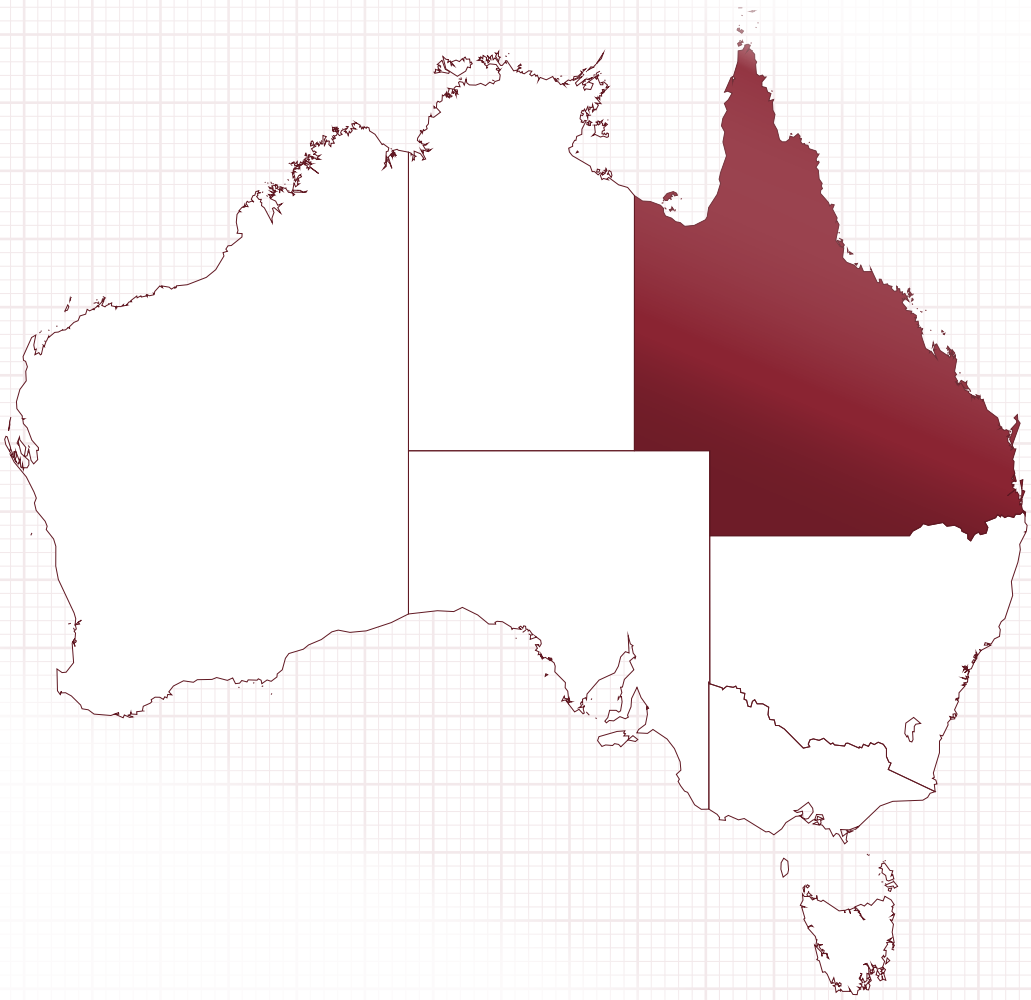
Statewide Cardiac Clinical Network

Queensland Cardiac Outcomes Registry
2018 Annual Report
Electrophysiology and Pacing Audit



Queensland Cardiac Outcomes Registry
2018 Annual Report

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1 Foreword

Dr John Wakefield PSM
Director-General
Queensland Health

As Director General of Queensland Health, I am pleased to present the ***Queensland Cardiac Outcomes Registry (QCOR) 2018 Annual Report***. The Annual Report provides detailed information on the performance of our clinical care for, and outcomes of, people with cardiac disorders.

The Annual Report examines a range of clinical areas including cardiac and thoracic surgery, cardiac rehabilitation, cardiac catheter interventions, electrophysiology and pacing, and heart failure support services. This year's Annual Report includes additional analysis of specific areas of interest to enable examination of clinical issues faced by practitioners at the face of patient care.

