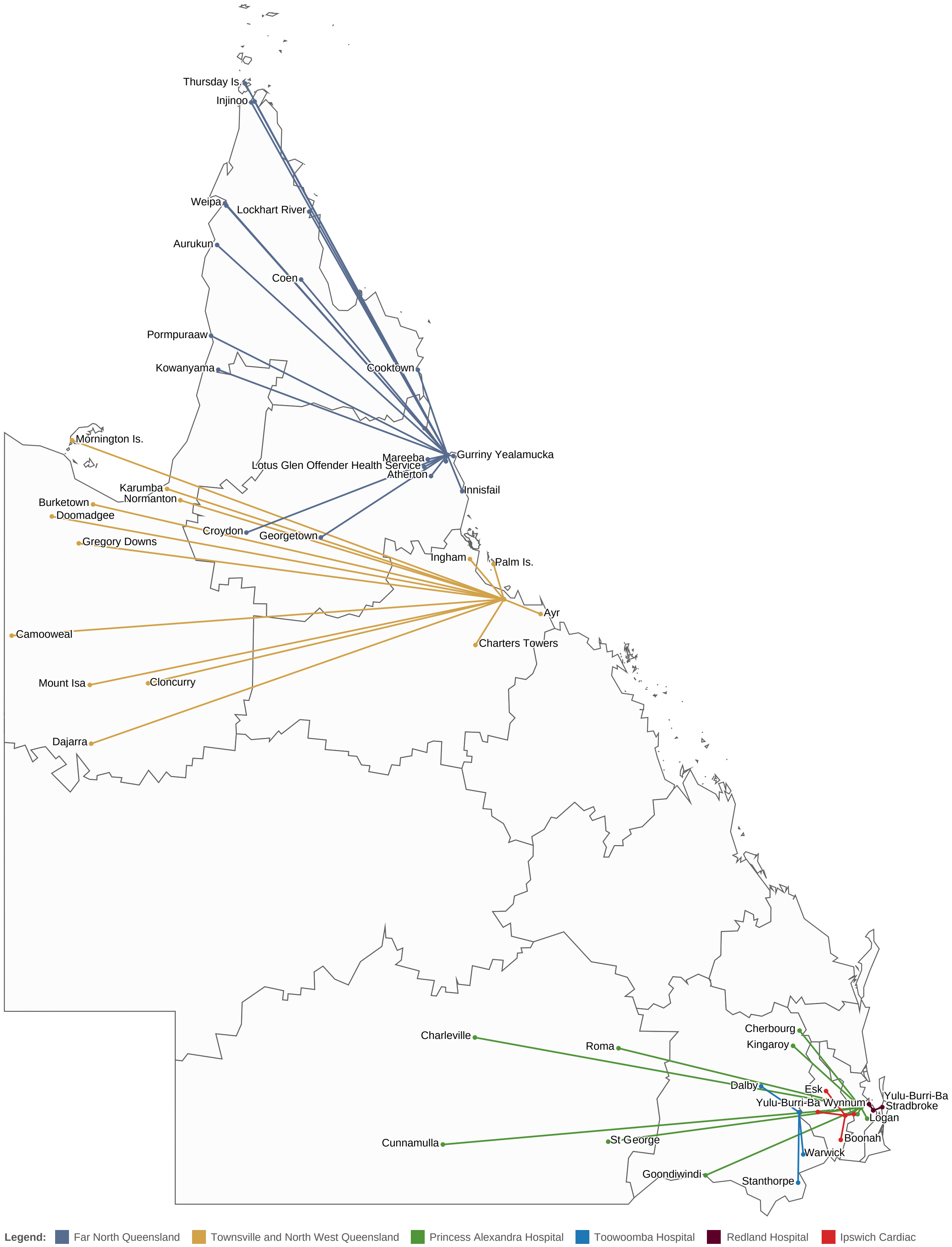


Figure 1: Cardiac outreach hub and spoke locations

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

In 2022, participating cardiac outreach units delivered services across a total of 55 spoke sites. The Far North Queensland unit provided services to 21 sites extending north to Thursday Island in the Torres Strait. The Townsville and North West Queensland and Princess Alexandra Hospital units delivered services to 14 and 11 spoke sites respectively, while the Toowoomba, Redland and Ipswich units delivered outreach services to 9 spoke sites collectively.

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

Cardiac outreach unit	Total spokes n
Far North Queensland	21
Townsville and North West Queensland	14
Princess Alexandra Hospital	11
Toowoomba Hospital	3
Redland Hospital	2
Ipswich Hospital	4
ALL	**55**

There were 500 clinics operated through the NCS model in 2022. Not all units were operating at full capacity for the entire duration of the year due to impact of COVID-19 related clinic cancellations. This is reflected in Table 4 below. Some units also took on clinic sites that were previously operated by other services, whilst some units continued their previous work which were services offered for many years but transitioned to the NCS model.

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

Cardiac outreach unit	Total clinics n
Far North Queensland	95
Townsville and North West Queensland	219
Princess Alexandra Hospital	122
Toowoomba Hospital	29
Redland Hospital	10
Ipswich Hospital	25

During 2022, 6,336 total consults were delivered as part of the NCS program. Larger and more established hub sites comprise of the greatest numbers which is also reflective of the higher number of clinics performed and number of spoke sites the unit is responsible for.

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

Cardiac outreach unit	Total consults n	Total patients* n
Far North Queensland	1,861	1,560
Townsville and North West Queensland	1,520	1,172
Princess Alexandra Hospital	2,377	1,664
Toowoomba Hospital	306	266
Redland Hospital	95	72
Ipswich Hospital	177	161
ALL	**6,336**	**4,883**

* Total of all total patients is greater than 4,883 as some patients were seen by multiple units.

There were 4,883 patients seen in the NCS outreach service in 2022. Of these patients 2,753 (56.4%) were male. The largest subgroup of this cohort were males aged between 60 years and 69 years and males aged between 70 years and 79 years. The largest proportion of females was in the cohort aged between 70 years and 79 years of age.

The median age for all patients was 63 years, ranging from 59 years to 66 years across all participating cardiac outreach units.

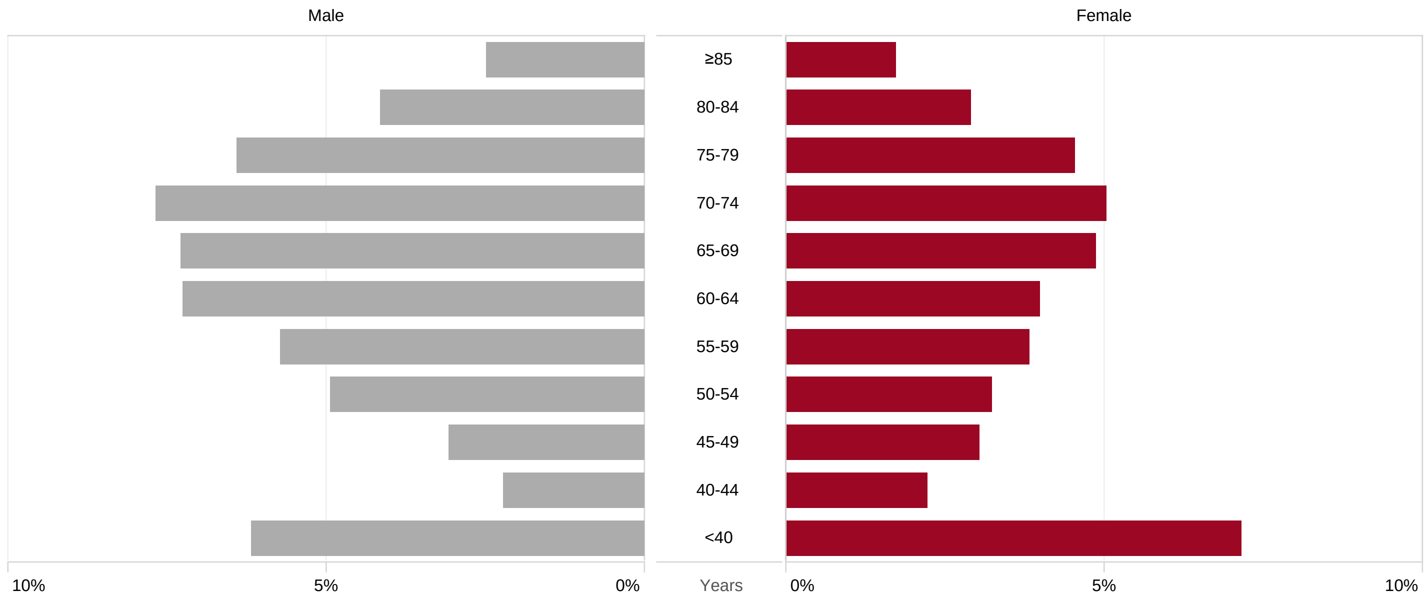


Figure 2: Proportion of outreach consults by age and gender

Table 6: Median patient age by gender and cardiac outreach unit

Cardiac outreach unit	Male years	Female years	ALL years
Far North Queensland	61	57	59
Townsville and North West Queensland	66	61	64
Princess Alexandra Hospital	66	66	66
Toowoomba Hospital	64	68	66
Redland Hospital	64	64	64
Ipswich Hospital	53	61	58
Total	**64**	**62**	**63**

Aboriginal and Torres Strait Islander patients accounted for 33.1% of the overall cohort enrolled in NCS outreach programs (n=4,883). This is considerably higher than the resident proportion of Aboriginal and Torres Strait Islander population of Queensland of 4.6%.*

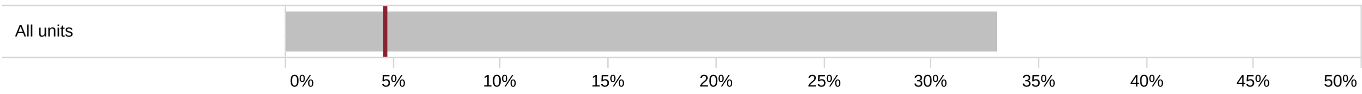
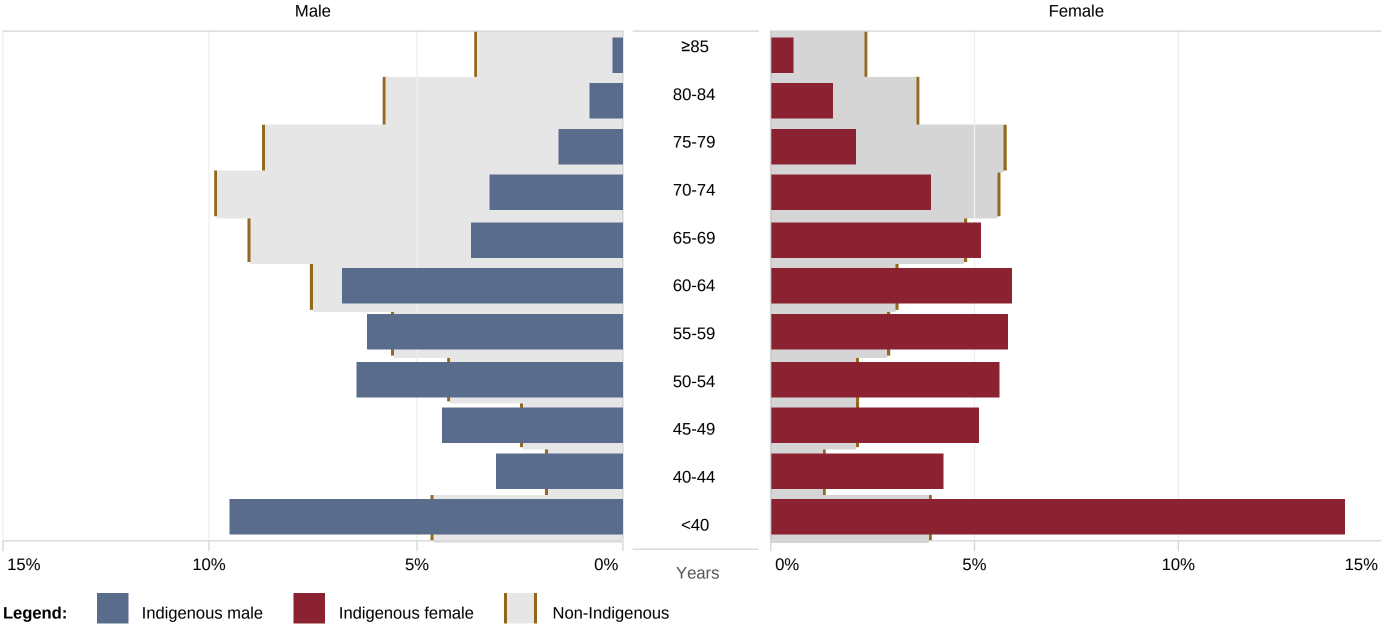


Figure 3: Proportion of Aboriginal and Torres Strait Islander patients seen in cardiac outreach

The median age of Aboriginal and Torres Strait Islander patients seen in cardiac outreach was lower than that of non Aboriginal and Torres Strait Islander patients (54 years vs. 68 years).



% of total Aboriginal and Torres Strait Islander (n=1,615) vs. total non-Indigenous (n=3,268)

Figure 4: Aboriginal and Torres Strait Islander status and age category

Table 7: Median patient age by gender and Aboriginal and Torres Strait Islander status

	Male years	Female years	ALL years
Aboriginal and Torres Strait Islander	54	53	54
Non Aboriginal and Torres Strait Islander	67	68	68
Total	**64**	**62**	**63**

* Australian Bureau of Statistics. (2021). Census of Population and Housing - Counts of Aboriginal and Torres Strait Islander Australians. ABS. https://www.abs.gov.au/statistics/people/aboriginal-and-torres-strait-islander-peoples/census-population-and-housing-counts-aboriginal-and-torres-strait-islander-australians/2021#queensland

Patients who reside in the Darling Downs HHS account for the largest proportion (20%) of patients seen. This is followed closely by the Cairns and Hinterland HHS (17%) and Torres and Cape HHS (15%). A small proportion of patients had a residential address which was interstate at the time of their encounter (1.2%).

It should be noted that some patients may temporarily reside in one HHS but their permanent address is elsewhere but for the purpose of this analysis, permanent address is presented.

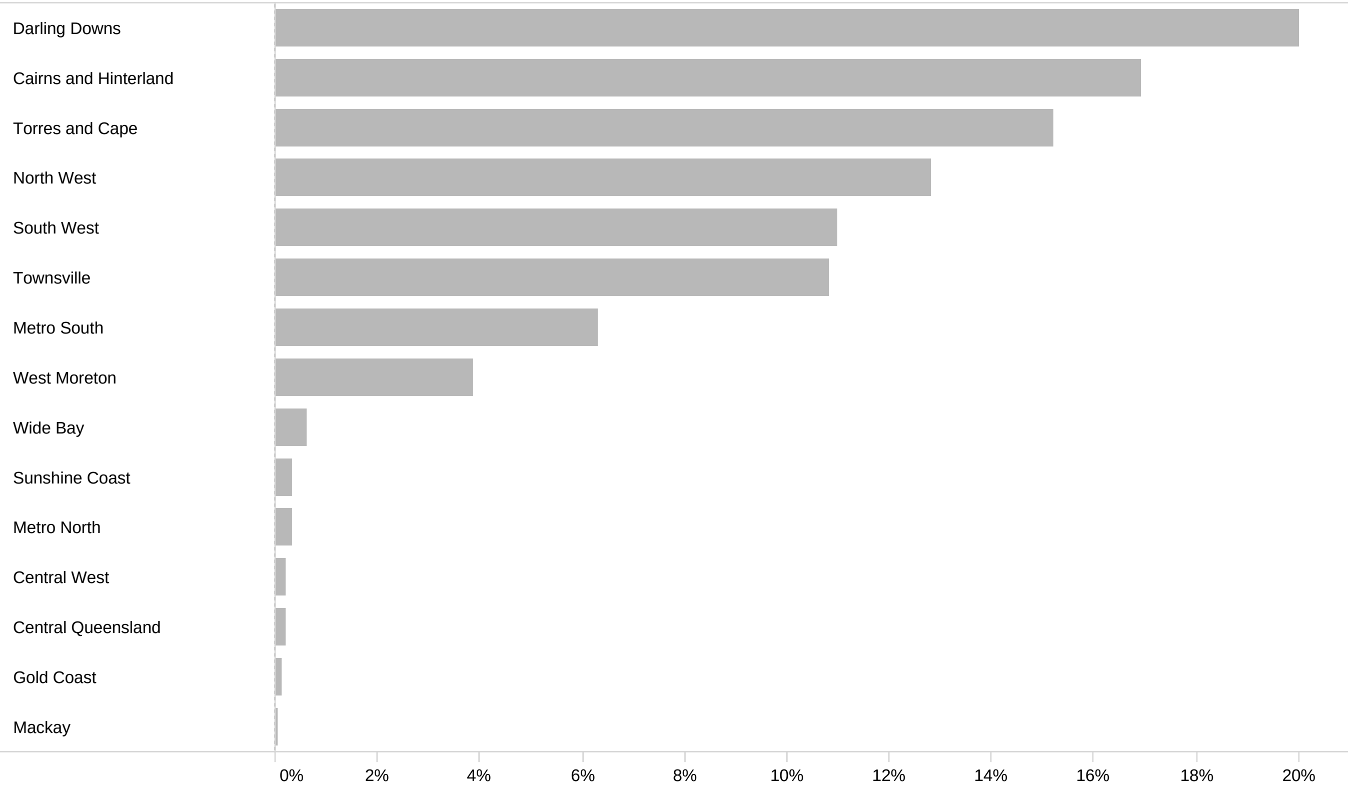


Figure 5: Proportion of patients seen by HHS of residence

Of the 6,336 total consults delivered as part of the NCS program, 38% of these consults were new encounters, which represents a large volume of clinical work and focus to establish patient rapport, assess often complex medical history, and formulate a plan of treatment and management. Over time the proportion of new to review patients has shifted with new patients representing 45% of consults in 2020 and 43% in 2021.

Table 8: Number and proportion of new and review cardiac outreach consults

Consult type	n (%)
New	2,391 (37.7)
Review	3,945 (62.3)
Total	**6,336 (100.0)**

Integrated outreach services are flexible and look to add value where opportunity presents. Opportunistic specialist review of inpatients while treating teams are in regional facilities allows for expert clinical treatment and efficient facilitation of treatment and escalation for transfer where appropriate. NCS teams are also instrumental in the organisation and provision of telehealth consultations which are performed both in clinic and in other non-clinic locations such as GP practices and other healthcare facilities. Due to the COVID-19 pandemic throughout 2020-2022 a large proportion of consultations were performed via telehealth (17%).

Table 9: Number and proportion of in person and telehealth consults by clinic mode

Delivery mode	Clinic n (%)	Non-clinic n (%)	ALL n (%)
In person	5,146 (97.5)	134 (2.5)	5,280 (83.3)
Telehealth	354 (33.5)	702 (66.5)	1,056 (16.7)
Total	**5,500 (86.8)**	**836 (13.2)**	**6,336 (100.0)**

The majority of patients seen in outreach resided less than 50 kilometres from their consult location (80%), demonstrating that cardiac outreach units are meeting their objective to provide care closer to home. A smaller proportion of patients (7%) still needed to travel more than 150 kilometres to access specialist care, which highlights the barriers to care and travel distances faced by Queenslanders living in regional and remote locations.

Table 10: Number and proportions of patients by driving distance to consult

Driving distance – home to consult	n (%)
≤50 km	5,094 (80.4)
50–100 km	661 (10.4)
100–150 km	146 (2.3)
>150 km	410 (6.5)
Incomplete data	25 (0.4)
Total	**6,336 (100.0)**

Outreach services offered large travel distance savings as a result of patients attending clinics at local spoke sites instead of travelling to the hub site. These values are determined by calculating the difference in driving distance between the patient's place of residence to the hub site and the patient's place of residence to the spoke site.

The largest travel distance savings per patient were observed in the cohort residing furthest from the cardiac outreach unit hub.

Table 11: Median patient travel distance avoided

Distance category	Median distance saved km
≤50 km	11
50–100 km	78
100–150 km	112
>150 km	472
Total	**216**

The ability to perform cardiac investigations on site at the time the patient attends the outreach clinic further demonstrates savings in travel, increases treatment efficiency due to immediate availability of information and decreases complexity of investigations for patients who often have significant barriers to care. The models of care employed at various units varies, and as such the ability to perform investigations within cardiac outreach clinics differs by unit and the spoke site being visited.

The most frequently performed investigation during outreach was 12 lead electrocardiography (ECG) followed by transthoracic echocardiography (TTE) – 3,681 and 1,559 investigations respectively.

Table 12: Investigations offered in outreach clinics

Cardiac outreach unit	Cardiology consults	12 lead ECG	TTE	CIED* interrogation	24 hour Holter ECG	Exercise stress test
Far North Queensland	✓	✓	✓	✓	✓	–
Townsville and North West Queensland	✓	✓	✓	–	–	–
Princess Alexandra Hospital	✓	✓	✓	✓	✓	✓
Toowoomba Hospital	✓	✓	✓	–	–	–
Redland Hospital	✓	✓	✓	–	–	–
Ipswich Hospital	✓	✓	✓	–	✓	–

* Cardiac implantable electronic device

Table 13: Number of investigations performed in outreach clinics

Investigation	n
12 lead ECG	3,681
Transthoracic echocardiogram	1,559
Cardiac implantable electronic device interrogation	62
24 hour Holter ECG monitor	23
Exercise stress test	16
Other	131
Total	**5,472**

8 Spotlight: COVID-19 pandemic

8.1 Introduction

Throughout 2022 health services in the state of Queensland were impacted by restrictions and changes to the way healthcare is provided due to the COVID-19 pandemic. Access to cardiac services was impacted with reductions in the number of some elective admissions and procedures as well as inpatient and outpatient diagnostic studies and outpatient consultations. Outpatient support services such as cardiac rehabilitation and heart failure support services were mainly affected toward the early part of 2022 with most services returning to normal, or more usual monthly volumes later in the year.

As health services began to adapt to "COVID normal", health service operations have largely returned to usual activity levels. Concomitantly, restrictions relating to the management of diagnosed cases of COVID-19, close contacts, public gatherings including work and social events, vaccinations and mask wearing were all gradually revoked in the latter part of 2022.

8.2 Procedure volumes

As the COVID-19 pandemic has progressed, the impacts on healthcare provision have changed from year to year and have had a varied effect on the different lines of cardiac services in Queensland.

Interventional cardiology

An overall reduction in cardiac catheterisation laboratory cases was observed in January 2022. At this time, reported cases of COVID-19 were rapidly increasing with associated load on health services. This combined with a usual reduction in elective cases during this period saw procedural volumes drop to the lowest monthly level in four years. Case volumes returned to pre-pandemic volumes by March 2022.

Total case volumes for all of 2022 decreased by 3.7% for PCI procedures when compared to the benchmark year of 2019. Similarly, case numbers for other diagnostic coronary procedures decreased with a 6.2% reduction compared to 2019.

Cardiac surgery

In 2022, there were 2,230 cardiac surgery procedures which was a decrease of 15% on 2021. A significant consideration in cardiac surgery is the requirement for an intensive care unit bed following the operation. With intensive care units being an integral part of the COVID-19 response, this was a well documented important factor effecting volumes of cardiac surgeries in 2022 compared to 2021.

Thoracic surgery

There was a 14% decrease in thoracic surgery cases performed in 2022 compared to 2021. This decrease is similar to the reduction noted for cardiac surgery likely indicating the similar challenges experienced across these surgical specialities.

Electrophysiology and pacing

Electrophysiology and pacing services saw a 14% growth in cases from 2019 to 2022 and a modest 0.7% increase from 2021 to 2022. A portion of this growth can be attributed to extra case detail captured for Toowoomba Hospital which was also evident in 2020. In 2022, there was again a small increase observed in the proportion of category 1 cases and also for elective cases when compared to 2021, however when compared to 2019, elective cases declined and the proportion of category 1 cases increased.

Table 1: Total cases for interventional cardiology, cardiac surgery, thoracic surgery and electrophysiology and pacing by year, 2019–2022

Service line	2019 n	2020 n	2021 n	2022 n
Interventional cardiology	5,002	4,966	4,894	4,818
Cardiac surgery	2,622	2,651	2,624	2,230
Thoracic surgery	1,042	1,093	1,067	918
Electrophysiology and pacing	4,654	5,201	5,269	5,305

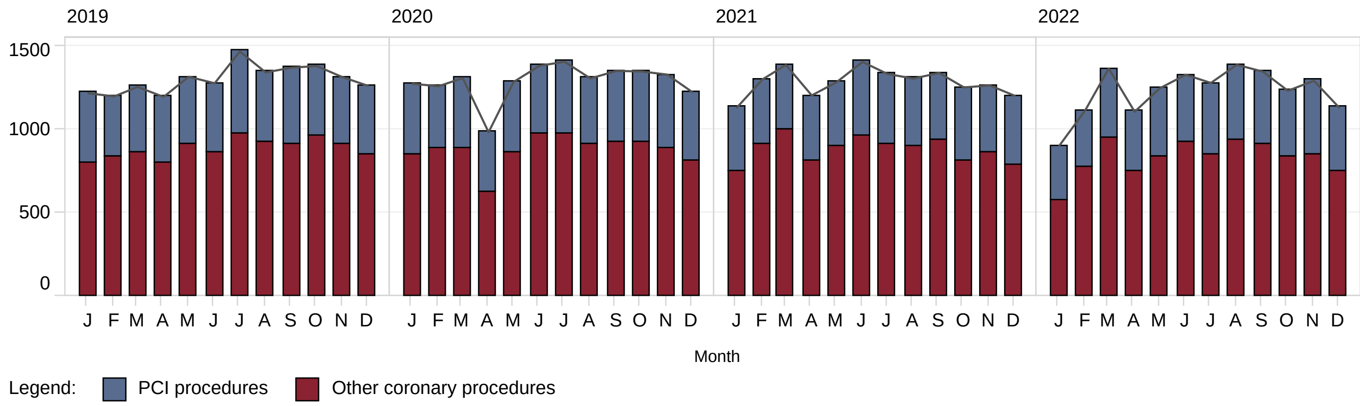


Figure 1: Proportion of all diagnostic and interventional cardiology cases by case category and month, 2019–2022

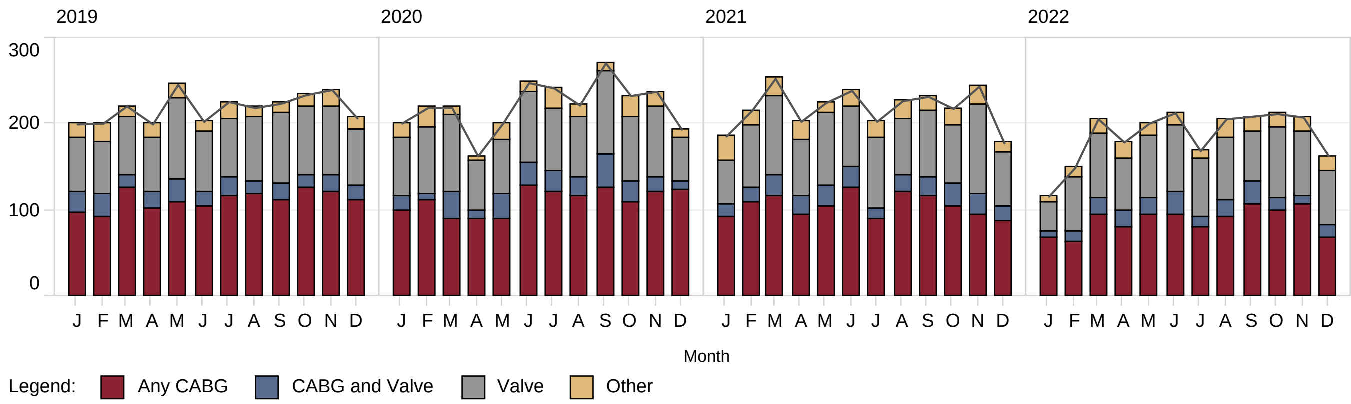


Figure 2: Proportion of all cardiac surgery cases by procedure category and month, 2019–2022

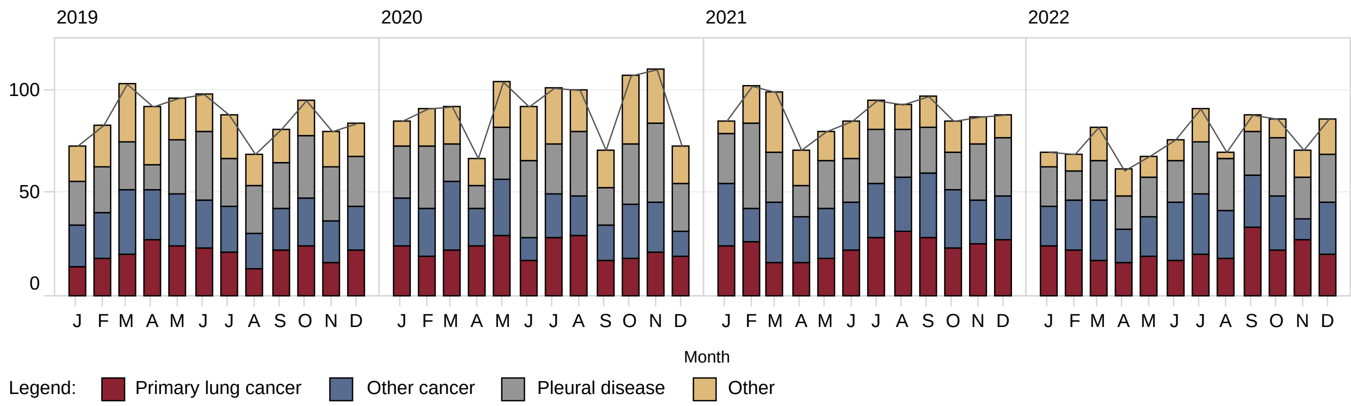


Figure 3: Proportion of all thoracic surgery cases by indication and month, 2019–2022

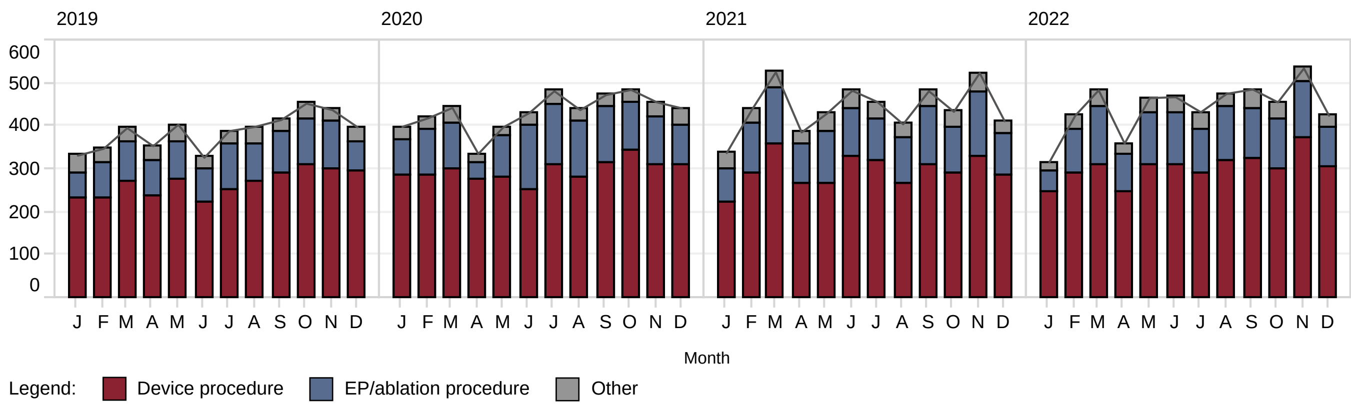


Figure 4: Proportion of all electrophysiology and pacing cases by procedure category and month, 2019–2022

8.3 Interstate and international patients

When examining the place of residence for patients undergoing cardiac interventions between 2019 and 2022, a notable decrease in the proportion of interstate and overseas patients was observed with a modest return to previous levels in 2022. The proportion of overseas patients reduced by over two thirds (0.7% to 0.2%). This is reflective of travel restrictions in place, limiting international and interstate travel for a large part of 2020 to 2022. The proportion of interstate patients reduced from 5.7% to 4.0% at the lowest point. In 2022, proportions began to once again increase.

Table 2: Patient place of residence at time of procedure, 2019–2022

Service line	2019 %	2020 %	2021 %	2022 %
Queensland	93.6	95.1	95.8	94.6
Interstate	5.7	4.5	4.0	4.8
Overseas	0.7	0.4	0.2	0.4

Excludes missing data (0.1%)

8.4 Admission status

There was a reduced proportion of elective procedures and category 3 procedures observed across all service lines from 2019 to 2022. In 2022, elective cardiac surgery cases fell to the lowest levels observed during the pandemic with a 15% decrease compared to 2019. Concurrently, there was an increase in the proportion of urgent cardiac surgery cases performed. This was similarly the case for interventional cardiology procedures, though without as marked a change in urgent procedures. Thoracic surgery cases also decreased by 11.9% compared to 2019 with a sustained increase in the proportions of emergent cases in 2021 and 2022 compared to previous years.

Table 3: Procedure status for interventional cardiology, cardiac surgery, thoracic surgery and electrophysiology and pacing by year, 2019–2022

Service line	2019	2020	2021	2022
Interventional cardiology, n	5,002	4,966	4,894	4,818
Elective, n (%)	1,094 (21.9)	1,059 (21.3)	1,055 (21.6)	977 (20.3)
Urgent, n (%)	2,719 (54.3)	2,585 (52.1)	2,568 (52.5)	2,588 (53.7)
Emergent, n (%)	1,104 (22.1)	1,252 (25.2)	1,174 (24.0)	1,156 (24.0)
Salvage, n (%)	87 (1.7)	70 (1.4)	91 (1.9)	97 (2.0)
Cardiac surgery, n	2,622	2,651	2,624	2,230
Elective, n (%)	1,523 (58.1)	1,472 (55.5)	1,432 (54.6)	1,103 (49.5)
Urgent, n (%)	913 (34.8)	990 (37.3)	970 (37.0)	928 (41.6)
Emergent, n (%)	169 (6.4)	185 (7.0)	211 (8.0)	191 (8.6)
Salvage, n (%)	17 (0.6)	4 (0.2)	10 (0.4)	8 (0.4)
Thoracic surgery, n	1,042	1,093	1,067	918
Elective, n (%)	730 (70.1)	719 (65.8)	734 (68.8)	631 (68.7)
Urgent, n (%)	254 (24.4)	282 (25.8)	131 (12.3)	186 (20.3)
Emergent, n (%)	58 (5.6)	92 (8.4)	202 (18.9)	101 (11.0)
Electrophysiology and pacing, n	4,654*	5,201†	5,269‡	5,305§
Category 1, n (%)	2,636 (56.6)	3,051 (58.7)	3,123 (59.3)	3034 (61.2)
Category 2, n (%)	1,143 (24.6)	1,365 (26.2)	1,377 (26.1)	1423 (28.7)
Category 3, n (%)	548 (11.8)	459 (8.8)	487 (9.2)	500 (10.1)

Category 1: Clinically indicated within 30 days
Category 2: Clinically indicated within 90 days
Category 3: Clinically indicated within 365 days

* 7.0% missing data
† 6.3% missing data
‡ 5.4% missing data
§ 8.0% missing data

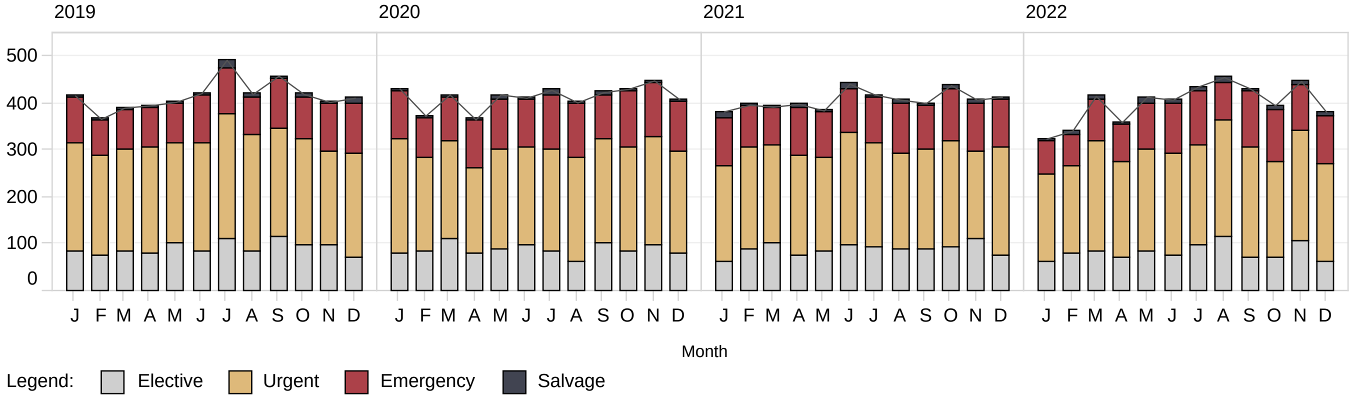


Figure 5: Proportion of all interventional cardiology cases by admission status and month, 2019–2022

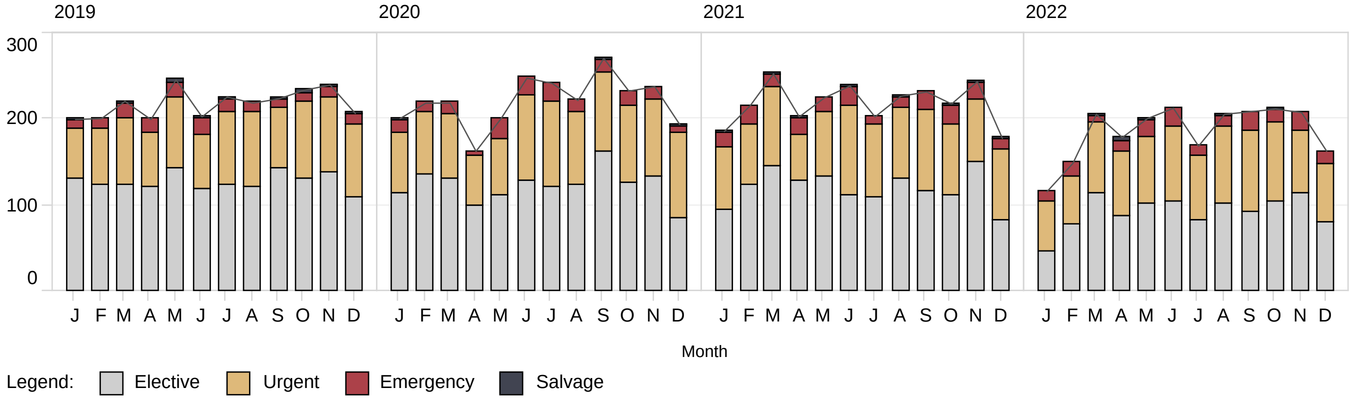


Figure 6: Proportion of all cardiac surgery cases by admission status and month, 2019–2022

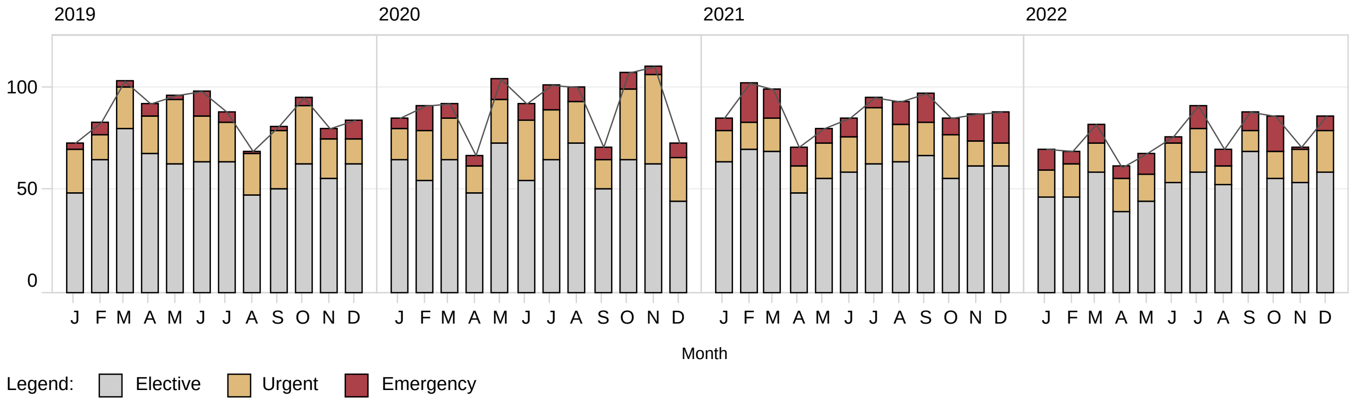
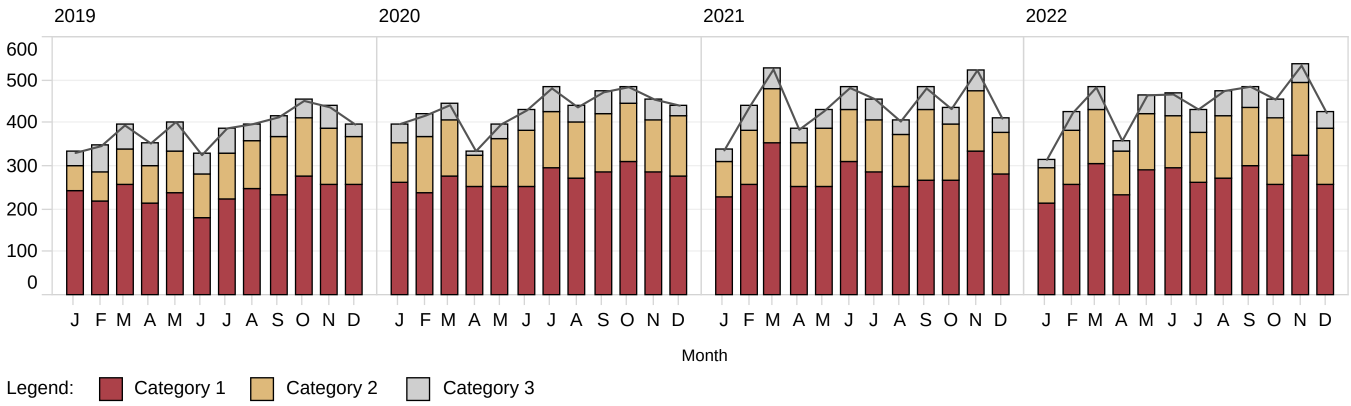


Figure 7: Proportion of all thoracic surgery cases by admission status and month, 2019–2022



Note: imputed missing data

Figure 8: Proportion of all electrophysiology and pacing cases by urgency status and month, 2019–2022

8.5 Outpatient support services

Cardiac rehabilitation services across the state were subject to disruption due to resources being redistributed to support the state's COVID-19 response. The overall number of referrals in 2022 was less than 2019, 2020 and 2021 with a total of 9,317 referrals, 19.3% less than 2019.

Heart failure support services showed a 19.7% increase in referrals received in 2022 compared to 2019. The impacts on heart failure support services appear to have been limited.

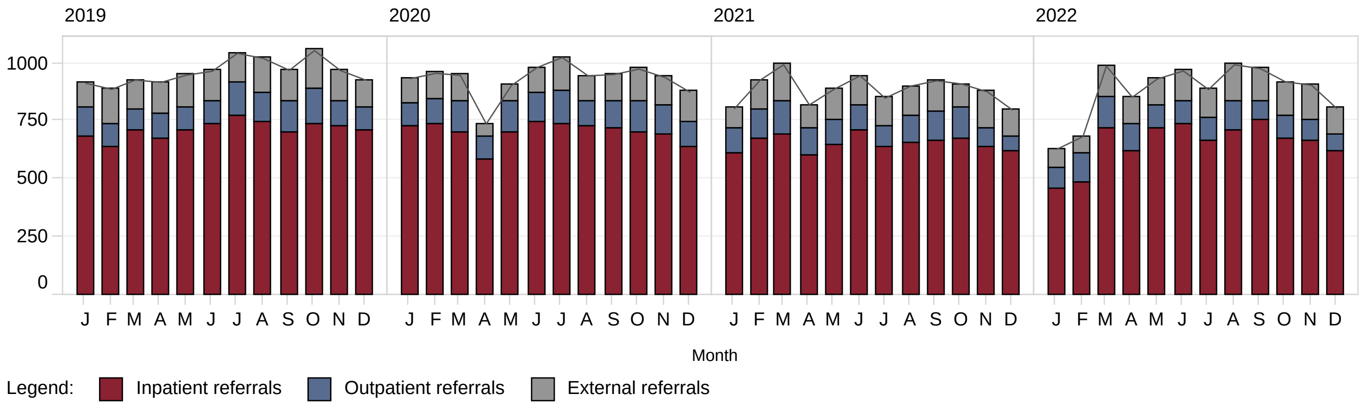


Figure 9: Cardiac rehabilitation referral source, 2019–2022

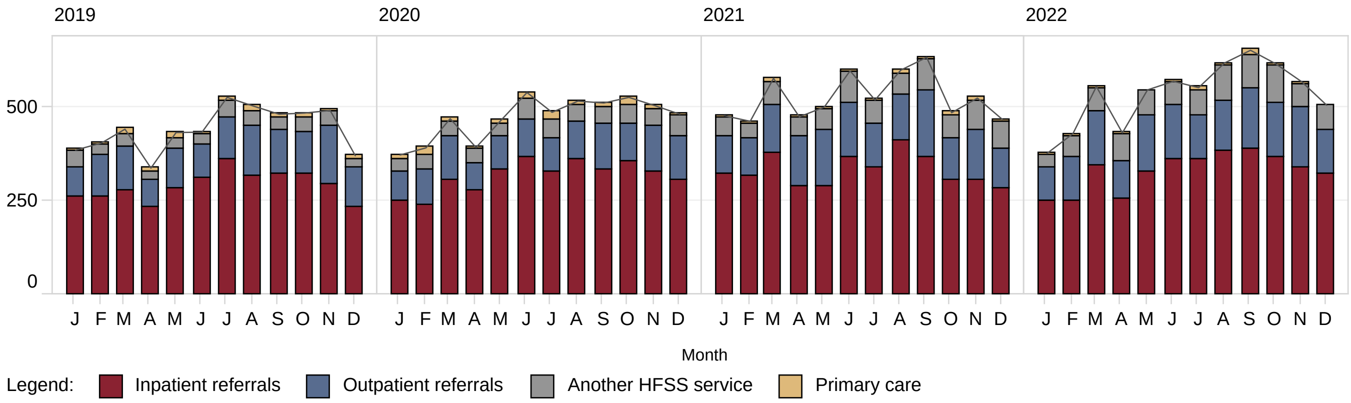


Figure 10: Heart failure support services referral source, 2019–2022

Table 4: Outpatient support services referral volumes, 2019–2022

Service line	2019 n	2020 n	2021 n	2022 n
Cardiac rehabilitation	11,547	11,177	10,647	9,317
Heart failure support services	5,304	5,664	6,326	6,438

8.6 Clinical performance indicators

Key clinical performance indicators for Queensland cardiac services in 2022 were largely similar to the previous year. It is difficult to draw conclusions as any impact is likely to be multifactorial. These issues are examined in more detail in the relevant sections of this report.

Table 5: Performance measures for interventional cardiology, electrophysiology and pacing, cardiac rehabilitation and heart failure support services by year, 2019–2022

Service line	2019	2020	2021	2022
Interventional cardiology				
Proportion of STEMI* patients presenting within six hours of symptom onset who received an intervention within 90 minutes of first diagnostic ECG (%)	65	67	63	58
Proportion of STEMI* patients with arrival at PCI facility to first device time less than 60 minutes (%)	70	70	74	69
Proportion of all NSTEMI† patients who received angiography within 72 hours of first hospital admission (%)	60	69	69	67
Electrophysiology and pacing				
Median wait time for elective pacemaker implantation (days)	21	3	2	13
Median wait time for elective ICD‡ implantation (days)	32	36	21	21
Median wait time for elective standard ablation (days)	117	99	99	99
Median wait time for elective complex ablation (days)	65	104	78	88
Cardiac rehabilitation				
Timely referral – documented referral to CR within three days of discharge (%)	94	93	93	92
Timely assessment (inpatients) – initial CR pre assessment completed within 28 days of discharge date (%)	59	62	64	58
Timely assessment (non acute patients) – proportion of CR patients completing a CR pre assessment within 28 days of referral date (%)	61	57	61	64
Timely journey (inpatients) – composite of timely referral and assessment (%)	56	58	59	53
Heart failure support services				
Follow-up of acute patients within two weeks (%)	79	80	78	79
Follow-up of non acute patients within four weeks (%)	82	84	84	79
Assessment of left ventricular ejection fraction within two years (%)	96	96	97	98
ACEI/ARB§ or ARNI|| prescription at hospital discharge (%)	92	92	91	92
ACEI/ARB§ or ARNI|| at first clinical review (%)	90	92	92	93
Beta blocker prescription at hospital discharge (%)	89	92	90	91
Beta blocker prescription at first clinical review (%)	91	92	92	92
Prescription of MRA# for HFrEF** at time of hospital discharge (%)	45	46	51	58
Prescription of MRA# for HFrEF** at time of first HFSS clinical review (%)	43	46	51	58
Beta blocker titration status review at six months post referral (%)	67	75	79	74
Beta blocker achievement of guideline recommended target (%)	35	32	31	27
Beta blocker achievement of guideline recommended target dose or maximum tolerated dose (%)	75	77	80	72

* ST-elevation myocardial infarction

† Non-ST-elevation myocardial infarction

‡ Implantable cardioverter defibrillator

§ Angiotensin converting enzyme inhibitor/angiotensin II receptor blocker

|| Angiotensin receptor-neprilysin inhibitor

\# Mineralocorticoid receptor antagonists

** Heart failure with reduced ejection fraction

9 Spotlight: Cardiac genomics

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

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

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

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

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

9.1 Service rationale

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

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

9.2 Service description

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

- Cardiomyopathy
- Arrhythmia
- Aortopathy
- Familial hypercholesterolaemia

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

Appointments are divided into three pathways:

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

9.3 Service components

Pre-clinic intake

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

New patient consultation

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

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

Genetic testing

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

Multidisciplinary team meeting (MDT)

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

Results appointment

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

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

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

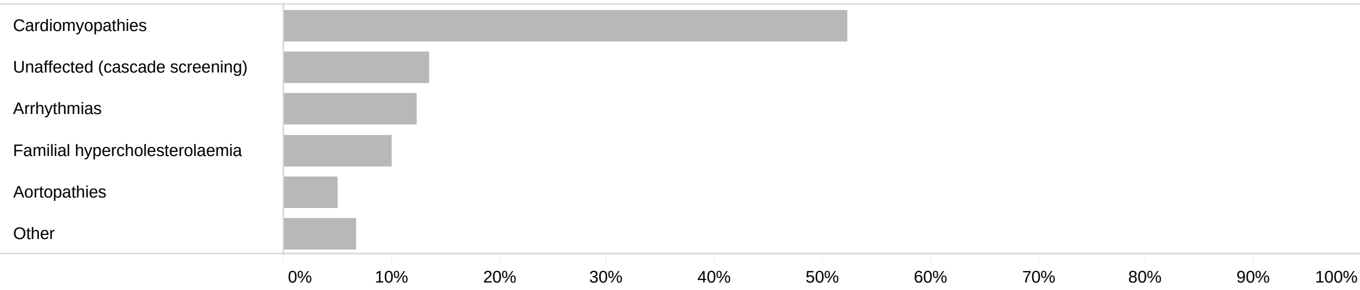


Figure 1: Proportion of cardiac genomics referrals by diagnosis, 2022

Table 1: Cardiology cardiac referrals by condition, 2022

Referral diagnosis	n (%)
Aortopathies	9 (5.1)
Arrhythmias	
Brugada syndrome	3 (1.7)
Catecholaminergic polymorphic ventricular tachycardia	3 (1.7)
Long QT syndrome	16 (9.0)
Cardiomyopathies	
Arrhythmogenic cardiomyopathy	9 (5.1)
Dilated cardiomyopathy	38 (21.3)
Hypertrophic cardiomyopathy	44 (24.7)
Left ventricular non-compaction	2 (1.1)
Familial hypercholesterolaemia	18 (10.1)
Other	12 (6.7)
Unaffected (cascade screening)	24 (13.5)
ALL	**178 (100.0)**

9.4 Evaluation

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

The outcomes of the evaluation demonstrated the following results:

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

9.5 Collaboration with QCOR

Queensland clinicians have collaborated with QCOR to develop and implement a bespoke application for cardiac genetic consultations, testing and management, allowing data to be recorded across the patient journey. As of 2023, the QCOR cardiac genomics application has been deployed in all four public hospitals offering cardiac genetics services. The new system enables streamlined data collection, enhances clinical care delivery and allows clinicians to produce clinically relevant comprehensive documentation to form part of the patient medical record.

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

Interventional Cardiology Audit

1 Message from the Interventional Cardiology Committee Chair

I am delighted to introduce the 2022 QCOR Interventional Cardiology Audit, the ninth edition of its kind. Despite the challenging and exceptional circumstances that the healthcare system in Queensland faced in 2022, it once again highlighted the outstanding quality of care our health system can deliver.

The ongoing and rapidly evolving impacts of the COVID-19 pandemic have required cardiology departments across the state to remain flexible and adapt with varying approaches at different times and within Hospital and Health Services. However, it is reassuring to know that even in the face of the pressures and challenges posed by the pandemic, the provision of care to Queenslanders continues to meet exceptionally high standards. Clinical indicators and all outcome measures either remain stable, show improvement, or surpass established benchmarks.

Interventional cardiology services operate in a dynamic and ever-changing environment, often strained by the growing needs of the community and the complexity of the healthcare landscape. This challenge presents an opportunity to embrace, drive, and apply the use of data. The data presented in this and previous reports have proven invaluable in advancing public cardiology services in Queensland by informing business cases for new services and aiding in future planning to fortify the healthcare system.

Access to high-quality, real-time data has never been more crucial for healthcare provision. Thanks to the dedicated efforts of clinicians, data managers, and the QCOR team, the reporting of clinical quality and care process indicators continues to become more readily available to stakeholders responsible for monitoring and enhancing care. With a commitment to quality and relevance at its core, this new functionality will further enhance clinical care and performance.

In this Audit, QCOR has continued to expand by incorporating for the first time, data from Ipswich Hospital. Although only diagnostics procedures are included, we look forward to incorporating another public facility into the QCOR clinical quality program. An important part of the process for establishing new services is establishing systems that ensure patient care is always at the forefront. The analysis provided by QCOR, both in the form of this Audit and via high availability, on demand reporting guarantees a level of insight that would not otherwise be available.

Looking ahead, we eagerly anticipate the introduction of a modern statewide cardiovascular information system for diagnostic and interventional cardiology and echocardiography services. This generational opportunity has already progressed rapidly toward its goal to enhance data collection for cardiology in Queensland and enable the reporting of new quality metrics and indicators, while providing a valuable clinical tool for information sharing and quality improvement.

These efforts reflect a comprehensive approach to ensuring quality and safe cardiac care for all Queenslanders. We continue to collaborate with national registries to leverage the insights gained in Queensland to advance these high-value initiatives. There are numerous synergies in this space that allow all participants to learn from one another and apply these lessons to their local jurisdictions.

Dr Rohan Poulter
Chair
QCOR Interventional Cardiology Committee

2 Key findings

The Interventional Cardiology Audit describes key aspects of the care and treatment of cardiac patients receiving percutaneous coronary interventions (PCI) during 2022.

Key findings include:

- 14,864 diagnostic coronary or interventional cases were performed across the nine cardiac catheterisation laboratory (CCL) facilities in Queensland public hospitals, including 4,818 PCI cases.
- 76% of all PCI patients residing in Queensland had a place of residence within 50 km of the nearest public PCI capable facility, while 12% 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 (BMI) over 25 kg/m^2.
- The proportion of patients identified as Aboriginal and Torres Strait Islander (7.6%) 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 (80%) were classed as urgent, emergent or salvage, highlighting the acute and often unstable patient cohort.
- There were 1,506 PCI cases following presentation with ST elevation myocardial infarction (STEMI), of which 59% were managed by primary PCI.
- There was a total of 414 thrombolysed STEMI presentations, for whom the median time from first diagnostic electrocardiograph (ECG) to the administration of thrombolysis was 40 minutes. The median time from thrombolysis to coronary angiography was 13 hours, with 74% 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 85 minutes (range 74 minutes to 97 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 59 minutes across sites).
- PCI for non-ST elevation myocardial infarction (NSTEMI) represented 32% of all cases, with the median time to angiography of 48 hours. Patients presenting to a non PCI capable facility have a median wait time to coronary angiography of 40 hours longer than those who present directly to a PCI capable facility (70 hours vs. 30 hours).
- Mortality within 30 days following PCI was 2.2% (107 deaths). Of these 107 deaths, 70% were classed as either salvage or emergency PCI.
- Of all cases, 0.93% 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 98.8% of PCI cases across all sites and 100% of other coronary procedures.

3 Participating sites

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

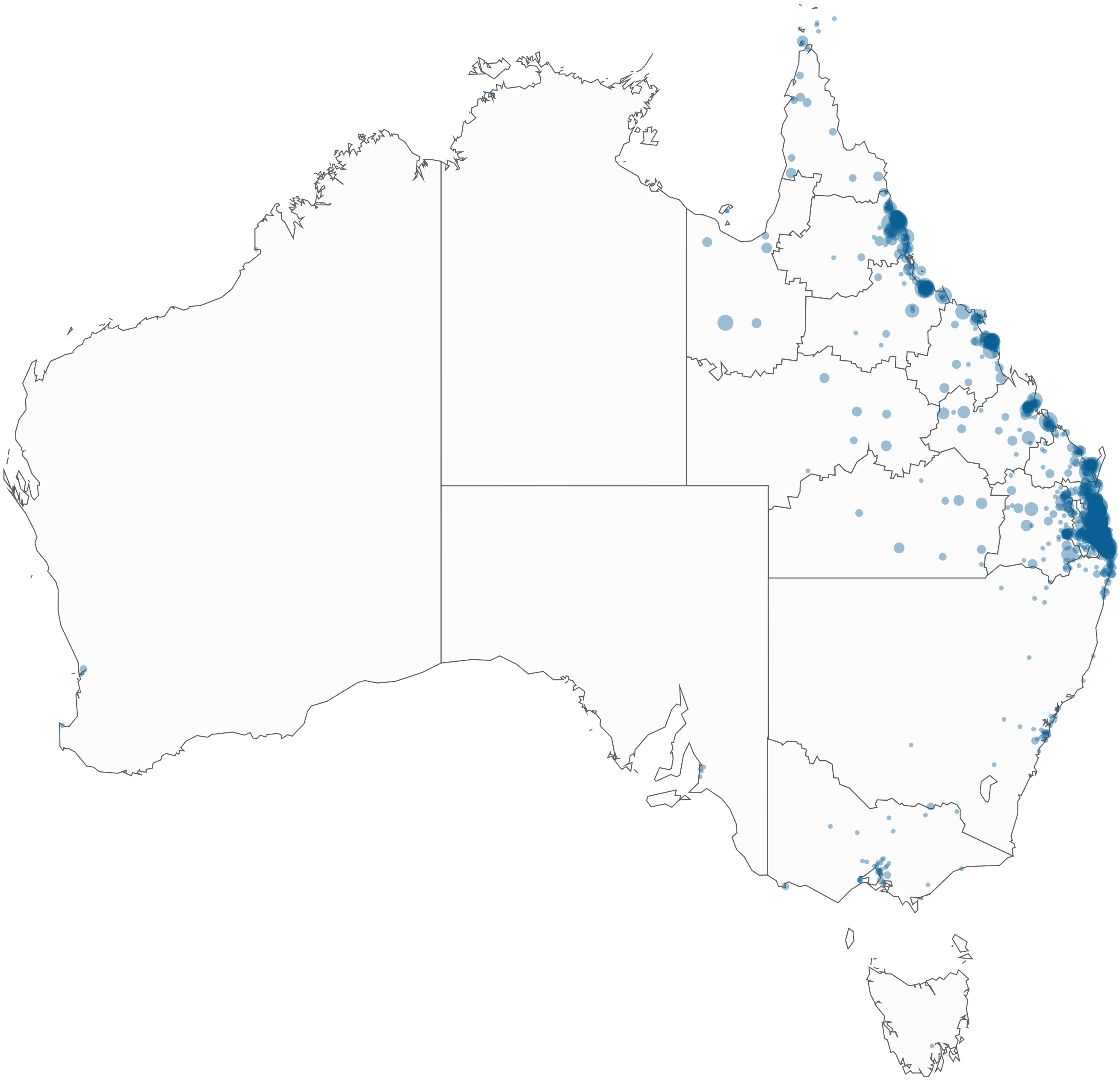


Figure 1: Statewide PCI cases by patient place of usual residence (by residential postcode)

Table 1: Participating sites

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

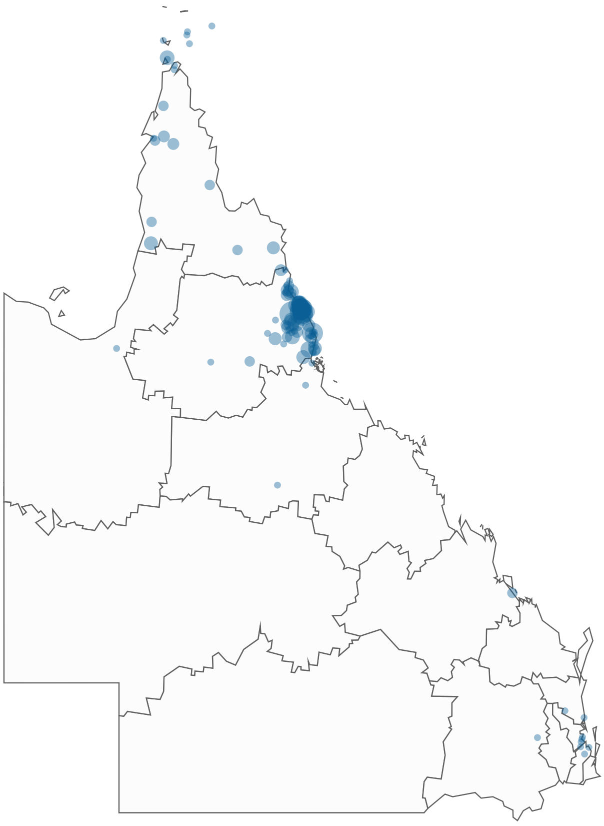


Figure 2: Cairns Hospital

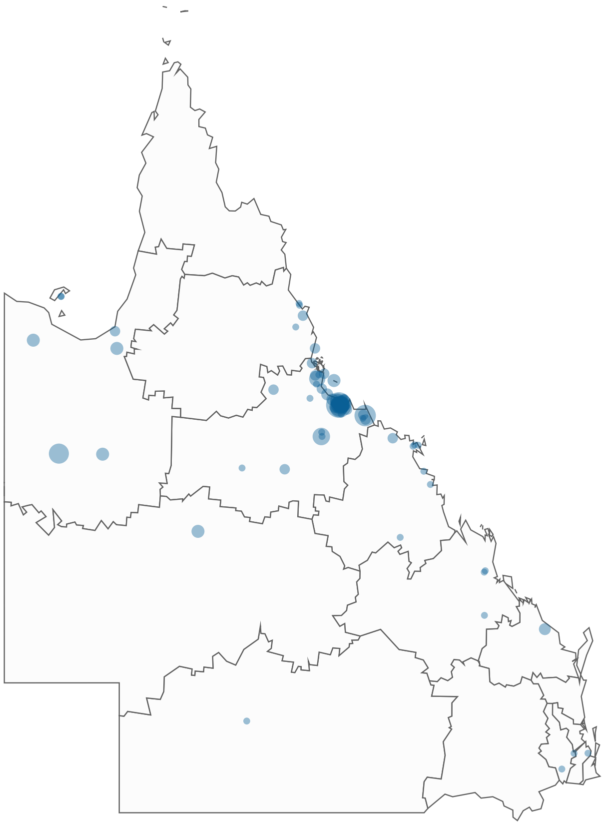


Figure 3: Townsville University Hospital

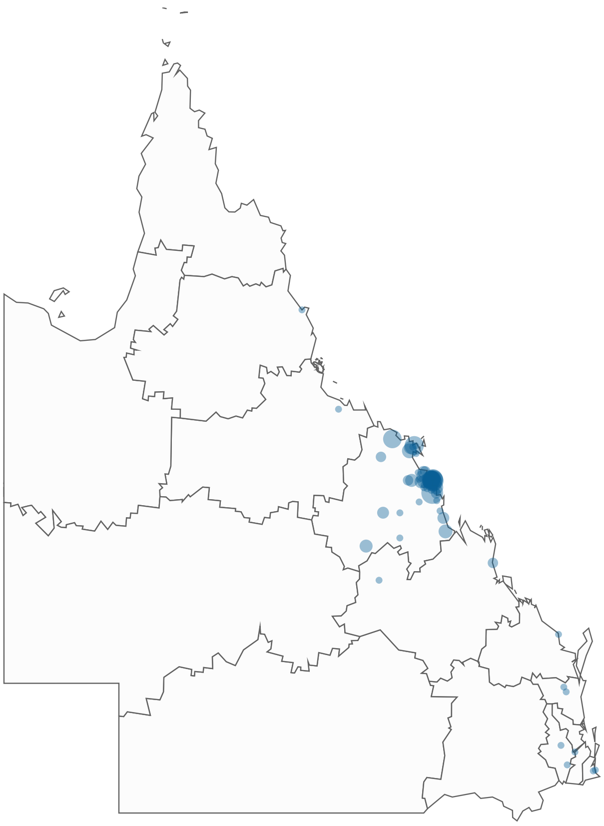


Figure 4: Mackay Base Hospital

Figure 5: Sunshine Coast University Hospital

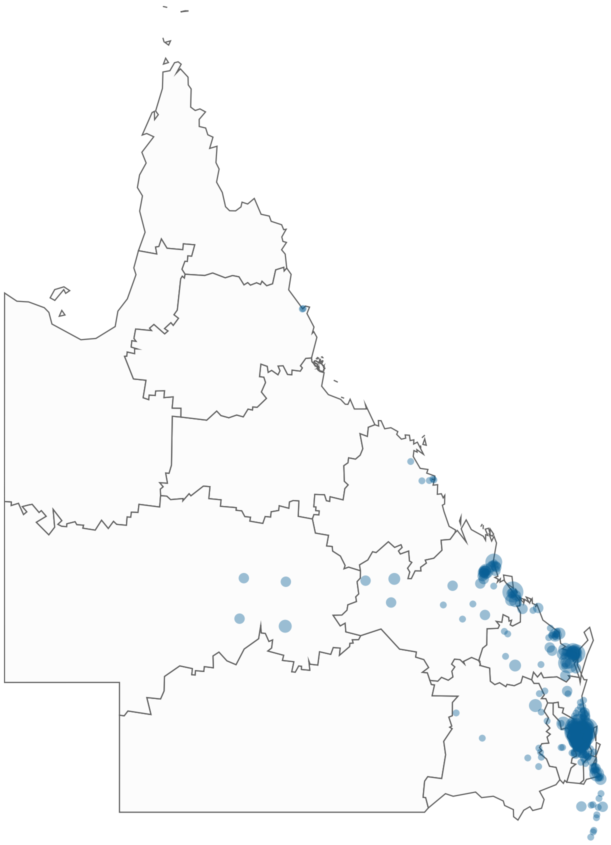


Figure 6: The Prince Charles Hospital

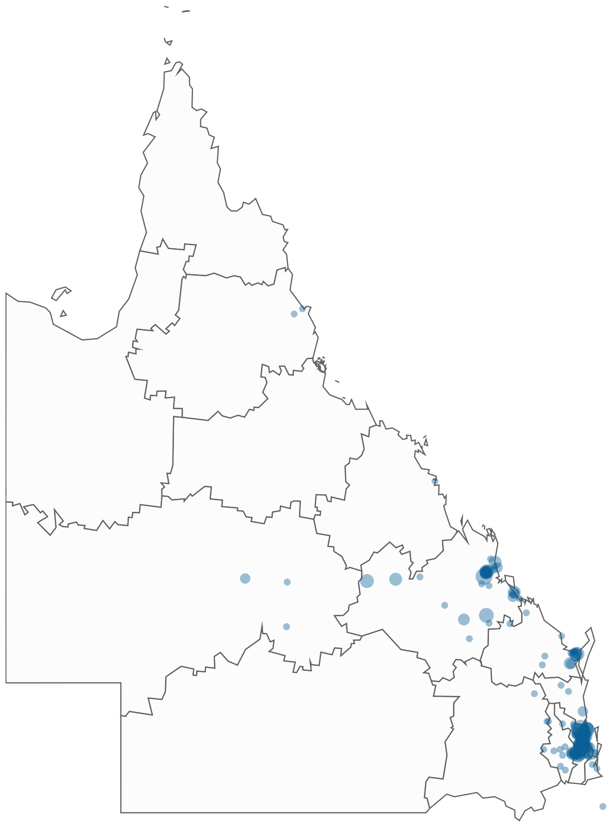


Figure 7: Royal Brisbane & Women's Hospital

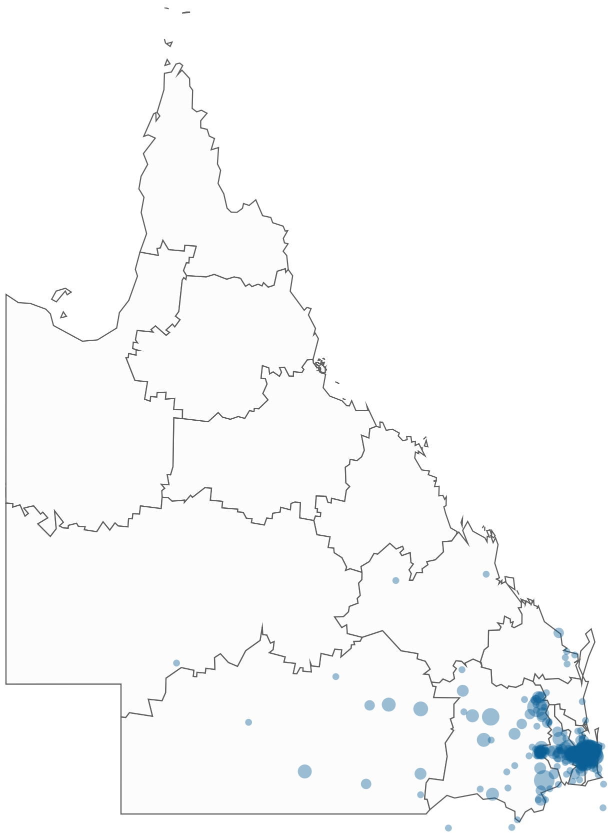


Figure 8: Princess Alexandra Hospital

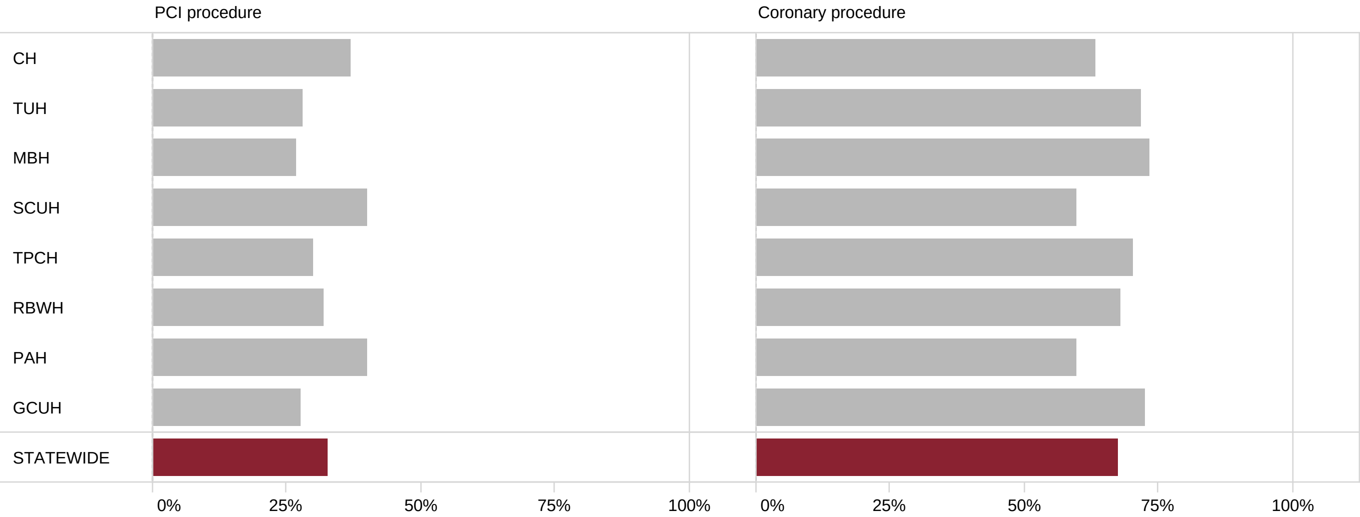
Figure 9: Gold Coast University Hospital

4 Total coronary cases

A total of 14,864 coronary cases were performed across the nine contributing cardiac catheterisation sites, with 4,818 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 485 structural heart disease interventions including percutaneous valve replacement, valvuloplasty and device closure procedures is included as a supplement to this Audit. Furthermore, Queensland electrophysiology and pacing procedure activity is included in a separate Audit within the QCOR Annual Report.



Excludes Ipswich Hospital coronary procedures

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	521 (36.7)	897 (63.3)	1,418
TUH	328 (28.1)	841 (71.9)	1,169
MBH	274 (26.7)	753 (73.3)	1,027
SCUH	482 (40.1)	720 (59.9)	1,202
TPCH	1,086 (29.8)	2,562 (70.2)	3,648
RBWH	439 (32.0)	935 (68.0)	1,374
PAH	1,058 (40.1)	1,580 (59.9)	2,638
IPH	–	95 (100.0)	95
GCUH	630 (27.5)	1,663 (72.5)	2,293
STATEWIDE	**4,818 (32.0)**	**10,046 (68.0)**	**14,864**

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

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

4.1 Total cases by clinical presentation

Within the larger cohort, the most common presentation category was of NSTEMI, while STEMI cases represented 13% of all cases, and 31% 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 (35%). The majority of PCI procedures undertaken were categorised as either STEMI or NSTEMI (63%).

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	166 (11.7)	327 (23.1)	925 (65.2)
TUH	163 (13.9)	242 (20.7)	764 (65.4)
MBH	69 (6.7)	156 (15.2)	802 (78.1)
SCUH	205 (17.1)	300 (25.0)	697 (58.0)
TPCH	383 (10.5)	712 (19.5)	2,553 (70.0)
RBWH	150 (10.9)	370 (26.9)	854 (62.2)
PAH	464 (17.6)	829 (31.4)	1,345 (51.0)
GCUH	297 (13.0)	329 (14.3)	1,667 (72.7)
STATEWIDE	**1,897 (12.8)**	**3,265 (22.1)**	**9,607 (65.0)**

Table 4: PCI cases by clinical presentation category

Site	STEMI n (%)	NSTEMI n (%)	Other n (%)
CH	133 (25.5)	194 (37.2)	194 (37.2)
TUH	122 (37.2)	76 (23.2)	130 (39.6)
MBH	62 (22.6)	63 (23.0)	149 (54.4)
SCUH	165 (34.2)	135 (28.0)	182 (37.8)
TPCH	315 (29.0)	338 (31.1)	433 (39.9)
RBWH	118 (26.9)	185 (42.1)	136 (31.0)
PAH	354 (33.5)	405 (38.3)	299 (28.3)
GCUH	237 (37.6)	150 (23.8)	243 (38.6)
STATEWIDE	**1,506 (31.3)**	**1,546 (32.1)**	**1,766 (36.7)**

4.2 Place of residence

The vast majority of PCI patients (96%) 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, 15% of cases originated from outside of Queensland.

Patients came from a wide geographical area with a large proportion of patients residing on the Eastern Seaboard. Almost three quarters (71%) 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	95.6	84.7	3.5	1.0
TUH	99.1	80.8	0.9	–
MBH	98.9	94.2	1.1	–
SCUH	96.3	86.3	3.1	0.6
TPCH	96.9	64.9	2.6	0.6
RBWH	95.2	49.8	3.7	1.1
PAH	97.9	58.6	1.3	0.8
GCUH	85.1	80.4	13.4	1.6
STATEWIDE	**95.5**	**71.2**	**3.8**	**0.8**

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	67.1	23.6	9.3
TUH	64.6	20.0	15.4
MBH	73.1	17.3	9.6
SCUH	74.4	23.4	2.2
TPCH	75.2	5.0	19.8
RBWH	69.9	3.6	26.5
PAH	77.1	15.1	7.8
GCUH	99.4	0.2	0.4
STATEWIDE	**76.1**	**12.2**	**11.6**

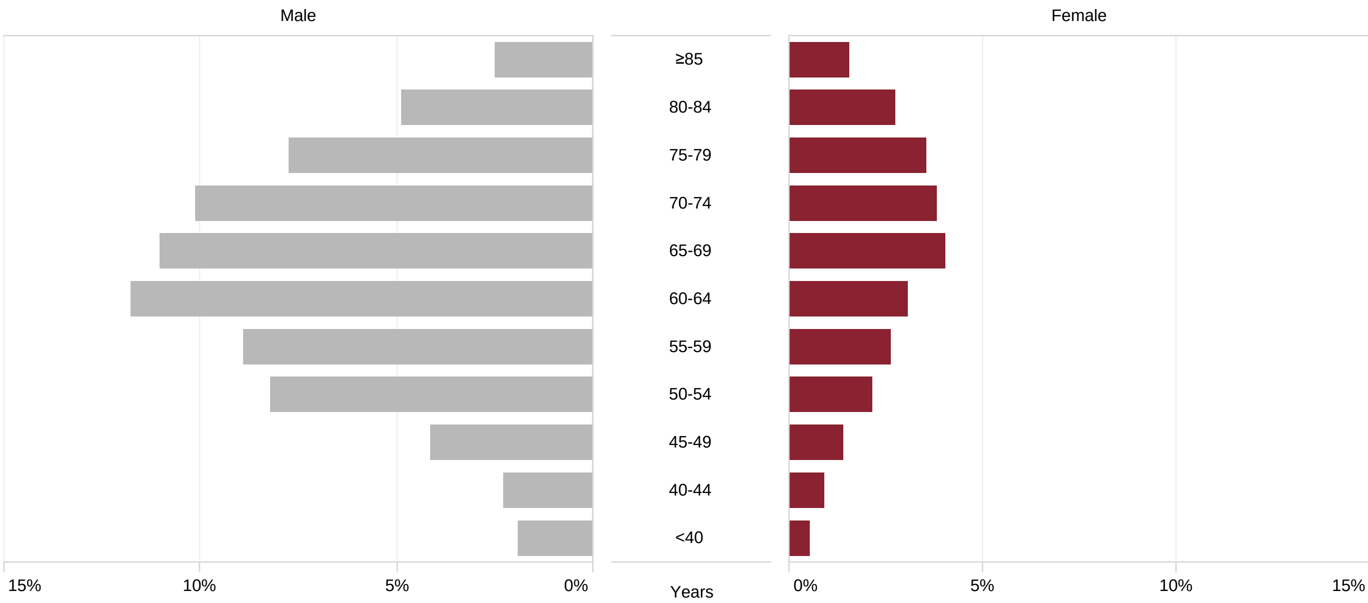
Excludes missing data (0.4%)

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 66 years of age and ranged from 62 years to 68 years across sites.

The majority of patients were male (74%), which reflects the increased risk of cardiovascular disease by gender. The median age for females was also higher than for males (68 years vs. 65 years).



% of total PCI (n=4,818)

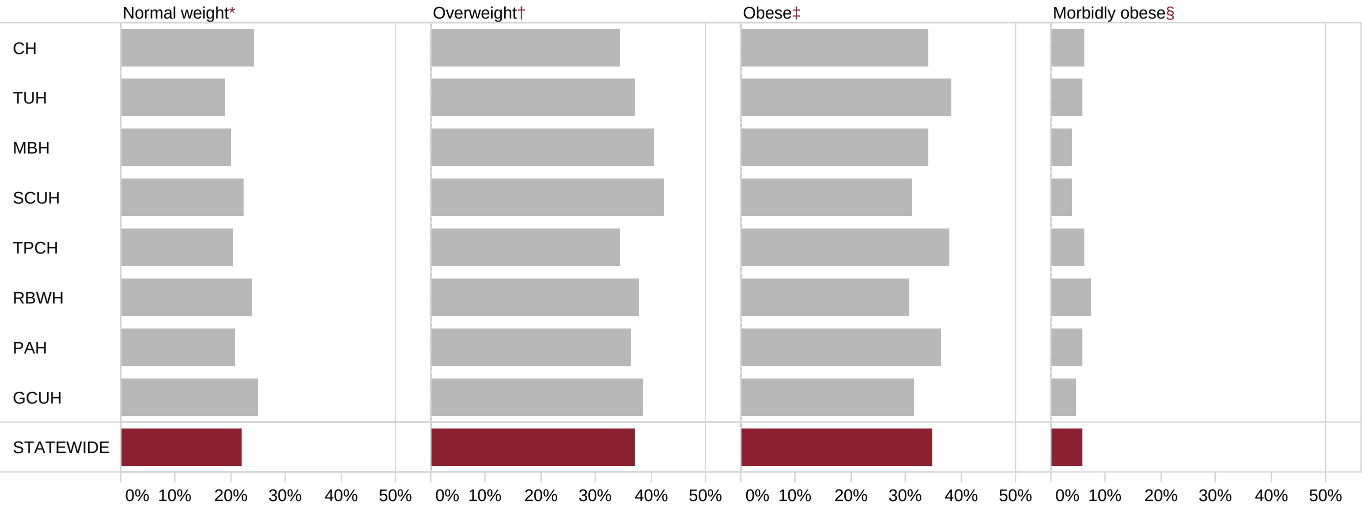
Figure 11: Proportion of all PCI cases by gender and age group

Table 7: Median PCI patient age by gender and site

Site	Male years	Female years	ALL years
CH	65	64	65
TUH	63	59	62
MBH	66	68	66
SCUH	67	71	68
TPCH	67	71	68
RBWH	63	67	64
PAH	62	67	64
GCUH	66	68	66
STATEWIDE	**65**	**68**	**66**

5.2 Body mass index

Patients across all sites displayed similar trends for BMI, with approximately one fifth of patients (22%) in the normal BMI range and 37%, 35% and 6% classified as overweight, obese and morbidly obese respectively. There were 1% of cases classified as underweight (BMI <18.5 kg/m²).



Excludes missing/invalid data (<0.1%)

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

Table 8: All PCI cases by body mass index category

Site	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Morbidly obese n (%)
CH	9 (1.7)	125 (24.0)	179 (34.4)	177 (34.0)	31 (6.0)
TUH	1 (0.3)	62 (18.9)	121 (36.9)	125 (38.1)	19 (5.8)
MBH	5 (1.8)	55 (20.1)	111 (40.5)	93 (33.9)	10 (3.6)
SCUH	3 (0.6)	108 (22.4)	203 (42.1)	149 (30.9)	19 (3.9)
TPCH	15 (1.4)	221 (20.4)	372 (34.3)	410 (37.8)	67 (6.2)
RBWH	4 (0.9)	104 (23.7)	165 (37.7)	134 (30.6)	31 (7.1)
PAH	9 (0.9)	219 (20.7)	384 (36.4)	384 (36.4)	60 (5.7)
GCUH	5 (0.8)	156 (24.8)	243 (38.6)	198 (31.4)	28 (4.4)
STATEWIDE	**51 (1.1)**	**1,050 (21.8)**	**1,778 (36.9)**	**1,670 (34.7)**	**265 (5.5)**

Excludes missing data (<0.1%)

5.3 Aboriginal and Torres Strait Islander status

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

The increased proportion of identified Aboriginal and Torres Strait Islander patients undergoing PCI in the northern HHSs (CH, 23% and TUH, 19%) is reflective of the resident population within these areas and should be noted for service provision and planning.

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

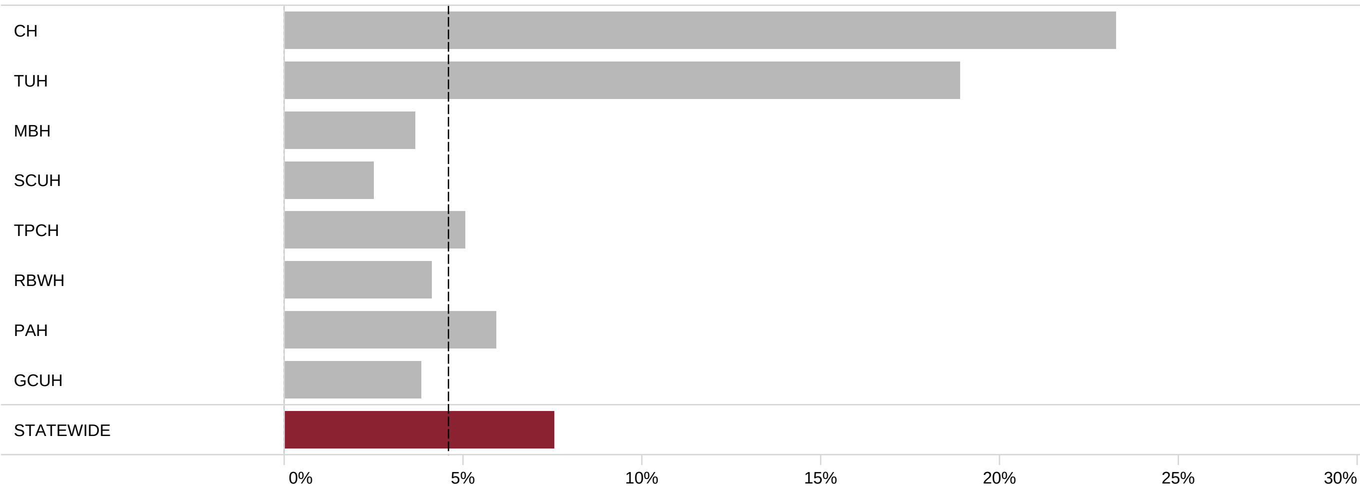


Figure 13: Proportion of all PCI cases by identified Aboriginal and Torres Strait Islander status

The median age of Aboriginal and Torres Strait Islander patients undergoing PCI was lower than that of non Aboriginal and Torres Strait Islander patients (56 years vs. 67 years).

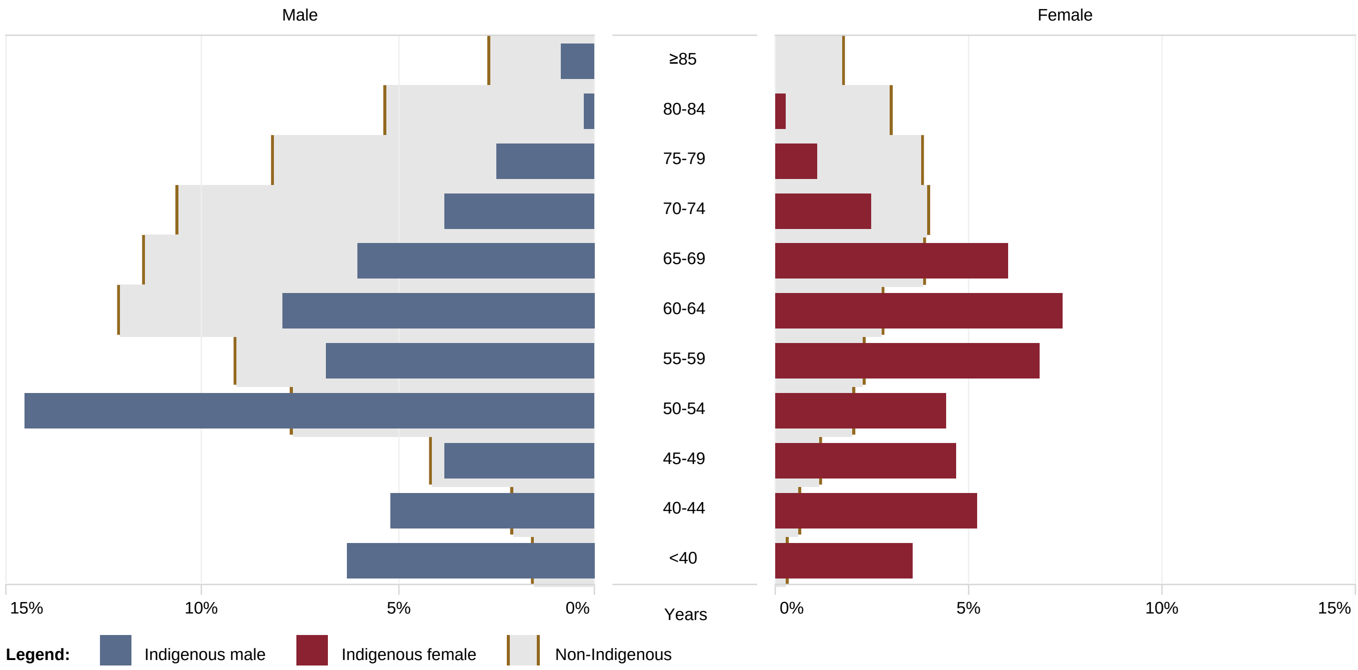


Figure 14: Proportion of all PCI cases by age group and Indigenous status

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

	Male years	Female years	ALL years
Aboriginal and Torres Strait Islander	55	57	56
Non Aboriginal and Torres Strait Islander	65	70	67
ALL	**65**	**68**	**66**

6 Care and treatment of PCI patients

6.1 Admission status

There were 4,818 PCI procedures performed in 2022 by eight of nine public sites across Queensland. Patients are categorised by admission status, with elective, urgent and emergency categories defined according to the National Cardiovascular Data Registry (NCDR) as stated below.[3]

From 2020, 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 these exceptional and highly complex clinical scenarios ranging from less than 0.3% to 6% of PCI volumes by site.

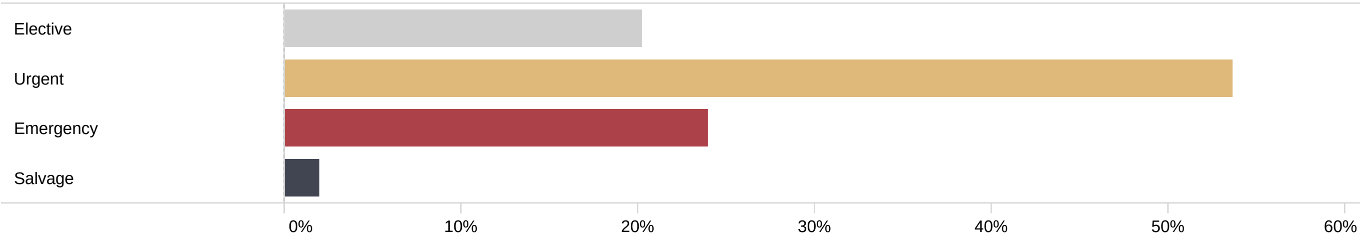


Figure 15: Proportion of all PCI cases by admission status

Table 11: PCI cases by site and admission status

Site	Elective n (%)	Urgent n (%)	Emergent n (%)	Salvage n (%)
CH	141 (27.1)	270 (51.8)	100 (19.2)	10 (1.9)
TUH	64 (19.5)	165 (50.3)	98 (29.9)	1 (0.3)
MBH	113 (41.2)	104 (38.0)	54 (19.7)	3 (1.1)
SCUH	80 (16.6)	274 (56.8)	124 (25.7)	4 (0.8)
TPCH	244 (22.5)	585 (53.9)	245 (22.6)	12 (1.1)
RBWH	64 (14.6)	273 (62.2)	96 (21.9)	6 (1.4)
PAH	148 (14.0)	644 (60.9)	244 (23.1)	22 (2.1)
GCUH	123 (19.5)	273 (43.3)	195 (31.0)	39 (6.2)
STATEWIDE	**977 (20.3)**	**2,588 (53.7)**	**1,156 (24.0)**	**97 (2.0)**

6.2 Stent usage

The majority of PCI cases (93%) involved the deployment of one or more stents, which ranged from 90% to 95% of PCI cases between centres. The mean number of stents deployed for each case was 1.5.

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

Site	Total stenting cases n	Proportion of PCI cases %	Mean stents per case n
CH	473	90.8	1.51
TUH	308	93.9	1.36
MBH	246	89.8	1.41
SCUH	459	95.2	1.73
TPCH	984	90.6	1.45
RBWH	409	93.2	1.47
PAH	1,000	94.5	1.58
GCUH	591	93.8	1.37
STATEWIDE	**4,470**	**92.8**	**1.50**

6.3 Access route

The majority of PCI cases (92%) used a single access route, with 83% being via the radial approach and 25% 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 (75% to 96%) which is a smaller range than observed in previous years and consistent with a trend toward increased radial access use.

Table 13: PCI access route by site

Site	Total PCI cases n	Radial approach %	Femoral approach %	Other approach %
CH	521	82.1	25.0	0.0
TUH	328	75.6	30.8	0.6
MBH	274	88.3	18.6	1.1
SCUH	482	96.3	8.3	0.8
TPCH	1,086	82.0	29.1	1.0
RBWH	439	88.2	21.4	0.2
PAH	1,058	75.4	31.9	0.6
GCUH	630	82.2	21.9	0.8
STATEWIDE	**4,818**	**82.5**	**25.1**	**0.7**

Totals >100% due to multiple access sites

Table 14: PCI total access routes by site

Site	Single approach %	Multiple approaches %
CH	92.9	7.1
TUH	93.0	7.0
MBH	92.0	8.0
SCUH	94.6	5.4
TPCH	87.8	12.2
RBWH	90.2	9.8
PAH	92.2	7.8
GCUH	95.1	4.9
STATEWIDE	**91.8**	**8.2**

There was minimal variation observed between access routes in the overall PCI cohort and the STEMI presenting within six hours of symptom onset cohort (25% vs. 24% femoral approach respectively).