The Annual Report exemplifies how Queensland Health is meeting its objective to *enable safe, high quality services*. The results show that Queenslanders are receiving some of the best cardiac care in the country, and often the world. Queensland Health is committed to empowering our people to provide the best possible healthcare, to be transparent in our work and importantly use information to inform and improve the health outcomes of our patients.

The high level of clinical engagement extends beyond clinical practice to working collaboratively with Queensland Health administrators to improve the efficiency of our organisation. Recently, cardiac clinicians and administrators collaborated and used QCOR data to improve the purchasing process of clinical products resulting in savings of $5 million. These funds will now be available in the relevant Hospital and Health Services to reinvest into patient care.

QCOR data allows us to be responsive to the needs of our patients and community. It is actively used to inform how we improve the access, equity, safety, efficiency and effectiveness of our cardiac healthcare.

I would like to acknowledge the ongoing effort of the Statewide Cardiac Clinical Network and its many clinicians and colleagues, who have collaborated to produce this Annual Report.

2 Message from the SCCN Chair

It is my pleasure to introduce the 4th Queensland Cardiac Outcome Registry (QCOR) Annual Report. The activities of QCOR continue to mature, and this report gives us yet another opportunity to re-examine the reasons for continuing this work, as well as forming a stimulus to reinvigorate our efforts. The chance to ask, "Why are we doing this?" – a lot of effort, repeated committee meetings, some late nights, and occasional irritation with colleagues, as a counterpoise to the ingrained clinician desire to do the absolute best for every patient we care for and to have data to prove it. The ledger is strongly tilted in the affirmative.

Queensland is now acknowledged as having some of the most comprehensive cardiac data in the country, and the success of this program absolutely rests on the sustained clinician participation on which the programme is built. Every step from patient care, through recording of data, to submission, reverification and analysis is heavily invested by the clinicians. This intensive participation towards a common goal has certainly drawn the cardiac community together and we can be rightly proud of the cohesiveness of the efforts to improve care across the state.

The report this year further extends important elements of patient care – we have a strong collaboration with Queensland Ambulance Service (QAS), and now have access to quite comprehensive prehospital care including QAS administered thrombolysis and outcomes. In a state as large as Queensland it is critical that we track these important aspects of care. The documentation of post hospital cardiac rehabilitation and heart failure management continues to provide a more comprehensive picture extending the window of acute admission and without doubt adding to the safety of our acute interventions.

It is gratifying to see that procedural outcomes across all of the participating institutions remain stable and of high quality.

Finally, one of the important reasons which clinicians originally identified supporting participation in the program has come to fruition – the cardiac data derived from QCOR has now led to specific investment by the state government in the processes of cardiac care. In the coming year, in an initial investment roll out, hospitals in Cairns and Townsville will significantly expand their outreach into rural and remote centres in Torres and Cape and across to the North West Hospital and Health Service. QCOR data has clearly profiled both the need and the shortfall of cardiac services in these areas and has led to a recognition of our responsibilities for delivering safe and efficacious treatment both for patients who live close to major centres, but also especially for those far removed. This programme will extend to the remaining Hospital and Health Services in a multi-year investment.

Again, I give thanks to all of the clinicians who continue to participate in this important work. In the coming year, QCOR will have the capacity to invite private cardiac providers in the state to submit data to QCOR, so that we can obtain a more complete picture both public and private, of cardiac services across the state.

A special thanks is given to the Statewide Cardiac Clinical Informatics Unit technical and administrative staff who continue to supply superb assistance to the program and who are truly integral to the quality of the attached report.

Dr Paul Garrahy
Chair
Statewide Cardiac Clinical Network

3 Introduction

The Queensland Cardiac Outcomes Registry (QCOR) is an ever-evolving clinical information collection which enables clinicians and other key stakeholders access to quality, contextualised clinical and procedural data. On the background of significant investment and direction from the Statewide Cardiac Clinical Network (SCCN) and under the auspices of Clinical Excellence Queensland, QCOR provides analytics and overview for several clinical information systems and databases. By utilising extensive ancillary complementary administrative datasets, a sophisticated level of multi-purpose reporting and insight has been gained.

QCOR data collections are governed by bespoke clinical committees which provide oversight and direction to reporting content and analysis as well as informing decision-making for future endeavours. These committees are supported by Statewide Cardiac Clinical Informatics Unit (SCCIU) who form the business unit of QCOR. All processes and groups report to the SCCN, which is facilitated by Clinical Excellence Queensland.