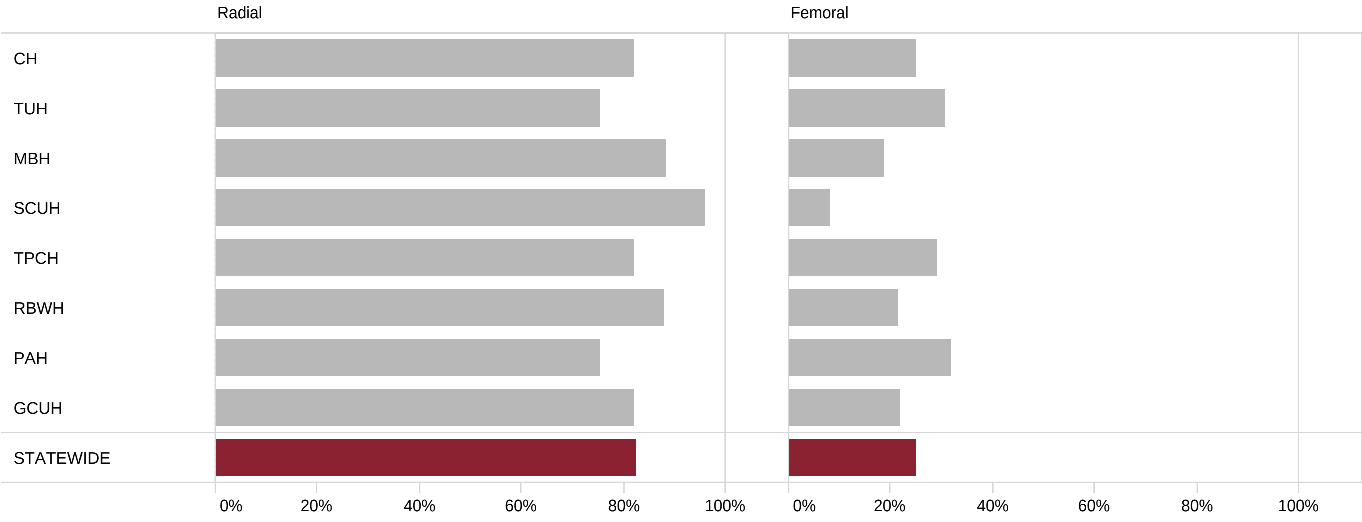


Figure 16: Proportion of PCI cases using radial and femoral access routes by site

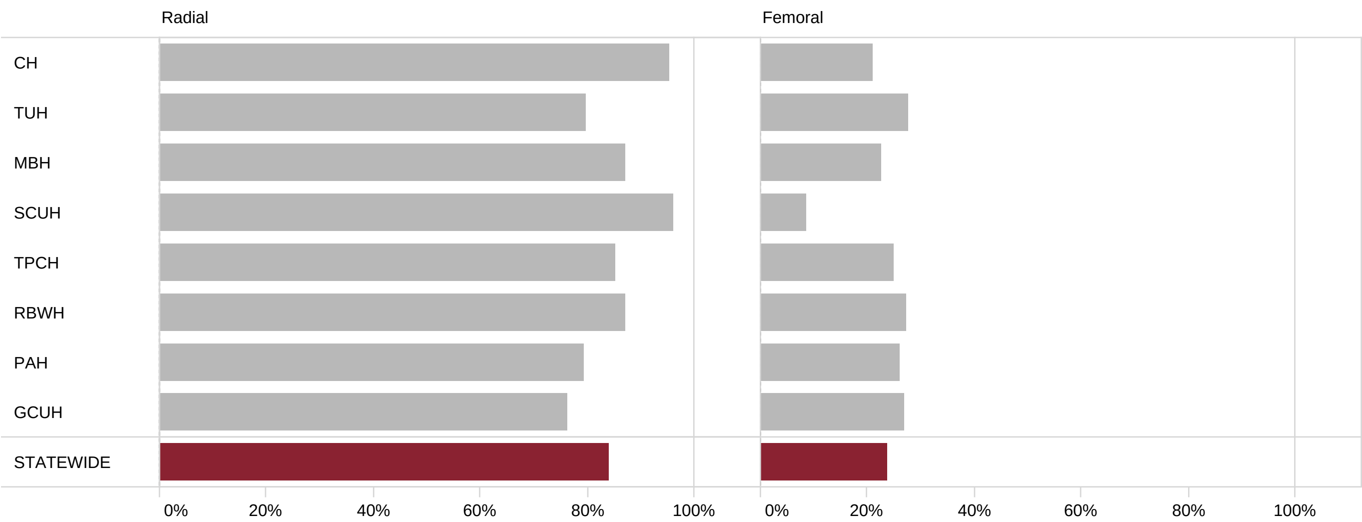


Figure 17: Proportion of STEMI presenting within six hours PCI cases using radial and femoral access routes by site

6.4 Vessels treated

The vast majority of vessels treated were native vessels with coronary bypass graft PCI accounting for 2% of interventions.

Of the vessels treated, 47% of cases involved the left anterior descending coronary artery (LAD), followed by the right coronary artery (RCA) at 36%, the circumflex coronary artery (LCx) at 24% and the left main coronary artery (LMCA) at 4%.

Multi-vessel PCI to native coronary arteries was performed in 12% of cases.

Table 15: Grafts and vessels treated by site

Site	LAD %	LMCA %	LCx %	RCA %	Graft %
CH	50.5	1.5	23.0	30.7	1.7
TUH	45.7	2.1	20.1	38.1	1.8
MBH	41.6	0.4	25.2	37.6	0.7
SCUH	49.4	8.5	28.6	32.8	1.9
TPCH	50.0	4.8	23.3	38.0	2.8
RBWH	41.5	4.1	26.7	37.4	0.9
PAH	47.4	4.3	24.3	38.3	1.4
GCUH	44.4	2.4	24.8	35.7	3.2
STATEWIDE	**47.2**	**3.9**	**24.4**	**36.4**	**2.0**

Table 16: Total native vessels treated by site

Site	Single vessel n (%)	Two vessels n (%)	Three or more vessels n (%)
CH	476 (93.0)	33 (6.4)	3 (0.6)
TUH	299 (92.9)	20 (6.2)	3 (0.9)
MBH	258 (94.9)	13 (4.8)	1 (0.4)
SCUH	395 (83.5)	56 (11.8)	22 (4.7)
TPCH	874 (82.8)	163 (15.4)	19 (1.8)
RBWH	392 (90.1)	40 (9.2)	3 (0.7)
PAH	900 (86.3)	122 (11.7)	21 (2.0)
GCUH	550 (90.2)	55 (9.0)	5 (0.8)
STATEWIDE	**4,144 (87.7)**	**502 (10.6)**	**77 (1.6)**

Excludes any graft PCI (n=95)

Table 17: Grafts treated by site

Site	Graft only n (%)	Graft and native vessel/s n (%)
CH	8 (88.9)	1 (11.1)
TUH	6 (100.0)	–
MBH	2 (100.0)	–
SCUH	9 (100.0)	–
TPCH	26 (86.7)	4 (13.3)
RBWH	4 (100.0)	–
PAH	14 (93.3)	1 (6.7)
GCUH	19 (95.0)	1 (5.0)
STATEWIDE	**88 (92.6)**	**7 (7.4)**

6.5 Adjunctive procedures

The use of ancillary intracoronary imaging technologies and physiological assessment of coronary lesions in routine clinical practice is increasing as these technologies are adopted and the evidence base for use grows. Of the 4,818 PCI cases in 2022, intravascular ultrasound was utilised during 9% of interventions with flow and pressure derived indices used in 5% of PCI cases. Optical coherence tomography was utilised in 3% of interventions. The figures reported below do not include the use of these adjunctive techniques undertaken in diagnostic coronary procedures.

Rotational atherectomy was utilised in 5% of PCI procedures and intracoronary lithotripsy was used in 1%. Intra-aortic balloon pumps for support of haemodynamically unstable patients were inserted in 2% of interventions.

Table 18: Adjunctive procedure types

Procedure	n (%)
Intravascular ultrasound	441 (9.2)
Coronary physiology assessment*	255 (5.3)
Percutaneous transluminal coronary rotational atherectomy	229 (4.8)
Optical coherence tomography	143 (3.0)
Thrombectomy	117 (2.4)
Intra-aortic balloon pump	73 (1.5)
Intra-coronary lithotripsy	55 (1.1)

* Includes fractional flow reserve, instantaneous wave-free ratio, diastolic hyperaemia-free ratio, resting full-cycle ratio

6.6 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.

6.6.1 Clinical presentation

There were 1,506 documented STEMI PCI cases, with over half (59%) presenting as primary PCI cases and 12% presenting after 12 hours (late presenters).

Less than one fifth (19%) of patients had received thrombolysis (lysis) prior to invasive coronary revascularisation while 5% required rescue PCI following unsuccessful thrombolysis.

Table 19: Proportion of STEMI PCI cases by presentation

Site	Transient STEMI n (%)	STEMI ‹6 hours n (%)	STEMI 6–12 hours n (%)	Late presentation n (%)	Post successful thrombolysis n (%)	Rescue PCI (failed thrombolysis) n (%)
CH	20 (15.0)	66 (49.6)	6 (4.5)	13 (9.8)	18 (13.5)	10 (7.5)
TUH	6 (4.9)	69 (56.6)	7 (5.7)	14 (11.5)	23 (18.9)	3 (2.5)
MBH	3 (4.8)	31 (50.0)	5 (8.1)	11 (17.7)	9 (14.5)	3 (4.8)
SCUH	27 (16.4)	80 (48.5)	6 (3.6)	22 (13.3)	19 (11.5)	11 (6.7)
TPCH	20 (6.3)	141 (44.8)	32 (10.2)	44 (14.0)	62 (19.7)	16 (5.1)
RBWH	5 (4.2)	70 (59.3)	7 (5.9)	13 (11.0)	17 (14.4)	6 (5.1)
PAH	53 (15.0)	164 (46.3)	20 (5.6)	29 (8.2)	65 (18.4)	23 (6.5)
GCUH	18 (7.6)	157 (66.2)	23 (9.7)	31 (13.1)	4 (1.7)	4 (1.7)
STATEWIDE	**152 (10.1)**	**778 (51.7)**	**106 (7.0)**	**177 (11.8)**	**217 (14.4)**	**76 (5.0)**

6.6.2 Admission pathway

After first medical contact, 67% of STEMI PCI patients were admitted directly to the treating centre.

As expected, admission pathway varied considerably by STEMI presentation. For thrombolysed and rescue PCI, there were 86% and 81% admitted via interhospital transfer respectively, whereas a large proportion (93%) of the STEMI presenting within six hours of symptom onset cohort presented directly to a PCI facility.

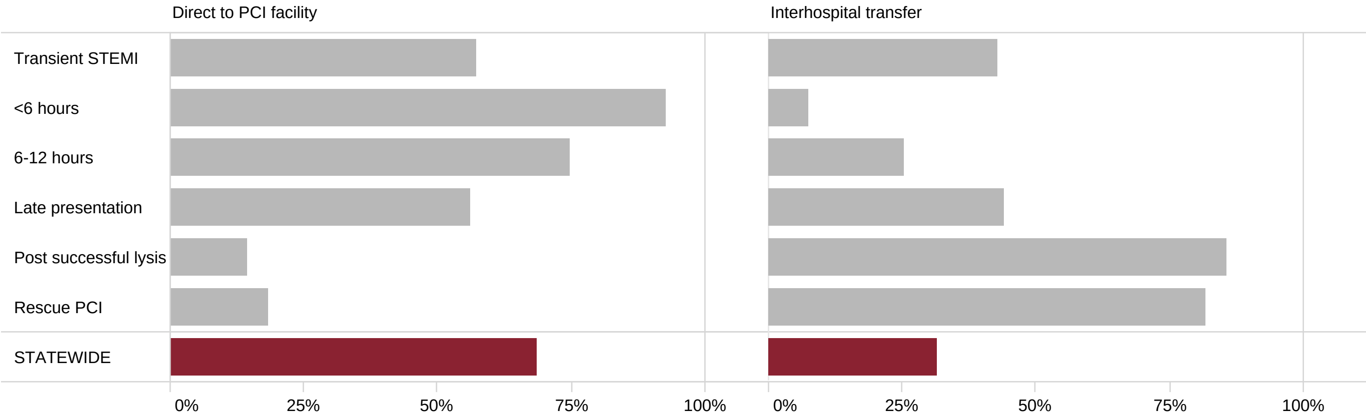


Figure 18: Proportion of STEMI PCI cases by admission pathway and clinical presentation

6.6.3 First medical contact

For STEMI cases presenting for PCI within six hours of symptom onset, most patients presented via the Queensland Ambulance Service (QAS) (83%), while a smaller proportion self-presented to the emergency department (ED) of either a PCI (on-site ED) or non PCI capable (satellite ED) facility (11% and 4% respectively). The remaining 2% presented to other health facilities such as GP clinics, community health centres or any other outpatient setting.

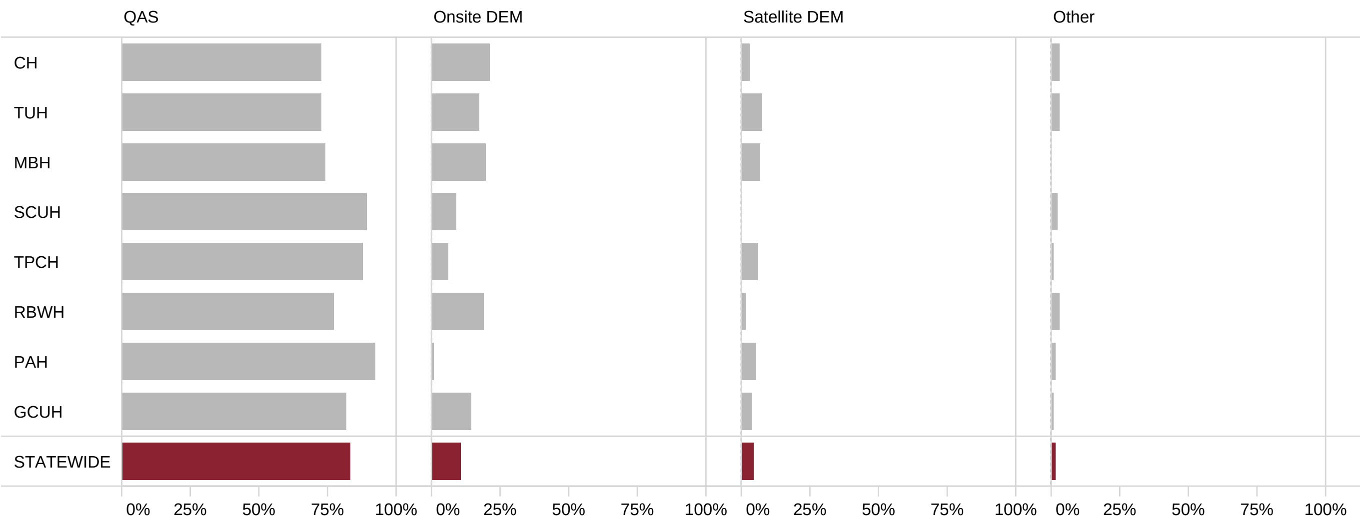


Figure 19: Proportion of STEMI PCI cases presenting within six hours of symptom onset by first medical contact

6.6.4 Thrombolysed patients

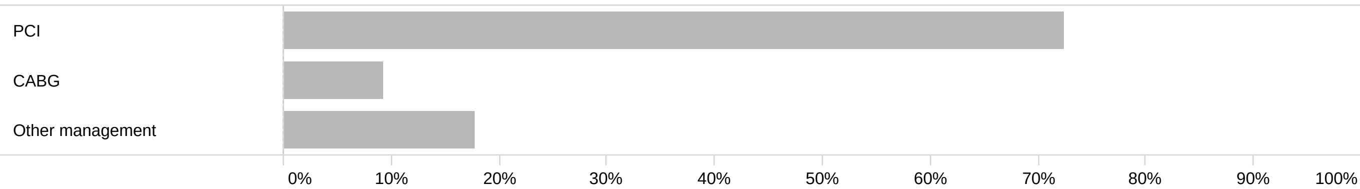
As mentioned above, the method of reperfusion depends on many factors which together determine the treatment method most appropriate for the particular presentation.

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 414 thrombolysed STEMI presentations with the majority (71%) receiving a PCI, which increased to 72% when accounting for subsequent staged interventions within 90 days (Table 21). A smaller proportion (9%) went on to receive coronary artery bypass graft surgery (CABG) at a Queensland Health facility within 90 days.

Table 20: Total thrombolysed STEMI cases by tertiary cardiac centre

Site	Total thrombolysed STEMIs n	Receiving a PCI n (%)	Proportion of all PCI cases %
CH	42	28 (66.7)	5.4
TUH	42	26 (61.9)	7.9
MBH	14	12 (85.7)	4.4
SCUH	41	30 (73.2)	6.2
TPCH	109	78 (71.6)	7.2
RBWH	30	23 (76.7)	5.2
PAH	121	88 (72.7)	8.3
GCUH	15	8 (53.3)	1.3
STATEWIDE	**414**	**293 (70.8)**	**6.1**



PCI and CABG revascularisation not displayed (0.5%)

Figure 20: Proportion of thrombolysed patients by clinical management

Table 21: Thrombolysed patients by revascularisation method within 90 days

Site	PCI %	CABG %	PCI + CABG %	Other management* %
CH	70.2	5.3	1.8	22.8
TUH	72.7	13.6	0.0	13.6
MBH	64.7	23.5	0.0	11.8
SCUH	61.8	10.3	0.0	27.9
TPCH	71.4	10.7	0.0	17.9
RBWH	70.3	13.5	0.0	16.2
PAH	84.1	3.5	0.9	11.5
GCUH	61.1	22.2	0.0	16.7
ALL	**72.4**	**9.3**	**0.5**	**17.8**

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

Overall, there were 414 thrombolysed STEMI patients who reached a public hospital CCL site in 2022, with a median time from first diagnostic ECG (FdECG) to thrombolysis of 40 minutes.

Time from FdECG to thrombolysis varied depending on the pathway by which it was administered, with patients presenting directly to the thrombolysis facility having a higher median time from FdECG to thrombolysis compared to those receiving prehospital thrombolysis by QAS paramedics (38 minutes vs. 32 minutes).

The patients in the other hospital thrombolysis group took a median of 59 minutes from FdECG to thrombolysis. The extended time delay likely representative of the travel time taken to arrive at a thrombolysis facility, noting Queensland's vast geography and rural and remote population.

Table 22: 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.

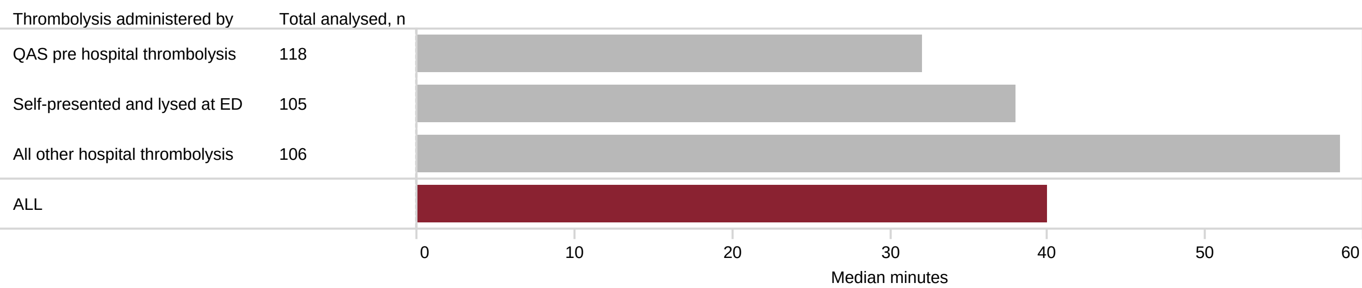
Table 23: Total thrombolysed STEMI cases by thrombolysis administration pathway

	Total thrombolysed STEMIs n	Total analysed n	Median FdECG to thrombolysis minutes	Interquartile range minutes
QAS pre-hospital thrombolysis	127	118	32	23–42
Self-presented and thrombolysed at ED	155	105	38	20–57
Other pre-hospital thrombolysis*	15	9	N/A	N/A
All other hospital thrombolysis†	117	106	59	39–84
ALL	**414**	**338**	**40**	**26–60**

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

* Thrombolysed by Royal Flying Doctor Service, primary health care centre or other first responder

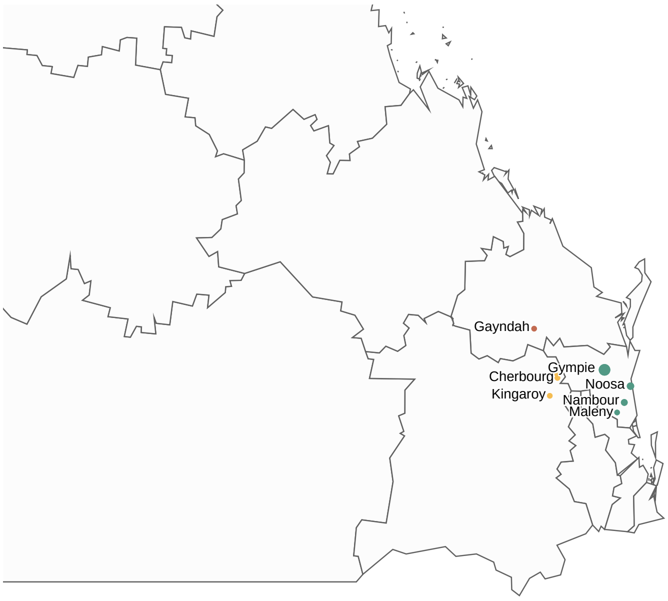
† Includes initial presentation to QAS or GP and subsequent thrombolysis in hospital



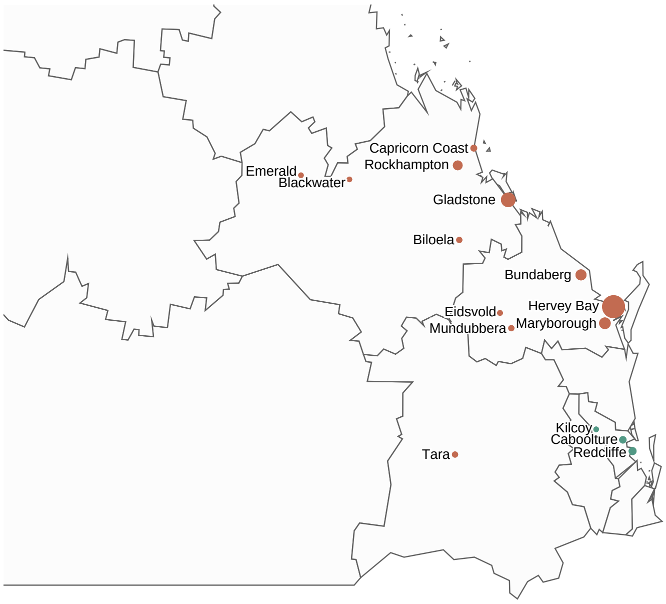
Excludes other pre-hospital thrombolysis (n=15)

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

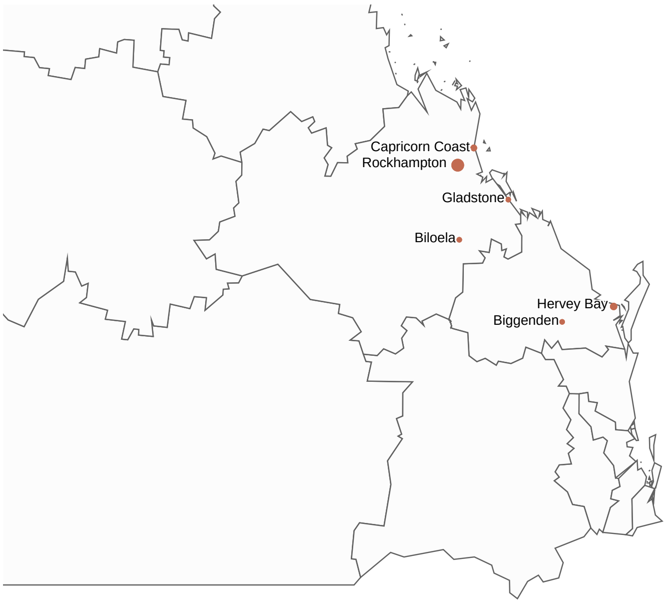
Figure 22: Thrombolysed STEMI interhospital transfers by estimated distance to transfer



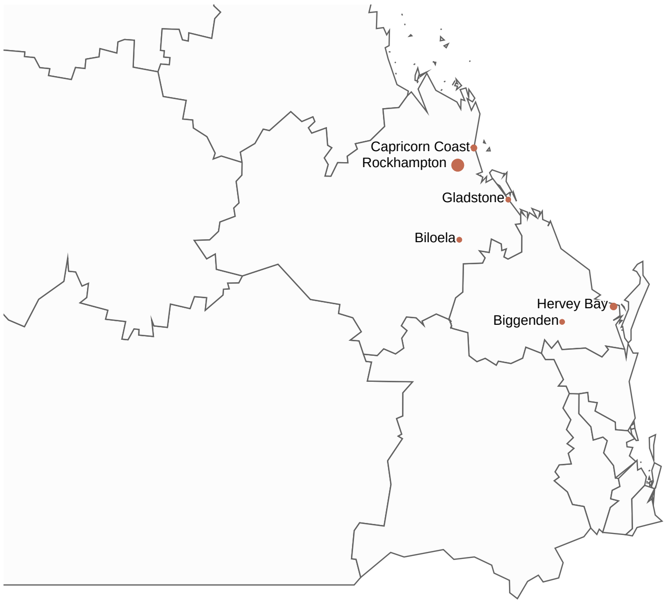
Inset A: Sunshine Coast University Hospital



Inset B: The Prince Charles Hospital



Inset C: Royal Brisbane & Women's Hospital



Inset D: Princess Alexandra Hospital

Inset E: Gold Coast University Hospital

QAS has a well-defined set of contraindications for the administration of pre-hospital thrombolysis. There were 117 thrombolysed STEMI patients (28%) who were not indicated for pre-hospital thrombolysis based on QAS criteria but were subsequently eligible for thrombolysis based on Queensland public hospital guidelines. The most common reason for this was that the patient had been located within close proximity to a hospital (49%). A smaller proportion had been contraindicated for pre-hospital thrombolysis due to advanced age (23%), other comorbidity or complex clinical presentation (Table 24).

For the cohort of thrombolysed patients, the median time to angiography was 13 hours post thrombolysis with 74% of patients undergoing coronary angiography within 24 hours. The unadjusted all-cause mortality within 30 days for STEMI patients receiving thrombolysis was 3.4%.

Table 24: Thrombolysed patients not indicated for pre-hospital thrombolysis

	n (%)
Close proximity to hospital	52 (49.1)
Advanced age >75 years	24 (22.6)
GCS* <15	8 (7.5)
Prolonged pain duration >6 hours	7 (6.6)
Hypertensive	4 (3.8)
Other	11 (10.4)
ALL	**106 (100.0)**

Excludes missing data (n=11)

* Glasgow Coma Scale

Table 25: 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	42	31	9	4–32	71.0
TUH	42	32	16	6–23	75.0
MBH	14	12	5	3–11	91.7
SCUH	41	41	10	3–23	75.6
TPCH	109	106	13	8–24	74.5
RBWH	30	30	20	8–24	73.3
PAH	121	83	15	4–26	69.9
GCUH	15	13	12	6–17	84.6
STATEWIDE	**414**	**348**	**13**	**5–24**	**74.1**

Table 26: Unadjusted all-cause thrombolysed STEMI mortality within 30 days of procedure

	Total cases n	**Total salvage n (%)**	**In-lab death n**	**In hospital death n**	**Post discharge to 30 days n**	**Total mortality n (%)**
Post successful thrombolysis	338	8 (2.4)	0	2	3	5 (1.5)
Rescue PCI	76	8 (10.5)	2	7	0	9 (11.8)
ALL	**414**	**16 (3.9)**	**2**	**9**	**3**	**14 (3.4)**

6.7 NSTEMI presentations

Of all PCI and coronary cases performed in CCLs during 2022, there were 3,265 coded with a procedural indication of NSTEMI. These cases accounted for 32% of all PCI cases across all centres, with site variation ranging from 23% to 42%. This represents a slight increase in cases compared to the 2020 and 2021 patient cohorts.

Of patients presenting with NSTEMI, 47% were revascularised via PCI, which increased to 52% when accounting for staged interventions within 90 days of index presentation (Table 28). A further 13% underwent CABG, while the remainder were medically managed or referred outside of Queensland Health.

6.7.1 Case load

Table 27: NSTEMI cases by site

Site	Total NSTEMI cases n	NSTEMI receiving PCI n (%)	Proportion of all PCI cases %
CH	327	194 (59.3)	37.2
TUH	242	76 (31.4)	23.2
MBH	156	63 (40.4)	23.0
SCUH	300	135 (45.0)	28.0
TPCH	712	338 (47.5)	31.1
RBWH	370	185 (50.0)	42.1
PAH	829	405 (48.9)	38.3
GCUH	329	150 (45.6)	23.8
STATEWIDE	**3,265**	**1,546 (47.4)**	**32.1**

Table 28: NSTEMI patients by site and revascularisation method within 90 days

Site	PCI revascularisation %	CABG revascularisation %	PCI + CABG revascularisation %	Other management* %
CH	63.3	7.7	1.0	28.0
TUH	39.9	10.3	0.0	49.8
MBH	46.1	6.5	0.0	47.4
SCUH	53.5	13.7	0.0	32.7
TPCH	50.0	11.8	0.3	37.9
RBWH	54.6	13.3	0.6	31.5
PAH	51.7	17.1	0.4	30.9
GCUH	47.2	9.3	0.9	42.6
STATEWIDE	**51.3**	**12.5**	**0.4**	**35.8**

* Medical management or referred outside of Queensland Health

6.7.2 Admission source

There were similar numbers of NSTEMI cases where the patient was transferred from another facility or presenting directly to the PCI centre (50% and 50% respectively). Interhospital transfer for NSTEMI patients can present many challenges for guideline adherence with many logistical considerations making target adherence for invasive coronary angiography difficult. These issues are explored further in the clinical indicators section of the Audit.

Considerable variation was observed between sites, with the proportion of interhospital transfers for NSTEMI ranging from 26% to 69%, 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 30 and Figure 23 provide perspective based on cases where geographical data were available.

Table 29: NSTEMI admission source to treating facility

Site	Direct to PCI facility n (%)	Interhospital transfer n (%)
CH	201 (61.5)	126 (38.5)
TUH	165 (68.2)	77 (31.8)
MBH	95 (60.9)	61 (39.1)
SCUH	187 (62.3)	113 (37.7)
TPCH	350 (49.2)	362 (50.8)
RBWH	115 (31.1)	255 (68.9)
PAH	261 (31.5)	568 (68.5)
GCUH	244 (74.2)	85 (25.8)
STATEWIDE	**1,618 (49.6)**	**1,647 (50.4)**

Table 30: NSTEMI interhospital transfers by estimated distance to transfer

Site	Total analysed n	Median kilometres	Interquartile range kilometres
CH	98	93	75–143
TUH	70	302	133–901
MBH	52	125	58–191
SCUH	92	93	30–93
TPCH	288	80	39–505
RBWH	227	46	45–611
PAH	520	27	24–148
GCUH	55	17	17–17
STATEWIDE	**1,402**	**63**	**27–275**

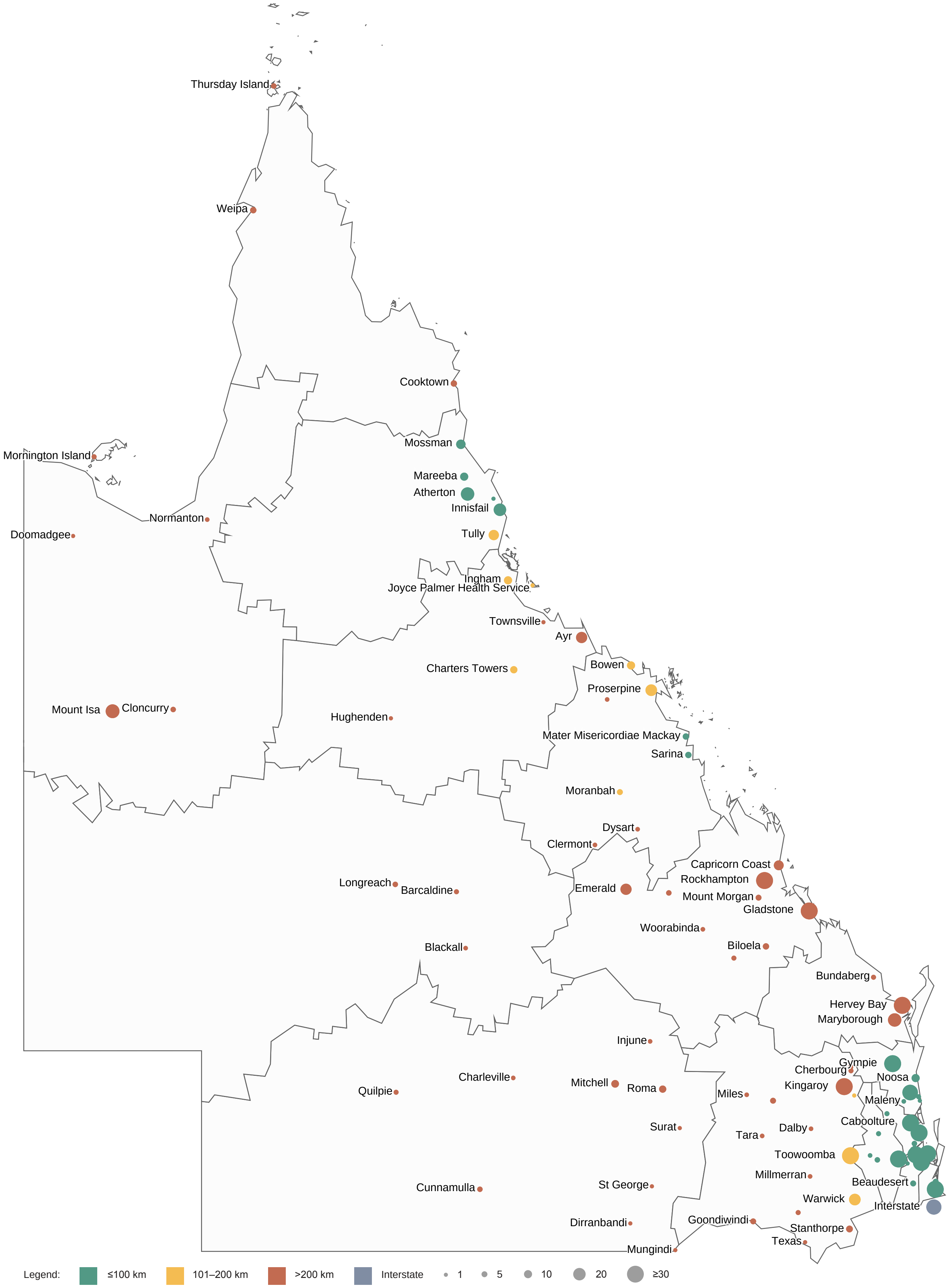


Figure 23: NSTEMI interhospital transfers by estimated distance to transfer

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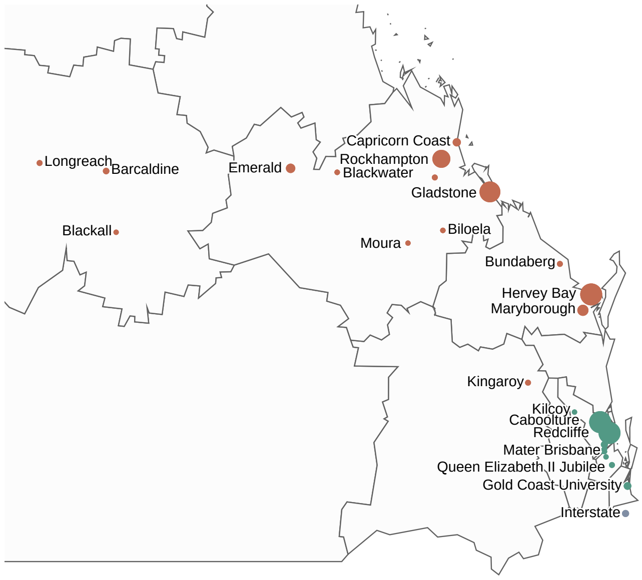
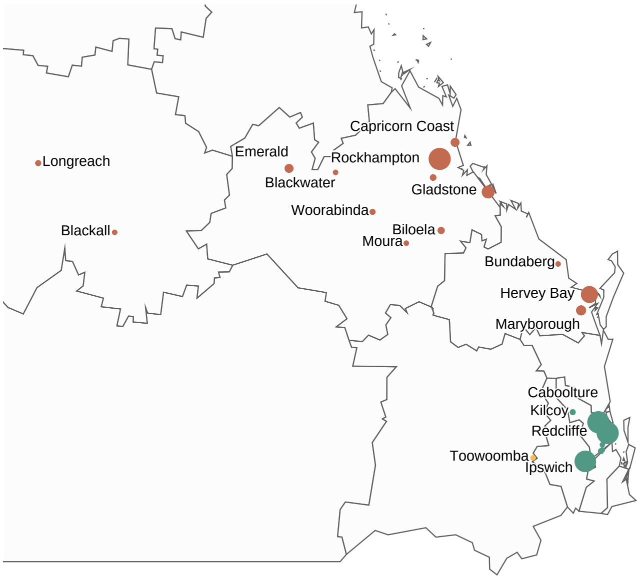
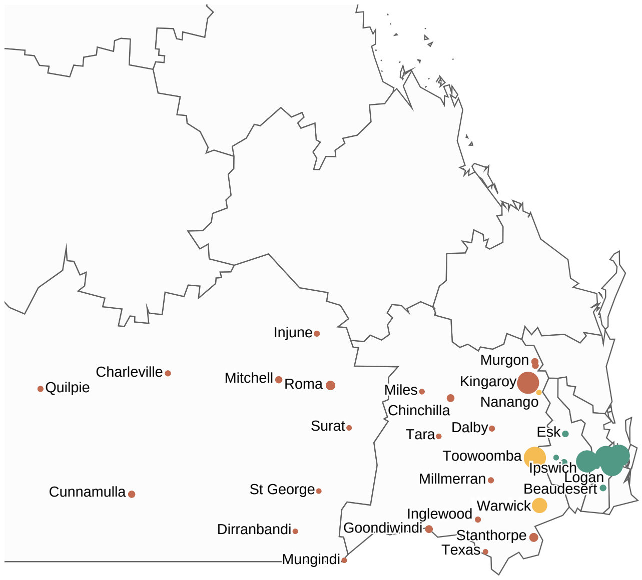


Inset B: The Prince Charles Hospital



Inset C: Royal Brisbane & Women's Hospital



Inset D: Princess Alexandra Hospital

Inset E: Gold Coast University Hospital

7 Clinical indicators

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

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

The quality and safety indicators which have been nominated by the QCOR Interventional Cardiology Committee are outlined in Table 31.

Table 31: 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 2022 was 2.2%. This result compares favourably with the 30 day mortality rate of 2.9% for the 2022 Victoria, Australia PCI cohort[6] and 2.8% presented by the British Cardiovascular Interventional Society (BCIS) in their review of PCI outcomes for the 2014 calendar year. This metric is chosen as the comparator as BCIS reports in subsequent years have given in-hospital rather than 30 day mortality.[7]

Table 32 presents unadjusted mortality according to admission status. As should be expected, the risk of death increases according to the severity of the patient's condition (admission status). 30 day mortality was 45% in the critically ill patients who underwent salvage PCI.

Table 32: 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	521	0 (0.0)	7 (2.6)	3 (3.0)	6 (60.0)	16 (3.1)
TUH	328	0 (0.0)	0 (0.0)	6 (6.1)	1 (100.0)	7 (2.1)
MBH	274	1 (0.9)	0 (0.0)	3 (5.6)	2 (66.7)	6 (2.2)
SCUH	482	1 (1.3)	2 (0.7)	1 (0.8)	3 (75.0)	7 (1.5)
TPCH	1,086	3 (1.2)	8 (1.4)	7 (2.9)	9 (75.0)	27 (2.5)
RBWH	439	0 (0.0)	4 (1.5)	4 (4.2)	2 (33.3)	10 (2.3)
PAH	1,058	0 (0.0)	3 (0.5)	4 (1.6)	8 (36.4)	15 (1.4)
GCUH	630	0 (0.0)	3 (1.1)	3 (1.5)	13 (33.3)	19 (3.0)
STATEWIDE	**4,818**	**5 (0.5)**	**27 (1.0)**	**31 (2.7)**	**44 (45.4)**	**107 (2.2)**

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

Reassuringly, observed mortality rates from all sites are within the expected range for their respective risk adjusted mortality rates. This is despite the limited risk adjustment model, which only adjusts for six factors – ACS, age, LAD coronary artery involvement, eGFR, LVEF, and cardiogenic shock. Other critical presentations with very high mortality risk, such as out of hospital ventricular fibrillation 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 0.3%–6.2% of PCI volume).

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

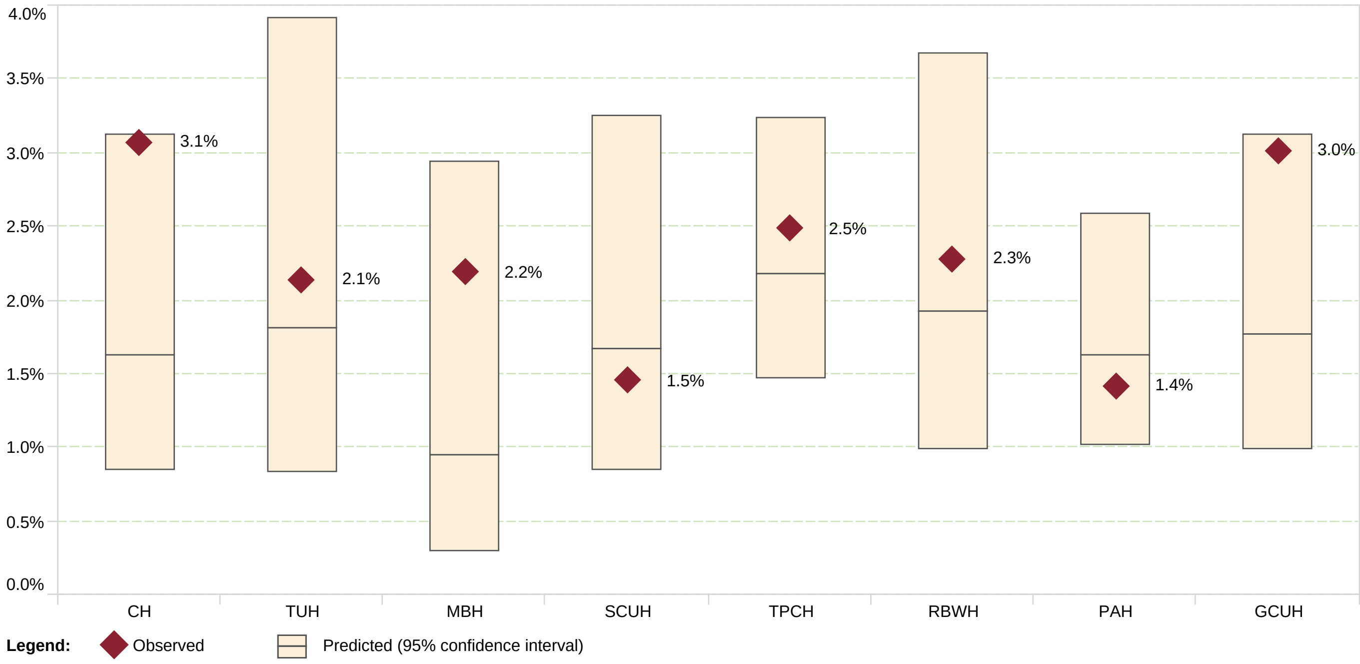
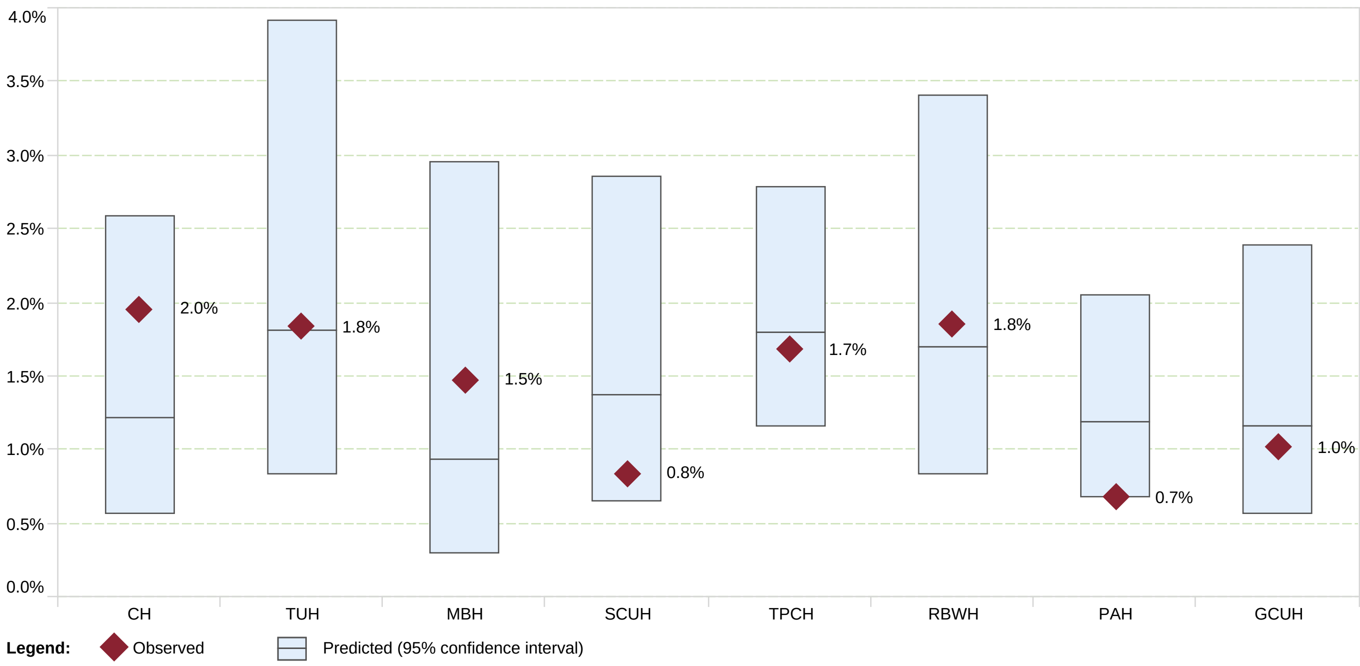


Figure 24: Comparison of observed and predicted mortality rates by site

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

With an expanded dataset of reliable data, a more thorough evaluation of international PCI risk adjustment models can be explored. This would allow for recalibration and the option to adapt one of these models to the specific characteristics of the QCOR dataset, or develop a new, locally relevant model. The variation in salvage cases between different hospitals highlights the importance of this. Some of these cases are STEMI complicated by out of hospital ventricular fibrillation (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=97)

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

7.1.2 STEMI mortality

A separate analysis was performed to assess mortality in patients presenting with STEMI. Of the 1,897 documented STEMI cases in 2022, 1,506 cases (79%) 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 PCI remain encouraging. All-cause mortality rates at 30 days varied from 0.6% to 5.1% between participating centres with a statewide rate of 2.2%. Of these 1,429 patients analysed, a total of 32 mortalities were identified with the majority (81%) occurring in hospital.

Table 33: Mortality up to 30 days in patients who underwent PCI for STEMI

Site	In-lab n	In hospital n	Post discharge to 30 days n	Total cases* n	Total mortality n (%)
CH	0	4	1	124	5 (4.0)
TUH	3	4	1	121	5 (4.1)
MBH	0	3	0	59	3 (5.1)
SCUH	0	1	0	162	1 (0.6)
TPCH	1	4	3	307	7 (2.3)
RBWH	0	2	2	115	4 (3.5)
PAH	0	3	1	335	4 (1.2)
GCUH	0	1	2	206	3 (1.5)
STATEWIDE	**4**	**22**	**10**	**1,429**	**32 (2.2)**

* Excluding salvage cases (n=77)

7.1.3 STEMI presentation within 6 hours from symptom onset

Further analysis of the STEMI cohort who underwent primary PCI within six hours of symptom onset demonstrates a statewide all-cause 30 day mortality rate of 1.9%.

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

Table 34: Mortality up to 30 days in patients who underwent PCI for STEMI presenting 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	1	0	60	1 (1.7)
TUH	2	2	1	69	3 (4.3)
MBH	0	1	0	30	1 (3.3)
SCUH	0	0	0	78	0 (0.0)
TPCH	0	0	1	137	1 (0.7)
RBWH	0	1	0	69	1 (1.4)
PAH	0	3	1	155	4 (2.6)
GCUH	0	1	2	130	3 (2.3)
STATEWIDE	**2**	**9**	**5**	**728**	**14 (1.9)**

* Excluding salvage cases (n=50)

7.1.4 Out of hospital cardiac arrest

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

With this in mind, it is imperative that these cases be interpreted with caution noting that the outcomes reflect an 76% survival rate to 30 days which is markedly better than the larger OOHCA with resuscitation group. This is reassuring and indicates that patient selection for PCI in this high-risk, critically unwell group is appropriate.

Variation exists among sites with OOHCA accounting for 0.9% to 4.3% of total PCI cases and a statewide proportion of 2.4%. In this group, death within 30 days of the PCI procedure in 2022 almost exclusively occurred in hospital.

Table 35: Total out of hospital cardiac arrest cases by site

Site	Total cases n	Proportion of PCI cases %
CH	12	2.3
TUH	6	1.8
MBH	3	1.1
SCUH	12	2.5
TPCH	40	3.7
RBWH	4	0.9
PAH	14	1.3
GCUH	27	4.3
STATEWIDE	**118**	**2.4**

Table 36: 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	**118**	**0**	**27**	**1**	**28 (23.7)**

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.[12,13]

During 2022, European STEMI guidelines recommended a target FdECG-to-device time less than 90 minutes.[13] It is widely recognised that these targets are ambitious and difficult to achieve in real-world practice as primary PCI becomes more available to larger catchment populations.

Achieving these times requires efficient coordination of care within and between the ambulance service and transferring/receiving hospitals. Accepted strategies to improve reperfusion times include pre-hospital activation of the 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 37: Definitions for STEMI time to reperfusion

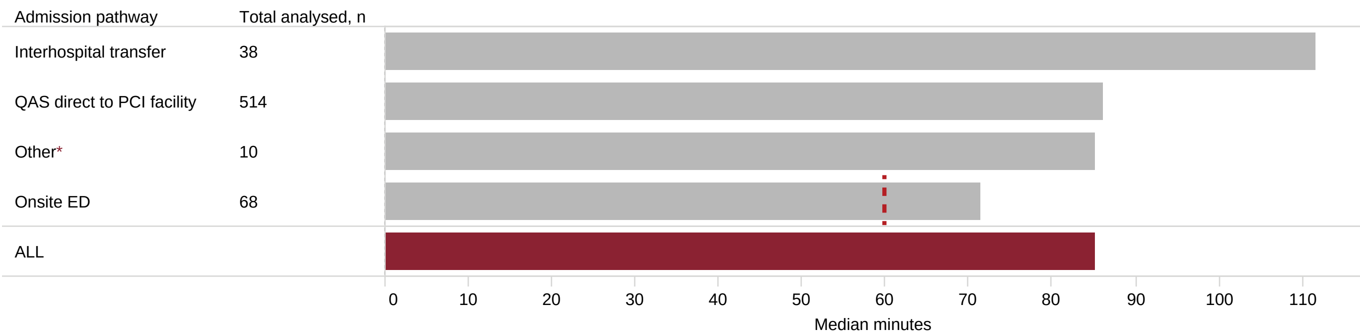
Time	Definition
First diagnostic ECG	First diagnostic ECG refers to the timestamp when the ECG shows ST-segment elevation (or equivalent) and can be regarded as time zero in the therapeutic pathway. The interpretation of the first diagnostic ECG may be undertaken by ambulance personnel, general practitioners 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)[14]

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

In total, there were 778 STEMI primary PCI cases presenting within six hours of symptom onset. Of these, there were 148 cases which had been excluded per the criteria in Table 38 leaving 630 cases which are eligible for the following analysis.

As observed in previous annual reports, there was considerable variation in time from FdECG to reperfusion depending on the admission pathway to the treating facility, ranging from 112 minutes to 68 minutes for interhospital transfers and PCI facility onsite ED respectively.



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

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

Table 38: STEMI presenting within six hours of symptom onset cases ineligible for analysis

Summary	n (%)
Salvage	49 (33.1)
Out of hospital arrest	18 (12.2)
Significant comorbidities/frailty	17 (11.5)
Thrombolysis contraindicated	14 (9.5)
Previous CABG	11 (7.4)
Intubation	7 (4.7)
Shock/acute pulmonary oedema	6 (4.1)
Unsuccessful PCI	7 (4.7)
Incomplete data	19 (12.8)
Total	**148 (100.0)**

7.2.1 Time from first diagnostic ECG to first device

The all-site median time from FdECG to reperfusion was 83 minutes, with median individual site times ranging from 74 minutes to 97 minutes. These results indicate that overall Queensland public facilities are approaching the ambitious benchmark of 90 minutes from time of FdECG to first device. However, only 58% of patients analysed receive timely reperfusion per the current benchmark (FdECG to reperfusion within 90 minutes)[7], supporting the view that the current target is idealistic.

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

Table 39: First diagnostic ECG 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	66	54	76	59–100	70.4
TUH	69	51	87	67–109	58.8
MBH	31	27	97	75–147	40.7
SCUH	80	62	76	68–91	74.2
TPCH	141	122	89	79–112	53.3
RBWH	70	63	74	65–95	68.3
PAH	164	132	89	79–109	50.8
GCUH	157	119	89	74–107	57.1
STATEWIDE	**778**	**630**	**85**	**71–105**	**58.4**

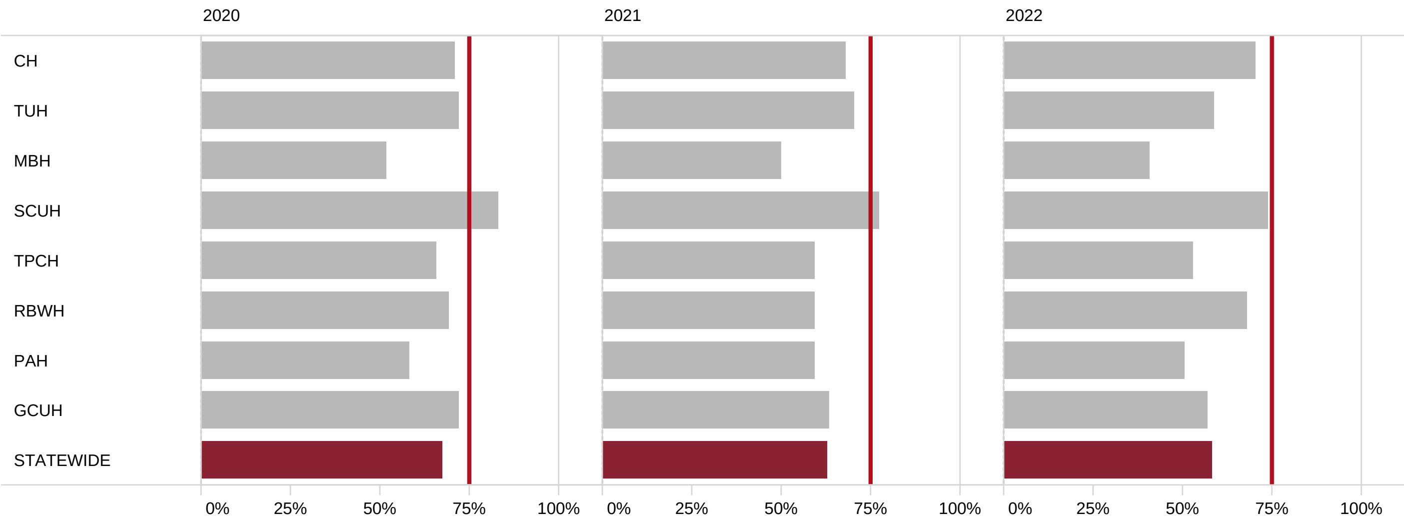


Figure 27: Proportion of STEMI cases (presenting within six hours of symptom onset) where time from first diagnostic ECG to reperfusion met 90 min target, 2020–2022

7.2.1.1 Pre-hospital notification processes

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

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

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

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

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

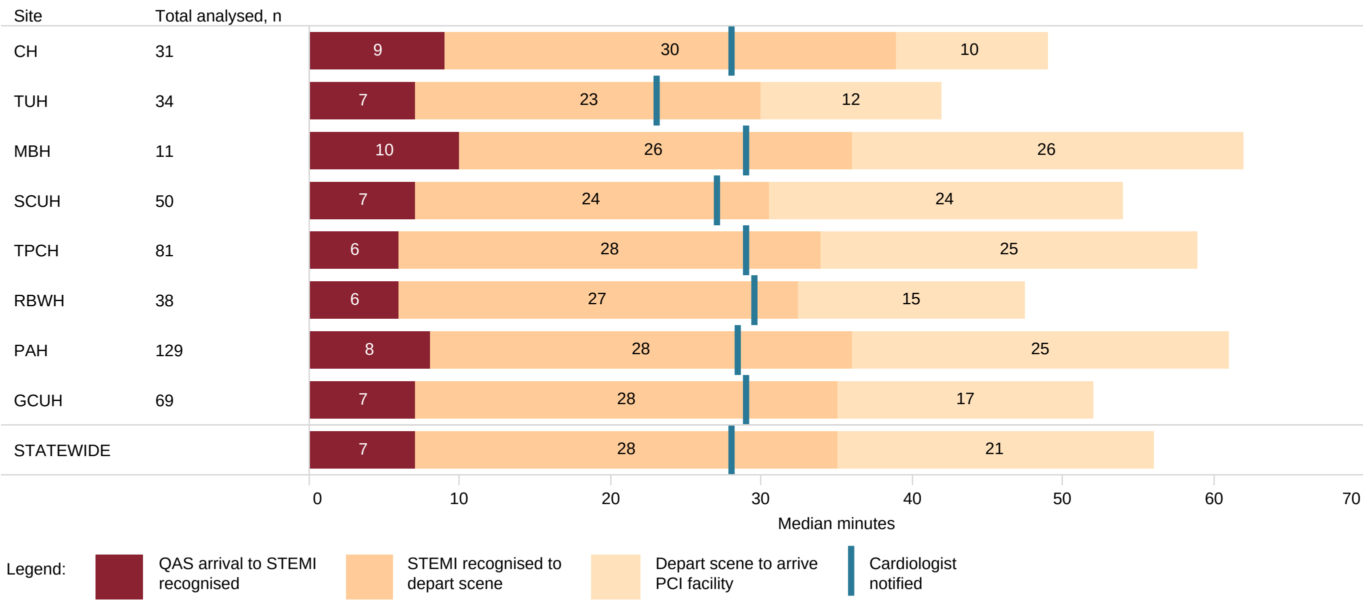


Figure 28: STEMI presenting within six hours of symptom onset pre-hospital component breakdown – QAS direct to PCI facility

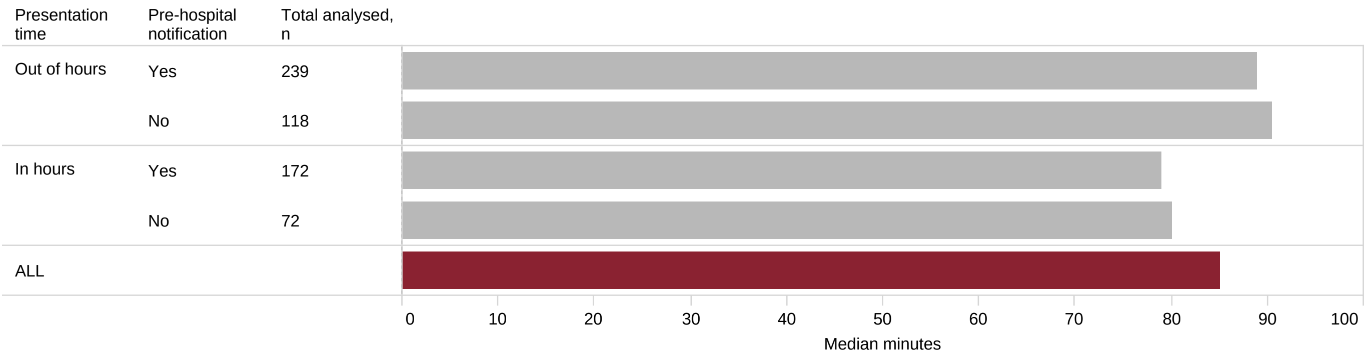
7.2.1.2 Hospital processes

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

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

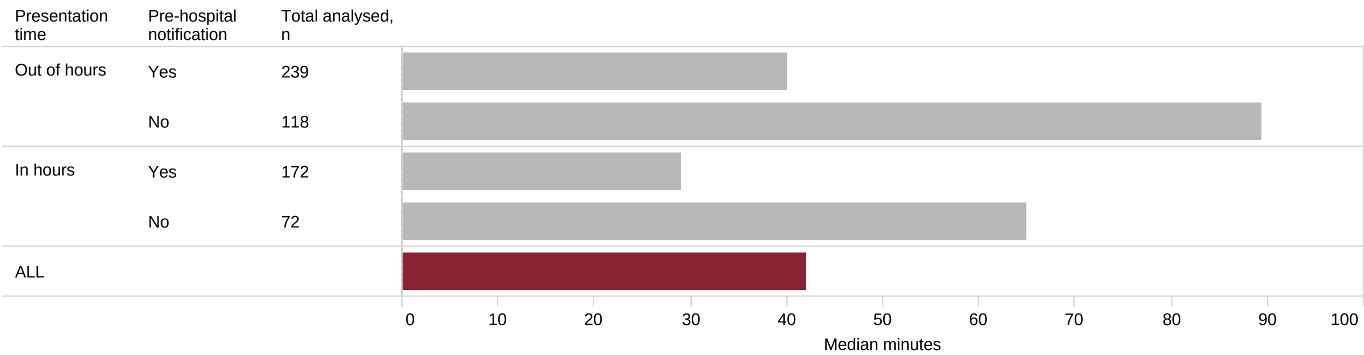
Total time to reperfusion was lowest in the in hours cohort where pre-hospital notification occurred. Even when pre-hospital notification was not a factor, in hours cases had a swifter time to reperfusion than those taking place out of hours. It is important to note that the out of hours cohort accounts for the larger proportion of cases (358 out of hours vs. 246 in hours), meaning particular attention can be paid to this group for future quality improvement activities.

When examining arrival at PCI facility to reperfusion, pre-hospital notification resulted in marked differences in system performance. Pre-hospital notification was associated with a 37 minute improvement for in hours cases and a 50 minute improvement for out of hours cases. These findings support the importance of pre-hospital notification and the effect it has on providing an efficient, systematic approach to patient care.



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

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



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

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

7.2.2 Time from arrival PCI capable facility to first device

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

For parts of 2022, COVID-19 caused disruption to the usual in-hospital journey of a STEMI patient. Hospital and Health Services mandated rapid antigen testing of all patients presenting to the emergency department. Despite best efforts, the mandate is likely to have prolonged treatment time and ultimately the time to reperfusion.

Results demonstrate that for almost three quarters of cases (70%), 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 59 minutes across sites). These results demonstrate a slight decrease in performance from previous years (2020 median – 40 minutes, 2021 median – 39 minutes). There were three sites that met the 75% benchmark target.

Table 40: 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	66	53	54	24–89	52.8
TUH	69	51	59	43–92	51.0
MBH	31	27	49	34–83	59.3
SCUH	80	62	39	26–76	66.1
TPCH	141	122	37	29–54	80.3
RBWH	70	62	42	31–59	75.8
PAH	164	132	38	30–49	83.3
GCUH	157	118	52	27–87	56.8
STATEWIDE	**778**	**627**	**42**	**29–72**	**69.1**

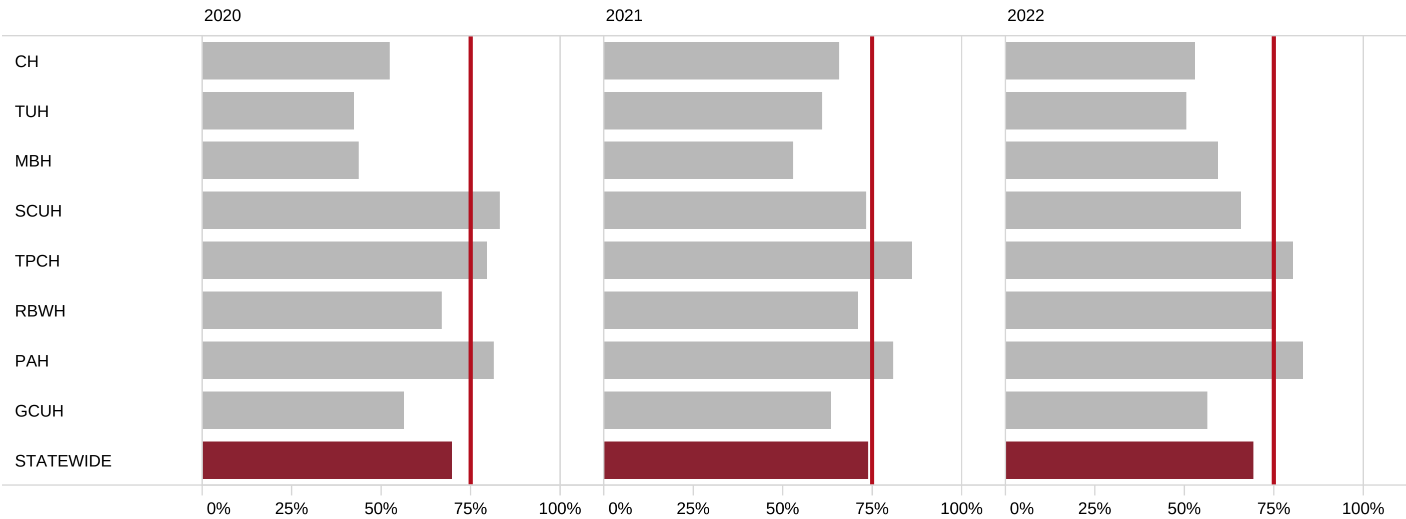


Figure 31: Proportion of cases where arrival at PCI hospital to first device ≤60 minutes was met for STEMI presenting within six hours of symptom onset, 2020–2022

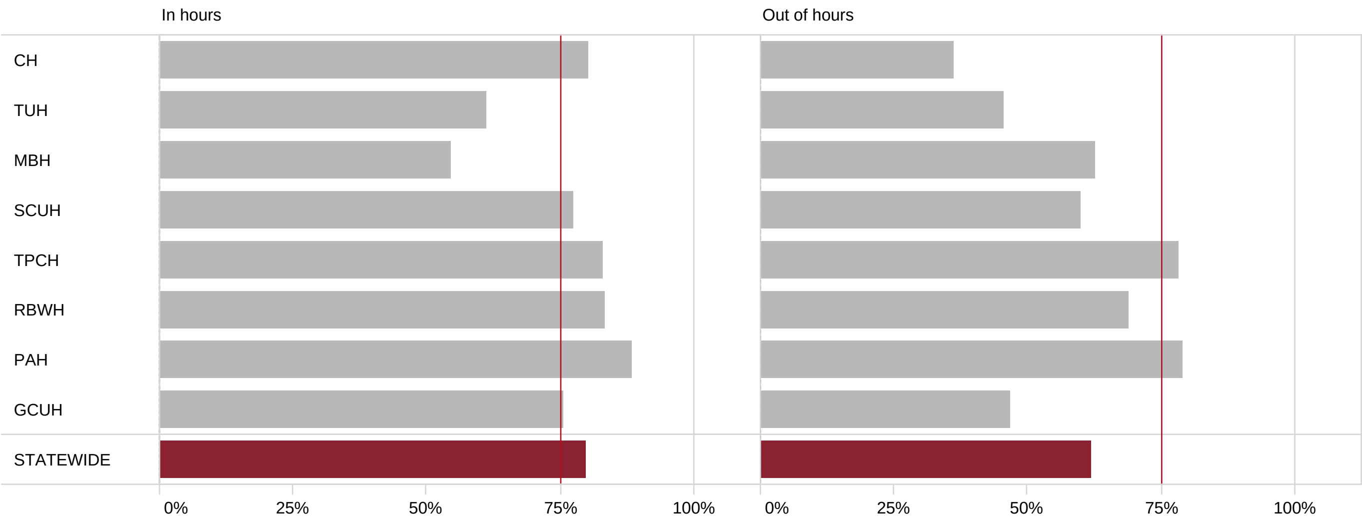
7.2.2.1 In hours versus out of hours presentation

The majority of cases (59%) presented out of hours. For the purpose of this analysis, business hours were defined as 8am–6pm, Monday to Friday, excluding public holidays. This high proportion of out of hours cases demonstrates the frequency at which teams are required to respond to these medical emergencies. Each out of hours case has its own logistical challenges and requires a whole-of-system approach to ensuring timely intervention. It is important to note that this analysis does not include all out of hours work performed by CCL teams with a wide and varied case mix regularly encountered.

When examining PCI hospital arrival and reperfusion, patient presentation in hours was associated with better performance. Over three quarters (80%) of cases met the door-to-device time target of 60 minutes in hours compared to 62% out of hours.

Table 41: STEMI presenting within six hours of symptom onset – arrival PCI facility to reperfusion by site and time of presentation

Site	Total analysed n	Proportion out of hours %	In hours median minutes	Out of hours median minutes	In hours target met %	Out of hours target met %
CH	53	62.3	27	68	80.0	36.4
TUH	51	64.7	48	63	61.1	45.5
MBH	27	59.3	51	49	54.5	62.5
SCUH	62	64.5	25	51	77.3	60.0
TPCH	122	56.6	37	36	83.0	78.3
RBWH	62	51.6	38	44	83.3	68.8
PAH	132	53.8	32	42	88.5	78.9
GCUH	118	65.3	30	62	75.6	46.8
STATEWIDE	**627**	**59.2**	**35**	**48**	**79.7**	**61.7**



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

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

7.2.2.2 Pre-hospital notification

Pre-hospital notification was utilised in approximately two thirds (68%) of cases, with considerable variation observed among sites. Achievement of the benchmark of 75% of cases meeting the 60 minute target was achieved at all sites where pre-hospital notification was utilised. Statewide, the 60 minute timeframe was achieved in 90% of cases where there was pre-hospital notification compared to 26% without pre-hospital notification.

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

Table 42: STEMI presenting within six hours of symptom onset – arrival PCI facility to reperfusion by pre-hospital notification and site

Site	Total analysed n	Proportion with pre-hospital notification %	Pre-hospital notification median minutes	No pre-hospital notification median minutes	Pre-hospital notification target met %	No pre-hospital notification target met %
CH	52	50.0	25	88	84.6	19.2
TUH	50	46.0	44	77	82.6	22.2
MBH	27	55.6	36	102	93.3	16.7
SCUH	62	67.7	28	82	95.2	5.0
TPCH	108	79.6	34	55	94.2	50.0
RBWH	60	61.7	35	69	94.6	43.5
PAH	132	84.8	35	87	92.9	30.0
GCUH	110	63.6	40	95	78.6	20.0
STATEWIDE	**601**	**68.4**	**34**	**84**	**90.0**	**25.8**

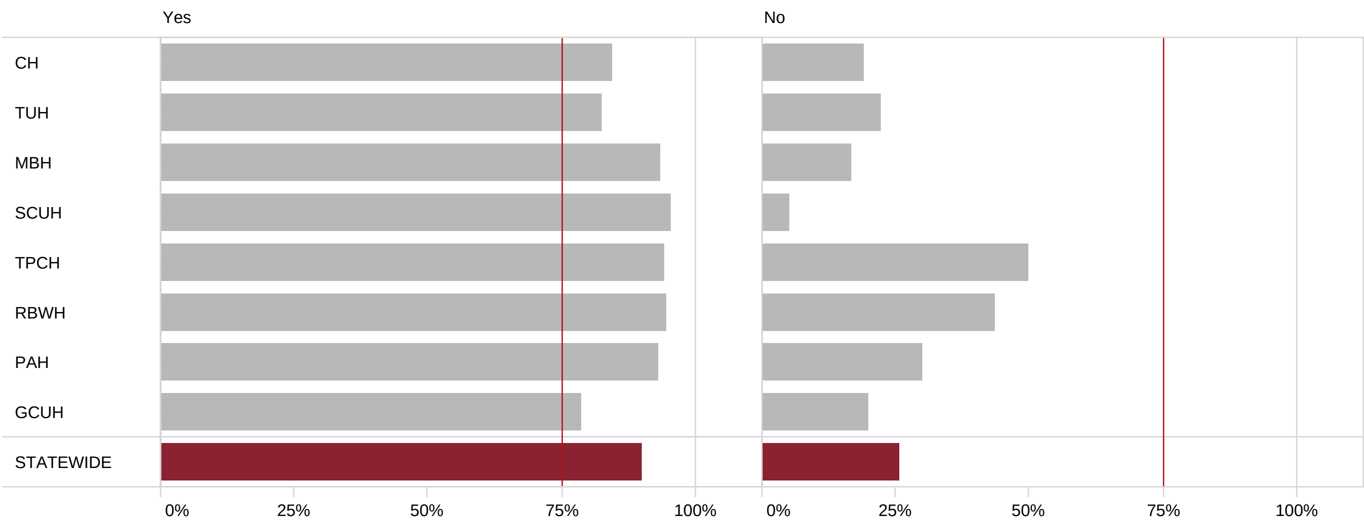


Figure 33: STEMI presenting within six hours of symptom onset – proportion of cases where arrival at PCI hospital to first device ≤60 minutes by site and pre-hospital notification

7.3 NSTEMI – time to angiography

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

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

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

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

Table 43 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 43: NSTEMI time to angiography – cases excluded from analysis

	n
Planned or staged PCI	160
Admitted with an unrelated principal diagnosis	141
Stable non admitted patients transferred directly to lab for planned angiography	43
Coronary angiography not performed at index admission	39
Transferred from a private hospital	37
Transferred from an interstate hospital	27
Incomplete data	7
Total ineligible	**454**

Patients presenting directly to a PCI capable facility had a median wait to coronary angiography time of 30 hours and were more likely to have angiography performed within the target timeframe of 72 hours compared with interhospital transfers (82% vs. 52%).

For direct presenters, the wide range of 20 hours to 46 hours before angiography is influenced by several factors including patient demographics, clinical case mix and competing caseloads. The centres with <75% meeting target had the widest interquartile ranges, providing opportunity to review local factors that may be modifiable to promote time efficiencies.

Across the state, in comparison with 2021, there was for direct presenters (Table 44) an increased number of analysable NSTEMI cases (1,446 vs. 1,313) and a slight increase in the proportion meeting target (82% vs. 80%). While for interhospital transfers (Table 45), there were a similar number of analysable cases (1,365 vs. 1,373) and a decrease in the proportion meeting the target (52% vs. 59%).

Table 44: Time to angiography – direct to PCI facility

Site	Total cases n	Total analysed n	Median hours	Interquartile range hours	Met 72 hour target %
CH	201	177	34	15–60	80.2
TUH	165	149	41	20–65	79.9
MBH	95	92	22	11–42	89.1
SCUH	187	169	27	18–46	89.9
TPCH	350	313	24	13–51	86.3
RBWH	115	100	20	10–42	94.0
PAH	261	220	46	25–84	69.1
GCUH	244	226	39	17–76	73.9
STATEWIDE	**1,618**	**1,446**	**30**	**16–62**	**81.5**

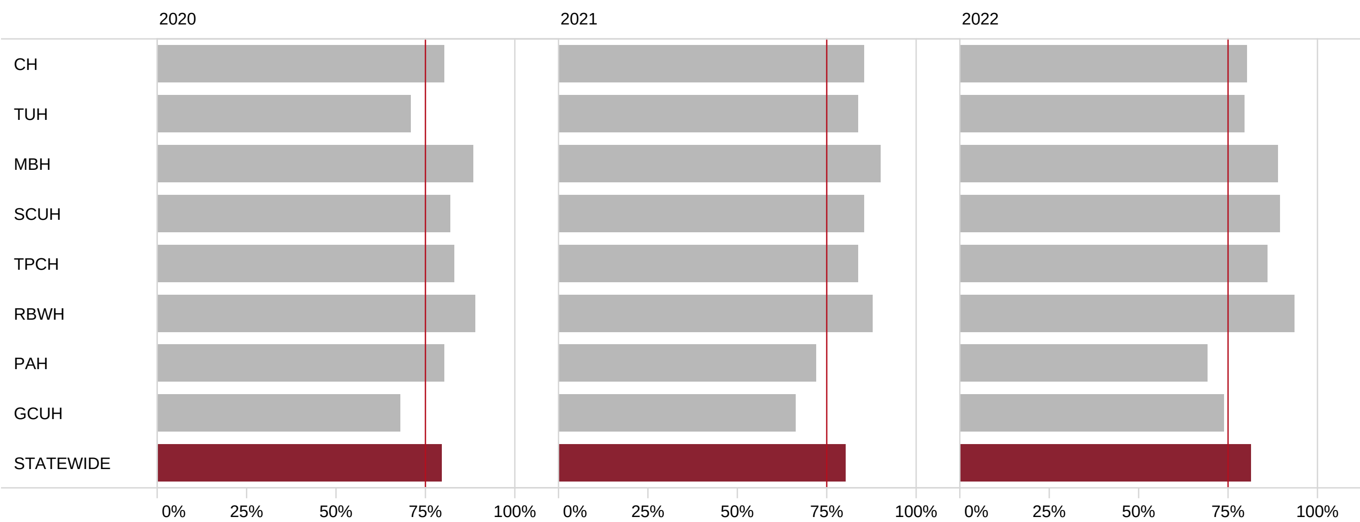


Figure 34: Proportion of NSTEMI direct presenters receiving angiography within 72 hours, 2020–2022

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. The median time to angiography in this group has increased to 70 hours from 63 hours in 2021.

Table 45: Time to angiography – interhospital transfers

Site	Total cases n	Total analysed n	Median hours	Interquartile range hours	Met 72 hour target %
CH	126	98	48	30–68	78.6
TUH	77	70	60	36–84	68.6
MBH	61	45	48	29–71	75.6
SCUH	113	78	40	21–58	91.0
TPCH	362	281	81	45–134	42.3
RBWH	255	224	68	42–100	54.0
PAH	568	514	87	53–128	38.1
GCUH	85	55	48	22–89	67.3
STATEWIDE	**1,647**	**1,365**	**70**	**41–111**	**51.5**

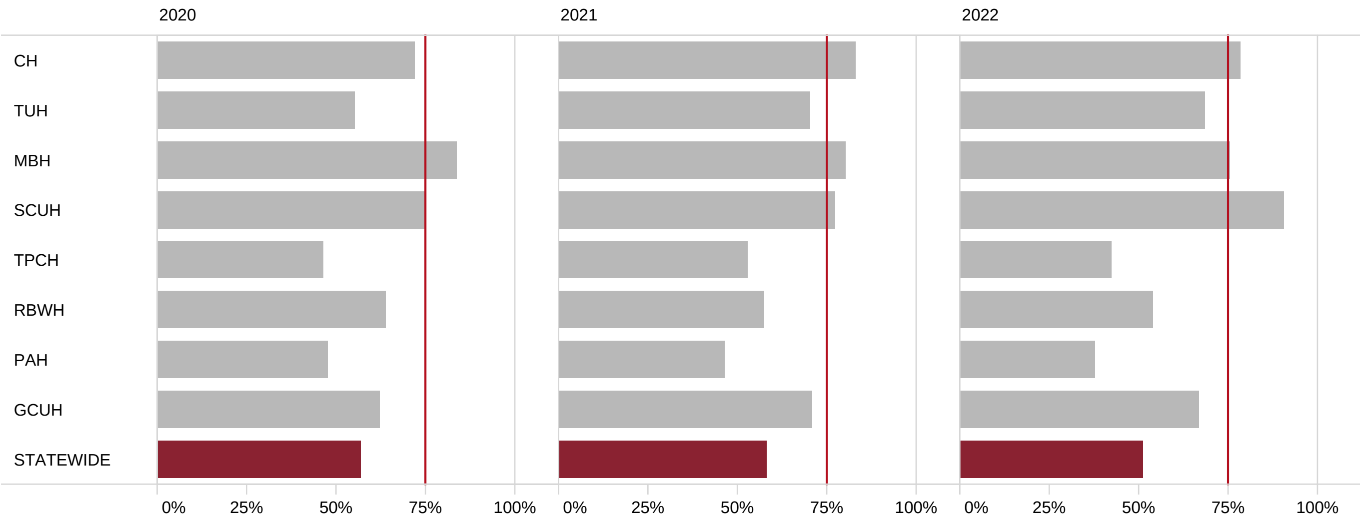


Figure 35: Proportion of NSTEMI interhospital transfers receiving angiography within 72 hours, 2020–2022

7.3.1 NSTEMI interhospital transfers – time to transfer to PCI facility

The median time to transfer NSTEMI patients to the PCI-capable facility for angiography was 36 hours, ranging from 4 hours to 63 hours by institution.

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

Once transferred to the PCI facility the median time from arrival to angiography being performed was 34 hours.

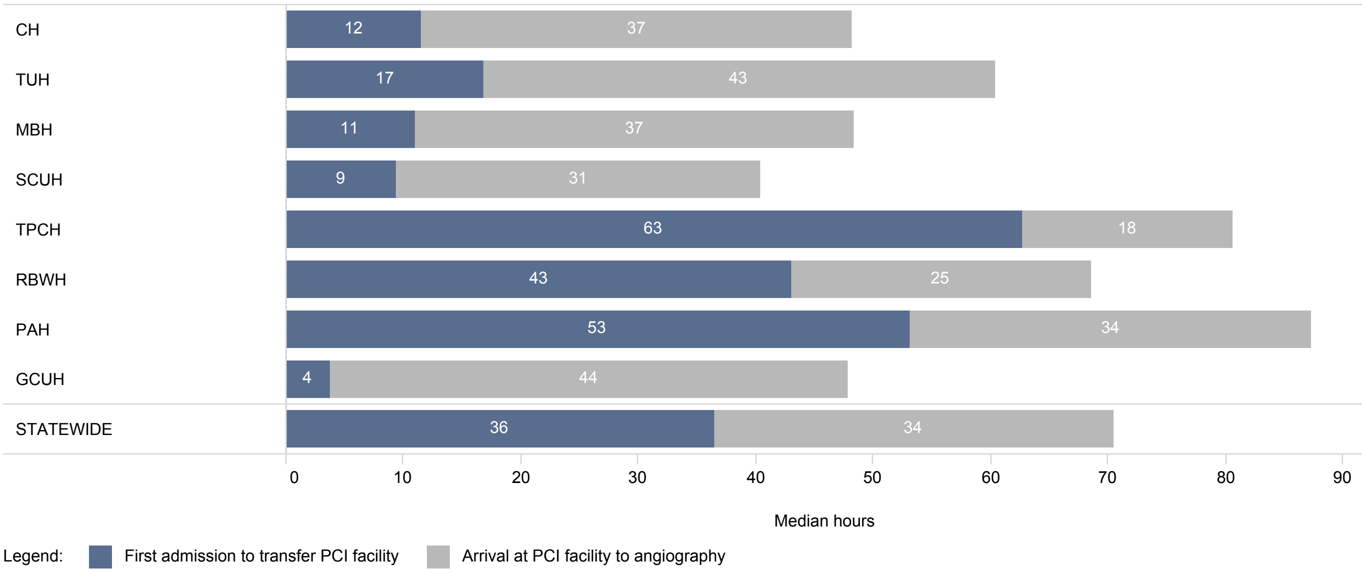
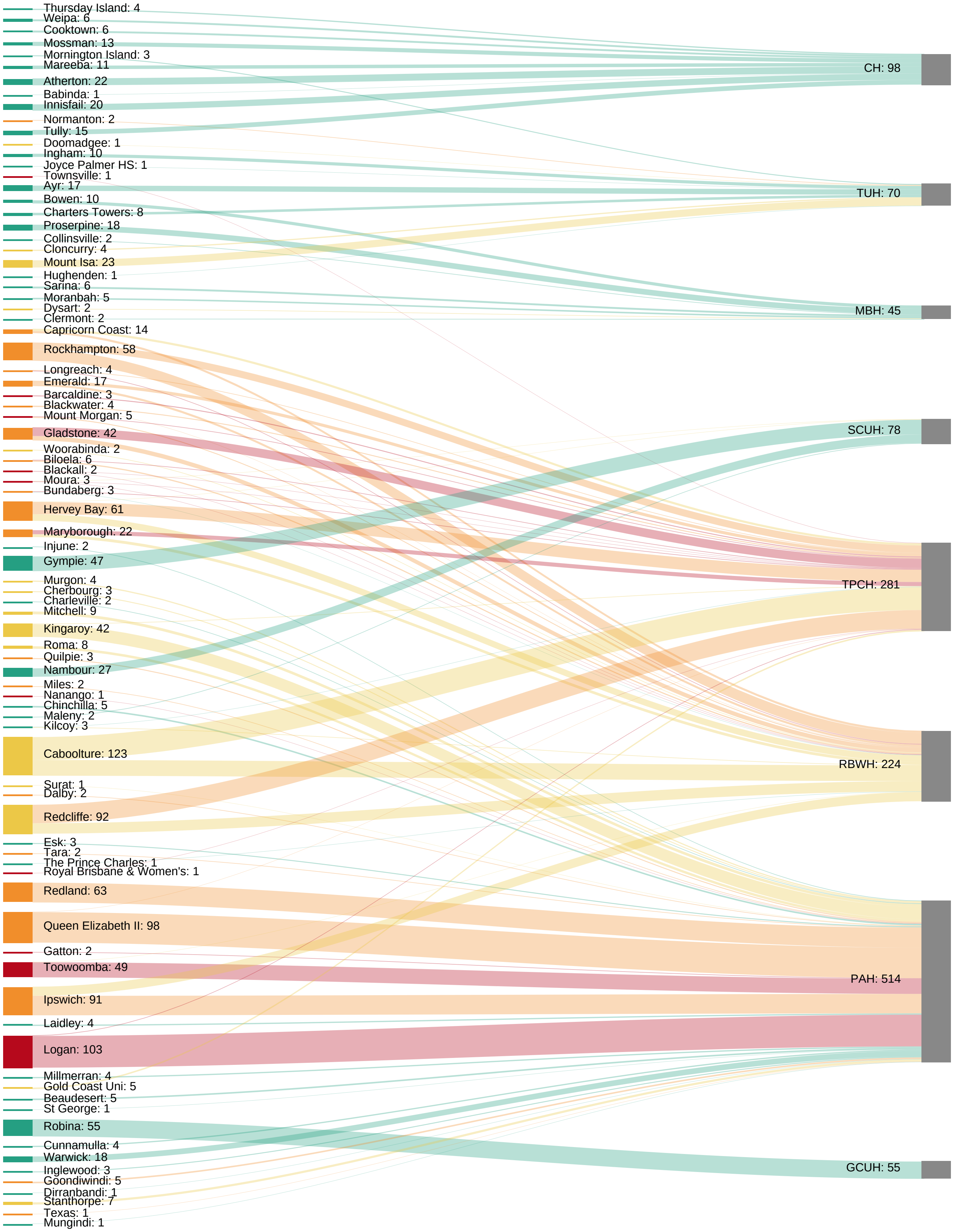


Figure 36: Median duration to transfer to PCI facility for angiography, NSTEMI interhospital transfers

Table 46: Median times to transfer to PCI facility for angiography, NSTEMI interhospital transfers

Site	Total cases n	Total analysed n	Median (IQR) distance transferred kilometres	Median time to transfer to PCI facility hours	Median overall time to angiography hours
CH	126	98	93 (75–143)	12	48
TUH	77	70	302 (133–901)	17	60
MBH	61	45	125 (58–191)	11	48
SCUH	113	78	93 (30–93)	9	40
TPCH	362	281	80 (39–505)	63	81
RBWH	255	224	46 (45–611)	43	68
PAH	568	514	27 (24–148)	53	87
GCUH	85	55	17 (17–17)	4	48
STATEWIDE	**1,647**	**1,365**	63 (27–275)	**36**	**70**



Excludes interhospital transfers originating in New South Wales

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

Of the 3,265 total NSTEMI cases, 50% were interhospital transfers. The median time to angiography with or without PCI was 48 hours. This represents a small increase compared to the previous year where the median time to angiography was 46 hours, with the overall proportion of cases meeting the target time (67%) – reduced from 69% in 2021.

Table 47: 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	327	275	38.5	42	20–64	79.6
TUH	242	219	31.8	45	22–71	76.3
MBH	156	137	39.1	29	17–55	84.7
SCUH	300	247	37.7	32	19–49	90.3
TPCH	712	594	50.8	46	21–93	65.5
RBWH	370	324	68.9	53	24–87	66.4
PAH	829	734	68.5	77	41–117	47.4
GCUH	329	281	25.8	41	17–79	72.6
STATEWIDE	**3,265**	**2,811**	**50.4**	**48**	**23–88**	**66.9**

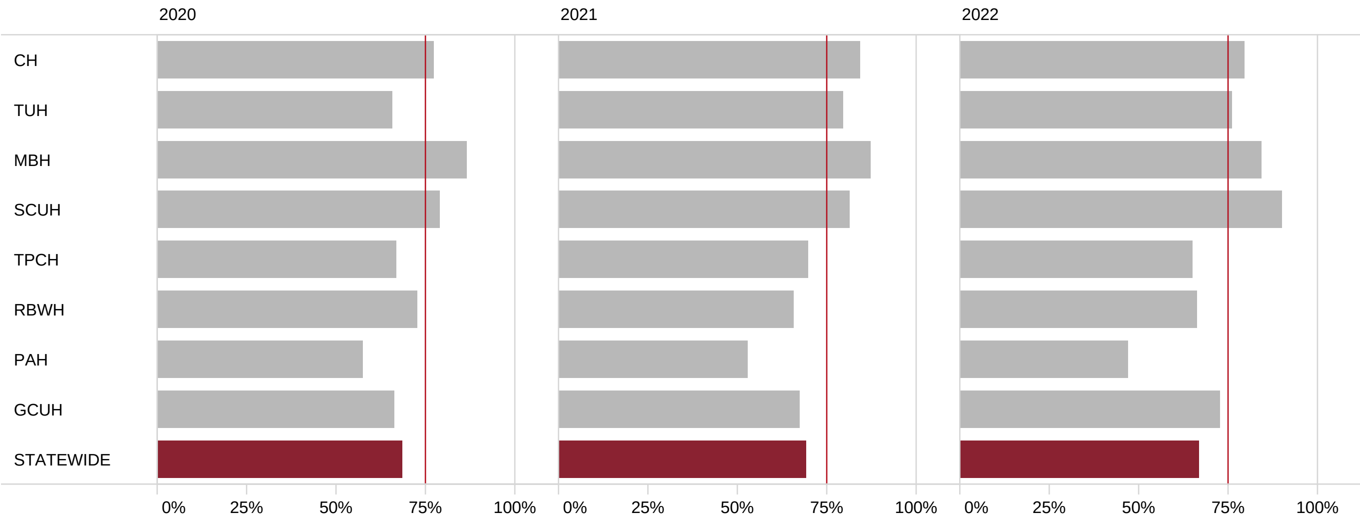


Figure 38: Proportion of NSTEMI cases meeting time to angiography target of 72 hours, 2020–2022

7.4 Major procedural complications

This quality indicator examines in-lab intra-procedural complications. In 2022, 45 cases (0.93%) recorded an immediate major procedural complication.

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

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

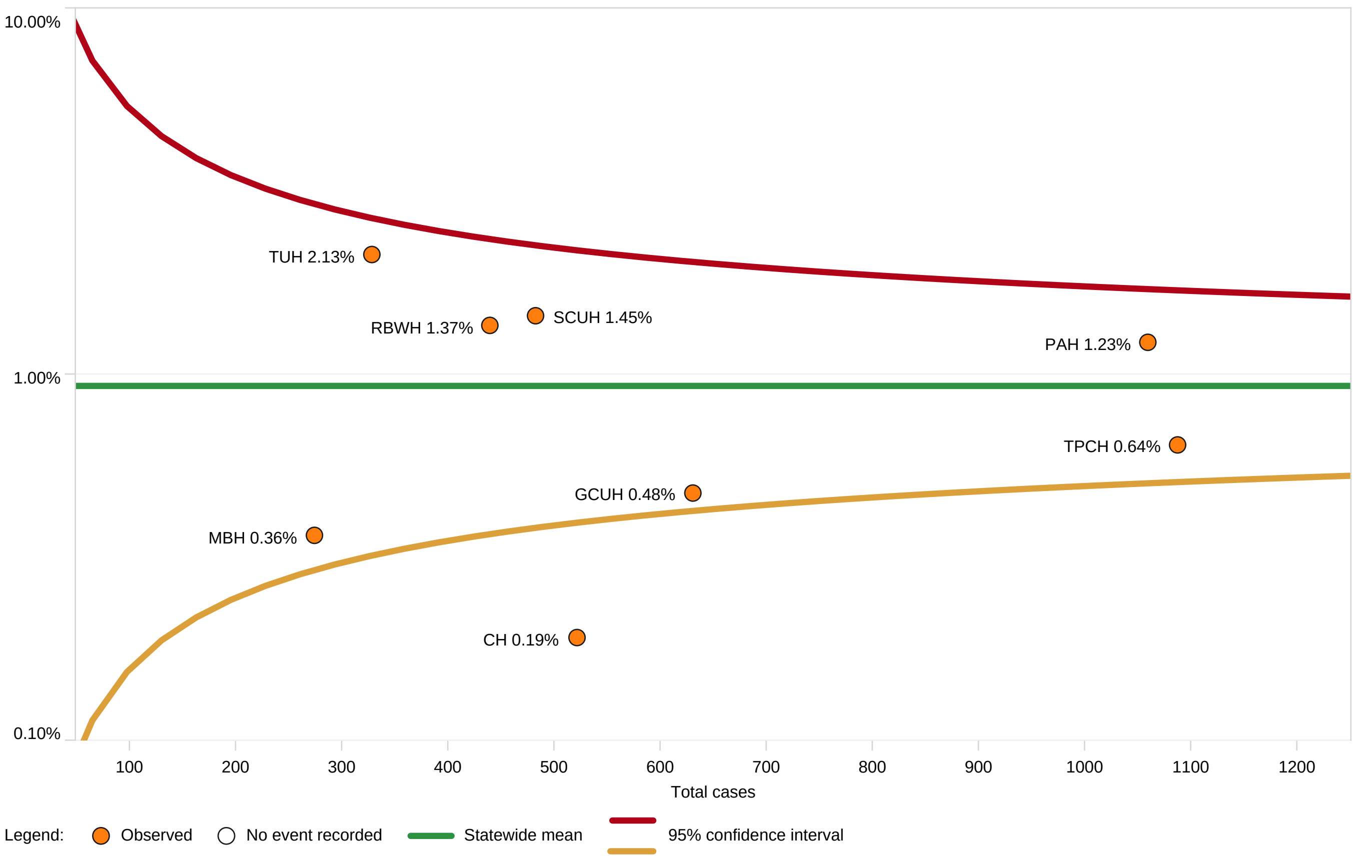


Figure 39: Proportion of PCI cases with immediate major procedure complication by site

Table 48: All PCI cases by immediate major procedural complication type

Complication type	Case n	%
Major intra-procedural complication	**45**	**0.93**
Coronary artery perforation	25	0.52
CVA	6	0.12
In-lab death*	5	0.10
Tamponade	5	0.10
Emergency CABG	4	0.08
No immediate major procedural complication	4,773	99.07
Total	**4,818**	**100.0**

* Excluding salvage deaths

7.5 High radiation doses

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

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

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

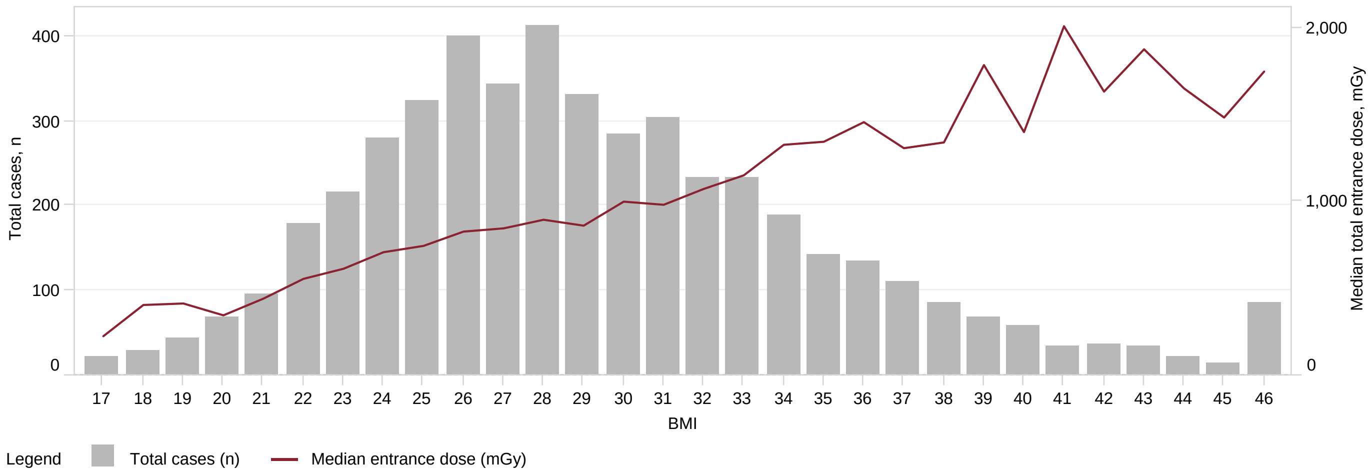


Figure 40: All coronary and PCI procedures median total entrance dose by body mass index

Table 49: Proportion of cases meeting the safe dose threshold by case type

Site	PCI procedures %	Other coronary procedures %
CH	100.0	100.0
TUH	100.0	100.0
MBH	100.0	100.0
SCUH	99.4	100.0
TPCH	99.4	100.0
RBWH	99.8	100.0
PAH	95.7	99.9
GCUH	99.7	100.0
STATEWIDE	**98.8**	**100.0**

8 Supplement: Structural heart disease

Minimally invasive, surgical and/or catheter-based structural heart disease (SHD) interventions have recently seen a dramatic increase in uptake around the world. Transcatheter aortic valve replacement (TAVR) for severe aortic stenosis (AS) is an emerging clinical technology, and next generation devices and careful patient selection have minimised the limitations of TAVR including paravalvular leak, conduction disturbances, ischaemic stroke, and vascular complications. The indications for TAVR continue to shift toward lower risk patients and patients with complex anatomy such as bicuspid AS or native pure aortic regurgitation. However, in Queensland public facilities, TAVR continues to be offered primarily as an alternative to surgical interventions, often for patients of advanced age and with many comorbidities and complex chronic diseases.

TAVR has emerged as a first-line treatment in preference to traditional open aortic valve surgery for growing population patients owing to a growing randomised controlled trial evidence base. Successful clinical results in TAVR have generated considerable interest in further transcatheter technologies targeting mitral regurgitation and toward tricuspid regurgitation. Continued technical and device improvements and accumulated evidence will expand its possibility and the future of SHD interventions.

Catheter based interventions for the closure of septal defects also continues to evolve. With advances in technology, larger and more complex defects are now able to be closed via this minimally invasive approach. Furthermore, the use of catheter-based interventions to treat a broad range of conditions and anatomic anomalies continues to increase and diversify.

Since 2018 in Queensland public facilities, there has been a 61% increase in the volume of transcatheter valve interventions across four sites. Similarly, in the same period there has been a 38% increase in device closure procedures which are now offered at seven facilities.

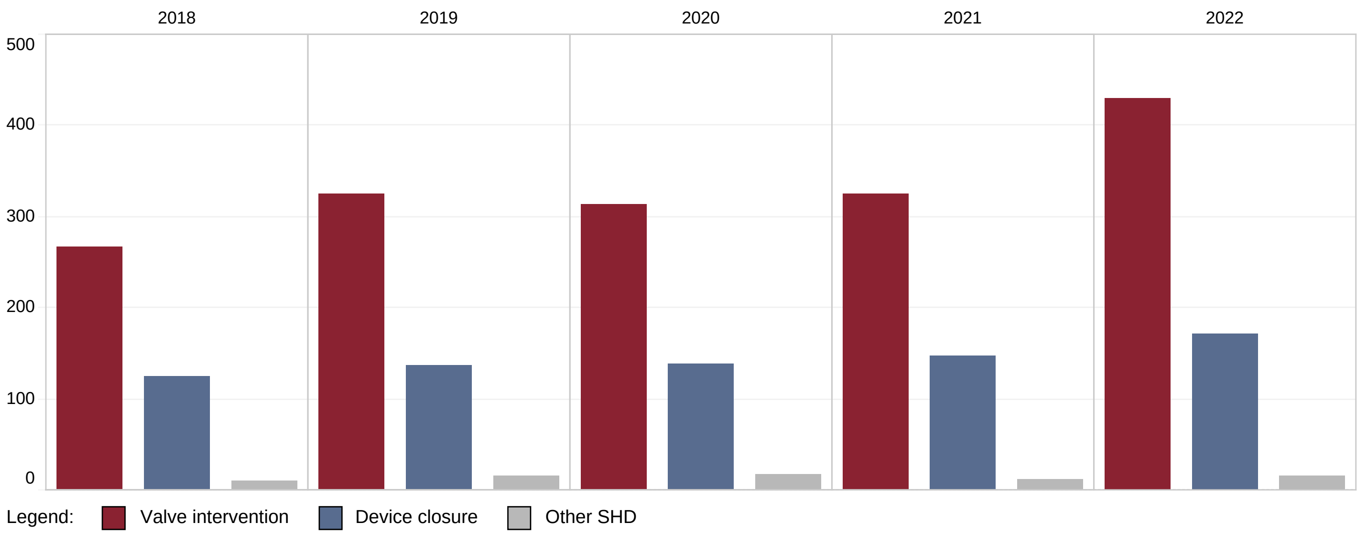


Figure 1: SHD cases by procedure category (2018–2022)

8.1 Participating sites

A total of 617 SHD interventions were performed across the seven Queensland public cardiac catheterisation laboratories. Over two thirds (70%) 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	36	25 (69.4)	9 (25.0)	2 (5.6)
TUH	37	12 (32.4)	25 (67.6)	–
SCUH	13	13 (100.0)	–	–
TPCH	290	39 (13.4)	242 (83.4)	9 (3.1)
RBWH	27	19 (70.4)	7 (25.9)	1 (3.7)
PAH	153	37 (24.2)	112 (73.2)	4 (2.6)
GCUH	61	26 (42.6)	35 (57.4)	–
STATEWIDE	**617**	**171 (27.7)**	**430 (69.7)**	**16 (2.6)**

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

† Percutaneous valve replacement and valvuloplasty

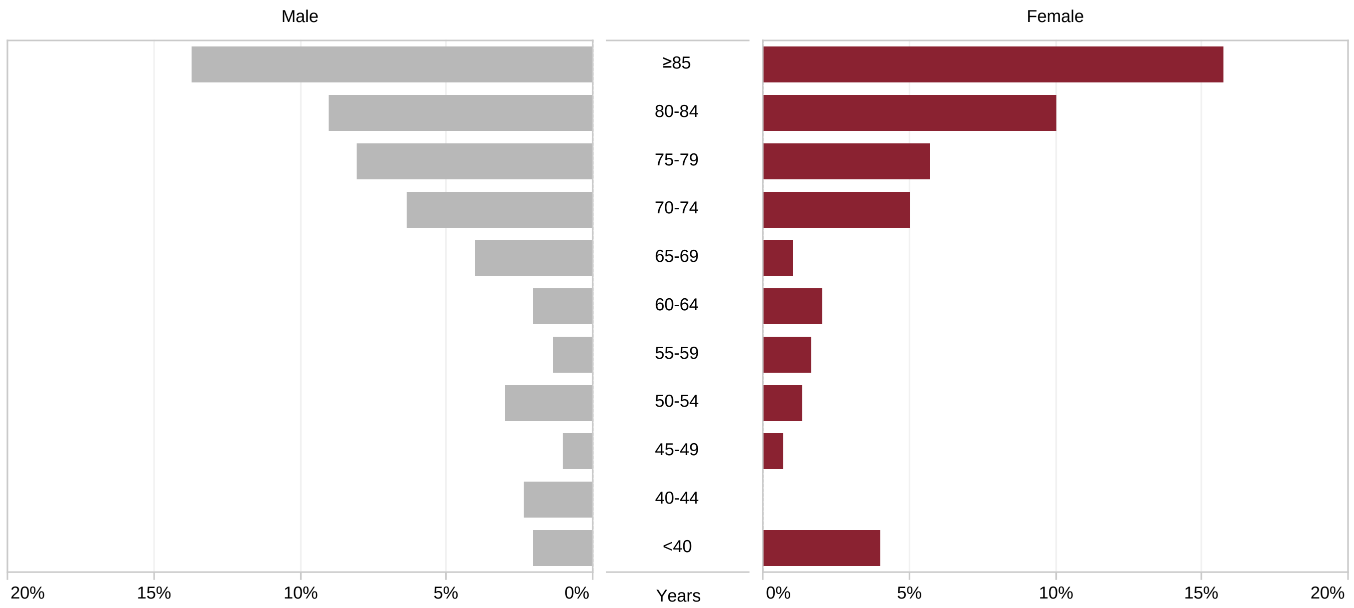
‡ Myocardial septal ablation, renal denervation and percutaneous insertion of pulmonary arterial pressure monitoring device

8.2 Patient characteristics

8.2.1 Age and gender

Gender of patients undergoing an SHD intervention were closely distributed with 52% male and 48% female. Almost one third (30%) of all procedures were performed on patients aged 85 years and older.

Age varied considerably by procedure category, with patients undergoing a valvular intervention having an overall median age of 81 years compared to 52 years for device closures procedures.



% of total (n=617)

Figure 2: 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	54	49	52
Valvular intervention	80	82	81
Other	61	64	61
ALL	77	77	77

8.3 Care and treatment of SHD patients

8.3.1 Device closures

There were 171 device closures performed across the seven participating centres. The majority of procedures involved atrial septal closure devices for the correction of a patent foramen ovale (PFO) and atrial septal defect (ASD), at 69% and 19% of case volumes respectively. A smaller proportion of cases were for left atrial appendage closure and interventions to address prosthetic valve paravalvular leaks.

Table 3: Device closure procedures by participating site

Site	Total cases n	PFO* n (%)	ASD† n (%)	PDA‡ n (%)	LAA§ n (%)	Paravalvular leak n (%)	VSD|| n (%)
CH	25	20 (80.0)	5 (20.0)	–	–	–	–
TUH	12	10 (83.3)	–	–	–	2 (16.7)	–
SCUH	13	11 (84.6)	1 (7.7)	1 (7.7)	–	–	–
TPCH	39	14 (35.9)	8 (20.5)	3 (7.7)	9 (23.1)	4 (10.3)	1 (2.6)
RBWH	19	14 (73.7)	5 (26.3)	–	–	–	–
PAH	37	26 (70.3)	11 (29.7)	–	–	–	–
GCUH	26	23 (88.5)	3 (11.5)	–	–	–	–
STATEWIDE	**171**	**118 (69.0)**	**33 (19.3)**	**4 (2.3)**	**9 (5.3)**	**6 (3.5)**	**1 (0.6)**

* Patent foramen ovale

† Atrial septal defect

‡ Patent ductus arteriosus

§ Left atrial appendage

|| Ventricular septal defect

8.3.2 Valvular interventions

The total number of valvular interventions performed across the seven participating sites was 430, comprising of transcatheter valve replacement (83%) and transcatheter valvuloplasty (17%) procedures.

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

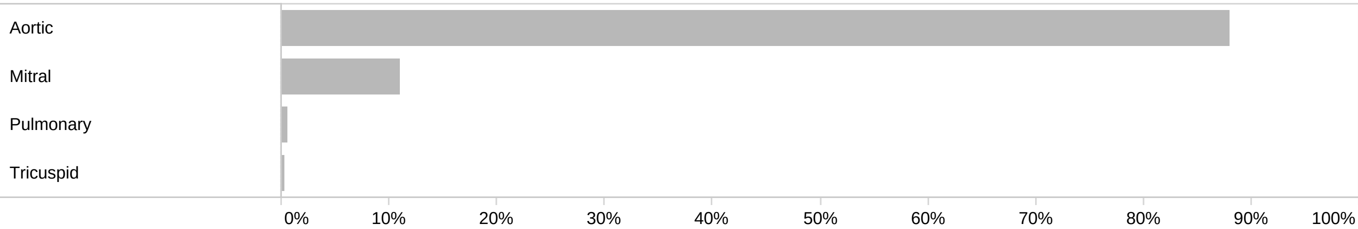


Figure 3: Proportion of all transcatheter valvular interventions by valve type

Table 4: Transcatheter valvular interventions by cardiac valve

Site	Total cases n	Aortic n (%)	Mitral n (%)	Pulmonary n (%)	Tricuspid n (%)
CH	9	9 (100.0)	–	–	–
TUH	25	24 (96.0)	1 (4.0)	–	–
TPCH	242	200 (82.6)	28 (11.6)	8 (3.3)	6 (2.5)
RBWH	7	7 (100.0)	–	–	–
PAH	112	105 (93.8)	7 (6.3)	–	–
GCUH	35	35 (100.0)	–	–	–
STATEWIDE	**430**	**380 (88.4)**	**36 (8.4)**	**8 (1.9)**	**6 (1.4)**

Table 5: Transcatheter valvular interventions by type

Site	Total cases n	Transcatheter valve replacement n (%)	Transcatheter valvuloplasty n (%)
CH	9	–	9 (100.0)
TUH	25	24 (96.0)	1 (4.0)
TPCH	242	198 (81.8)	44 (18.2)
RBWH	7	–	7 (100.0)
PAH	112	104 (92.9)	8 (7.1)
GCUH	35	29 (82.9)	6 (17.1)
STATEWIDE	**430**	**355 (82.6)**	**75 (17.4)**

The rapid evolution of transcatheter based technology has meant that transcatheter valve replacement procedures have become an increasing common approach for treating patients with conditions often otherwise reliant on cardiac surgery. There were four sites that offered transcatheter valve replacement procedures where the vast majority were transcatheter aortic valve replacement (94%).

Table 6: Transcatheter valvuloplasty procedures

Site	Balloon aortic valvuloplasty n (%)	Balloon mitral valvuloplasty n (%)	Mitral leaflet clip n (%)	Balloon tricuspid valvuloplasty n (%)	Balloon tricuspid valvuloplasty n (%)
CH	9 (100.0)	–	–	–	–
TUH	–	1 (100.0)	–	–	–
TPCH	21 (47.7)	1 (2.3)	17 (38.6)	3 (6.8)	2 (4.5)
RBWH	7 (100.0)	–	–	–	–
PAH	2 (25.0)	1 (12.5)	5 (62.5)	–	–
GCUH	6 (100.0)	–	–	–	–
STATEWIDE	**45 (60.0)**	**3 (4.0)**	**22 (29.3)**	**3 (4.0)**	**2 (2.7)**

Table 7: Transcatheter valve replacement procedures

Site	TAVR* n (%)	TMVR† n (%)	TTVR‡ n (%)	TPVR§ n (%)
TUH	24 (100.0)	–	–	–
TPCH	179 (90.4)	10 (5.1)	3 (1.5)	6 (3.0)
PAH	103 (99.0)	1 (1.0)	–	–
GCUH	29 (100.0)	–	–	–
STATEWIDE	**335 (94.4)**	**11 (3.1)**	**3 (0.8)**	**6 (1.7)**

* 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 (%)	Percutaneous insertion of pulmonary arterial pressure monitoring device n (%)	Renal denervation n (%)
CH	–	–	2 (100.0)
TPCH	1 (11.1)	4 (44.4)	4 (44.4)
RBWH	1 (100.0)	–	–
PAH	4 (100.0)	–	–
STATEWIDE	**6 (37.5)**	**4 (25.0)**	**6 (37.5)**

8.4 Patient outcomes

8.4.1 All-cause 30 day mortality

Thirty day mortality rates typically reflect the success of the procedural or technical component of any intervention. Across the seven public cardiac catheterisation laboratories in Queensland that offer SHD interventions, the all-cause, unadjusted 30 day mortality rate for all SHD procedures was 1.6%. Further descriptions of longer term outcomes for TAVR cohorts from previous years are discussed further in the subsequent analysis.

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	36	0 (0.0)	2 (22.2)	0 (0.0)	2 (5.6)
TUH	37	0 (0.0)	0 (0.0)	–	0 (0.0)
SCUH	13	0 (0.0)	–	–	0 (0.0)
TPCH	290	0 (0.0)	5 (2.1)	0 (0.0)	5 (1.7)
RBWH	27	0 (0.0)	1 (14.3)	0 (0.0)	1 (3.7)
PAH	153	0 (0.0)	1 (0.9)	0 (0.0)	1 (0.7)
GCUH	61	0 (0.0)	1 (2.9)	–	1 (1.6)
STATEWIDE	**617**	**0 (0.0)**	**10 (2.3)**	**0 (0.0)**	**10 (1.6)**

8.4.2 Transcatheter aortic valve replacement cases

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

Table 10: Median age of TAVR patients by year

Year	Total cases n	Median age at procedure years	Interquartile range years
2018	148	85	80–88
2019	249	83	78–86
2020	249	81	76–85
2021	239	83	77–86
2022	335	81	76–86

2022 cases

Of the four sites performing TAVR in 2022, the all-cause unadjusted mortality rate within 30 days of the procedure for the statewide cohort was 1.8%.

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

Site	Total cases n	30 day mortality n (%)
TUH	24	0 (0.0)
TPCH	179	4 (2.2)
PAH	103	1 (1.0)
GCUH	29	1 (3.4)
STATEWIDE	**335**	**6 (1.8)**

2021 and 2020 cases

Of the four sites performing TAVR in 2021, the overall all-cause unadjusted mortality rate within 30 days of the procedure was 0.8%, and 6.7% at one year. For the TAVR procedures performed in 2020, the overall all-cause unadjusted mortality rate at two years post procedure was 16.1%. This is in-line with similarly age and risk matched international cohorts from high-volume TAVR centres.[21,22,23] It is recognised that all-cause mortality, especially beyond 30 days, include patient factors not necessarily related to the procedure or intervention in this older and often comorbid patient group.

Table 12: All-cause unadjusted 30 day and 1 year mortality post TAVR by site (2021 cohort)

Site	Total cases n	Median age at procedure years	Interquartile range years	30 day mortality n (%)	1 year mortality n (%)
TUH	13	82	77–85	0 (0.0)	2 (15.4)
TPCH	136	83	77–87	1 (0.7)	8 (5.9)
PAH	62	81	78–84	0 (0.0)	6 (9.7)
GCUH	28	83	77–87	1 (3.6)	1 (3.6)
STATEWIDE	**239**	**83**	**77–86**	**2 (0.8)**	**17 (7.1)**

Table 13: All-cause unadjusted mortality up to 2 years post TAVR by site (2020 cohort)

Site	Total cases n	Median age at procedure years	Interquartile range years	30 day mortality n (%)	1 year mortality n (%)	2 year mortality n (%)
TUH	21	84	82–86	0 (0.0)	4 (19.0)	6 (28.6)
TPCH	150	81	76–86	2 (1.3)	16 (10.7)	25 (16.7)
PAH	55	81	76–84	1 (1.8)	2 (3.6)	5 (9.1)
GCUH	23	81	78–83	0 (0.0)	1 (4.3)	4 (17.4)
STATEWIDE	**249**	**81**	**76–85**	**3 (1.2)**	**23 (9.2)**	**40 (16.1)**

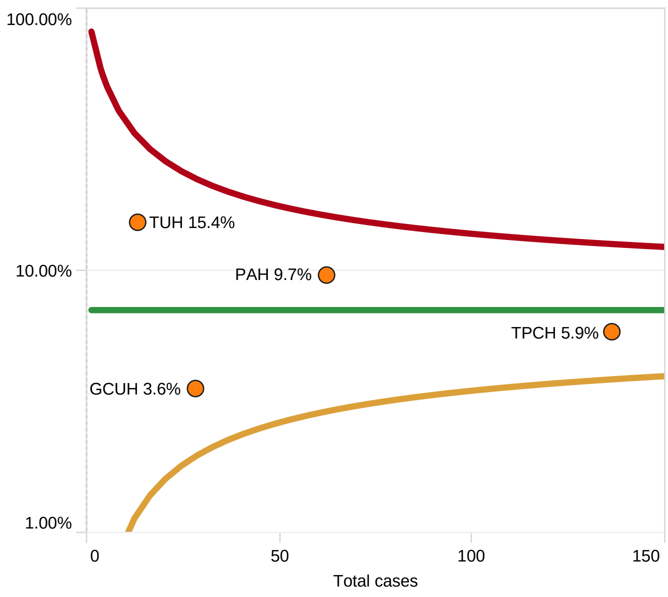


Figure 4: One year mortality post TAVR by site (2021 cohort)

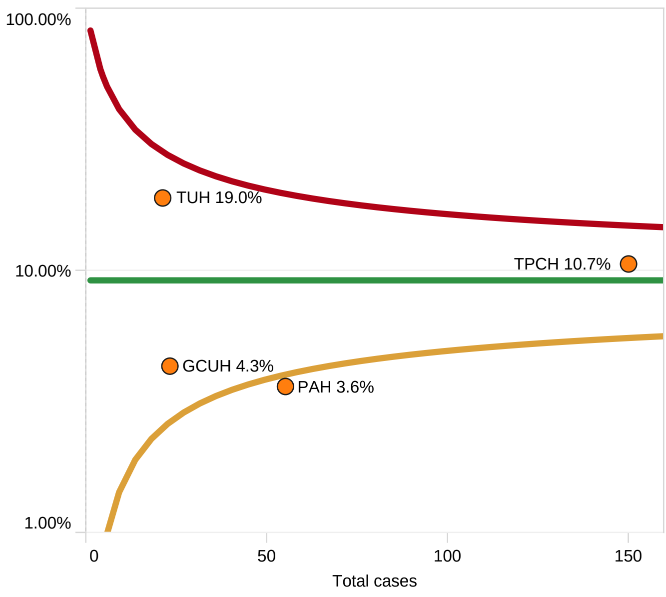


Figure 5: One year mortality post TAVR by site (2020 cohort)

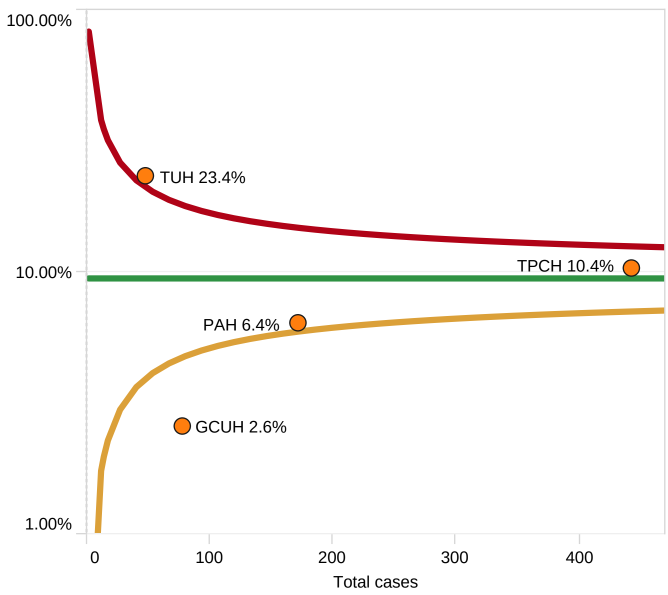
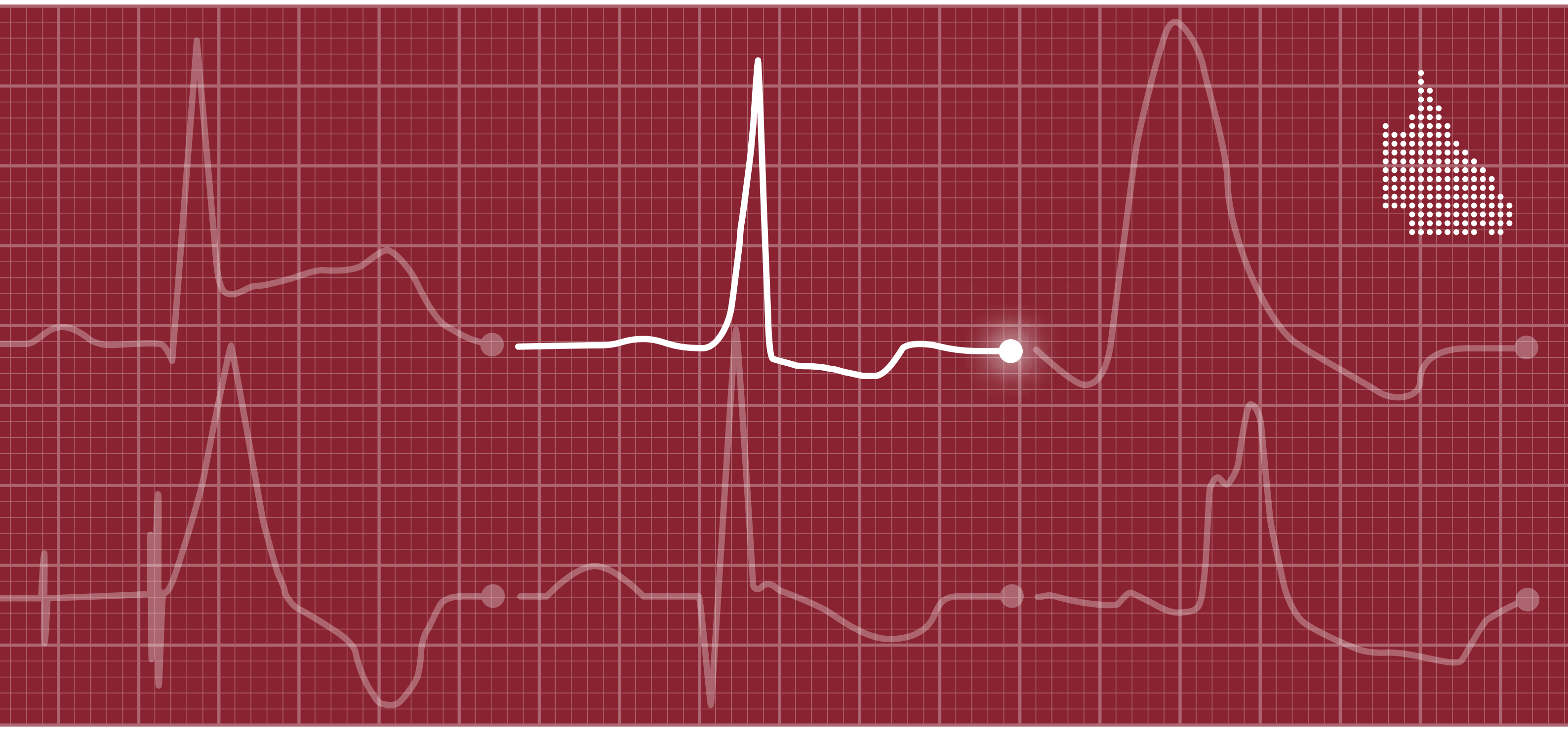


Figure 6: One year mortality post TAVR by site (2019–2021 cohort)

Cardiac Surgery Audit



1 Message from the QCOR Cardiothoracic Steering Committee Chair

In 2022, 400 fewer Queenslanders underwent cardiac surgery than in 2021. The number of patients who had gone through the journey of cardiac surgery had been stable in 2019, 2020, and 2021, despite increases in the Queensland population. However, in 2022, that number dropped by 400, approximately 15%. The number of units, surgeons and theatres did not change, but due to well described public health response reasons, the ability of our systems to take a patient who is listed for surgery, admit them to hospital, perform their surgery, admit them to intensive care, have them recover enough to reach the ward, and then recover further until they can be discharged home, was reduced. As all Queensland cardiac surgical units are not stand-alone but are in hospitals that have other specialty units that treat the wide array of diseases and conditions, this reflects likely reflect an increase in demand from competing specialties. More beds occupied in hospitals by patients suffering from non cardiac surgical conditions unfortunately means that cardiac surgery cannot be performed. Despite the willingness of teams to perform complex cardiac surgical procedures, competing capacity demands in our hospital system reduces access for cardiac surgical patients.

The rate of cardiac surgery per population has changed with technology, but over the last three years, there has not been a significant change in practice to explain a change in the numbers of cardiac surgical patients. Instead, reduced capacity usually results in longer waiting times for surgery, and reduced numbers of procedures. What is noticed over the QCOR Cardiac Surgery Annual Reports from 2018 to 2022 is that the rate of elective surgery has dropped from 60% to below 50%. Cardiac surgery is often an urgent or emergent procedure. A condition develops rapidly, or a condition reaches a critical level, and surgery must be performed in an urgent time frame. For some Queenslanders, their heart condition has a degree of stability, and they wait at home, carefully going about their lives, waiting for an admission to hospital to undergo their surgery. In a system under pressure, urgent or emergent inpatient operations continue to be done out of necessity .While we do not have data about the morbidity or mortality of the waiting list we do have data on the patients who reach surgery. We do not have data on the stable patients, on the waiting list for surgery, who then become unstable, are admitted acutely and then undergo emergency or urgent surgery. The hearts of Queenslanders seem able to withstand these testing times to a degree that there has not been an increase in mortality after cardiac surgery. Hearts waiting for surgery gradually deteriorate, and longer waiting times can then increase the risk of surgery. However, cardiac surgery continues to be performed at a high level with expected or better than expected rates of mortality for those Queenslanders who arrive on our operating tables.

The QCOR project of examining the quality of surgery has continued to expand, with the Quality Assurance Committee (QAC) that was established having improved the outcomes of surgery, as evidenced in the research presented by the team, led by Mr Vollbon.*†‡

The cardiothoracic surgery QAC under QCOR uses multiple statistical analyses and markers, which are demonstrated in this report within the mortality and morbidity reporting section that shows the exponentially weighted moving averages. There are patterns, variations and spikes in the reporting. This report shows statewide results across time. In the QAC meetings, under qualified privilege with representatives from each unit, unit-based results are discussed and variations from the expected and changes in the rates are discussed and units provide actions and responses. The nature of cardiac surgeons is to compete for high performance, and regular reviews of performance encourage us all to lead our teams to high performance.

Hopefully as Queensland Health builds increased capacity in the system, the ability of Queenslanders to undergo timely surgery will improve.

Dr Christopher Cole
Chair
QCOR Cardiothoracic Surgery Committee

* Vollbon, W., Poulter, R., Stewart, P., Atherton, J., Kidby, K., Starmer, G., Hammett, C., Cole, C., Hill, J., Mallouhi, M., Prior, M., Smith, I., Bryce, V., Hickey, A., & Phillips, S. (2023). Establishment of a Clinical Quality Program for Cardiac Services in Queensland Public Hospitals: The Evolution of the Queensland Cardiac Outcomes Registry (QCOR)). *Heart, Lung and Circulation, 32*. https://doi.org/10.1016/j.hlc.2023.06.810

† Vollbon, W., Cole, C., Windsor, M., Prabhu, A., Stroebel, A., Mathew, M., Prior, M., Mallouhi, M., & Smith, I. (2023) Deep Sternal Wound Infection Following Cardiothoracic Surgery—Insights and Outcomes of Public Reporting in Queensland Public Hospitals. *Heart, Lung and Circulation, 32*. https://doi.org/10.1016/j.hlc.2023.06.457

‡ Vollbon, W., Cole, C., Windsor, M., Prabhu, A., Stroebel, A., Mathew, M., Prior, M., Mallouhi, M., & Smith, I. (2023). Establishment of a Cardiothoracic Surgical Clinical Quality Assurance Committee in Queensland Public Hospitals. *Heart, Lung and Circulation, 32*. https://doi.org/10.1016/j.hlc.2023.06.459

2 Key findings

This Queensland Cardiac Surgery Audit describes baseline demographics, risk factors, surgeries performed and surgery outcomes for 2022.

Key findings include:

- The number of surgeries performed across the four public adult cardiac surgery units in Queensland were 2,230.
- The majority of patients were aged between 61 years and 80 years of age (69%) with a median age of 67 years old.
- Approximately three quarters of patients were male (74%).
- The majority of all patients were overweight or obese (74%), with less than one quarter (24%) of patients having a body mass index within the normal range.
- The overall proportion of Aboriginal and Torres Strait Islander patients was 6.6%, and had a wide variation between sites with 19% of patients in Townsville identifying as Aboriginal and Torres Strait Islander.
- The majority of patients had high blood pressure (64%) or high cholesterol (68%) or presented with a combination of several background risk factors.
- There were 29% of patients reported to be diabetic at the time of their operation, increasing to 38% of all patients undergoing coronary artery bypass grafting (CABG).
- Over one quarter (29%) of patients had an element of left ventricular systolic dysfunction at the time of surgery.
- Half of all cases were elective admissions with 18% of elective patients being admitted on the day of surgery.
- In 2022, 1,246 patients had a CABG procedure, of whom the majority (91%) had multi-vessel disease.
- There were 243 patients who underwent aortic surgery. The majority of aortic procedures involved aortic replacement surgery (73%).
- Among the 1,003 patients undergoing valve surgery, the most common interventions were single valve replacements of the aortic valve (64%) or mitral valve (21%). Approximately 13% of valve surgeries involved multiple valves.
- The primary pathology for patients undergoing valvular surgery was degenerative valve disease (47%).
- Cardiac surgeons were involved in 47% of the 335 transcatheter aortic valve replacements performed in Queensland public hospitals.
- Major morbidities were evaluated using Society of Thoracic Surgeons (STS) models with most results demonstrating that the observed rate of adverse events is within or better than expected.
- The mortality rate after surgery is either within the expected range or lower than expected, depending on the risk model used to evaluate this outcome.

3 Participating sites

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

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

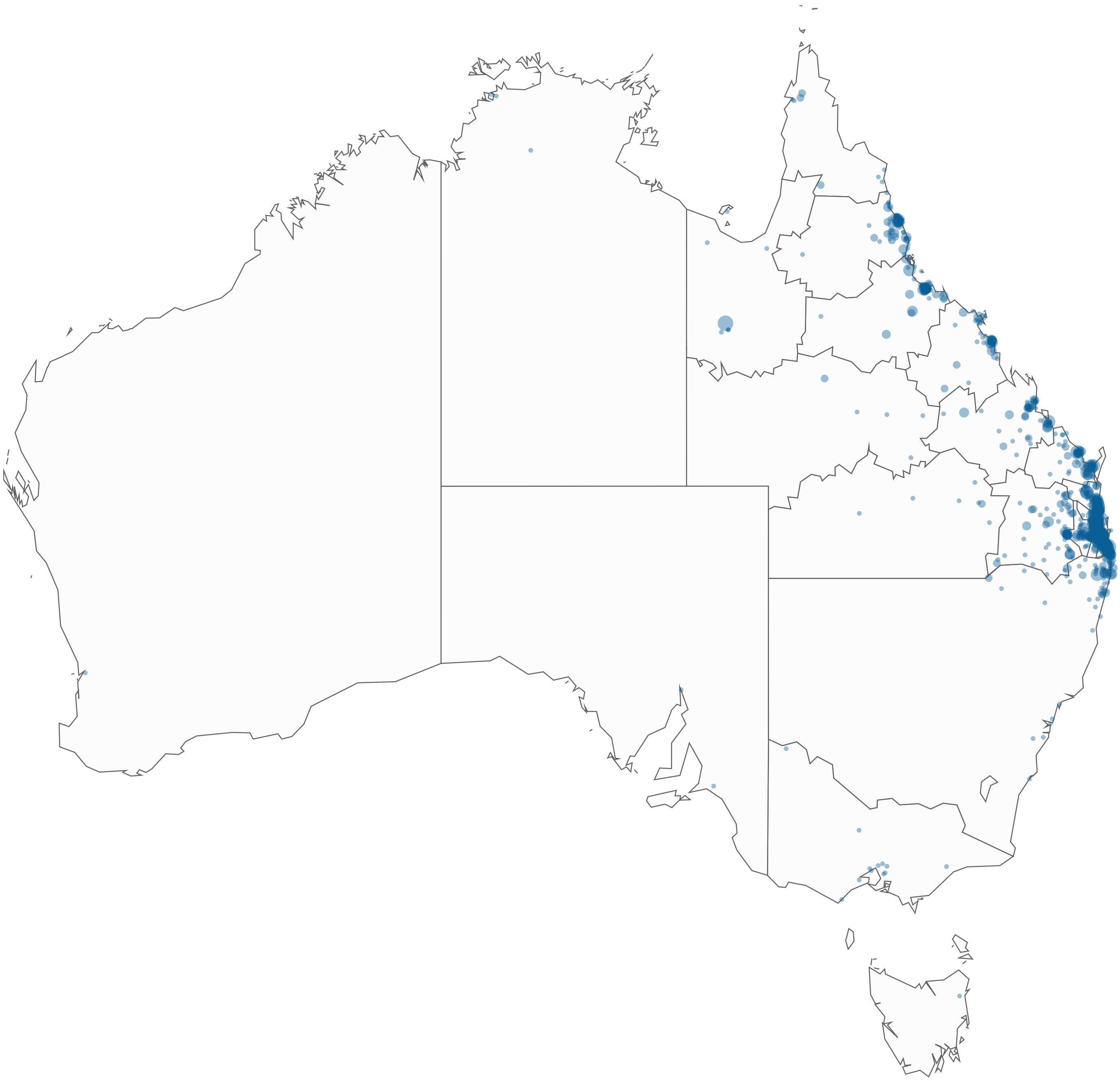


Figure 1: Cardiac surgery cases by residential postcode

Table 1: Participating sites

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

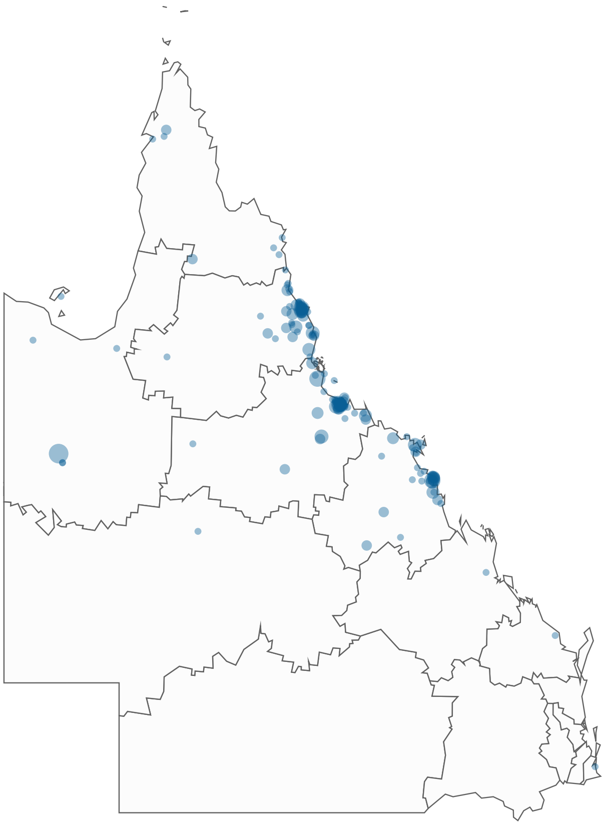


Figure 2: Townsville University Hospital

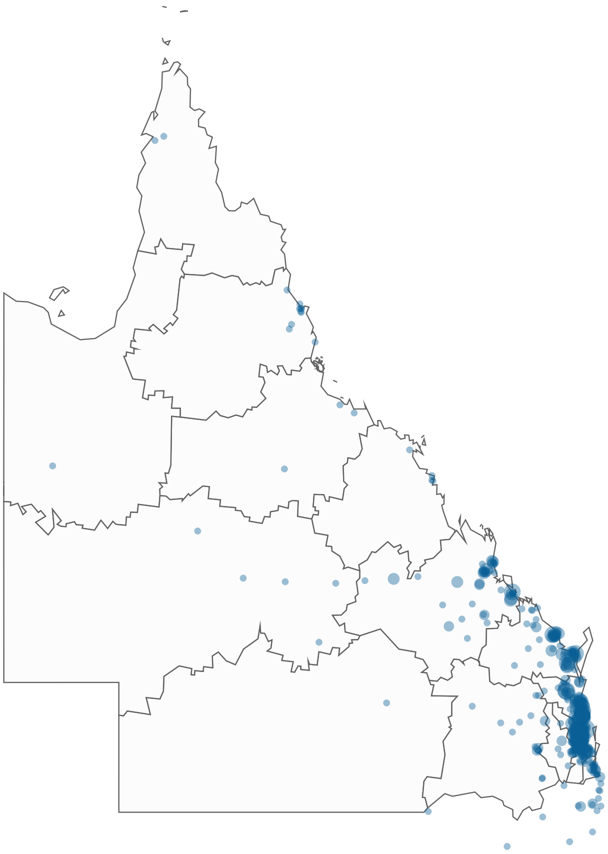


Figure 3: The Prince Charles Hospital

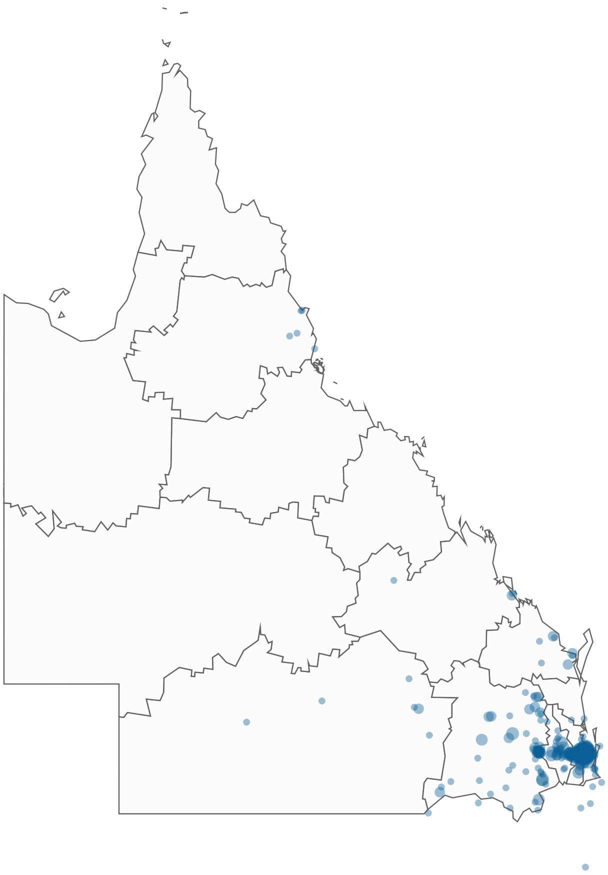


Figure 4: Princess Alexandra Hospital

Figure 5: Gold Coast University Hospital

4 Case totals

4.1 Total surgeries

In 2022, the four public hospitals performed a total of 2,230 cardiac surgical procedures. For the purposes of this report, each of the procedure combinations included in those cases has been assigned to a cardiac surgery procedure category.

There was a notable reduction of the total number of cases compared to the previous year, where the number of cardiac surgical procedures was 2,623.

Table 2: Procedure counts and surgery category

Procedure combination	Category*	Count n
CABG	ANY CABG	989
CABG + other cardiac procedure		42
CABG + aortic procedure		6
CABG + other non cardiac procedure		6
CABG + aortic procedure + other cardiac procedure		1
CABG + other cardiac procedure + other non cardiac procedure		1
CABG + valve	CABG + VALVE	153
CABG + valve + aortic procedure		24
CABG + valve + other cardiac procedure		17
CABG + valve + aortic procedure + other cardiac procedure		3
CABG + valve + other non cardiac procedure		3
CABG + valve + aortic procedure + other non cardiac procedure		1
Valve	VALVE†	569
Valve + aortic procedure		107
Valve + other cardiac procedure		95
Valve + aortic procedure + other cardiac procedure		26
Valve + other non cardiac procedure		3
Valve + aortic procedure + other non cardiac procedure		1
Valve + other cardiac procedure + other non cardiac procedure		1
Other cardiac procedure	OTHER	105
Aortic procedure		61
Aortic procedure + other cardiac procedure		7
Aortic procedure + other non cardiac procedure		6
Other cardiac procedure + other non cardiac procedure		3
ALL		**2,230**

* Category procedure combination allocated

† Includes TAVR procedures involving CTS (n=157)

4.2 Cases by category

Over half (56%) of all cardiac surgery procedures involved coronary artery bypass grafting (CABG) with 9% involving a simultaneous CABG and valve procedure.

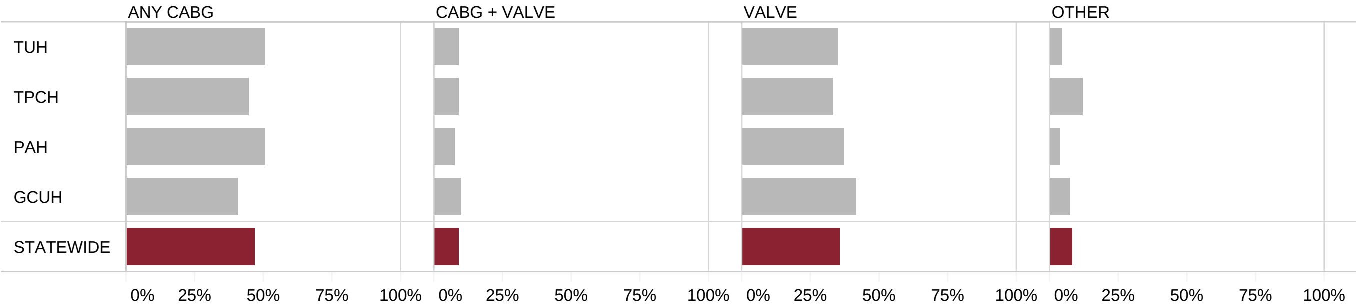


Figure 6: Proportion of cases by site and surgery category

Table 3: Proportion of cases by surgery category

SITE	Total cases n	ANY CABG* n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)
TUH	338	172 (50.9)	32 (9.5)	118 (34.9)	16 (4.7)
TPCH	985	443 (45.0)	90 (9.1)	332 (33.7)	120 (12.2)
PAH	566	290 (51.2)	45 (8.0)	210 (37.1)	21 (3.7)
GCUH	341	140 (41.1)	34 (10.0)	142 (41.6)	25 (7.3)
STATEWIDE	**2,230**	**1,045 (46.9)**	**201 (9.0)**	**802 (36.0)**	**182 (8.2)**

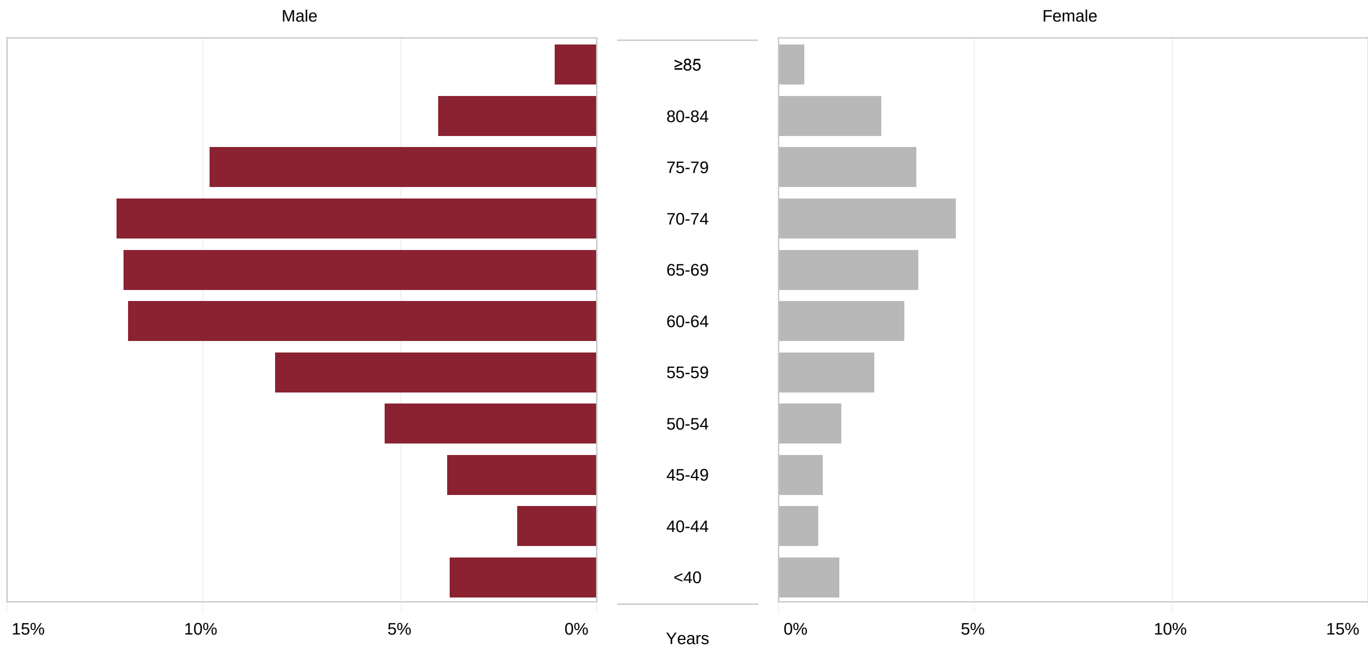
* Coronary artery bypass grafting procedures not including concurrent valve surgery, these operations may occur in isolation or in conjunction with aortic, non cardiac or non valvular cardiac interventions

5 Patient characteristics

5.1 Age and gender

Age is a demonstrated risk factor for developing cardiovascular disease. More than two thirds of patients were aged between 61 years and 80 years (69%). The male cohort of 70 years to 74 years accounted for the largest proportion of cases (12% of all cases or 17% of males). Approximately 8% of surgeries were performed on patients younger than 45 years of age.

The median age for both males and females undergoing cardiac surgery was 67 years. Females undergoing cardiac surgery were more likely to be older than males (68 years vs. 66 years respectively).



% of total (n=2,230)

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	1,045	66	68	67
CABG + VALVE	201	70	71	71
VALVE	802	67	70	69
OTHER	182	59	61	60
ALL	**2,230**	**66**	**68**	**67**

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

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

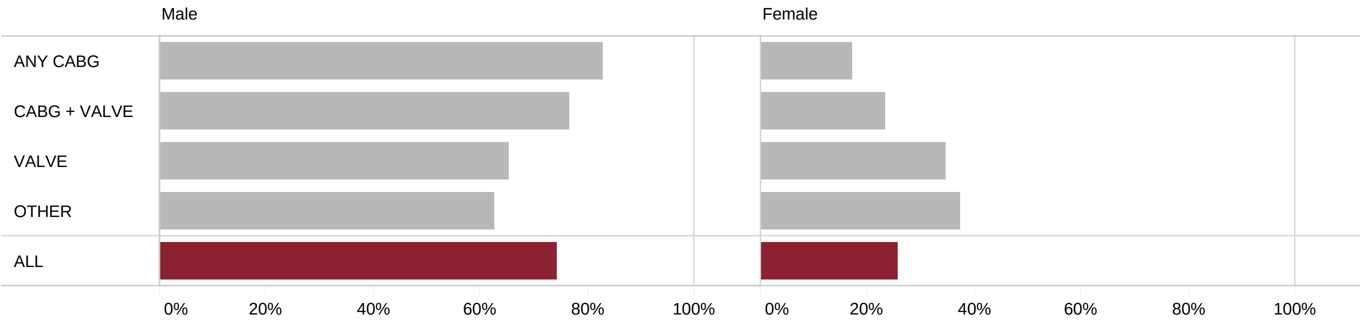


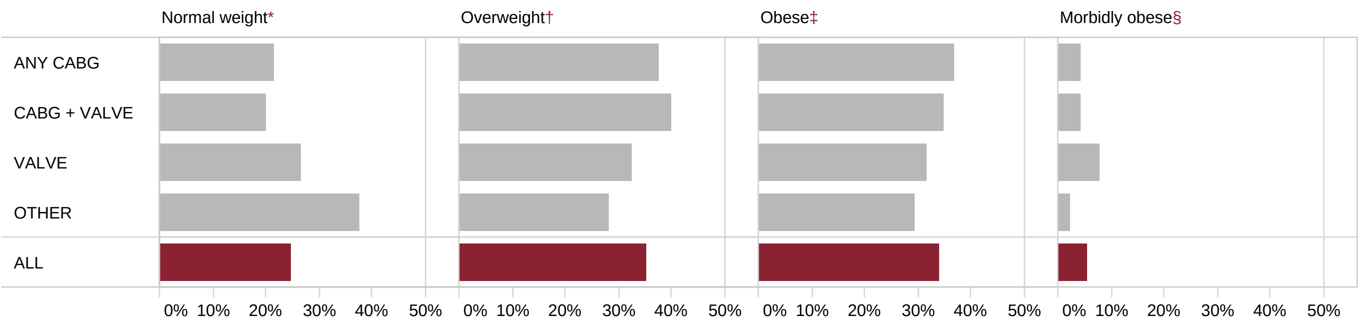
Figure 8: Proportion of cases by gender and surgery category

5.2 Body mass index

Only 24% of patients undergoing heart surgery had a body mass index (BMI) in the healthy range, compared to 74% of patients who fell into the categories of overweight, obese, or severely obese.

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 <18.5 kg/m²) represented 1% of all cases.



Excludes missing data (<0.1%)

* BMI 18.5–24.9 kg/m²

† BMI 25.0–29.9 kg/m²

‡ BMI 30.0–39.9 kg/m²

§ BMI ≥40.0 kg/m²

Figure 9: Proportion of cases by BMI and surgery category

Table 5: Cases by BMI and surgery category

	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Morbidly obese n (%)
ANY CABG	4 (0.4)	223 (21.3)	390 (37.3)	384 (36.7)	44 (4.2)
CABG + VALVE	2 (1.0)	40 (19.9)	80 (39.8)	70 (34.8)	9 (4.5)
VALVE	12 (1.5)	214 (26.7)	261 (32.5)	253 (31.5)	62 (7.7)
OTHER	6 (3.3)	68 (37.4)	51 (28.0)	53 (29.1)	4 (2.2)
ALL	**24 (1.1)**	**545 (24.4)**	**782 (35.1)**	**760 (34.1)**	**119 (5.3)**

5.3 Aboriginal and Torres Strait Islander status

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

Overall, the proportion of identified Aboriginal and Torres Strait Islander patients undergoing cardiac surgery was 6.6%. This proportion is larger than the estimated 4.6% of the overall Queensland population that Aboriginal and Torres Strait Islander people account for.[2]

Approximately one fifth (19%) of patients undergoing cardiac surgery at TUH identified as Aboriginal and Torres Strait Islander.

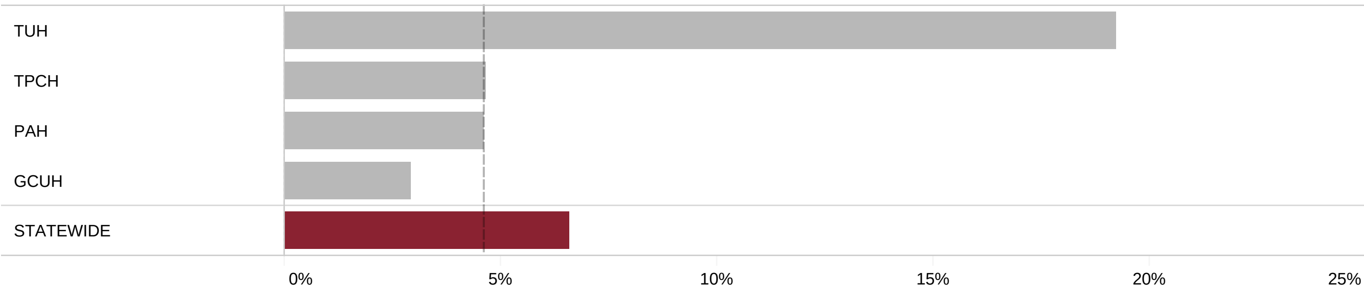


Figure 10: Proportion of all cardiac surgical cases by identified Aboriginal and Torres Strait Islander status and site

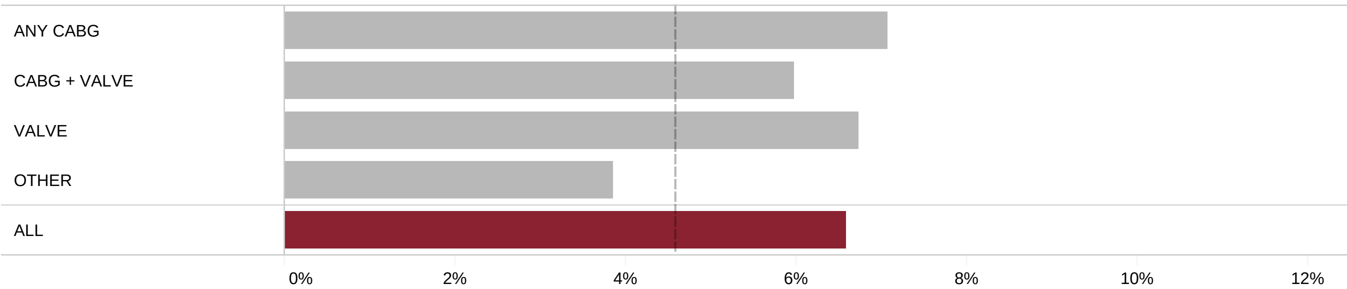
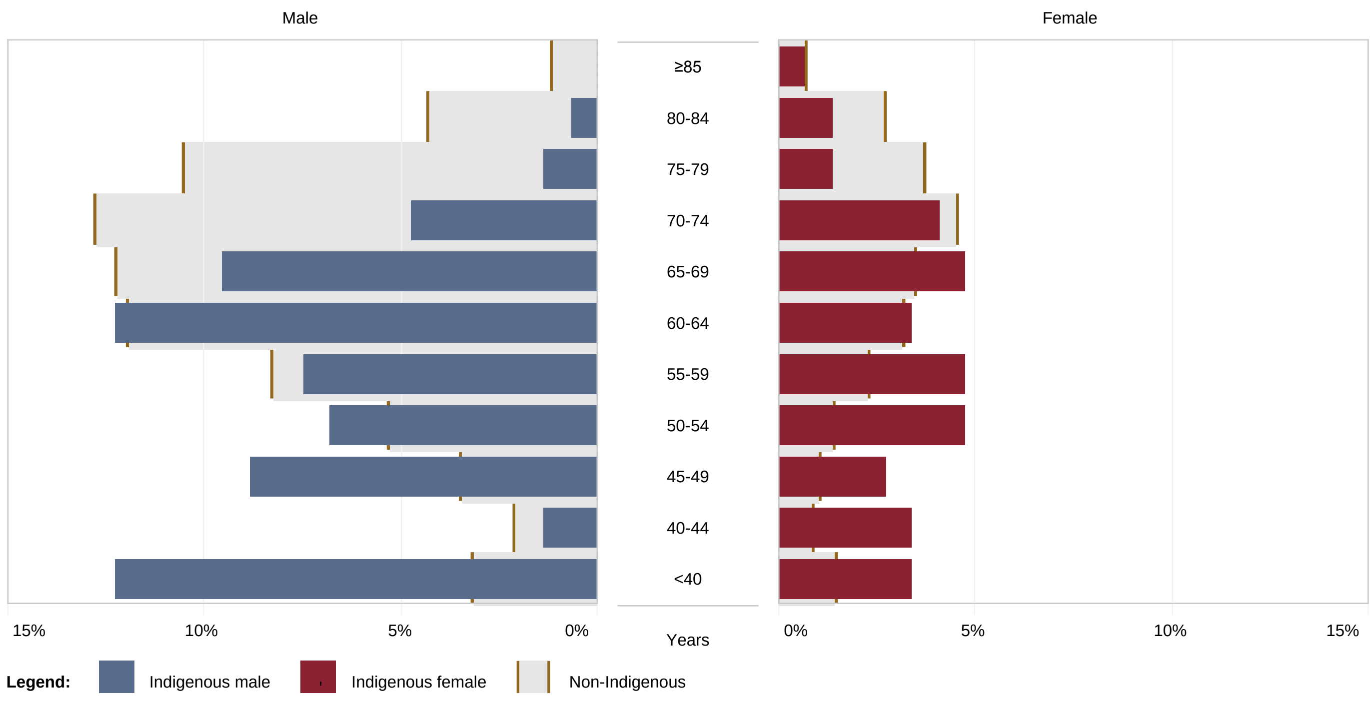


Figure 11: Proportion of cases by identified Aboriginal and Torres Strait Islander status and surgery category

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



% of total Aboriginal and Torres Strait Islander (n=147) vs. total non-Indigenous (n=2,230)

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

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

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

6 Risk factors and comorbidities

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

- The majority of patients (57%) had a history of tobacco use including 18% current smokers (defined as smoking within 30 days of the procedure) and 39% former smokers.
- Overall, 29% of all cardiac surgical patients were reported as diabetic. The prevalence of diabetes was highest in the CABG patient group (38%).
- Hypertension, defined as receiving antihypertensive medications at the time of surgery, was present in 63% of patients with considerable variation by surgery type (range 39% to 72%).
- Overall, 68% of patients had hypercholesterolaemia at the time of surgery, ranging from 83% in the CABG category to 35% in the other surgery category.
- Over half (53%) of all patients were identified as having impaired renal function (eGFR ≤89 mL/min/1.73 m^2) at the time of their surgery.
- There were 103 patients with active or previous infective endocarditis.
- Over one quarter (29%) of patients were classed as having an impaired left ventricular ejection fraction (LVEF), including, 4% with severe LV dysfunction (LVEF less than 30%), 6% with moderate LV dysfunction (LVEF between 30% to 39%) and 19% having mild LV dysfunction (LVEF between 40% to 49%) at the time of surgery.
- 39% of patients had a BMI which was classed as obese or morbidly obese (BMI ≥30 kg/m^2).

Table 7: Summary of risk factors by surgery category

	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)	ALL n (%)
Former smoker	466 (42.7)	87 (43.3)	282 (35.2)	57 (31.3)	872 (39.1)
Current smoker	228 (21.8)	36 (17.9)	112 (14.0)	32 (17.6)	408 (18.3)
Diabetes	401 (38.4)	65 (32.3)	155 (19.3)	25 (13.7)	646 (29.0)
Hypertension	753 (72.1)	138 (68.7)	464 (57.9)	70 (38.5)	1,425 (63.9)
Hypercholesterolaemia	869 (83.3)	153 (76.1)	420 (52.4)	63 (34.6)	1,505 (67.5)
eGFR 60–89 mL/min/1.73 m^2	350 (33.5)	72 (35.8)	242 (30.2)	58 (31.9)	722 (32.4)
eGFR 30–59 mL/min/1.73 m^2	155 (14.8)	51 (25.4)	195 (24.3)	21 (11.5)	422 (18.9)
eGFR <30 mL/min/1.73 m^2	15 (1.4)	5 (2.5)	21 (2.6)	3 (1.6)	44 (2.0)
Infective endocarditis	3 (0.3)	7 (3.5)	3 (1.6)	90 (11.2)	103 (4.6)
LVEF 40–50%	236 (22.6)	46 (22.4)	133 (16.6)	10 (5.5)	424 (19.0)
LVEF 30–39%	79 (7.6)	16 (8.0)	36 (4.5)	4 (2.2)	135 (6.1)
LVEF <30%	36 (3.4)	8 (4.0)	29 (3.6)	12 (6.6)	85 (3.8)
BMI ≥30 kg/m^2	428 (41.0)	79 (39.3)	315 (39.3)	57 (31.3)	879 (39.4)

The majority of patients (90%) had a combination of two or more of those risk factors outlined in Table 8, while almost one third of patients undergoing CABG (31%) had five or more risk factors. This demonstrates the variation of disease processes associated with underlying pathology and highlights the complex medical history of this cohort.

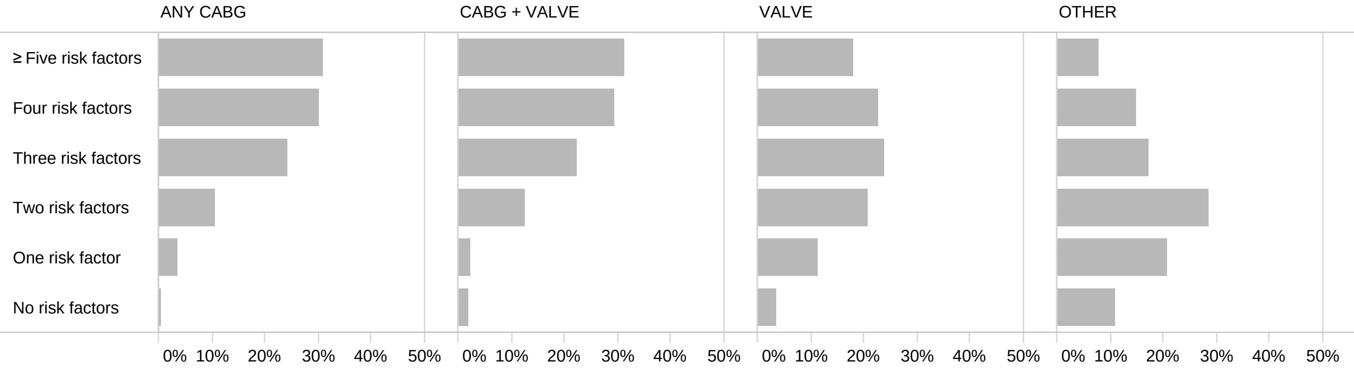


Figure 13: Number of patient risk factors by surgery category

Table 8: Aggregated patient risk factors by surgery category

	ANY CABG n (%)	CABG + VALVE n (%)	VALVE n (%)	OTHER n (%)	ALL n (%)
Five or more risk factors	322 (30.8)	63 (31.3)	142 (17.7)	13 (7.1)	540 (24.2)
Four risk factors	316 (30.2)	59 (29.4)	182 (22.7)	28 (15.4)	585 (26.2)
Three risk factors	254 (24.3)	45 (22.4)	192 (23.9)	31 (17.0)	522 (23.4)
Two risk factors	111 (10.6)	25 (12.4)	168 (20.9)	52 (28.6)	356 (16.0)
One risk factor	37 (3.5)	5 (2.5)	90 (11.2)	38 (20.9)	170 (7.6)
No risk factors	5 (0.5)	4 (2.0)	28 (3.5)	20 (11.0)	57 (2.6)
Total	**1,045 (100.0)**	**201 (100.0)**	**802 (100.0)**	**182 (100.0)**	**2,230 (100.0)**

6.1 Infective endocarditis

There were 103 cases of infective endocarditis (IE) that required cardiac surgical intervention. At the time of surgery, over three quarters (79%) were active infections.

Native valve endocarditis was observed in 72% of active infections, with prosthetic valve infection apparent in 17% of active endocarditis cases.

Table 9: Infective endocarditis status

Endocarditis status	n (%)
Active	81 (78.6)
Treated	22 (21.4)
Total	**103 (100.0)**

Table 10: Active infective endocarditis by site of infection

Active endocarditis site	n (%)
Native valve	58 (71.6)
Prosthetic valve	12 (14.8)
Aortic root	8 (9.9)
Aortic root and prosthetic valve	2 (2.5)
Aortic conduit	1 (1.2)
Total	**81 (100.0)**

6.1.1 Organism

Nearly two thirds (32%) of all active IE cases were identified as Methicillin-susceptible Staphylococcus aureus, while a Streptococcus infection was responsible for one quarter of all surgeries for active IE. The responsible organism was unidentified in 5% of cases.

Table 11: Identified organism in active IE cases

Active organism	n (%)
MSSA*	26 (32.1)
Streptococcus	20 (24.7)
Other	12 (14.8)
Enterococcus faecalis	11 (13.6)
Staphylococcus (other)	5 (6.2)
Aggregatibacter	3 (3.7)
Organism unidentified	4 (4.9)
Total	**81 (100.0)**

* Methicillin-susceptible Staphylococcus aureus

6.1.2 Intravenous drug use

Overall, 21% of all active infective endocarditis cases were linked to a history of intravenous drug use (IVDU) with the majority being previous IVDU.

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

IVDU history	n (%)
Current IVDU (≤3 months)	5 (6.2)
Previous IVDU (>3 months)	12 (14.8)
No history of IVDU	55 (67.9)
Unknown	9 (11.1)
Total	**81 (100.0)**

7 Care and treatment of patients

7.1 Admission status

The admission status of patients undergoing cardiac surgery varied widely. Most CABG cases were performed as urgent cases, whilst also contributing to a significant proportion (37%) of the emergency cases. Over one third (38%) of all operations in the 'Other surgery' category were performed on an emergent basis, in particular correction of aortic dissection. Valve procedures were mostly performed on an elective basis.

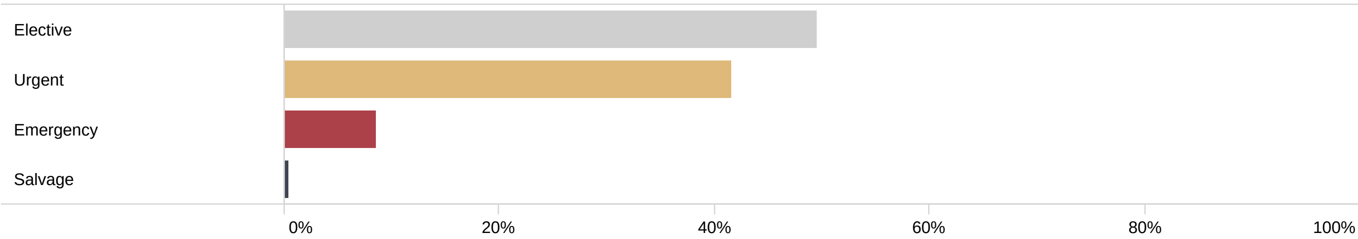


Figure 14: Proportion of cases by admission status

Table 13: Cases by admission status and surgery category

	Elective n (%)	Urgent n (%)	Emergency n (%)	Salvage n (%)
ANY CABG	335 (32.1)	647 (61.9)	58 (5.6)	5 (0.5)
CABG + VALVE	112 (55.7)	74 (36.8)	14 (7.0)	1 (0.5)
VALVE	561 (70.0)	190 (23.7)	50 (6.2)	1 (0.1)
OTHER	95 (52.2)	17 (9.3)	69 (37.9)	1 (0.5)
ALL	**1,103 (49.5)**	**928 (41.6)**	**191 (8.6)**	**8 (0.4)**

7.2 Day of surgery admission

Day of surgery admission (DOSA) rates accounted for 18% of all elective cases, with some variation observed across some surgery categories.

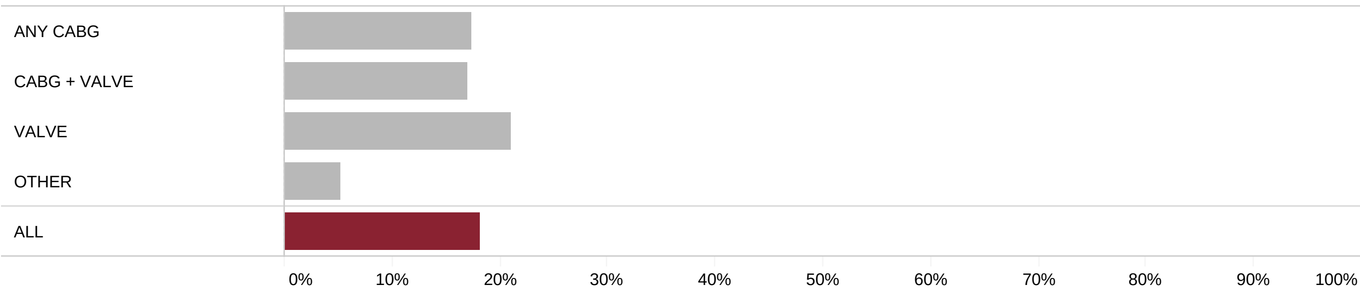


Figure 15: Proportion of elective cases for DOSA cases by surgery category

Table 14: DOSA cases by surgery category

	Total elective cases n	DOSA cases n (%)
ANY CABG	335	58 (17.3)
CABG + VALVE	112	19 (17.0)
VALVE	561	118 (21.0)
OTHER	95	5 (5.3)
Total	**1,103**	**200 (18.1)**

7.3 Coronary artery bypass grafting

7.3.1 Number of diseased vessels

There were 1,246 CABG procedures performed across all sites. The majority (91%) had multi-vessel disease.

When CABG was performed in conjunction with a valve procedure, 69% of patients had multi-vessel disease compared to 95% when CABG surgery was performed without a valve intervention.

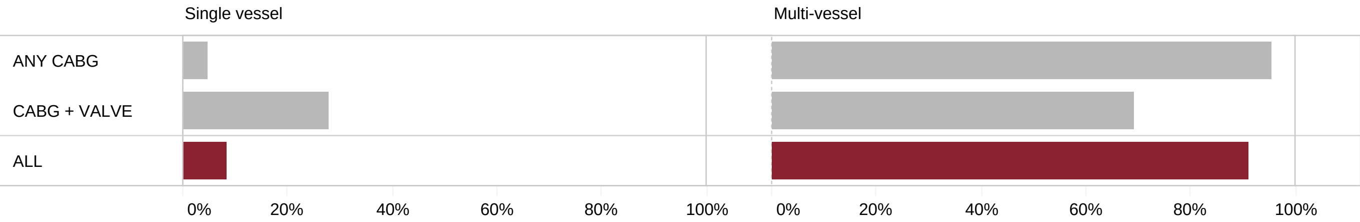


Figure 16: Number of diseased vessels by surgery category

Table 15: Number of diseased vessels by surgery category

	Single vessel n (%)	Multi-vessel n (%)	Total n (%)
ANY CABG	48 (4.6)	997 (95.4)	1,045 (100.0)
CABG + VALVE	56 (27.9)	139 (69.2)	201 (100.0)
ALL	**104 (8.3)**	**1,136 (91.2)**	**1,246 (100.0)**

Missing data not displayed (n=6)

7.3.2 Number of grafts

For CABG procedures an average of 2.6 grafts were used. In multi vessel CABG, the mean number of grafts utilised was 2.8.

Table 16: Number of grafts by number of diseased vessels

	Single vessel mean	Multi-vessel mean	Multi-vessel median	Total mean
ANY CABG	1.3	2.8	3.0	2.8
CABG + VALVE	1.0	2.3	2.0	1.9
ALL	**1.2**	**2.8**	**3.0**	**2.6**

Cardiac Surgery

7.3.3 Conduits used

In CABG, including surgeries involving valvular intervention, the most common method of revascularisation included the use of a combination of an arterial and venous graft (64%). Over one quarter of cases (28%) underwent total arterial revascularisation.

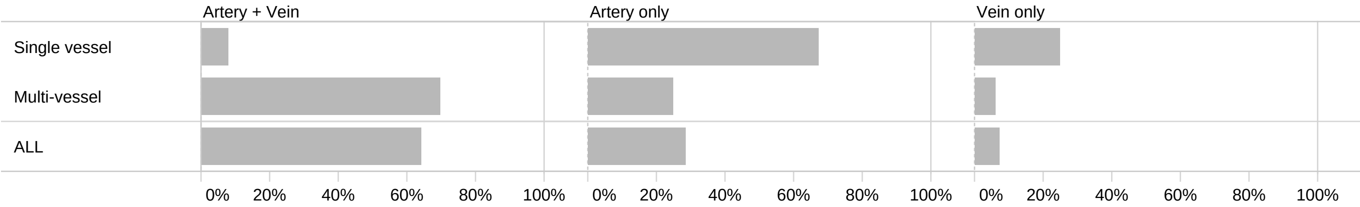


Figure 17: Proportion of diseased vessels by conduits used

Table 17: Conduits used by number of diseased vessels

	Artery + vein n (%)	Artery only n (%)	Vein only n (%)
Single vessel	8 (7.7)	70 (67.3)	26 (25.0)
Multi-vessel	789 (69.5)	280 (24.6)	67 (5.9)
ALL	**797 (64.3)**	**350 (28.2)**	**93 (7.5)**

Excludes missing data (n=9)

7.3.4 Off pump CABG

Overall, 2% of isolated CABG operations were performed without the use of cardiopulmonary bypass.

Table 18: Off pump CABG

	Total cases n	Off pump n (%)
Isolated CABG	989	24 (2.4)

7.3.5 Y or T grafts

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

Table 19: Y or T graft used by procedure category

	Total cases n	Y or T graft n (%)
ANY CABG	1,045	67 (6.4)
CABG + VALVE	201	6 (3.0)
ALL	**1,246**	**73 (5.9)**

7.4 Aortic surgery

There were 243 cases that included a procedure involving the aorta (not including procedures performed on the aortic valve). Aortic aneurysm was the primary reason for aortic surgery (51%), while acute aortic dissection was the pathology responsible for one quarter of aortic surgery cases.

Most aortic surgery procedures included replacement of the ascending aorta in isolation (40%), while surgery to replace both the ascending aorta and aortic arch accounted for 12% of cases.

Aortoplasty involving patch repair was performed in approximately 14% of aortic surgery cases.

Table 20: Aortic surgery by procedure type

Aortic surgery type	n (%)
Replacement	**136 (56.0)**
Ascending aorta	97 (39.9)
Ascending aorta + aortic arch	28 (11.5)
Aortic arch	4 (1.6)
Ascending aorta + aortic arch + descending aorta	3 (1.2)
Descending aorta	2 (0.8)
Ascending aorta + descending aorta	1 (0.4)
Descending aorta + thoraco-abdominal	1 (0.4)
Aortoplasty	**66 (27.2)**
Direct aortoplasty	33 (13.6)
Patch repair	33 (13.6)
Aortoplasty and replacement	**41 (16.9)**
Direct aortoplasty + ascending aorta	15 (6.2)
Patch repair + ascending aorta	13 (5.3)
Direct aortoplasty + ascending aorta + aortic arch	6 (2.5)
Patch repair + ascending aorta + aortic arch	4 (1.6)
Patch repair + aortic arch	3 (1.2)
ALL	**243 (100.0)**

7.4.1 Aortic pathology

Table 21: Aortic surgery cases by pathology type

Aortic pathology type	n (%)
Aortic aneurysm	125 (51.4)
Aortic dissection (≤2 weeks)	61 (25.1)
Abscess	17 (7.0)
Calcification	13 (5.3)
Aortic dissection (>2 weeks)	6 (2.5)
Rupture	2 (0.8)
Traumatic transection	1 (0.4)
Other	18 (7.4)
Total	**243 (100.0)**

7.5 Valve surgery

There were 1,003 valve surgery procedures performed at the participating sites during 2022.

The aortic valve was the most commonly operated on valve either with or without other valves (70%). While over one fifth (21%) of valve surgeries were performed on the mitral valve in isolation.

Overall, 13% of valve operations performed comprised of intervention to multiple valves.

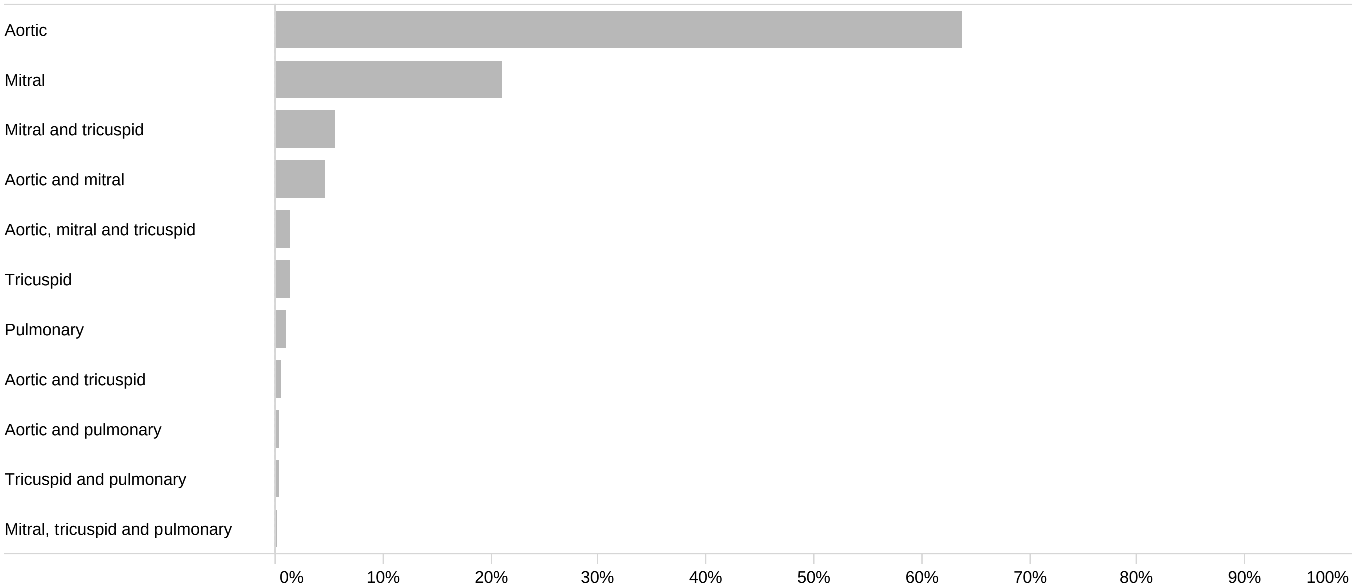


Figure 18: Proportion of valve surgery cases by valve

Table 22: Valve surgery cases by valve

Type of valve surgery	n (%)
Aortic	639 (63.7)
Mitral	212 (21.1)
Mitral and tricuspid	57 (5.7)
Aortic and mitral	46 (4.6)
Aortic, mitral and tricuspid	13 (1.3)
Tricuspid	13 (1.3)
Pulmonary	10 (1.0)
Aortic and tricuspid	5 (0.5)
Aortic and pulmonary	4 (0.4)
Tricuspid and pulmonary	3 (0.3)
Mitral, tricuspid and pulmonary	1 (0.1)
ALL	**1,003 (100.0)**

7.5.1 Valve pathology

The most common valve pathology across all valve types was a degenerative cause (47%) which accounted for the largest proportion of all aortic (52%) and mitral (47%) valve procedures.

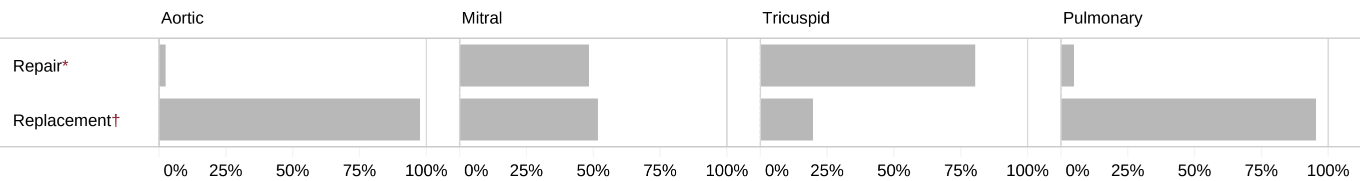
Table 23: Valve pathology by valve type

	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Degenerative	366 (51.8)	155 (47.1)	18 (19.6)	–	539 (47.0)
Congenital	154 (21.8)	6 (1.8)	3 (3.3)	9 (50.0)	172 (15.0)
Rheumatic	19 (2.7)	50 (15.2)	15 (16.3)	–	84 (7.3)
Infection	51 (7.2)	45 (13.7)	11 (12.0)	5 (27.8)	112 (9.8)
Prosthesis failure	40 (5.7)	23 (7.0)	2 (2.2)	4 (22.2)	69 (6.0)
Dissection	36 (5.1)	–	–	–	36 (3.1)
Annuloaortic ectasia	24 (3.4)	–	–	–	24 (2.1)
Functional	–	12 (3.6)	38 (41.3)	–	50 (4.4)
Ischaemic	–	22 (6.7)	–	–	22 (1.9)
Failed prior repair	–	–	1 (1.1)	–	1 (0.1)
Peri-prosthetic leak	3 (0.4)	–	–	–	3 (0.3)
Trauma	–	1 (0.3)	–	–	1 (0.1)
Other	14 (2.0)	15 (4.6)	4 (4.3)	–	33 (2.9)
ALL	**707 (100.0)**	**329 (100.0)**	**92 (100.0)**	**18 (100.0)**	**1,146 (100.0)**

7.5.2 Types of valve surgery

Fifty five percent of valve interventions involved aortic valve surgery. The most common aortic valve procedure was replacement surgery (97%).

Mitral valve replacement was more commonly undertaken compared with mitral valve repair (59% vs. 41%).



Inspection only procedures not shown (n=2)

* Includes transcatheter mitral valve repair procedures involving CTS

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

Figure 19: Valve surgery category by valve

Table 24: Valve surgery category by valve type

Valve surgery category	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Repair*	23 (3.3)	134 (40.7)	77 (83.7)	–	234 (20.4)
Replacement†	683 (96.6)	195 (59.3)	15 (16.3)	18 (100.0)	911 (79.5)
Inspection only	1 (0.1)	–	–	–	2 (0.1)
ALL	**707 (100.0)**	**329 (100.0)**	**92 (100.0)**	**18 (100.0)**	**1,288 (100.0)**

* Includes transcatheter mitral valve repair procedures involving CTS

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

Transcatheter aortic valve replacement (TAVR)

A multidisciplinary heart team involving both cardiologists and cardiac surgeons is often required to plan and perform a TAVR procedure. Despite the varied role of the surgeon in the heart team, 47% of all TAVR were performed with a cardiac surgeon involved in the valve procedure.

This Audit reflects those TAVR cases where a cardiothoracic surgeon was present during the procedure. As such, it does not represent the total number of these interventions performed in Queensland public hospitals in 2022.

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

Table 25: TAVR cases by site and CS involvement

Site	ALL TAVR n	Combined CS and cardiologist TAVR n (%)
TUH	24	24 (100.0)
TPCH	179	8 (4.5)
PAH	103	96 (93.2)
GCUH	29	29 (100.0)
STATEWIDE	**335**	**157 (46.9)**

7.5.3 Valve repair surgery

Over two-thirds (71%) of valve repair surgery were repair/reconstruction with annuloplasty followed by annuloplasty only (13%). The most common individual valve repair surgery type was mitral valve repair/reconstruction with annuloplasty, comprising close to half of overall valve repair surgery (47%).

There were no pulmonary valve repair procedures recorded at participating sites for 2022.

Table 26: Valve repair surgery by valve type

Surgery category	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Total n (%)
Repair/reconstruction with annuloplasty	–	112 (83.6)	53 (61.9)	165 (70.5)
Annuloplasty only	–	11 (8.2)	19 (30.4)	30 (12.8)
Repair/reconstruction without annuloplasty	3 (13.0)	6 (4.5)	5 (5.4)	14 (6)
Resuspension of the aortic valve	10 (43.5)	–	–	10 (4.3)
Root reconstruction with valve sparing	9 (39.1)	–	–	9 (3.8)
Tumour tissue removal	1 (4.3)	3 (2.2)	–	4 (1.7)
Paravalvular leak repair	–	2 (1.5)	–	2 (0.9)
ALL	**23 (100.0)**	**134 (100.0)**	**77 (100.0)**	**234 (100.0)**

7.5.4 Valve replacement surgery

Aortic valve replacement accounted for the majority of valve replacement surgeries (75%), which included 158 TAVR procedures and 96 aortic root reconstruction surgeries utilising a valved conduit.

Table 27: Valve replacement surgery by valve type

Surgery type	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Surgical valve replacement	429 (62.8)	193 (99.0)	15 (100.0)	18 (100.0)†	655 (71.9)
Transcatheter valve replacement*	158 (23.1)	2 (1.0)	–	–	160 (17.6)
Root reconstruction with valve conduit	96 (14.1)	–	–	–	96 (10.5)
ALL	**683 (100.0)**	**195 (100.0)**	**15 (100.0)**	**18 (100.0)**	**911 (100.0)**

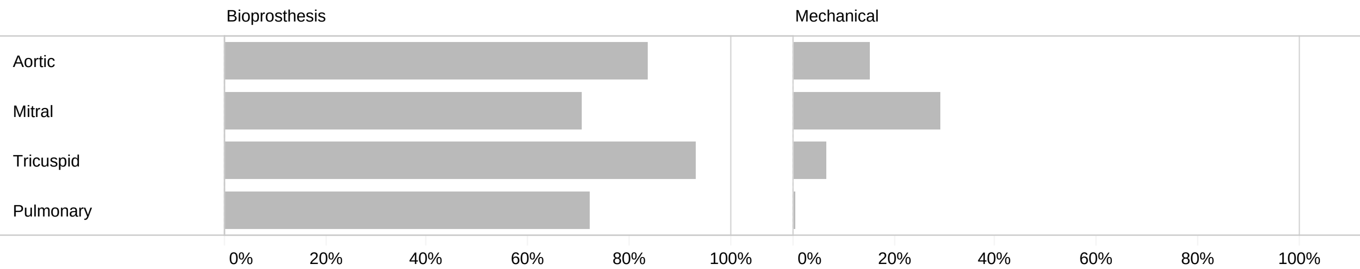
* Includes TAVR or TMVR procedures involving a cardiothoracic surgeon

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

Prosthesis type

The most common form of valve prostheses used across all valve types were biological (81%), either bovine (64%) or porcine (17%). Mechanical prostheses were used in 18% of cases with a greater proportion represented in mitral valve replacement surgeries.

Bovine-derived aortic valve prostheses accounted for the largest proportion of all valves used, representing 79% of all aortic valve prostheses and 64% of the total valvular prostheses used.



Homograft/allograft and autograft prosthesis not displayed (1.4%)

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

Table 28: Types of valve prosthesis by valve type

Prosthesis type	Aortic n (%)	Mitral n (%)	Tricuspid n (%)	Pulmonary n (%)	Total n (%)
Biological – bovine	540 (79.1)	26 (13.3)	4 (26.7)	13 (72.2)	583 (64.0)
Biological – porcine	31 (4.5)	112 (57.4)	10 (66.7)	–	153 (16.8)
Mechanical	104 (15.2)	57 (29.2)	1 (6.7)	–	162 (17.8)
Homograft/allograft	7 (1.0)	–	–	3 (16.7)	10 (1.1)
Autograft	1 (0.1)	–	–	2 (11.1)	3 (0.3)
ALL	**683 (100.0)**	**195 (100.0)**	**15 (100.0)**	**18 (100.0)**	**911 (100.0)**

Cardiac Surgery

7.6 Other cardiac surgery

The most common form of other cardiac surgery were left atrial appendage closure (32%), followed by atrial arrhythmia surgery, accounting for 10% of other cardiac surgeries. These procedures may have been performed in conjunction with a cardiac procedure or solely as an index operation.

Table 29: Other cardiac procedures

Procedure	n (%)
Left atrial appendage closure	116 (32.0)
Atrial arrhythmia surgery	37 (10.2)
Lung transplant – BSSLTx*	23 (6.3)
Atrial septal defect repair	23 (6.3)
Cardiac tumour	23 (6.3)
Other congenital cardiac procedure	20 (5.5)
LVOT† myectomy for HOCM‡	11 (3.0)
Other vascular surgery	11 (3.0)
Other thoracic surgery	9 (2.5)
VAD§ procedure	9 (2.5)
Cardiac transplant	8 (2.2)
CIED|| procedure (revision/removal)	8 (2.2)
Permanent LV epicardial lead	5 (1.4)
RVOT# repair/reconstruction	5 (1.4)
Acquired ventricular septal defect repair	4 (1.1)
Left ventricular reconstruction	4 (1.1)
Lung transplant – single lung	4 (1.1)
Aortic root/LVOT† procedure to facilitate AVR	4 (1.1)
Trauma	3 (0.8)
Pulmonary thrombo-endarterectomy	3 (0.8)
Lung resection	3 (0.8)
Pericardiectomy	2 (0.6)
LV rupture repair	2 (0.6)
LV aneurysm repair	2 (0.6)
Coronary endarterectomy	2 (0.6)
Mitral annulus repair	2 (0.6)
Cardiopulmonary transplant	1 (0.3)
ECMO** procedure	1 (0.3)
Other cardiac	15 (4.1)
Total	**363 (100.0)**

* Bilateral sequential single lung transplantation

† Left ventricular outflow tract

‡ Hypertrophic obstructive cardiomyopathy

§ Ventricular assist device

|| Cardiac implantable electronic device

Right ventricular outflow tract

** Extracorporeal membrane oxygenation

7.7 Blood product usage

The majority of surgeries did not require blood product transfusion (64%). However, as the urgency of operations increased, so too did the requirement for red blood cells (RBC) and non-red blood cells (NRBC). Over three quarters (77%) of all emergency cases utilised at least one blood product.

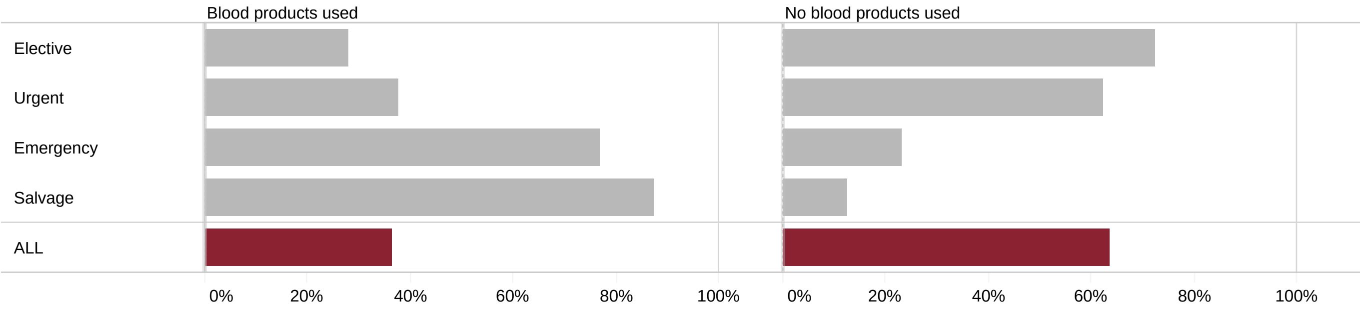


Figure 21: Blood products used by admission status

Table 30: Blood product type used by admission status

Admission status	Both RBC and NRBC n (%)	RBC only n (%)	NRBC only n (%)	No blood products n (%)
Elective	106 (9.6)	91 (8.3)	109 (9.9)	797 (72.3)
Urgent	142 (15.3)	137 (14.8)	72 (7.8)	577 (62.2)
Emergency	106 (55.5)	14 (7.3)	27 (14.1)	44 (23.0)
Salvage	5 (62.5)	1 (12.5)	1 (12.5)	1 (12.5)
ALL	**359 (16.1)**	**243 (10.9)**	**209 (9.4)**	**1,419 (63.6)**

8 Outcomes

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

8.1 Risk prediction models

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

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

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

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

The risk prediction models used in evaluating the 2022 clinical outcomes for cardiac surgical cases are:

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

8.1.1 Mortality

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

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.