The strength of the Registry would not be possible without significant clinician input. Assisting to maintain quality, relevance and context through QCOR committees, clinicians are continually developing and evolving the analysis and focus of each specific group. The SCCIU performs the role of coordinating these individual QCOR committees which each have their individual direction and unique requirements.

The SCCIU provide the reporting, analysis, and development of the many clinical cardiology and cardiothoracic surgical applications and systems in use across Queensland Health. The SCCIU also provides data quality and audit functions as well as expert technical and informatics resources for development, maintenance and continual improvement of specialised clinical applications and relevant secondary uses.

The SCCIU team consists of:

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

This 2018 QCOR report now includes a total of 6 clinical audits. The addition of the thoracic surgery audit report complements the existing cardiac surgery report to enable a clearer picture of the work undertaken by cardiac and thoracic surgeons in Queensland. This work reflects efforts in this space and the highlights the vast patient cohort that are encountered by clinicians working in this specialty. It is with this continual development and evolution of clinical reporting maturity that QCOR hopes to further support cardiothoracic clinical informatics into the future.

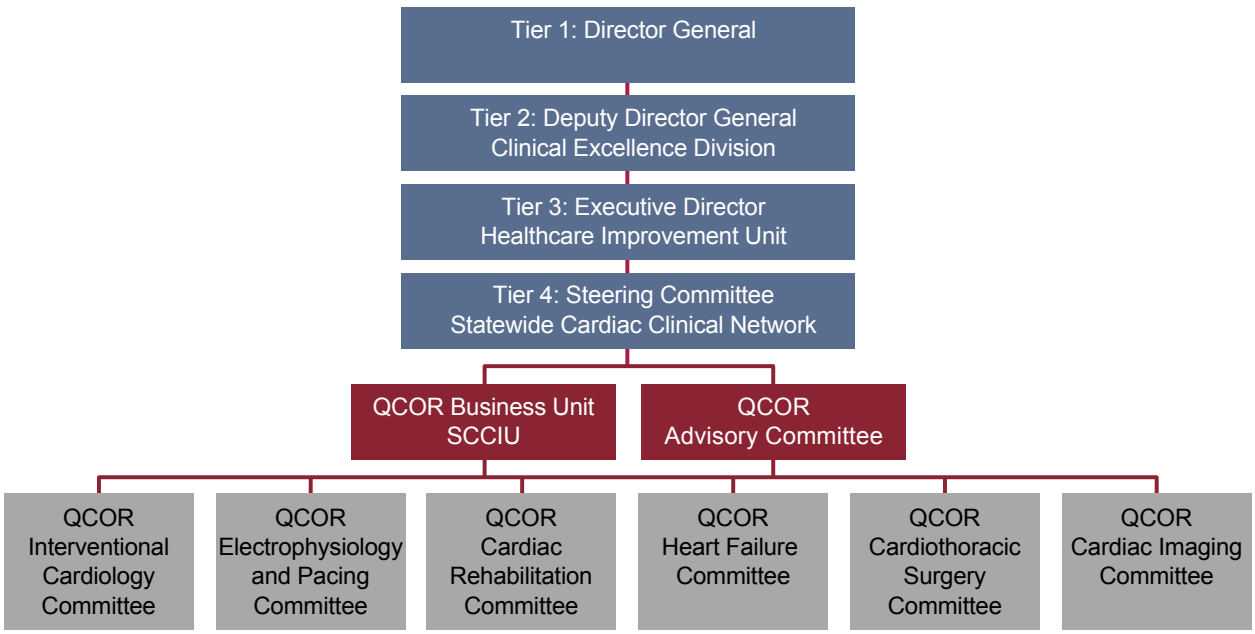
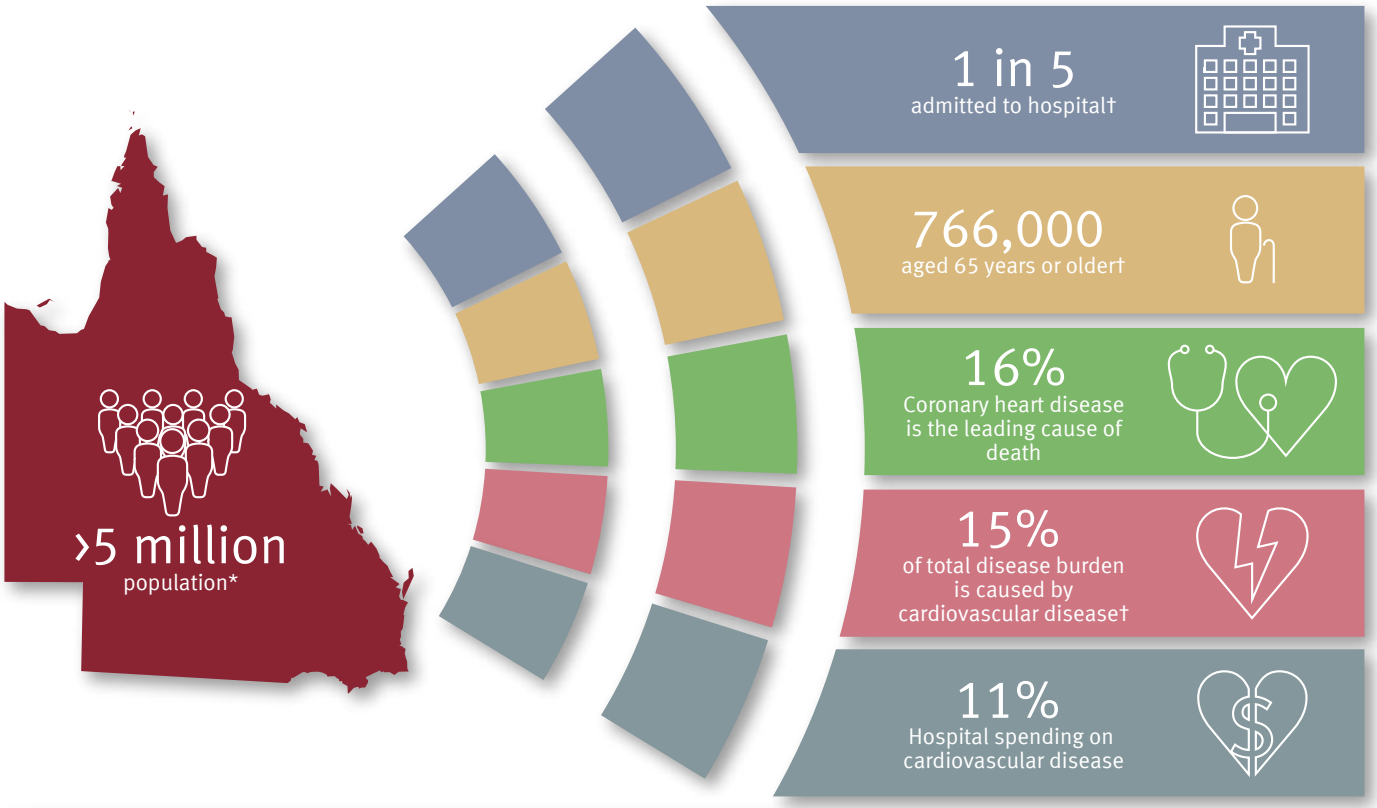


Figure A: Operational structure

Queensland Cardiac Outcomes Registry

The health of Queenslanders



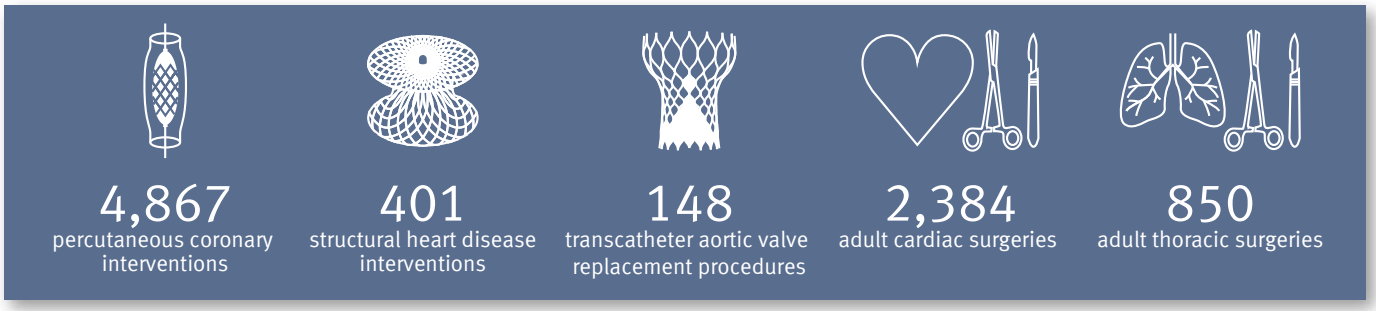
What's new?