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

Legend: ◆ Observed ▭ Predicted (95% confidence interval)

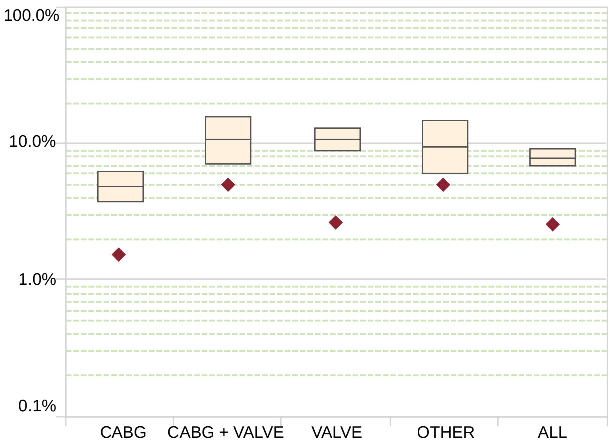


Figure 22: EuroSCORE

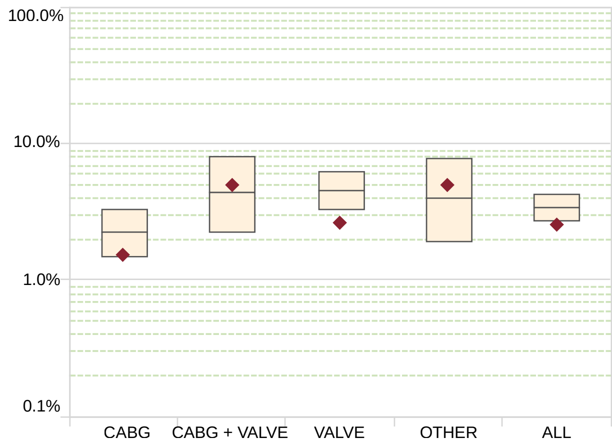


Figure 23: EuroSCORE II

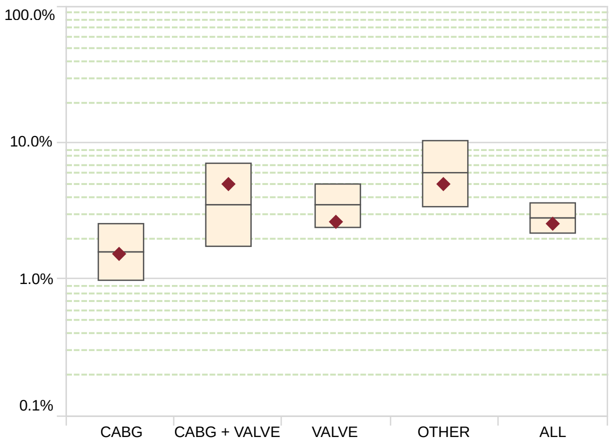


Figure 24: ANZSCTS (General Score)

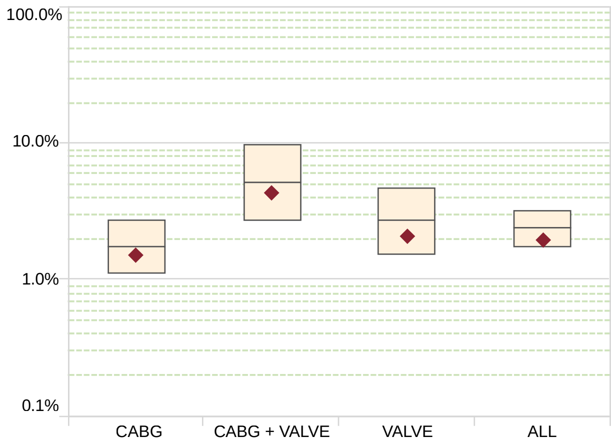


Figure 25: STS (death)

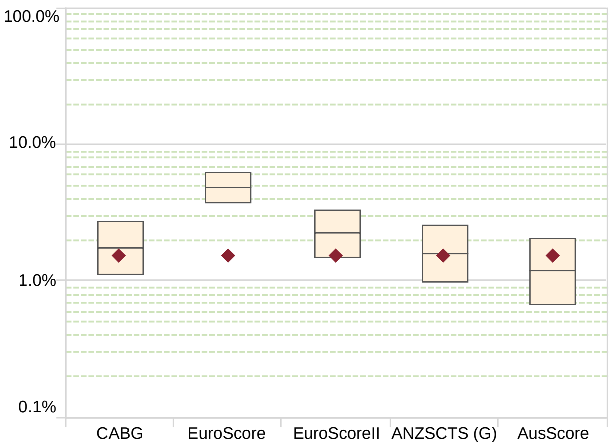


Figure 26: CABG

Cardiac Surgery

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 adjustment models provide an estimate of the level risk for a patient undergoing cardiac surgery to be afflicted with these morbidities. These models have been applied to the defined surgical subgroups using the distinct inclusion criteria.

The aggregated morbidities chart (Figure 32) represents the observed rate of cases involving at least one of the five morbidities.

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

Deep sternal wound infection

The rate of deep sternal wound infection (DSWI) is a significant postoperative adverse outcome that increases the risk of death for a patient and has significant consequences in terms of healthcare system resource utilisation. As such, it continues to be a focus for all participating units. Historically this outcomes had been consistently identified as occurring at a rate higher than predicted by the STS model.

Establishment of a correction factor was based on the DSWI data presented in the Australian and New Zealand Society of Cardiac & Thoracic Surgeons Cardiac Surgery Database Program Annual Report for 2020[31]. This report suggests that the national rate of DSWI in public hospitals for 2017–2019 was approximately 1.13% while for 2020 the rate had dropped to 0.91% (comparable rates for Queensland public hospitals in the same time period were 1.7% and 1.4% respectively).

Therefore, for the purposes of quality assurance and monitoring, the STS model was adjusted to deliver an expected event rate of 1.13% using an odds correction factor of 3.70.

After applying an odds correction of 3.70 to the 2022 cohort, the observed rate of DSWI is within the expected rate for all surgical categories.

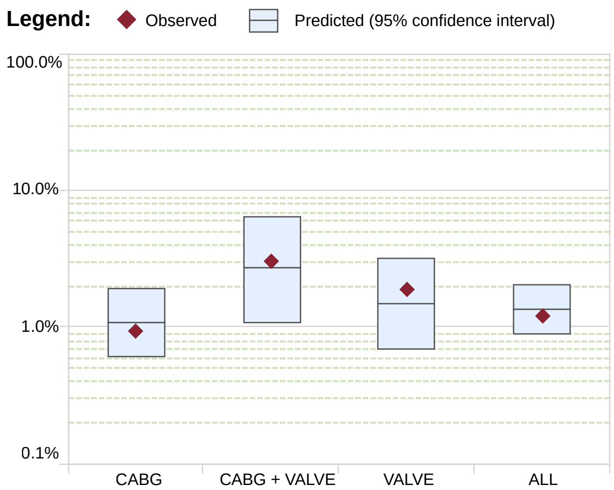


Figure 27: Cerebrovascular accident

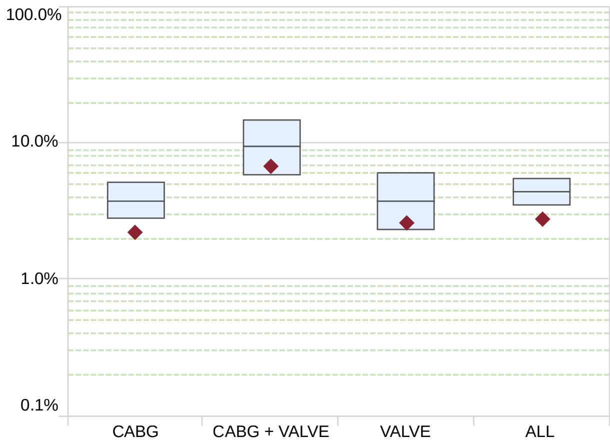


Figure 28: Renal failure

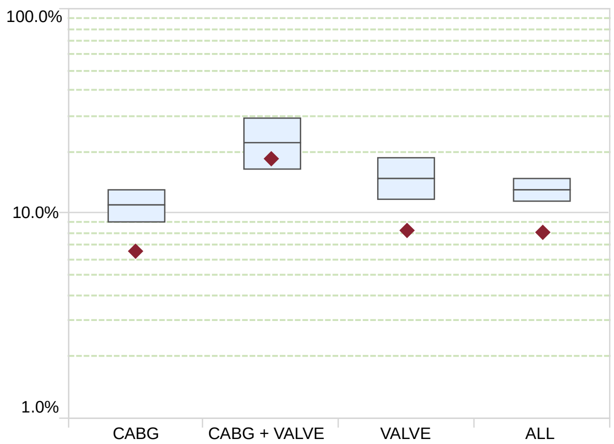


Figure 29: Ventilation >24 hours

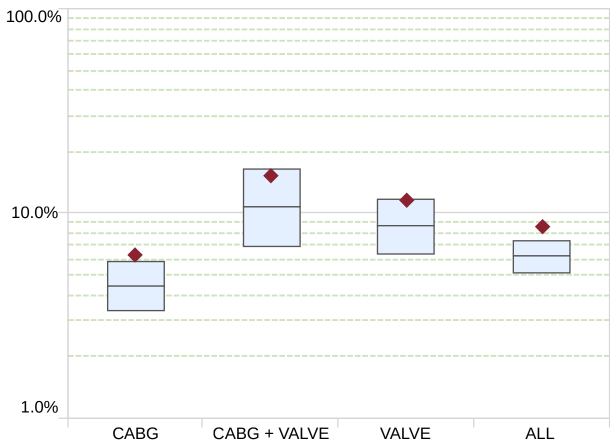


Figure 30: Reoperation

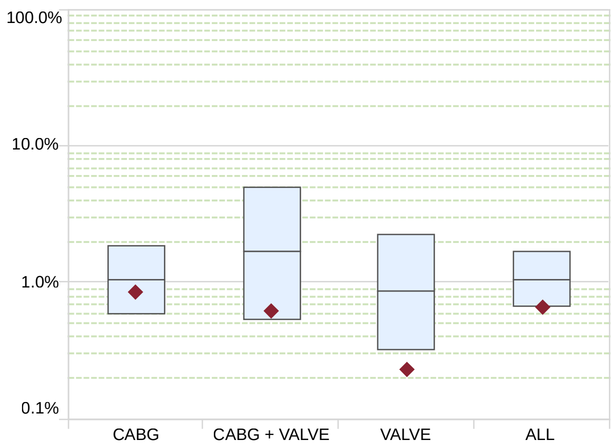


Figure 31: Deep sternal wound infection

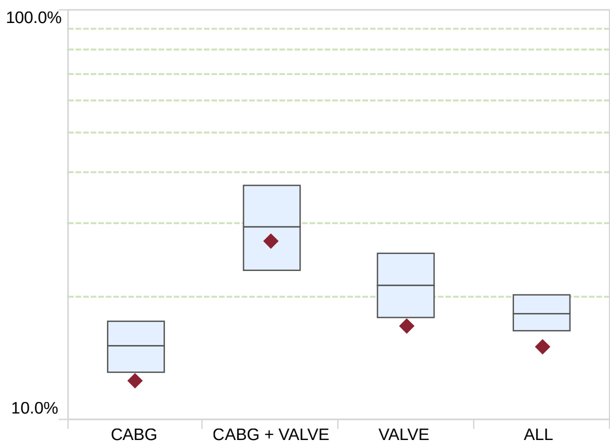


Figure 32: Major morbidity

8.1.3 Measures of process

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

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

The LOS comparison indicates that the proportion of cases staying less than six days is lower than expected, regardless of surgery category. Similarly, the proportion of patients who stay longer than 14 days is greater than predicted.

Further investigation is needed to delineate whether this outcome is prolonged due to institutional processes or factors relating to patient care.

Legend: Observed | Predicted (95% confidence interval)

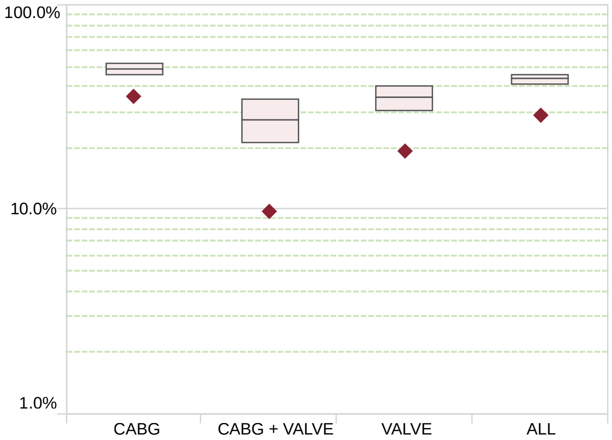


Figure 33: LOS ‹6 days

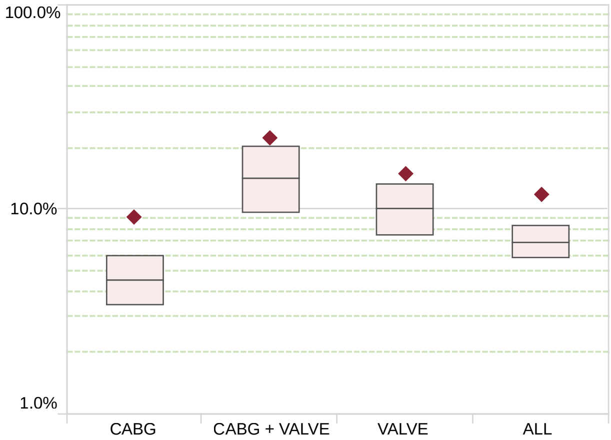


Figure 34: LOS ›14 days

8.1.4 Failure to rescue

Failure to rescue (FTR) is an indicator of quality in surgery that focuses primarily on the system of care rather than the surgical procedure alone. It is used to describe the prognosis of the patient cohort that has experienced a 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 wound infection and prolonged ventilation (>24 hours) as described by the STS risk models.

From this analysis, the FTR observed rate across all surgery categories is similar to the predicted rate, suggesting that the processes in place to deal with adverse events are functioning at the expected level.

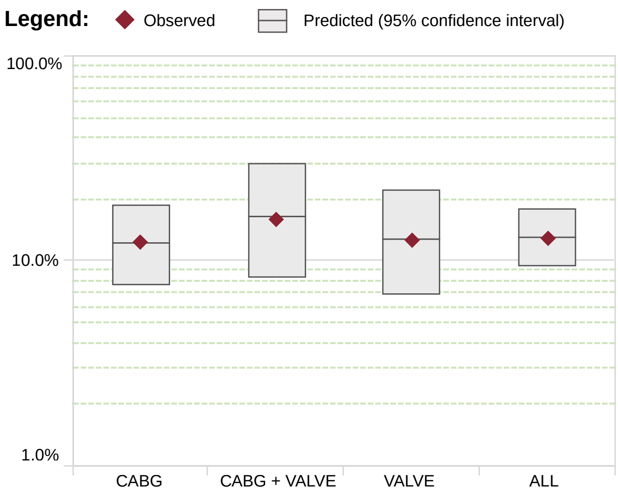


Figure 35: Failure to rescue

8.1.5 Outcome trends

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

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

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

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

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

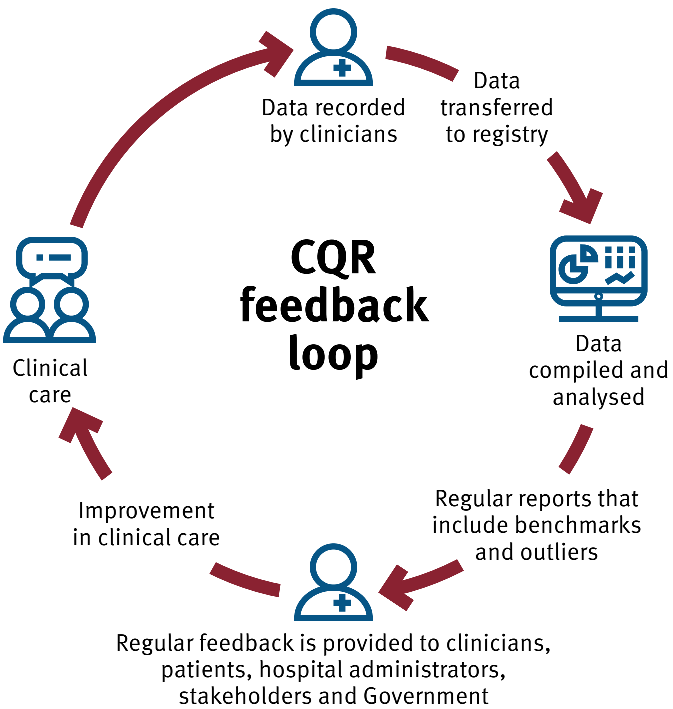


Figure 36: Clinical Quality Registry feedback loop

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

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

Mortality

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

For all prediction models employed, the mortality rate has trended towards being below the predicted range. Peaks in the observed mortality rates were often accompanied by an uptick in the expected range, likely reflecting the complexity or high-risk nature of this dynamic cohort.

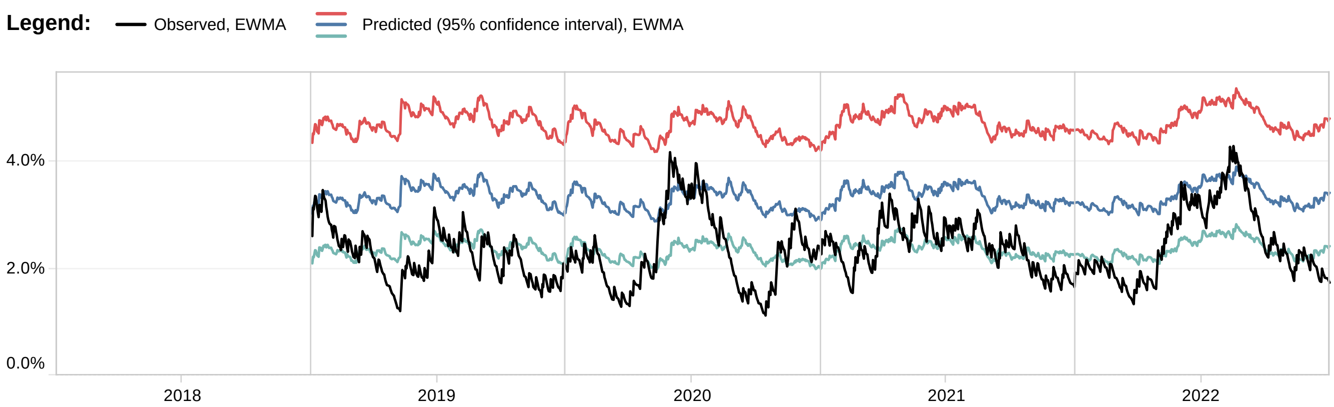


Figure 37: EuroSCORE II, 2018–2022

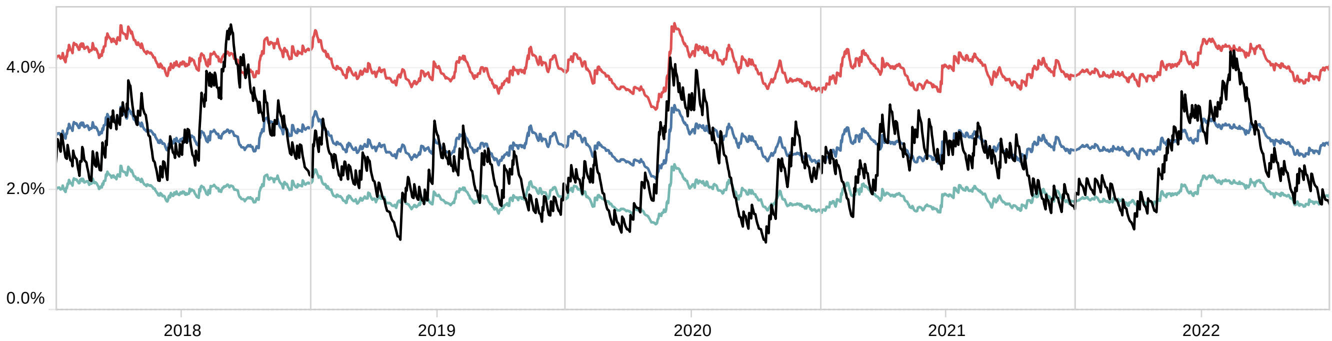


Figure 38: ANZSCTS General Score, 2018–2022

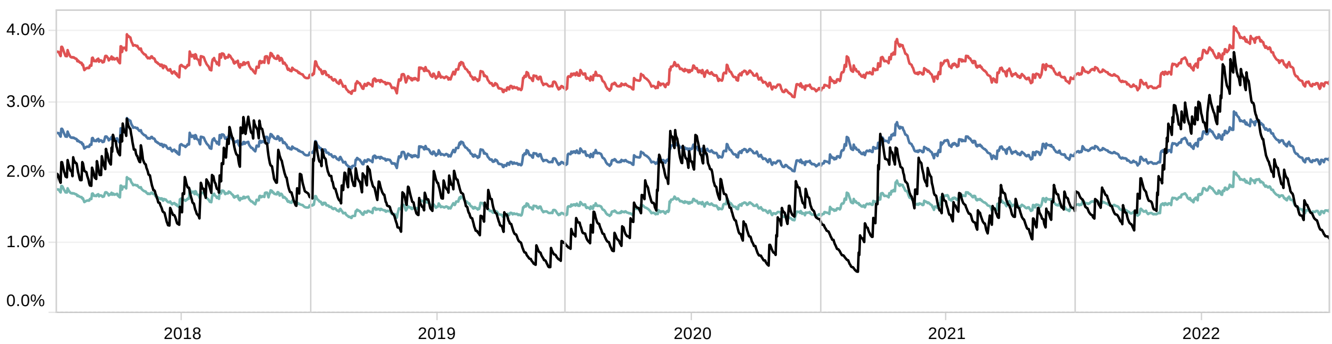


Figure 39: STS mortality, 2018–2022

Morbidity

Cerebrovascular accident or stroke, defined as a new central neurologic deficit that persists for greater than 72 hours, caused by an ischaemic or haemorrhagic event peri or postoperatively is a recognised complication and risk of cardiac surgery. Over the monitored period the incidence of cerebrovascular accident has varied, while remaining within or below the expected range.

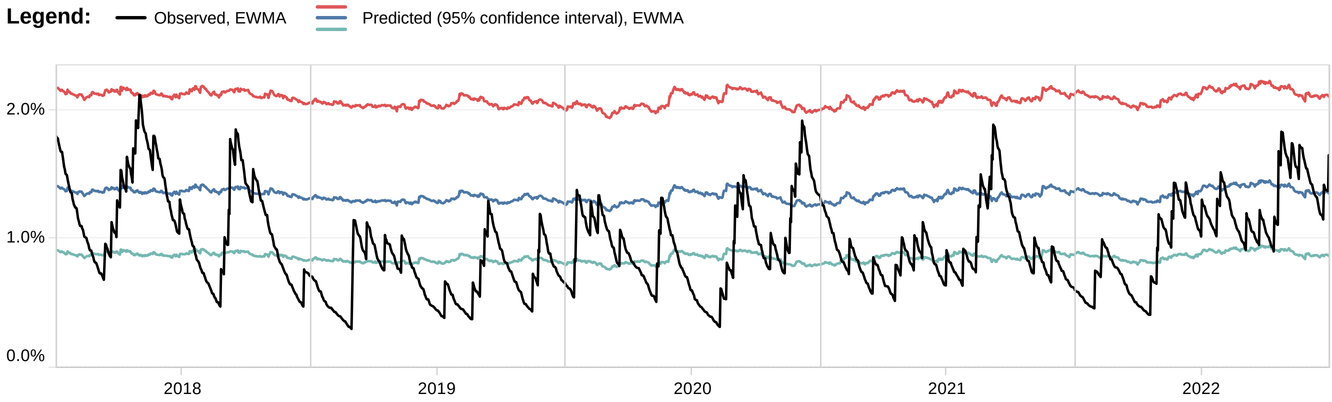


Figure 40: Cerebrovascular accident, 2018–2022

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

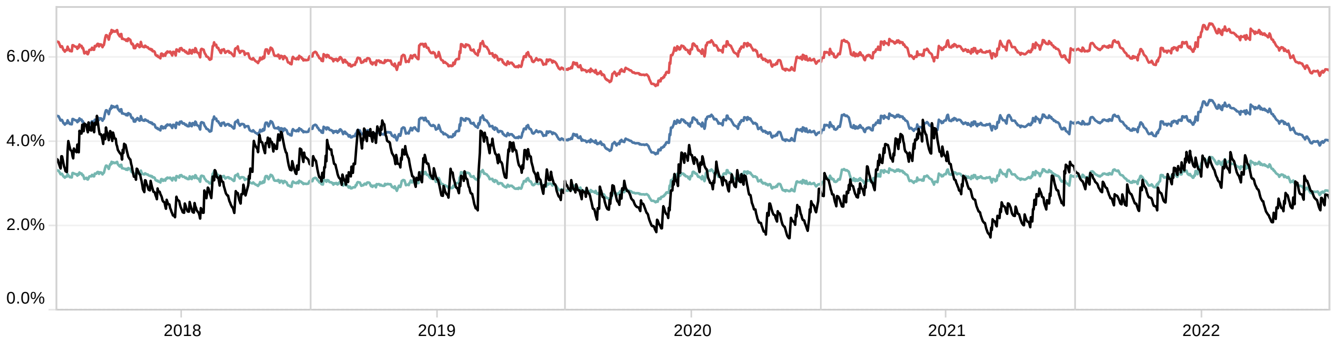


Figure 41: Renal failure, 2018–2022

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

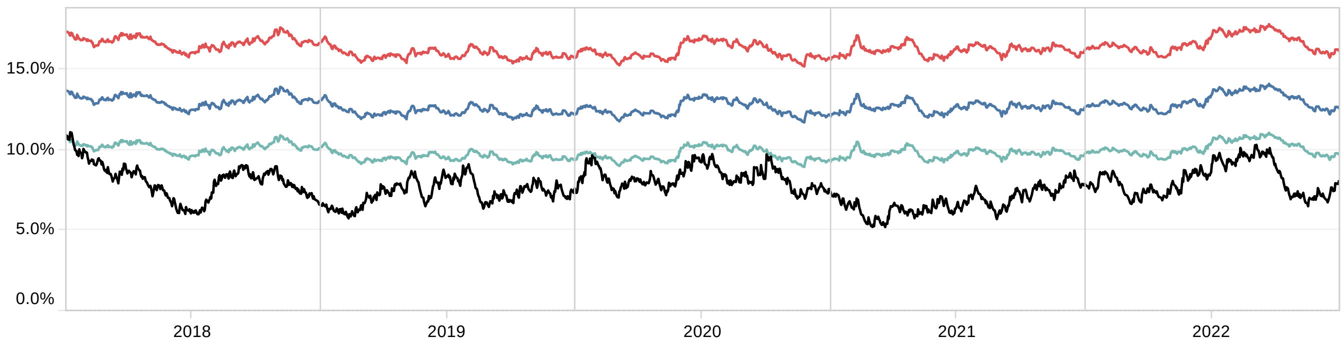


Figure 42: Ventilation >24 hours, 2018–2022

DSWI is a significant postoperative adverse outcome that increases the risk of death for a patient and has significant consequences in terms of healthcare system resource utilisation. Over the past five years, there has been a reduction in the observed rate of DSWI. Various sites have implemented a range of quality improvement activities, projects and audits to investigate and reflect on local practices with an aim to understand the contributing factors that may increase the likelihood of a patient suffering DSWI.

Legend: — Observed, EWMA — Predicted (95% confidence interval), EWMA

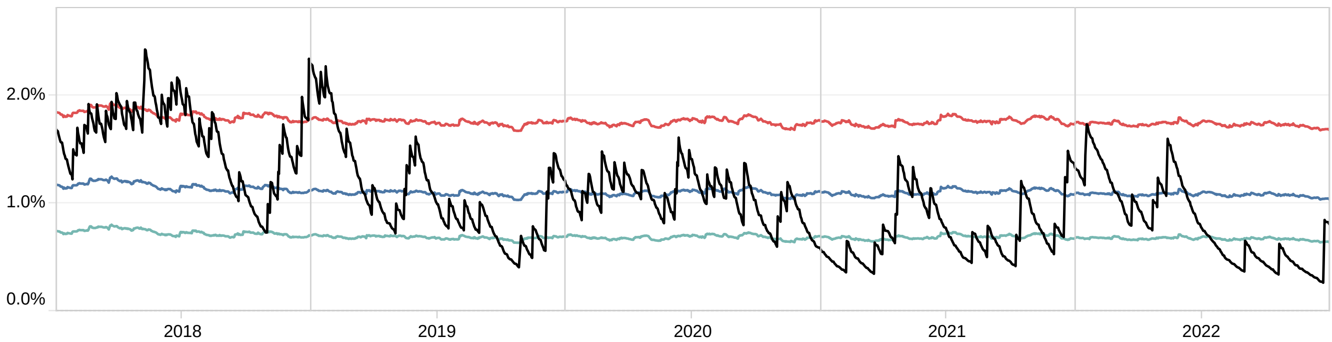


Figure 43: Deep sternal wound infection, 2018–2022

Reoperation following cardiac surgery is performed as a last resort to correct a surgical complication or unplanned sequalae of the index operation. This outcome has been largely within, or exceeding the upper limit of, the predicted rate.

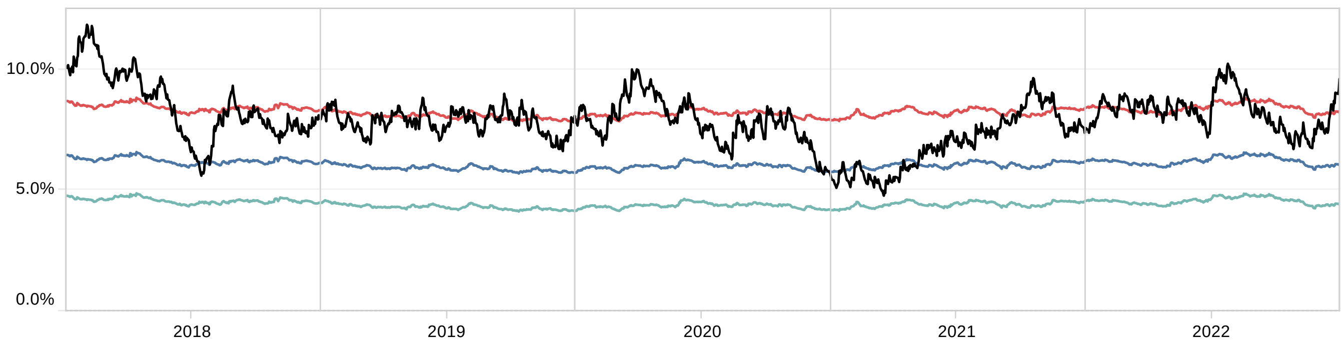


Figure 44: Reoperation, 2018–2022

The development of any of the five major morbidities previously described (including DSWI) is an important aggregate measure of surgical outcomes. Since the inception of the quality program for cardiac surgery, the major morbidity rate has remained largely consistent within the expected range or below the expected rate.

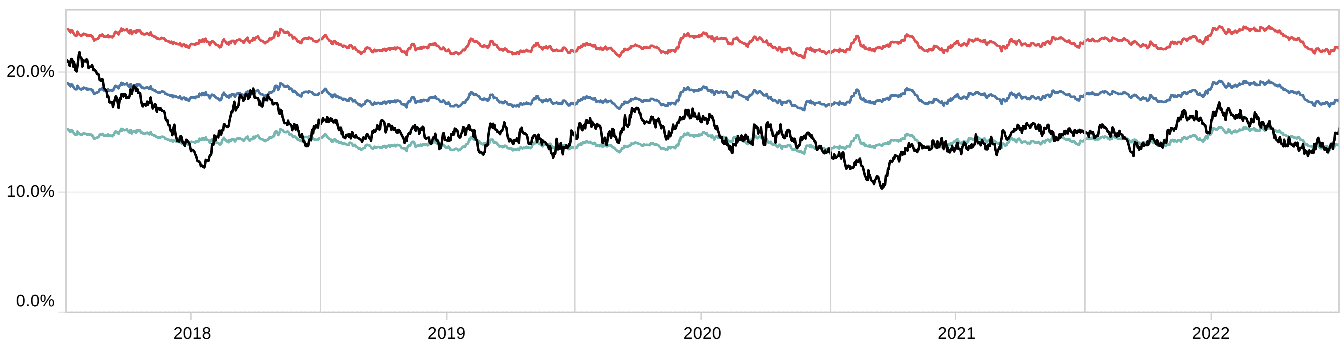


Figure 45: Major morbidity, 2018–2022

Measures of process

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

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

Similarly, the proportion of patients who stay longer than 14 days is consistently larger than expected, though sites are able to achieve close to the expected rate. This suggests that the STS targets are realistic, even though they may not account for Queensland's well-described geographic challenges and with sustained focus, performance within the benchmark range may be possible.

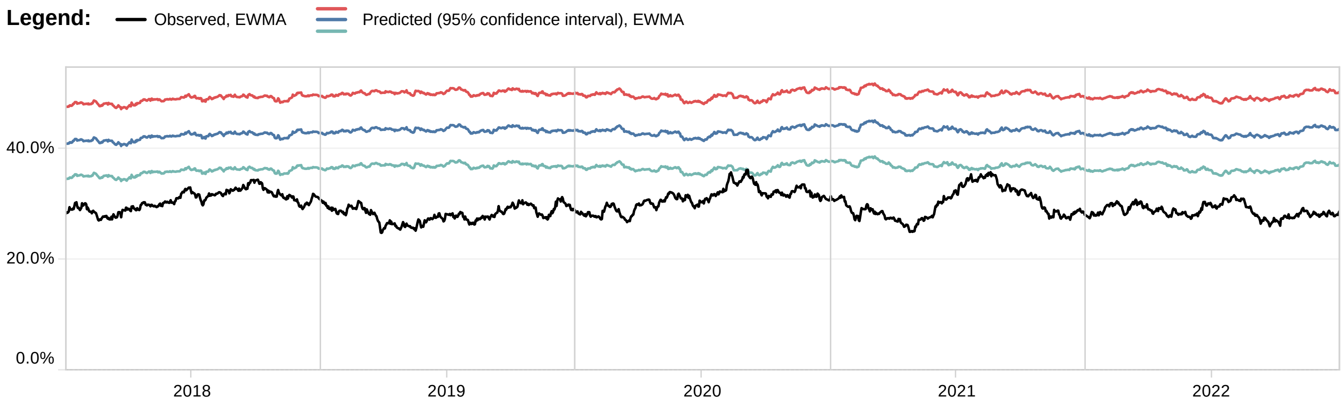


Figure 46: LOS <6 days, 2018–2022

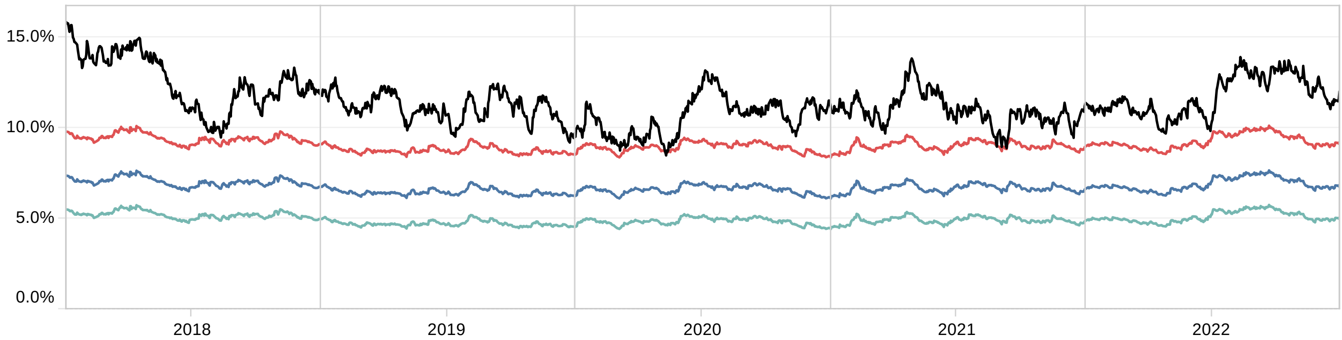


Figure 47: LOS >14 days, 2018–2022

Failure to rescue

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

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

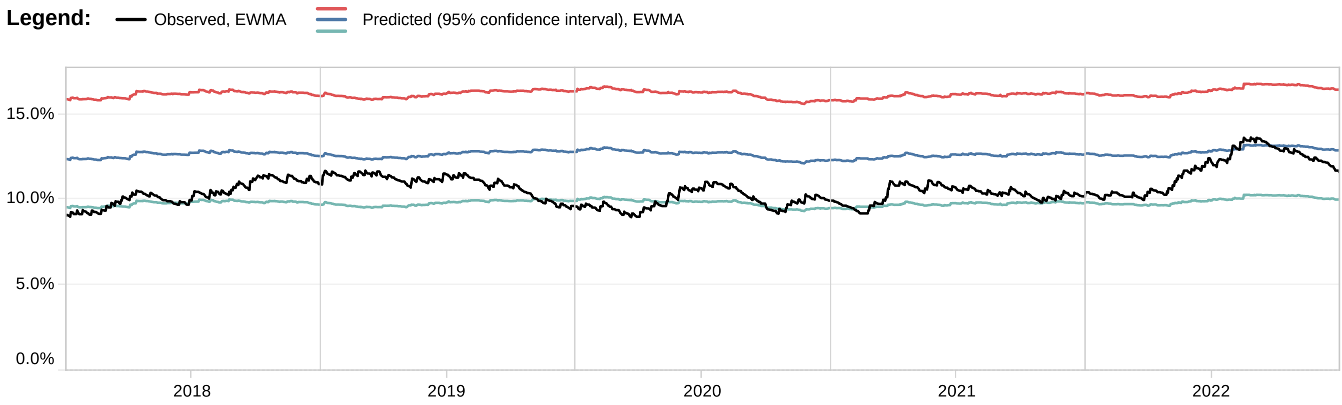


Figure 48: Failure to rescue, 2018–2022

9 Supplement: Cardiac surgery equity

A health system that demonstrates equity would have an absence of disparities in health outcomes and access to healthcare services among different population groups. In Australia, there are several health equity challenges that have been identified. These challenges stem from social, economic, and structural factors. Key health equity themes and challenges in Australia include:

- **Aboriginal and Torres Strait Islander persons health disparities**
  One of the most significant health equity challenges in Australia is the gap in health status and outcomes between Aboriginal and Torres Strait Islander peoples and Australians of other descent. Aboriginal and Torres Strait Islander peoples experience higher rates of chronic diseases, lower life expectancy, and poorer access to healthcare services compared to non Aboriginal and Torres Strait Islander persons.[32]
- **Geographic disparities**
  Rural and remote areas in Australia often have limited access to healthcare services, including doctors and specialists. This has been linked to disparities in health outcomes between urban and regional/remote populations.[32]
- **Gender health inequities**
  Gender-based disparities exist in areas such as reproductive health, domestic violence, and access to gender-specific healthcare services. Women and gender-diverse individuals may face unique health challenges or present with clinical signs and symptoms of disease that vary from medical norms.[32]
- **Socioeconomic disparities**
  Socioeconomic status is a significant determinant of health outcomes in Australia. People from lower socioeconomic backgrounds often face higher rates of chronic conditions, mental health issues, and reduced access to healthcare services.[32]

Efforts to address these health equity challenges in Australia have involved policy initiatives at local, state and federal government levels, community-based programs, and research collaborations. It is important to note that the health equity landscape is constantly evolving with the impacts of various programs to investigate and improve equity currently underway across the country.

This supplement aims to investigate and analyse these key determinants of health equity and their trends over time in a cohort of Queenslanders who have undergone cardiac surgery in public surgical units from 2017 to 2022.

9.1 Aboriginal and Torres Strait Islander persons health disparities

Access to cardiac surgery for Aboriginal and Torres Strait patients has been a longstanding concern due to various social, economic, geographic, and healthcare system factors. This issue highlights disparities in healthcare and outcomes among Aboriginal and Torres Strait Islander Australians.

First Nations Australians experience significantly higher rates of cardiovascular disease, including coronary artery disease, heart failure, and rheumatic heart disease, compared to Australians of other descent.[32] These disparities are linked to a range of social determinants of health, such as lower socioeconomic status, limited access to healthcare services, and higher rates of risk factors like smoking, poor nutrition, and physical inactivity.[33] Many Indigenous Queenslander communities are in remote or rural areas, making it challenging to access specialised cardiac care facilities. Transportation barriers, including long distances to hospitals and the cost of travel, can limit access for First Nations patients to timely cardiac care.

Aboriginal and Torres Strait Islander persons often present with more advanced cardiac diseases due to delayed access to care, leading to higher surgical risks.[32] Comorbidities like diabetes and kidney disease are more prevalent among First Nations patients, increasing the complexity of cardiac surgeries.[33]

Cultural competence among healthcare providers is essential for providing quality care to First Nations peoples. Insensitivity to cultural beliefs and practices is also a barrier for Aboriginal and Torres Strait Islander people in need of healthcare.[34] Communication issues, including language and cultural differences, may lead to misunderstandings and hinder patient-provider relationships.[34]

9.2 Geographic disparities

Access to cardiac surgery for Australians living in rural and remote locations can be a significant challenge. These areas often face geographical, infrastructural, and healthcare workforce limitations that can affect the timely delivery of specialised medical services, such as cardiac surgery.

Safe performance of cardiac surgery requires a certain volume of case load. As case loads relate to absolute population numbers, when servicing a low density, sparsely populated regional area, the area is necessarily large, resulting in significant travel times from regional and remote communities. Along with the challenge of attracting and retaining medical specialists, the need for minimum volume and outcome considerations relating to the minimum surgical volumes for units to attain and retain accreditation necessarily creates an upper limit on the number of cardiac surgical units that can be supported in regional areas. Telehealth solutions, while improving, might not always be sufficient for cardiac surgery consultations or follow-up care.[37]

Rural and remote areas in Australia are often far from major healthcare facilities, including cardiac surgery centres. This distance can delay access to timely care, especially in emergencies. Limited transportation options can further hinder access.[35] Some patients may struggle to reach medical centres, leading to delayed diagnosis and treatment. Harsh weather conditions and challenging terrain in some remote regions can make travel to healthcare centres even more difficult.[35]

Rural and remote areas often suffer from a shortage of specialist medical practitioners, including cardiac surgeons. Attracting and retaining healthcare professionals in remote areas can be challenging due to factors like professional isolation and limited career opportunities for their spouses.[36]

Patients may face significant expenses related to travel, accommodation, and meals when seeking cardiac surgery in urban centres. Limited private insurance coverage for surgeries outside of major cities can also be a challenge. Furthermore, support networks and access to family can also present challenges for patients whose support network resides outside of major cities.

The allocation of healthcare resources and funding often favours urban areas, leaving rural and remote regions with fewer healthcare services. There is a need for targeted policy initiatives to address these disparities, such as subsidies for healthcare providers in remote areas.[38]

9.3 Gender health inequities

When discussing gender-specific issues related to access to cardiac surgery for Australian women, several key aspects have been found to be important.

It has been reported that women often underestimate their risk of heart disease, and healthcare providers may not recognise the symptoms in women as readily as they do in men.[39] This can lead to delays in diagnosis and treatment. Encouraging awareness campaigns about heart disease and its symptoms in women is crucial.

Women may experience symptoms of myocardial infarction that differ from the traditional crushing chest pain sometimes accompanied by arm or jaw pain commonly experienced by males.[39] Women with myocardial infarction may have atypical symptoms such as nausea, shortness of breath, or back pain. The atypical nature of these symptoms, disease manifestation differences, and tendency to present later in life can lead to misdiagnosis or delayed diagnosis.[39] The system is biased toward the “typical” presentation of diseases, and hence a system bias exists against the atypical presentations that are more common in women. The majority of cardiac surgical cases are performed on males, with typical presentations, and so the system is geared toward this activity, and biased against non-males with atypical presentations.

The different life expectancy of men and women means that a larger proportion of older woman, who may have multiple comorbidities may face increased challenges due to higher surgical risks than mean.[32] Shared decision-making between patients, their families and healthcare providers is crucial in such cases to ensure the best possible outcome and timely intervention to avoid disease progression.[40]

9.4 Socioeconomic disparities

Social disadvantage is a factor that also encompasses other factors such as socioeconomic status, education level, geographic location, cultural background, and Aboriginal and Torres Strait Islander descent.

Socioeconomic disparities can affect access to cardiac surgery. People with lower incomes may have limited access to private healthcare options, which can result in longer wait times for publicly funded surgeries.[41]

The distance of patients in rural and remote areas to cardiac surgery centres creates a barrier for the socioeconomically disadvantaged.[41] Expanding telehealth services and providing specialist outreach clinics can help bridge the gap for patients in remote areas, whilst also essential to invest in regional healthcare infrastructure and improve transportation options.

Patients from culturally diverse backgrounds may face language and cultural barriers when seeking cardiac surgery. Developing culturally sensitive healthcare services, employing interpreters, and training healthcare providers in cultural competence can enhance access for culturally diverse populations.[41]

Aboriginal and Torres Strait Islander peoples often face disparities in healthcare access, including cardiac surgery.[34] Historical and systemic factors contribute to this issue.[34] Culturally appropriate healthcare services, community engagement, and improving access to healthcare facilities in Aboriginal and Torres Strait Islander communities are crucial steps.[34] Collaborative efforts with Aboriginal and Torres Strait Islander communities are essential to address this issue effectively.

Low health literacy can hinder individuals from seeking timely cardiac care or understanding treatment options.[41] Public health campaigns and educational programs can raise awareness about cardiovascular health and available treatment options, especially among disadvantaged populations.

9.5 Patient characteristics

A total of 14,813 patients having surgery between 2017 and 2022 were included in the analysis. Of this cohort, the largest proportion were males (74% of total) who underwent CABG, followed by males who underwent isolated valve surgery. Females accounted for 26% of the overall cohort and were more likely to have undergone isolated valve surgery followed by CABG. Aboriginal and Torres Strait Islander patients accounted for 6.8% of the cohort with the largest proportion of the group (62%) undergoing CABG. 9% of the overall cohort were elective day of surgery admissions.

Table 1: Demographic and treatment characteristics by surgery category, 2017–2022

	ANY CABG* n (%)	CABG + Valve n (%)	Valve n (%)	Other n (%)
Gender				
Male	5,933 (54.4)	1,147 (10.5)	3,138 (28.8)	684 (6.3)
Female	1,351 (34.5)	272 (7.0)	1,822 (46.6)	466 (11.9)
Age group (years)				
<40	74 (8.8)	5 (0.6)	488 (58.2)	272 (32.4)
40–49	474 (40.9)	47 (4.1)	454 (39.2)	183 (15.8)
50–59	1,615 (57.8)	153 (5.5)	802 (28.7)	226 (8.1)
60–69	2,629 (58.2)	442 (9.8)	1,166 (25.8)	284 (6.3)
70–79	2,140 (49.5)	623 (14.4)	1,400 (32.4)	158 (3.7)
≥80	352 (29.9)	149 (12.6)	650 (55.2)	27 (2.3)
Body mass index (BMI) category				
Underweight†	32 (17.7)	8 (4.4)	101 (55.8)	40 (22.1)
Normal range‡	1,402 (41.0)	284 (8.3)	1,361 (39.8)	370 (10.8)
Overweight§	2,759 (51.3)	546 (10.2)	1,693 (31.5)	375 (7.0)
Obese‖	2,760 (54.0)	521 (10.2)	1,520 (29.7)	311 (6.1)
Morbidly obese#	331 (46.0)	60 (8.3)	285 (39.6)	44 (6.1)
Admission status				
Elective	2,824 (34.8)	880 (10.8)	3,875 (47.8)	535 (6.6)
Urgent	4,085 (73.6)	484 (8.7)	857 (15.4)	127 (2.3)
Emergency	351 (32.1)	53 (4.8)	219 (20.0)	470 (43.0)
Salvage	24 (45.3)	2 (3.8)	9 (17.0)	18 (34.0)
Aboriginal and Torres Strait Islander descent				
Aboriginal and Torres Strait Islander peoples	625 (62.2)	76 (7.6)	253 (25.2)	51 (5.1)
Australians of other descent	6,659 (48.2)	1,343 (9.7)	4,707 (34.1)	1,099 (8.0)
Elective day of surgery admission				
Yes	498 (36.8)	122 (9.0)	673 (49.8)	59 (4.4)
No	6,786 (50.4)	1,297 (9.6)	4,287 (31.8)	1,091 (8.1)
ALL	**7,284 (49.2)**	**1,419 (9.6)**	**4,960 (33.5)**	**1,150 (7.8)**

Excludes missing data: BMI (n=10, <0.1%)

* Includes coronary artery bypass grafting procedures not including concurrent valve surgery, these operations may occur in isolation or in conjunction with aortic, non cardiac or non valvular cardiac interventions

† BMI <18.5 kg/m²

‡ 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

9.6 Socioeconomic Indexes for Areas

Socioeconomic Indexes for Areas (SEIFA) is a suite of measures compiled by the Australian Bureau of Statistics (ABS) that ranks areas in Australia according to relative socioeconomic advantage and disadvantage. These indices were developed using variables collected during the ABS Census that span several areas including household income, employment, education status, occupation, housing and other indicators of advantage and disadvantage. The scores of these indices are standardised to a distribution where the average equals 1,000 and roughly two-thirds of the scores lie between 900 and 1,100.

The four indexes are below:

- Index of Relative Socioeconomic Disadvantage (IRSD)
- Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD)
- Index of Economic Resources (IER)
- Index of Education and Occupation (IEO)

For the purpose of this analysis, SEIFA indexes were derived from the postcode of the patient's usual place of residence. Overseas patients were excluded from the analysis.

Index of Relative Socioeconomic Disadvantage (IRSD)

The ISRD contains only indicators of relative disadvantage and as such provides a broad measure of disadvantage.

An ISRD score above 1,000 indicates a relative lack of disadvantage whereas, a score below 1,000 indicates relatively greater disadvantage in general.

For example, an area could have a low score if there are:

- many households with low income,
- many people with no qualifications, or
- many people in low skill occupations.

Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD)

The ISRAD contains both indicators of relative advantage and disadvantage. As such the ISRAD provides a summary of the economic and social conditions.

An ISRAD score above 1,000 indicates a relative lack of disadvantage and greater advantage, whereas a low score indicates relatively greater disadvantage and a lack of advantage in general.

For example, an area could have a low score if there are:

- many households with low incomes, or many people in unskilled occupations, AND
- few households with high incomes, or few people in skilled occupations.

Index of Economic Resources (IER)

The IER takes into account the financial aspects of relative socioeconomic advantage and disadvantage.

Education and occupation are excluded because they are not direct measures of economic resources.

The IER ignores some asset classes such as savings or equities which could not be included as this data was not collected in the 2016 Census.

For example, an area could have a low score if there are:

- many households with low income, or many households paying low rent, AND
- few households with high income, or few owned homes.

Index of Education and Occupation (IEO)

The IEO was compiled to reflect the educational and occupational level of populations. The IEO does not include any income variables but rather focuses on education variables (highest level of qualification achieved or whether further education is being undertaken) and occupation classification (occupation skill level and unemployment).

A low score indicates relatively lower education and occupation status of people in the area in general.

For example, an area could have a low score if there are:

- many people without qualifications, or many people in low skilled occupations or many people unemployed, AND
- few people with a high level of qualifications or in highly skilled occupations.

In this cohort, there was relative parity in socioeconomic scores between males and females. The median scores for the overall cohort were below 1,000 indicating that a large proportion of this group experience some form of disadvantage. Aboriginal and Torres Strait Islander patients included in the analysis had more disadvantage than Australians of other descent.

Patients who underwent any form of CABG surgery tended to have a greater propensity for disadvantage than those who had isolated valve or other cardiac surgery. Those patients who resided in major cities were less likely to experience disadvantage compared to those living in regional or remote locations.

Table 2: Median SEIFA indexes by surgery category, 2017–2022

	Total cases n	Median (IQR) IRSD* score	Median (IQR) IRSAD† score	Median (IQR) IER‡ score	Median (IQR) IEO§ score
Gender					
Male	10,902	988 (938–1,024)	964 (912–1,010)	991 (956–1,022)	956 (905–1,001)
Female	3,911	987 (936–1,024)	964 (912–1,009)	989 (956–1,020)	957 (905–1,001)
Aboriginal and Torres Strait Islander descent					
Aboriginal and Torres Strait Islander peoples	1,005	953 (896–985)	931 (884–966)	956 (911–990)	916 (886–965)
Australians of other descent	13,808	991 (943–1,028)	964 (919–1,013)	992 (960–1,023)	958 (905–1,004)
Surgery category					
Any CABG	7,284	985 (936–1,023)	963 (910–1,005)	988 (956–1,020)	952 (903–994)
CABG + Valve	1,419	985 (936–1,023)	963 (910–1,007)	982 (955–1,020)	952 (905–995)
Valve	4,960	990 (939–1,026)	964 (915–1,010)	991 (959–1,021)	958 (905–1,001)
Other	1,150	1,000 (954–1,035)	980 (927–1,022)	1,000 (960–1,032)	971 (911–1,020)
Remoteness category					
Major cities	8,021	1,013 (967–1,041)	995 (956–1,028)	1,008 (975–1,035)	986 (949–1,028)
Inner regional	3,969	954 (930–991)	927 (904–961)	972 (959–1,000)	908 (895–954)
Outer regional	2,273	965 (931–998)	945 (908–967)	962 (941–994)	927 (890–973)
Remote	219	944 (870–975)	927 (855–947)	941 (887–976)	906 (884–934)
Very remote	331	948 (765–963)	935 (850–949)	931 (716–948)	924 (882–928)
ALL	**14,813**	**988 (938–1,024)**	**964 (912–1,009)**	**991 (956–1,022)**	**956 (905–1,001)**

* Index of Relative Socioeconomic Disadvantage

† Index of Relative Socioeconomic Advantage and Disadvantage

‡ Index of Economic Resources

§ Index of Education and Occupation

An illustration of Queensland postal areas ranked by the decile of the associated SEIFA index is included in Figure 1–Figure 4. Darker colours indicate higher relative advantage according to the index.

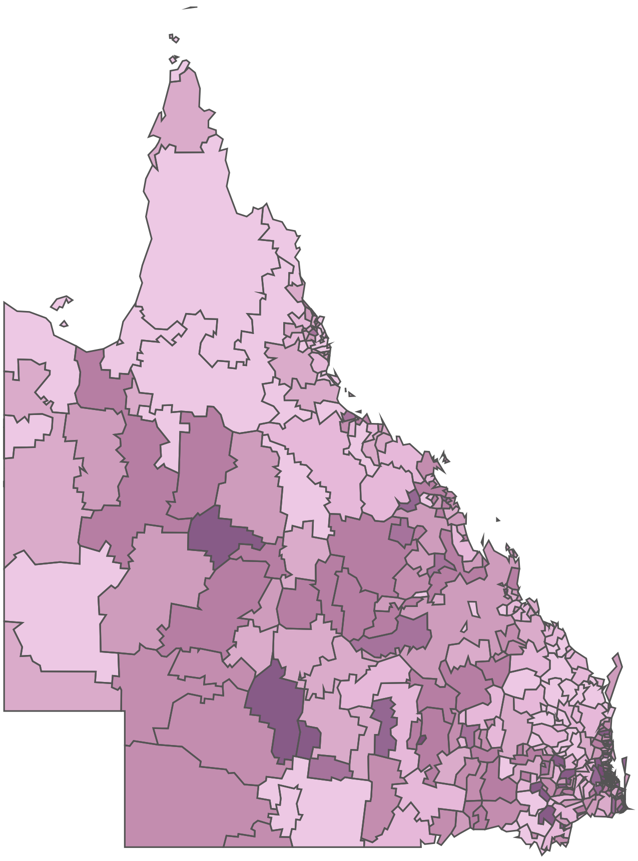


Figure 1: Queensland postal areas by Index of Relative Socioeconomic Disadvantage (IRSD) decile

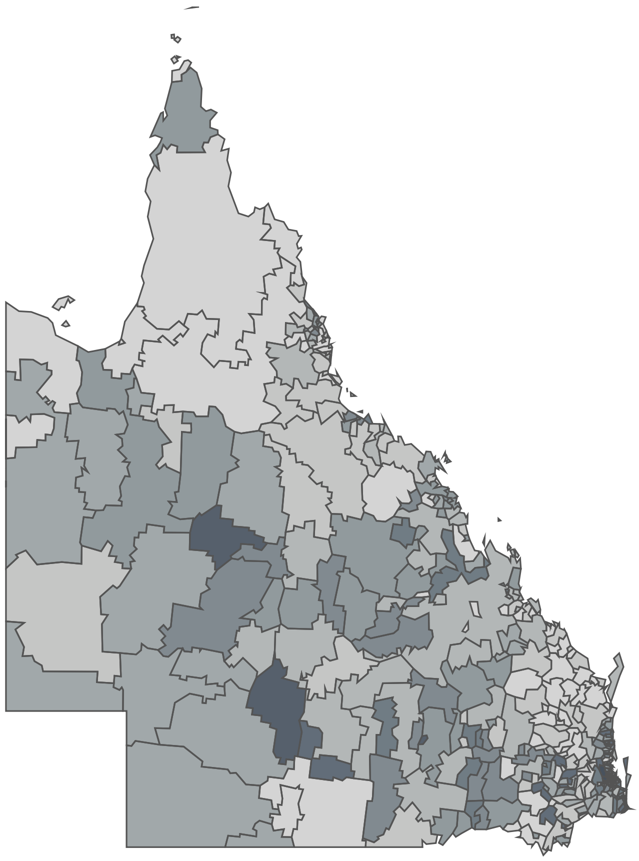


Figure 2: Queensland postal areas by Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) decile

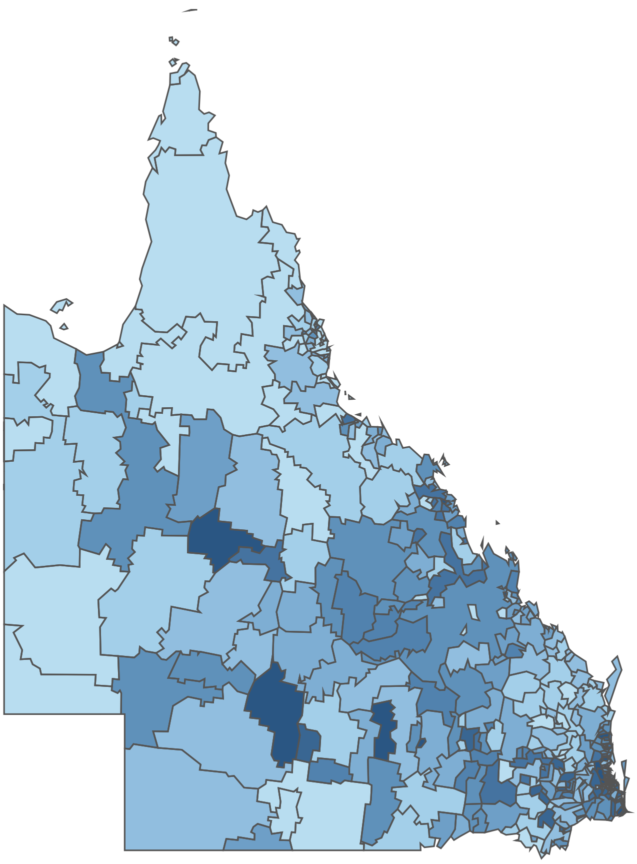


Figure 3: Queensland postal areas by Index of Economic Resources decile

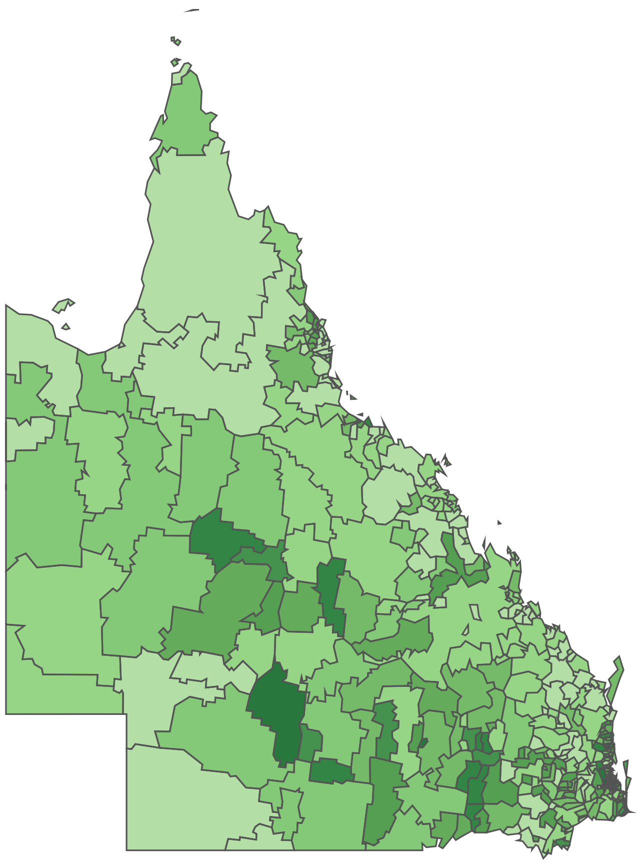


Figure 4: Queensland postal areas by Index of Education and Occupation decile

9.7 Patient outcomes

Mortality

For this analysis, the ANZSCTS General Score[42] has been utilised as this has been shown to be the best performing comprehensive predictive model (discrimination and calibration) in the QCOR cohort. This analysis presents the standardised incidence ratio (SIR) which is defined as a ratio of the observed number of events divided by the predicted number of events. Unlike many other outcome measures, this clinical indicator is based on the number of events, not population. A SIR greater than 100% indicates poorer than expected performance.

Aboriginal and Torres Strait Islander peoples and mortality

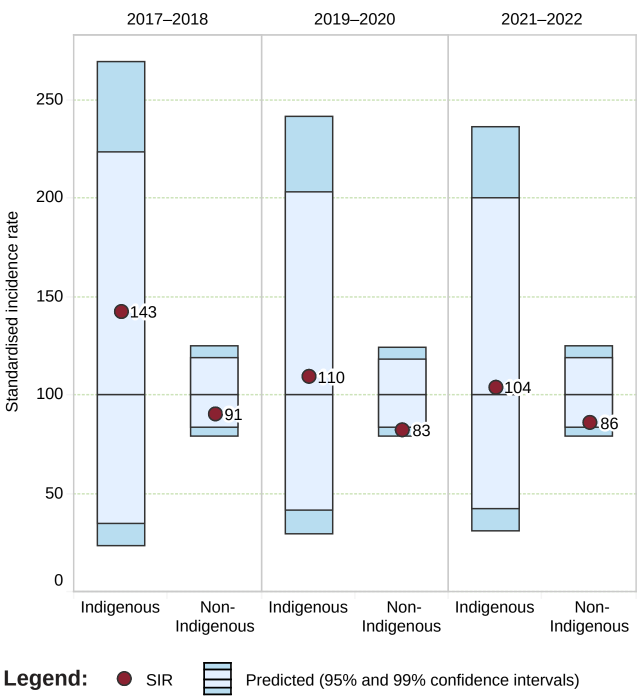


Figure 5: Standardised incidence of mortality by Aboriginal and Torres Strait Islander descent and year

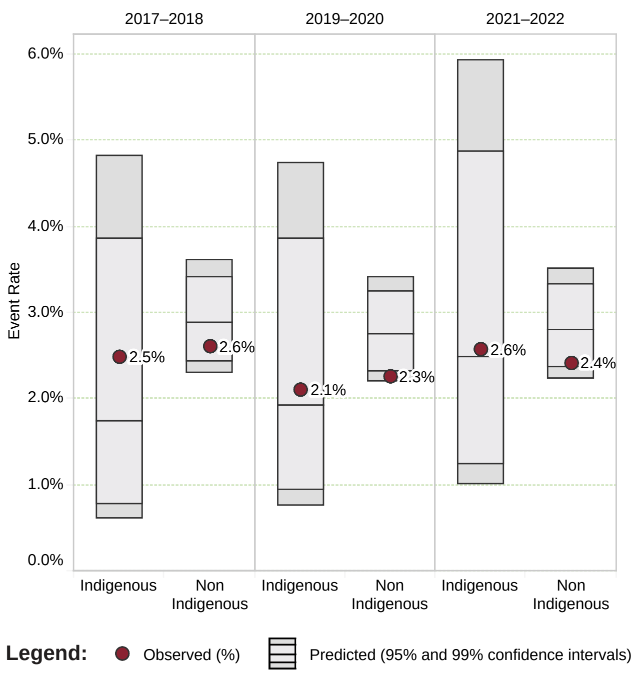


Figure 6: Mortality rate by Aboriginal and Torres Strait Islander descent and year

When comparing outcomes between 2017–2018 and 2021–2022, for Australians of other descent, the SIR remains around 90% for both periods, residing at the lower end of the confidence interval. For Aboriginal and Torres Strait Islander patients, the SIR has decreased from 143% to 104%, although neither change is statistically significant. However, both figures remain higher than those for Australians of other descent, reflecting a trend to potentially poorer than expected outcomes.

When examining event rates, there appears to be no discernible difference in the raw mortality rate between First Nations peoples and Australians of other descent across the two periods, with rates ranging between 2.4% and 2.6%. Yet, the expected mortality rate for the First Nations peoples in 2017–2018 is notably lower than that for First Nations and Australians of other descent in 2021–2022.

It should be noted that the confidence intervals in the above analysis are based on the predicted rate and the number at risk in each cohort. As such First Nations peoples will have broader confidence intervals due to the relatively smaller cohort size.

Since 2017–2018 many initiatives have been implemented to improve access to care for patients living remotely, in Aboriginal and Torres Strait Islander communities and areas with high proportions of Aboriginal and Torres Strait Islander peoples such as the Networked Cardiac Services initiative.

Remoteness and mortality

In this analysis, the disparity in mortality rates between individuals in remote areas and those in other locations has diminished between 2017 and 2022. During 2017–2018, even though the expected mortality rates were similar for both cohorts at approximately 2.7%, the observed mortality rate in remote areas was roughly 40% higher (3.7% vs. 2.6%). In 2021–2022, the SIR in remote areas stood at 121%, compared to 87% in non-remote centres indicating poorer outcomes for those living in remote areas.

However, across all years examined, the observed mortality rate for those patients living remotely was 1.8% vs. 2.4% for those living in non remote locations. For the same period, the SIR was 89% for those living remotely vs. 87% for all others.

For the purpose of this analysis, patients residing in remote and very remote areas were combined into a single group.

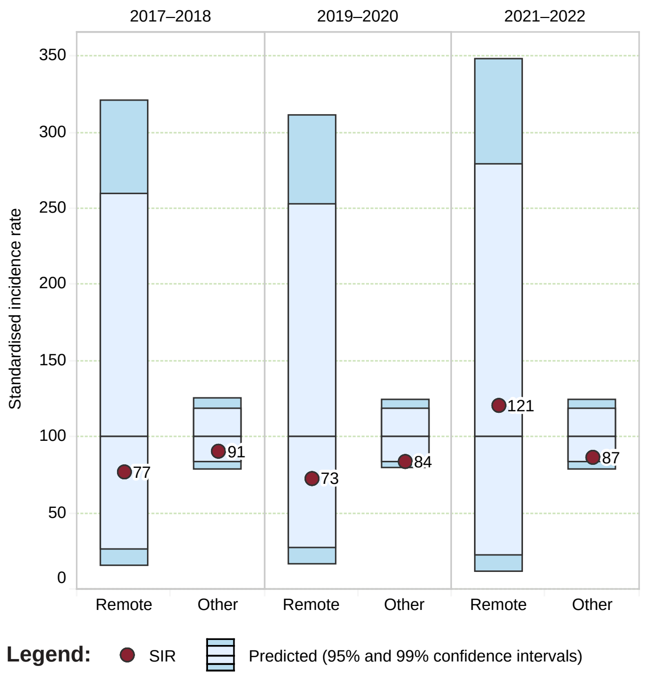


Figure 7: Standardised incidence of mortality by Remote/Very Remote status and year

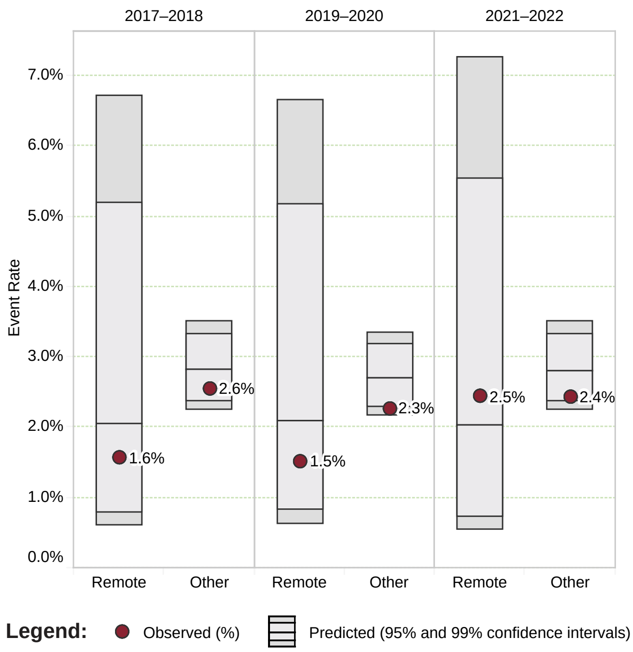


Figure 8: Mortality rate by Remote/Very Remote status and year

Gender and mortality

In the ANZSCTS General Score risk model, being of female sex is associated with a higher expected risk of death. When comparing outcomes between 2017–2018 and 2021–2022 the SIR for males has remained relatively constant, remaining at approximately 85%. However, the SIR for females has decreased from 104 to 91. Although this change is not statistically significant, it represents a reduction of over 12%. When comparing observed and predicted mortality rates, it is apparent that women still exhibit a mortality rate approximately twice as high as that of males (3.7% vs. 2.0%).

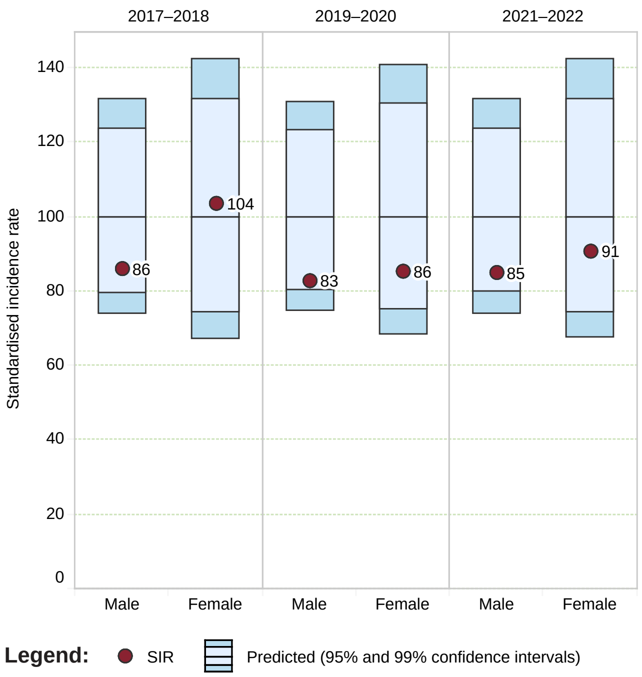


Figure 9: Standardised incidence of mortality by gender and year

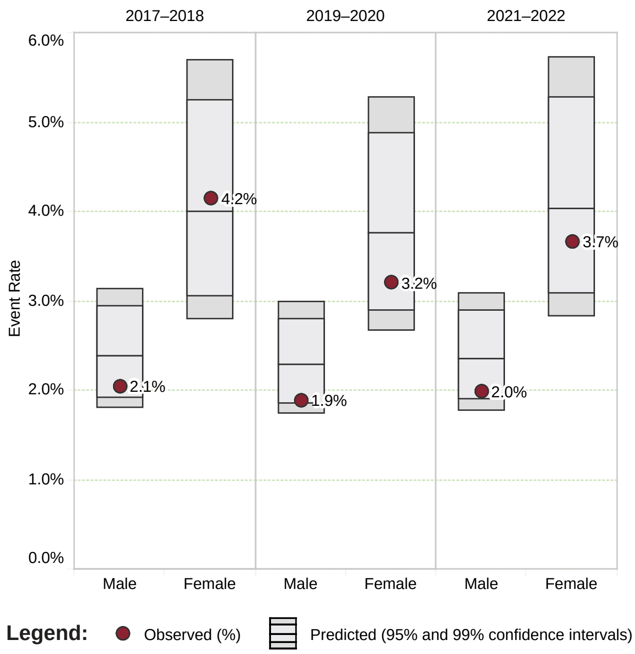


Figure 10: Mortality rate by gender and year

Cardiac Surgery

9.8 Multivariate analysis

To explore the impact of key health equity themes and challenges and how they relate to patient outcomes, multivariate logistic regression analysis has been employed. Inputs for this analysis included factors inherent in the patient preoperatively (age, gender and BMI), the urgency with which the surgery was required, the type of surgery (CABG only, CABG + valve, valve only or other), Aboriginal and Torres Strait Islander descent and various indices of socioeconomic advantage or disadvantage. The output of this analysis for each factor is the odds ratio. This is a measure of association of the factor (or category of factor) in the context of the other factors explored compared to a reference cohort. Outcomes explored include mortality and other major postoperative adverse events (myocardial infarction, deep sternal wound infection, or cerebrovascular accident).

An odds ratio of:

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

When all factors present are taken into consideration, the magnitude of the odds ratio reflects the likelihood the patient will experience the outcome if the factor is present by comparison to the reference cohort.

Mortality

When considering a range of geographic, social, and demographic variables, a number of observations can be made. The risk of death has shown relatively little change since 2017. As demonstrated in univariate analysis, being of the female sex is associated with a higher risk of death, and this association is statistically significant.

Although Aboriginal and Torres Strait Islander descent in isolation does not appear to be a significant risk factor, this analysis suggests that the odds of death for this cohort are only slightly elevated compared to the Australians of other descent population undergoing surgery. This result, however, must be interpreted with the knowledge that patients in outer regional and remote areas (where a higher proportion of First Nations patients are located) also face an increased risk of death.

Patients undergoing valve surgery, either alone or with concurrent CABG, appear to be at a higher risk of death. While the odds of death tend to increase with age, this increase is not statistically significant. Patient geographic remoteness does not seem to have a significant impact on outcomes.

The risk of death appears to be influenced by socioeconomic advantage/disadvantage and education/occupation status, with those in the highest quartile facing a significantly higher risk of death. Access to economic resources, however, does not appear to be linked to significantly elevated odds, though a discernible trend is evident.

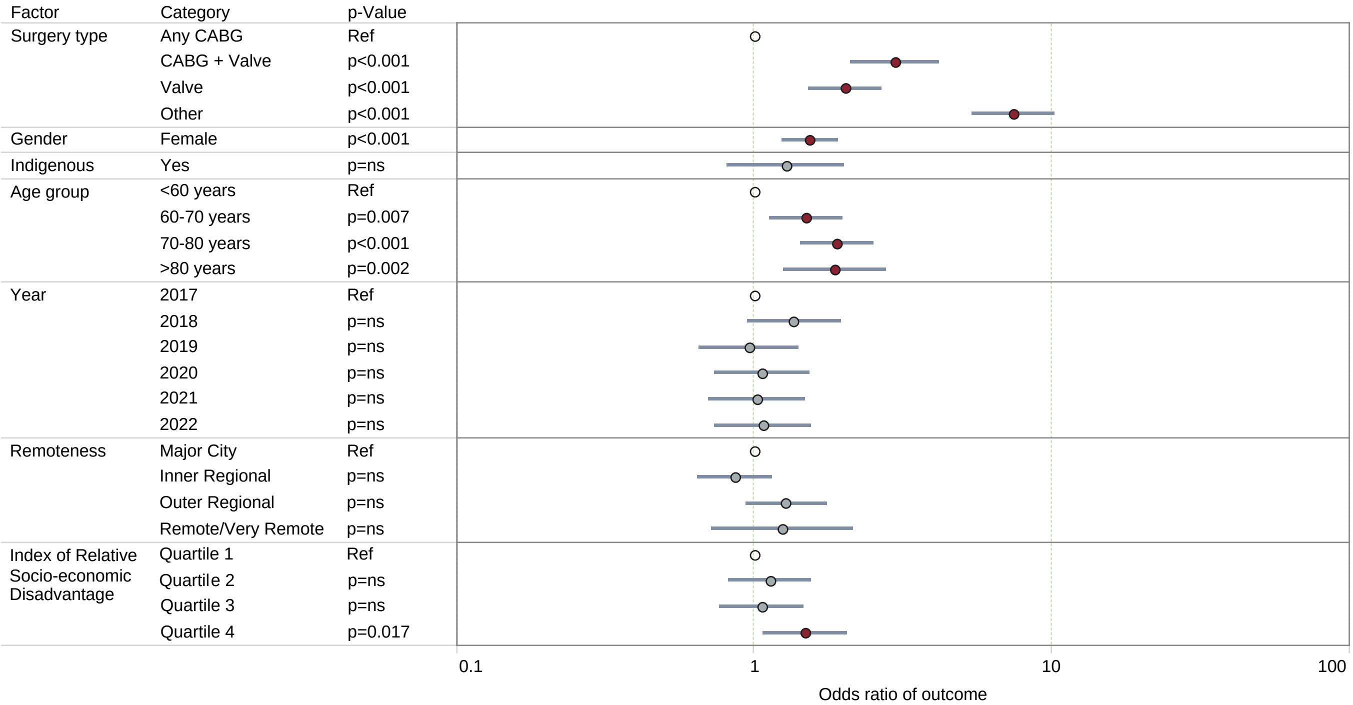


Figure 11: Association of factors including IRSD index with mortality

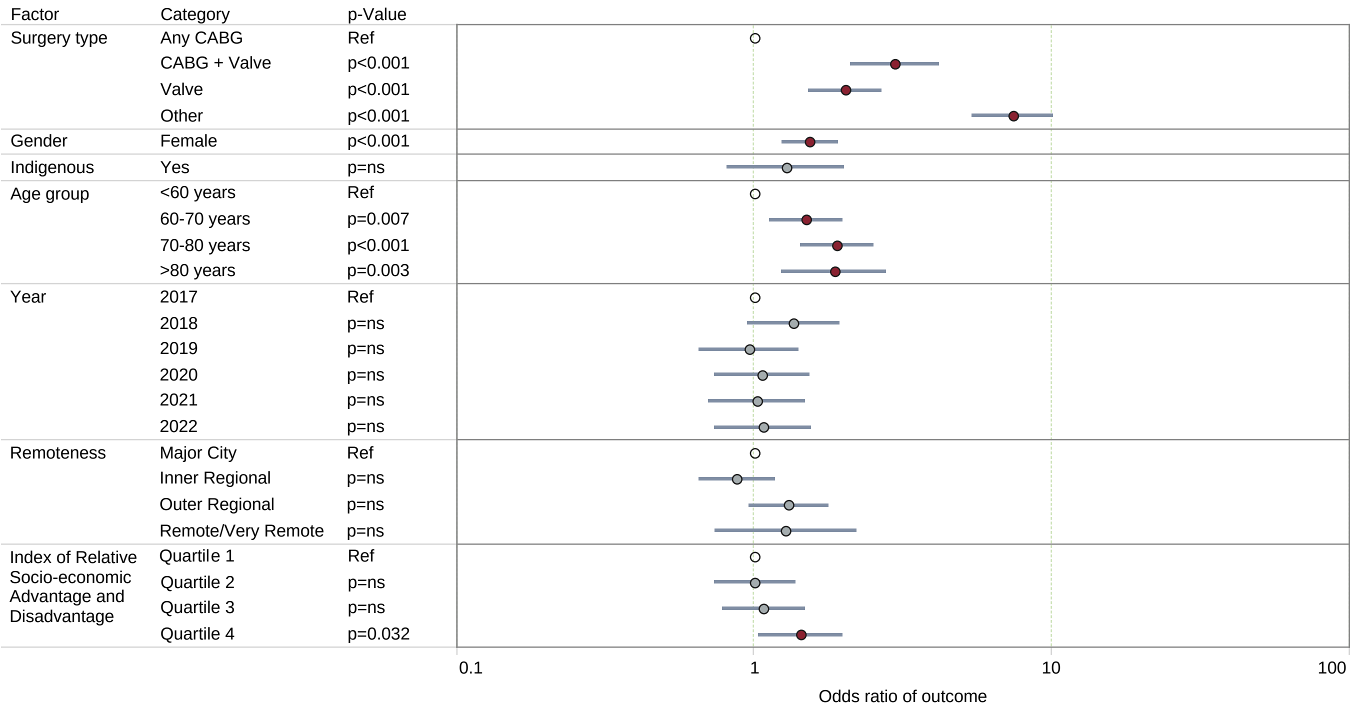


Figure 12: Association of factors including IRSAD index with mortality

Factor	Category	p-Value
Surgery type	Any CABG	Ref
	CABG + Valve	p<0.001
	Valve	p<0.001
	Other	p<0.001
Gender	Female	p<0.001
Indigenous	Yes	p=ns
Age group	<60 years	Ref
	60-70 years	p=0.006
	70-80 years	p<0.001
	>80 years	p=0.002
Year	2017	Ref
	2018	p=ns
	2019	p=ns
	2020	p=ns
	2021	p=ns
	2022	p=ns
Remoteness	Major City	Ref
	Inner Regional	p=0.038
	Outer Regional	p=ns
	Remote/Very Remote	p=ns
Index of Economic Resources	Quartile 1	Ref
	Quartile 2	p=ns
	Quartile 3	p=ns
	Quartile 4	p=ns

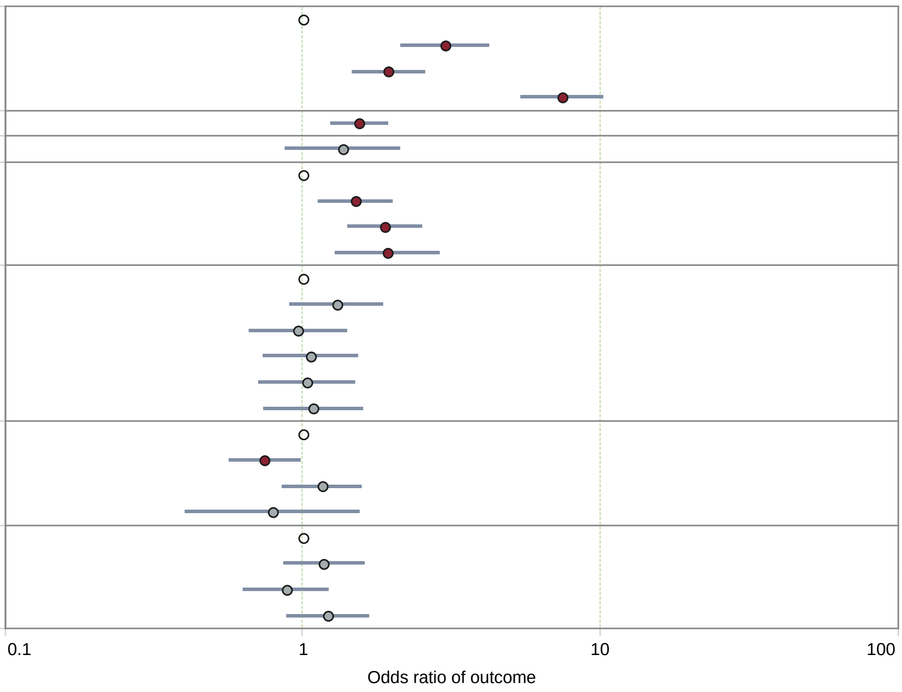


Figure 13: Association of factors including IER index with mortality

Factor	Category	p-Value
Surgery type	Any CABG	Ref
	CABG + Valve	p<0.001
	Valve	p<0.001
	Other	p<0.001
Gender	Female	p<0.001
Indigenous	Yes	p=ns
Age group	<60 years	Ref
	60-70 years	p=0.007
	70-80 years	p<0.001
	>80 years	p=0.002
Year	2017	Ref
	2018	p=ns
	2019	p=ns
	2020	p=ns
	2021	p=ns
	2022	p=ns
Remoteness	Major City	Ref
	Inner Regional	p=ns
	Outer Regional	p=ns
	Remote/Very Remote	p=ns
Index of Education and Occupation	Quartile 1	Ref
	Quartile 2	p=ns
	Quartile 3	p=ns
	Quartile 4	p=0.040

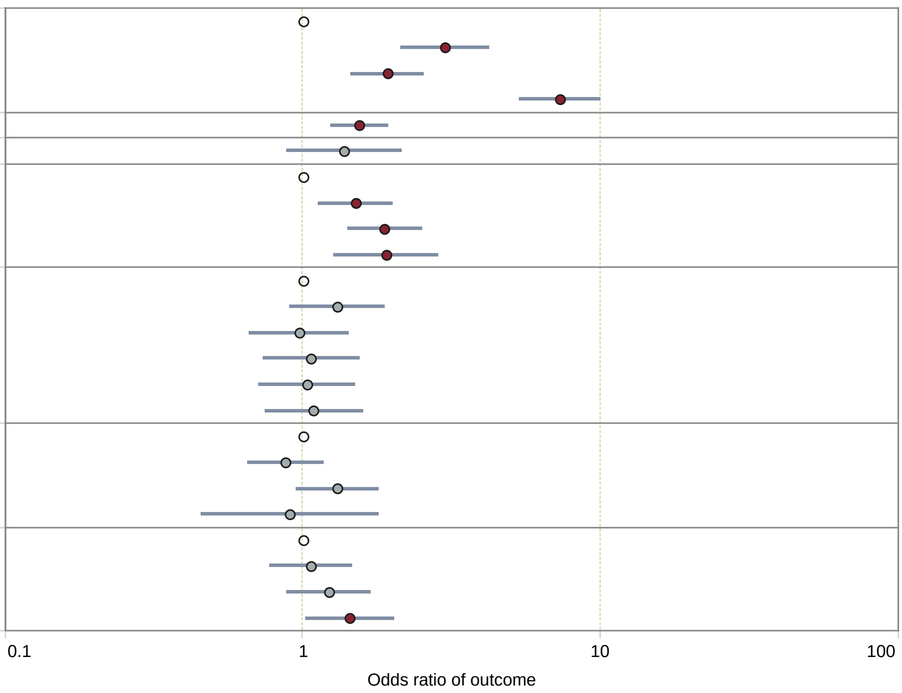


Figure 14: Association of factors including IEO index with mortality

Cardiac Surgery

Major morbidity

When considering a range of geographic, social, and demographic variables, it becomes evident that since 2017–2018, the likelihood of experiencing a major postoperative adverse event (including death, myocardial infarction, deep sternal wound infection and cerebrovascular accident) has exhibited a decline. Notably, this decline reached statistical significance in two of the years, namely 2019 and 2021.

Similar to the pattern observed with death, female patients are at a significantly higher risk than males of experiencing a major adverse event. This has been shown in multiple analyses and data sets around the world. While not achieving statistical significance, Aboriginal and Torres Strait Islander patients do show a tendency toward a higher risk of major postoperative events.

Patients undergoing valve-only surgery do not appear to carry a significantly higher risk of adverse events when compared to isolated CABG procedures. However, cases involving concurrent valve surgery have an odds ratio of 2, and other cardiac surgery cases have an odds ratio of 4, signifying a markedly higher risk of adverse events.

The odds of experiencing a major adverse event generally show an increasing trend with advancing age.

Patient geographic remoteness does not have a substantial impact on these outcomes. The risk of a major adverse event does not appear to be significantly influenced by socioeconomic advantage/disadvantage, access to economic resources, or education/occupation status.

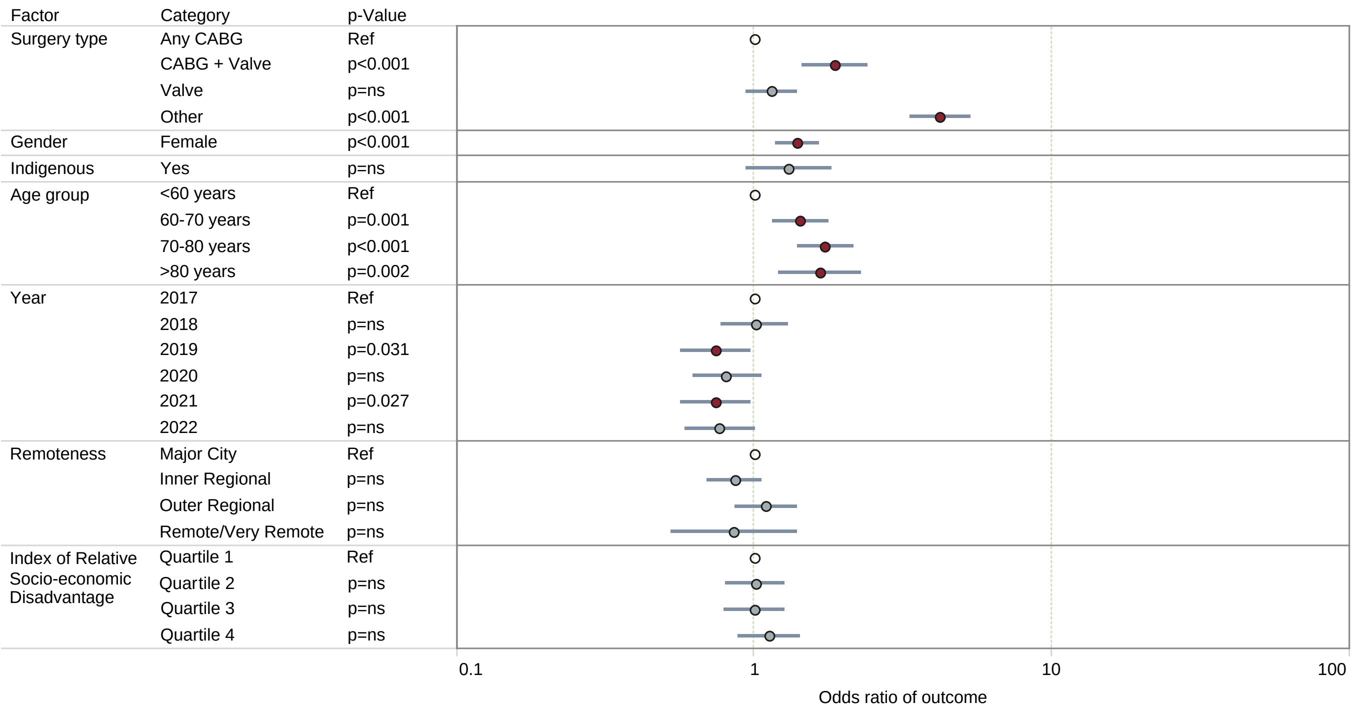


Figure 15: Association of factors including IRSD index with major morbidity

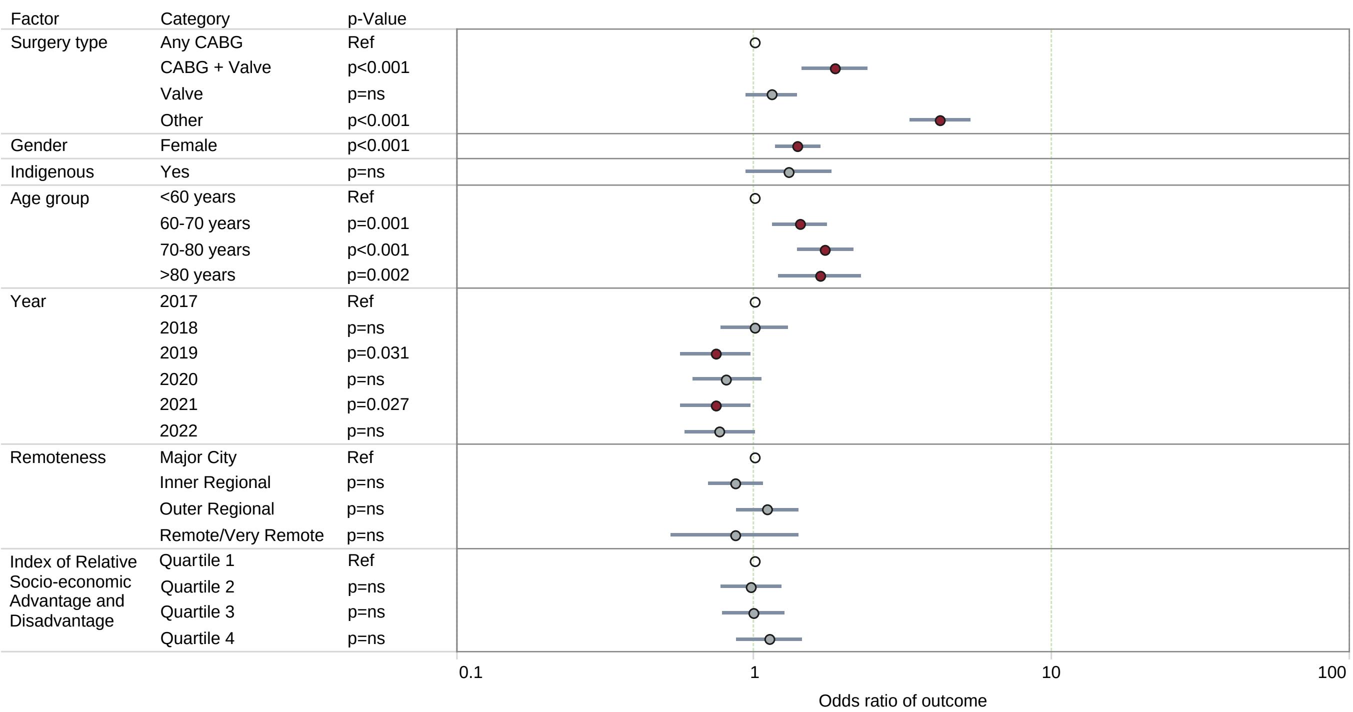


Figure 16: Association of factors including IRSAD index with major morbidity

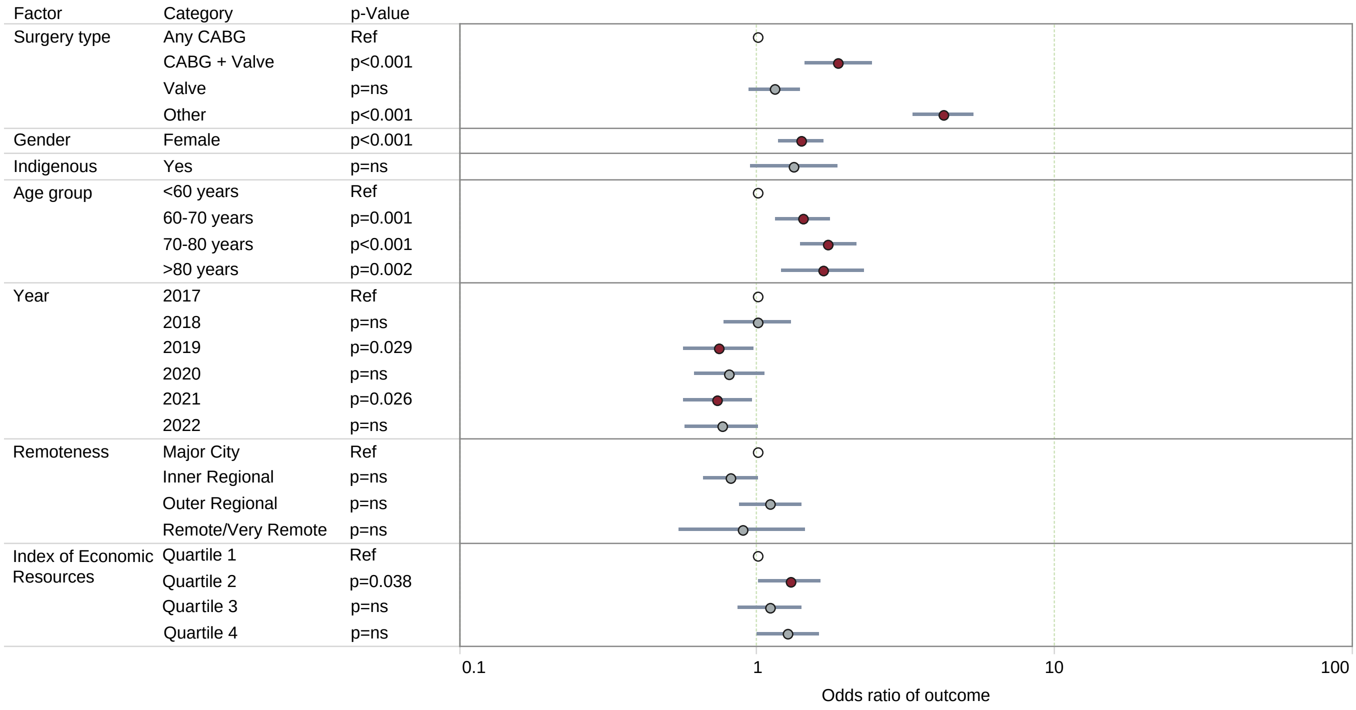


Figure 17: Association of factors including IER index with major morbidity

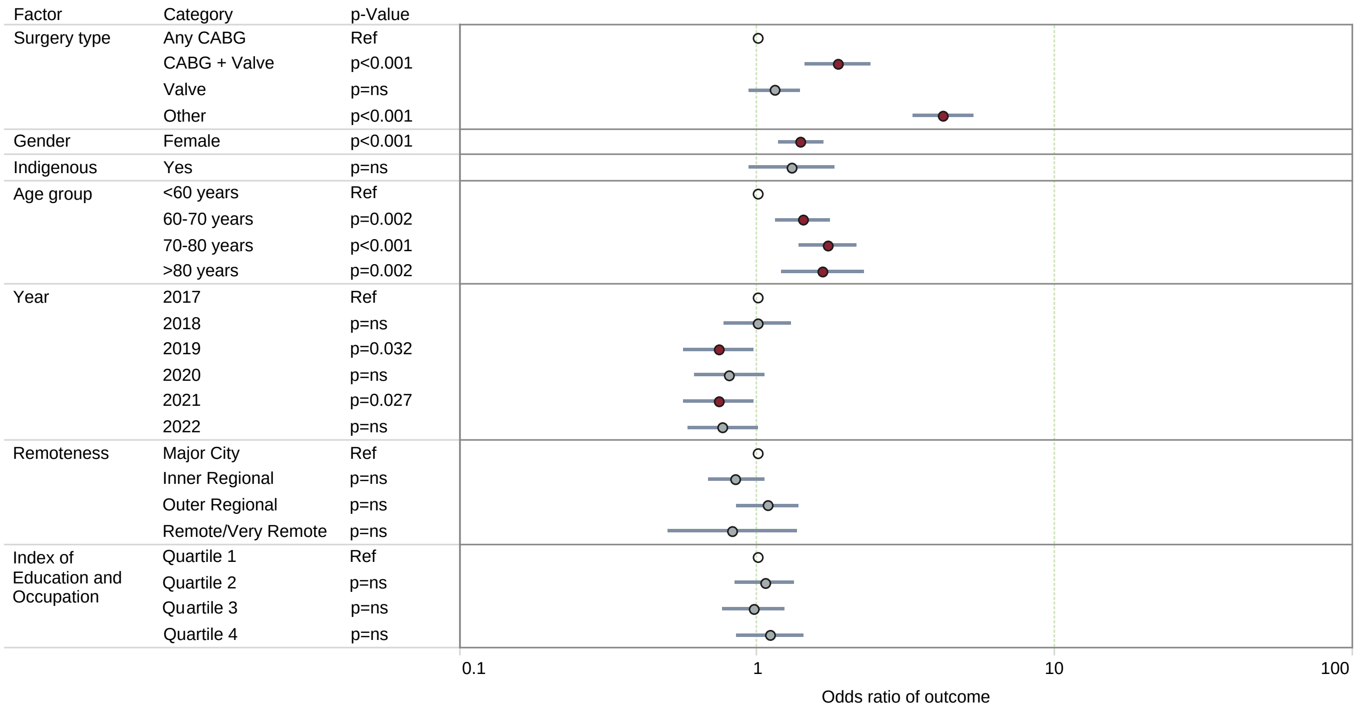


Figure 18: Association of factors including IEO index with major morbidity

9.9 Time to care

It is evident that Aboriginal and Torres Strait Islander patients travel considerably greater distances to access care, however, the time between cardiac catheterisation (an indicative marker of the time a definitive diagnosis or indication for surgery is confirmed) for elective surgery is notably shorter (64 days vs. 91 days in 2021–2022).

Additionally, it is noted that although the delay has increased for Australians of other descent, rising from 59 days to 91 days, the median delay for Aboriginal and Torres Strait Islander patients has remained similar (61 days vs. 64 days) although, an increase in time to care has been noted at the upper end of the interquartile range.

The time to elective surgery was longer for females as compared to males across 2017–2022 (72 days vs. 61 days respectively). The median days to elective cardiac surgery for those patients living in regional and remote areas was 11 days less than those Queenslanders who resided in non remote areas.

Overall, there was a slight increase in the time to treatment for all patients for 2021–2022, which is likely attributable to treatment delays resulting from the impacts of the COVID-19 pandemic.

Table 3: Median days to care for elective surgery by Aboriginal and Torres Strait Islander descent, 2017–2022

Year of surgery	Aboriginal and Torres Strait Islander descent Median (IQR) days	Australians of other descent Median (IQR) days
2017–2018	61 (21–123)	59 (22–111)
2019–2020	48 (13–105)	71 (24–133)
2021–2022	64 (16–141)	91 (41–170)
ALL	**61 (20–125)**	**72 (27–136)**

Table 4: Median days to care for elective surgery by patient gender, 2017–2022

Year of surgery	Male Median (IQR) days	Female Median (IQR) days
2017–2018	56 (21–106)	68 (29–125)
2019–2020	70 (21–129)	73 (26–140)
2021–2022	90 (38–165)	98 (42–174)
ALL	**61 (20–125)**	**72 (27–136)**

Table 5: Median days to care for elective surgery by remoteness status, 2017–2022

Year of surgery	Remote Median (IQR) days	Not Remote Median (IQR) days
2017–2018	52 (32–119)	59 (22–111)
2019–2020	58 (17–99)	71 (23–133)
2021–2022	75 (19–180)	91 (40–168)
ALL	**61 (20–125)**	**72 (27–136)**

Table 6: Median distance from usual place of residence by Aboriginal and Torres Strait Islander descent, 2017–2022

Year of surgery	Aboriginal and Torres Strait Islander descent Median (IQR) kilometres	Australians of other descent Median (IQR) kilometres
2017–2018	258 (30–513)	36 (15–167)
2019–2020	213 (34–510)	34 (14–140)
2021–2022	173 (25–345)	33 (14–140)
ALL	**213 (30–492)**	**35 (14–156)**

9.10 Discussion

Addressing access to cardiac surgery for socially disadvantaged patients in Australia requires a multifaceted approach that considers socioeconomic, cultural, and geographic factors. Collaborative efforts from healthcare providers, policymakers, and communities are crucial in achieving equitable access to cardiac surgical care.

Various initiatives have been implemented to improve access to cardiac surgery and other cardiac services. Programs such as the Queensland Rheumatic Register and Networked Cardiac Services program have focused on improving access, equity and quality of care for Aboriginal and Torres Strait Islander patients and those residing in rural and remote communities. Culturally sensitive healthcare programs and outreach services help bridge the gap between rural and remote, and Aboriginal and Torres Strait Islander communities and healthcare facilities. Telehealth services have also been used to provide specialist consultations and testing for remote Aboriginal and Torres Strait Islander communities. Regular data collection and research are crucial for understanding the specific needs of Aboriginal and Torres Strait Islander cardiac patients and monitoring healthcare disparities. Research studies have highlighted the importance of community-driven interventions and culturally appropriate healthcare models.

Lack of social support networks can impact a patient's ability to navigate the healthcare system. Providing assistance programs and support groups can help patients access the necessary resources and emotional support to undergo cardiac surgery. An example of this is the Bridging the Heart Gap preoperative telehealth program that has been implemented to better support Aboriginal and Torres Strait Islander and rural and remote children who need cardiac surgery.

Queensland Health has implemented a First Nations health equity agenda[44] as part of a legislative requirement passed by the Queensland Parliament in 2020 and 2021 for Hospital and Health Services to co-develop and co-implement Health Equity Strategies. This reflects a commitment to working in partnership with prescribed Aboriginal and Torres Strait Islander stakeholders and is embedded in a legal framework guiding the public health system in Queensland to achieve health equity and improve Aboriginal and Torres Strait Islander outcomes, eliminate institutional racism and racial discrimination from the public health sector, and strengthen decision-making and power sharing arrangements with Aboriginal and Torres Strait Islander peoples.

Furthermore, the Queensland Women and Girls' Health Strategy[45] aims to address health inequity and improve accessibility to healthcare for women and girls living in Queensland. The Strategy will take a whole-of-government approach to health and wellbeing by considering the social determinants of health and the roles that other Queensland Government agencies play in supporting the health of women and girls.

Policymakers and healthcare institutions need to recognise the specific needs of women in cardiac care and invest in research to address gender disparities. Addressing these issues requires a multi-faceted approach, including education, healthcare provider training, policy changes, and efforts to reduce socioeconomic disparities.

This Audit demonstrates that there is still significant work to be done to create equitable access and outcomes for all Queenslanders. This brief analysis is an important monitoring and evaluation activity in understanding some of the barriers to care and areas for improvement. It provides valuable insights to guide the priorities of clinical and administrative staff in order to meet targets and drive improvement.

10 Supplement: Australia and New Zealand Congenital Outcomes Registry for Surgery (ANZCORS) – Queensland snapshot

10.1 Message from the chair

It is my pleasure to present Queensland's paediatric cardiac surgical data from the Australia and New Zealand Congenital Outcomes Registry for Surgery (ANZCORS) as part of the QCOR Annual Report for 2022. The cardiac surgical team at the Queensland Children's Hospital has validated all the data included in this Report.

ANZCORS was created in 2017 and represents a collaborative effort between the five hospitals delivering paediatric cardiac surgery across Australia and New Zealand. The Registry is managed by a dedicated team of surgeons and data analysts at the Children's Health Research Centre, Brisbane. Using ANZCORS, the team benchmarks outcomes after paediatric cardiac surgery across the region and translate findings that are important for consumers into practice in a timely manner. The risk model used by ANZCORS incorporates machine learning methodology. To better understand longer-term outcomes, the Registry is also expanding its data linkage activities. Over the past year the team has been working in collaboration with the Australia and New Zealand Society of Cardiothoracic Surgeons, Akkodis, and eHealth Queensland to develop a new cloud-based data platform for ANZCORS.

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

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

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

10.2 Acknowledgements

Data Custodian and ANZCORS Program Manager

- Dr Nelson Alphonso

ANZCORS Data Analysts

- Ms Janelle Johnson
- Mr Jason Christiansen

Biostatistician and Machine Learning

- Dr Kim Betts, PhD

Cardiac Surgeons at Queensland Children's Hospital

- Nelson Alphonso
- Supreet Marathe
- Prem Venugopal, Director

ANZCORS Steering Committee

- Prem Venugopal, Queensland Children's Hospital, Committee Chair
- Matthew Liava'a, The Children's Hospital at Westmead
- Christian Brizard, The Royal Children's Hospital, Melbourne
- David Andrews, Perth Children's Hospital
- Kirsten Finucane, Starship Children's Hospital, Auckland
- Robert Justo, Queensland Children's Hospital
- Tom Gentles, Starship Children's Hospital, Auckland
- Jayme Bennetts, ANZSCTS Past president

10.3 Introduction

This report provides an overview of the major findings from the 2022 annual ANZCORS report for Queensland. The data covers the five year rolling period from July 2017 to June 2022 and includes 1,728 cardiothoracic procedures (1,140 using cardiopulmonary bypass, 352 without cardiopulmonary bypass, 236 delayed sternal closures).

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

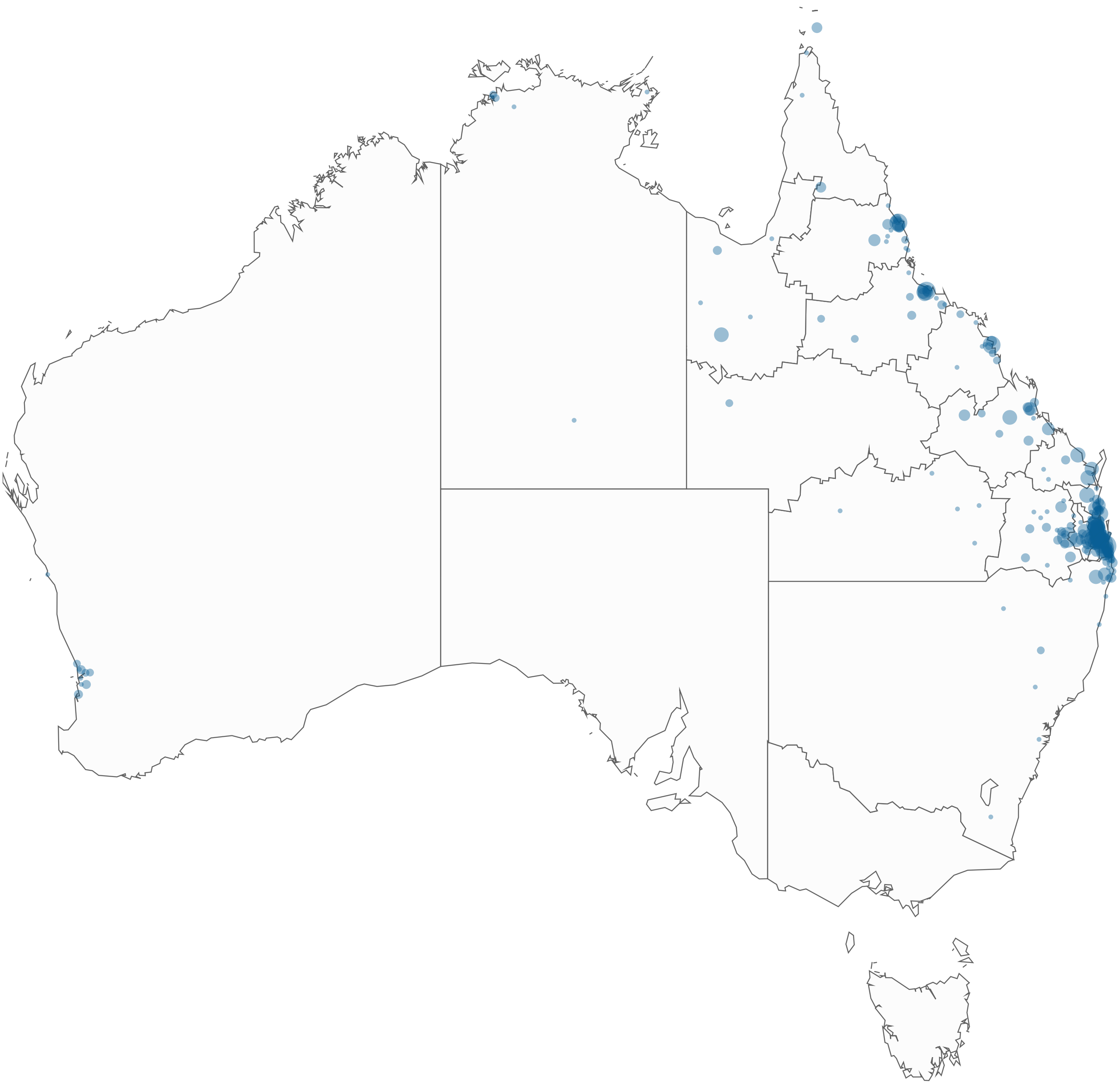


Figure 1: Cardiac patients treated by the Queensland Paediatric Cardiac Service between 2017–2022, by patient's place of usual residence (residential postcode)

10.4 Childhood heart surgery patients and procedures

During the five year reporting period from July 2017 to June 2022 there were 2,335 procedures performed by the Queensland Paediatric Cardiac Service at the Queensland Children's Hospital. These procedures included cardiac surgical procedures with and without the use of cardiopulmonary bypass, extracorporeal membrane oxygenation (ECMO), thoracic and delayed sternal wound closure procedures (Table 1). The focus of this report is cardiac surgical procedures either for childhood heart disease and as such delayed sternal closure, ECMO and thoracic procedures are excluded from the analysis.

Over the five year reporting period, there were 1,340 patients with childhood heart disease who underwent 1,492 cardiothoracic surgical procedures either with or without cardiopulmonary bypass (1,140 and 352 procedures respectively) at the Queensland Children's Hospital.

Table 1: Total procedures by case category, 2017–2022

Case category	2017/18 n	2018/19 n	2019/20 n	2020/21 n	2021/22 n	ALL n (%)
CPB*	246	214	209	240	231	1,140 (48.82)
Non-CPB*	86	68	65	72	61	352 (15.07)
Delayed sternal closure	55	40	44	50	47	236 (10.11)
ECMO†	61	50	68	34	38	251 (10.75)
Thoracic‡	43	74	82	63	52	314 (13.45)
Other§	9	7	11	11	4	42 (1.80)
Total	**500**	**453**	**479**	**470**	**433**	**2,335 (100.0)**

* Cardiopulmonary bypass

† Extracorporeal membrane oxygenation – includes pre and post cardiotomy and all ECMO not related to cardiac surgery

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

§ Other procedures include catheterisation procedures, hybrid procedures, and miscellaneous procedures

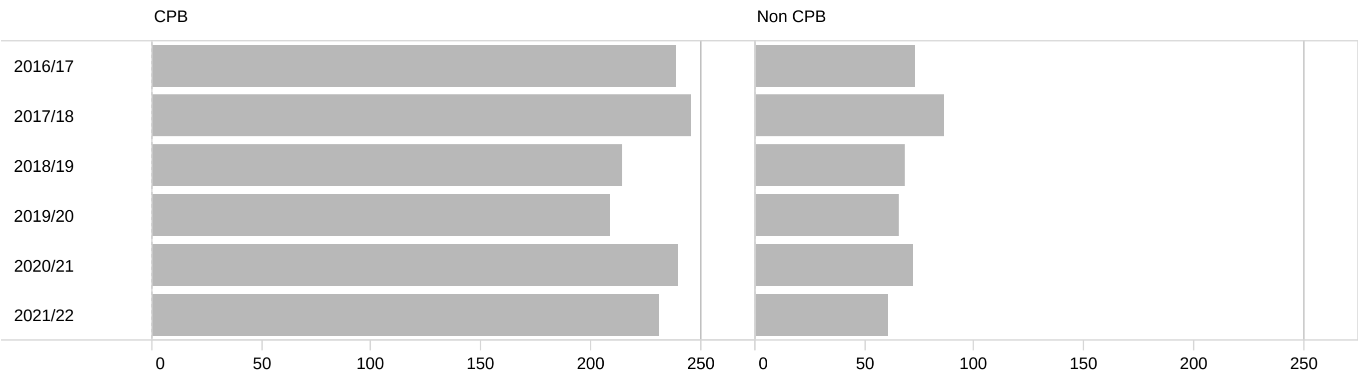


Figure 2: Number of cardiac patients by utilisation of cardiopulmonary bypass, 2017–2022

Table 2: Total cardiac patients and procedures, 2017–2022

	2017/18 n	2018/19 n	2019/20 n	2020/21 n	2021/22 n	ALL n
Cardiac patients	287	245	252	287	269	1,340
Cardiac procedures	332	282	274	312	292	1,492

10.5 Patient characteristics

10.5.1 Age and gender

Approximately 20% of the patient population were neonates aged between 0 and 28 days. Thirty-three percent were infants aged between 29 days and 365 days. Thus, 53% of the patient population were under 1 year of age. Forty-five percent of the cohort were aged between one and sixteen years, and 2% were over sixteen years of age.

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

Table 3: Cardiac procedures by age group and year, 2017–2022

Age group	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	2020/21 n (%)	2021/22 n (%)	ALL n (%)
>16 years	12 (3.6)	6 (2.0)	3 (1.1)	5 (1.6)	4 (1.4)	30 (2.0)
1–16 years	149 (44.9)	140 (49.6)	124 (45.3)	145 (46.5)	113 (38.7)	671 (45.0)
29–365 days	102 (30.7)	84 (30)	85 (31.0)	101 (32.4)	118 (40.4)	490 (32.8)
0–28 days	69 (20.8)	52 (18.4)	62 (22.6)	61 (19.5)	57 (19.5)	301 (20.2)
Total	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**292 (100.0)**	**1,492 (100.0)**

Table 4: Cardiac procedures by gender and year, 2017–2022

Gender	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	2020/21 n (%)	2021/22 n (%)	ALL n (%)
Female	146 (44.0)	127 (45.0)	130 (47.4)	136 (43.6)	134 (46)	673 (45.0)
Male	186 (56.0)	155 (55.0)	144 (52.6)	176 (56.4)	158 (54)	819 (55.0)
Total	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**292 (100.0)**	**1,492 (100.0)**

10.5.2 Aboriginal and Torres Strait Islander status

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

Table 5: Cardiac procedures by Aboriginal and Torres Strait Islander status, 2017–2022

	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	2020/21 n (%)	2021/22 n (%)	ALL n (%)
Indigenous	38 (11.4)	32 (11.3)	41 (15.0)	43 (13.8)	46 (15.7)	200 (13.4)
Non-Indigenous	294 (88.6)	250 (88.7)	233 (85.0)	269 (86.2)	246 (84.3)	1,292 (86.6)
Total	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**292 (100.0)**	**1,492 (100.0)**

10.6 Procedural complexity

10.6.1 Aristotle Comprehensive Complexity score

The Aristotle Comprehensive Complexity Score (ACC)[46] is a risk stratification tool that rates the projected complexity of the surgical procedures performed. By stratifying patients by complexity, the ACC aims to facilitate more realistic evaluation of surgical outcomes and more meaningful comparison of outcomes between paediatric cardiac surgical centres. The complexity score is based on three subjective determinations; potential for mortality, potential for morbidity, and anticipated surgical difficulty. Complexity is calculated in two phases. Firstly, the basic complexity of the procedure involved is scored from 0.5 to 15.0. This rates only the simplest form of the cardiac surgical procedure. Secondly, a specific value is added, based on a precise analysis of the associated pathology along with any comorbid conditions that are present. Procedure dependent factors include anatomical variations, associated procedures, and patient age, and can add a maximum of 5 points to the basic score. Procedure independent factors include patient characteristics which are more general but have the potential to significantly affect the outcome. Procedure independent factors can add an additional 5 points.

Between 2017 and 2022, 1,340 patients underwent 1,492 cardiac procedures, including those performed without using cardiopulmonary bypass. Fifty percent of procedures belonged in the higher-risk categories, with an ACC score of ten or above and a predicted mortality of >10%.

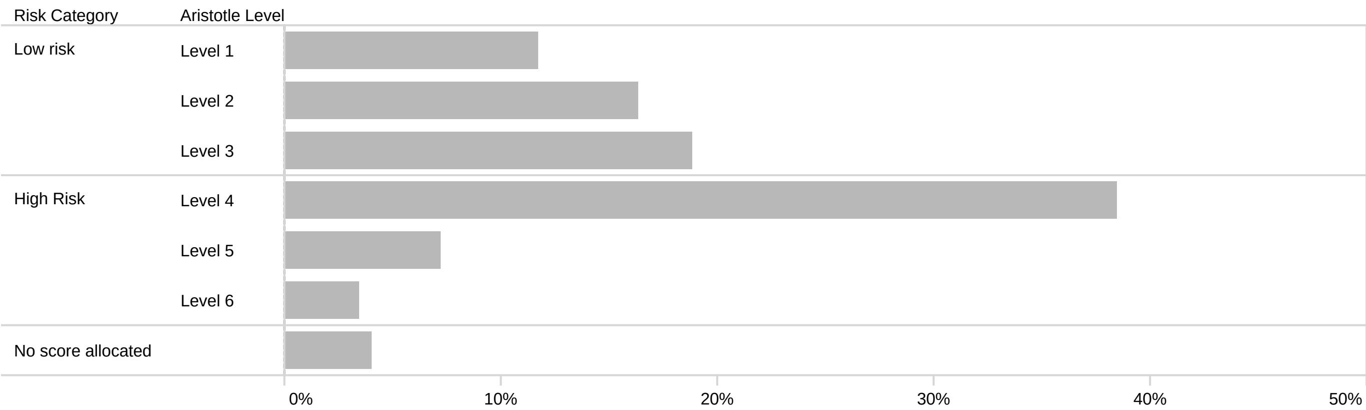


Figure 3: Proportion of all cardiac procedures stratified by Aristotle Comprehensive Complexity score and risk category

Table 6: Cardiac procedures by Aristotle Comprehensive Complexity score, 2017–2022

Complexity category	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	2020/21 n (%)	2021/22 n (%)	ALL n (%)
Level 1	39 (11.7)	33 (11.8)	26 (9.5)	42 (13.5)	34 (11.6)	174 (11.7)
Level 2	57 (17.2)	45 (16.0)	49 (17.9)	53 (17.0)	40 (13.7)	244 (16.3)
Level 3	69 (20.8)	43 (15.2)	52 (19)	62 (19.8)	55 (18.8)	281 (18.8)
Level 4	115 (34.7)	127 (45.0)	102 (37.3)	110 (35.3)	120 (41.1)	574 (38.5)
Level 5	26 (7.8)	10 (3.5)	22 (8.0)	22 (7.1)	27 (9.3)	107 (7.2)
Level 6	11 (3.3)	10 (3.5)	13 (4.7)	11 (3.5)	7 (2.4)	52 (3.5)
No score	15 (4.5)	14 (5.0)	10 (3.6)	12 (3.8)	9 (3.1)	60 (4.0)
Total	**332 (100.0)**	**282 (100.0)**	**274 (100.0)**	**312 (100.0)**	**292 (100.0)**	**1,492 (100.0)**

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

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

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

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

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

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

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10.7 Outcomes – length of stay

10.7.1 Paediatric intensive care unit length of stay for cardiac patients

In 2017–2022, the median length of stay in the paediatric intensive care unit (PICU) for cardiac patients was 2 days, with a mean of 5.8 days.

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

PICU length of stay	2017/18 days	2018/19 days	2019/20 days	2020/21 days	2021/22 days	ALL days
Maximum length of stay	294	97	504	186	101	504
Median length of stay	2	2	2	2	3	2
Mean length of stay	6.0	4.8	8.0	5.2	5.3	5.8

10.7.2 Hospital length of stay for cardiac patients

In 2017–2022, the median hospital length of stay for cardiac patients was 10 days, with a mean of 22.6 days.

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

Hospital length of stay	2017/18 days	2018/19 days	2019/20 days	2020/21 days	2021/22 days	ALL days
Maximum length of stay	329	272	504	308	308	504
Median length of stay	9	10	9	10	11	10
Mean length of stay	21.0	22.6	22.0	25.8	21.2	22.6

10.8 Outcomes – mortality

10.8.1 30 day mortality by Aristotle Comprehensive Complexity score

Overall, the 30 day mortality after paediatric cardiac surgery from 2017–2022 was less than 1%. Most deaths (7 of 9) were in the high-risk procedure categories (ACC level 4–6). Twenty two percent of the deaths that occurred after cardiac surgical procedures belonging in the highest risk ACC category. The observed incidence of mortality across the five year period was consistently below the predicted mortality for each ACC risk category.

There was some variation noted across the reporting period, reflective of the heterogenous patient population, spectrum of congenital heart defects and the complex and unpredictable nature of the work. The mortality rate was the same for non-cardiopulmonary bypass (CPB) patients compared to those performed with CPB (0.7% versus 0.7% over the five year reporting period).

Table 9 shows the 30 day mortality for cardiac surgical procedures performed with or without using cardiopulmonary bypass over the five year period. In 2017/18, there was one death in a patient who underwent patent ductus arteriosus ligation without CPB. The cause of death in this patient was unrelated to their cardiac condition.

Table 9: Cardiac patients 30 day surgical mortality by case category (patients), 2017–2022

	2016/17	2017/18	2018/19	2019/20	2020/21	ALL
Patients, n	**287**	**245**	**252**	**287**	**269**	**1,340**
CPB, n	231	199	196	228	212	1,066
Non-CPB, n	56	46	56	59	57	274
Deaths, n (%)	**4 (1.4)**	**2 (0.8)**	**0 (0.0)**	**2 (0.7)**	**1 (0.4)**	**9 (0.7)**
CPB, n	3	2	0	2	0	7
Non-CPB, n	1	0	0	0	1	2

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

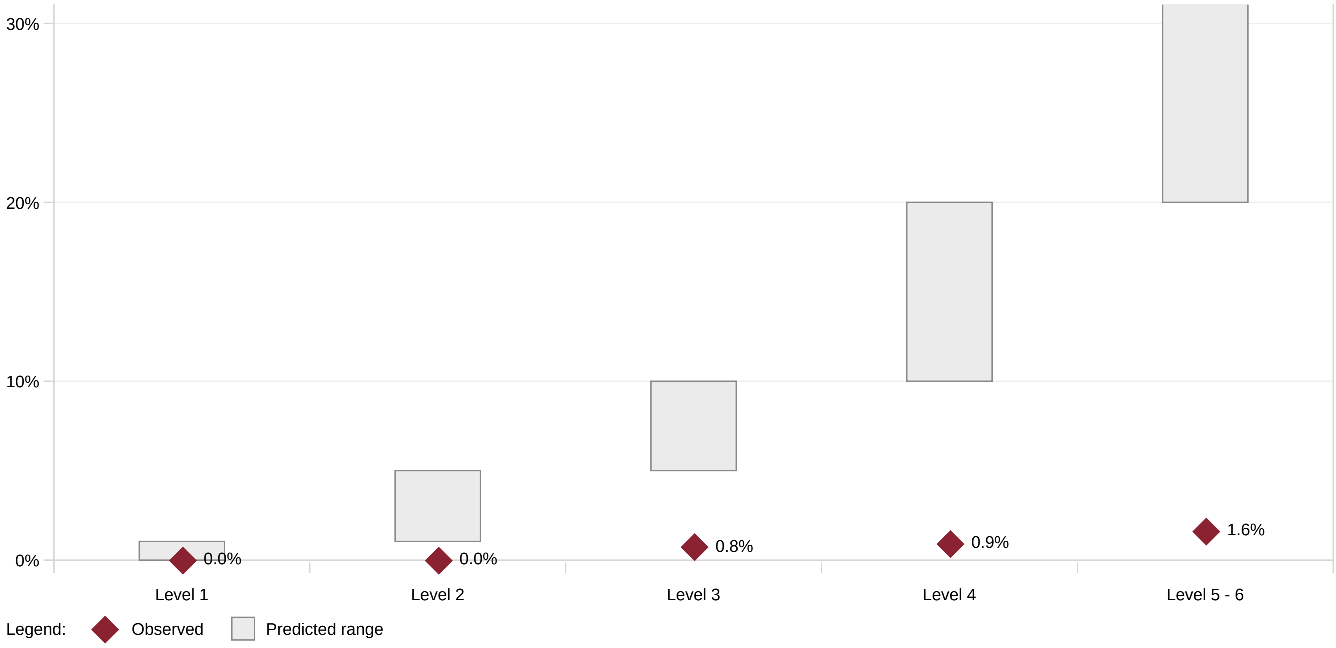


Figure 4: Cardiac patients 30 day mortality by Aristotle Comprehensive Complexity score, 2017–2022

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

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

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

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

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

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

Table 10: Cardiac patients 30 day surgical mortality by complexity level (patients), 2017–2022

	2017/18	2018/19	2019/20	2020/21	2021/22	ALL
Patients, n	**287**	**245**	**252**	**287**	**269**	**1,340**
Level 1, n	30	28	26	42	33	159
Level 2, n	56	42	47	52	39	236
Level 3, n	62	39	52	58	54	265
Level 4, n	110	119	96	106	111	542
Level 5, n	20	9	19	20	21	89
Level 6, n	8	6	7	9	4	34
No score, n	1	2	5	0	7	15
Deaths, n (%)	**4 (1.4)**	**2 (0.8)**	**0 (0.0)**	**2 (0.7)**	**1 (0.4)**	**9 (0.7)**
Level 1, n	0	0	0	0	0	0
Level 2, n	0	0	0	0	0	0
Level 3, n	0	1	0	0	1	2
Level 4, n	2	1	0	2	0	5
Level 5, n	0	0	0	0	0	0
Level 6, n	2	0	0	0	0	2
No score, n	0	0	0	0	0	0

Thoracic Surgery Audit

1 Message from the Chair

In 2022, the number of patients undergoing thoracic surgery also declined, as in cardiac surgery, but not to the same degree. This may be a year-on-year variation but may reflect the different nature of thoracic surgery.* Surgery is generally for cancer resections that involve time-dependent procedures or for urgent inpatient conditions such as infections and effusions. A smaller proportion of cases can be delayed for long periods such as in cardiac surgery. The cases that can be delayed on the waiting list in thoracic surgery can be delayed for much longer, but overall, are a smaller percentage of the overall conditions treated than in cardiac surgery.

In addition, thoracic surgery is less resource-demanding on hospitals, in that cardiac surgery requires intensive care to manage patients, whereas thoracic surgery, like a lot of general surgery, does not routinely involve intensive care. Many units perform both cardiac and thoracic surgery, and so when there is reduced intensive care access for cardiac cases, the same teams often then utilise theatre space for thoracic surgery, given that patients do not often require admission to intensive care after surgery.

Within the Quality Assurance Committee, we have seen the development by Dr Ian Smith, of statistical analysis for performance in thoracic surgery. This is an important step as this is completely novel in the world of thoracic surgery.

The river plot demonstrating the changes in staging from pre to postoperative is a fascinating area. Small changes based on pathological measurement compared to radiological measurement of the size of tumours is a minor change, but significant upstaging, by detection of involved mediastinal nodes is a significant change, as are operations on more advanced stages that are found to be less advanced than predicted. This is interesting as the role of neo-adjuvant immunotherapy is expanded and surgery for IIIA disease is further encouraged.

The mortality rate across the state is exceptionally low. The data has been used to demonstrate the safety in our older patients†, as well as the marked difference, particularly in the low numbers of Aboriginal and Torres Strait Islander patients who have surgery for lung cancer.

Dr Christopher Cole
Chair
QCOR Cardiothoracic Surgery Committee

* Kirk, F., Crathern, K., Chang, S., Yong, M. S., He, C., Hughes, I., Yadav, S., Lo, W., Cole, C., Windsor, M., Naidoo, R., & Stroebel, A. (2023). The influence of the COVID-19 pandemic on lung cancer surgery in Queensland. *ANZ Journal of Surgery, 93*(6), 1536–1542. https://doi.org/10.1111/ans.18465

† Kirk, F., Chang, S., Yong, M. S., He, C., Hughes, I., Yadav, S., Lo, W., Cole, C., Windsor, M., Naidoo, R., & Stroebel, A. (2023). Thoracic Surgery and the Elderly; Is Lobectomy Safe in Octogenarians? *Heart, Lung and Circulation, 32*(6), 755–762. https://doi.org/10.1016/j.hlc.2023.03.005

2 Key findings

Key findings include:

- There were 918 thoracic surgical cases entered for 2022 across the five public thoracic surgery units in Queensland.
- The median age of patients undergoing thoracic surgery was 63 years of age, with 18% of patients aged under 40 years of age.
- Nearly one third of patients (31%) 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 (64%) including 5% classed as morbidly obese.
- The proportion of Aboriginal and Torres Strait Islander patients undergoing thoracic surgery was 5.0% of the total cohort.
- Operations performed for preoperative diagnoses of primary lung cancer were undertaken in 28% of all cases, while pleural disease accounted for 28% of all surgeries. A diagnosis of other thoracic cancer was reported in 30% of surgeries while other thoracic surgery was performed in 17% of the cohort.
- Approximately two thirds of patients had some smoking history, including 24% who were current smokers at the time of surgery.
- Elective procedures accounted for 69% of the total surgeries performed, while 11% of cases were emergency operations. Of elective cases, 43% were performed on a day of surgery admission pathway.
- Lobectomy (81%) and lymph node sampling (80%) were the most common procedures performed on patients with an indication of primary lung cancer.
- Overall, 5% of all cases required a blood product transfusion.
- The median postoperative length of stay for thoracic surgery patients was 5 days.
- There were 103 cases having one or more new major morbidities recorded post procedure. Reoperation occurred in nearly one third (33%) of patients with a recorded major morbidity.
- Pathological upstaging occurred in 37% of primary lung cancer cases while 16% were downstaged postoperatively and 46% had no change to the preoperative staging classification.
- Unadjusted all-cause mortality at 30 days was 1.0%, increasing to 2.6% at 90 days. The other thoracic surgery group had the highest unadjusted mortality rates at 30 days and 90 days at 3.0% and 4.5% respectively.

3 Participating sites

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

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

Figure 1: Thoracic surgery cases by residential postcode

Table 1: Participating sites

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

Thoracic Surgery

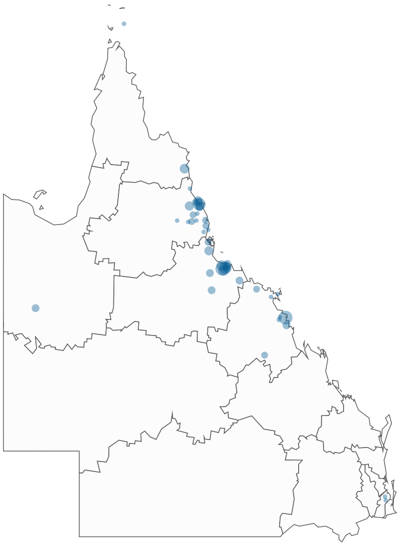


Figure 2: Townsville University Hospital

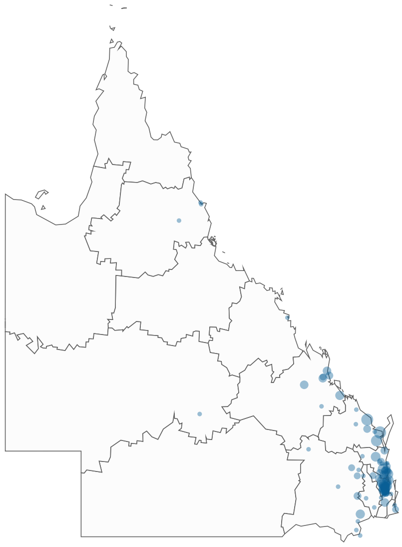


Figure 3: The Prince Charles Hospital

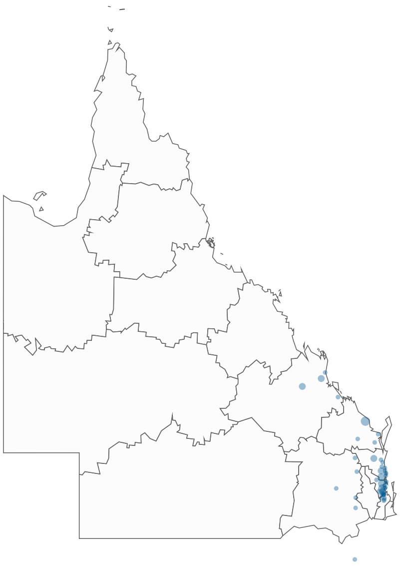


Figure 4: Royal Brisbane & Women's Hospital

Figure 5: Princess Alexandra Hospital

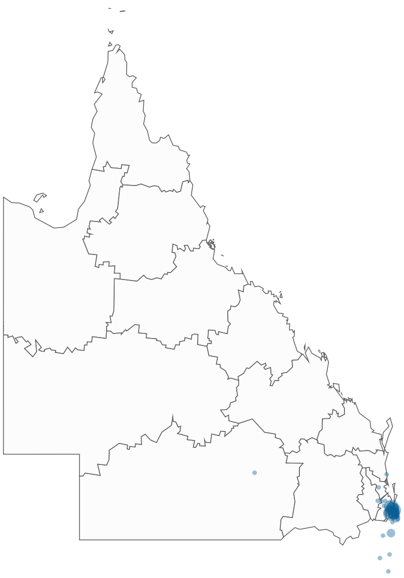


Figure 6: Gold Coast University Hospital

4 Case totals

4.1 Total surgeries

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

Of the 918 cases performed across the five public thoracic surgery units in Queensland, over half of patients (58%) presented with an indication including some form of cancer. Diagnosis of primary lung cancer accounted for 28% and 30% had another cancer diagnosis.

Non cancer diagnoses accounted for 43% of the overall cases, including pleural disease (28%) or other non cancer indication (15%).

Table 2: Cases by site and indication category

SITE	Total n	Primary lung cancer n (%)	Other cancer* n (%)	Pleural disease† n (%)	Other‡ n (%)
TUH	163	42 (25.8)	64 (39.3)	41 (25.2)	16 (9.8)
TPCH	287	96 (33.4)	92 (32.1)	72 (25.1)	27 (9.4)
RBWH	63	29 (46.0)	20 (31.7)	9 (14.3)	5 (7.9)
PAH	236	52 (22.0)	47 (19.9)	85 (36.0)	52 (22.0)
GCUH	169	36 (21.3)	50 (29.6)	49 (29.0)	34 (20.1)
STATEWIDE	**918**	**255 (27.8)**	**273 (29.7)**	**256 (27.9)**	**134 (14.6)**

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

† Pneumothorax, haemothorax, empyema or pleural thickening/nodules

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

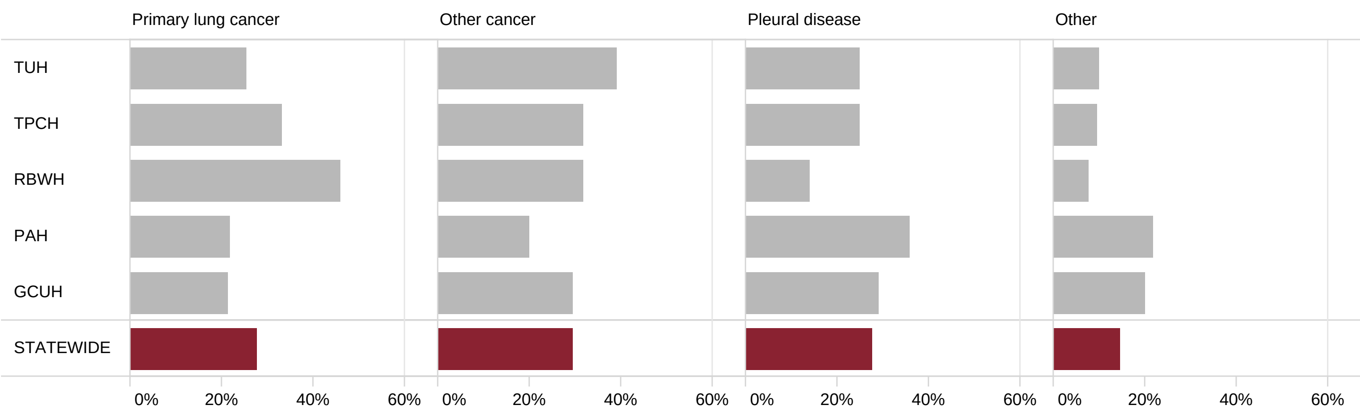


Figure 7: Proportion of cases by site and indication category

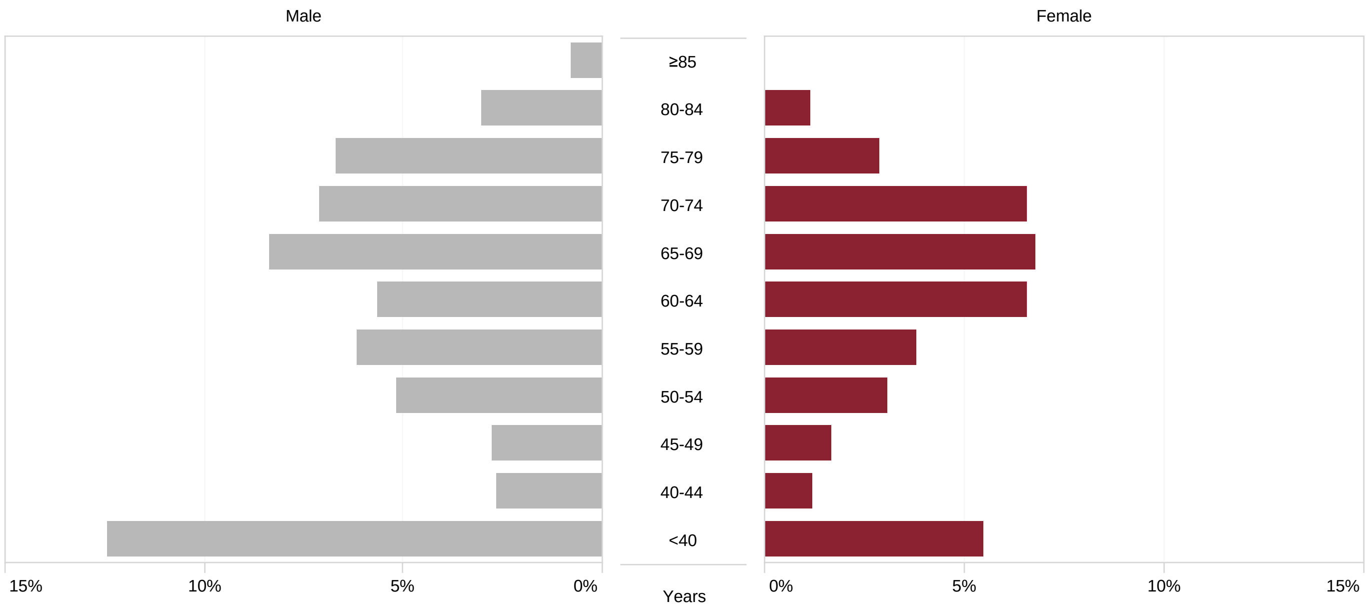
Thoracic Surgery

5 Patient characteristics

5.1 Age and gender

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

Whilst the majority of patients were male (61%), there was a nearly even distribution of cases between genders among patients with a preoperative cancer diagnosis. By contrast, over three quarters of patients with pleural disease were male (76%).



% of total (n=918)

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

Table 3: Median age by gender and indication category

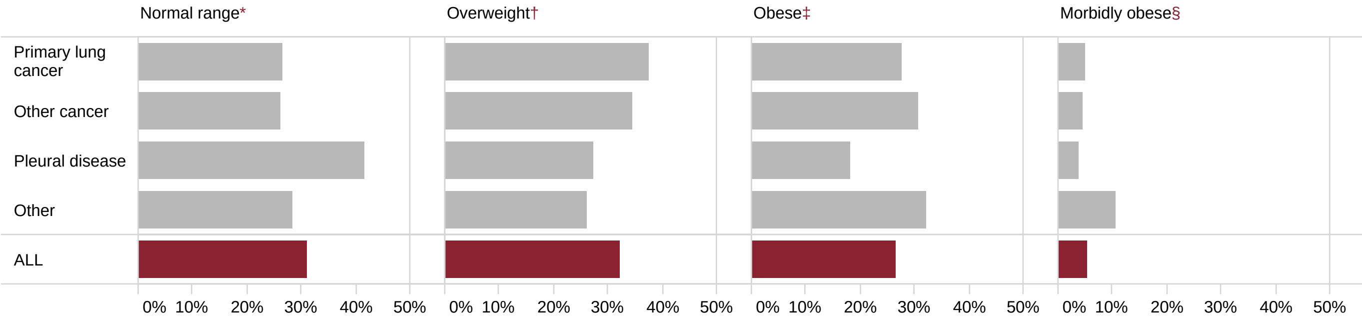
Indication	Male years	Female years	ALL years
Primary lung cancer	69	66	68
Other cancer	66	64	65
Pleural disease	51	44	48
Other	59	58	59
ALL	**61**	**64**	**63**

Table 4: Proportion of cases by gender and indication category

Indication	Male n (%)	Female n (%)
Primary lung cancer	124 (48.4)	131 (51.4)
Other cancer	150 (55.1)	123 (45.1)
Pleural disease	194 (75.8)	62 (24.2)
Other	94 (70.1)	40 (29.9)
ALL	**562 (61.2)**	**356 (38.8)**

5.2 Body mass index

Nearly two thirds of thoracic surgery patients (64%) were classed as overweight or obese, while 31% of patients had a body mass index (BMI) classed within the normal range. More than 5% of patients were classed as underweight.



Underweight category (BMI ‹18.5 kg/m²) is not displayed (7.2%)

Excludes missing data (10.0%)

* 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 indication categories

Table 5: BMI category by indication category

Indication	Underweight n (%)	Normal weight n (%)	Overweight n (%)	Obese n (%)	Morbidly obese n (%)
Primary lung cancer	9 (3.5)	67 (26.4)	95 (37.5)	70 (27.6)	12 (4.7)
Other cancer	12 (4.4)	71 (26.3)	93 (34.3)	83 (30.7)	12 (4.4)
Pleural disease	23 (9.3)	103 (41.7)	67 (27.1)	45 (18.2)	9 (3.6)
Other	4 (3.1)	37 (28.2)	34 (26.0)	42 (32.1)	14 (10.7)
ALL	**48 (5.3)**	**278 (30.8)**	**289 (32.0)**	**240 (26.6)**	**47 (5.2)**

Excludes missing data (1.7%)

5.3 Aboriginal and Torres Strait Islander status

The overall proportion of identified Aboriginal and Torres Strait Islanders undergoing thoracic surgery was 5.0%.

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

Indication	Indigenous n (%)	Non-Indigenous n (%)
Primary lung cancer	14 (5.5)	241 (94.5)
Other cancer	10 (3.7)	263 (96.3)
Pleural disease	18 (7.1)	237 (92.9)
Other	4 (3.0)	130 (97.0)
ALL	**46 (5.0)**	**871 (95.0)**

Excludes missing data (0.1%)

6 Risk factors and comorbidities

6.1 Smoking history

Almost one quarter of patients (24%) were current smokers (defined as smoking within 30 days prior to surgery), while 42% of patients had a smoking history recorded. Only 26% of patients were identified as having never smoked. In 7% of cases, smoking status was unknown.

There was considerable variation for patients in the primary lung cancer category, where the majority (81%) were recorded as either current or former smokers.

Table 7: Smoking history by indication category

Indication	Current smoker n (%)	Former smoker n (%)	Never smoked n (%)	Unknown n (%)
Primary lung cancer	70 (27.5)	138 (54.1)	42 (16.5)	4 (1.6)
Other cancer	40 (14.8)	134 (49.6)	85 (31.4)	12 (4.4)
Pleural disease	93 (36.9)	66 (26.2)	71 (28.2)	22 (8.7)
Other	18 (13.6)	45 (34.1)	42 (31.8)	27 (20.5)
ALL	**221 (24.3)**	**383 (42.1)**	**240 (26.4)**	**65 (7.2)**

Excludes missing data (1.0%)

6.2 Respiratory disease

The majority of patients (74%) did not have respiratory disease, while approximately one quarter (24%) were recorded as having mild or moderate respiratory disease.

Table 8: Respiratory disease according to indication category

Indication	Mild* n (%)	Moderate† n (%)	Severe‡ n (%)
Primary lung cancer	58 (24.0)	38 (15.7)	4 (1.7)
Other cancer	33 (12.6)	18 (6.9)	7 (2.7)
Pleural disease	16 (6.6)	28 (11.5)	3 (1.2)
Other	16 (12.9)	6 (4.8)	2 (1.6)
ALL	**123 (14.1)**	**90 (10.3)**	**16 (1.8)**

Excludes missing data (5.1%)

* Patient is on chronic inhaled or oral bronchodilator therapy

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

‡ Mechanical ventilation for chronic lung disease, pO_2 on room air <60 mmHg or pCO_2 on room air >50 mmHg

6.3 Diabetes

There were 13% of thoracic surgery patients recorded as having diabetes. The incidence of diabetes was varied across indication categories, ranging from 17% in the other thoracic indication category to 6% in the pleural disease cohort.

Table 9: Diabetes status by indication category

Indication	Diabetes n (%)	No diabetes n (%)
Primary lung cancer	38 (14.9)	216 (85.0)
Other cancer	40 (14.8)	231 (85.2)
Pleural disease	15 (6.0)	237 (94.0)
Other	22 (16.7)	110 (83.3)
ALL	**115 (12.7)**	**794 (87.3)**

Excludes missing data (1.0%)

6.4 Coronary artery disease

Overall, 13% of thoracic surgery patients were identified as having a preoperative history of coronary artery disease (CAD), while 13% of the cohort had an unknown CAD history.

Table 10: Coronary artery disease status by indication category

Indication	CAD n (%)	No CAD n (%)	Unknown n (%)
Primary lung cancer	32 (12.7)	189 (75.3)	30 (11.9)
Other cancer	30 (11.5)	192 (73.3)	40 (15.3)
Pleural disease	25 (10.3)	181 (74.8)	36 (14.9)
Other	28 (21.4)	95 (72.5)	8 (6.1)
ALL	**115 (13.0)**	**657 (74.2)**	**114 (12.9)**

Excludes missing data (3.5%)

6.5 Renal function

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

Table 11: Renal function by indication category

Indication	Normal* n (%)	Mild† n (%)	Moderate‡ n (%)	Severe§ n (%)
Primary lung cancer	93 (38.6)	103 (42.7)	44 (18.3)	–
Other cancer	124 (47.5)	98 (37.5)	40 (15.3)	–
Pleural disease	164 (71.0)	49 (21.2)	13 (5.6)	5 (2.2)
Other	71 (58.7)	35 (28.9)	13 (10.7)	2 (1.7)
ALL	**452 (52.9)**	**285 (33.4)**	**110 (12.9)**	**7 (0.8)**

Excludes missing data (7.0%)

* 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

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6.6 Cerebrovascular disease

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

Table 12: Cerebrovascular disease type by indication category

Indication	Reversible* n (%)	Irreversible† n (%)	No n (%)
Primary lung cancer	9 (3.5)	2 (0.8)	243 (95.7)
Other cancer	15 (5.6)	1 (0.4)	255 (94.1)
Pleural disease	3 (1.2)	1 (0.4)	248 (98.4)
Other	5 (3.8)	2 (1.5)	125 (94.7)
ALL	**32 (3.5)**	**6 (0.7)**	**871 (95.8)**

Excludes missing data (1.0%)

* Typically includes transient ischaemic attack

† Typically includes cerebrovascular accident

6.7 Peripheral vascular disease

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

Table 13: Peripheral vascular disease status by indication category

Indication	Yes n (%)	No n (%)
Primary lung cancer	16 (6.3)	238 (93.7)
Other cancer	15 (5.6)	256 (94.4)
Pleural disease	6 (2.4)	246 (97.6)
Other	4 (3.0)	128 (97.0)
ALL	**41 (4.5)**	**868 (95.5)**

Excludes missing data (1.0%)

6.8 Previous interventions

6.8.1 Previous thoracic surgery

There were 14% of patients with a history of prior thoracic surgery, ranging from 8% in the primary lung cancer group to 19% in the pleural disease category.

Table 14: Previous thoracic surgery by indication category

Indication	Yes n (%)	No n (%)
Primary lung cancer	20 (8.0)	229 (92.0)
Other cancer	33 (12.5)	233 (87.5)
Pleural disease	48 (19.1)	203 (80.9)
Other	21 (16.0)	110 (84.0)
ALL	**122 (13.6)**	**775 (86.4)**

Excludes missing (2.3%)

6.8.2 Previous pulmonary resection

Overall, 5% of patients had undergone a previous pulmonary resection operation.

Table 15: Previous pulmonary resection surgery by indication category

Indication	Yes n (%)	No n (%)
Primary lung cancer	10 (4.0)	240 (96.0)
Other cancer	15 (5.5)	256 (94.5)
Pleural disease	14 (5.6)	235 (94.4)
Other	4 (3.0)	128 (97.0)
ALL	**43 (4.8)**	**859 (95.2)**

Excludes missing data (1.7%)

7 Care and treatment of patients

7.1 Admission status

Over two thirds of all cases (69%) were classed as elective, while emergency admissions accounted for 11% of cases.

An indication of pleural disease was noted in 64% of all emergency cases and 63% of all urgent cases.

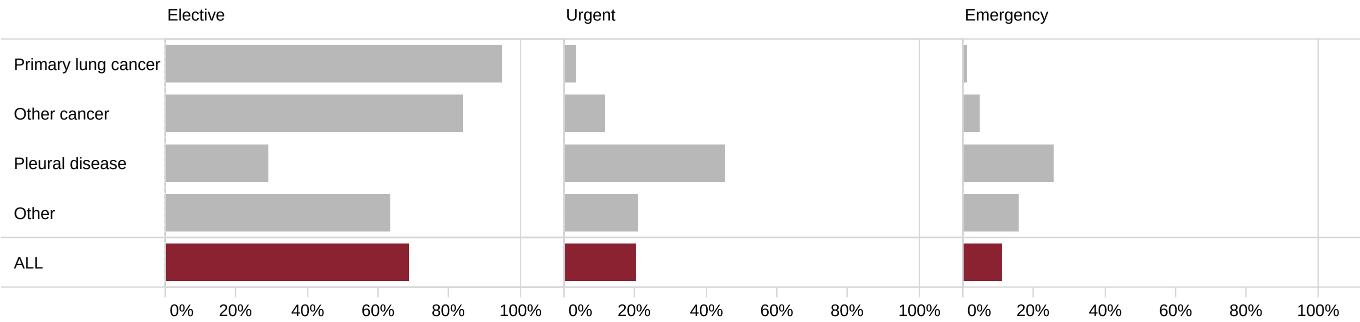


Figure 10: Admission status by indication category

Table 16: Admission status by indication category

Indication	ALL n	Elective n (%)	Urgent n (%)	Emergency n (%)
Primary lung cancer	255	243 (95.3)	9 (3.5)	3 (1.2)
Other cancer	273	229 (83.9)	32 (11.7)	12 (4.4)
Pleural disease	256	74 (28.9)	117 (45.7)	65 (25.4)
Other	134	85 (63.4)	28 (20.9)	21 (15.7)
ALL	**918**	**631 (68.7)**	**186 (20.3)**	**101 (11.0)**

7.1.1 Elective day of surgery admissions

Of the 631 elective cases, 43% were recorded as day of surgery admissions (DOSA).

Table 17: Day of surgery admissions by indication category

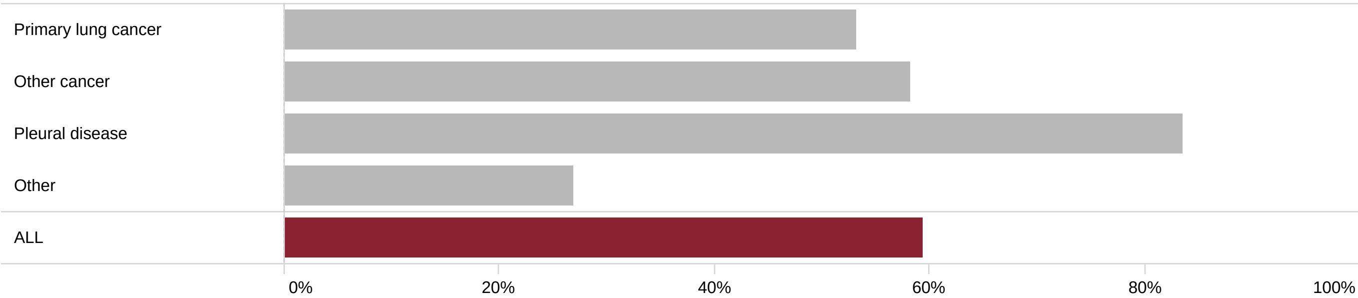
Indication	DOSA n (%)
Primary lung cancer	95 (39.1)
Other cancer	97 (42.4)
Pleural disease	30 (40.5)
Other	49 (57.6)
ALL	**271 (42.9)**

7.2 Surgical technique

7.2.1 Video-assisted thoracic surgery

Overall, 59% of cases utilised video-assisted thoracic surgery (VATS), including 83% of cases in the pleural disease category.

Of procedures undertaken through VATS, 38% utilised 3 ports for the operation.



Excludes missing data (0.2%)

Figure 11: Proportion of cases utilising VATS by indication category

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

Indication	1 port n (%)	2 ports n (%)	3 ports n (%)	≥4 ports n (%)
Primary lung cancer	35 (26.1)	50 (37.3)	46 (34.3)	3 (2.2)
Other cancer	42 (26.6)	48 (30.4)	62 (39.2)	6 (3.8)
Pleural disease	69 (32.4)	62 (29.1)	80 (37.6)	2 (0.9)
Other	5 (13.9)	11 (30.6)	16 (44.4)	4 (11.1)
ALL	**151 (27.9)**	**171 (31.6)**	**204 (37.7)**	**15 (2.8)**

Excludes missing data (0.2%)

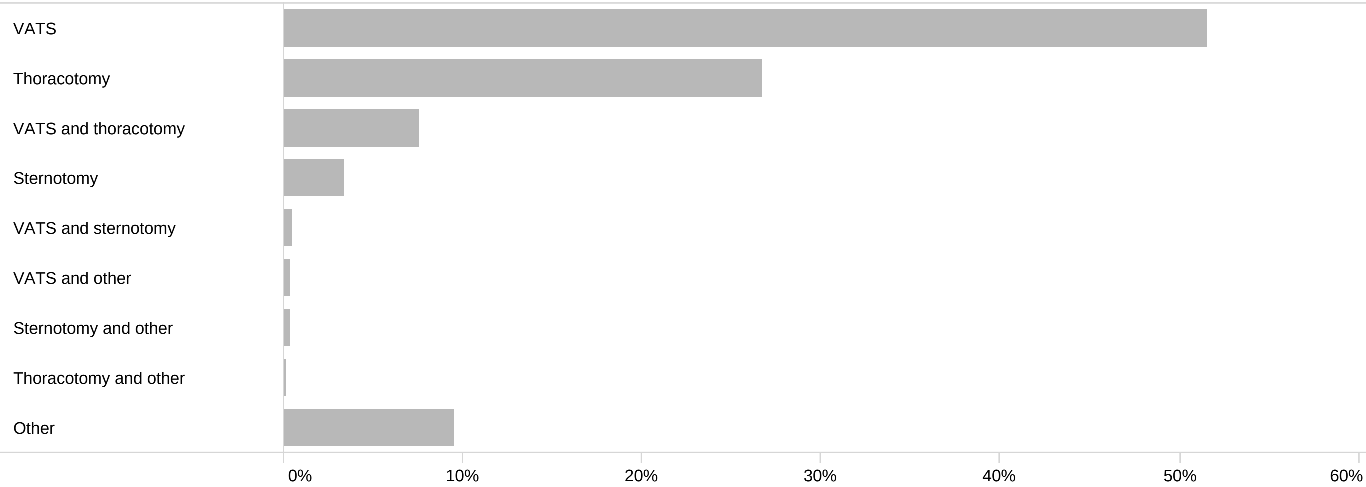
Thoracic Surgery

7.2.2 Incision type

Over half of all surgeries (52%) were solely video assisted, while 27% of the total surgeries were performed via thoracotomy.

Video-assisted thoracoscopy access was more likely for patients presenting with a cancer diagnosis, where the most common approaches were by VATS only (44%), thoracotomy only (36%), or VATS and thoracotomy (7%).

Use of sternotomy accounted for 4% of overall cases.



Excludes missing data (1.4%)

Figure 12: Proportion of all cases by incision type

Table 19: Incision type by indication category

Incision type	Primary lung cancer n (%)	Other cancer n (%)	Pleural disease n (%)	Other n (%)	Total n (%)
VATS	94 (37.2)	137 (51.1)	202 (79.5)	34 (26.2)	467 (51.6)
Thoracotomy	113 (44.7)	72 (26.9)	29 (11.4)	28 (21.5)	242 (26.7)
VATS and thoracotomy	40 (15.8)	18 (6.7)	10 (3.9)	–	68 (7.5)
Sternotomy	2 (0.8)	21 (7.8)	2 (0.8)	6 (4.6)	31 (3.4)
VATS and sternotomy	–	3 (1.1)	–	1 (0.8)	4 (0.4)
VATS and other	1 (0.4)	–	1 (0.4)	1 (0.8)	3 (0.3)
Sternotomy and other	–	1 (0.4)	1 (0.4)	1 (0.8)	3 (0.3)
Thoracotomy and other	–	–	1 (0.4)	–	1 (0.1)
Other	3 (1.2)	16 (6.0)	8 (3.1)	59 (45.4)	86 (9.5)
ALL	**253 (100.0)**	**268 (100.0)**	**254 (100.0)**	**130 (100.0)**	**905 (100.0)**

Excludes missing data (1.4%)

7.3 Surgery types

Thoracic surgery cases will often involve a number of procedures undertaken in combination. For patients with an indication of primary lung cancer, there was an average of 2.1 procedures per operation with a lobectomy being the most frequently performed procedure type (81%).

Lymph node sampling (33%) and lobectomy (28%) were the most common procedures performed in the other cancer cohort, while pleural disease was commonly treated with pleurodesis and pleural drainage (45% and 44% respectively).

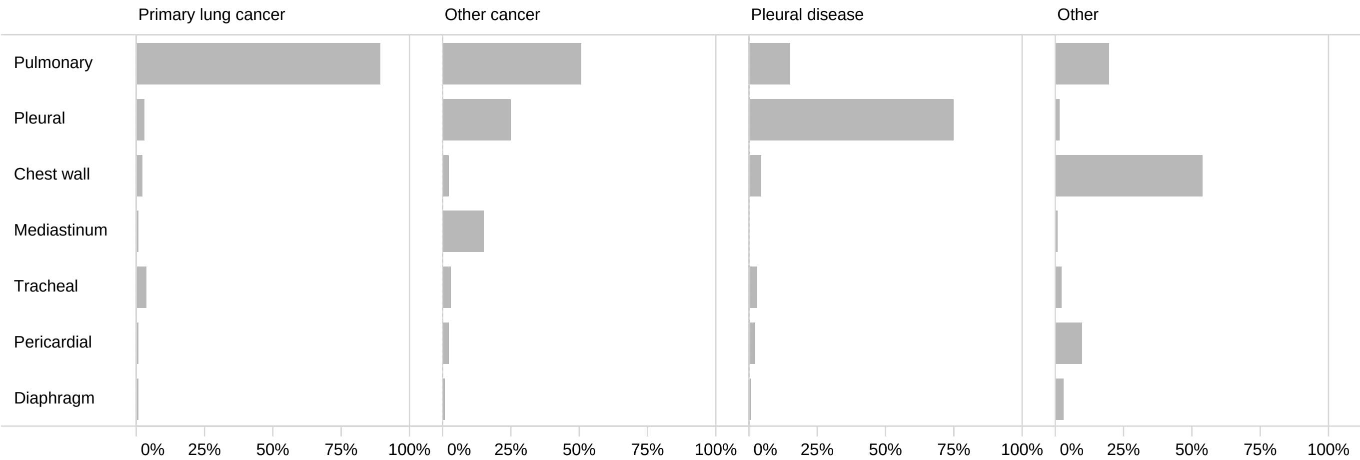


Figure 13: Proportion of procedure types by thoracic structure and indication category

Table 20: Surgical procedures for primary lung cancer

	n (%)
Lobectomy	206 (80.8)
Lymph node sampling	204 (80.0)
Wedge resection	28 (11.0)
Bronchoscopy	18 (7.1)
Lymph node dissection	18 (7.1)
Bilobectomy	6 (2.4)
Pleural drainage	6 (2.4)
Segmentectomy	6 (2.4)
Pleurodesis	5 (2.0)
Pleural biopsy	4 (1.6)
Pneumonectomy	4 (1.6)
Rib resection	4 (1.6)
Cardiopulmonary bypass	2 (0.8)
Muscle flap	2 (0.8)
Planned surgery abandon	2 (0.8)
Chest wall reconstruction	2 (0.8)
Open biopsy	1 (0.4)
Pericardial window	1 (0.4)
Diaphragmatic reconstruction	1 (0.4)
Other	10 (3.9)
Total	**255 (100.0)**

Table 21: Surgical procedures for other cancer

	n (%)
Lymph node sampling	90 (33.0)
Lobectomy	77 (28.2)
Wedge resection	67 (24.5)
Pleural biopsy	40 (14.7)
Pleural drainage	38 (13.9)
Pleurodesis	32 (11.7)
Resection mediastinal mass	26 (9.5)
Thymectomy	19 (7.0)
Segmentectomy	15 (5.5)
Bronchoscopy	13 (4.8)
Mediastinoscopy	17 (6.2)
Decortication	6 (2.2)
Pericardial window	6 (2.2)
Chest wall resection	4 (1.5)
Lung biopsy	3 (1.1)
Lymph node dissection	3 (1.1)
Air leak control	2 (0.7)
Pneumonectomy	2 (0.7)
Rib resection	2 (0.7)
Sympathectomy	2 (0.7)
Pericardial biopsy	2 (0.7)
Bullectomy	1 (0.4)
Cardiopulmonary bypass	1 (0.4)
Chest wall reconstruction	1 (0.4)
Clot evacuation	1 (0.4)
Endobronchial ablation	1 (0.4)
ORIF* ribs	1 (0.4)
Planned surgery abandon	1 (0.4)
Plication	1 (0.4)
Tracheal resection	1 (0.4)
Pericardiocentesis	1 (0.4)
Other	21 (7.7)
Total	**273 (100.0)**

* Open reduction internal fixation

Table 22: Surgical procedures for pleural disease

	n (%)
Pleurodesis	115 (44.9)
Pleural drainage	113 (44.1)
Decortication	85 (33.2)
Pleural biopsy	58 (22.7)
Wedge resection	47 (18.4)
Haematoma evacuation	26 (10.2)
Bullectomy	19 (7.4)
Bronchoscopy	14 (5.5)
Pleural washout	14 (5.5)
Air leak control	8 (3.1)
Pleural tent	5 (2.0)
Chyle leak control	3 (1.2)
Lobectomy	3 (1.2)
ORIF* ribs	3 (1.2)
Drainage of chest wall collection	3 (1.2)
Repair of bleeding artery	4 (1.6)
Pericardial effusion drainage	3 (1.2)
Removal of foreign body	3 (1.2)
Blebectomy	3 (1.2)
Pericardial window	3 (1.2)
Rib Resection	3 (1.2)
Bilobectomy	2 (0.8)
Sternal plating	2 (0.8)
Pericardial biopsy	2 (0.8)
Lung volume reduction	1 (0.4)
Muscle flap	1 (0.4)
Open biopsy	1 (0.4)
Other	15 (5.9)
Total	**256 (100.0)**

* Open reduction internal fixation

Table 23: Surgical procedures for all other surgeries

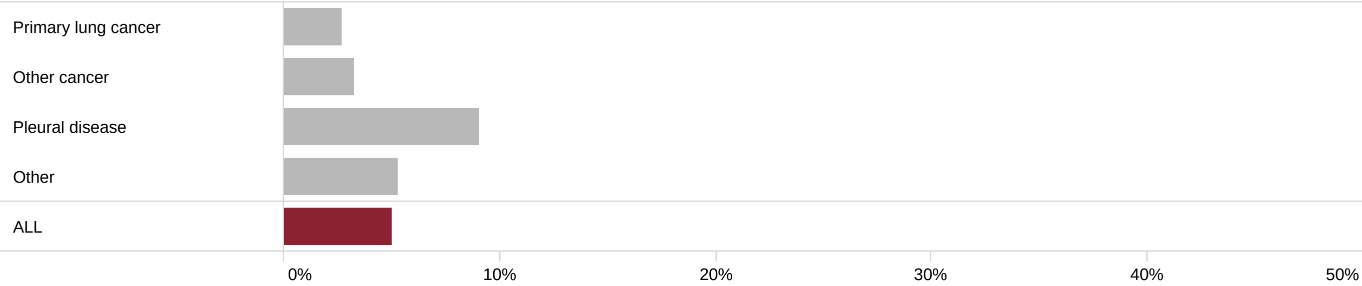
	n (%)
Sternal wiring/plating procedure	22 (16.4)
CIED# procedure	14 (10.4)
Washout procedure	11 (8.2)
Wedge resection	11 (8.2)
Chest wall resection/reconstruction	10 (7.5)
Lobectomy	10 (7.5)
ORIF* ribs	10 (7.5)
Rib resection	9 (6.7)
Pericardial window	9 (6.7)
Lymph node sampling	8 (6.0)
Nuss bar procedure	8 (6.0)
Chest wall closure (sternotomy/thoracotomy)	5 (3.7)
Chest wall debridement	4 (3.0)
Rib plating/fixation	4 (3.0)
Epicardial left atrial appendage exclusion	3 (2.2)
Diaphragmatic plication	3 (2.2)
Decortication	2 (1.5)
Bronchoscopy	2 (1.5)
Hernia repair	2 (1.5)
Open biopsy	2 (1.5)
Removal of foreign body	2 (1.5)
Air leak control	1 (0.7)
Bronchial repair	1 (0.7)
Cardiac denervation	1 (0.7)
Chest wall biopsy	1 (0.7)
Muscle flap	1 (0.7)
Pericardial cyst resection	1 (0.7)
Sternectomy	1 (0.7)
Tracheoesophageal fistula repair	1 (0.7)
Sympathectomy	1 (0.7)
Other	5 (3.7)
Total	**183 (100.0)**

* Open reduction internal fixation

Cardiac implantable electronic device

7.4 Blood product usage

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



Excludes missing data (0.3%)

Figure 14: Proportion of cases requiring blood product transfusion

Table 24: Blood product types used by indication category

Indication	RBC and NRBC n (%)	RBC only n (%)	NRBC only n (%)	No blood products used n (%)
Primary lung cancer	1 (0.4)	6 (2.3)	–	248 (97.3)
Other cancer	2 (0.7)	5 (1.8)	2 (0.7)	264 (96.7)
Pleural disease	4 (1.6)	19 (7.5)	–	232 (90.9)
Other	4 (3.0)	3 (2.3)	–	125 (94.7)
ALL	**11 (1.2)**	**33 (3.6)**	**2 (0.2)**	**869 (95.0)**

Excludes missing data (0.3%)

Thoracic Surgery

8 Clinical outcomes

8.1 Length of stay

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

For primary lung cancer cases the median post operative length of stay was five days, which compares similarly to results published through the Queensland Lung Cancer Quality Index.[47]

Table 25: Postoperative length of stay by indication category

Indication	Median days	Interquartile range days
Primary lung cancer	5	4–7
Other cancer	4	3–6
Pleural disease	5	4–9
Other	4	2–10
ALL	**5**	**3–7**

Thoracic Surgery

8.2 Major morbidity

There were 103 cases (11%) having one or more new major morbidities recorded post procedure. The incidence rate of major morbidity ranged from 14% in the primary lung cancer group to 9% in the other cancer and other indication category.

Approximately 4% of all patients undergoing thoracic surgery required reoperation.

Table 26: New major morbidity by diagnosis category

Indication	Yes n (%)	No n (%)
Primary lung cancer	35 (13.7)	219 (85.9)
Other cancer	24 (8.8)	240 (87.9)
Pleural disease	32 (12.5)	216 (84.4)
Other	12 (9.0)	118 (88.1)
ALL	**103 (11.2)**	**793 (86.4)**

Excludes missing data (2.4%)

Table 27: Type of major morbidity

Major morbidity type	n (%)
Reoperation	34 (3.7)
Air leak >7days	23 (2.5)
Atrial fibrillation	22 (2.4)
Wound infection	17 (1.9)
Pneumonia	14 (1.5)
Pulmonary embolism	6 (0.7)
Lung torsion	1 (0.1)
Other major morbidity	32 (3.5)

Excludes missing data (2.4%)

8.3 Primary lung cancer outcomes

8.3.1 Final histopathology

In patients with a preoperative suspicion of primary lung malignancy, adenocarcinoma (68%) was the most common lung cancer according to final histopathology, followed by squamous cell carcinoma (18%).

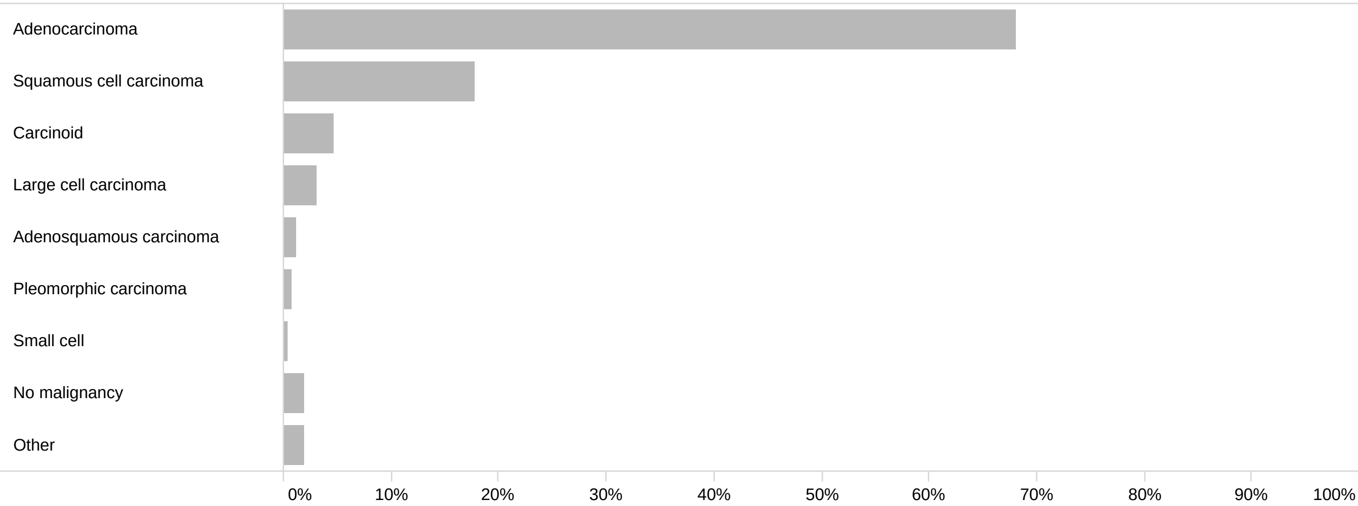


Figure 15: Proportion of primary lung cancer cases by final histopathology

Table 28: Final histopathology results for primary lung malignancy

Histopathology	n (%)
Adenocarcinoma	173 (68.1)
Squamous cell carcinoma	45 (17.7)
Carcinoid	12 (4.7)
Large cell carcinoma	8 (3.1)
Adenosquamous carcinoma	3 (1.2)
Pleomorphic carcinoma	2 (0.8)
Small cell	1 (0.4)
No malignancy	5 (2.0)
Other	5 (2.0)
ALL	**254 (100.0)**

NB: Excludes planned surgery abandoned case (n=1)

Thoracic Surgery

8.3.2 Stage classification

The tumour-node-metastasis (TNM)[48] staging classification system has been used to categorise lung cancer cases into stages of severity. Primary lung malignancy patients are clinically staged in the preoperative period as well as pathologically staged postoperatively. Assessing cancer staging plays an important role in guiding treatment options for patients. It is important to note that these cases below are the cohort of primary lung cancer patients who proceeded to surgical intervention.

Tumours graded Ib (23%) were the most common postoperative pathological TNM classification for primary lung malignancy, followed by Ia2 (18%) and Ia3 (18%). Preoperatively diagnosed stage four cancers (2.9%) are the least likely malignancy to proceed to surgery when compared with other cancer stages.

Table 29: Primary lung malignancy by preoperative clinical classification

Clinical classification	n (%)
Ia1	14 (5.9)
Ia2	64 (26.8)
Ia3	63 (26.4)
Ib	38 (15.9)
IIa	12 (5.0)
IIb	25 (10.5)
IIIa	14 (5.9)
IIIb	2 (0.8)
IVa	5 (2.1)
IVb	2 (0.8)
Total	**239 (100.0)**

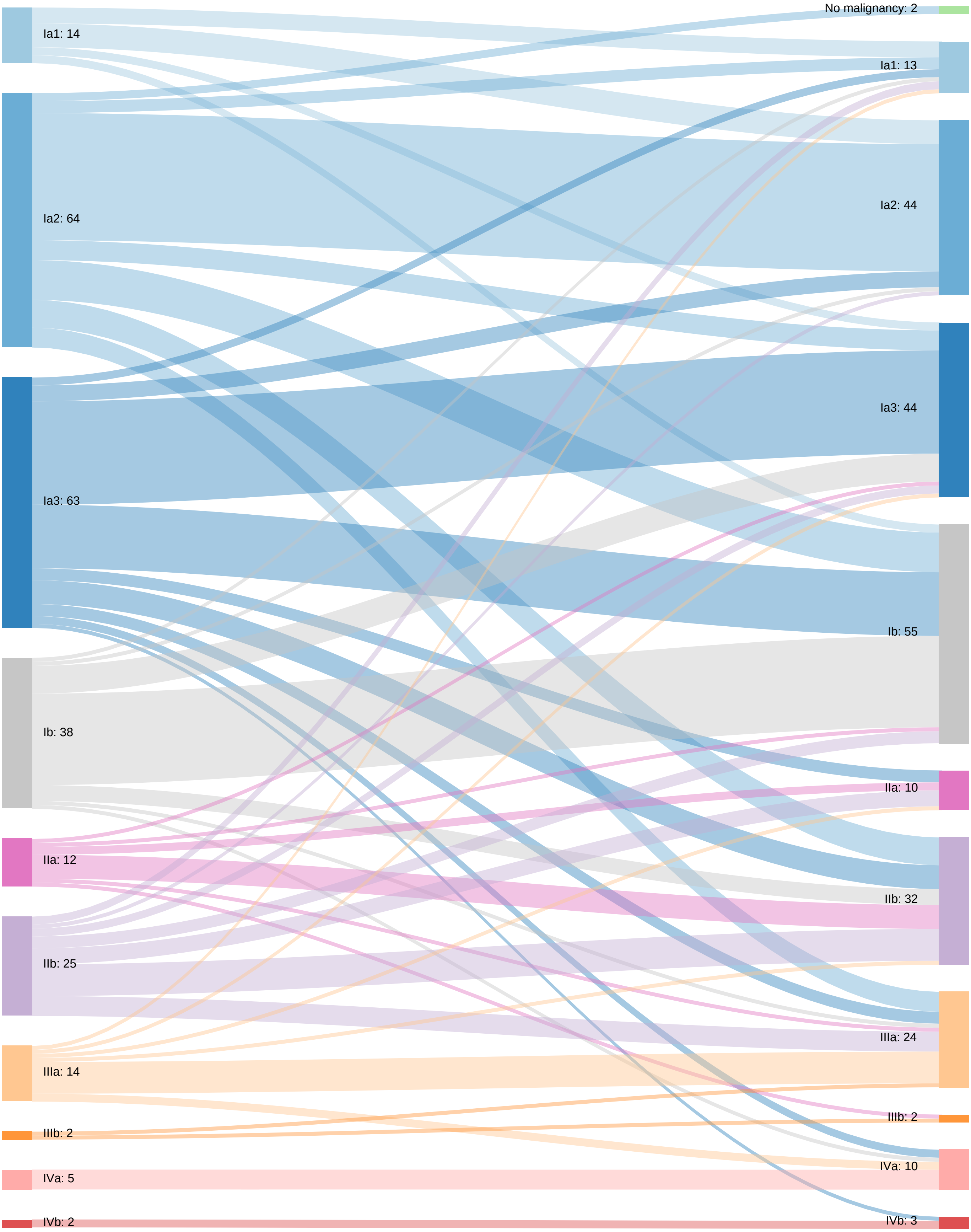
Excludes missing data (6.3%)

Table 30: Primary lung malignancy by postoperative pathological classification

Pathological classification	n (%)
Ia1	13 (5.4)
Ia2	44 (18.4)
Ia3	44 (18.4)
Ib	55 (23.0)
IIa	10 (4.2)
IIb	32 (13.4)
IIIa	24 (10.0)
IIIb	2 (0.8)
IVa	10 (4.2)
IVb	3 (1.3)
No malignancy	2 (0.8)
Total	**239 (100.0)**

Excludes missing data (6.3%)

Of the 239 primary lung cancer procedures with complete data, pathological upstaging occurred in 37% of cases, while 16% were downstaged postoperatively. Less than half (46%) of cases had no change to the preoperative staging classification.



Excludes missing data (6.3%)

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

8.4 Unadjusted all-cause mortality

The unadjusted all-cause mortality rate within 30 days of all thoracic surgery was 1.0%, increasing to 2.6% at 90 days. Mortality rates at 90 days for malignancy related surgeries are higher than the overall group, though caution should be used when interpreting these results due to small patient volumes in this cohort.

Survival following thoracic surgery is influenced by many factors which are not always directly related to the operation itself. Outcomes of thoracic surgery for cancer can be affected by how advanced a 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.

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	255	1 (0.4)	6 (2.4)
Other cancer	273	3 (1.1)	9 (3.3)
Pleural disease	256	2 (0.8)	4 (1.6)
Other	134	4 (3.0)	6 (4.5)
ALL	**918**	**9 (1.0)**	**24 (2.6)**

Electrophysiology and Pacing Audit

1 Message from the QCOR Electrophysiology and Pacing Committee Chair

I am pleased to present the 2022 Annual Report on behalf of the Electrophysiology and Pacing Committee. It provides key insights into the performance of the nine public sites that contribute data to the statewide registry. Overall procedural volumes continue to increase with over 5,300 cases performed in 2022. Device-related procedures accounted for 68% of the workload.

Device procedures continue to account for the majority of electrophysiology (EP) and pacing procedures across the state. Low-voltage device procedures account for 78% of the case mix. Pleasingly, reported procedural complications in the first 12 months remain low. Lead dislodgement is the most common and has remained static at 2.3% over the last few years. Infection resulting in the removal of the device is by far the most serious complication in the first 12 months after a cardiac device procedure and this was reported at 0.2% for the 2021 patient cohort. This is a truly remarkable result for the state. Access times for device-related procedures remain essentially unchanged from previous years. There is still incomplete data capture for all adverse events following EP and pacing procedures, but as QCOR reporting matures over the next three to five years, it is my hope that we can leverage other data sources to improve the accuracy of these outcomes.

There has been a small reduction in the total number of ablation procedures performed this year which probably reflects the increased demand for atrial fibrillation ablation, which is a considerably more complex and longer procedure. Since 2018 there has been a 55% increase in the number of ablations for atrial fibrillation performed across the state. During the same period, there has been a very modest reduction in the number of simple ablations (i.e. bypass tracts and atrioventricular node re-entry tachycardia) which is consistent with worldwide trends. Coupled with the continued growth in device-related procedures, this continues to place considerable pressure on EP and pacing infrastructure. Median waiting times for atrial fibrillation ablation have increased slightly in 2022, suggesting that at least at some sites, infrastructure constraints are starting to play a role in service delivery. To overcome this, significant investments in both infrastructure (EP labs) and/or emerging technologies like pulsed field ablation will need to be explored more seriously. Importantly, despite the increased complexity of EP procedures, overall reported complication rates remain low at 1.2% with cardiac tamponade rates under 0.5%.

Finally, I would like to thank all the staff for their enormous effort in the collection of the data that makes this report possible. It allows us to provide reassurance to all Queenslanders that across the state, EP and pacing procedures are being delivered to a high standard with a low complication rate.

Dr Russell Denman
Chair
QCOR Electrophysiology and Pacing Committee

2 Key findings

This Electrophysiology and Pacing Audit describes baseline demographics, risk factors, procedures performed and outcomes for 2022.

Key findings include:

- Across Queensland, nine public sites contributed to the registry with all sites contributing a complete year of data.
- Of the 5,305 electrophysiology and pacing cases, 3,611 were device procedures and 1,286 were electrophysiology procedures.
- An increase of 475 device procedures was observed in 2022 over 2018 volumes and an additional 225 electrophysiology procedures were performed.
- Complex electrophysiology has increased as proportion of all electrophysiology cases from 52% in 2018 to 85% in 2022.
- Pulmonary vein isolation for atrial fibrillation cases have increased from 295 in 2018 to 458 in 2022.
- Almost three quarters of patients were aged 60 years or over (72%) with a median age of 70 years.
- The overall proportion of Aboriginal and Torres Strait Islander patients was 3.7%.
- The vast majority of patients (73%) were classed as having an unhealthy body mass index (BMI) of greater than 30 kg/m^2.
- Complex electrophysiology procedures which utilise three-dimensional mapping technology, involve pulmonary vein isolation or ventricular arrhythmias accounted for 85% of this case cohort.
- Atrial flutter, pulmonary vein isolation for atrial fibrillation, and atrioventricular node re-entry tachycardia ablations accounted for 75% of all ablation cases.
- The reported complication rate for all device procedures was 0.6%, while electrophysiology procedures had a 1.2% complication rate.
- There was a 0.2% procedural tamponade rate reported for all cases.
- The statewide median wait time for complex ablation was 88 days with 75% of cases meeting the 180 day benchmark.
- The 12 month device system loss rate due to infection was 0.2%.

3 Participating sites

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

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

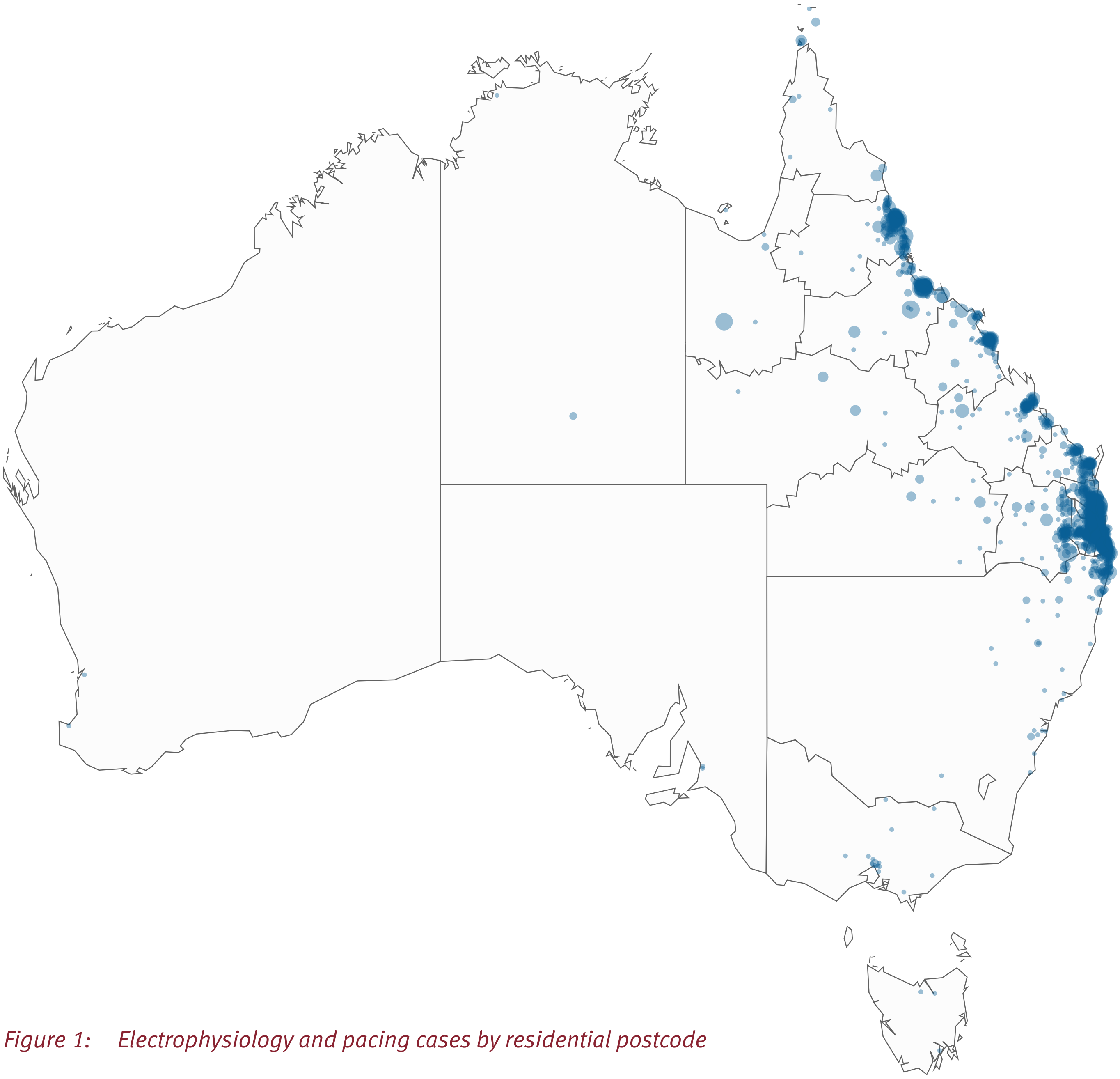


Figure 1: Electrophysiology and pacing cases by residential postcode

Table 1: Participating sites

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

4 Case totals

4.1 Case volume

In 2022, were 5,305 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	3,566 (67.2)
Cardiac device procedure + EP study		22 (0.4)
Cardiac device procedure + other procedure		8 (0.2)
Cardiac device procedure + EP study + ablation		4 (0.1)
Cardiac device procedure + drug challenge		4 (0.1)
Cardiac device procedure + cardioversion		3 (0.1)
Cardiac device procedure + pericardiocentesis		3 (0.1)
Cardiac device procedure + EP study + cardioversion		1 (<0.1)
EP study + ablation	EP	1,009 (19.0)
EP study		139 (2.6)
Ablation		94 (1.8)
EP study + ablation + cardioversion		33 (0.6)
EP study + ablation + other procedure		3 (0.1)
EP study + ablation + cardioversion + other procedure		2 (<0.1)
EP study + cardioversion		2 (<0.1)
EP study + drug challenge		2 (<0.1)
EP study + other procedure		2 (<0.1)
Cardioversion	Other	352 (6.6)
Drug challenge		33 (0.6)
Other procedure		17 (0.3)
Pericardiocentesis		5 (0.1)
Cardioversion + other procedure		1 (<0.1)
ALL		**5,305 (100.0)**

4.2 Cases by category

The majority of cases performed were cardiac device procedures accounting for over two thirds (68%) of documented procedures. The rest of the cases were electrophysiology and ablation procedures (24%), with the remainder categorised as 'other' procedures (8%).

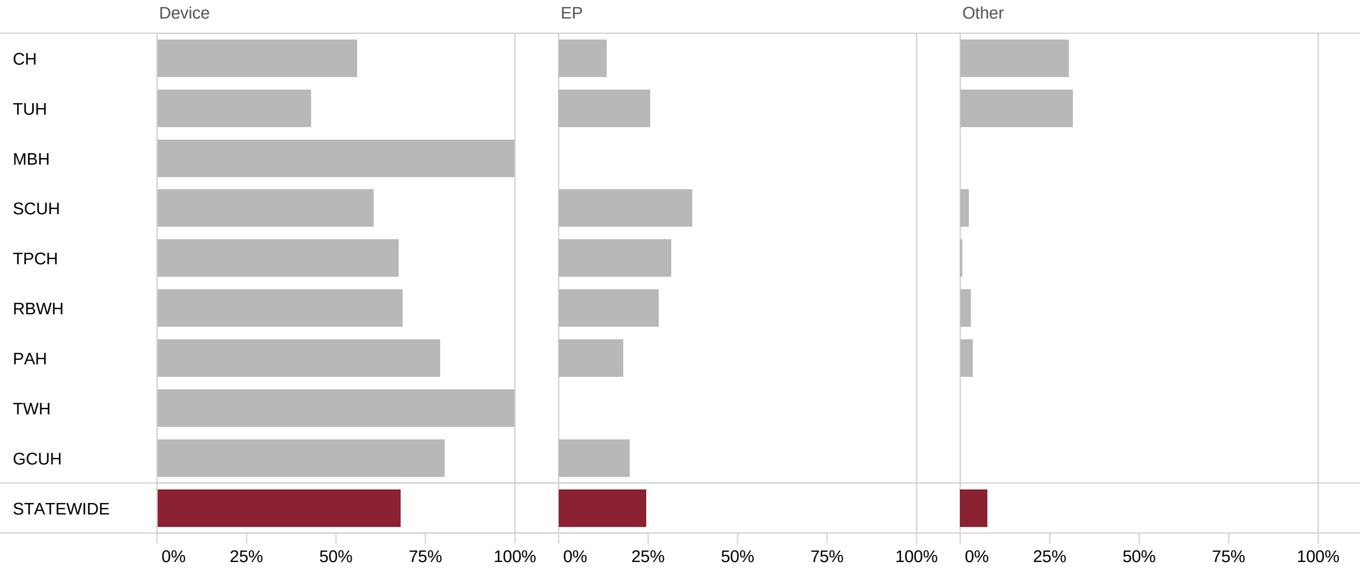


Figure 2: Proportion of cases by site and category

Table 3: Cases by case category

Site	Device n (%)	EP n (%)	Other n (%)	Total n (%)
CH	312 (8.6)	75 (5.8)	169 (41.4)	556 (10.5)
TUH	224 (6.2)	132 (10.3)	164 (40.2)	520 (9.8)
MBH	142 (3.9)	–	–	142 (2.7)
SCUH	397 (11.0)	243 (18.9)	15 (3.7)	655 (12.3)
TPCH	805 (22.3)	375 (29.2)	10 (2.5)	1,190 (22.4)
RBWH	451 (12.5)	184 (14.3)	20 (4.9)	655 (12.3)
PAH	737 (20.4)	166 (12.9)	30 (7.4)	933 (17.6)
TWH	94 (2.6)	–	–	94 (1.8)
GCUH	449 (12.4)	111 (8.6)	–	560 (10.6)
STATEWIDE	**3,611 (68.1)**	**1,286 (24.2)**	**408 (7.7)**	**5,305 (100.0)**

4.3 Yearly case distribution

Yearly growth has been noted over the years since QCOR reporting has begun and this can now be better understood with a larger dataset. It is evident that since 2020 that the volume of cardiac device procedures and electrophysiology procedures has increased. The reasons for these increases are likely multifactorial and include expansion of services at some sites and new services offered at others.