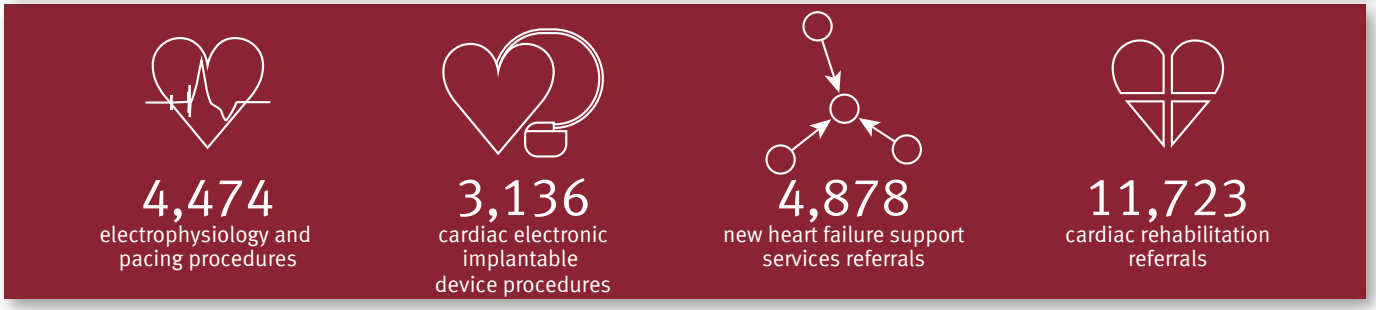
- Thoracic Surgery Audit
- Interhospital transfer for coronary intervention review
- Electrophysiology and pacing clinical indicators
- Cardiac rehabilitation patient outcome measures
- Thrombolysis for STEMI analysis
- Body mass index in cardiac surgery investigation

Figure B: QCOR 2018 infographic

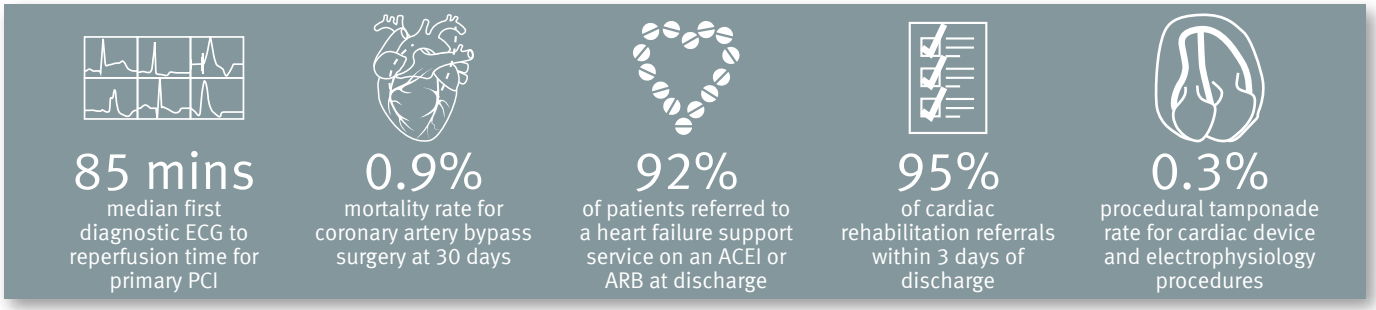
2018 Activity at a Glance

Case and patient volumes





Clinical indicator progress



Continuing our work

- Data linkage opportunities
- National registry alignment
- Clinical indicator review
- Structural heart disease application
- Cardiac outreach application
- ECG Flash project

* Australian Bureau of Statistics. Regional population growth, Australia, 2017-2018. Cat. no. 3218.0. ABS:Canberra; 2019

† Queensland Health (2018).The health of Queenslanders 2018. Report of the Chief Health Officer Queensland. Brisbane. Queensland Government

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

§ Diabetes Australia. State statistical snapshot: Queensland. As at 30 June 2018; 2018

4 Executive summary

This report encompasses procedures and cases for 8 cardiac catheterisation laboratories (CCL) and electrophysiology and pacing (EP) facilities and 5 cardiothoracic surgery units operating across Queensland public hospitals. It also includes referrals to clinical support and rehabilitation services for the management of heart disease including 22 heart failure support services and 55 cardiac rehabilitation outpatient facilities.