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

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

Wait times for procedures has varied over the past three years. Of particular note is a recent increase in wait time for elective pacemaker procedures. Also, wait times for complex ablation procedures has increased from 2021 to 2022 (78 days to 88 days).

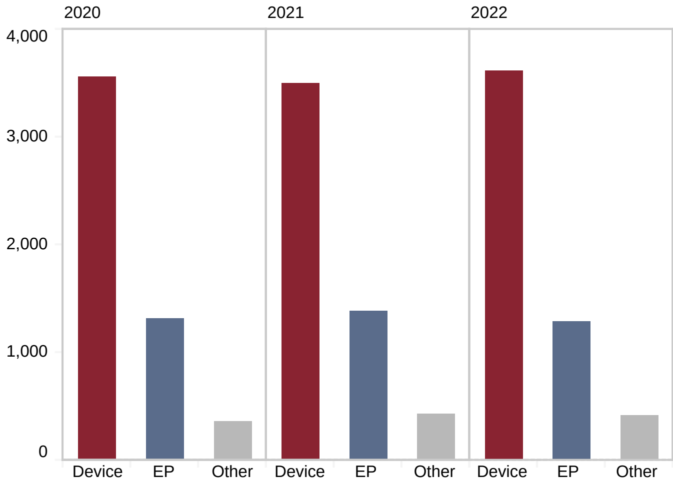


Figure 3: Proportion of cases by category, 2020–2022

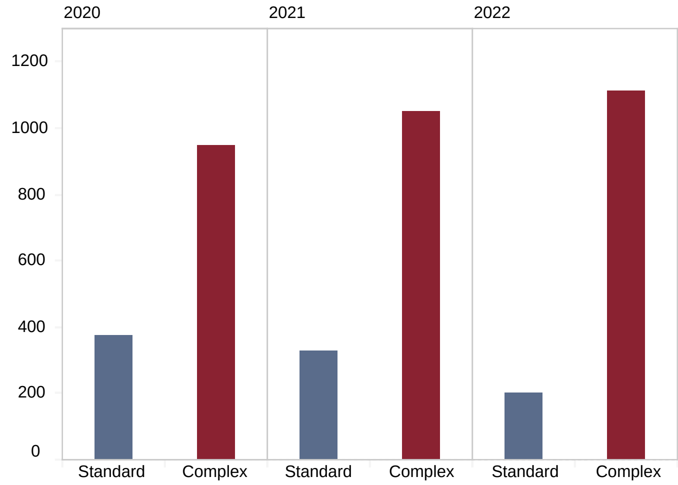


Figure 4: Yearly case volume by electrophysiology procedural complexity, 2020–2022

Table 4: Yearly case volume by case category, 2020–2022

Case category	2020 n (%)	2021 n (%)	2022 n (%)
Device	3,551	3,500	3,611
EP	1,319	1,379	1,286
Other	364	424	408

Table 5: Yearly case volume by electrophysiology procedural complexity, 2020–2022

Electrophysiology procedure complexity	2020 n (%)	2021 n (%)	2022 n (%)
Standard	374 (28.3)	327 (23.7)	201 (15.3)
Complex	946 (71.7)	1,052 (76.3)	1,113 (84.7)

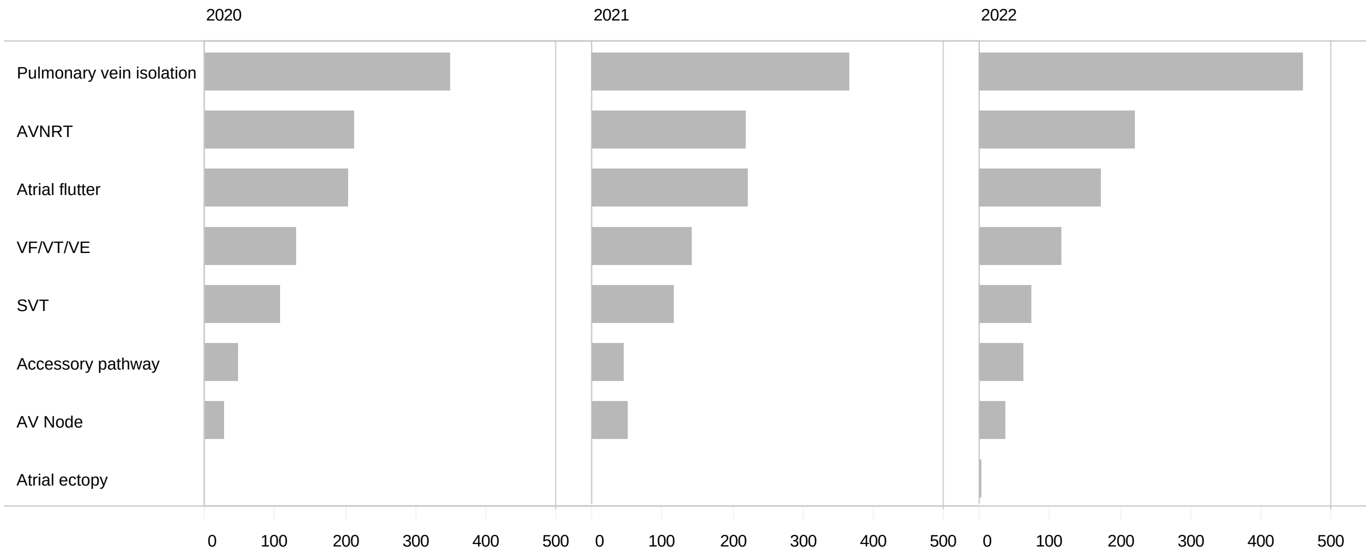


Figure 5: Number of yearly ablation cases by arrhythmia type, 2020–2022

Table 6: Yearly ablation cases by arrhythmia type, 2020–2022

Ablation type	2020 n	2021 n	2022 n
Pulmonary vein isolation	349	367	458
AVNRT	214	219	222
Atrial flutter	205	221	173
Ventricular arrhythmia/ectopy	129	141	116
Supraventricular tachycardia	107	115	63
Accessory pathway	49	45	44
AV node	27	52	37
Atrial ectopy	0	0	1

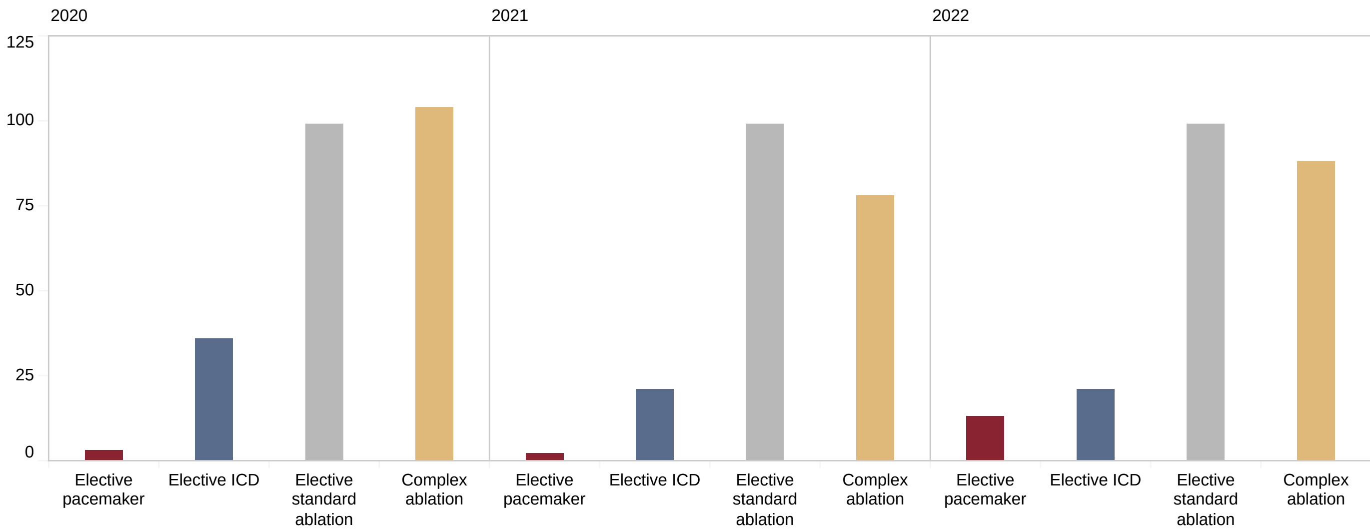


Figure 6: Median wait time analysis by procedure category, 2020–2022

Table 7: Median wait time analysis by procedure category, 2020–2022

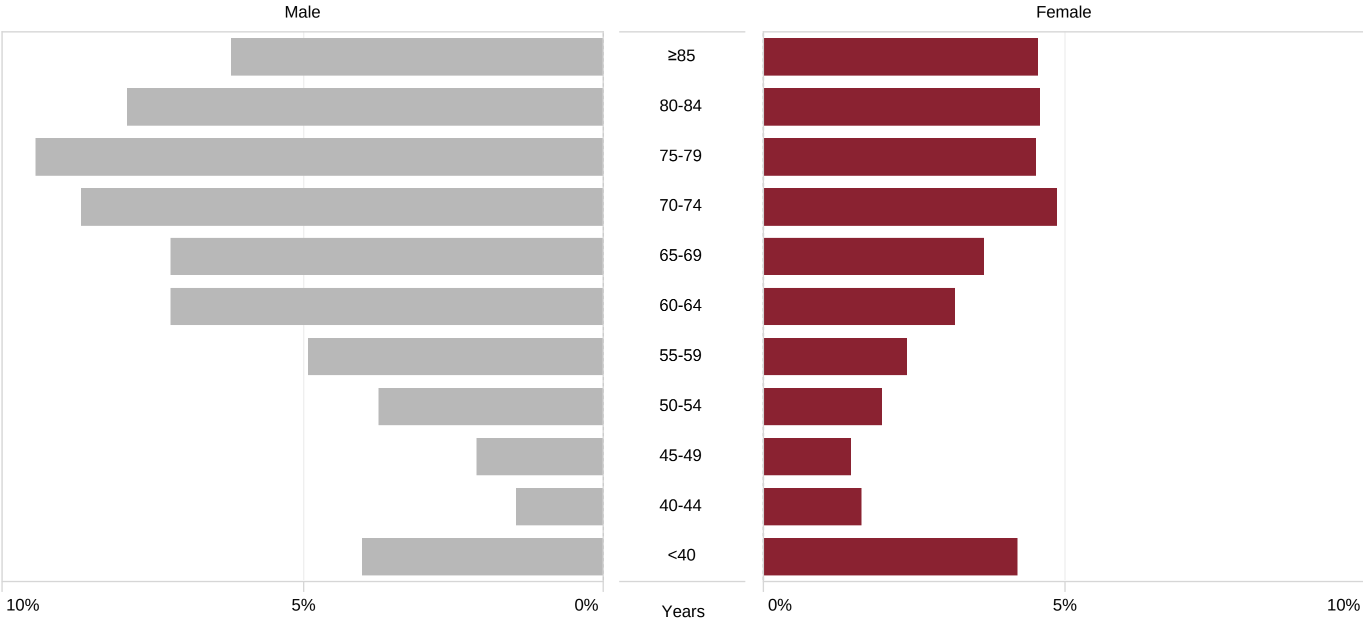
Procedure category	2020 days	2021 days	2022 days
Elective PPM	3	2	13
Elective ICD	36	21	21
Elective standard ablation	99	99	99
Complex ablation	104	78	88

5 Patient characteristics

5.1 Age and gender

Age is an important risk factor for developing cardiovascular disease with the majority of patients in this cohort aged 60 years and above (72%). The median age of the overall electrophysiology and pacing patient cohort was 70 years of age. Males between the age of 75 and 79 comprised the largest proportion by age and gender.

The median age of males and females was 70 years. Median patient age differed considerably by procedure category with the median age of patients undergoing electrophysiology procedures being 59 years compared to 74 years for cardiac device procedures.



% of total (n=5,305)

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

Table 8: Median age by gender and case category

	Total cases n	Male years	Female years	ALL years
Device	3,611	74	74	74
EP	1,286	60	56	59
Other	408	64	67	64
Total	**5,305**	**70**	**70**	**70**

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 (42%).

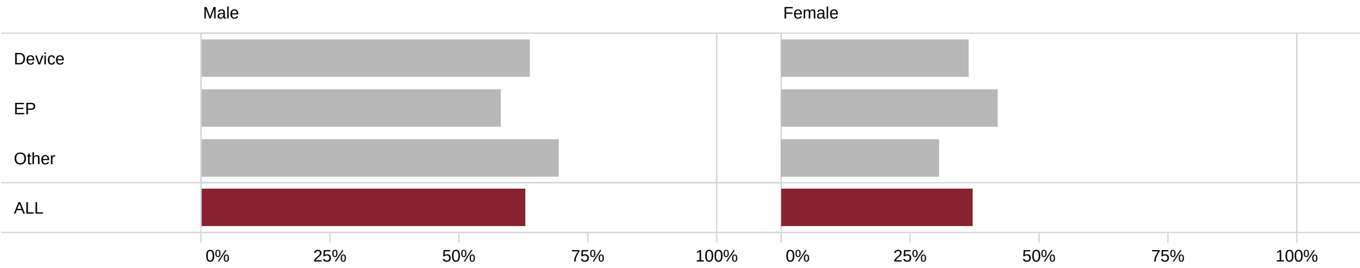


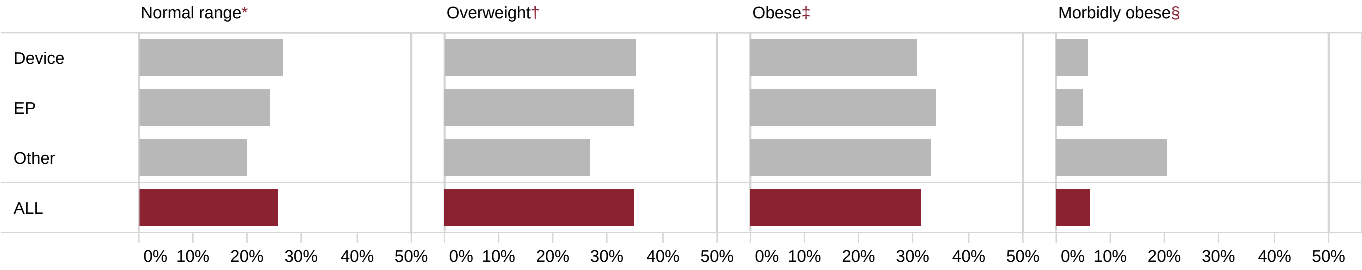
Figure 8: Proportion of cases by gender and category

Table 9: Proportion of cases by gender and category

	Total cases n	Male n (%)	Female n (%)
Device	3,611	2,304 (63.8)	1,307 (36.2)
EP	1,286	749 (58.2)	537 (41.8)
Other	408	283 (69.4)	125 (30.6)
ALL	**5,305**	**3,336 (62.9)**	**1,969 (37.1)**

5.2 Body mass index

Patients classed as having a body mass index (BMI) category of overweight (35%), obese (32%) or morbidly obese (6%) represented almost three quarters of all electrophysiology and pacing patients. Patients classed as underweight represented less than 2% of all cases.



* BMI 18.5–24.9 kg/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 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 3.7%. This correlates with the estimated proportion of Aboriginal and Torres Strait Islander peoples within Queensland (4.6%).[2] There was large variation between units, with the North Queensland and western Queensland sites seeing a larger proportion of Aboriginal and Torres Strait Islander patients.

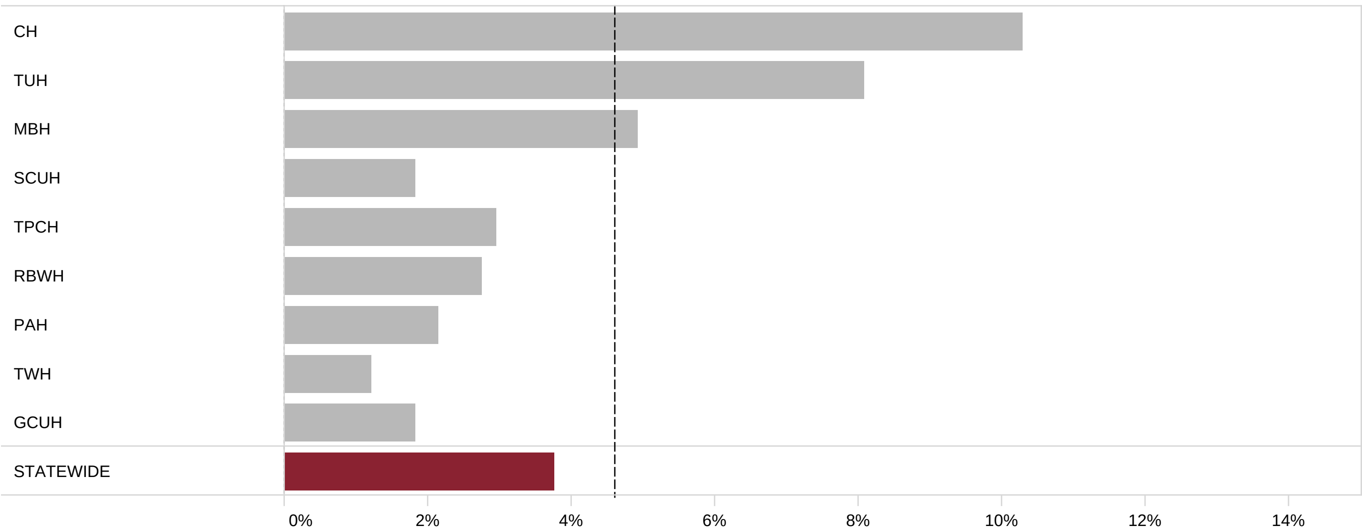


Figure 10: Proportion of cases by identified Aboriginal and Torres Strait Islander status and site

Electrophysiology and Pacing

5.4 Device procedures

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

Table 10: Cardiac device case types by site

Procedure type	CH	TUH	MBH	SCUH	TPCH	RBWH	PAH	TWH	GCUH
	n	n	n	n	n	n	n	n	n
Pacemaker procedure*	157	86	85	223	392	207	470	60	261
ICD procedure*	36	42	7	42	116	87	104	6	75
Loop recorder implant/explant	76	18	49	58	76	93	40	14	43
BiV ICD procedure*	16	42	–	27	80	37	53	9	25
BiV pacemaker procedure*	8	12	–	25	25	8	14	2	10
Device explant	1	2	1	3	70	3	7	1	6
Lead revision/replacement/pocket revision	8	7	–	13	24	8	19	1	12
Temporary pacing system	6	–	–	6	7	5	24	–	6
Leadless pacemaker implant	4	15	–	–	13	3	6	1	11
Insertion of epicardial lead	–	–	–	–	2	–	–	–	–
ALL	**312**	**224**	**142**	**397**	**805**	**451**	**737**	**94**	**449**

* Implant/generator change/upgrade

Electrophysiology and Pacing

5.5 Electrophysiology studies/ablations

Electrophysiology studies involving radiofrequency ablation were the most common individual procedure performed across all sites, ranging from 46% of case volume at Cairns Hospital to 87% at PAH.

Table 11: Electrophysiology study/ablation types by site

Site	Procedure type	Complex EP n	Standard EP n	Case n (%)
CH	Radiofrequency ablation	18	18	36 (46.2)
	Cryotherapy ablation	27	–	27 (34.6)
	Electrophysiology study	8	6	14 (17.9)
	Radiofrequency and cryotherapy ablation	1	–	1 (1.3)
TUH	Radiofrequency ablation	94	5	99 (74.4)
	Electrophysiology study	17	3	20 (15.0)
	Cryotherapy ablation	13	–	13 (9.8)
	Radiofrequency and cryotherapy ablation	1	–	1 (0.8)
SCUH	Radiofrequency ablation	149	7	156 (63.7)
	Cryotherapy ablation	49	–	49 (20.0)
	Electrophysiology study	26	12	38 (15.5)
	Radiofrequency and cryotherapy ablation	2	–	2 (0.8)
TPCH	Radiofrequency ablation	203	43	246 (64.2)
	Cryotherapy ablation	75	–	75 (19.6)
	Electrophysiology study	17	20	37 (9.7)
	Electrophysiology study and pulsed field ablation	22	–	22 (5.7)
	Radiofrequency and cryotherapy ablation	2	–	2 (0.5)
	Electrophysiology study and drug challenge	–	1	1 (0.3)
RBWH	Radiofrequency ablation	135	–	135 (71.4)
	Cryotherapy ablation	25	–	25 (13.3)
	Electrophysiology study	17	5	22 (11.6)
	Radiofrequency and cryotherapy ablation	6	–	6 (3.2)
	Electrophysiology study and drug challenge	1	–	1 (0.5)
PAH	Radiofrequency ablation	129	24	153 (87.4)
	Electrophysiology study	12	10	22 (12.6)
GCUH	Radiofrequency ablation	52	38	90 (81.1)
	Electrophysiology study	5	9	14 (12.6)
	Cryotherapy ablation	7	–	7 (6.3)
STATEWIDE		**1,113**	**201**	**1,314**

5.5.1 Ablation type/arrhythmia

The most frequently ablated clinical arrhythmia was atrial fibrillation (pulmonary vein isolation), which accounted for 40% of ablations across all sites. This was followed by atrioventricular nodal re-entry tachycardias (AVNRT) (19%) and atrial flutter (15%).

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

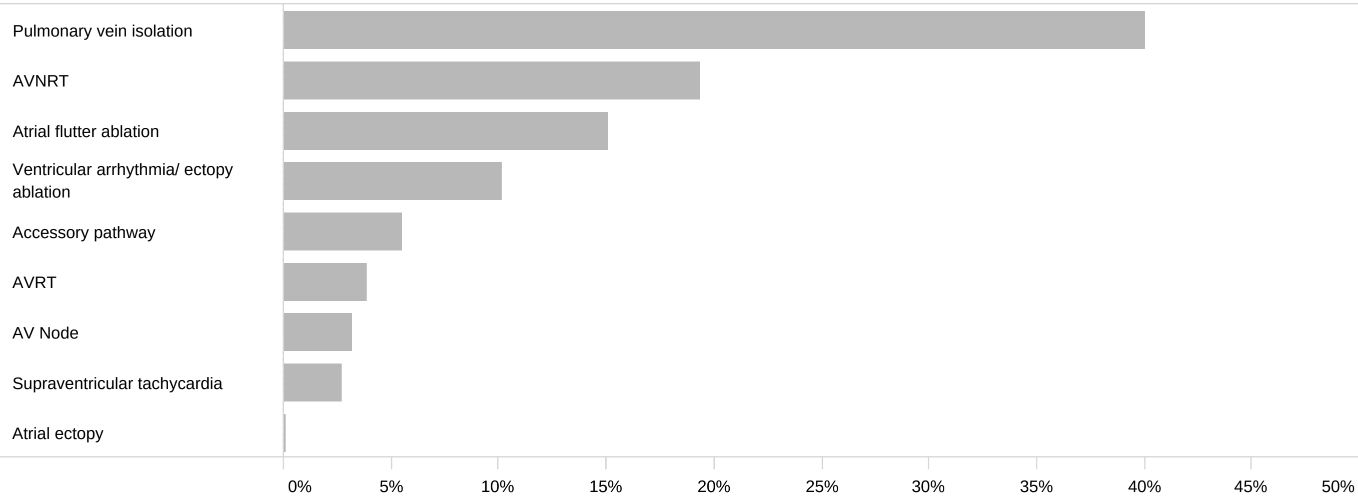


Figure 11: Proportion of arrhythmias ablated

Table 12: Median age and gender by ablation type

Ablation type	Gender	Total cases n (%)	Median age years
Pulmonary vein isolation	Male	301 (65.7)	61
	Female	157 (34.3)	64
AVNRT	Male	84 (37.8)	58
	Female	138 (62.2)	47
Atrial flutter	Male	135 (78.0)	66
	Female	38 (22.0)	68
Ventricular arrhythmia/ectopy	Male	72 (62.1)	63
	Female	44 (37.9)	53
Accessory pathway	Male	32 (50.8)	32
	Female	31 (49.2)	31
AVRT	Male	25 (56.8)	37
	Female	19 (43.2)	34
AV node	Male	13 (35.1)	66
	Female	24 (64.9)	76
Supraventricular tachycardia	Male	14 (45.2)	36
	Female	17 (54.8)	55
Atrial ectopy	Female	1 (100.0)	22
ALL		**1,145 (100.0)**	**59**

Table 13: Arrhythmia type by site

Site	Ablation type	Count n (%)
CH	Pulmonary vein isolation	35 (3.1)
	AVNRT	15 (1.3)
	Atrial flutter ablation	4 (0.3)
	AVRT	3 (0.3)
	AV node	3 (0.3)
	Ventricular arrhythmia/ectopy ablation	2 (0.2)
	Supraventricular tachycardia	2 (0.2)
TUH	Pulmonary vein isolation	40 (3.5)
	AVNRT	26 (2.3)
	Atrial flutter ablation	18 (1.6)
	Ventricular arrhythmia/ectopy ablation	14 (1.2)
	Accessory pathway	8 (0.7)
	AV node	3 (0.3)
	Supraventricular tachycardia	3 (0.3)
	AVRT	1 (0.1)
SCUH	Pulmonary vein isolation	78 (6.8)
	Atrial flutter ablation	45 (3.9)
	AVNRT	35 (3.1)
	AV node	16 (1.4)
	Supraventricular tachycardia	11 (1.0)
	Ventricular arrhythmia/ectopy ablation	9 (0.8)
	Accessory pathway	9 (0.8)
	AVRT	4 (0.3)
TPCH	Pulmonary vein isolation	149 (13.0)
	AVNRT	59 (5.2)
	Ventricular arrhythmia/ectopy ablation	52 (4.5)
	Atrial flutter ablation	40 (3.5)
	Accessory pathway	24 (2.1)
	AVRT	10 (0.9)
	Supraventricular tachycardia	8 (0.7)
	AV node	3 (0.3)
RBWH	AVNRT	47 (4.1)
	Pulmonary vein isolation	45 (3.9)
	Atrial flutter ablation	32 (2.8)
	Ventricular arrhythmia/ectopy ablation	13 (1.1)
	AVRT	13 (1.1)
	Accessory pathway	9 (0.8)
	AV node	4 (0.3)
	Supraventricular tachycardia	2 (0.2)
	Atrial ectopy	1 (0.1)
PAH	Pulmonary vein isolation	70 (6.1)
	AVNRT	25 (2.2)
	Ventricular arrhythmia/ectopy ablation	20 (1.7)
	Atrial flutter ablation	15 (1.3)
	Accessory pathway	11 (1.0)
	AVRT	6 (0.5)
	AV node	3 (0.3)
	Supraventricular tachycardia	3 (0.3)
GCUH	Pulmonary vein isolation	41 (3.6)
	AVNRT	15 (1.3)
	Atrial flutter ablation	19 (1.7)
	AVRT	7 (0.6)
	Ventricular arrhythmia/ectopy ablation	6 (0.5)
	AV node	5 (0.4)
	Accessory pathway	2 (0.2)
	Supraventricular tachycardia	2 (0.2)
STATEWIDE		**1,145 (100.0)**

5.6 Other procedures

The most common other procedure was cardioversion (87%). Variations in clinical practice across sites can be observed here with not all cardioversions performed being carried out in the electrophysiology laboratory environment or documented using the QCOR module.

Table 14: Other procedures

	Total n	Cardioversion n (%)	Drug challenge n (%)	Other procedure n (%)	Pericardiocentesis n (%)
CH	169	160 (94.7)	8 (4.7)	1 (0.6)	–
TUH	164	161 (98.2)	–	3 (1.8)	–
SCUH	15	–	11 (73.3)	2 (13.3)	2 (13.3)
TPCH	10	–	1 (10.0)	6 (60.0)	3 (30.0)
RBWH	20	6 (30.0)	10 (50.0)	4 (20.0)	–
PAH	30	26 (86.7)	3 (10.0)	1 (3.3)	–
STATEWIDE	**408**	**353 (86.5)**	**33 (8.1)**	**17 (4.2)**	**5 (1.2)**

6 Procedural complications

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

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

The overall device procedure complication rate was 0.6%, while electrophysiology procedures had a 1.2% complication rate.

Table 15: Cardiac device procedure complications

Procedure type	Complication	Total n (%)
Pacemaker implant/generator change	Pericardial effusion without tamponade	2 (0.1)
	Lead complication	1 (0.1)
	Pneumothorax	1 (0.1)
	Conduction block	1 (0.1)
	Haematoma	1 (0.1)
	Drug reaction	1 (0.1)
	Other	1 (0.1)
ICD implant/generator change/upgrade	Coronary sinus dissection	3 (0.6)
BiV ICD implant/generator change/upgrade	Coronary sinus dissection	3 (1.0)
	Pericardial effusion without tamponade	2 (0.7)
	Cardiac arrest	1 (0.3)
BiV pacemaker implant/generator change/upgrade	Coronary sinus dissection	2 (1.9)
	Pericardial effusion with tamponade	1 (1.0)
	Vascular injury	1 (1.0)
Device explant	Pericardial effusion with tamponade	1 (1.1)
Temporary pacing system	Conduction block	1 (1.9)
ALL		**23 (0.6)**

Table 16: Electrophysiology procedure complications by study type and complexity

Procedure type	Complexity	Complication	Total n (%)
Electrophysiology study	Complex EP	Pericardial effusion without tamponade	2 (2.0)
Radiofrequency ablation	Standard EP	Conduction block	1 (0.7)
Radiofrequency ablation	Complex EP	Pericardial effusion with tamponade	3 (0.4)
		Haematoma	2 (0.3)
		Drug reaction	1 (0.1)
		Vascular injury	1 (0.1)
Cryotherapy ablation	Complex EP	Phrenic nerve injury	3 (1.5)
		Pericardial effusion with tamponade	1 (0.5)
		Bleeding requiring transfusion	1 (0.5)
Radiofrequency and cryotherapy ablation	Complex EP	Haemodynamic instability	1 (0.1)
ALL			**16 (1.2)**

7 Clinical indicators

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

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

Table 17: Electrophysiology and pacing clinical indicators

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

7.1 Waiting time from referral date to procedure by case category

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

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

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

7.1.1 Elective pacemaker

Examination of the waiting time for elective pacemaker procedures is below. Of the 325 cases with complete data, the median wait time was 13 days.

Table 18: Elective pacemaker wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
STATEWIDE	403	325	13	0–41

7.1.2 Elective ICD wait time and proportion within 28 days

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

Table 19: Elective ICD wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
STATEWIDE	197	151	21	0–55	59.6

7.1.3 Standard ablation

Waiting times for standard ablation procedures are presented below. Of the 93 cases eligible for analysis, the median wait time was 99 days.

Table 20: Elective standard ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
STATEWIDE	100	93	99	21–198

7.1.4 Complex ablation with proportion within 180 days or less

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

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

Table 21: Elective complex ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
STATEWIDE	869	662	88	29–180	75.1

7.2 Procedural tamponade rates

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

Table 22: Procedural tamponade analysis

Procedure category	Total cases analysed n	Procedural tamponade observed n	Procedural tamponade rate %
Device	3,611	4	0.1
EP	1,286	4	0.3
ALL	**4,897**	**8**	**0.2**

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

This indicator identifies the number of cases where one or more lead dislodgements were 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 2021 calendar year.

The analysis found 51 cases (2.3%) where reintervention was required within 12 months of the index procedure. There were 32 right ventricular lead dislodgements, 22 right atrial and 4 left ventricular. More than one lead dislodgement was observed in some cases.

These results compare similarly with international cohorts, where observed dislodgement rates for pacemaker system implants vary from 1.0 to 2.7%.[49]

Table 23: Reintervention due to lead dislodgement analysis

	Cases analysed n	12 month lead dislodgement n	12 month lead dislodgement rate %	Median time to dislodgement days	Interquartile range days
Eligible 2021 device cases	2,176	51	2.3	5	1–25

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

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

A system loss rate of 0.2% was observed at 12 months post procedure. This is reassuring when compared to international literature which suggests infection rates necessitating explant of approximately 2.4%.[50]

Table 24: Rehospitalisation with device loss analysis

	Cases analysed n	12 month system loss due to infection n	12 month system loss rate %
Eligible 2021 device cases	2,655	6	0.2

7.5 12 month all-cause mortality for cardiac device procedures

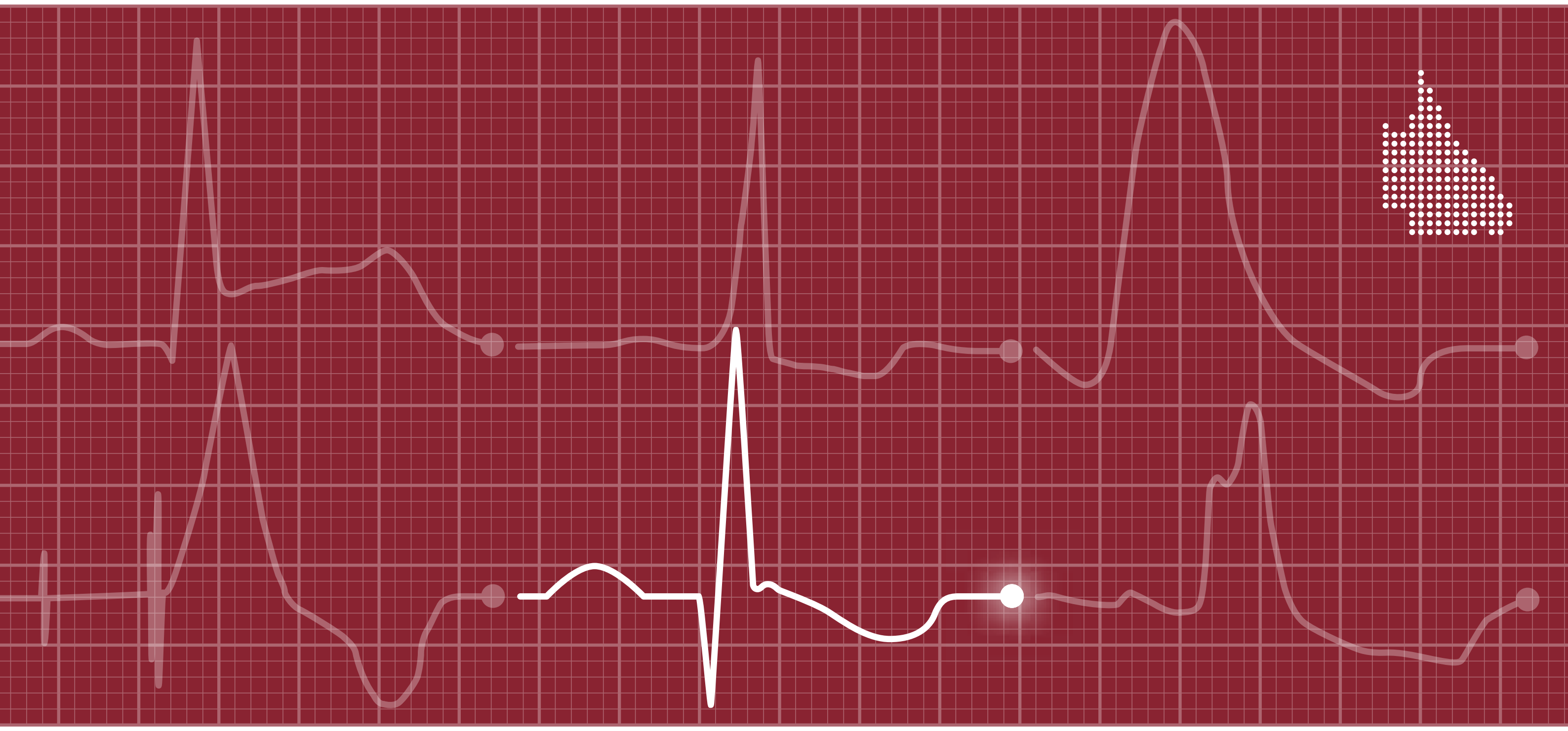
The all-cause unadjusted mortality rate following cardiac device procedure was 6.5%. To allow complete follow up over 12 months, these outcomes are reported for the previous 2021 patient cohort.

When interpreting this figure, it is important to note patients undergoing cardiac device procedures are often of advanced age (median age 81 years). In addition, many patients have advanced symptomology such as advanced heart failure, or most likely suffering from multiple underlying risk factors or comorbidities.

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

	Cases analysed n	12 month mortality observed n	12 month mortality rate %	Median age at procedure years	Interquartile range years
Any BiV procedure	420	25	6.0	76	68–79
ICD procedure	551	23	4.2	68	64–77
Pacemaker procedures	1,889	139	7.4	84	77–89
ALL 2021 device cases	**2,860**	**187**	**6.5**	**81**	**75–87**

Cardiac Rehabilitation Audit



1 Message from the Cardiac Rehabilitation Committee Chair

Cardiac rehabilitation (CR) is evidence-based therapy to assist those with cardiovascular disease recover and prevent the recurrence of secondary events, aiming to reduce both hospital readmissions and mortality rates. Despite the benefits, referral and participation rates have traditionally been low, however, there has been little data recorded until the introduction of QCOR. The 2022 Annual Report for CR services in Queensland marks the sixth year of data collection, collating input from 59 Queensland Health CR service providers.

QCOR is a data-rich registry, which continues to evolve. The data gathered provides valuable information for ongoing service development and resourcing and aligns with national quality indicators and clinical standards. It enables services to monitor and evaluate performance and benchmark against statewide data.

The data obtained from QCOR has enabled the publication of the Clinical Standards for Cardiac Rehabilitation (2023). This Queensland Health publication has been endorsed by the Queensland Cardiac Clinical Network and the Statewide Cardiac Rehabilitation Collaborative. It aims to standardise CR delivery in Queensland ensuring that service delivery is evidence-based, person-centred, culturally aware, flexible, and applicable to all modes of delivery with consistent and clear messaging. The Clinical Standards outline essential components for CR programs incorporating both Queensland and National CR Indicators with desired target ranges. Data obtained within QCOR is essential to evaluate service performance and in the future, we will see this data aligned with the Clinical Standards.

With the recent global pandemic, we saw innovative models of service delivery moving from traditional face-to-face programs to telehealth, home-based programs and hybrid models. This was necessary to ensure patients still received some form of care to improve their outcomes post cardiovascular event. To date, the data collected has been unable to discriminate between the different models of care that exist across Queensland. When reviewing the outcomes, it is challenging to interpret, as the intervention experienced may have been quite different across services. This year (2023) we have implemented a new model of care application into the QCOR data collection. This will enable outcomes to be reviewed according to the type of CR program experienced and assist in informing future delivery of CR. This information we can look forward to in next year's Annual Report.

Data collected within QCOR is not only valuable to the clinician and health service but also to the patient accessing the service and their general practitioner. QCOR enables the generation of reports including their pre and post assessment data and an ongoing management plan which are directly communicated to The Viewer, the interface with primary care. This is valuable for patients to see the positive changes that CR intervention has made to their health and encourages them to continue to adopt these healthy lifestyle measures, as well as provide timely feedback to their general practitioner.

We would like to take this opportunity to thank the QCOR Committee and the clinicians for their ongoing commitment and support to the QCOR module. As clinicians, we understand the clinical demands and appreciate everyone's time incorporating QCOR into standard practice and using the QCOR CR module for direct entry of assessment information. With six years of data collection to date and expansion of the dataset, we know that this will only assist in future research opportunities and developing world-class CR programs with optimal patient outcomes.

Maura Barnden and Michelle Aust
Co-chairs, QCOR Cardiac Rehabilitation Committee

2 Key findings

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

- There were 59 public cardiac rehabilitation (CR) sites that contributed data to QCOR.
- A total of 9,317 referrals were made to public CR programs across Queensland. A further 1,428 referrals were declined, unsuitable or referred outside of Queensland Health at the point of first contact.
- Approximately 72% of referrals originated from an inpatient setting, while 16% of referrals originated from outside of Queensland Health.
- There were 6,385 referrals (69%) which proceeded to a pre assessment. The most common reasons that the pre assessment did not take place was that the patient declined, was medically unsuitable or inappropriate, had been uncontactable or failed to attend the appointment.
- Male patients accounted for 70% of all CR referrals.
- The median age of patients was 66 years, with three quarters of patients aged 57 years and above. There was considerable variation in median age between Aboriginal and Torres Strait Islander patients (56 years) and patients of other descent (67 years).
- The total proportion of Aboriginal and Torres Strait Islander patients was 6.4%. Large geographical variance was noted, with sites in North Queensland having a significantly higher proportion of Aboriginal and Torres Strait Islander patients.
- Overall, 68% 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 44% of patients. There were 15% of patients who had undergone coronary artery bypass grafting.
- Only 35% 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 92% of cases.
- A timely overall journey occurred in 53% of cases (Queensland Health inpatients referred within 3 days of discharge and assessed by CR program within 28 days of discharge).
- 48% of patients who completed a pre assessment continued CR to the completion of a post assessment.
- Where a six minute walk test was undertaken, 76% patients demonstrated an improved result from pre to post assessment, with 56% recording an increase of greater than 50 metres.
- When measured using the AQoL-4D instrument, 60% of patients demonstrated an improved quality of life score after CR intervention. When quality of life was measured using other metrics, 54% of participants reported a feeling of improved health following completion of CR, while 51% of patients reported an improved mood at post assessment compared to pre assessment, and 43% of patients reported that their fitness had improved following completion of the program.
- There was a 38% increase in patients assessed as being sufficiently active at completion of the program.

3 Participating sites

Table 1: Participating CR sites

Legend: ✓ Engaged and contributing ◑ Partially contributing (<50% of referrals) ○ Not contributing

HHS/Organisation	CR program	Locations	2020	2021	2022
Cairns and Hinterland	Cairns Outpatient CR Program	Cairns	✓	✓	✓
	Cassowary Area CR	Innisfail, Tully	✓	✓	✓
	Tablelands CR	Atherton, Mareeba	✓	✓	✓
	Mossman CR and Prevention Program	Mossman	✓	✓	✓
Central Queensland	Community Health CR	Gladstone	✓	✓	✓
	Biloela CR Program	Biloela	✓	✓	✓
	CR Outpatient Program	Rockhampton, Capricorn Coast	✓	✓	✓
	Mount Morgan CR	Mount Morgan	✓	✓	✓
Central West	Longreach and Central West CR Program	Longreach	✓	✓	✓
		Blackall	✓	✓	✓
		Winton	✓	✓	✓
		Barcaldine*	✓	✓	✓
Darling Downs	Toowoomba Hospital Heart Care	Toowoomba	✓	✓	✓
	Warwick CR Service	Warwick	✓	✓	✓
	Chinchilla-Miles CR Service	Chinchilla, Miles	✓	✓	✓
	Dalby-Tara CR Service	Dalby, Tara	✓	✓	✓
	Kingaroy Hospital South Burnett CR	Kingaroy	✓	✓	✓
	Goondiwindi CR	Goondiwindi	✓	✓	✓
	Texas OPCR Program	Texas	○	○	N/A
	Stanthorpe Health CR Program	Stanthorpe	○	○	N/A
Gold Coast	Gold Coast Heart Health Service	Robina	✓	✓	✓
HCC†	SMoCC‡	Health Contact Centre	✓	✓	✓
Mackay	Mackay Heart Health Service	Mackay	✓	✓	✓
	Mackay Rural District CR	Proserpine, Bowen	○	○	◑
Metro North	Complex Chronic Disease	Caboolture, Chermside, North Lakes, Redcliffe	✓	✓	✓
Metro South	PAH Heart Recovery Program	Princess Alexandra Hospital	✓	✓	✓
	Bayside CR Program	Redland	✓	✓	✓
	Brisbane South CR Service	Eight Mile Plains, Inala	✓	✓	✓
	Logan-Beaudesert CR Service	Browns Plains	✓	✓	✓
North West	North West CR Program	Mount Isa	✓	✓	✓
South West	South West HHS CR Services	Charleville, Roma	✓	✓	✓
		St George	✓	✓	✓
Sunshine Coast	Sunshine Coast HHS Cardiac Rehab	Caloundra, Gympie, Maroochydore, Nambour, Noosa	✓	✓	✓
Townsville	Townsville CR Outpatient Program	Townsville	✓	✓	✓
	Ingham CR Outpatient Program	Ingham	○	○	◑
	Ayr Health Service	Ayr	◑	○	○
West Moreton	Ipswich and West Moreton CR	Ipswich, Boonah, Esk, Gatton, Laidley	✓	✓	✓
Wide Bay	Fraser Coast CR	Hervey Bay, Maryborough	✓	✓	✓
	Wide Bay Rural and Allied Health*	Biggenden, Eidsvold, Gayndah, Mundubbera	✓	✓	✓

* New service commencing in 2020

† Health Contact Centre

‡ Self Management of Chronic Conditions (delivering the COACH program)

N/A Existing service ceased operations

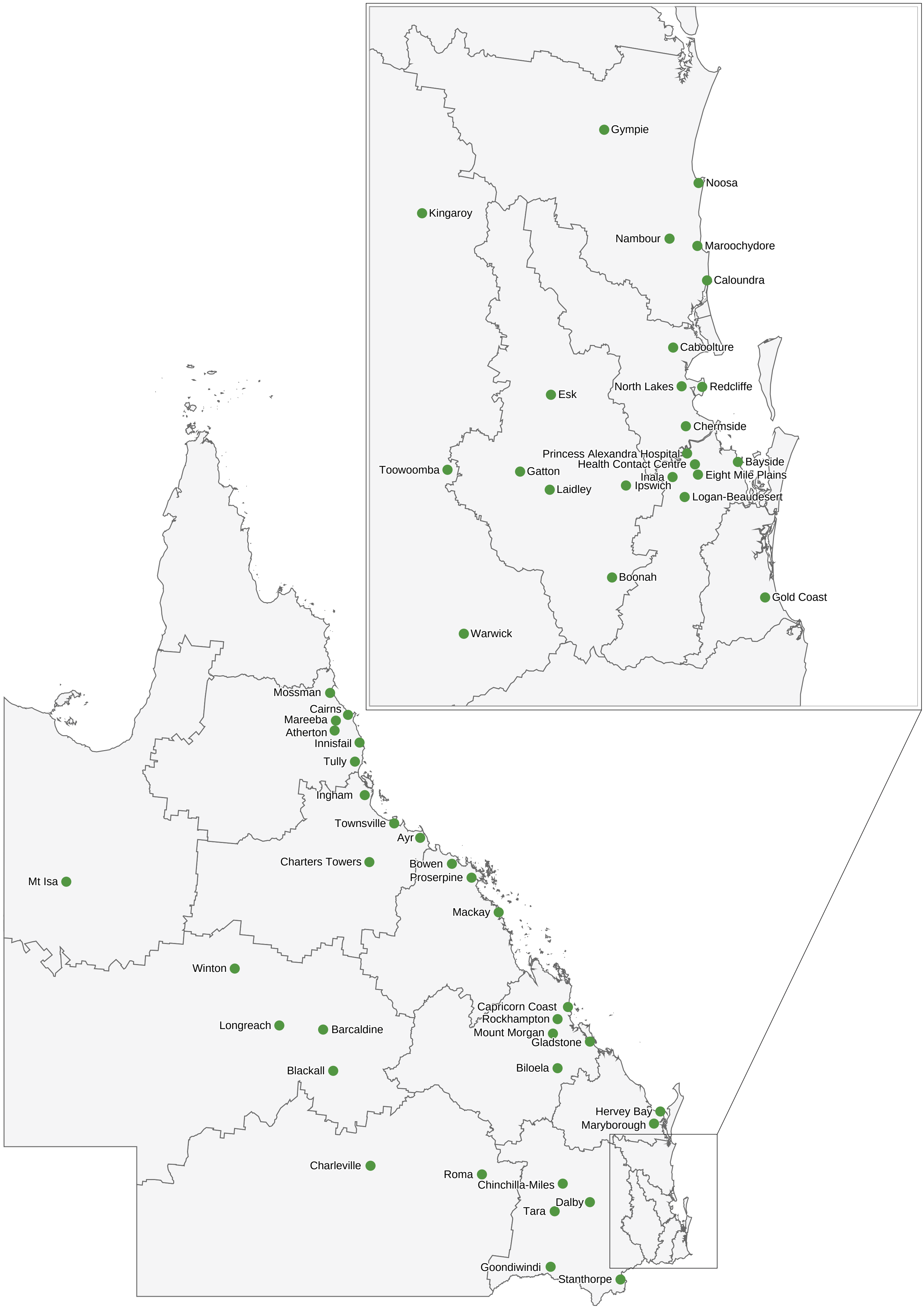


Figure 1: Map of Queensland public CR sites

4 Total referrals

4.1 Statewide

The volume of cardiac rehabilitation (CR) referrals entered into the QCOR clinical application expanded through 2022 to include an additional 9,317 new referrals for the calendar year. This brings the overall total to over 60,000 referrals since data collection commenced in July 2017.

Clinicians at 59 Queensland CR sites have incorporated data entry into their daily practices. A smaller number of sites deliver public outpatient CR but contribute to the database inconsistently or not at all. This can be a result of various factors such as resource availability. These sites remain a focus for engagement and involvement.

There is now an increased level of detail that can be recorded in the QCOR module in cases where the patient declined a CR referral or was considered unsuitable to participate in CR during the acute inpatient period (phase 1). This has increased the availability of data, allowing these cases to be examined in more detail.

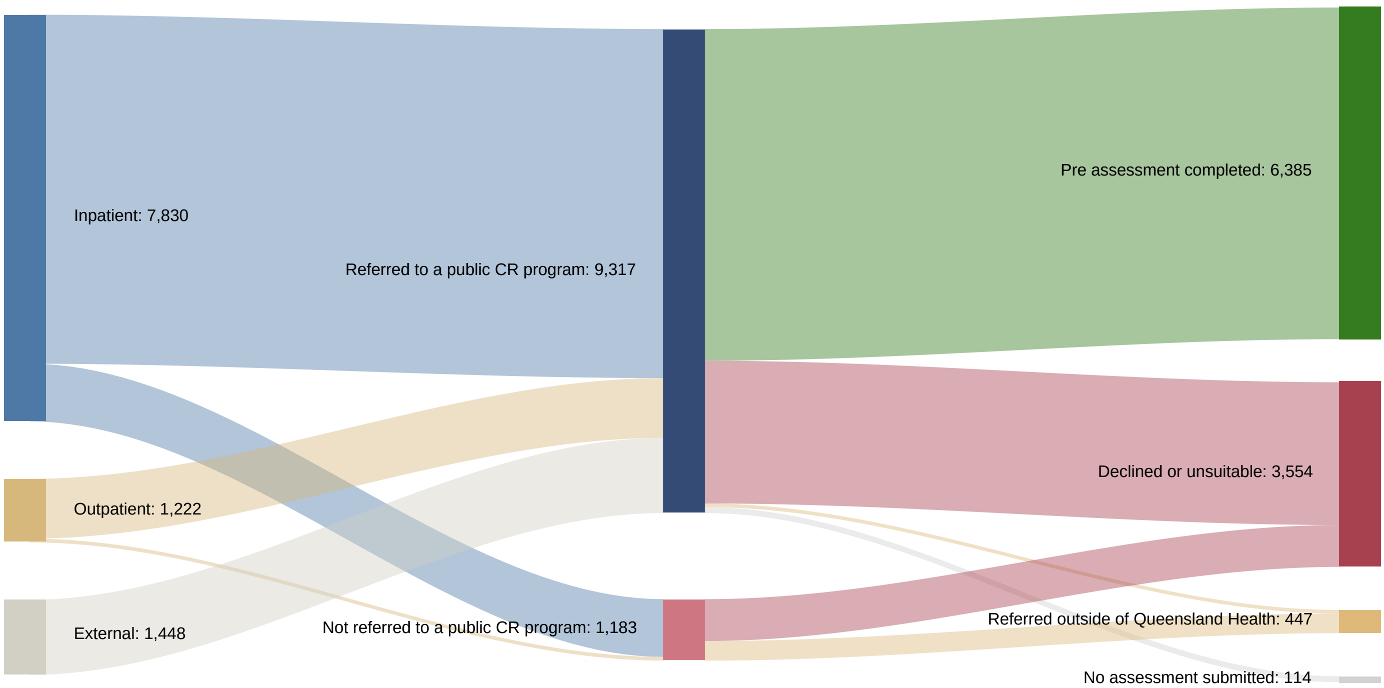


Figure 2: Statewide cardiac rehabilitation referrals flow

Cardiac Rehabilitation

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

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

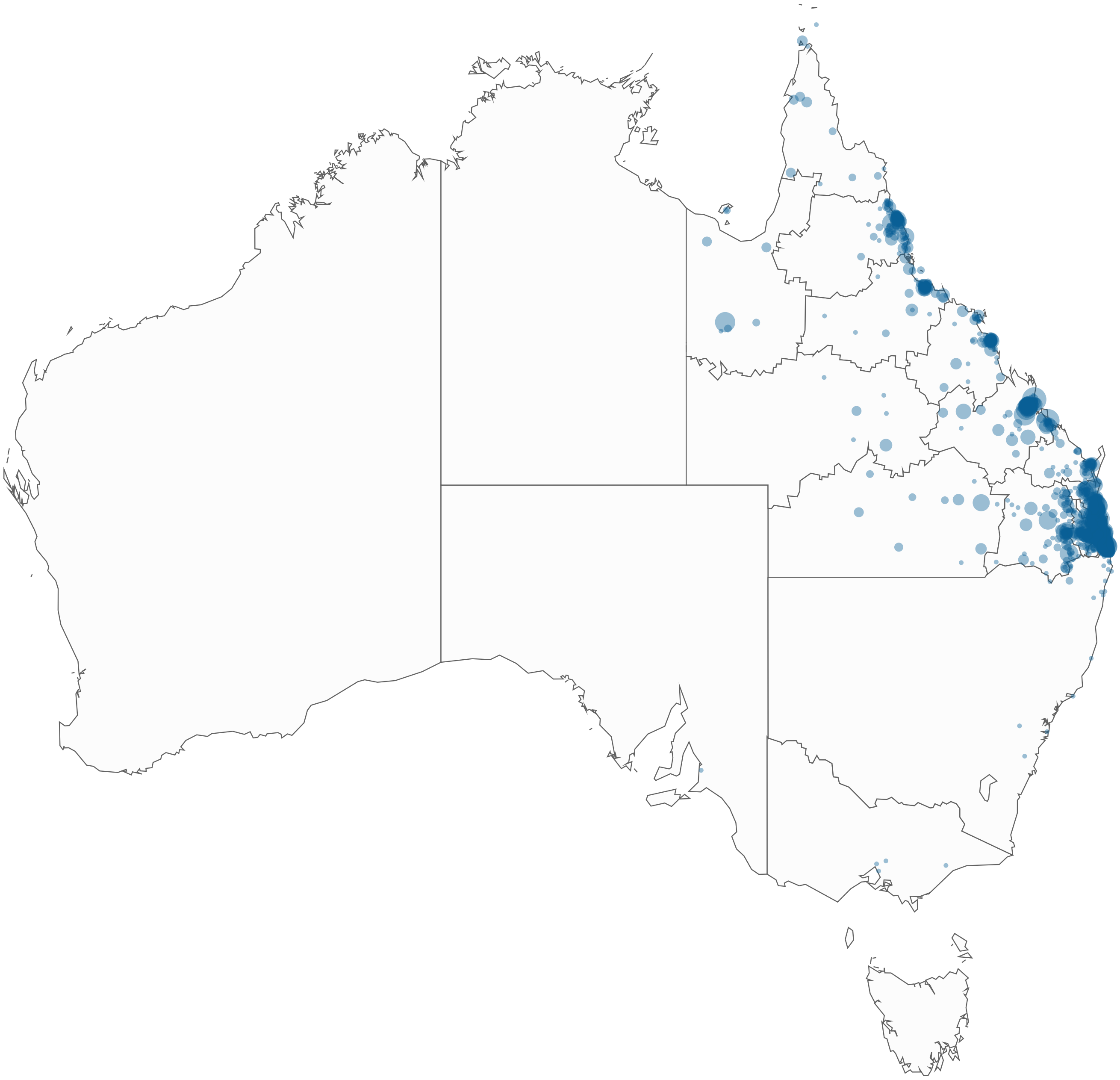


Figure 3: Distribution of CR referrals by usual place of residence

Table 2: Proportion of CR referrals by remoteness classification

Remoteness area*	%
Major Cities of Australia	54.0
Inner Regional Australia	27.2
Outer Regional Australia	15.3
Remote Australia	1.3
Very Remote Australia	2.2
ALL	**100.0**

Excludes missing data (0.2%)

* Classified by Australian Statistical Geography Standard remoteness area

4.2 Origin of referrals

The majority of referrals (72%) originated from an inpatient setting, with smaller proportions of referrals flowing to CR from an outpatient setting (12%) and outside of Queensland Health (16%).

There was considerable variation across participating CR programs in the proportion of referrals from external sources, which ranged from <1% to 31%. It is possible that not all sites are entering referrals received from general practitioners, private hospitals or external specialists, or that local access management strategies are in place where public referrals are prioritised entry into the program, or that local services are unaware that a CR program exists within the area.

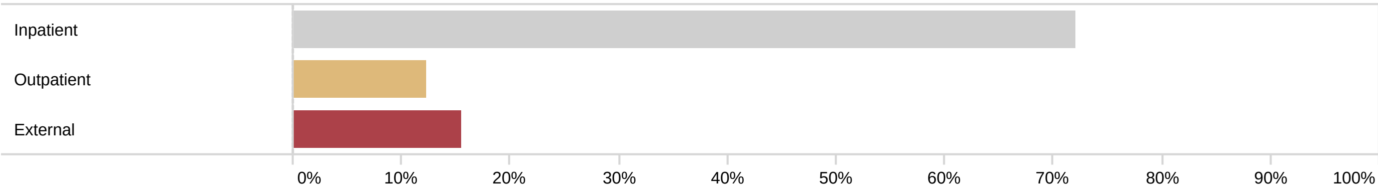


Figure 4: Proportion of referrals by referral source

Table 3: Referral sources by outpatient program HHS

HHS/division	Total referrals n	Inpatient* n (%)	Outpatient* n (%)	External n (%)
Cairns and Hinterland	639	545 (85.3)	39 (6.1)	55 (8.6)
Central Queensland	877	394 (44.9)	293 (33.4)	190 (21.7)
Central West	18	13 (72.2)	5 (27.8)	–
Darling Downs	415	272 (65.5)	61 (14.7)	82 (19.8)
Gold Coast	1,067	785 (73.6)	130 (12.2)	152 (14.2)
Health Contact Centre	1,268	1,113 (87.8)	108 (8.5)	47 (3.7)
Mackay	293	209 (71.3)	70 (23.9)	14 (4.8)
Metro North	1,290	840 (65.1)	188 (14.6)	262 (20.3)
Metro South	1,328	915 (68.9)	51 (3.8)	362 (27.3)
North West	52	33 (63.5)	17 (32.7)	2 (3.8)
South West	66	30 (45.5)	23 (34.8)	13 (19.7)
Sunshine Coast	843	743 (88.1)	45 (5.3)	55 (6.5)
Townsville	314	246 (78.3)	63 (20.1)	5 (1.6)
West Moreton	655	421 (64.3)	33 (5.0)	201 (30.7)
Wide Bay	192	160 (83.3)	25 (13.0)	7 (3.6)
Statewide	**9,317**	**6,719 (72.1)**	**1,151 (12.4)**	**1,445 (15.5)**

* Includes referrals from a Queensland Health public facility

Cardiac Rehabilitation

More than half of all patients were residing in major cities (54%), and the remainder in regional and remote areas of Queensland. This is consistent with the decentralised distribution of the population within the state.

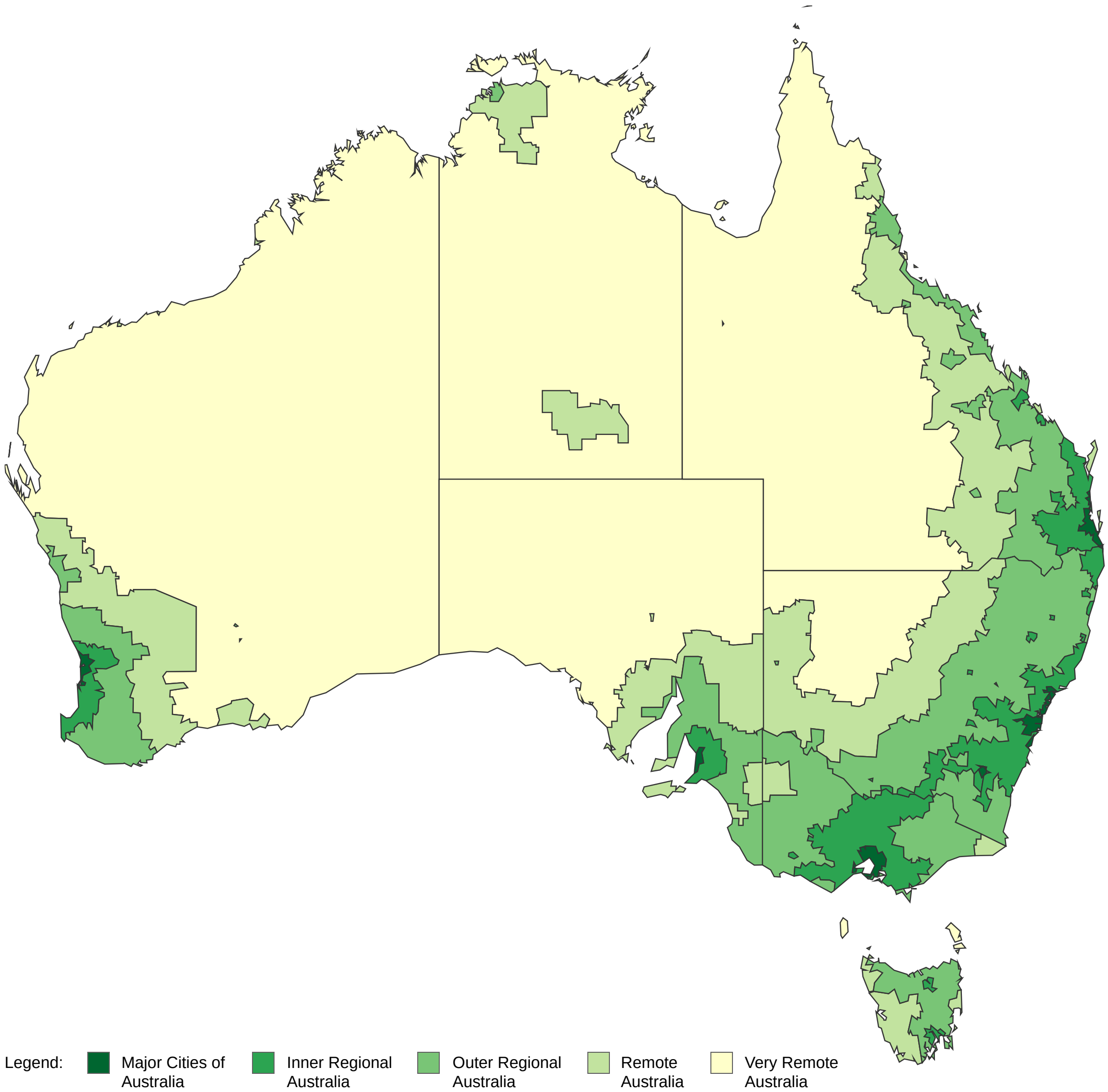


Figure 5: Australian Statistical Geography Standard remoteness areas

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

HHS/division	Major Cities n (%)	Inner Regional n (%)	Outer Regional n (%)	Remote n (%)	Very Remote n (%)
Cairns and Hinterland	2 (0.3)	2 (0.3)	560 (87.9)	25 (3.9)	48 (7.5)
Central Queensland	3 (0.3)	810 (92.5)	54 (6.2)	7 (0.8)	2 (0.2)
Central West	–	–	–	–	18 (100.0)
Darling Downs	2 (0.5)	318 (76.6)	92 (22.2)	2 (0.5)	1 (0.2)
Gold Coast	1,021 (96.1)	36 (3.4)	4 (0.4)	–	1 (0.1)
Health Contact Centre	668 (52.8)	267 (21.1)	234 (18.5)	43 (3.4)	52 (4.1)
Mackay	2 (0.7)	172 (58.7)	110 (37.5)	9 (3.1)	–
Metro North	1,153 (89.4)	132 (10.2)	2 (0.2)	–	3 (0.2)
Metro South	1,235 (93.3)	78 (5.9)	6 (0.5)	5 (0.4)	–
North West	–	–	1 (1.9)	3 (5.8)	48 (92.3)
South West	1 (1.5)	1 (1.5)	22 (33.3)	17 (25.8)	25 (37.9)
Sunshine Coast	489 (58.4)	342 (40.8)	7 (0.8)	–	–
Townsville	1 (0.3)	1 (0.3)	296 (94.3)	13 (4.1)	3 (1.0)
West Moreton	443 (67.6)	207 (31.6)	4 (0.6)	1 (0.2)	–
Wide Bay	1 (0.5)	162 (84.4)	29 (15.1)	–	–
Statewide	**5,021 (54.0)**	**2,528 (27.2)**	**1,421 (15.3)**	**125 (1.3)**	**201 (2.2)**

4.3 Inpatient referrals

For referrals originating from an inpatient setting, the largest referrer was Metro North HHS which accounted for over one quarter (27%) of these referrals. The largest proportion of inpatient referrals was received by the Health Contact Centre (17%). The higher volumes of referrals to the Health Contact Centre is likely a result of model of care changes during the COVID-19 pandemic.

Table 5: CR inpatient referrals by source and destination HHS

HHS/organisation	Outgoing inpatient referrals n (%)	Incoming inpatient referrals n (%)
Cairns and Hinterland	517 (7.7)	545 (8.1)
Central Queensland	238 (3.5)	394 (5.9)
Central West	–	13 (0.2)
Darling Downs	84 (1.2)	272 (4.0)
Gold Coast	784 (11.7)	785 (11.7)
Health Contact Centre	–	1,113 (16.6)
Mackay	163 (2.4)	209 (3.1)
Mater Health Services	84 (1.2)	–
Metro North	1,816 (27.0)	840 (12.5)
Metro South	1,752 (26.1)	915 (13.6)
North West	1 (<0.1)	33 (0.5)
South West	–	30 (0.4)
Sunshine Coast	640 (9.5)	743 (11.1)
Townsville	509 (7.6)	246 (3.7)
West Moreton	128 (1.9)	421 (6.3)
Wide Bay	3 (<0.1)	160 (2.4)
Statewide	**6,719 (100.0)**	**6,719 (100.0)**

Cardiac Rehabilitation

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

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

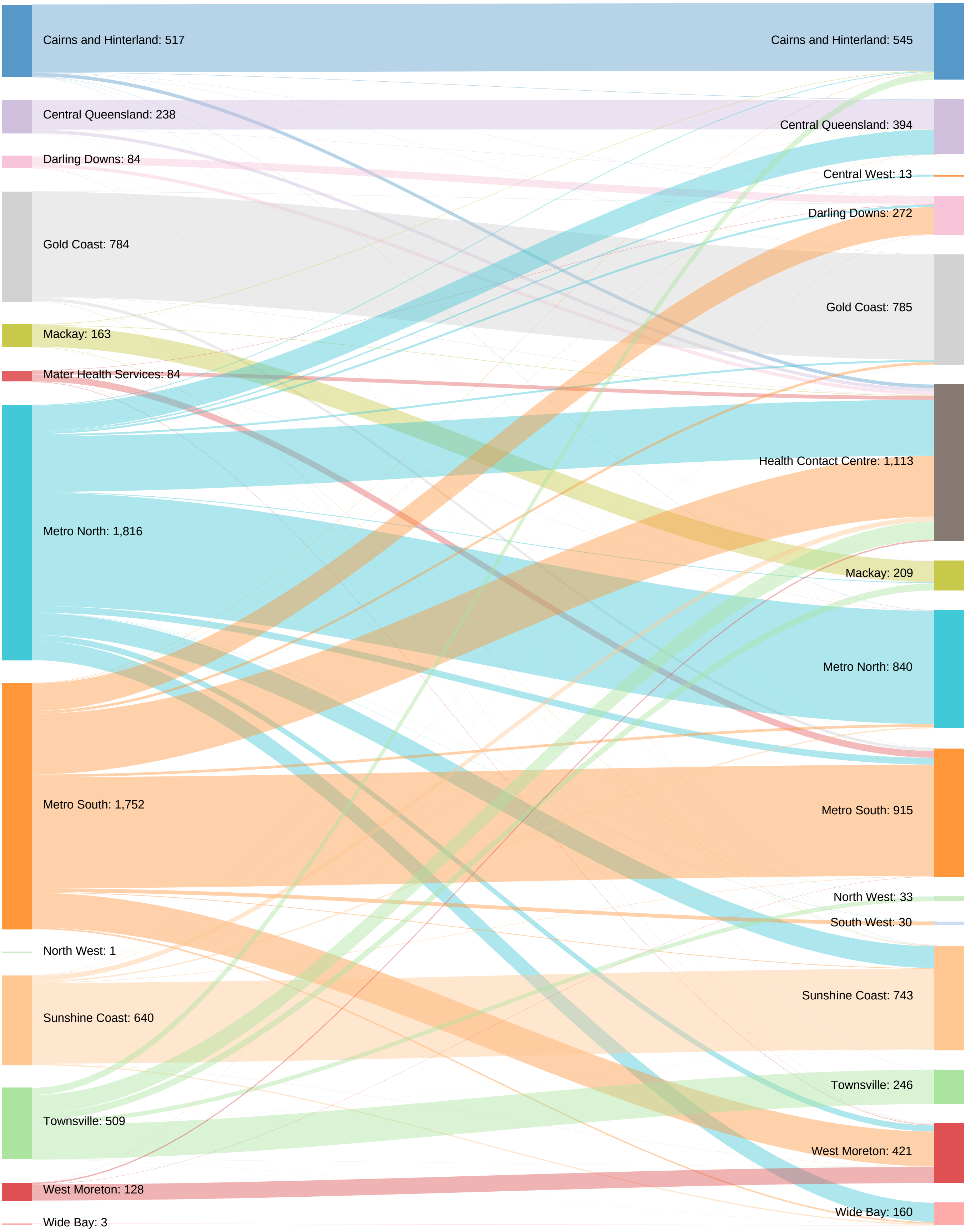


Figure 6: CR inpatient referrals by source and destination HHS

5 Program participation

5.1 Pre assessment stage

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

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

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

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

Table 6: 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	469 (73.4)	170 (26.6)	–
Central Queensland	604 (68.9)	273 (31.1)	–
Central West	12 (66.7)	6 (33.3)	–
Darling Downs	272 (65.5)	129 (31.1)	14 (3.4)
Gold Coast	813 (76.2)	254 (23.8)	–
Health Contact Centre	863 (68.1)	405 (31.9)	–
Mackay	197 (67.2)	96 (32.8)	–
Metro North	886 (68.7)	404 (31.3)	–
Metro South	911 (68.6)	416 (31.3)	1 (0.1)
North West	46 (88.5)	4 (7.7)	2 (3.8)
South West	57 (86.4)	6 (9.1)	3 (4.5)
Sunshine Coast	511 (60.6)	332 (39.4)	–
Townsville	160 (51.0)	108 (34.4)	46 (14.6)
West Moreton	433 (66.1)	174 (26.6)	48 (7.3)
Wide Bay	151 (78.6)	41 (21.4)	–
Statewide	**6,385 (68.5)**	**2,818 (30.2)**	**114 (1.2)**

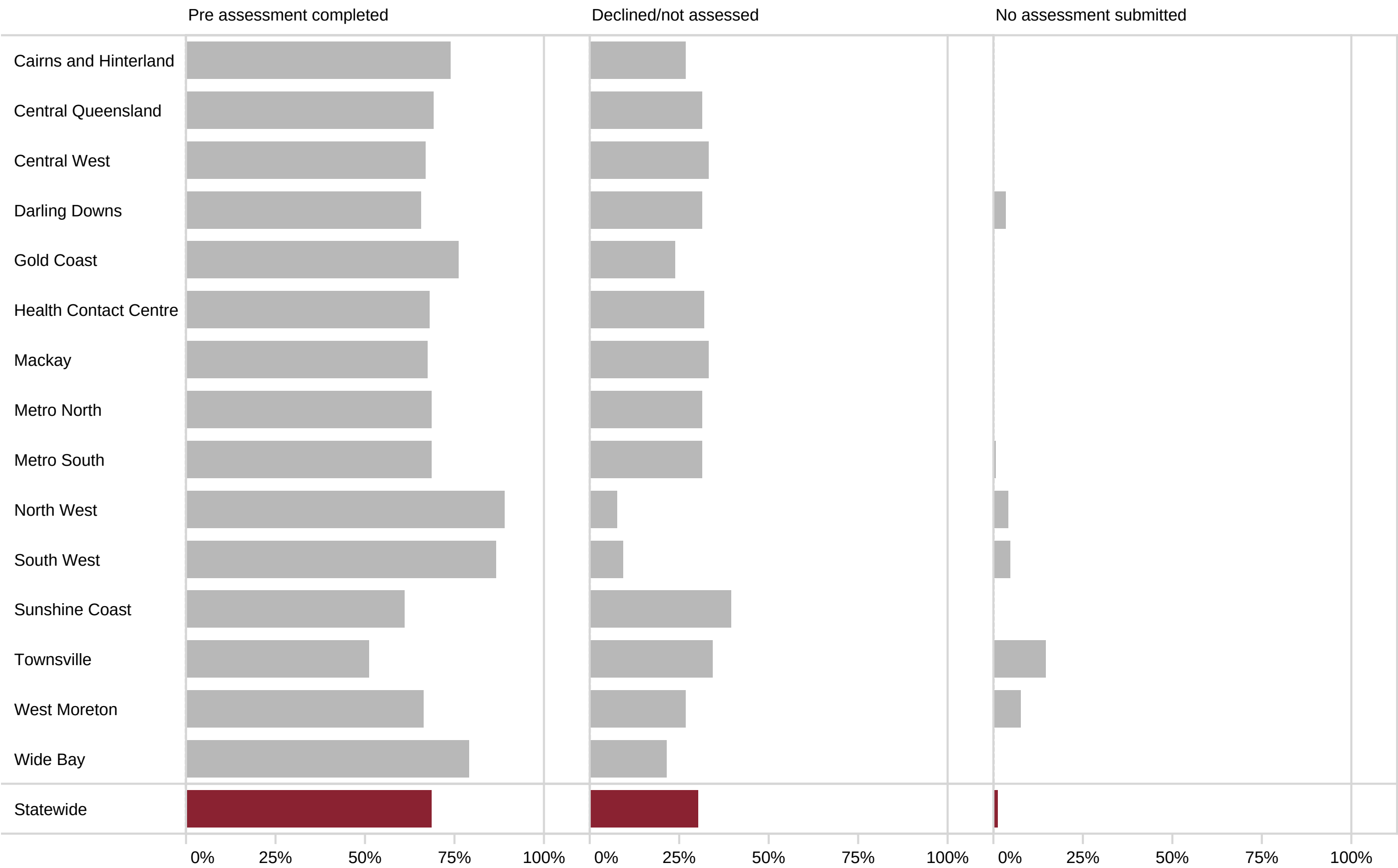


Figure 7: Proportion of CR referrals proceeding to pre assessment by outpatient HHS/division

Cardiac Rehabilitation

5.2 Post assessment stage

In most cases, the post assessment is representative of completion and graduation from the specialist CR outpatient program. This provides an opportunity for the patient and clinician to reflect upon the targets defined at the pre assessment and discuss the impact of the program. Of 6,385 completed pre assessments, almost half (48%) proceeded to post assessment which is an improvement over the three previous years where 41% progressed.

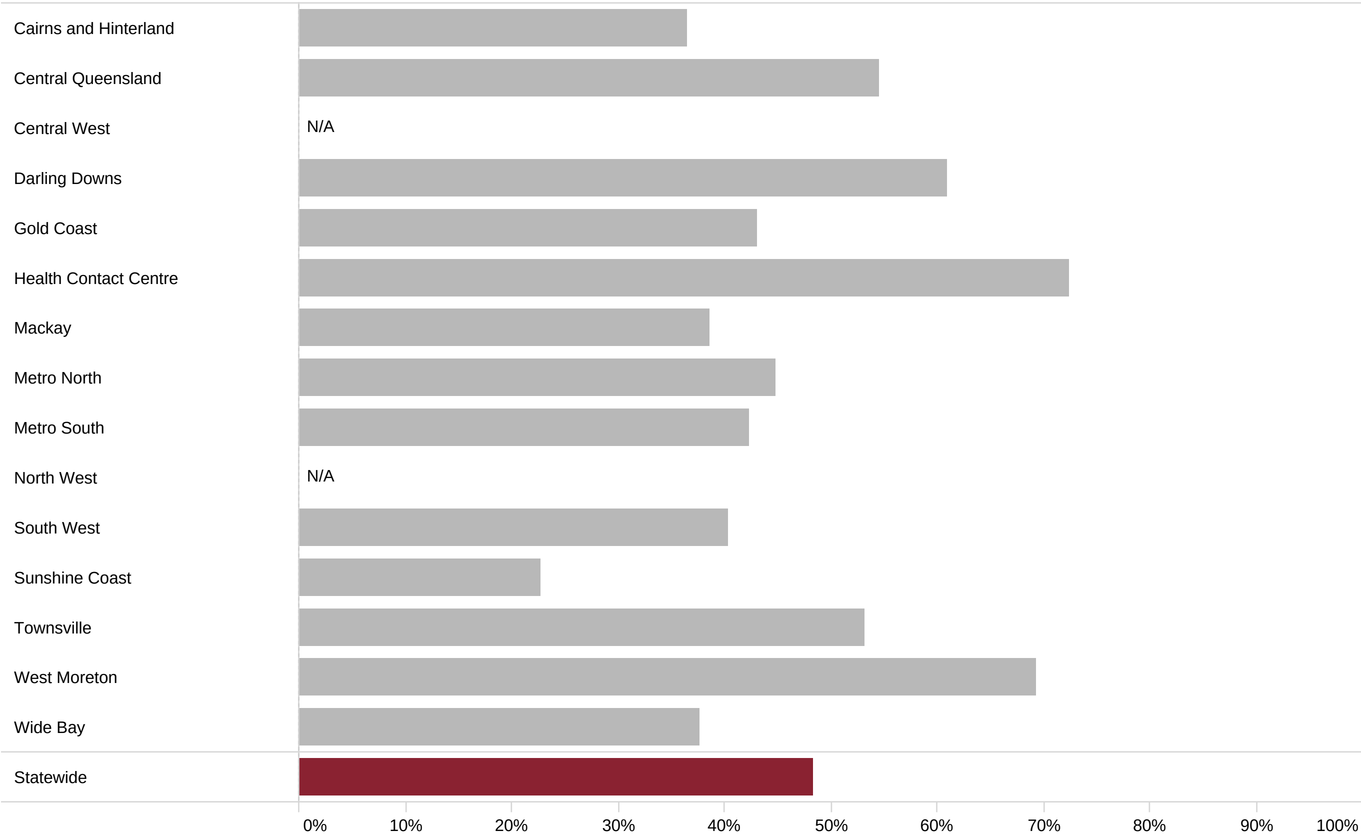
Completion rates and median time interval from pre assessment to post assessment varied considerably by HHS. The median time from pre assessment to post assessment was 82 days, with a range of 55 days to 142 days across outpatient HHS. There was considerable variation in the proportion of cases where a post assessment was completed, suggesting the model of care and data entry vary at a local level. A range of issues can contribute to completion of the post assessment which may include timing, patient availability or other factors outside the control of the program. In 2023, additional fields related to cardiac rehabilitation model of care have been added to the QCOR module, to provide additional information in future reports.

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

Table 7: Total post assessments completed by HHS

Outpatient HHS/division	Post assessment completed n (%)	Median time to post assessment days
Cairns and Hinterland	171 (36.5)	62
Central Queensland	330 (54.6)	81
Central West	3 (25.0)	N/A
Darling Downs	166 (61.0)	63
Gold Coast	351 (43.2)	59
Health Contact Centre	625 (72.4)	142
Mackay	76 (38.6)	84
Metro North	398 (44.9)	87
Metro South	386 (42.4)	70
North West	2 (4.3)	N/A
South West	23 (40.4)	101
Sunshine Coast	116 (22.7)	89
Townsville	85 (53.1)	71
West Moreton	300 (69.3)	55
Wide Bay	57 (37.7)	57
Statewide	**3,089 (48.4)**	**82**

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



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

Figure 8: Proportion of CR assessments proceeding to post assessment

6 Patient characteristics

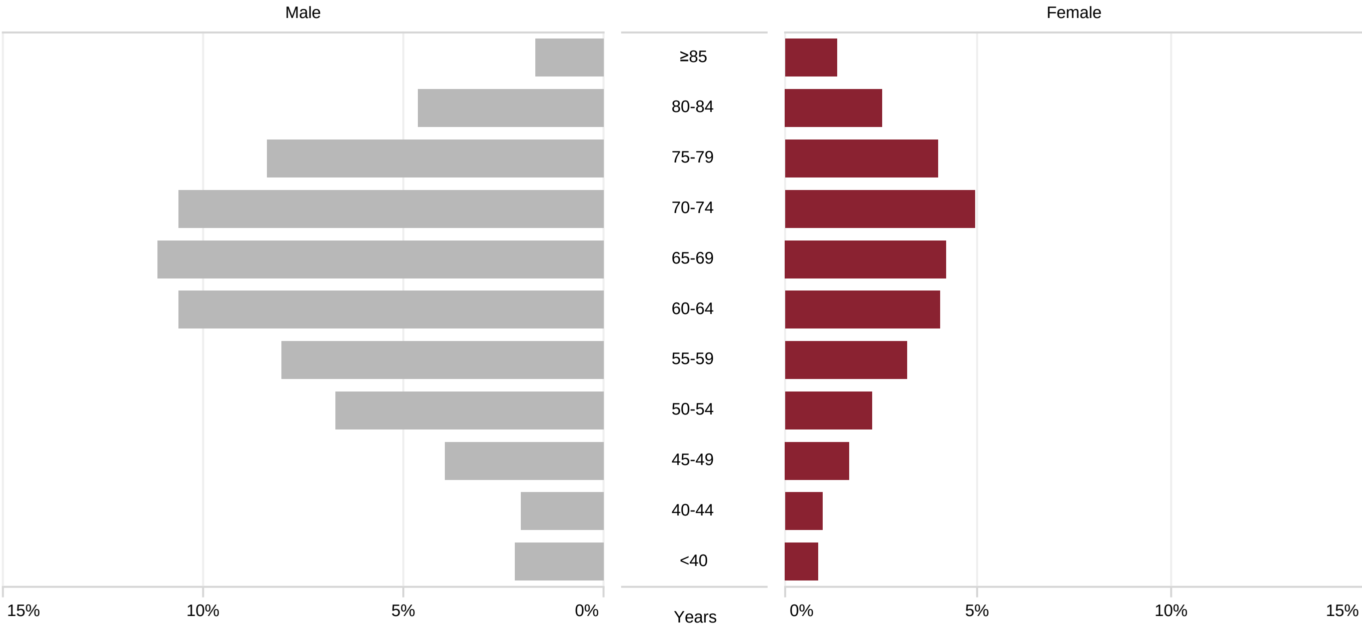
The following analysis examines the characteristics of the 9,317 patients who were referred to a public CR program. Largely these characteristics are similar to those reported over previous years.

6.1 Age and gender

Development of cardiovascular disease is related to age. Overall, 70% of patients were male and 30% 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).

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

These characteristics are similar to those observed in previous years.



% of total referrals (n=9,317)

Figure 9: Referrals by patient gender and age group

Table 8: Median patient age by gender and HHS

Outpatient HHS/division	**Male years**	**Female years**	**ALL years**
Cairns and Hinterland	64	65	65
Central Queensland	68	67	68
Central West	65	78	75
Darling Downs	64	67	66
Gold Coast	70	66	67
Health Contact Centre	68	64	65
Mackay	66	65	65
Metro North	69	67	68
Metro South	67	65	65
North West	57	59	59
South West	70	62	63
Sunshine Coast	68	68	68
Townsville	64	63	63
West Moreton	66	65	65
Wide Bay	66	69	68
Statewide	**68**	**66**	**66**

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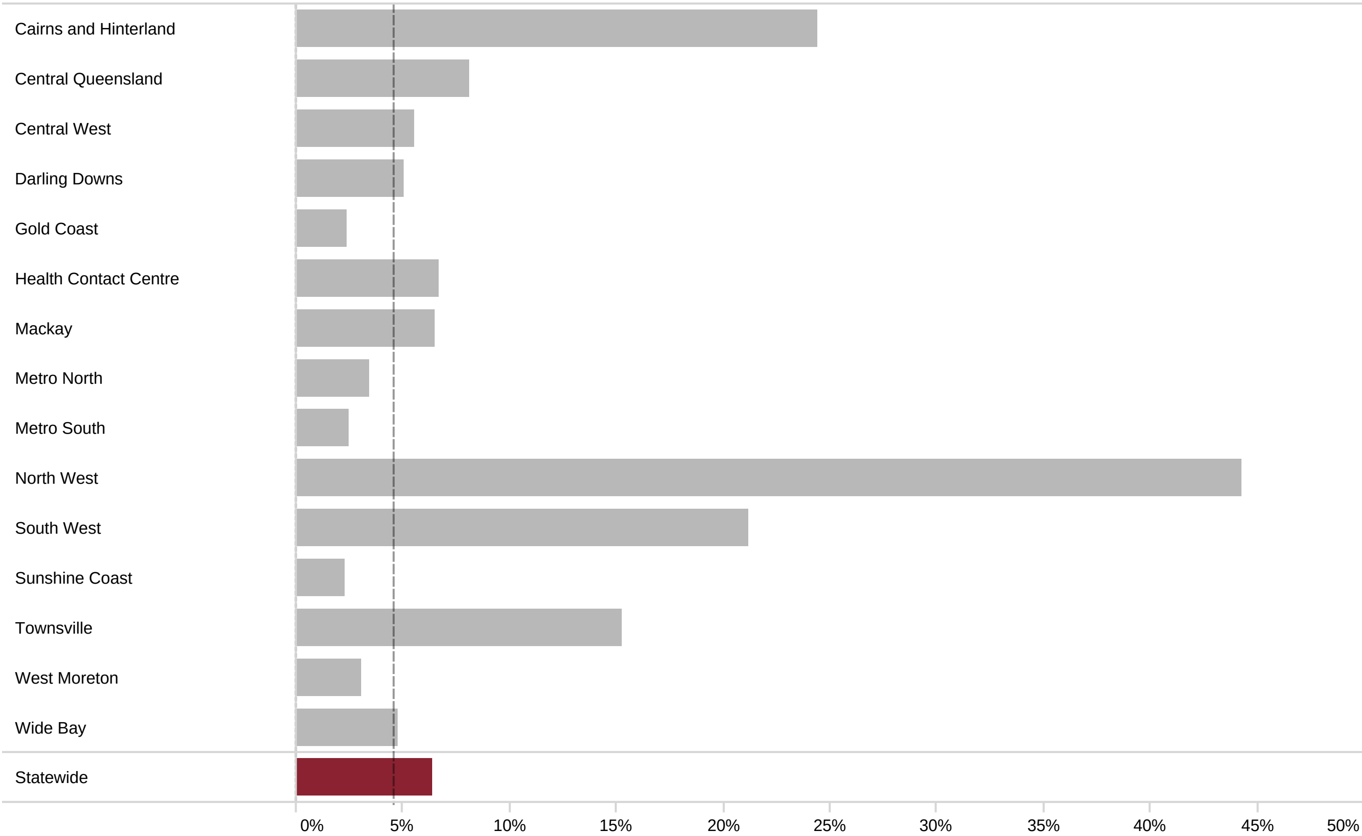
6.2 Aboriginal and Torres Strait Islander status

It is recognised that the Aboriginal and Torres Strait Islander population has a higher incidence and prevalence of coronary artery disease with ischaemic heart disease identified as the leading cause of death among Indigenous Australians in 2020.[1]

In this cohort, Aboriginal and Torres Strait Islander patients represent 6.4% of all statewide referrals with considerable variation observed across CR programs. By comparison, the estimated overall proportion of the Aboriginal and Torres Strait Islander population in Queensland is 4.6%.[2]



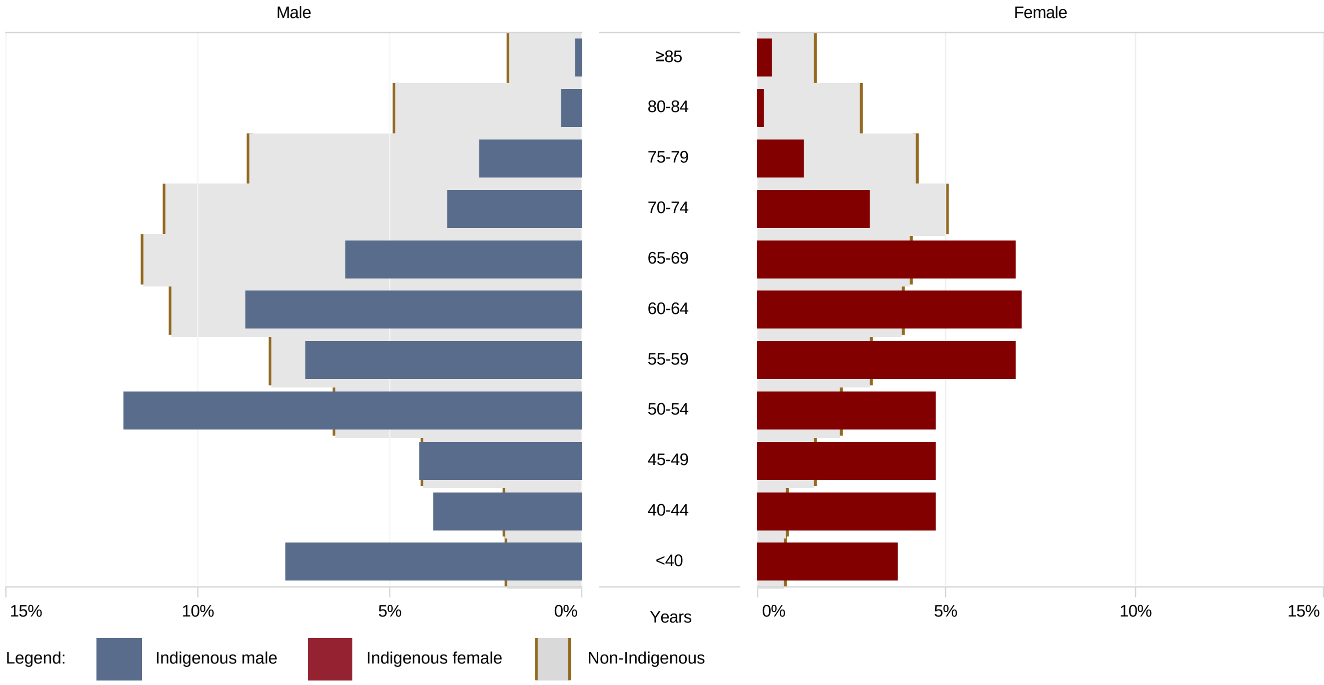
Excludes missing data (4.7%)

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

Cardiac Rehabilitation

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).

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



Excludes missing data (4.1%)

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

Table 9: Median patient age by gender and Indigenous status

	Male years	Female years	ALL years
Aboriginal and Torres Strait Islander	56	58	56
Non Aboriginal and Torres Strait Islander	66	68	67
ALL	**66**	**67**	**66**

Excludes missing data 4.7%

7 Clinical presentation

7.1 Diagnosis

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

The majority of pre assessments (68%) followed a previous diagnosis of ischaemic heart disease (IHD).

Table 10: Pre assessments by diagnosis category

Diagnosis category	n	%
Ischaemic heart disease*	4,332	67.9
Valvular disease	576	9.0
Other†	1,477	23.1
ALL	**6,385**	**100.0**

* STEMI, NSTEMI and angina

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

7.2 Most recent procedure

The most common procedure preceding a referral to CR was PCI. This was documented for 44% of all referrals and 58% of referrals for patients with IHD.

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

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

Most recent procedure	Ischaemic heart disease n (%)	Valvular disease n (%)	Other n (%)	ALL n (%)
PCI	2,515 (58.1)	5 (0.9)	311 (21.1)	2,831 (44.3)
Coronary angiogram	692 (16.0)	16 (2.8)	202 (13.7)	910 (14.3)
CABG	718 (16.6)	13 (2.3)	216 (14.6)	947 (14.8)
Valve procedure	7 (0.2)	464 (80.6)	97 (6.6)	568 (8.9)
Device procedure	11 (0.3)	2 (0.3)	93 (6.3)	106 (1.7)
CABG + valve procedure	54 (1.2)	52 (9.0)	23 (1.6)	129 (2.0)
Other	22 (0.5)	9 (1.6)	131 (8.9)	162 (2.5)
Not specified	313 (7.2)	15 (2.6)	404 (27.4)	732 (11.5)

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:

- The majority of patients (91%) had a history of abnormal cholesterol levels or had been prescribed lipid lowering therapy at the time of assessment. This ranged from 66% to 97% across diagnosis categories.
- Only 35% 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.
- The majority of patients were identified as having an unhealthy body mass index (BMI) with just over one fifth (21%) of patients having a BMI within the normal range.
- Overall, 27% of patients had diabetes as a comorbidity with some variation observed between diagnosis categories.
- Almost half (46%) of patients had a family history of cardiovascular disease.
- Overall, there were 18% of patients assessed by outpatient CR who were documented as having heart failure.
- Of the patients documented to have heart failure, 88% were classed as having a reduced ejection fraction (LVEF <50%).
- Over one quarter (29%) of patients had a documented history of depression.
- More than half of patients (60%) were identified as having a history of hypertension.
- There were 13% of patients identified as current smokers (defined as smoking within 30 days), while 46% were classed as former smokers. Patients with ischaemic heart disease were those with the highest rate of current smoking.

Table 12: Summary of risk factors by diagnosis category

Risk factor	Ischaemic heart disease %	Valvular disease %	Other %	ALL %
Abnormal cholesterol*	97.3	66.0	82.7	91.1
Activity level				
Sufficiently active	36.9	36.1	28.8	34.8
Insufficiently active	43.3	46.8	49.9	45.3
Inactive	19.7	17.2	21.3	19.9
Body mass index				
Normal range†	20.8	24.6	18.9	20.7
Overweight‡	38.4	34.5	34.2	37.1
Obese§	35.0	35.7	38.3	35.8
Morbidly obese‖	4.8	4.1	7.6	5.4
Diabetes	28.4	16.1	26.8	26.9
Family history of CVD#	47.8	32.9	44.2	45.6
Heart failure	14.6	13.0	30.9	18.2
Heart failure, LVEF**				
≥50%	5.9	28.8	17.2	11.7
40–49%	42.0	34.3	26.2	35.4
30–39%	39.1	24.7	33.2	35.8
<30%	13.1	12.3	23.4	17.0
History of depression	28.4	26.9	30.9	28.9
Hypertension	59.4	55.4	62.5	59.7
Smoking status				
Current smoker††	15.7	3.3	9.9	13.2
Former smoker	46.5	46.9	46.0	46.4
Never smoked	37.8	49.8	44.1	40.3

% from total complete data per case category

* Total cholesterol >4.0 mmol/L, HDL <1.0 mmol/L, LDL >2.0 mmol/L or triglycerides >2.0 mmol/L

† BMI 18.5–24.9 kg/m²

‡ BMI 25.0–29.9 kg/m²

§ BMI 30.0–39.9 kg/m²

‖ BMI ≥40.0 kg/m²

\# Cardiovascular disease

** Left ventricular ejection fraction

†† Within 30 days

7.4 Current medications

Over three quarters of patients were being treated with aspirin (83%) and lipid lowering medications (86%). As expected, there was variation in medication across diagnosis categories. Patients with IHD tended to use antiplatelet and sublingual nitrate medications more than patients with valvular disease. This is consistent with the different disease processes and respective treatment regimes.

Although these measures are not directly influenced by CR practitioners, these data are important to note for the overall care and treatment of cardiac disease.

Table 13: Current medications by diagnosis category

Medications	IHD %	Valvular disease %	Other %	ALL %
Aspirin	90.9	65.2	65.3	82.7
ACEI/ARB*	66.9	40.2	55.0	61.8
Antiplatelet	73.1	13.2	35.7	59.1
Anticoagulant	14.4	45.6	29.1	20.6
Beta blocker	68.7	54.6	64.4	66.4
Diabetic medications	25.3	14.3	24.4	24.1
Dual antiplatelet	68.1	7.8	28.0	53.4
Lipid lowering	92.9	58.1	75.6	85.8
Sublingual nitrate	60.6	4.5	24.8	47.3
Other	67.8	83.5	77.0	71.3

* Angiotensin converting enzyme inhibitor/angiotensin receptor blocker

8 Program outcomes

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

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

Table 14: Summary of program outcome measures

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

8.1 Lipid profile

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

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

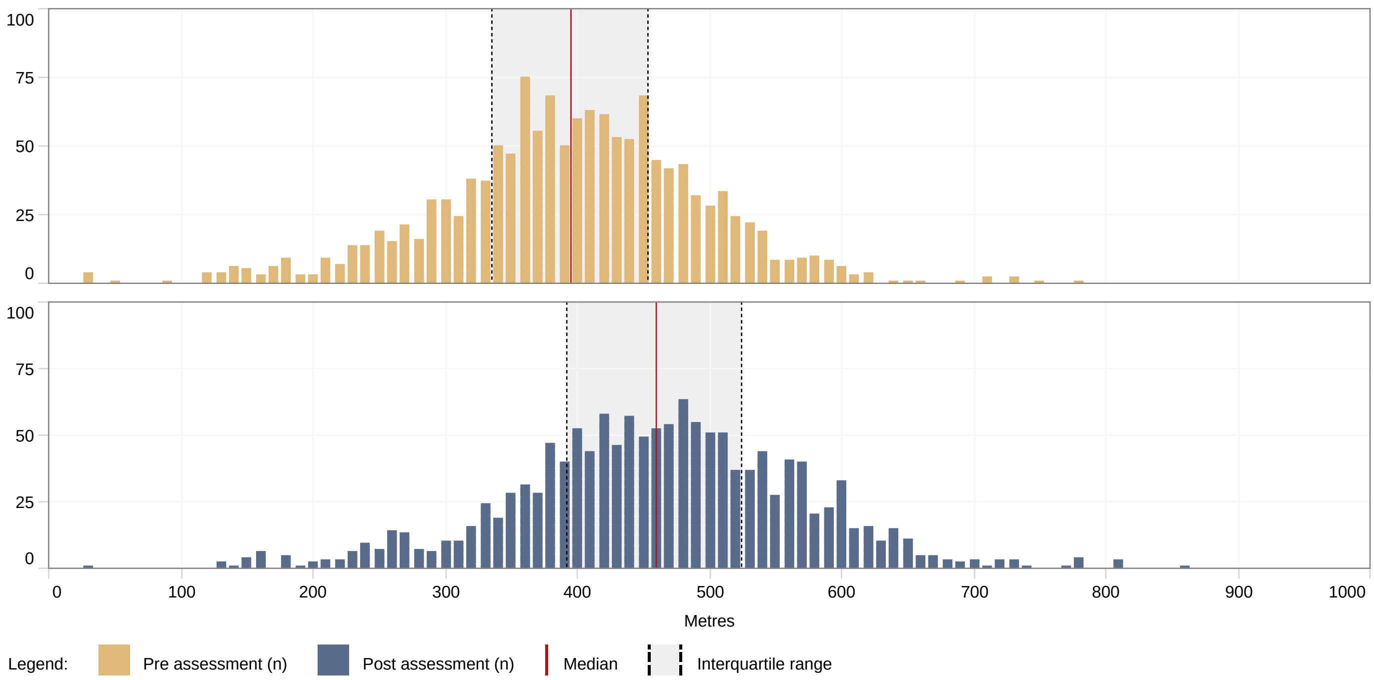
Table 15: Summary of lipid values

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Total cholesterol (mmol/L)	444	4.6 ± 1.4	3.4 ± 0.9	-1.2 ± 1.4
Triglycerides (mmol/L)	409	1.8 ± 1.2	1.5 ± 0.8	-0.3 ± 1.1
HDL-C (mmol/L)	368	1.1 ± 0.5	1.1 ± 0.5	0.0 ± 0.6
LDL-C (mmol/L)	356	2.7 ± 1.2	1.7 ± 0.7	-1.1 ± 1.2

8.2 Six minute walk test

A functional measure is commonly utilised prior to implementing an exercise program in order to determine exercise prescription and enable changes to be measured. The six minute walk test (6MWT) is a standardised investigation of submaximal exercise capacity that is often used in patients with cardiopulmonary disease. Changes in the six minute walk distance are useful in assessing functional capacity and the efficacy of therapeutic interventions such as pharmacotherapy and CR.[51]

There were 1,393 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. The majority of patients (76%) had a clinically significant improvement in 6MWT distance of greater than 25 metres with 56% recording an increase of greater than 50 metres (Table 17).



Results rounded to 10 metres

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

Table 16: Summary of six minute walk test results

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Distance travelled (metres)	1,393	391.1 ± 100.2	452.5 ± 116.0	61.4 ± 73.3

Table 17: Change in six minute walk test results

	n (%)
Improved ≥50 metres	779 (55.9)
Improved 26–49 metres	285 (20.5)
No change (±25 metres)	281 (20.2)
Worsened >25 metres	48 (3.4)
ALL	**1,393 (100.0)**

8.3 Patient reported outcome measures

Patient Health Questionnaire

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

The Patient Health Questionnaire-4 (PHQ-4) is a validated tool for screening anxiety and depressive disorders. [52] This instrument is a four item composite measure derived from the Generalised Anxiety Disorder-7 scale (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9). Each of the four items on the PHQ-4 is scored using a four point scale:

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

A total of 2,179 paired data were available for analysis. One third of patients (33%) demonstrated an improved PHQ-4 score at post assessment while 52% recorded no change to their PHQ-4 score. Given a large proportion of patients reported minimal depression and anxiety at the pre assessment there is often no scope for improvement via this metric.

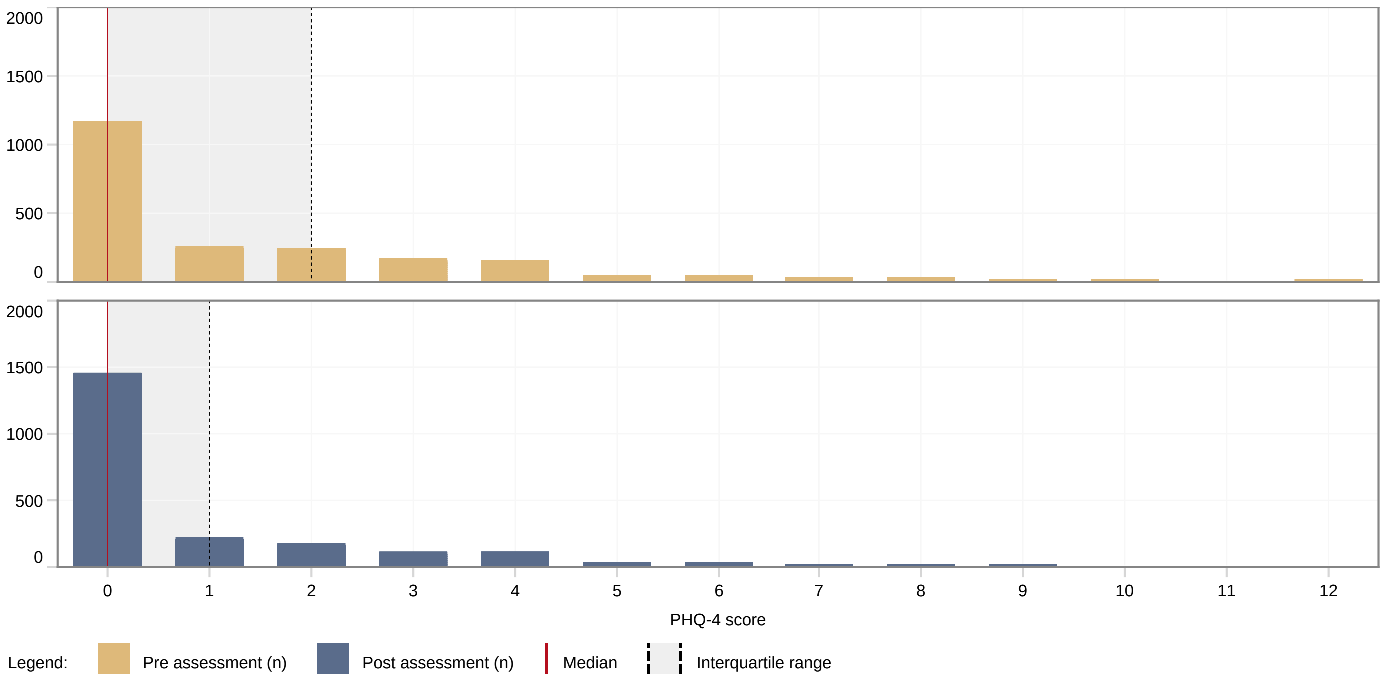


Figure 13: Comparison of pre assessment and post assessment PHQ-4 results

Table 18: Summary of PHQ-4 results

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Depression score (PHQ-2)	2179	0.7 ± 1.2	0.4 ± 1.0	-0.2 ± 1.2
Anxiety score (GAD-2)	2,179	0.8 ± 1.3	0.6 ± 1.1	-0.3 ± 1.3
Overall score	**2,179**	**1.5 ± 2.2**	**1.0 ± 1.9**	**-0.5 ± 2.1**

Table 19: Change in PHQ-4 results

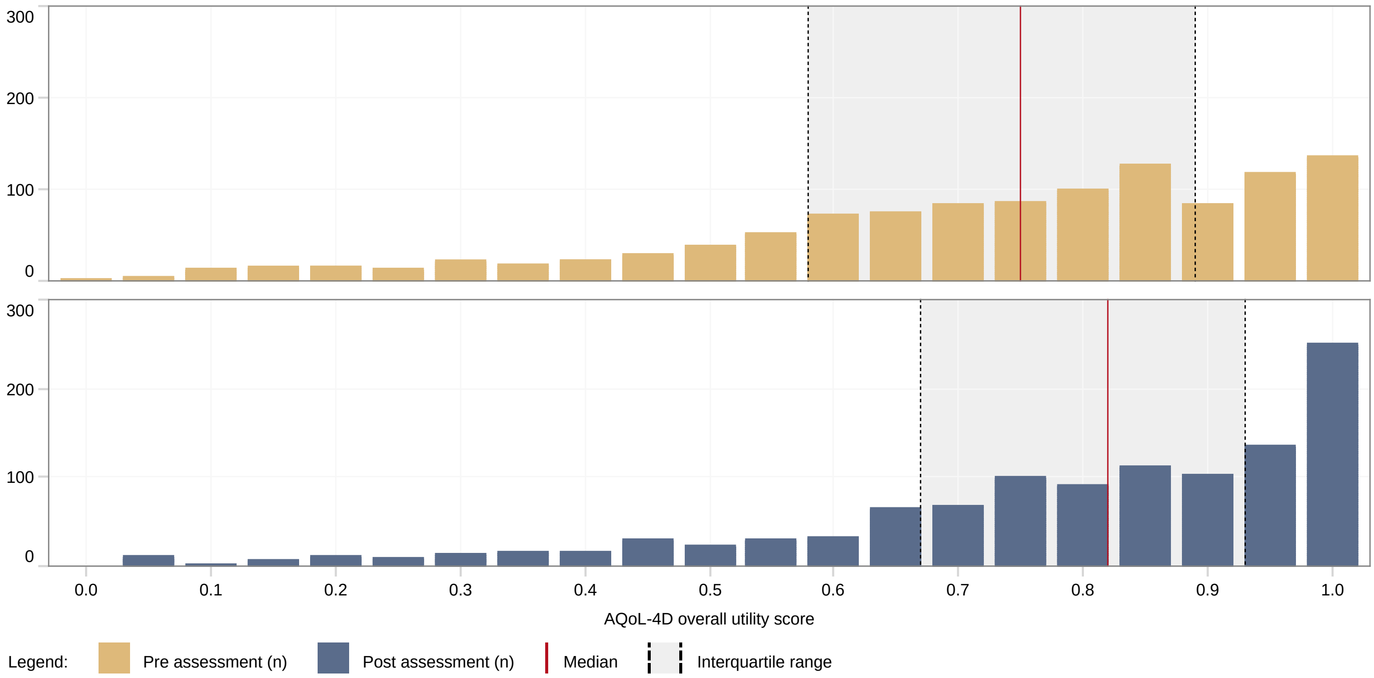
	n (%)
Any improvement	725 (33.3)
No change	1,131 (51.9)
Any worse result	323 (14.8)
ALL	**2,179 (100.0)**

Cardiac Rehabilitation

Assessment of Quality of Life

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

For the 1,135 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.[53] This utility score improved to 0.77 at the post assessment stage, where 60% of patients demonstrated an improved overall utility score after CR intervention (Table 20 and Table 21).



Results rounded to 0.05 utility score

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

Table 20: Summary of AQoL-4D results

	Total analysed n	Pre assessment Mean ± SD	Post assessment Mean ± SD	Change in value Mean ± SD
Independent living	1,135	0.88 ± 0.19	0.94 ± 0.13	0.06 ± 0.17
Relationships	1,135	0.91 ± 0.15	0.92 ± 0.15	0.01 ± 0.14
Senses	1,135	0.94 ± 0.08	0.94 ± 0.09	<0.01 ± 0.08
Mental health	1,135	0.90 ± 0.11	0.91 ± 0.11	0.01 ± 0.11
Overall score	**1,135**	**0.71 ± 0.23**	**0.77 ± 0.22**	**0.06 ± 0.21**

Table 21: Change in AQoL-4D results

	n (%)
Any improvement	685 (60.4)
No change	117 (10.3)
Any worse result	333 (29.3)
ALL	**1,135 (100.0)**

Other patient reported quality of life

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

The questions asked include:

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

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

Paired data on the condensed QOL survey were available for 1,305 assessments.

Self reported health

There were 48% of patients reporting a health status of very good or excellent at post assessment, compared with 17% at the pre assessment phase. Over half (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 11% of patients, however caution should be exercised when interpreting this result as there are many confounding factors which may affect the health status of a patient with what is often a newly diagnosed complex chronic disease.

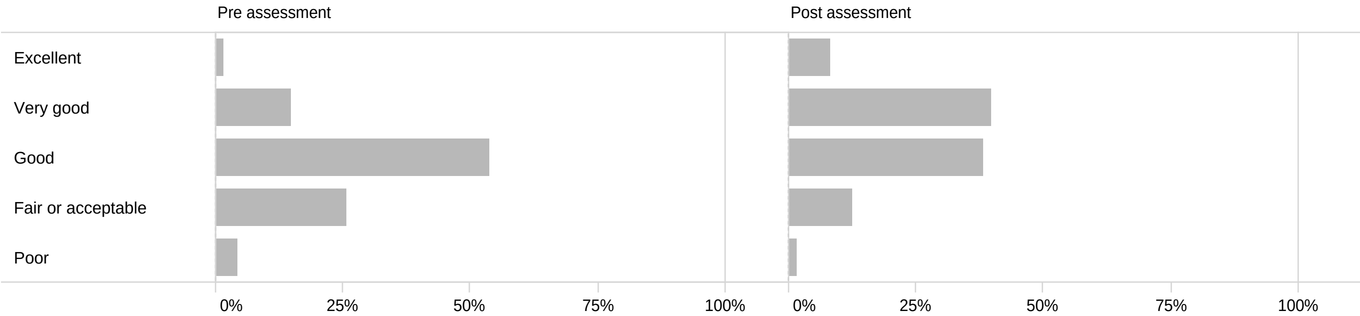


Figure 15: Comparison of patient reported health status at pre and post assessment

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

	n (%)
Any improvement	699 (53.6)
No change	467 (35.8)
Any worse result	139 (10.7)
ALL	**1305 (100.0)**

Self reported mood

Approximately half of patients (51%) reported an improved mood compared to the pre assessment stage. The proportion of patients reporting excellent mood scores at post assessment increased from 4% to 10%, while those with very good mood scores increased from 19% to 45%.

There were 10% of patients who reported a decrease in mood, however it is reassuring to note an overall decrease in the proportion of patients reporting fair or poor mood.

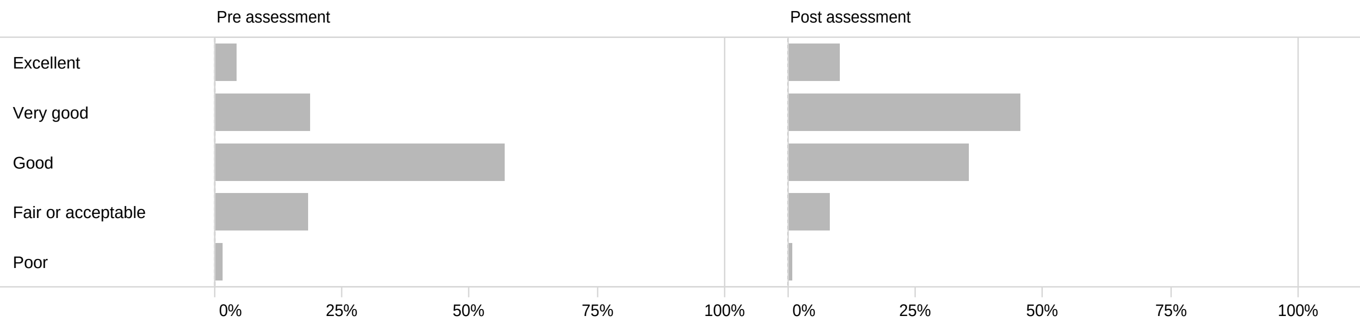


Figure 16: Comparison of patient reported mood at pre and post assessment

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

	n (%)
Any improvement	662 (50.7)
No change	508 (38.9)
Any worse result	135 (10.3)
ALL	**1,305 (100.0)**

Self reported fitness

When asked to compare fitness level to the period six months prior to completing a CR program, 43% of patients reported that their fitness had improved. Decreases in fitness were reported by 18% of patients.

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

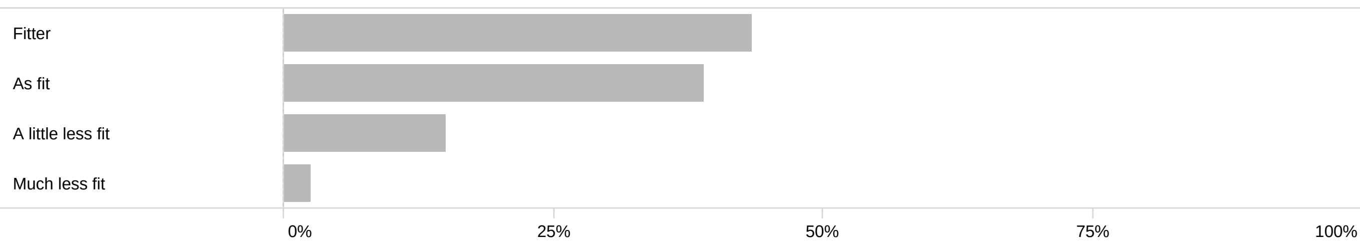


Figure 17: Patient reported change in fitness at post assessment

Table 24: Patient reported change in fitness at post assessment

	n (%)
Fitter	566 (43.4)
As fit	509 (39.0)
A little less fit	197 (15.1)
Much less fit	33 (2.5)
ALL	**1,305 (100.0)**

Other patient reported outcomes

Smoking

There were 3,049 patients where smoking status at pre assessment and post assessment was available for analysis. For the vast majority of patients (96%), smoking status was unchanged over the course of the CR program. However, there was a slight decrease in the proportion of patients reported as current smokers (defined as smoking within the last 30 days), with 10% of patients identified as current smokers at the time of the pre assessment, which decreased to 8% at the time of the post assessment.

The change in current smoking status includes 3% of patients who reported that they had ceased smoking between the CR pre assessment and post assessment. However, conversely, 1% of patients who identified as former smokers at pre assessment reported that they had relapsed at post assessment.

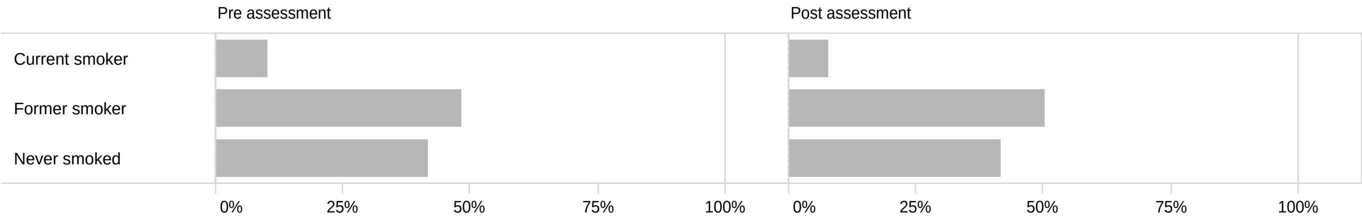


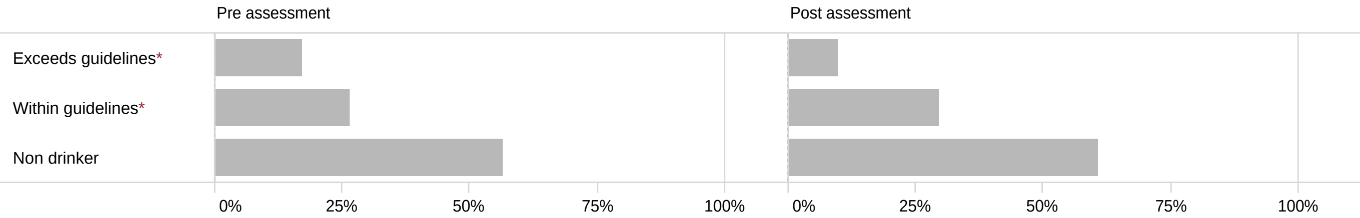
Figure 18: Patient reported smoking status at pre and post assessment

Table 25: Change in patient reported smoking status at pre and post assessment

	n (%)
Ceased smoking	96 (3.1)
No change to smoking status	2,926 (96.0)
Relapsed smoker	27 (0.9)
ALL	**3,049 (100.0)**

Alcohol consumption

Patient reported alcohol consumption was available for comparison between 2,464 pre and post assessments. Almost one fifth (17%) reported unhealthy levels of alcohol consumption (exceeding 10 standard drinks per week or more than 4 standard drinks on any single day)[54] at the time of the pre assessment, which had reduced to 10% at the time of the post assessment.



* No more than 10 standard drinks per week, and no more than 4 standard drinks any single day of the week

Figure 19: Patient reported alcohol consumption at pre and post assessment

Table 26: Patient reported alcohol consumption at pre and post assessment

	Pre assessment n (%)	Post assessment n (%)
Exceeds guideline	426 (17.3)	237 (9.6)
Within guideline	651 (26.4)	732 (29.7)
Non drinker	1,387 (56.3)	1,495 (60.7)
ALL	**2,464 (100.0)**	**2,464 (100.0)**

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Activity level

There were 2,462 patients for whom self reported activity level could be compared between the pre and post assessment. Approximately half of all patients (49%) reported an increased activity level following the completion of their CR program, with almost three quarters (73%) reporting sufficient levels of physical activity at the post assessment compared to 35% at the pre assessment.

The proportion of patients reported as inactive decreased from 18% at the pre assessment to 2% at the post assessment.

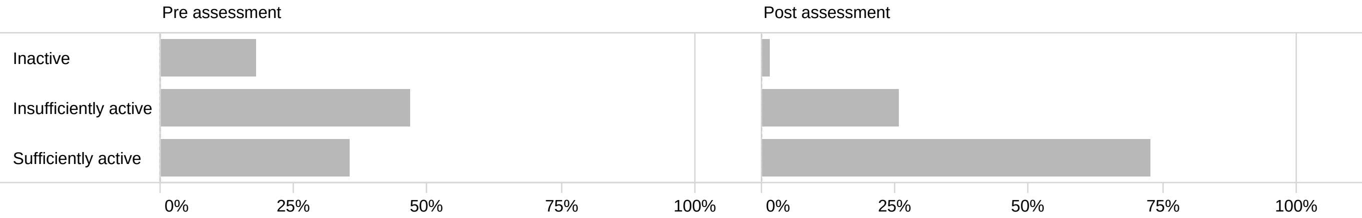


Figure 20: Patient reported activity level at pre and post assessment

Table 27: Change in patient reported activity level at pre and post assessment

	n (%)
Improved	1,196 (48.6)
No change	1,167 (47.4)
Worsened	99 (4.0)
ALL	**2,462 (100.0)**

8.4 Failure to participate

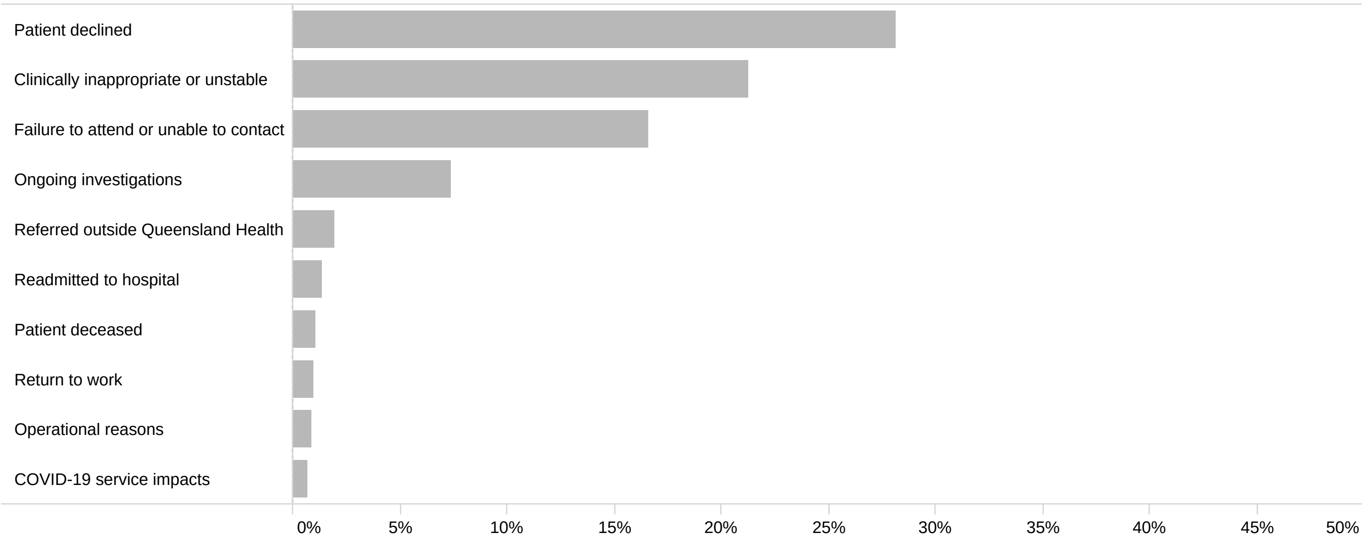
There are many reasons a patient may not participate in a CR program. In this cohort, which includes patients who declined or were unsuitable during phase 1 and phase 2, the most common reason for not participating in a CR program was that the patient had declined (28%). Twenty one percent were medically inappropriate to participate, while 17% had been uncontactable or failed to attend.

For 2022 referrals, 1% were recorded as declined due to impacts of the global COVID-19 pandemic such as compulsory service closures, staff redeployment and patient unwillingness to proceed. While this is unchanged from the 2021 data, this may not reflect the true impact of COVID-19 on CR participation. During 2022, some CR programs were temporarily unavailable due to service closure. This may have resulted in referrals being redirected to other sites or patients declining to be referred while their closest site was not accepting referrals.

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

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

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



Not displaying other reasons (18%)

Figure 21: Reasons for no pre assessment being conducted

Cardiac Rehabilitation

8.4.1 Age and gender

There was considerable variation in patient age when comparing patients who participated in CR as opposed to patients who declined or were not interested and patients who were medically unsuitable. Patients who participated in CR had a median age of 66 years, whilst patients who declined or were medically unsuitable had a median age four years older and three years older respectively.

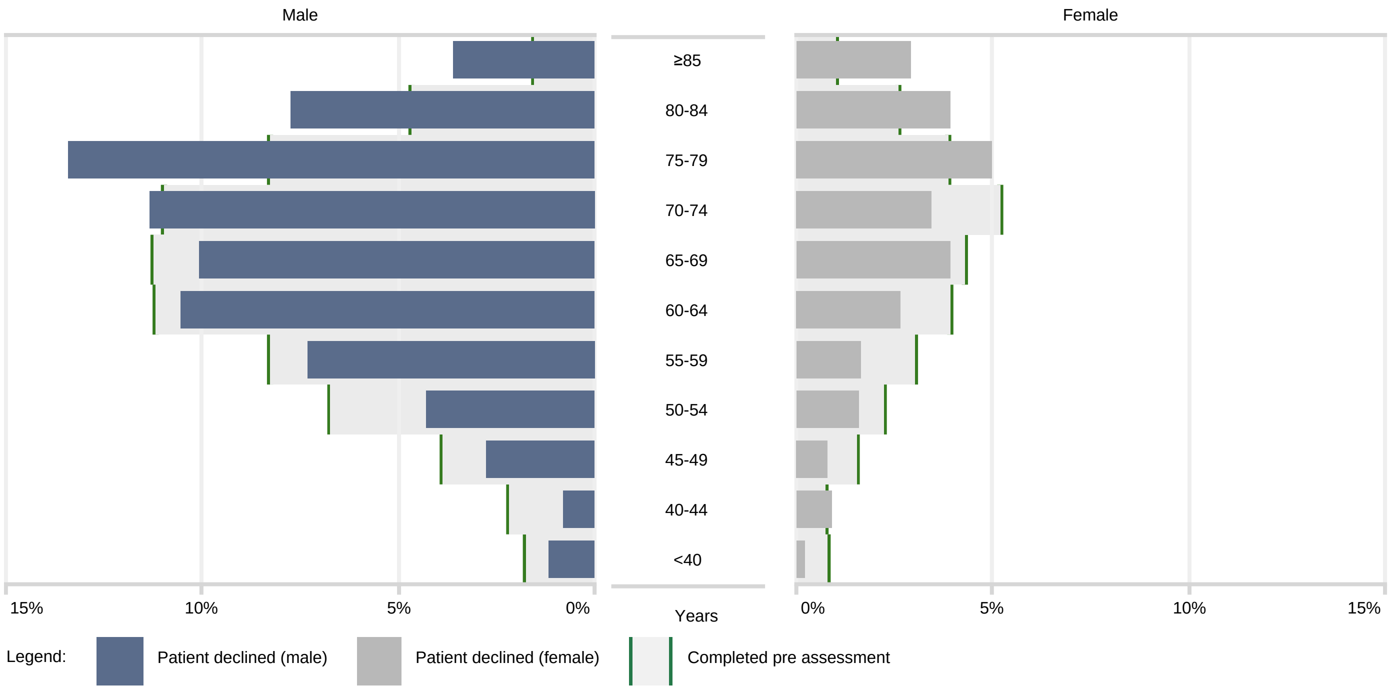


Figure 22: Patient age group and gender, patient declined vs. completed pre assessment

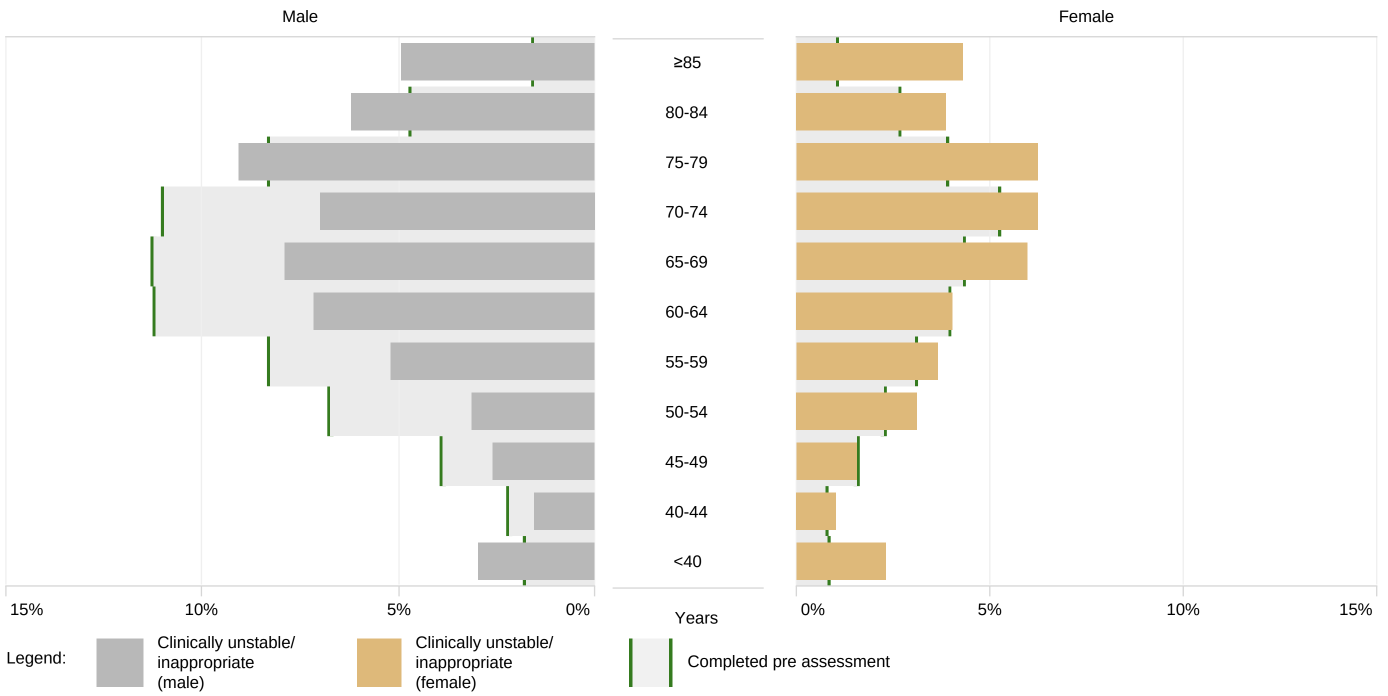


Figure 23: Patient age group and gender, clinically unstable/inappropriate vs. completed pre assessment

Table 28: Patient age (years) by program participation status

	Male Median (IQR)	Female Median (IQR)	ALL Median (IQR)
Pre assessment completed	65 (57–73)	67 (58–75)	66 (57–74)
Patient declined	69 (60–77)	72 (62–80)	70 (61–78)
Clinically unstable or inappropriate	69 (58–77)	69 (58–77)	69 (58–77)
Other reason not assessed	65 (56–74)	67 (56–75)	65 (56–74)

Table 29: Patient gender by program participation status

Gender	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
Male	4,511 (62.8)	747 (10.4)	445 (6.2)	1,478 (20.6)
Female	1,874 (59.8)	275 (8.8)	326 (10.4)	660 (21.1)
ALL	**6,385 (61.9)**	**1,022 (9.9)**	**771 (7.5)**	**2,138 (20.7)**

8.4.2 Diagnosis category

Of the patients who declined, 41% had a diagnosis of ischaemic heart disease and approximately 6% had valvular disease. The majority (54%) had an other diagnosis. By comparison, patients who had completed an initial assessment via CR were more likely to have a diagnosis of ischaemic heart disease or valvular heart disease (68% and 9% respectively).

Patients without IHD or valvular disease were least likely to commence a CR program, with 16% of these referrals declined by the patient and 14% declined by the service as they were not appropriate for cardiac rehabilitation.

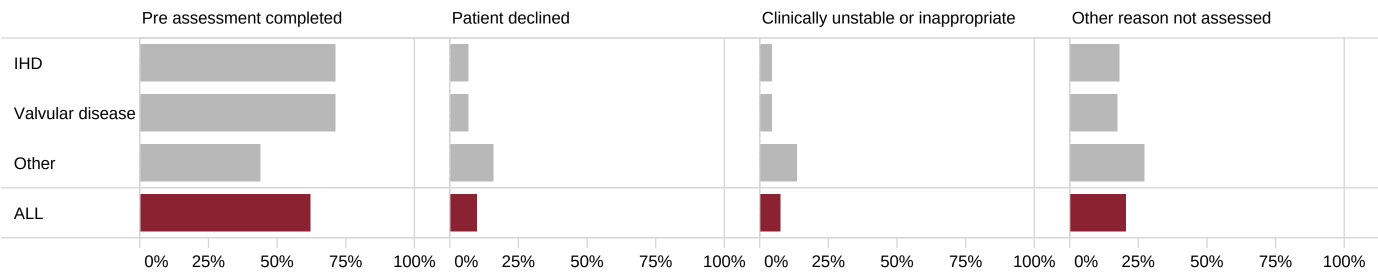


Figure 24: Proportion of cases by diagnosis category and program participation status

Table 30: Diagnosis category by program participation status

Diagnosis category	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
IHD	4,332 (70.9)	417 (6.8)	276 (4.5)	1,084 (17.7)
Valvular disease	576 (71.2)	57 (7.0)	35 (4.3)	141 (17.4)
Other	1,477 (43.5)	548 (16.1)	460 (13.5)	913 (26.9)
ALL	**6,385 (61.9)**	**1,022 (9.9)**	**771 (7.5)**	**2,138 (20.7)**

8.4.3 Most recent procedure

For the cohort that proceeded to assessment, their most recent procedure was closely related to their participation status. 76% of patients who had a PCI procedure and 84% of patients who underwent CABG completed a pre assessment. This suggests that patients who have undergone an invasive cardiac procedure are more likely to have participated in a CR program.

Approximately half (52%) of patients who declined CR had no recent procedure specified. Furthermore, 23% of patients that elected not to participate in CR were recorded as having undergone PCI, while approximately 7% had undergone CABG (with or without a concomitant valve procedure).

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

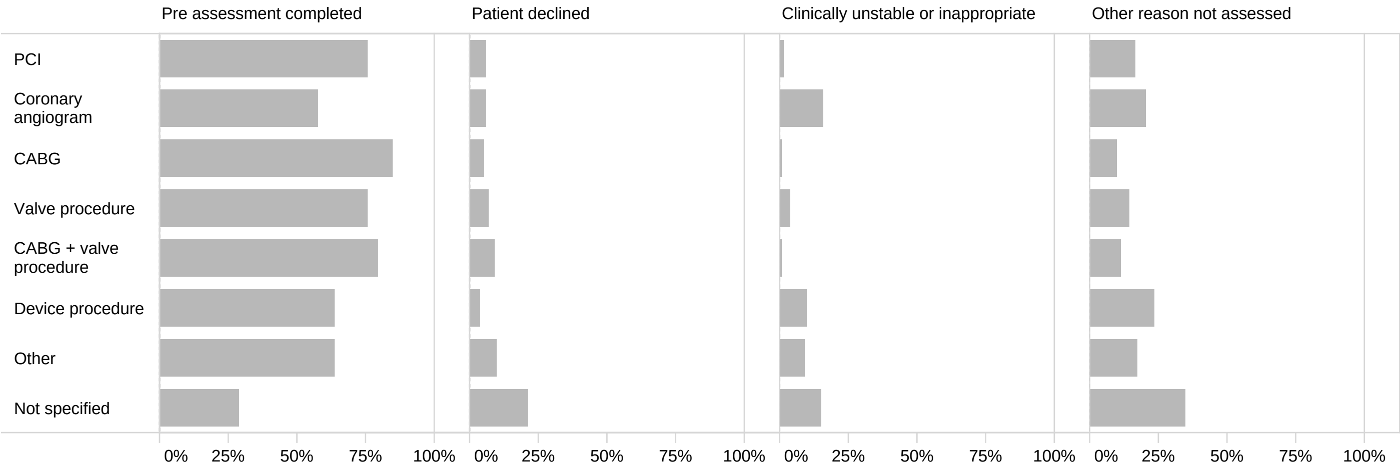


Figure 25: Proportion of referrals by most recent procedure and program participation status

Table 31: Most recent procedure by program participation status

Most recent procedure	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
PCI	2,831 (75.7)	238 (6.4)	62 (1.7)	609 (16.3)
Coronary angiogram	910 (57.5)	95 (6.0)	253 (16.0)	324 (20.5)
CABG	947 (84.4)	60 (5.3)	7 (0.6)	108 (9.6)
Valve procedure	568 (75.6)	51 (6.8)	27 (3.6)	105 (14.0)
CABG + valve procedure	129 (79.1)	15 (9.2)	1 (0.6)	18 (11.0)
Device procedure	106 (63.5)	6 (3.6)	16 (9.6)	39 (23.4)
Other	162 (63.8)	24 (9.4)	23 (9.1)	45 (17.7)
Not specified	732 (28.9)	533 (21.0)	382 (15.1)	890 (35.1)
ALL	**6,385 (61.9)**	**1,022 (9.9)**	**771 (7.5)**	**2,138 (20.7)**

8.4.4 Place of residence

There was some variation in patient participation in CR based on place of residence, with higher proportions of patients who did not attend CR residing in regional and remote areas of Queensland.

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

Table 32: Remoteness classification by program participation status

Remoteness area*	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
Major cities	3,479 (64.9)	569 (10.6)	264 (4.9)	1,045 (19.5)
Inner regional	1,738 (63.4)	260 (9.5)	165 (6.0)	579 (21.1)
Outer regional	948 (53.2)	160 (9.0)	282 (15.8)	391 (22.0)
Remote	65 (43.3)	14 (9.3)	20 (13.3)	51 (34.0)
Very remote	144 (60.0)	10 (4.2)	34 (14.2)	52 (21.7)
ALL	**6,374 (62.1)**	**1,013 (9.9)**	**765 (7.4)**	**2,118 (20.6)**

Excludes missing data (0.4%)

* Classified by Australian Statistical Geography Standard remoteness area

8.4.5 Indigenous status

Considerable variation in program participation was observed for Aboriginal and Torres Strait Islander patients when compared to patients of other descent. Less than half (47%) of Aboriginal and Torres Strait Islander patients participated in the initial CR pre assessment, compared to 63% of other patients.

This finding should be noted and considered as a potential focus for future service improvement activities.

Table 33: Program participation by Indigenous status

Indigenous status	Pre assessment completed n (%)	Patient declined n (%)	Clinically unstable or inappropriate n (%)	Other reason not assessed n (%)
Indigenous	326 (46.8)	49 (7.0)	100 (14.3)	222 (31.9)
Non-Indigenous	5,750 (62.6)	926 (10.1)	646 (7.0)	1,857 (20.2)
ALL	**6,076 (61.5)**	**975 (9.9)**	**746 (7.6)**	**2,079 (21.1)**

Excludes missing data (4.3%)

9 Clinical indicators

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

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

Table 34: 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

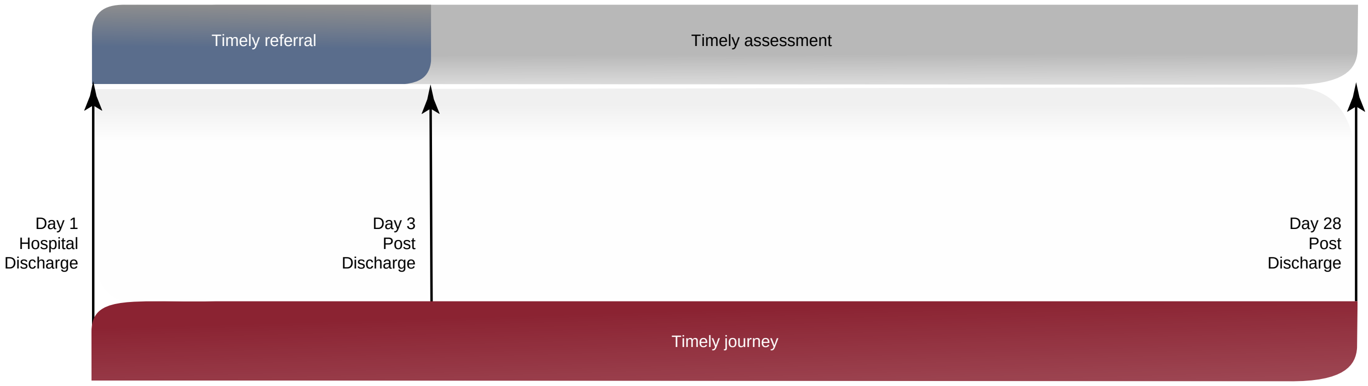


Figure 26: Timely referral, assessment and overall journey for inpatient referrals

Cardiac Rehabilitation

9.1 Timely referral

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

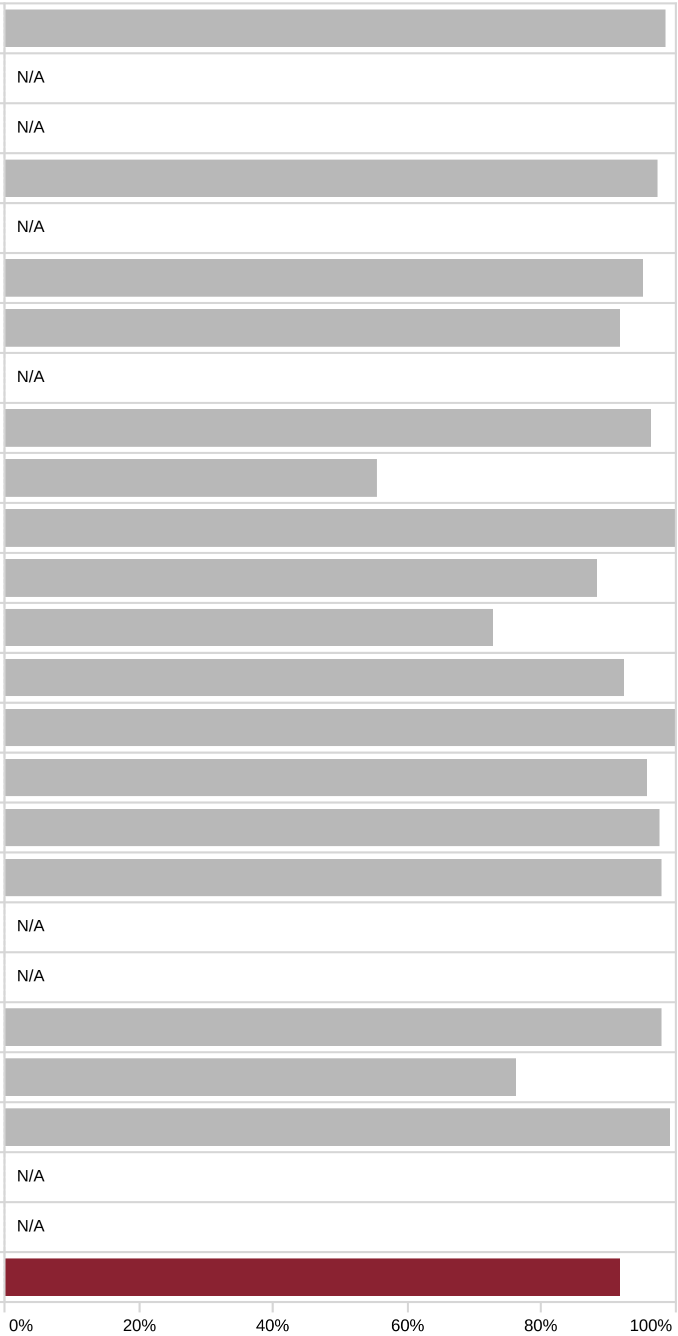
Overall, performance is high with 92% of referrals contributed to QCOR being submitted within three days of discharge.

Table 35: Timely referrals by referring HHS

Referring HHS/organisation	Total inpatient referrals n	Total eligible for analysis n	Target met n (%)
Cairns and Hinterland	517	510	502 (98.4)
Central Queensland	238	217	210 (96.8)
Darling Downs	84	81	77 (95.1)
Gold Coast	784	777	713 (91.8)
Mackay	163	156	150 (96.2)
Mater Health Services	84	83	46 (55.4)
Metro North	1,816	1,802	1,575 (87.4)
Metro South	1,752	1,731	1,660 (95.9)
North West	1	1	N/A
Sunshine Coast	640	625	610 (97.6)
Townsville	509	506	385 (76.1)
West Moreton	128	126	125 (99.2)
Wide Bay	3	3	N/A
Statewide	**6,719**	**6,618**	**6,057 (91.5)**

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

Referred by HHS	Referred by hospital	Total analysed, n	
Cairns and Hinterland	Cairns Hospital	510	
Central Queensland	Capricorn Coast Hospital	1	N/A
	Gladstone Hospital	1	N/A
	Rockhampton Hospital	215	
Darling Downs	Chinchilla Hospital	1	N/A
	Toowoomba Hospital	80	
Gold Coast	Gold Cost University Hospital	776	
	Robina Hospital	1	N/A
Mackay	Mackay Base Hospital	156	
Mater Health Services	Mater Hospital Brisbane	83	
Metro North	Caboolture Hospital	90	
	Redcliffe Hospital	34	
	Royal Brisbane & Women's Hospital	476	
	The Prince Charles Hospital	1,202	
Metro South	Logan Hospital	36	
	Princess Alexandra Hospital	1,571	
	Queen Elizabeth II Jubilee Hospital	77	
	Redland Hospital	47	
North West	Mount Isa Base Hospital	1	N/A
Sunshine Coast	Gympie Hospital	1	N/A
	Sunshine Coast University Hospital	624	
Townsville	Townsville University Hospital	506	
West Moreton	Ipswich Hospital	126	
Wide Bay	Bundaberg Base Hospital	1	N/A
	Gayndah Hospital	2	N/A
Statewide			



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

Figure 27: Timely referrals by referring hospital

Cardiac Rehabilitation

9.2 Timely assessment – inpatients

This indicator examines the proportion of referrals to CR which proceed to an assessment within 28 days of discharge. In order to retain focus on the performance of the outpatient CR program, referrals which are not provided in a timely manner (<3 days from discharge) have been excluded from the analysis. Further to this, other ineligibility criteria are outlined in Table 36. The exclusions are applied where information is available and has been documented in the application.

Overall, more than half of all patients (58%) are being assessed in a timely manner, however there was some variation across health services.

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

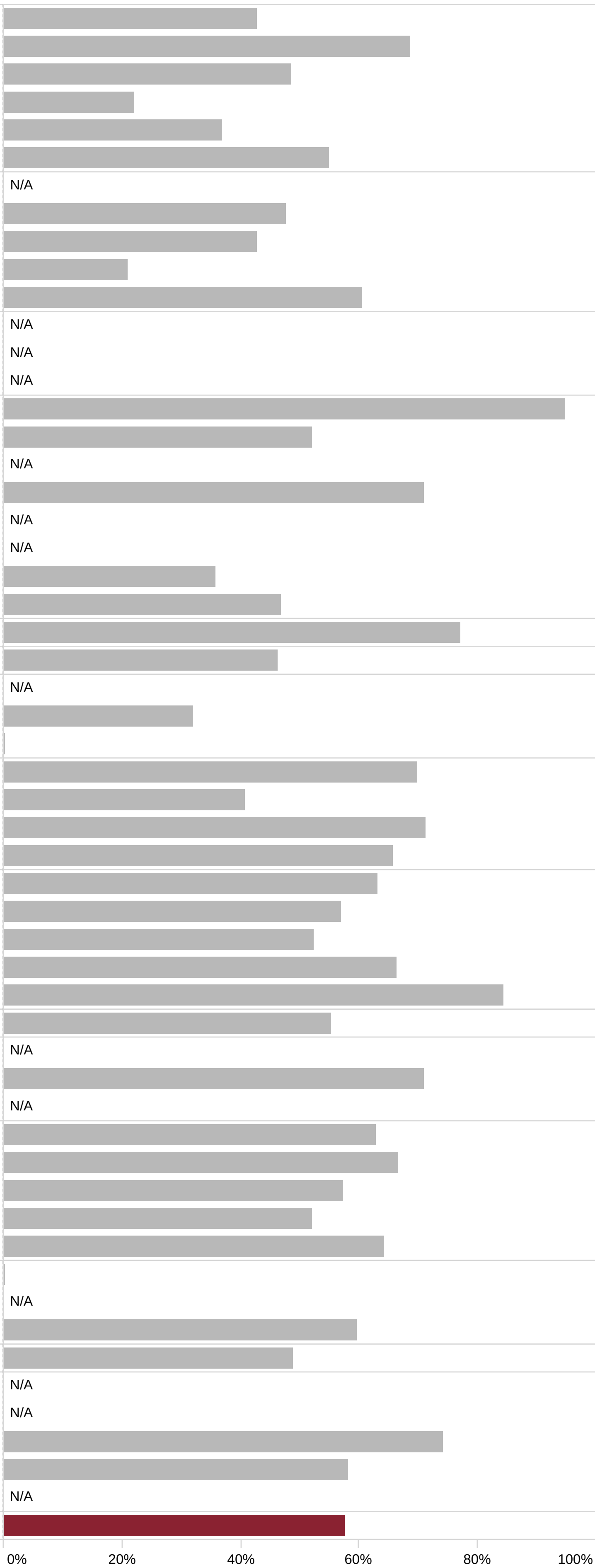
Summary	n
Not referred within 3 days of discharge	518
Clinically unstable/inappropriate	108
Same day admission	98
Patient accepted onto existing program	67
Referred outside of Queensland Health	47
Patient readmitted to hospital	42
Patient deceased	31
Total ineligible	**911**

Table 37: 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	545	491	298 (60.7)
Central Queensland	394	313	162 (51.8)
Central West	13	9	N/A
Darling Downs	272	236	106 (44.9)
Gold Coast	785	671	516 (76.9)
Health Contact Centre	1,113	921	425 (46.1)
Mackay	209	179	49 (27.4)
Metro North	840	739	454 (61.4)
Metro South	915	817	524 (64.1)
North West	33	29	16 (55.2)
South West	30	29	20 (69.0)
Sunshine Coast	743	662	401 (60.6)
Townsville	246	191	87 (45.5)
West Moreton	421	383	187 (48.8)
Wide Bay	160	138	95 (68.8)
Statewide	**6,719**	**5,808**	**3,340 (57.5)**

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

Outpatient HHS/division	Outpatient program	Total analysed, n	
Cairns and Hinterland	Atherton	44	
	Cairns	384	
	Innisfail	37	
	Mareeba	30	
	Mossman	21	
	Tully	22	
Central Queensland	Biloela	3	N/A
	Capricorn Coast	47	
	Gladstone	69	
	Mount Morgan	28	
	Rockhampton	226	
Central West	Barcaldine	2	N/A
	Blackall	3	N/A
	Longreach	7	N/A
Darling Downs	Chinchilla-Miles	21	
	Dalby-Tara	27	
	Goondiwindi	13	N/A
	Kingaroy	24	
	Stanthorpe	11	N/A
	Texas OPCR program	1	N/A
	Toowoomba	135	
	Warwick	36	
Gold Coast	Gold Coast	779	
Health Contact Centre	SMoCC	1,100	
Mackay	Bowen	7	N/A
	Mackay	170	
	Proserpine	25	
Metro North	Caboolture	261	
	Chermside	237	
	North Lakes	250	
	Redcliffe	87	
Metro South	Bayside	249	
	Eight Mile Plains	125	
	Inala	91	
	Logan-Beaudesert	367	
	Princess Alexandra Hospital	73	
North West	Mt Isa	33	
South West	Charleville	3	N/A
	Roma	25	
	St George	2	N/A
Sunshine Coast	Caloundra	192	
	Gympie	153	
	Maroochydore	155	
	Nambour	134	
	Noosa	95	
Townsville	Ayr	27	
	Ingham	19	N/A
	Townsville	197	
West Moreton	Ipswich	416	
Wide Bay	Biggenden	3	N/A
	Gayndah	5	N/A
	Hervey Bay	93	
	Maryborough	54	
	Mundubbera	3	N/A
Statewide			



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

Figure 28: Timely assessment by outpatient program – inpatients

Cardiac Rehabilitation

9.3 Timely assessment – non acute patients

This indicator examines the proportion of referrals from the non acute setting which proceed to an assessment within 28 days of referral. The majority of non acute patients (64%) are being assessed in a timely manner, with some notable variation between health services.

Table 38: Summary of referrals ineligible for timely assessment clinical indicator – non acute patients

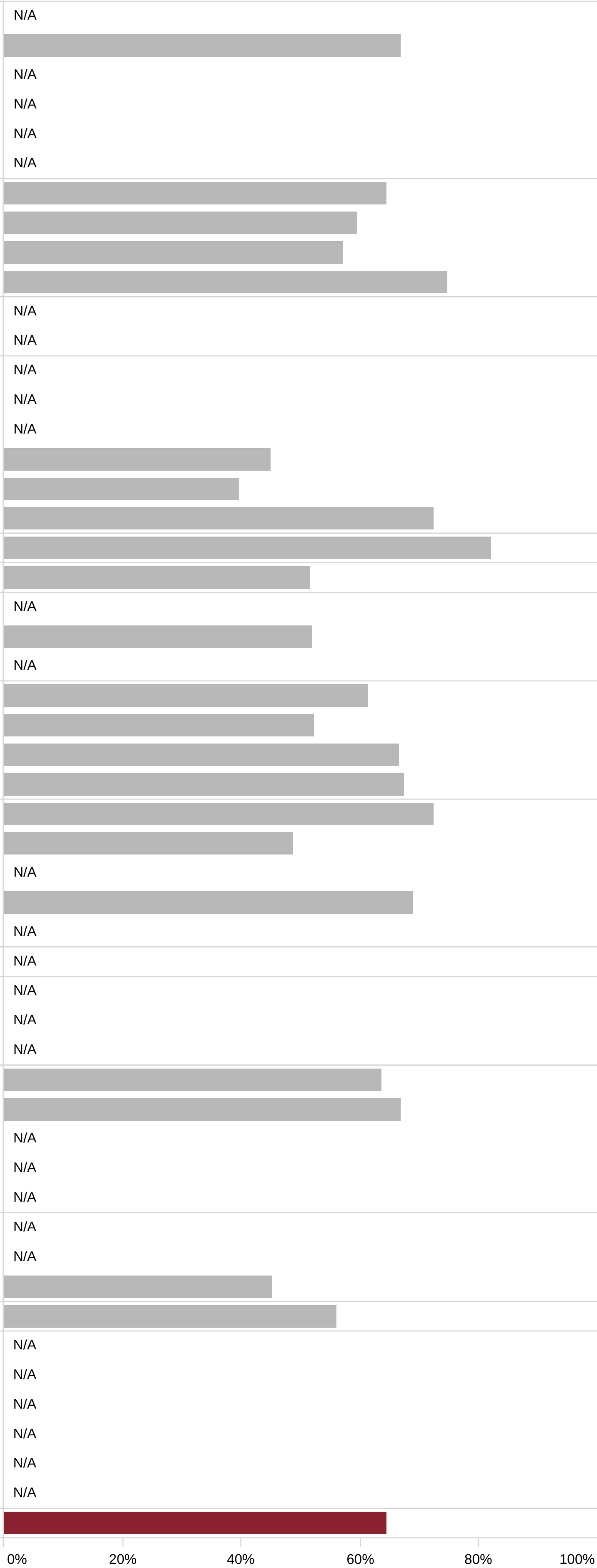
Summary	n
Clinically unstable/inappropriate	25
Referred outside of Queensland Health	23
Patient accepted onto an existing program	12
Patient deceased	7
Patient admitted to hospital	6
Total ineligible	**73**

Table 39: 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	94	91	66 (72.5)
Central Queensland	483	471	319 (67.7)
Central West	5	5	N/A
Darling Downs	143	140	76 (54.3)
Gold Coast	282	267	219 (82.0)
Health Contact Centre	155	153	79 (51.6)
Mackay	84	83	42 (50.6)
Metro North	450	436	274 (62.8)
Metro South	413	404	264 (65.3)
North West	19	18	N/A
South West	36	35	29 (82.9)
Sunshine Coast	100	94	60 (63.8)
Townsville	68	68	29 (42.6)
West Moreton	234	230	129 (56.1)
Wide Bay	32	30	25 (83.3)
Statewide	**2,598**	**2,525**	**1,624 (64.3)**

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

Outpatient HHS/division	Outpatient program	Total analysed, n	
Cairns and Hinterland	Atherton	14	N/A
	Cairns	36	
	Innisfail	18	N/A
	Mareeba	8	N/A
	Mossman	8	N/A
	Tully	7	N/A
Central Queensland	Capricorn Coast	101	
	Gladstone	89	
	Mount Morgan	49	
	Rockhampton	232	
Central West	Barcaldine	1	N/A
	Blackall	4	N/A
Darling Downs	Chinchilla-Miles	9	N/A
	Dalby-Tara	15	N/A
	Goondiwindi	2	N/A
	Kingaroy	20	
	Toowoomba	58	
	Warwick	36	
Gold Coast	Gold Coast	267	
Health Contact Centre	SMoCC	153	
Mackay	Bowen	1	N/A
	Mackay	81	
	Proserpine	1	N/A
Metro North	Caboolture	121	
	Chermside	71	
	North Lakes	161	
	Redcliffe	83	
Metro South	Bayside	177	
	Eight Mile Plains	78	
	Inala	14	N/A
	Logan-Beaudesert	128	
	Princess Alexandra Hospital	7	N/A
North West	Mt Isa	18	N/A
South West	Charleville	10	N/A
	Roma	12	N/A
	St George	13	N/A
Sunshine Coast	Caloundra	33	
	Gympie	21	
	Maroochydore	16	N/A
	Nambour	13	N/A
	Noosa	11	N/A
Townsville	Ayr	2	N/A
	Ingham	2	N/A
	Townsville	64	
West Moreton	Ipswich	230	
Wide Bay	Biggenden	7	N/A
	Eidsvold	2	N/A
	Gayndah	4	N/A
	Hervey Bay	5	N/A
	Maryborough	5	N/A
	Mundubbera	7	N/A
Statewide			



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

Figure 29: Timely assessment by outpatient program – non acute patients

9.4 Timely journey

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

Referrals are excluded from the analysis for the reasons outlined in Table 40. The exclusions are applied where information is available and has been documented in the application.

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

Table 40: Summary of referrals ineligible for timely journey clinical indicator – inpatients

Summary	n
Clinically unstable/inappropriate	108
Same day admission	98
Patient accepted onto existing program	67
Referred outside of Queensland Health	47
Patient readmitted to hospital	42
Patient deceased	31
Total ineligible	**393**

Table 41: 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	580	540	308 (57.0)
Central Queensland	422	370	168 (45.4)
Central West	13	10	N/A
Darling Downs	303	278	112 (40.3)
Gold Coast	820	763	530 (69.5)
Health Contact Centre	1113	1,062	425 (40.0)
Mackay	222	211	56 (26.5)
Mater Health Services	84	83	35 (42.2)
Metro North	1850	1,764	930 (52.7)
Metro South	1876	1,804	970 (53.8)
North West	33	33	16 (48.5)
South West	30	30	20 (66.7)
Sunshine Coast	809	744	423 (56.9)
Townsville	510	503	185 (36.8)
West Moreton	434	414	191 (46.1)
Wide Bay	160	148	95 (64.2)
Statewide	**6,719**	**6,326**	**3,341 (52.8)**

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

* Includes both incoming and outgoing referrals

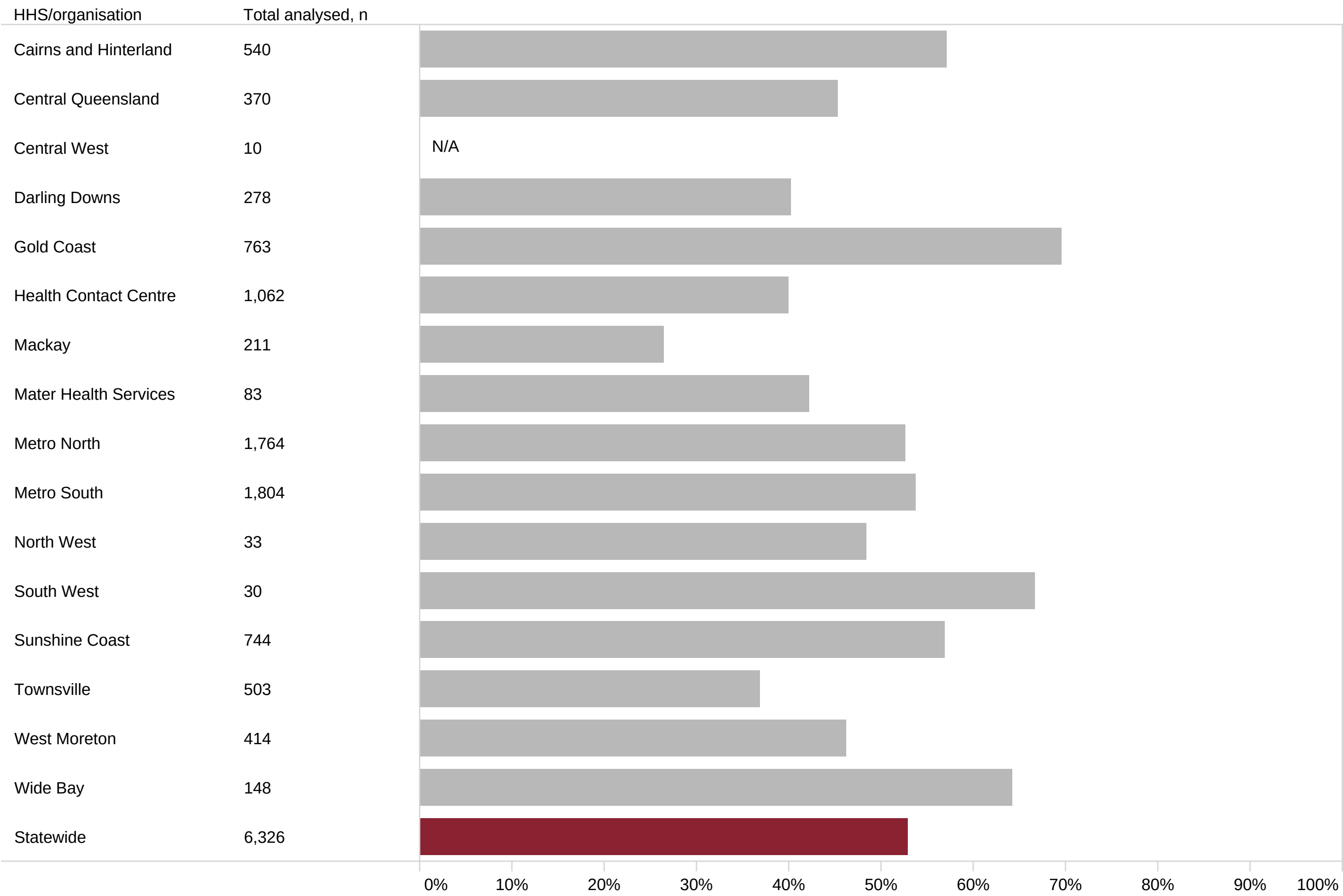


Figure 30: Timely journey indicator by participating HHS – inpatients

9.5 Clinical indicator trends, 2019–2022

The QCOR CR module has been in operation since July 2017, since then there has been a breadth of data captured by clinicians in relation to education, exercise and support programs designed to help patients make healthy, sustainable lifestyle choices. Undertaking CR after a cardiac event or procedure is aimed at reducing the likelihood of readmission and a cardiac cause of death.

With almost five years of data capture, longitudinal follow-up of clinical indicators is possible.

Clinical indicator 1

Submitting a timely referral, within 3 days, to an outpatient CR service remains high with 92% of referrals contributed to QCOR being submitted within three days of discharge, reduced by one percent from 2021 and 2020 (93%).

Clinical indicator 2a

Initial CR pre assessment for inpatient referrals, completed within 28 days of discharge for 2022 (58%) has declined 6% since 2021 (64%). However, the proportion of inpatients being seen in a timely manner in 2022 is similar to that noted in 2019 (59%).

Clinical indicator 2b

Timely assessment for non acute patients, completed within 28 days of referral date in 2022 is at the highest level seen since 2019 (61%).

Clinical indicator 3

The proportion of inpatients completing CR in a timely manner has reduced from 59% in 2021 to 53% in 2022, this figure is at the lowest observed level since 2019 (56%).

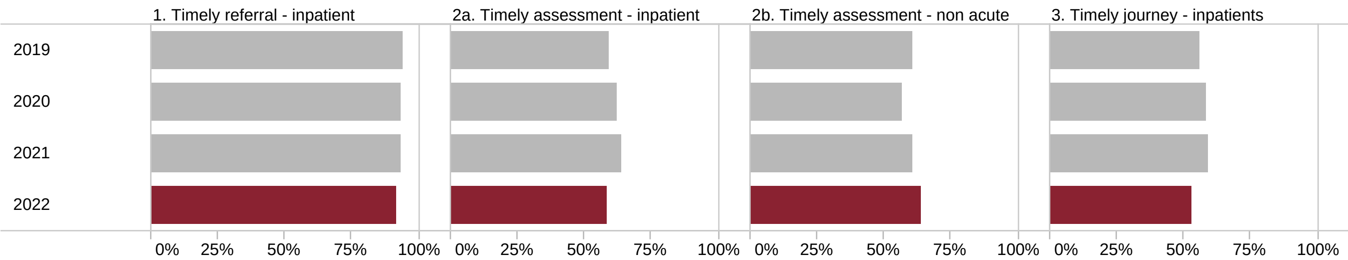
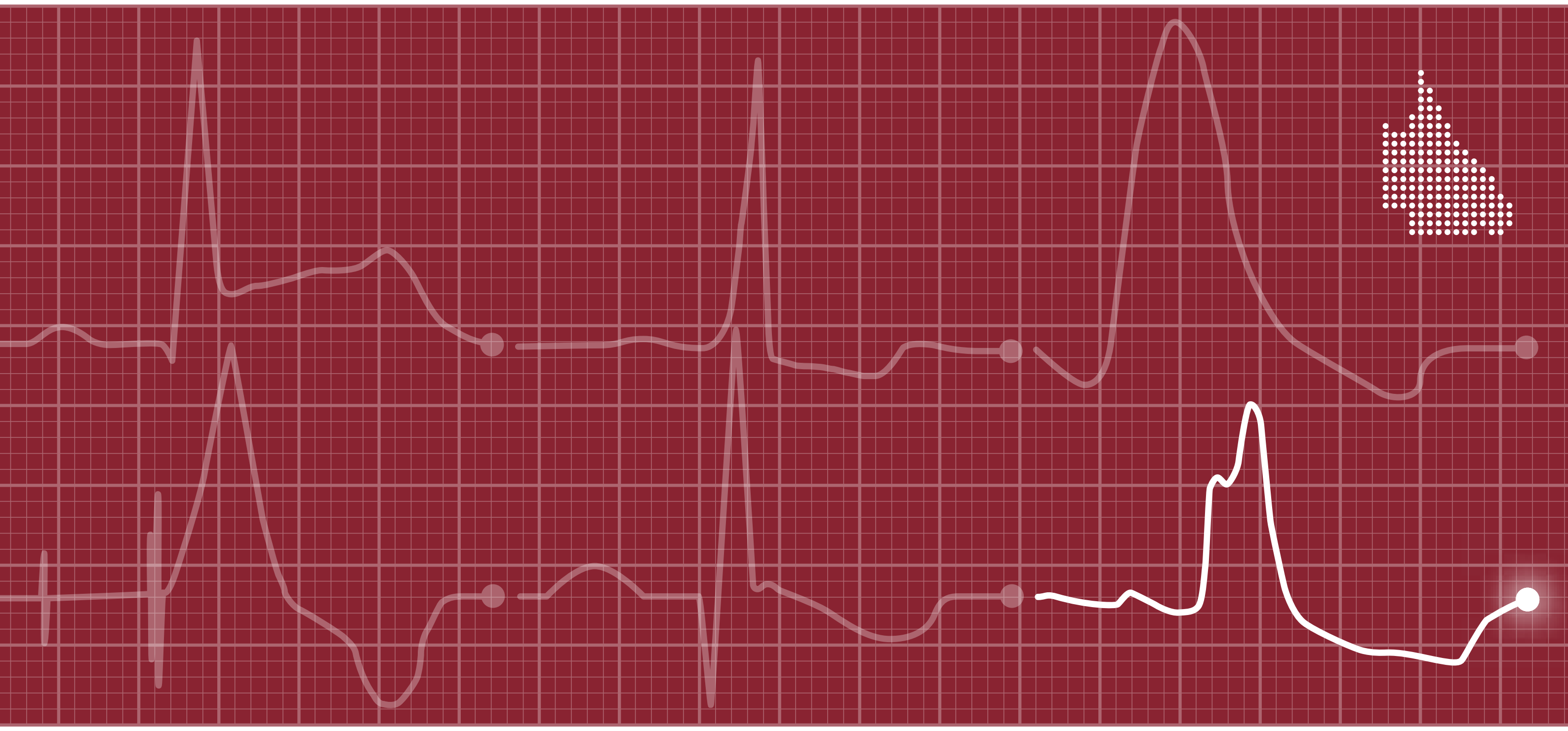


Figure 31: Clinical indicator trends, 2019–2022

Heart Failure Support Services Audit



1 Message from the QCOR Heart Failure Steering Committee Chair

The HERO (Heart Failure Evaluation and Reporting of Outcomes) registry provides a rich dataset that informs clinical teams about their practices and guides quality improvement priorities. The twenty-one heart failure teams across Queensland contribute to HERO and, in return, receive regular feedback within the context of structured planning and review. Quality improvement is supported by the statewide heart failure services coordinator, with oversight by a steering committee of clinicians and consumer advisors.

Some clinical indicators exhibit high variability between sites and some fall below the expected benchmarks. The mineralocorticoid receptor antagonist prescribing indicator (clinical indicator 5) serves as an example of how registry data can enhance prescription rates within a supported quality improvement environment. This led to a significant improvement in prescribing at the time of the first clinical review between 2019 (43%) and 2022 (58%).

New clinical indicators introduced this year focus on the prescription of sodium-glucose cotransporter-2 (SGLT2) inhibitors for heart failure with reduced ejection fraction (HFrEF) and heart failure with preserved ejection fraction (HFpEF) (clinical indicators 6 and 8). In this inaugural year of auditing SGLT2 inhibitors, prescribing rates were consistently below the 80% benchmark, with an average rate of 40% for HFrEF and 13% for HFpEF at the time of the first clinical review. To drive change, clinical practice feedback for this indicator has been accompanied by clinical education, updates to medication optimisation plans, distribution of an SGLT2 inhibitor resource for patients, and identification of any barriers to prescribing.

The demographic information in this report helps identify the needs and adequacy of representation for specific populations. For example, HFpEF appears under-represented in the registry (12% of referrals), which is relevant given the new indications for SGLT2 inhibitors that can improve clinical outcomes for this population.

Finally, we are excited to announce that in 2024, we will measure exercise prescription and launch an update to HERO, including auditing clinical practice at 6 months from referral or at the date of deactivation from a heart failure support service (whichever occurs sooner).

In conclusion, I would like to express gratitude to all the clinicians who contribute to HERO and commend their commitment to improving practice and to the patients and their families that inform this review.

Professor John Atherton
Chair
QCOR Heart Failure Support Services Committee

2 Key findings

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

There were 6,438 new referrals in 2022, a 60% growth in referrals since 2016. Characteristics of referrals included: male (68%), Aboriginal and Torres Strait Islander patients (5.7%), HFrEF (85%), and patients referred from hospital (62%).

The median age of people referred was 68 years old with male patients presenting younger than females (68 years vs. 71 years respectively). Aboriginal and Torres Strait Islander patients represented a younger cohort compared with non-Indigenous patients (57 years vs. 69 years respectively), and HFrEF patients are younger than HFpEF patients (67 years vs. 76 years respectively). Patients aged 75 years or older represented approximately one third of total cases (32%).

Clinical indicator performance

Most indicators met benchmarks at a statewide level. MRA|| prescription rates, despite not reaching targets are improving: 43% (2019), 46% (2020), 51% (2021) and 58% (2022). The titration and review of beta blockers (clinical indicator 7a, 7b and 7c) show that achievement of guideline recommended targets remains low at 27%, with review of beta blockers status at 6 months at 74% and achievement of maximum tolerated beta blocker dose at 72%. Prescription of SGLT2 inhibitor§ for HFrEF is reported for the first time both at hospital discharge (38%) and at first clinical review (40%). All sites were below the benchmark for SGLT2 inhibitor prescription. It is expected that the prescription rates for SGLT2 inhibitor will increase over time as prescription subsidies by the Pharmaceutical Benefits Scheme align with the international literature showing benefit to HFrEF patients despite diabetic status.

There was variation in practice between sites for all indicators, except for clinical indicators 2, 3 and 4 where all sites are above or approaching the benchmark.

Table 1: Summary of statewide clinical indicator performance

#	Clinical indicator	% referrals
Non pharmacological indicators		
1a	Follow-up of acute patients within 2 weeks	79.1
1b	Follow-up of non acute patients within 4 weeks	79.4
2	Assessment of left ventricular ejection fraction within 2 years	97.7*
Pharmacological indicators		
3a	ACEI/ARB or ARNI† prescription for HFrEF‡ at hospital discharge	91.8*
3b	ACEI/ARB or ARNI† prescription for HFrEF‡ at first clinical review	92.7*
4a	Beta blocker§ prescription for HFrEF‡ at hospital discharge	91.0*
4b	Beta blocker§ prescription for HFrEF‡ at first clinical review	92.2*
5a	Prescription of MRA|| for HFrEF‡ at time of hospital discharge	57.6
5b	Prescription of MRA|| for HFREF‡ at time of first HFSS clinical review	57.5
6a	Prescription of SGLT2§ inhibitor for HFrEF‡ at time of hospital discharge	38.1
6b	Prescription of SGLT2§inhibitor for HFrEF‡ at time of first HFSS clinical review	40.0
7a	Beta blocker# titration status review at six months post referral	73.9
7b	Beta blocker# achievement of guideline recommended target	27.2
7c	Beta blocker# achievement of guideline recommended target dose or maximum tolerated dose	72.2

* Benchmark met (benchmark is 80% achievement except for 7b which is 50%)

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

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

§ Sodium-glucose cotransporter-2 inhibitor

|| Mineralocorticoid receptor antagonists

Bisoprolol, carvedilol, metoprolol sustained release or nebivolol

Patient outcomes

Patient outcomes are based on inpatient referrals from the previous year to allow for 12 month follow-up from the index hospitalisation. Mortality was 1.2% at 30 days and 12.2% at 12 months. Death/rehospitalisation was 17.0% at 30 days and 54.1% at 12 months. Based on 3,443 eligible patients, 112,096 days were lost due to death or hospitalisation over 12 months.

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

#	Measures post index hospitalisation	30 days	1 year
1	All-cause mortality	1.2%	12.2%
2	a) All-cause rehospitalisation	16.4%	52.8%
	b) Heart failure rehospitalisation	4.7%	19.4%
3	Composite all-cause hospitalisation or all-cause mortality	17.0%	54.1%
4	Days alive and out of hospital	N/A	364 median days

Conclusion

Follow up time of new referrals remain high overall. Optimal therapy can be difficult to achieve at hospital discharge or by the first clinical review for a range of valid reasons. As medication optimisation become more complex, it is recommended that pharmacological clinical indicators include a review of prescription and titration for all medications at 6 months so that the uptake of combined therapies can be evaluated. Evolving guidelines for the treatment of HFrEF are resulting in new therapies and measurement of prescription rates will be of interest in future audits.

3 Participating sites

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

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

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

Figure 1: Heart Failure Support Service (HFSS) locations

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

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

* Nurse practitioner who can prescribe medications

† Pharmacist

‡ Physiotherapist or accredited exercise physiologist

§ The HFSS has a cardiologist or general physician mentor

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

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

4 New referrals

There were 6,438 new referrals reported by the 21 participating HFSS, with Metropolitan sites comprising 55% of all referrals. Seven year trends in referral to HFSS can be seen in the figure below. Between 2016 and 2022 referral volumes increased by 60%.

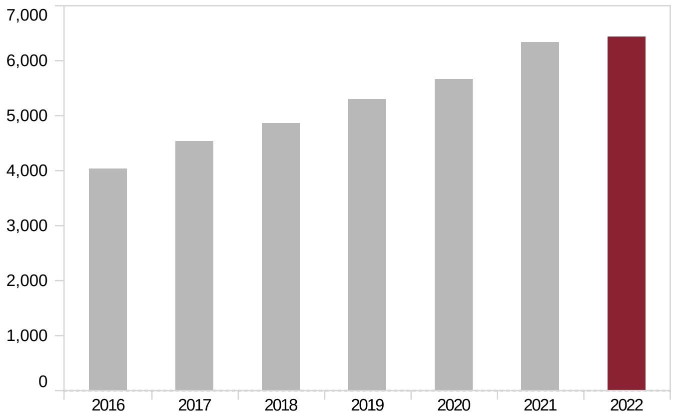


Figure 2: Total yearly HF referrals, 2016–2022

Table 5: Yearly HF referral volume, 2016–2022

	2016 n	2017 n	2018 n	2019 n	2020 n	2021 n	2022 n
Yearly referrals	4,021	4,528	4,878	5,304	5,664	6,326	6,438

4.1 Location of referrals

Table 6: Distribution of new referrals by HFSS location

Referrals per HHS	n (%)	Referrals per facility	n (%)
Cairns and Hinterland	283 (4.4)	Cairns Hospital	283 (4.4)
Central Queensland	293 (4.6)	Gladstone Hospital	30 (0.5)
		Rockhampton Hospital	263 (4.1)
Darling Downs	78 (1.2)	Toowoomba Hospital	78 (1.2)
Gold Coast	512 (8.0)	Gold Coast Community Health	512 (8.0)
Mackay	152 (2.4)	Mackay Base Hospital	152 (2.4)
Metro North	1,929 (30.0)	Caboolture Hospital	305 (4.7)
		Redcliffe Hospital	192 (3.0)
		Royal Brisbane & Women's Hospital	533 (8.3)
		The Prince Charles Hospital HFS	899 (14.0)
Metro South	1,575 (24.5)	Logan Hospital	514 (8.0)
		Princess Alexandra Hospital	739 (11.5)
		Queen Elizabeth II Hospital	146 (2.3)
		Redland Hospital	176 (2.7)
North West	29 (0.5)	Mt Isa Hospital	29 (0.5)
Sunshine Coast	627 (9.7)	Gympie	87 (1.4)
		Sunshine Coast University Hospital	540 (8.4)
Townsville	273 (4.2)	Townsville Hospital	273 (4.2)
West Moreton	396 (6.2)	Ipswich Community Health	396 (6.2)
Wide Bay	291 (4.5)	Bundaberg Hospital	184 (2.9)
		Hervey Bay Hospital & Hervey Bay/ Maryborough Hospitals	107 (1.7)
Statewide			**6,438 (100.0)**

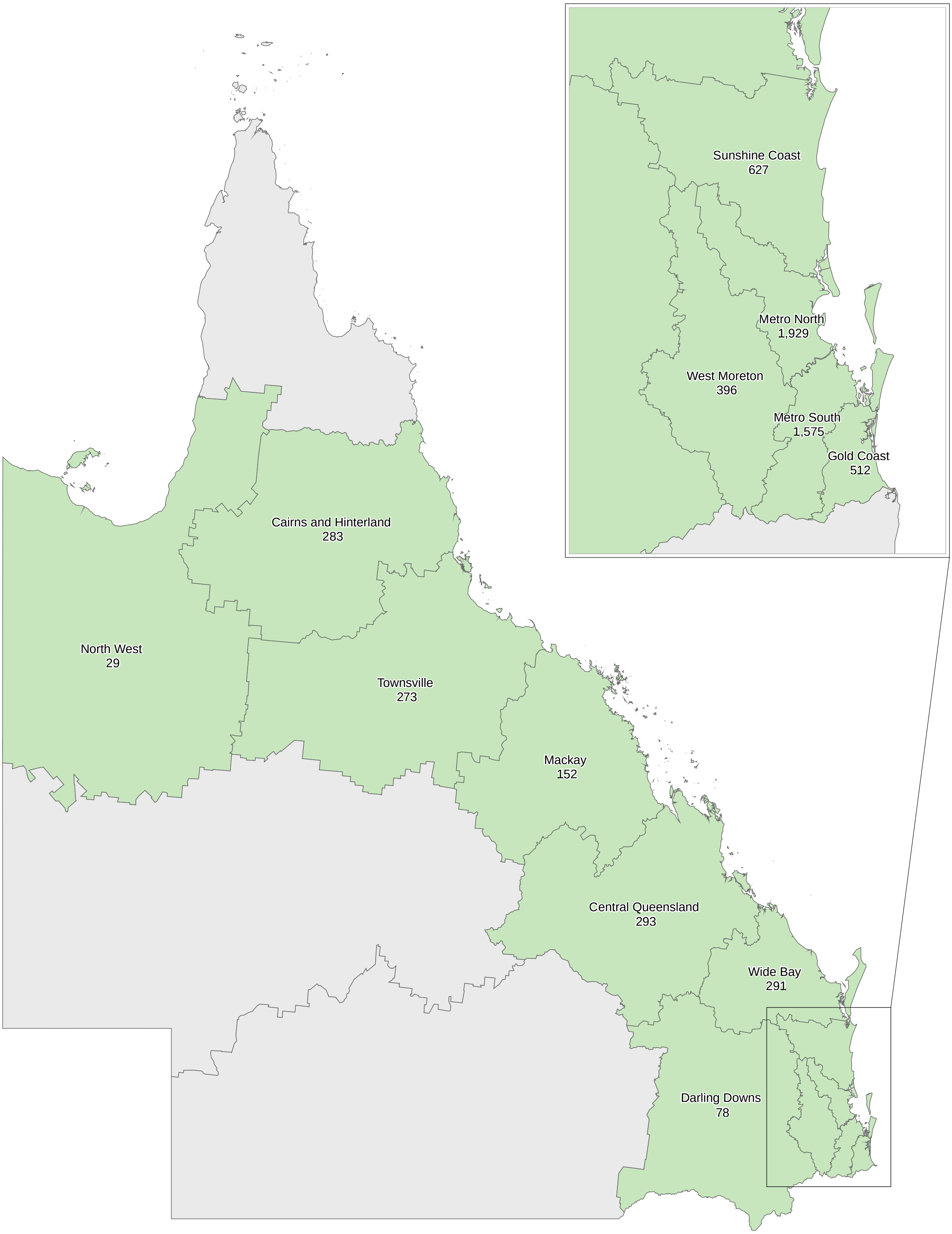


Figure 3: Regional distribution of new referrals

4.2 Referral source

Most referrals originated from an inpatient setting (62%), with smaller proportions originating from an outpatient setting (24%) or as a transfer from another service (13%).

Few referrals came directly from primary care (1%), which is expected as most referrals flow to specialty outpatient clinics for diagnosis and treatment optimisation prior to referral to an HFSS.

Table 7: Source of HFSS referral

HHS	HFSS	Inpatient n (%)	Outpatient n (%)	Another HFSS n (%)	Primary care n (%)
Cairns and Hinterland	Cairns Hospital	206 (72.8)	76 (26.9)	1 (0.4)	–
Central Queensland	Gladstone Hospital	11 (36.7)	7 (23.3)	12 (40.0)	–
	Rockhampton Hospital	147 (55.9)	95 (36.1)	11 (4.2)	10 (3.8)
Darling Downs	Toowoomba Hospital	24 (30.8)	46 (59.0)	7 (9.0)	1 (1.3)
Gold Coast	Gold Coast Community Health	325 (63.5)	147 (28.7)	32 (6.3)	8 (1.6)
Mackay	Mackay Base Hospital	70 (46.1)	75 (49.3)	6 (3.9)	1 (0.7)
Metro North	Caboolture Hospital	128 (42.0)	28 (9.2)	131 (43.0)	18 (5.9)
	Redcliffe Hospital	40 (20.8)	55 (28.6)	97 (50.5)	–
	Royal Brisbane & Women's Hospital	357 (67.0)	167 (31.3)	9 (1.7)	–
	The Prince Charles Hospital	694 (77.2)	191 (21.2)	14 (1.6)	–
Metro South	Logan Hospital	318 (61.9)	44 (8.6)	149 (29.0)	3 (0.6)
	Princess Alexandra Hospital	652 (88.2)	77 (10.4)	10 (1.4)	–
	Queen Elizabeth II Hospital	94 (64.4)	22 (15.1)	30 (20.5)	–
	Redland Hospital	31 (17.6)	49 (27.8)	95 (54.0)	1 (0.6)
North West	Mt Isa Hospital	10 (34.5)	18 (62.1)	1 (3.4)	–
Sunshine Coast	Gympie Hospital	25 (28.7)	28 (32.2)	33 (37.9)	1 (1.1)
	Sunshine Coast University Hospital	356 (65.9)	172 (31.9)	12 (2.2)	–
Townsville	Townsville Hospital	173 (63.4)	93 (34.1)	7 (2.6)	–
West Moreton	Ipswich Community Health	184 (46.5)	114 (28.8)	96 (24.2)	2 (0.5)
Wide Bay	Bundaberg Hospital	90 (48.9)	39 (21.2)	42 (22.8)	13 (7.1)
	Hervey Bay Hospital	23 (21.5)	26 (24.3)	49 (45.8)	9 (8.4)
Statewide		**3,958 (61.5)**	**1,569 (24.4)**	**844 (13.1)**	**67 (1.0)**

5 Patient characteristics

5.1 Age and gender

The statewide median age of patients managed by an HFSS was 68 years. The median age of women (71 years) was three years older than men. Approximately one third of patients (32%) were 75 years of age and older.

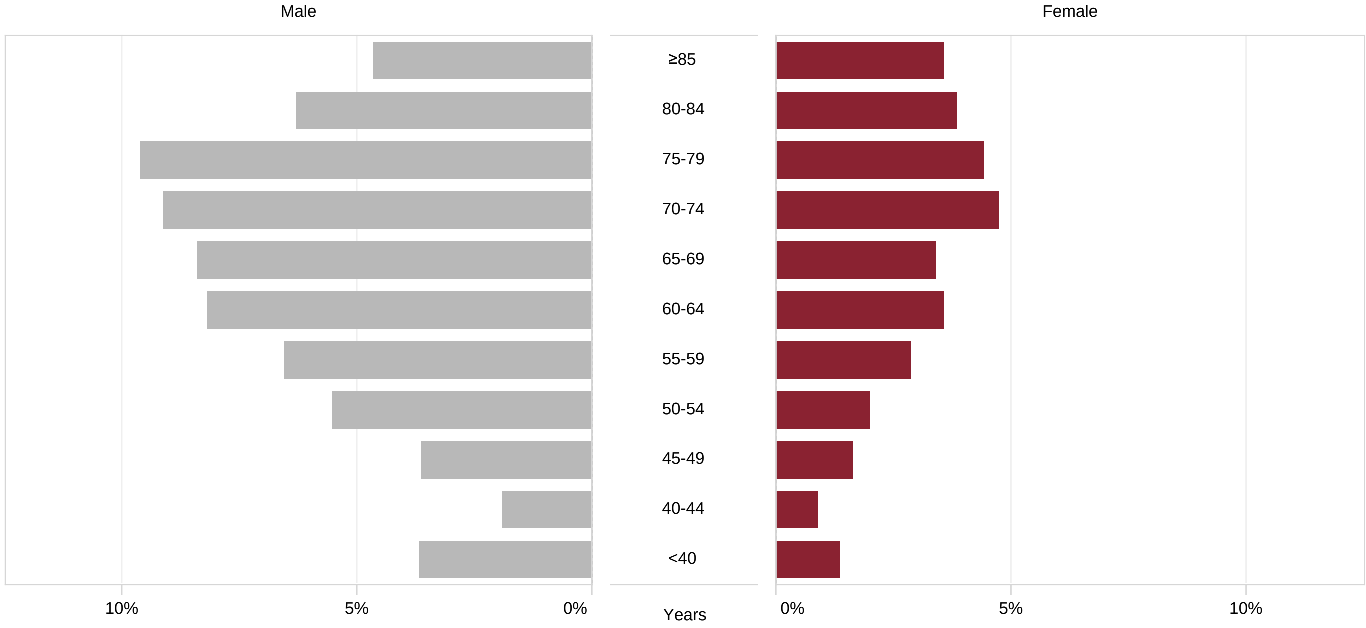


Figure 4: Proportion of all referrals by gender and age group

Table 8: Median age in years by gender and HFSS

HHS	HFSS	Male years	Female years	ALL years
Cairns and Hinterland	Cairns Hospital	67	66	67
Central Queensland	Gladstone Hospital	63	64	64
	Rockhampton Hospital	66	72	68
Darling Downs	Toowoomba Hospital	68	64	67
Gold Coast	Gold Coast Community Health	68	68	68
Mackay	Mackay Base Hospital	66	70	66
Metro North	Caboolture Hospital	71	73	72
	Redcliffe Hospital	68	73	71
	Royal Brisbane & Women's Hospital	68	67	67
	The Prince Charles Hospital	68	73	70
Metro South	Logan Hospital	65	70	67
	Princess Alexandra Hospital	64	71	66
	Queen Elizabeth II Hospital	62	68	64
	Redland Hospital	69	74	70
North West	Mt Isa Hospital	66	69	67
Sunshine Coast	Gympie Hospital	73	74	73
	Sunshine Coast University Hospital	72	72	72
Townsville	Townsville Hospital	65	61	64
West Moreton	Ipswich Community Health	65	72	66
Wide Bay	Bundaberg Hospital	71	73	71
	Hervey Bay Hospital	70	70	70
Statewide		**68**	**71**	**68**

5.2 Gender

The majority of patients were male (68%), ranging from 61% to 83% across participating sites.

Table 9: Referrals by gender and HFSS

HHS	HFSS	Male n (%)	Female n (%)
Cairns and Hinterland	Cairns Hospital	184 (65.0)	99 (35.0)
Central Queensland	Gladstone Hospital	25 (83.3)	5 (16.7)
	Rockhampton Hospital	172 (65.4)	91 (34.6)
Darling Downs	Toowoomba Hospital	58 (74.4)	20 (25.6)
Gold Coast	Gold Coast Community Health	346 (67.6)	166 (32.4)
Mackay	Mackay Base Hospital	107 (70.4)	45 (29.6)
Metro North	Caboolture Hospital	199 (65.2)	106 (34.8)
	Redcliffe Hospital	117 (60.9)	75 (39.1)
	Royal Brisbane & Women's Hospital	362 (67.9)	171 (32.1)
	The Prince Charles Hospital	584 (65.0)	315 (35.0)
Metro South	Logan Hospital	352 (68.5)	162 (31.5)
	Princess Alexandra Hospital	548 (74.2)	191 (25.8)
	Queen Elizabeth II Hospital	99 (67.8)	47 (32.2)
	Redland Hospital	119 (67.6)	57 (32.4)
North West	Mt Isa Hospital	20 (69.0)	9 (31.0)
Sunshine Coast	Gympie Hospital	57 (65.5)	30 (34.5)
	Sunshine Coast University Hospital	365 (67.6)	175 (32.4)
Townsville	Townsville Hospital	181 (66.3)	92 (33.7)
West Moreton	Ipswich Community Health	268 (67.7)	128 (32.3)
Wide Bay	Bundaberg Hospital	132 (71.7)	52 (28.3)
	Hervey Bay Hospital	65 (60.7)	42 (39.3)
Statewide		**4,360 (67.7)**	**2,078 (32.3)**

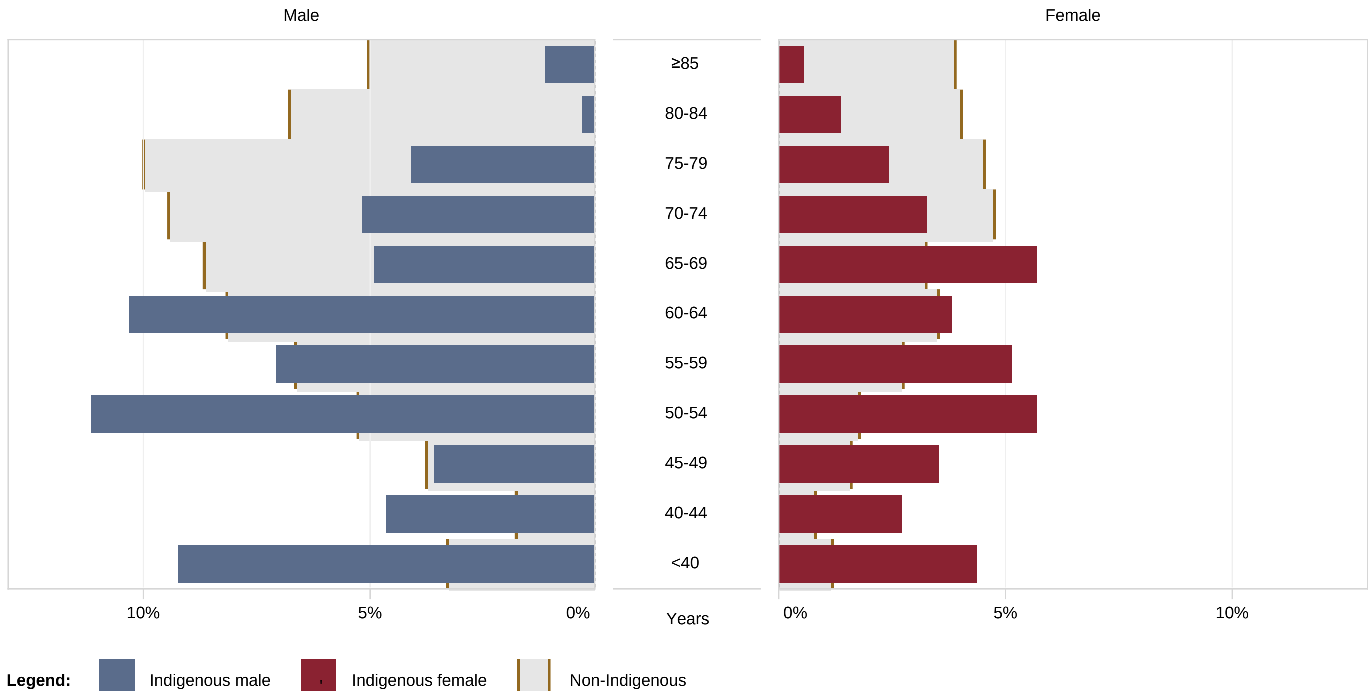
5.3 Aboriginal and Torres Strait Islander status

Patients of identified Aboriginal and Torres Strait Islander status made up 5.7% of all referrals. The number of referrals (n 368) was similar to the previous year (n 351). Aboriginal and Torres Strait Islander patients were significantly younger than other Queenslanders (median age of 57 years vs. 69 years). The proportion of caseload of Aboriginal and Torres Strait Islander patients was highest in Mount Isa (35%), followed by Cairns (21%) and Townsville (20%).

The number of Aboriginal and Torres Strait Islander referrals in the Greater Brisbane area (Metro North HHS and Metro South HHS) was 128 (35% of referrals statewide for Indigenous Australians).

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

HHS	HFSS	Indigenous n (%)	Non Indigenous n (%)	Not stated / unknown n (%)
Cairns and Hinterland	Cairns Hospital	58 (20.5)	216 (76.3)	9 (3.2)
Central Queensland	Gladstone Hospital	4 (13.3)	26 (86.7)	–
	Rockhampton Hospital	32 (12.2)	222 (84.4)	9 (3.4)
Darling Downs	Toowoomba Hospital	6 (7.7)	68 (87.2)	4 (5.1)
Gold Coast	Gold Coast Community Health	12 (2.3)	486 (94.9)	14 (2.7)
Mackay	Mackay Base Hospital	9 (5.9)	140 (92.1)	3 (2.0)
Metro North	Caboolture Hospital	14 (4.6)	284 (93.1)	7 (2.3)
	Redcliffe Hospital	3 (1.6)	187 (97.4)	2 (1.0)
	Royal Brisbane & Women's Hospital	21 (3.9)	501 (94.0)	11 (2.1)
	The Prince Charles Hospital	41 (4.6)	844 (93.9)	14 (1.6)
Metro South	Logan Hospital	22 (4.3)	481 (93.6)	11 (2.1)
	Princess Alexandra Hospital	19 (2.6)	713 (96.5)	7 (0.9)
	Queen Elizabeth II Hospital	4 (2.7)	137 (93.8)	5 (3.4)
	Redland Hospital	4 (2.3)	161 (91.5)	11 (6.3)
North West	Mt Isa Hospital	10 (34.5)	19 (65.5)	–
Sunshine Coast	Gympie Hospital	1 (1.1)	85 (97.7)	1 (1.1)
	Sunshine Coast University Hospital	14 (2.6)	520 (96.3)	6 (1.1)
Townsville	Townsville Hospital	55 (20.1)	214 (78.4)	4 (1.5)
West Moreton	Ipswich Community Health	19 (4.8)	362 (91.4)	15 (3.8)
Wide Bay	Bundaberg Hospital	17 (9.2)	162 (88.0)	5 (2.7)
	Hervey Bay Hospital	3 (2.8)	84 (78.5)	20 (18.7)
Statewide		**368 (5.7)**	**5,912 (91.8)**	**158 (2.5)**



% of total Indigenous (n=368) vs. total non-Indigenous (n=5,912)

Excludes missing data (2.5%)

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

Table 11: Median patient age by gender and Indigenous status

	Total referrals* n	Male years	Female years	ALL years
Aboriginal and Torres Strait Islander	368	57	58	57
Non Aboriginal and Torres Strait Islander	5,912	68	71	69
ALL	**6,280**	**68**	**71**	**69**

* Excludes missing data (2.5%)

5.4 Phenotype of heart failure

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

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

The most common referral to a HFSS was for HFrEF (85%). The median age for HFrEF was ten years younger than for patients with HFpEF (67 vs. 76 years respectively). More men had HFrEF than women (71% male), whereas HFpEF did not have a significant gender difference (48% male and 52% female).

Table 12: Proportion of patients by heart failure phenotype

HHS	HFSS	HFrEF* n (%)	HFpEF† n (%)	Primary right HF n (%)	Unsure/ unknown n (%)
Cairns and Hinterland	Cairns Hospital	270 (95.4)	6 (2.1)	3 (1.1)	4 (1.4)
Central Queensland	Gladstone Hospital	28 (93.3)	2 (6.7)	–	–
	Rockhampton Hospital	214 (81.4)	44 (16.7)	1 (0.4)	4 (1.5)
Darling Downs	Toowoomba Hospital	71 (91.0)	4 (5.1)	–	3 (3.8)
Gold Coast	Gold Coast Community Health	430 (84.0)	63 (12.3)	9 (1.8)	10 (2.0)
Mackay	Mackay Base Hospital	138 (90.8)	14 (9.2)	–	–
Metro North	Caboolture Hospital	219 (71.8)	70 (23.0)	6 (2.0)	10 (3.3)
	Redcliffe Hospital	148 (77.1)	43 (22.4)	–	1 (0.5)
	Royal Brisbane & Women's Hospital	461 (86.5)	65 (12.2)	2 (0.4)	5 (0.9)
	The Prince Charles Hospital	680 (75.6)	198 (22.0)	8 (0.9)	13 (1.4)
Metro South	Logan Hospital	432 (84.0)	59 (11.5)	14 (2.7)	9 (1.8)
	Princess Alexandra Hospital	685 (92.7)	40 (5.4)	12 (1.6)	2 (0.3)
	Queen Elizabeth II Hospital	131 (89.7)	12 (8.2)	2 (1.4)	1 (0.7)
	Redland Hospital	152 (86.4)	19 (10.8)	3 (1.7)	2 (1.1)
North West	Mt Isa Hospital	13 (44.8)	1 (3.4)	1 (3.4)	14 (48.3)
Sunshine Coast	Gympie Hospital	75 (86.2)	9 (10.3)	–	3 (3.4)
	Sunshine Coast University Hospital	507 (93.9)	26 (4.8)	3 (0.6)	4 (0.7)
Townsville	Townsville Hospital	261 (95.6)	7 (2.6)	–	5 (1.8)
West Moreton	Ipswich Community Health	336 (84.8)	43 (10.9)	11 (2.8)	6 (1.5)
Wide Bay	Bundaberg Hospital	161 (87.5)	20 (10.9)	3 (1.6)	–
	Hervey Bay Hospital	85 (79.4)	17 (15.9)	4 (3.7)	1 (0.9)
Statewide		**5,497 (85.4)**	**762 (11.8)**	**82 (1.3)**	**97 (1.5)**

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

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

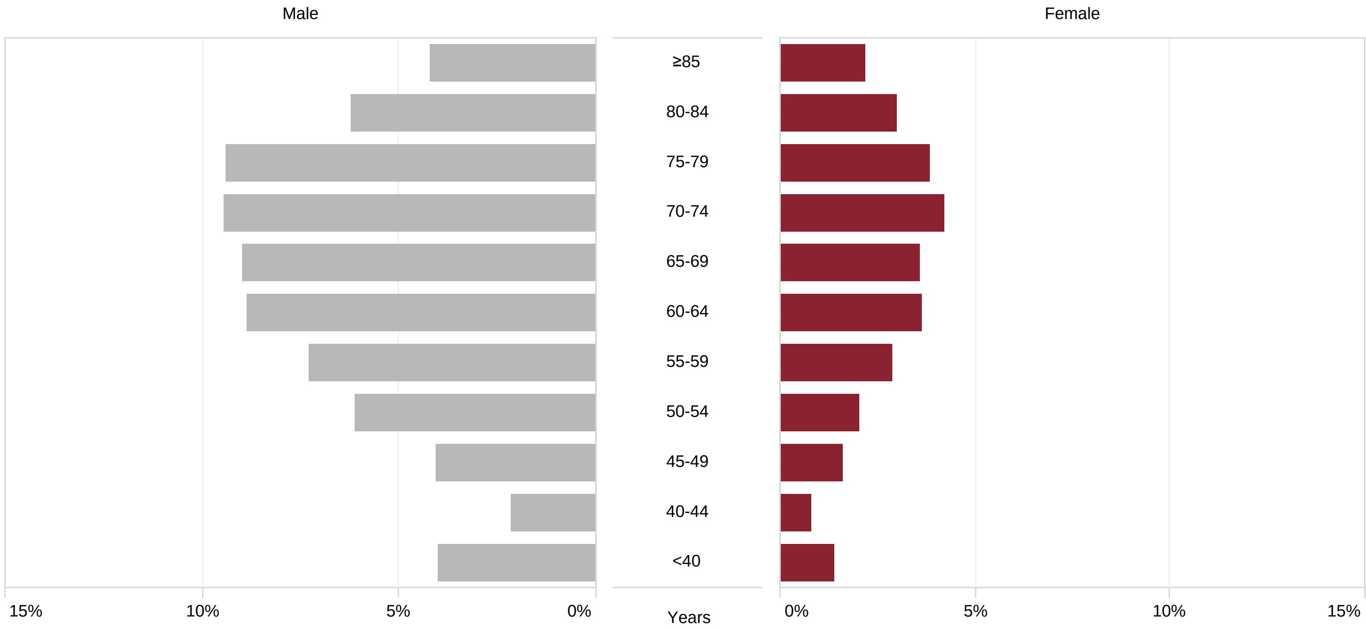
Table 13: Summary of patient age, gender and Indigenous status by heart failure phenotype

	HFrEF*	HFpEF†	Primary right HF
Number	5,497	762	82
Age (median years)	67	76	75
% male	70.9%	48.3%	52.4%
% Aboriginal and Torres Strait Islander	6.0%	3.5%	3.7%

Excludes unsure/unknown HF phenotype (1.5%)

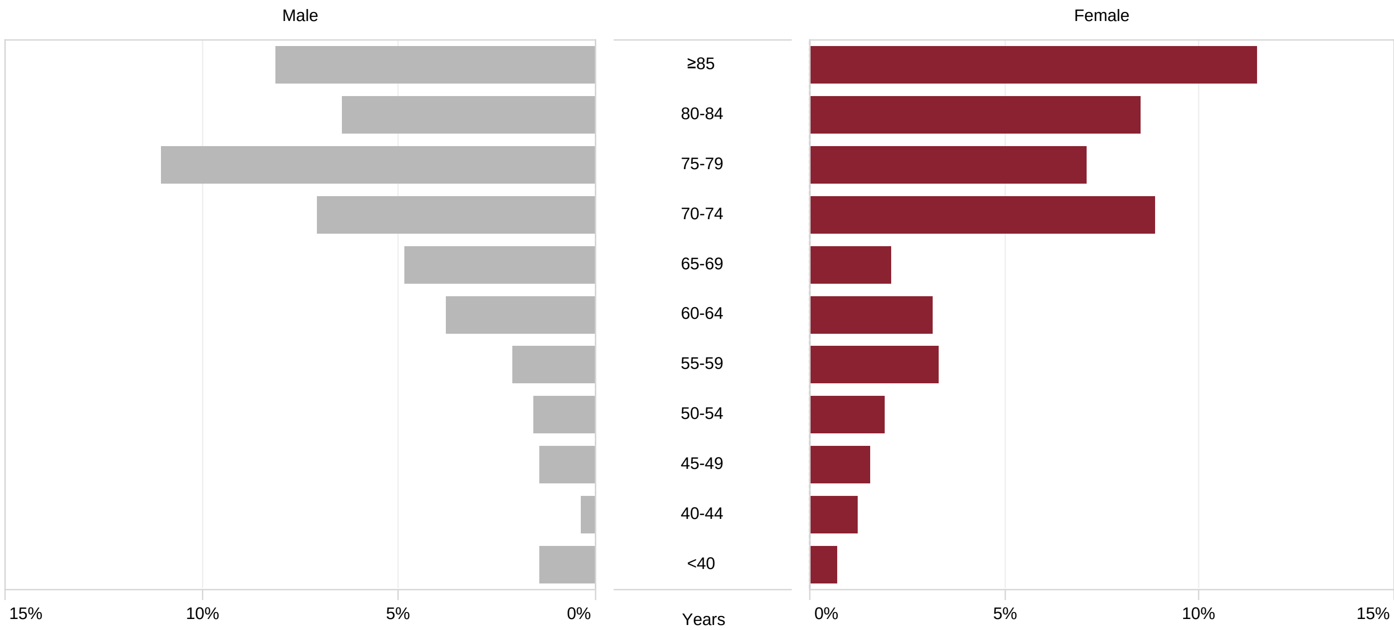
* Heart failure with reduced ejection fraction (LVEF <50%)

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



% of total with HFrEF (n=5,497)

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



% of total with HFpEF (n=762)

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

5.5 Summary of patient characteristics

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

Table 14: Summary of patient characteristics

Characteristic	Summary
Participating HFSS	21
New referrals	6,438
Referrals from South East Queensland	72%
Referral source:	
Inpatient	61.5%
Outpatient	24.4%
Another HFSS	13.1%
Primary care	1.0%
Age (median years):	
All (median, range by service)	68 (64–73) years
Male vs. Female	68 vs. 71 years
Indigenous vs. non-Indigenous	57 vs. 69 years
HFrEF* vs. HFpEF†	67 vs. 76 years
Age group:	
75 years and over	32.0%
Males	67.7%
Aboriginal and Torres Strait Islander patients	5.7%
Heart failure phenotype:	
HFrEF*	85.4%
HFpEF†	11.8%
Primary right HF	1.3%
Unsure/unknown	1.5%

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

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

6 Clinical indicators

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

The target benchmark for all indicators was set at 80%, except for 7b (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.[55]

Table 15: Clinical process indicators

Indicator #	Process measures
1	**Timely follow-up and first clinical review** 1a) First clinical review within two weeks for inpatient referrals 1b) First clinical review within four weeks for non acute referrals
2	**Left ventricular ejection fraction (LVEF) assessed within 2 years of referral to HFSS**
3	**Prescription of angiotensin-converting-enzyme inhibitor (ACEI), angiotensin II receptor blockers (ARB) or angiotensin receptor neprilysin inhibitor (ARNI) for HFrEF** 3a) Prescription at time of hospital discharge (inpatient referrals) 3b) Prescription at time of first clinical review (all referrals)
4	**Prescription of guideline recommended beta blockers (bisoprolol, carvedilol, metoprolol sustained release or nebivolol) for HFrEF** 4a) Prescription at time of hospital discharge (inpatient referrals) 4b) Prescription at time of first clinical review (all referrals)
5	**Prescription of mineralocorticoid receptor antagonists (MRA) for patients with HFrEF** 5a) Prescription at time of hospital discharge (inpatient referrals) 5b) Prescription at time of first clinical review (all referrals)
6	**Prescription of sodium-glucose cotransporter-2 (SGLT2) inhibitors for HFrEF** 6a) Prescription at time of hospital discharge (inpatient referrals) 6b) Prescription at time of first clinical review (all referrals)
7	**Beta blocker review and titration** 7a) Titration review conducted within 6 months of first clinical review 7b) Guideline target dose achieved at time of titration review 7c) Either target or maximum dose achieved at time of titration review
8	**Prescription of sodium-glucose cotransporter-2 (SGLT2) inhibitors for HFpEF** 8a) Prescription at time of hospital discharge (inpatient referrals) 8b) Prescription at time of first clinical review (all referrals)

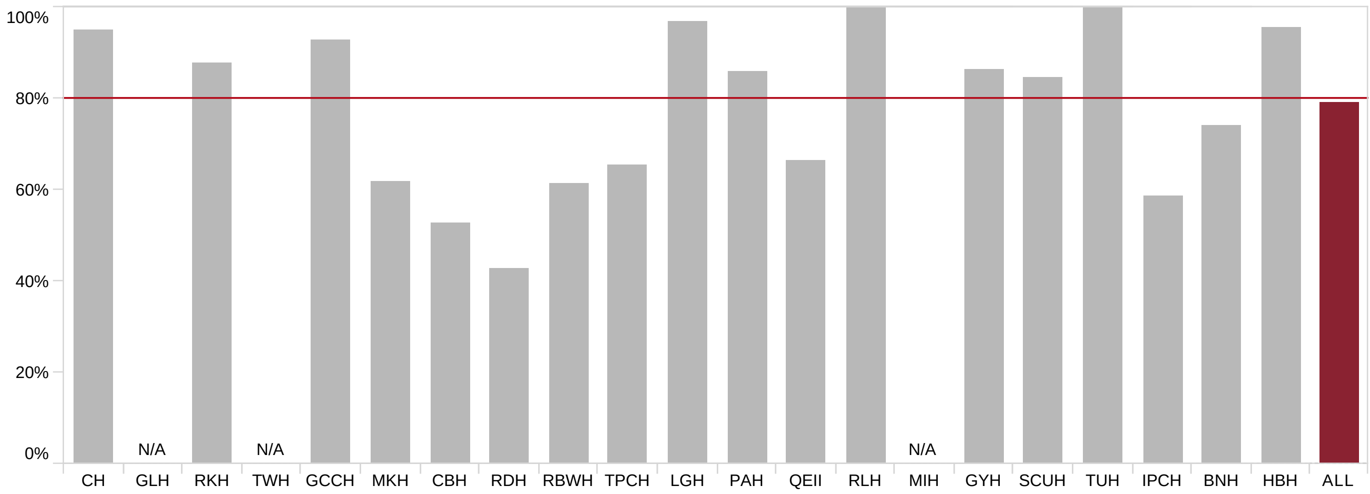
6.1 First clinical review

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

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

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

Of the 3,958 patients referred from an acute setting, 79% received a clinical review by an HFSS within two weeks of hospital discharge. Variation in performance was observed between services and is demonstrated in the figure below.



N/A: Eligible referrals <20

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

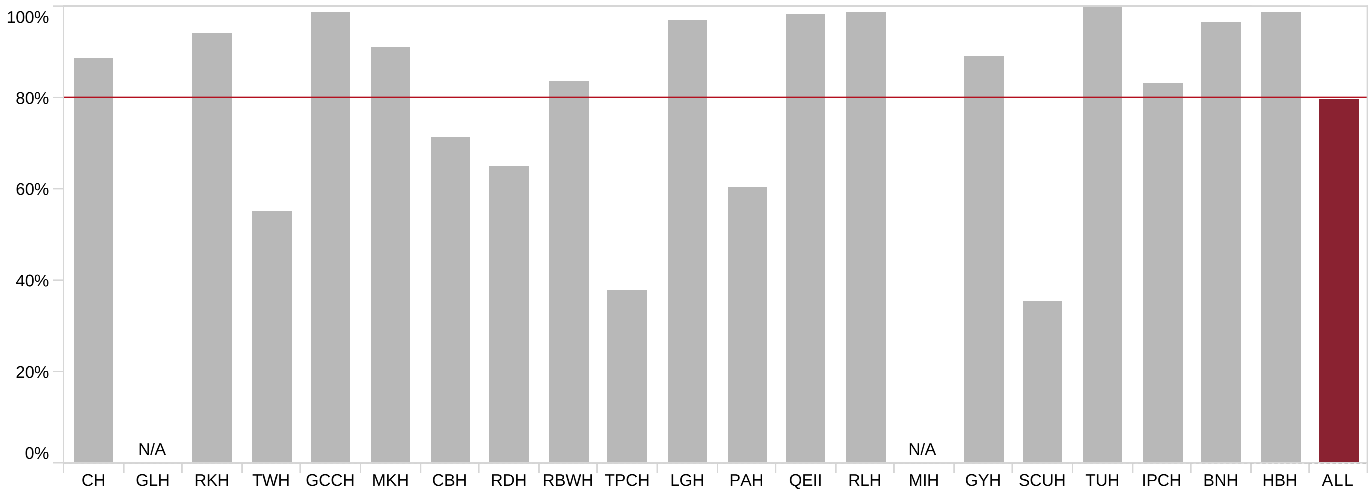
Table 16: Inclusion details for clinical indicator 1a: Inpatients receiving first HFSS clinical review within two weeks of hospital discharge

	n	%
Eligible for analysis	2,533	
Achieved benchmark	2,003	79.1
Benchmark not achieved	530	20.9
Ineligible	1,419	
Referred to another HFSS	780	
Patient could not be contacted, lives out of area or repeated failure to attend	178	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	125	
Patient declined service	113	
HF no longer prime issue (palliative care, high care nursing home etc.)	80	
Patient deceased	57	
Other reason	86	
Missing data	6	
Total inpatient referrals	**3,958**	

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

For non acute referrals, clinical follow-up should be within four weeks of the referral date.

Referrals for 2,480 patients came from non acute services, of which 79% of the cases eligible for analysis received a clinical review within four weeks of referral. Variation in performance amongst services was observed and is outlined below.



N/A: Eligible referrals <20

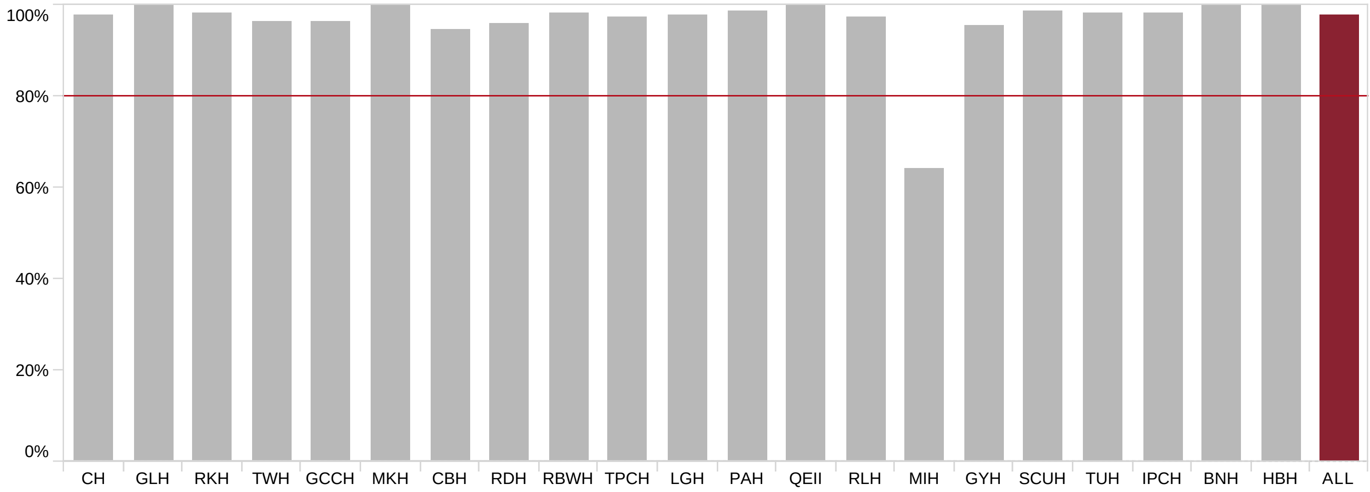
Figure 9: Proportion of non acute patients who received first HFSS clinical review within four weeks of referral

Table 17: Inclusion details for clinical indicator 1b: Non acute patients receiving first HFSS clinical review within four weeks of referral

	n	%
Eligible for analysis	2,186	
Achieved benchmark	1,735	79.4
Benchmark not achieved	451	20.6
Ineligible	293	
Referred to another HFSS	86	
Patient could not be contacted, lives out of area or repeated failure to attend	85	
Patient declined service	48	
HF no longer prime issue (palliative care, high care nursing home etc.)	27	
Patient deceased	12	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	10	
Other reason	25	
Missing data	1	
Total non acute patients	**2,480**	

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.[57] In 98% of cases, LVEF was assessed within two years of referral to an HFSS. Little variation in performance was observed and is demonstrated in the analysis below.



N/A: Eligible referrals <20

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

Table 18: Inclusion details for clinical indicator 2: Patients who had LVEF assessed within two years of referral

	n	%
Eligible for analysis	6,436	
Achieved benchmark	6,287	97.7
Benchmark not achieved	149	2.3
Ineligible	N/A	
Missing data	2	
Total referrals	**6,438**	

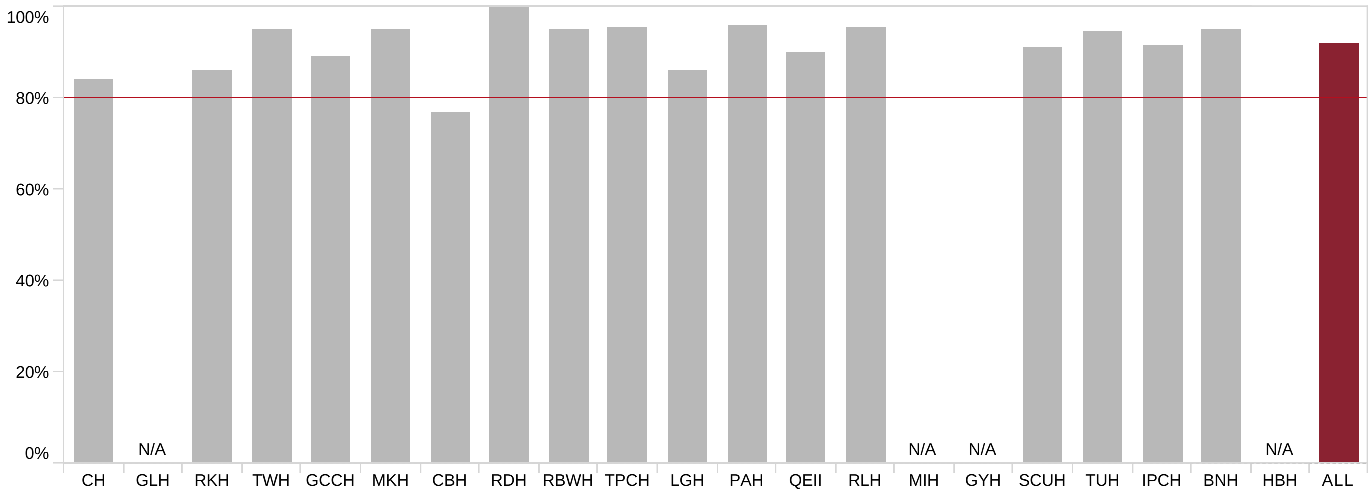
Heart Failure Support Services

6.3 Prescription of ACEI, ARB or ARNI for patients with HFrEF

Angiotensin-converting-enzyme inhibitor (ACEI), angiotensin II receptor blockers (ARB) or angiotensin receptor neprilysin inhibitor (ARNI) have been shown to reduce mortality and morbidity in patients with HFrEF and are recommended for all patients unless contraindicated or not tolerated.[57]

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 eligible patients. Of these patients there were 75% of patients who were prescribed ARNI and the remaining 25% an ACEI/ARB.



N/A: Eligible referrals <20

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

Table 19: Inclusion details for clinical indicator 3a: Inpatients on ACEI, ARB or ARNI at time of hospital discharge

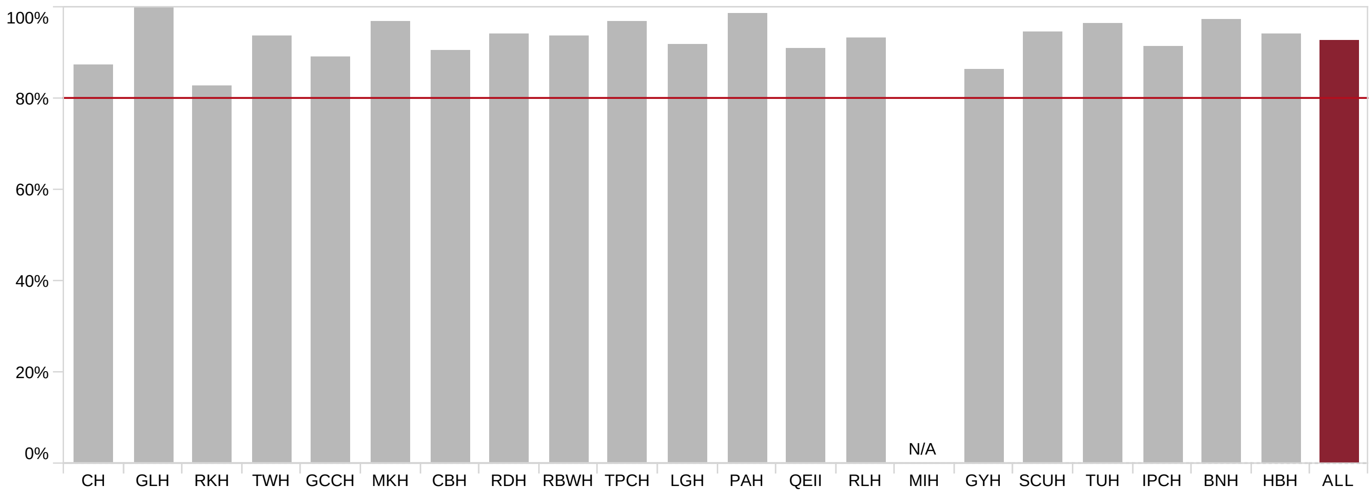
	n	%
Eligible for analysis	3,189	
Achieved benchmark	2,926	91.8
Benchmark not achieved	263	8.2
Ineligible		
Documented contraindication*	143	
Incomplete data	14	
Total inpatient referrals analysed	**3,346**	

* Adverse reaction to ACEI/ARB or ARNI, palliative intent to treatment, pregnancy, eGFR <30mL/min/1.73m², severe aortic stenosis, renal artery stenosis, serum potassium >5.5 mmol/L, symptomatic hypotension

Heart Failure Support Services

3b ACEI, ARB or ARNI prescription for HFrEF at time of first HFSS clinical review

At the time of first clinical review, the target for prescription of ACEI, ARB or ARNI was met for 93% of eligible patients. Of these patients there were 69% of patients who were prescribed ARNI and the remaining 31% an ACEI/ARB.



N/A: Eligible referrals <20

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

Table 20: Inclusion details for clinical indicator 3b: Patients on ACEI, ARB or ARNI at first clinical review

	n	%
Eligible for analysis	3,927	
Achieved benchmark	3,640	92.7
Benchmark not achieved	287	7.3
Ineligible		
Documented contraindication*	129	
Incomplete data	9	
Total analysed	**4,065**	

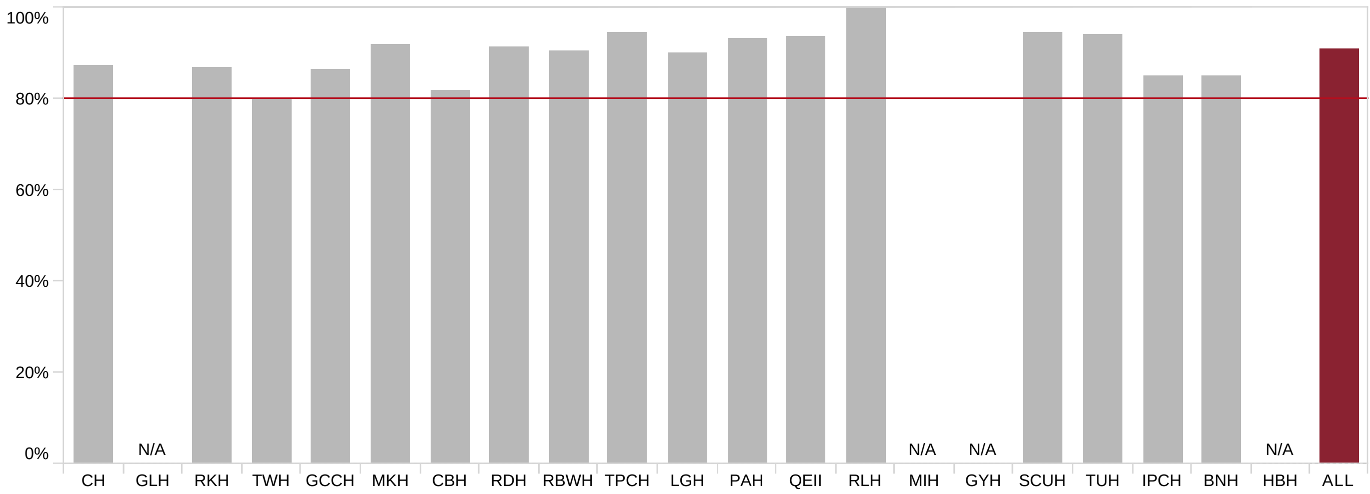
* Adverse reaction to ACEI/ARB or ARNI, palliative intent to treatment, pregnancy, eGFR <30mL/min/1.73m², severe aortic stenosis, renal artery stenosis, serum potassium >5.5 mmol/L, symptomatic hypotension

6.4 Prescription of guideline recommended beta blockers for HFrEF

Guideline recommended beta blockers have been shown to reduce mortality and morbidity in patients with HFrEF and are recommended for all patients unless contraindicated or not tolerated.[56,57] 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, 91% of eligible patients were prescribed guideline recommended beta blockers. Of these patients there were 85%, 8%, 5% and 2% of patients who were prescribed bisoprolol, metoprolol sustained release, carvedilol, and nebivolol respectively.



N/A: Eligible referrals <20

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

Table 21: Inclusion details for clinical indicator 4a: Patients on guideline recommended beta blocker at hospital discharge

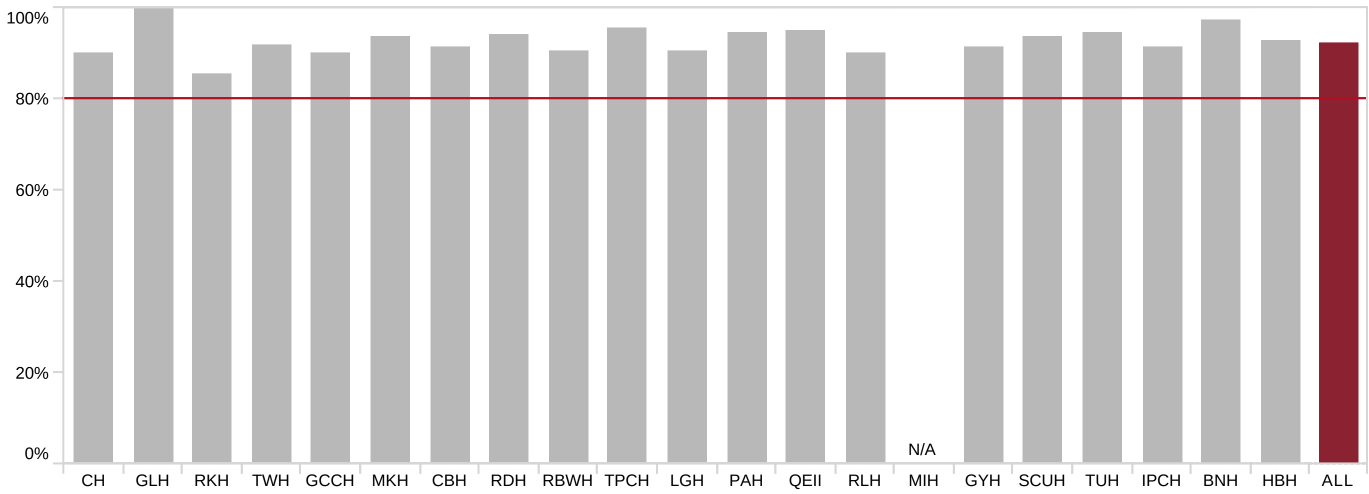
	n	%
Eligible for analysis	3,264	
Achieved benchmark	2,969	91.0
Benchmark not achieved	295	9.0
Ineligible		
Documented contraindication*	68	
Incomplete data	14	
Total inpatient referrals analysed	**3,346**	

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

Heart Failure Support Services

4b Beta blocker prescription for HFrEF at time of first HFSS clinical review

At the first clinical review, 92% of eligible referrals to HFSS were reported to be on a guideline recommended beta blocker. Of these patients there were 84%, 8%, 5% and 3% of patients who were prescribed bisoprolol, metoprolol sustained release, carvedilol, and nebivolol respectively.



N/A: Eligible referrals <20

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

Table 22: Inclusion details for clinical indicator 4b: Patients on guideline recommended beta blocker at first clinical review

	n	%
Eligible for analysis	3,976	
Achieved benchmark	3,664	92.2
Benchmark not achieved	312	7.8
Ineligible		
Documented contraindication*	80	
Incomplete data	9	
Total referrals analysed	**4,065**	

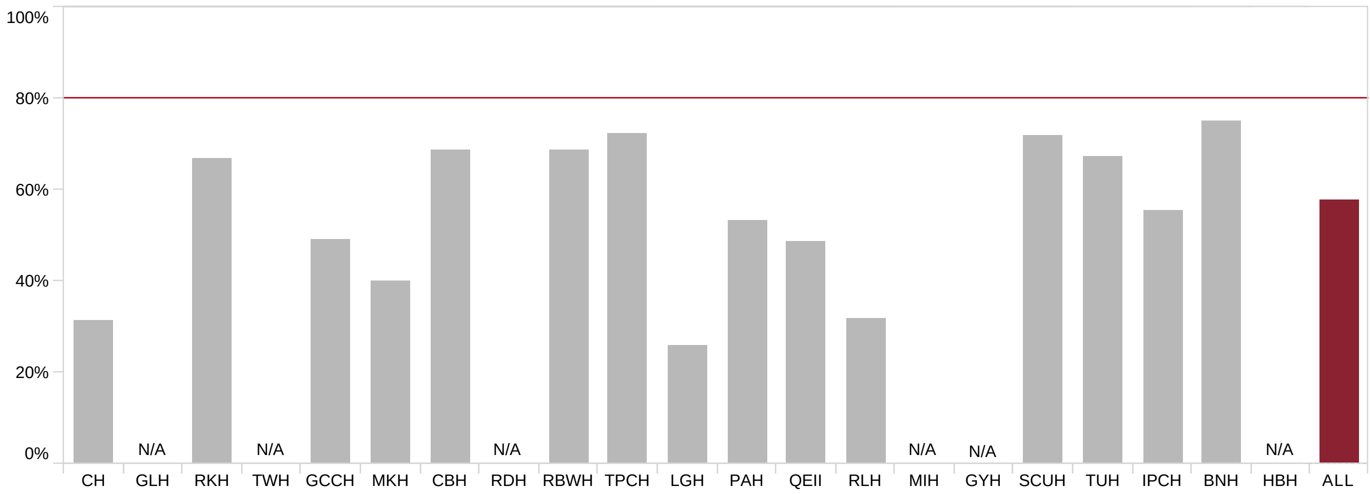
* Adverse reaction to beta blocker, palliative intent to treatment, pregnancy, bradycardia (HR <50bpm), symptomatic hypotension, severe COPD, asthma/reversible airways disease

6.5 Prescription of mineralocorticoid receptor antagonists (MRA) for patients with HFrEF

Guideline recommended mineralocorticoid receptor antagonists have been shown to reduce mortality and morbidity in patients with HFrEF and are recommended for all patients unless contraindicated or not tolerated.[56,57] 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, 58% of eligible patients referred to an HFSS were prescribed an MRA. Of these patients there were 81% who were prescribed spironolactone and 19% prescribed eplerenone. All sites were below the benchmark.



N/A: Eligible referrals <20

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

Table 23: Inclusion details for clinical indicator 5a: Patients on guideline recommended MRA at hospital discharge

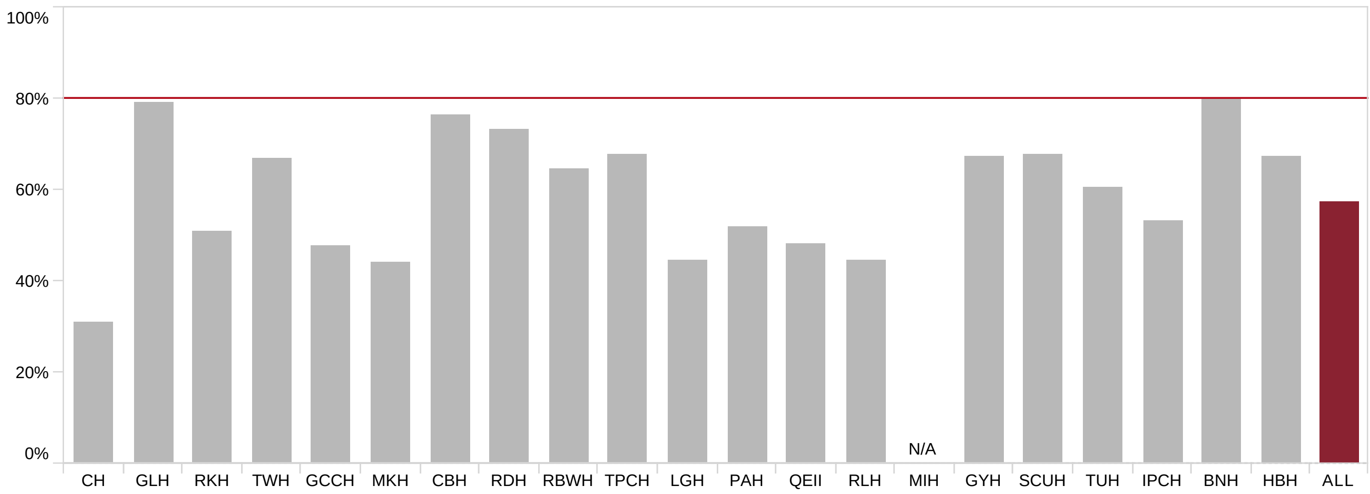
	n	%
Eligible for analysis	3,346	
Achieved benchmark	1,758	57.6
Benchmark not achieved	1,292	42.4
Ineligible		
Documented contraindication*	282	
Missing data	14	
Total inpatient referrals analysed	**3,346**	

* 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%

Heart Failure Support Services

5b Prescription of MRA for HFrEF at time of first HFSS clinical review

At the time of first clinical review, 58% of eligible referrals to an HFSS were reported to be on a guideline recommended MRA. Of these patients there were 86% prescribed spironolactone and 14% of patients who were prescribed eplerenone.



N/A: Eligible referrals <20

Figure 16: Proportion of patients on guideline recommended MRA at first clinical review by site

Table 24: Inclusion details for clinical indicator 5b: Patients on guideline recommended MRA at first clinical review

	n	%
Eligible for analysis	3,721	
Achieved benchmark	2,138	57.5
Benchmark not achieved	1,583	42.5
Ineligible		
Documented contraindication*	335	
Missing data	9	
Total referrals analysed	**4,065**	

* 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%

6.6 Prescription of sodium-glucose cotransporter-2 (SGLT2) inhibitors for HFrEF

Guideline recommended sodium-glucose cotransporter-2 (SGLT2) inhibitors have been shown to reduce mortality and morbidity in patients with HFrEF and are recommended for all patients unless contraindicated or not tolerated. Guideline recommended SGLT2 inhibitors include dapagliflozin and empagliflozin.[58,59,60]

6a Prescription of SGLT2 inhibitor for HFrEF at time of hospital discharge

At the time of discharge from hospital, 38% of eligible referrals to an HFSS were reported to be on a guideline recommended SGLT2 inhibitor for HFrEF.

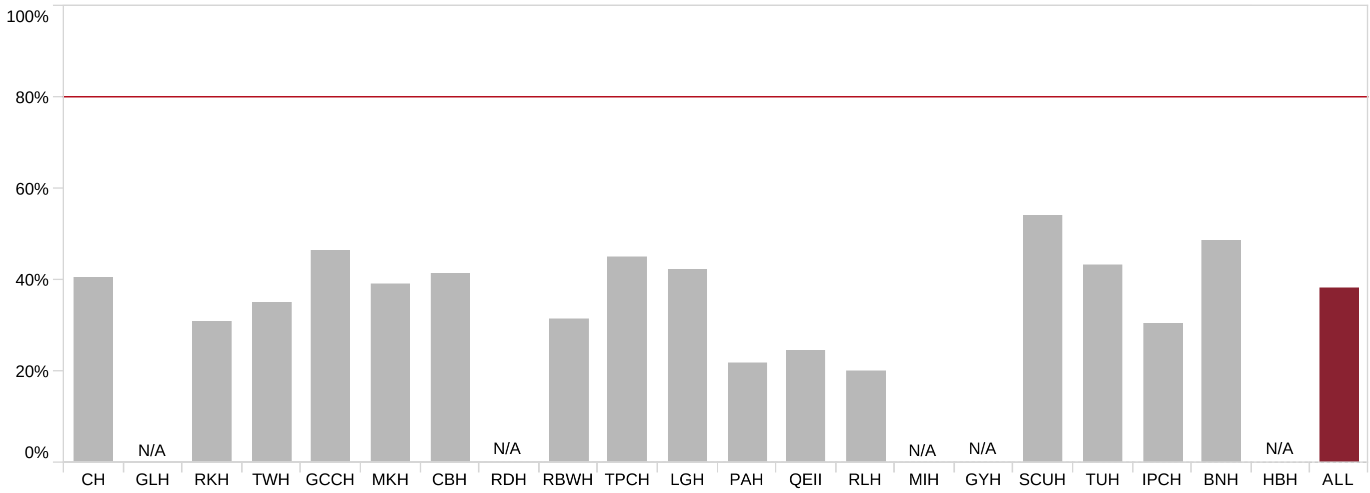


Figure 17: Proportion of HFrEF patients on guideline recommended SGLT2 inhibitor at hospital discharge by site

Table 25: Inclusion details for clinical indicator 6a: HFrEF patients on guideline recommended SGLT2 inhibitor at hospital discharge

	n	%
Eligible for analysis	2,812	
Achieved benchmark	1,072	38.1
Benchmark not achieved	1,740	61.9
Ineligible		
Documented contraindication*	251	
Missing data	283	
Total referrals analysed	**3,346**	

* SGLT2 inhibitor adverse reaction, type 1 diabetes mellitus, previous ketoacidosis, palliative intent to treatment, pregnancy, eGFR <20mL/min/1.73m², or symptomatic hypotension

6b Prescription of SGLT2 inhibitor for HFrEF at time of first HFSS clinical review

At the time of first clinical review, 40% of eligible referrals to an HFSS were reported to be on a guideline recommended SGLT2 inhibitor for HFrEF.

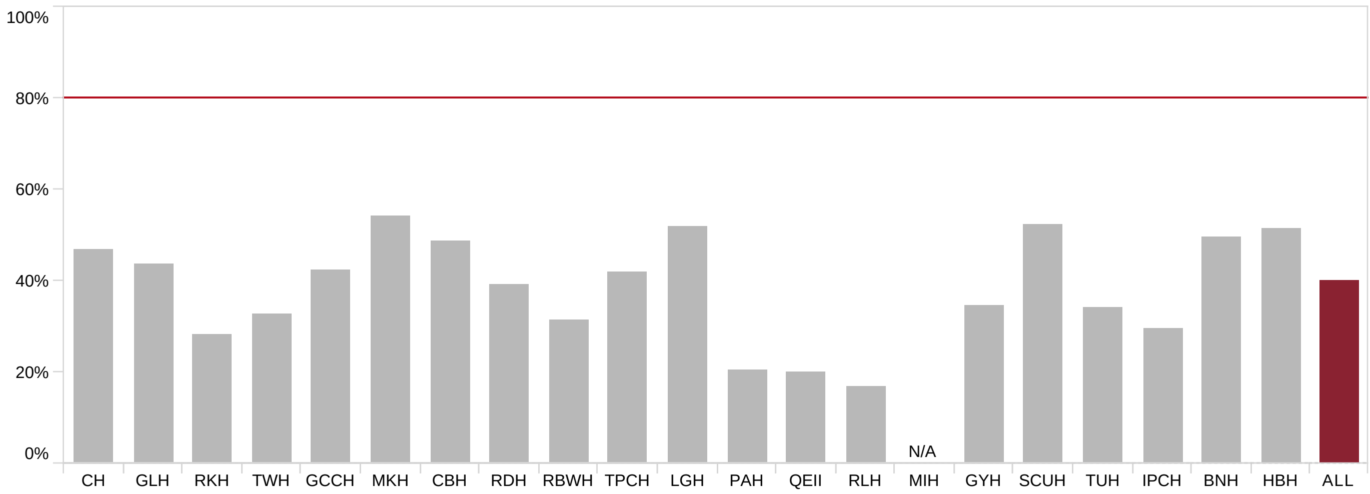


Figure 18: Proportion of HFrEF patients on guideline recommended SGLT2 inhibitor at first clinical review by site

Table 26: Inclusion details for clinical indicator 6b: HFrEF patients on guideline recommended SGLT2 inhibitor at first clinical review

	n	%
Eligible for analysis	3,529	
Achieved benchmark	1,410	40.0
Benchmark not achieved	2,119	60.0
Ineligible		
Documented contraindication*	262	
Missing data	274	
Total referrals analysed	**4,065**	

* SGLT2 inhibitor adverse reaction, type 1 diabetes mellitus, previous ketoacidosis, palliative intent to treatment, pregnancy, eGFR <20mL/min/1.73m², or symptomatic hypotension

6.7 Beta blocker titration

This indicator looks at the progress of titration of guideline recommended beta blockers at six months following hospital discharge or when deactivated from the HFSS, whichever is sooner. The timeframe is taken from the first clinical review by HFSS (usually at four weeks from referral or hospital discharge).

The indicator measures three components of beta blocker titration at six months, including:

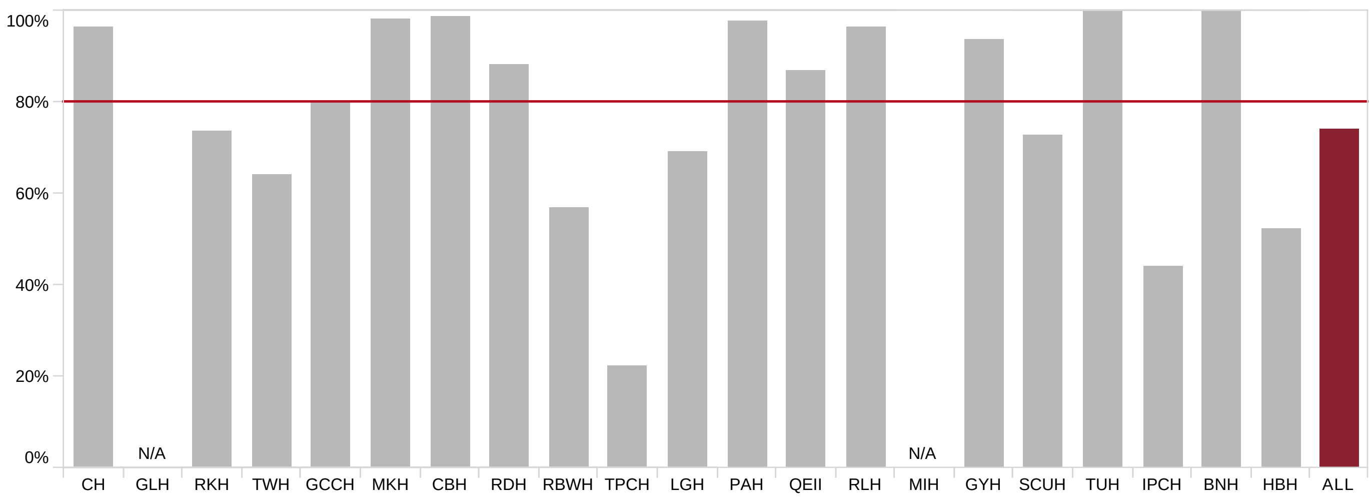
a) Review of titration status undertaken,

b) Achievement of target dose, and

c) Achievement of target or maximum tolerated dose.

7a 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), 74% of patients received a beta blocker titration review which is below the benchmark. Variation in performance amongst services was observed and is demonstrated in the figure below.



N/A: Eligible referrals <20

Figure 19: Proportion of patients who had a beta blocker titration review conducted within six months by site

Table 27: Inclusion details for clinical indicator 6a: Patients who had a beta blocker titration review within six months

	n	%
Eligible for analysis	1,959	
Achieved benchmark	1,447	73.9
Benchmark not achieved	512	26.1
Ineligible	1,653	
Patient on target dose at the time of referral	775	
Patient could not be contacted, lives out of area or repeated failure to attend	158	
Patient declined service	138	
Referred to another HFSS	79	
HF no longer prime issue (palliative care, high care nursing home etc.)	69	
Patient deceased	66	
Referred to another service (e.g. cardiac rehabilitation or community nursing)	51	
Documented contraindication*	28	
Other reason	289	
Incomplete data	38	
Total analysed	**3,650**	

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

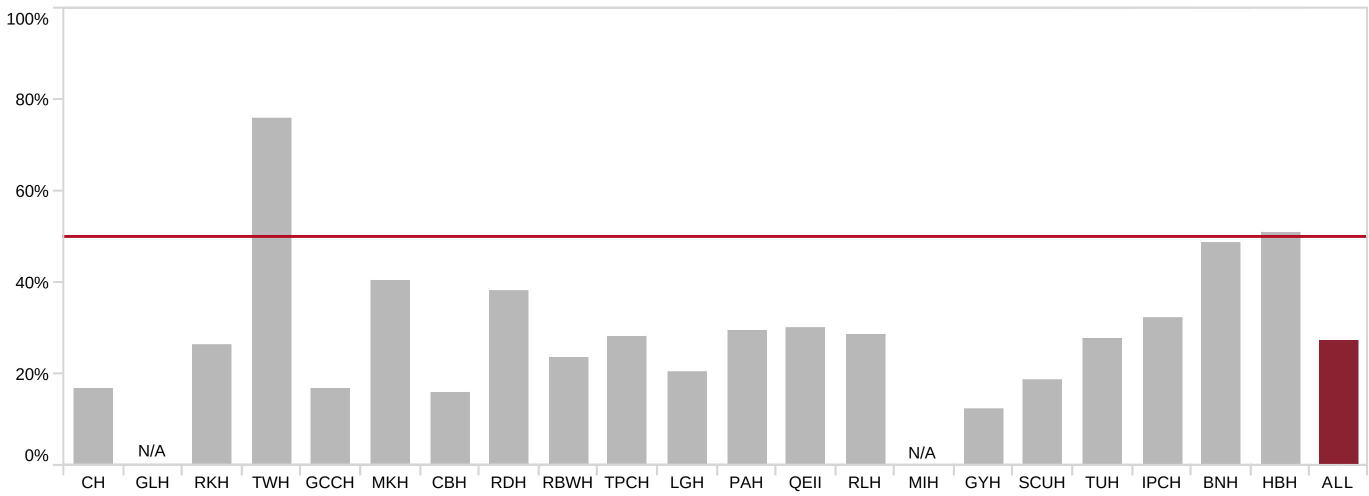
7b Beta blocker clinical guideline target dose achieved at time of titration review

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 27% of referrals within six months or at deactivation, with only two sites exceeding the benchmark (see Figure 20).

Daily target doses are:

- Carvedilol 50–100 mg
- Metoprolol sustained release 190 mg
- Bisoprolol 10 mg
- Nebivolol 10 mg



N/A: Eligible referrals <20

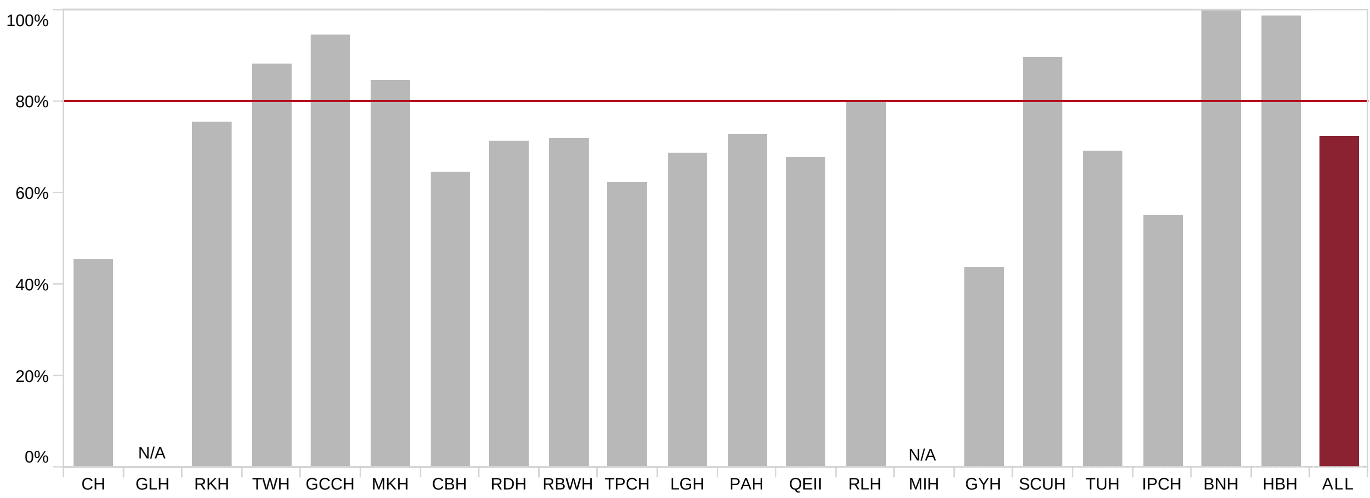
Figure 20: Proportion of patients who achieved target beta blocker dose at time of titration review by site

Table 28: Inclusion details for clinical indicator 6b: Patients who achieved target beta blocker dose at time of titration review

	n	%
Eligible for analysis	1,959	
Achieved benchmark	533	27.2
Benchmark not achieved	1,426	72.8
Ineligible	N/A	
Total titration reviews conducted	**1,959**	

7c Beta blocker titration clinical guideline target or maximum tolerated dose achieved at time of titration review

Maximum tolerated dose of beta blockers is based on a clinical judgement balancing the harm and benefit of up-titration. The proportion of patients reaching the target dose or maximum tolerated dose of guideline recommended beta blocker medication by the time of the titration review was 72%.



N/A: Eligible referrals <20

Figure 21: Proportion of patients who achieved target beta blocker dose or maximum tolerated dose at time of titration review

Table 29: 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	1,959	
Achieved benchmark	1,415	72.2
Benchmark not achieved	544	27.8
Ineligible	N/A	
Total titration reviews conducted	**1,959**	

6.8 Prescription of sodium-glucose cotransporter-2 (SGLT2) inhibitors for HFpEF

Guideline recommended sodium-glucose cotransporter-2 (SGLT2) have been shown to reduce cardiovascular death or HF hospitalisations in patients with HFpEF and are recommended for all patients unless contraindicated or not tolerated. Guideline recommended SGLT2 inhibitors for HFpEF including dapagliflozin and empagliflozin.[58,60]

8a Prescription of SGLT2 inhibitor for HFpEF at time of hospital discharge

At the time of discharge from hospital, 13% of eligible referrals to an HFSS were reported to be on a guideline recommended SGLT2 inhibitor for HFpEF.

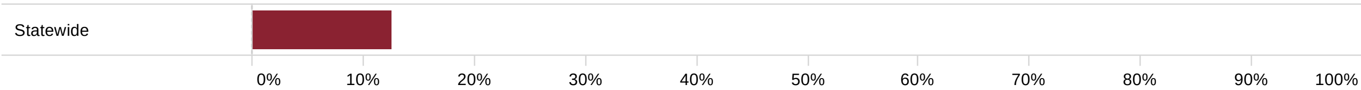


Figure 22: Proportion of HFpEF patients on guideline recommended SGLT2 inhibitor at hospital discharge

Table 30: Inclusion details for clinical indicator 8a: HFpEF patients on guideline recommended SGLT2 inhibitor at hospital discharge

	n	%
Eligible for analysis	287	
Achieved benchmark	36	12.5
Benchmark not achieved	251	87.5
Ineligible		
Documented contraindication*	43	
Missing data	45	
Total referrals analysed	**375**	

* SGLT2 inhibitor adverse reaction, type 1 diabetes mellitus, previous ketoacidosis, palliative intent to treatment, pregnancy, eGFR <20mL/min/1.73m^2, or symptomatic hypotension

8b Prescription of SGLT2 inhibitor for HFpEF at time of first HFSS clinical review

At the time of first clinical review, 14% of eligible referrals to an HFSS were reported to be on a guideline recommended SGLT2 inhibitor for HFpEF.

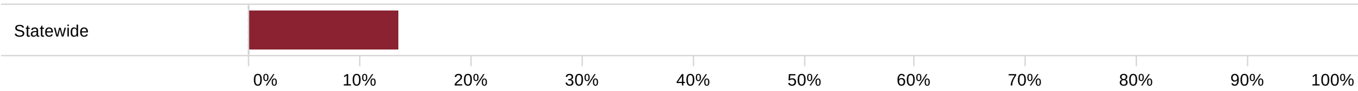


Figure 23: Proportion of HFpEF patients on guideline recommended SGLT2 inhibitor at first clinical review by site

Table 31: Inclusion details for clinical indicator 8b: HFpEF patients on guideline recommended SGLT2 inhibitor at first clinical review

	n	%
Eligible for analysis	312	
Achieved benchmark	42	13.5
Benchmark not achieved	270	86.5
Ineligible		
Documented contraindication*	47	
Missing data	69	
Total referrals analysed	**428**	

* SGLT2 inhibitor adverse reaction, type 1 diabetes mellitus, previous ketoacidosis, palliative intent to treatment, pregnancy, eGFR <20mL/min/1.73m², or symptomatic hypotension

6.9 Summary of clinical indicators

Table 32: Summary of clinical process indicator performance by site

	Clinical indicator achievement (%)													
HFSS	**1a**	**1b**	**2**	**3a**	**3b**	**4a**	**4b**	**5a**	**5b**	**6a**	**6b**	**7a**	**7b**	**7c**
Cairns Hospital	95	89	98	84	88	88	90	31	31	40	47	100	17	51
Gladstone Hospital	–	–	100	–	100	–	100	–	79	–	44	–	–	–
Rockhampton Hospital	88	94	98	86	83	87	86	67	51	31	28	97	29	76
Toowoomba Hospital	–	55	96	95	94	80	92	–	67	35	33	–	–	–
Gold Coast Community Health	93	99	97	89	89	87	90	49	48	46	42	78	18	94
Mackay Base Hospital	62	91	100	95	97	92	93	40	44	39	54	100	32	85
Caboolture Hospital	53	71	95	77	90	82	92	69	76	41	49	99	17	63
Redcliffe Hospital	43	65	96	100	94	91	94	–	73	–	39	–	–	–
Royal Brisbane & Women's Hospital	61	84	98	95	94	90	91	68	65	31	31	84	33	84
The Prince Charles Hospital	66	38	97	95	97	94	95	72	68	45	42	29	28	74
Logan Hospital	97	97	98	86	92	90	90	26	45	42	52	64	21	75
Princess Alexandra Hospital	86	61	99	96	98	93	95	53	52	22	21	97	29	71
Queen Elizabeth II Hospital	66	98	100	90	91	94	95	49	48	25	20	88	38	78
Redland Hospital	100	99	97	96	93	100	90	32	44	20	17	93	32	91
Mt Isa Hospital	–	–	64	–	–	–	–	–	–	–	–	–	–	–
Gympie Hospital	86	89	95	–	87	–	91	–	67	–	34	81	10	24
Sunshine Coast University Hospital	85	35	99	91	95	95	93	72	68	54	52	75	19	88
Townsville Hospital	100	100	98	95	96	94	95	67	60	43	34	100	29	72
Ipswich Community Health	59	83	98	92	91	85	91	56	53	31	30	33	35	55
Bundaberg Hospital	74	97	100	95	97	85	97	75	80	49	50	100	53	100
Hervey Bay Hospital	96	99	100	–	94	–	93	–	68	–	52	53	47	97
Statewide	**79**	**79**	**98**	**92**	**93**	**91**	**92**	**58**	**58**	**38**	**40**	**77**	**28**	**75**

Legend:

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

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

2 Assessment of left ventricular ejection fraction within two years (Benchmark: 80%)

3a ACEI, ARB or ARNI prescription at hospital discharge (Benchmark: 80%)

3b ACEI, ARB or ARNI prescription at first clinical review (Benchmark: 80%)

4a Guideline recommended beta blocker prescription at hospital discharge (Benchmark: 80%)

4b Guideline recommended beta blocker prescription at first clinical review (Benchmark: 80%)

5a Guideline recommended MRA prescription at hospital discharge (Benchmark: 80%)

5b Guideline recommended MRA prescription at first clinical review (Benchmark: 80%)

6a Guideline recommended SGLT2 inhibitor prescription for HFrEF at hospital discharge (Benchmark: 80%)

6b Guideline recommended SGLT2 inhibitor prescription for HFrEF at first clinical review (Benchmark: 80%)

7a Beta blocker titration status review at six months post referral (Benchmark: 80%)

7b Beta blockers achievement of guideline recommended target dose (Benchmark: 50%)

7c Beta blockers achievement of guideline recommended target dose or maximum tolerated dose (Benchmark: 80%)

7 Patient outcomes

Chronic heart failure is associated with recurrent hospitalisation and increased mortality. Support from multidisciplinary HF disease management programmes (such as an HFSS) and adherence to recommended therapies are associated with improved outcomes.

7.1 Methods

This analysis used the previously reported 2021 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 2021 were included. The earliest admission of the calendar year was considered the index admission (which may not be the first time that a patient has been hospitalised with heart failure).

Eligibility criteria for the mortality and readmission analysis cohort were applied at the time of the index admission. The eligibility status for days alive and out of hospital (DAOH) analysis was reviewed at all subsequent admissions over 12 months to exclude patients who were transferred to private hospitals or interstate.

The patient outcome indicators of interest are summarised in Table 33. Survival curves were constructed using the Kaplan–Meier method and cumulative incidence function was used to estimate the risk of all-cause and HF-related rehospitalisation to account for the competing risk of death.

DAOH was calculated to reflect the burden of recurrent hospitalisation, hospital length of stay and death, and was expressed as both median values, interquartile range, and mean values. Categorical variables were summarised as frequencies and percentages.

Table 33: 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 3,978 inpatient referrals of which 96% were successfully linked with the QHAPDC data. There were 454 patients who were ineligible for readmission and mortality analysis for the reasons shown in Table 34. A further 81 patients (2%) did not have complete follow up over one year to allow DAOH to be calculated.

Table 34: Eligibility criteria for patient outcome indicators

	n	%
Total 2021 inpatient referrals	**3,978**	**100.0**
Ineligible at index admission		
Duplicate patient record	139	3.5
Not a Queensland resident	58	1.5
Transferred to private hospital	35	0.9
Died during index admission	32	0.8
Index admission is not overnight	25	0.6
No linkage data available	165	4.1
Included in readmission and mortality analysis	**3,524**	**88.6**
Ineligible at subsequent admission over 1 year		
Transferred to private hospital	81	2.0
Included in days alive and out of hospital analysis	**3,443**	**86.6**

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 1.2% and 12.2%. The Kaplan-Meier survival analyses below (Figures 24 to 26) suggest that older age was associated with increased mortality rates at all time points and particularly at 12 months.

Table 35: 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	41 (1.2)	132 (3.7)	240 (6.8)	431 (12.2)
Died during subsequent admission*	16 (0.5)	66 (1.9)	133 (3.8)	237 (6.7)
All other deaths	25 (0.7)	66 (1.9)	107 (3.0)	194 (5.5)
Total at risk	**3,483 (98.8)**	**3,392 (96.3)**	**3,284 (93.2)**	**3,093 (87.8)**

* Data available for Queensland public hospitals only

Table 36: Cumulative all-cause unadjusted mortality by patient characteristic

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,275	24 (1.1)	79 (3.5)	148 (6.5)	275 (12.1)
Female	1,249	17 (1.4)	53 (4.2)	92 (7.4)	156 (12.5)
Age group					
<65 years	1301	7 (0.5)	26 (2.0)	41 (3.2)	67 (5.1)
65–74 years	910	14 (1.5)	34 (3.7)	57 (6.3)	107 (11.8)
≥75 years	1313	20 (1.5)	72 (5.5)	142 (10.8)	257 (19.6)
Heart failure phenotype					
HFrEF	2738	29 (1.1)	94 (3.4)	163 (6.0)	302 (11.0)
HFpEF	599	7 (1.2)	26 (4.3)	57 (9.5)	91 (15.2)
Primary right HF	125	3 (2.4)	9 (7.2)	15 (12.0)	29 (23.2)
Missing/unsure	62	2 (3.2)	3 (4.8)	5 (8.1)	9 (14.5)
ALL	**3,524**	**41 (1.2)**	**132 (3.7)**	**240 (6.8)**	**431 (12.2)**

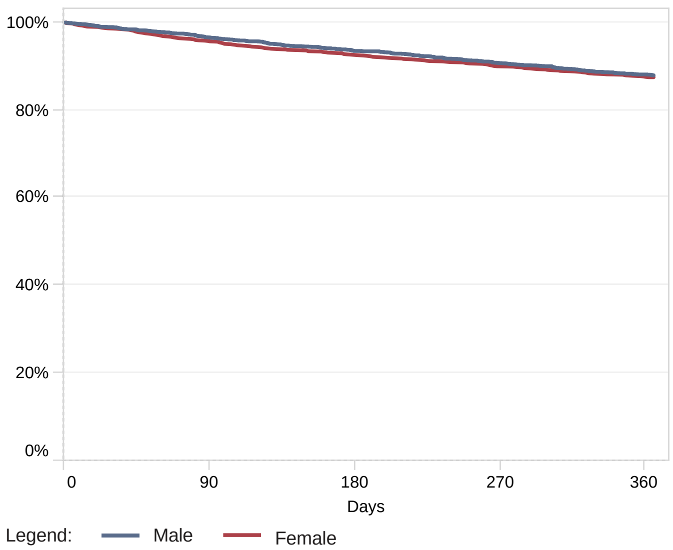


Figure 24: Heart failure survival by gender

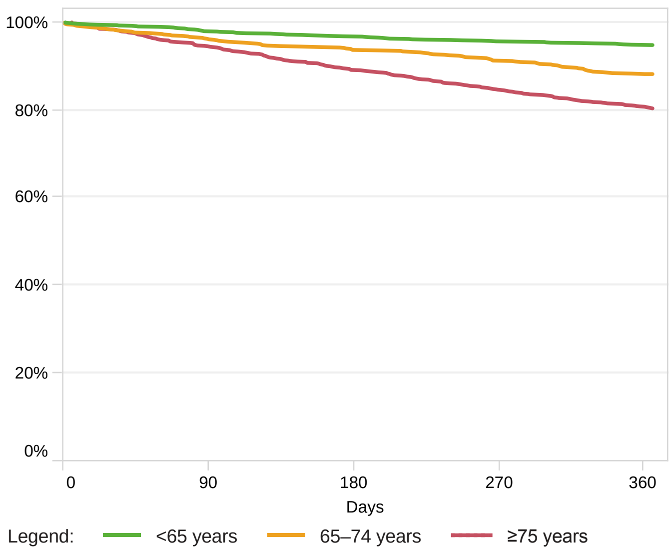


Figure 25: Heart failure survival by age group

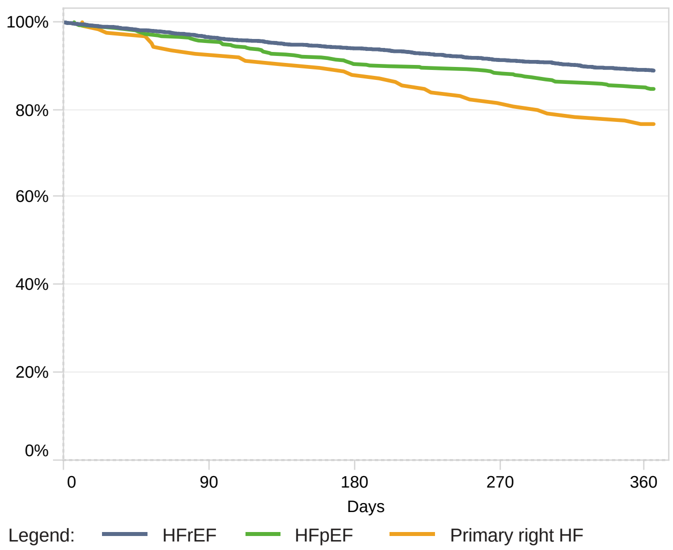


Figure 26: Heart failure survival by phenotype

7.2.2 All-cause and heart failure rehospitalisation

Cumulative incidence curves for all-cause and HF hospitalisation are shown in Figures 27 and 28. Of the 3,524 eligible patients referred to HFSS during 2021, the unadjusted rate of all-cause hospitalisation was 16.4% at 30 days, increasing to 52.8% at one year. Hospitalisations relating to HF (as identified by discharge diagnosis coding) were 4.7% and 19.4% at 30 days and one year respectively.

The overall risk of hospitalisation or death within 12 months post the index admission was 54.1% (Figure 29). More than one quarter of patients referred to an HFSS were rehospitalised at least twice in the subsequent 12 months (Table 37).

Table 37: Number of rehospitalisations per patient in the year post initial discharge

Total in one year	All-cause n (%)	Heart failure n (%)
0	1,713 (48.6)	2,894 (82.1)
1	841 (23.9)	426 (12.1)
2	417 (11.8)	124 (3.5)
3	231 (6.6)	46 (1.3)
4	139 (3.9)	14 (0.4)
≥5	183 (5.2)	20 (0.6)

Table 38: Cumulative incidence of all-cause rehospitalisation from 30 to 365 days post discharge

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,275	347 (15.4)	651 (29)	879 (39.4)	1,122 (50.8)
Female	1,249	226 (18.3)	400 (32.4)	527 (42.9)	689 (56.4)
Age group					
‹65 years	1,301	168 (13)	321 (24.9)	438 (34.1)	570 (44.4)
65–74 years	910	164 (18.2)	281 (31.2)	367 (41.1)	456 (51.9)
≥75 years	1,313	241 (18.5)	449 (34.8)	601 (46.9)	785 (62.0)
Heart failure phenotype					
HFrEF	2,738	422 (15.5)	766 (28.3)	1,024 (38.0)	1,310 (49.1)
HFpEF	599	114 (19.1)	217 (36.5)	286 (48.6)	377 (64.6)
Primary right HF	125	30 (24.4)	51 (41.8)	72 (59.5)	89 (76.1)
Missing/unsure	62	7 (11.7)	17 (28.8)	24 (40.7)	35 (59.3)
ALL	**3,524**	**573 (16.4)**	**1051 (30.2)**	**1406 (40.6)**	**1,811 (52.8)**

Table 39: Cumulative incidence of heart failure rehospitalisation from 30 to 365 days post discharge

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,275	105 (4.7)	205 (9.2)	289 (13.3)	384 (18.3)
Female	1,249	60 (4.9)	132 (10.9)	182 (15.3)	246 (21.4)
Age group					
‹65 years	1,301	48 (3.7)	98 (7.6)	135 (10.6)	173 (13.8)
65–74 years	910	46 (5.1)	84 (9.5)	116 (13.3)	168 (20.0)
≥75 years	1,313	71 (5.5)	155 (12.3)	220 (18.0)	289 (25.0)
Heart failure phenotype					
HFrEF	2,738	127 (4.7)	237 (8.9)	331 (12.6)	442 (17.3)
HFpEF	599	29 (4.9)	74 (12.6)	105 (18.7)	141 (26.1)
Primary right HF	125	7 (5.7)	20 (16.8)	29 (24.6)	37 (34.3)
Missing/unsure	62	2 (3.3)	6 (10.2)	6 (10.5)	10 (18.5)
ALL	**3,524**	**165 (4.7)**	**337 (9.8)**	**471 (14.0)**	**630 (19.4)**

Table 40: Cumulative incidence of all-cause rehospitalisation or death from 30 to 365 days post discharge

Characteristic	Total patients n	30 days n (%)	90 days n (%)	180 days n (%)	365 days n (%)
Gender					
Male	2,275	363 (16.0)	681 (29.9)	921 (40.5)	1190 (52.3)
Female	1,249	237 (19.0)	415 (33.2)	548 (43.9)	717 (57.4)
Age group					
<65 years	1,301	173 (13.3)	335 (25.7)	454 (34.9)	588 (45.2)
65–74 years	910	173 (19.0)	291 (32.0)	383 (42.1)	488 (53.6)
≥75 years	1,313	254 (19.3)	470 (35.8)	632 (48.1)	831 (63.3)
Heart failure phenotype					
HFrEF	2,738	442 (16.1)	801 (29.3)	1070 (39.1)	1380 (50.4)
HFpEF	599	117 (19.5)	221 (36.9)	296 (49.4)	392 (65.4)
Primary right HF	125	32 (25.6)	54 (43.2)	76 (60.8)	97 (77.6)
Missing/unsure	62	9 (14.5)	20 (32.3)	27 (43.5)	38 (61.3)
ALL	**3,524**	**600 (17.0)**	**1,096 (31.1)**	**1,469 (41.7)**	**1,907 (54.1)**

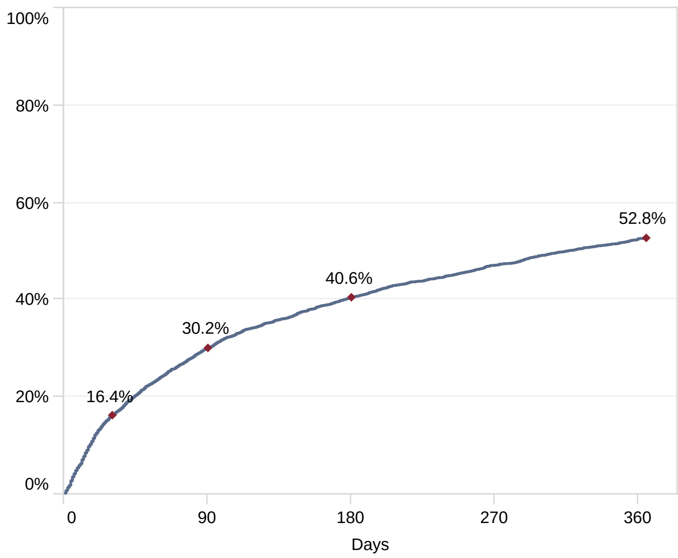


Figure 27: Cumulative incidence of all-cause rehospitalisation

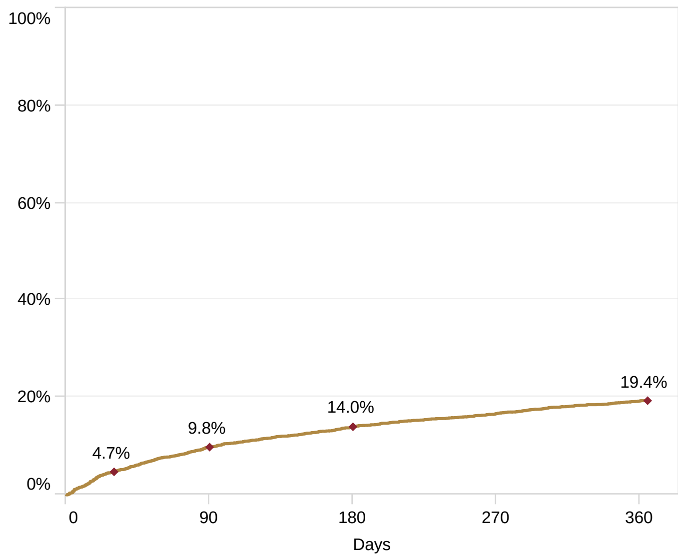


Figure 28: Cumulative incidence of heart failure rehospitalisation

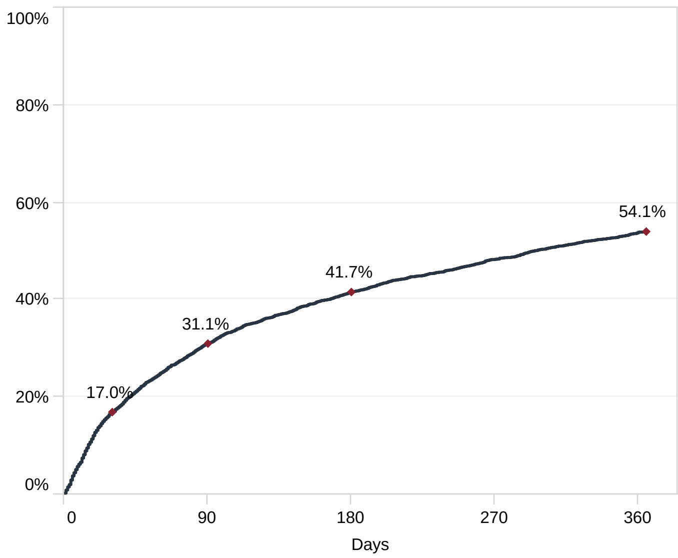


Figure 29: Cumulative incidence of all-cause rehospitalisation or death

7.2.3 Days alive and out of hospital

Days alive and out of hospital (DAOH) incorporates mortality and all hospitalisations (including length of hospital stay) within one year of discharge. This single measure demonstrates the post discharge time alive and not in hospital as a combined measure.

Almost 47% of patients survived more than a year without rehospitalisation, with a median of 364 days for the whole group. The mean days alive and out of hospital was 334.2, with 112,096 days lost due to death or hospitalisation over 12 months in 3,443 patients.

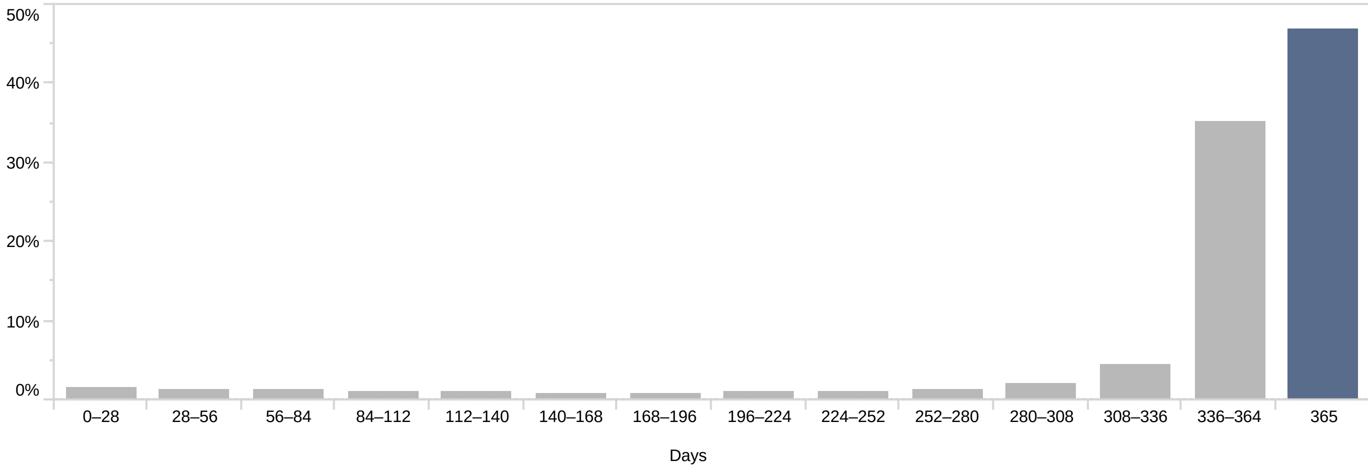
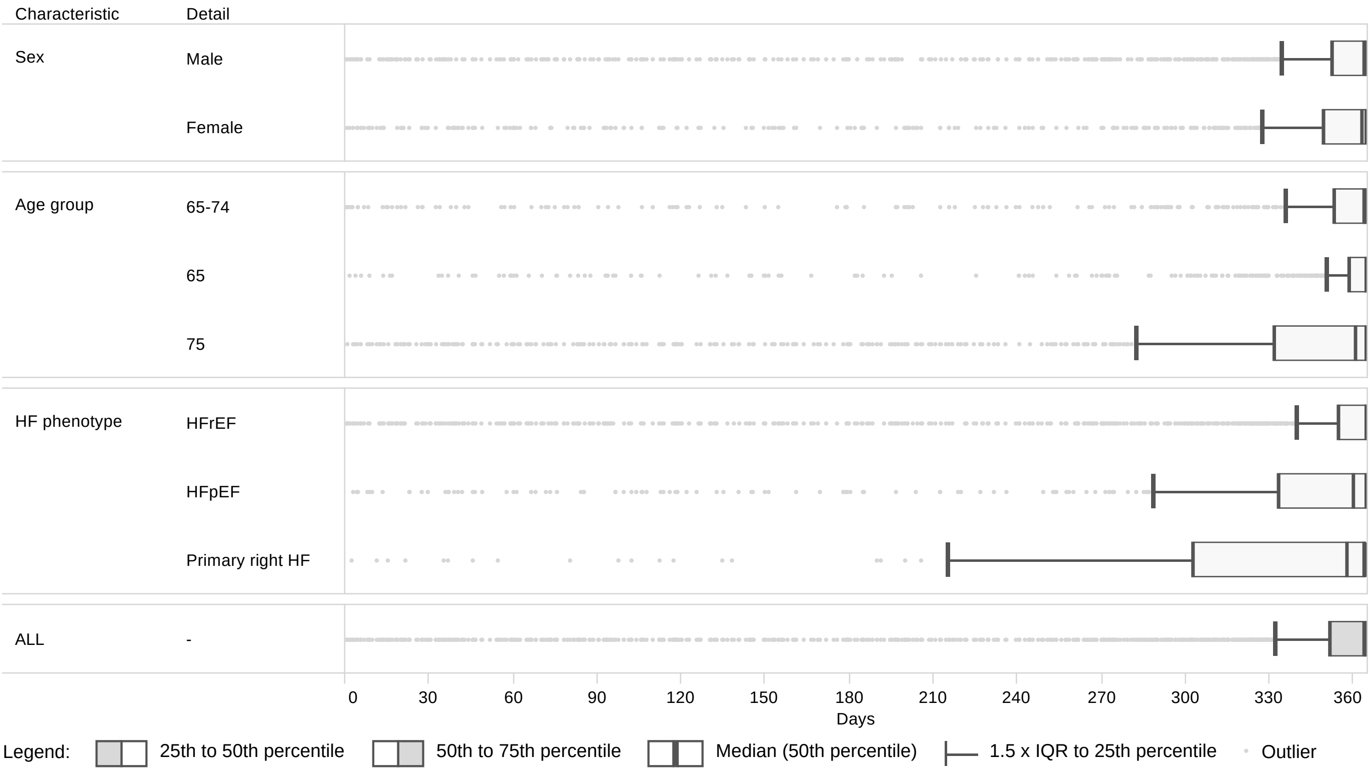


Figure 30: Days alive and out of hospital within one year after hospital discharge

Table 41: Days alive and out of hospital within one year of discharge by patient characteristic

Characteristic	Detail	n	Mean days	Median (IQR) days
Sex	Male	2,227	334.1	364 (353–365)
	Female	1,216	329.4	363 (350–365)
Age group	‹65	1,291	347.2	365 (359–365)
	65–74	884	334.2	364 (353–365)
	≥75	1,268	316.2	361 (332–365)
HF phenotype	HFrEF	2,688	336.1	365 (355–365)
	HFpEF	578	321.7	361 (334–365)
	Primary right HF	117	304.3	358 (303–365)
	Missing/unsure	60	326.1	363 (350–365)
ALL		**3,443**	**332.4**	**364 (352–365)**

The box and whisker plots in Figure 31 illustrate the distribution of DAOH for different characteristics. The median DAOH is close to 365 days for most categories (the box shows the middle 50% of scores). The whiskers stretching to the left illustrate that many patients spent subsequent time in hospital or died. The DAOH was much lower for patients who were over 75 years old.



Mean, median and interquartile range (IQR) are given in days

Figure 31: Days alive and out of hospital within one year of discharge by patient characteristic

Heart Failure Support Services

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Glossary

6MWT	Six Minute Walk Test
ACC	Aristotle Comprehensive Complexity
ACEI	Angiotensin Converting Enzyme Inhibitor
ACP	Advanced Care Paramedic
ACS	Acute Coronary Syndromes
AEP	Accredited Exercise Physiologist
ANZCORS	Australia and New Zealand Congenital Outcomes Registry for Surgery
ANZSCTS	Australian and New Zealand Society of Cardiac and Thoracic Surgeons
AQoL	Assessment of Quality of Life
ARB	Angiotensin II Receptor Blocker
ARNI	Angiotensin Receptor-Neprilysin Inhibitors
ASD	Atrial Septal Defect
AV	Atrioventricular
AVNRT	Atrioventricular Nodal Re-entry Tachycardia
AVRT	Atrioventricular Re-entrant Tachycardia
BCIS	British Cardiovascular Intervention Society
BiV	Biventricular
BMI	Body Mass Index
BNH	Bundaberg Hospital
BSSLTx	Bilateral Sequential Single Lung Transplant
CABG	Coronary Artery Bypass Graft
CAD	Coronary Artery Disease
CBH	Caboolture Hospital
CCL	Cardiac Catheter Laboratory
CCP	Critical Care Paramedic
CH	Cairns Hospital
CI	Clinical Indicator
CIED	Cardiac Implantable Electronic Device
CNC	Clinical Nurse Consultant
COVID-19	Coronavirus disease 2019
CPB	Cardiopulmonary Bypass
CR	Cardiac Rehabilitation
CRT	Cardiac Resynchronisation Therapy
CS	Cardiac Surgery
CVA	Cerebrovascular Accident
CVD	Cardiovascular Disease
DAOH	Days Alive and Out of Hospital
DOSA	Day of Surgery Admission
DSWI	Deep Sternal Wound Infection
ECG	12 lead Electrocardiograph
ECMO	Extracorporeal membrane oxygenation
ED	Emergency Department
eGFR	Estimated Glomerular Filtration Rate
EP	Electrophysiology
EuroSCORE	European System for Cardiac Operative Risk Evaluation
EWMA	Exponentially Weighted Moving Average
FdECG	First Diagnostic Electrocardiograph
FMC	First Medical Contact
FTR	Failure to Rescue
GAD	Generalised Anxiety Disorder
GC	Genetic Counsellor
GCCH	Gold Coast Community Health
GCS	Glasgow Coma Scale
GCUH	Gold Coast University Hospital
GLH	Gladstone Hospital
GP	General Practitioner
GYH	Gympie Hospital
HB	Haemoglobin
HBH	Hervey Bay Hospital (includes Maryborough)
HCC	Health Contact Centre
HF	Heart Failure
HFpEF	Heart Failure with Preserved Ejection Fraction
HFrEF	Heart Failure with Reduced Ejection Fraction
HFSS	Heart Failure Support Service
HHS	Hospital and Health Service
HOCM	Hypertrophic Obstructive Cardiomyopathy
IC	Interventional Cardiology
ICD	Implantable Cardioverter Defibrillator
IE	Infective Endocarditis
IER	Index of Economic Resources
IEO	Index of Education and Occupation
IHD	Ischaemic Heart Disease
IHT	Inter hospital Transfer
IPCH	Ipswich Community Health
IQR	Inter Quartile Range
IRSAD	Index of Relative Socioeconomic Advantage and Disadvantage
IRSD	Index of Relative Socioeconomic Disadvantage
IVDU	Intravenous Drug Use
LAA	Left Atrial Appendage
LAD	Left Anterior Descending Artery
LCX	Circumflex Artery
LGH	Logan Hospital
LMCA	Left Main Coronary Artery
LOS	Length Of Stay
LV	Left Ventricle

LVEF	Left Ventricular Ejection Fraction
LVOT	Left Ventricular Outflow Tract
MDT	Multidisciplinary Team Meeting
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
NCS	Networked Cardiac Services
NN	Nurse Navigator
NP	Nurse Practitioner
NRBC	Non-Red Blood Cells
NSTEMI	Non-ST Elevation Myocardial Infarction
OOHCA	Out of Hospital Cardiac Arrest
ORIF	Open Reduction Internal Fixation
PAH	Princess Alexandra Hospital
PCI	Percutaneous Coronary Intervention
PDA	Patent Ductus Arteriosus
PFO	Patent Foramen Ovale
PHQ	Patient Health Questionnaire
PICU	Paediatric intensive care unit
PPM	Permanent Pacemaker
PROMS	Patient Reported Outcome Measures
QAC	Quality Assurance Committee
QAS	Queensland Ambulance Service
QCCN	Queensland Cardiac Clinical Network
QCGP	Queensland Cardiology Genomics Project
QCOR	Queensland Cardiac Outcomes Registry
QEII	Queen Elizabeth II Jubilee Hospital
QHAPDC	Queensland Hospital Admitted Patient Data Collection
QPCR	Queensland Paediatric Cardiac Research
RBC	Red Blood Cells
RBWH	Royal Brisbane & Women's Hospital
RCA	Right Coronary Artery
RDH	Redcliffe Hospital
RHD	Rheumatic Heart Disease
RKH	Rockhampton Hospital
RLH	Redland Hospital
RVOT	Right Ventricular Outflow Tract
SAVR	Surgical Aortic Valve Replacement
SCCIU	Statewide Cardiac Clinical Informatics Unit
SCUH	Sunshine Coast University Hospital
SEIFA	Socioeconomic Indexes for Areas
SGLT2	Sodium-Glucose Cotransporter-2
SHD	Structural Heart Disease
SIR	Standardised Incidence Ratio
SMoCC	Self Management of Chronic Conditions
STEMI	ST-Elevation Myocardial Infarction
STS	Society of Thoracic Surgery
SVT	Supraventricular Tachycardia
TAVR	Transcatheter Aortic Valve Replacement
TIMI	Thrombolysis in Myocardial Infarction
TMVR	Transcatheter Mitral Valve Replacement
TNM	Tumour, Lymph Node, Metastases
TPCH	The Prince Charles Hospital
TPVR	Transcatheter Pulmonary Valve Replacement
TUH	Townsville University Hospital
TWH	Toowoomba Hospital
TTE	Transthoracic echocardiogram
VAD	Ventricular Assist Device
VATS	Video Assisted Thoracic Surgery
VCOR	Victorian Cardiac Outcomes Registry
VF	Ventricular Fibrillation
VSD	Ventricular Septal Defect