- 15,436 diagnostic or interventional cases were performed across the 8 public cardiac catheterisation laboratory facilities in Queensland hospitals. Of these, 4,867 involved percutaneous coronary intervention (PCI).
- Patient outcomes following PCI remain encouraging. The 30 day mortality rate following PCI was 1.9%, and of the 94 deaths observed, 74% were classed as either salvage or emergency PCI.
- In analysis for patients with STEMI, the median time from FdECG to reperfusion and arrival at PCI facility to reperfusion was observed at 85 minutes and 42 minutes. This compares favourably to results for previous years and internationally.
- Across the four sites with a cardiac surgery unit, a total of 2,384 cases were performed including 1,414 CABG and 1,005 valve procedures.
- As in previous years, 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. Once again the exception was the rate of deep sternal wound infection.
- The Cardiac Surgery Audit includes a focused supplement on obesity in cardiac surgery. This report highlights the increased rate of post-operative morbidity and mortality for patients with a higher BMI (>30 kg/m^2).
- The five public hospitals providing thoracic surgery services in 2018 performed a total of 850 cases. Almost one-third (30%) of surgeries followed a preoperative diagnosis of primary lung cancer or pleural disease (33%). This is the first QCOR Annual Report to examine thoracic surgery, and this will be expanded in future years.
- At the 8 public EP sites, a total of 4,474 cases were performed, which included 3,136 cardiac device procedures and 1,061 electrophysiology procedures. This audit includes expanded reporting around clinical indicators for EP cases.
- This Electrophysiology and Pacing Audit identified a median wait time of 81 days for complex ablation procedures, and 33 days for elective ICD implants.
- There were a total of 11,723 referrals to one of the 55 public cardiac rehabilitation services in 2018. Most referrals (77%) followed an admission at a public hospital in Queensland.
- The vast majority of referrals to CR were created within three days of the patient being discharged from hospital (95%), while over half of patients went on to complete an initial assessment by CR within 28 days of discharge (59%).
- There were 4,878 new referrals to a heart failure support service in 2018. Clinical indicator benchmarks were achieved for timely follow-up of referrals, and prescription of angiotensin-converting-enzyme inhibitor (ACEI) or angiotensin II receptor blockers (ARB) and appropriate beta blockers as per clinical guidelines.

5 Acknowledgements and authors

This collaborative report was produced by the SCCIU, audit lead for QCOR for and on behalf of the Statewide Cardiac Clinical Network.

The work of QCOR would not be possible without the continued support and funding from Clinical Excellence Queensland. This publication draws on the expertise of many teams and individuals. In particular, the assistance of the Statistical Services Branch, Healthcare Improvement Unit and Queensland Ambulance Service each make significant contributions to ensure the success of the program. Metro North Hospital and Health Service are also recognised through their stake in supporting and hosting the SCCIU operational team.

Furthermore, the tireless work of clinicians who contribute and collate quality data, as part of providing quality patient care, ensures credible analysis and monitoring of the standard of cardiac services in Queensland. The following provided writing assistance with this year's report:

Interventional Cardiology

Dr Sugeet Baveja
- The Townsville Hospital

Dr Niranjan Gaikwad
- The Prince Charles Hospital

Dr Christopher Hammett
- Royal Brisbane and Women's Hospital

A/Prof Richard Lim
- Princess Alexandra Hospital

Dr Rohan Poulter
- Sunshine Coast University Hospital

A/Prof Atifur Rahman
- Gold Coast University Hospital

Dr Shantisagar Vaidya
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Dr Gregory Starmer (Chair)
- Cairns Hospital

Queensland Ambulance Service

Dr Tan Doan, PhD

Mr Brett Rogers

Cardiothoracic Surgery

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Statewide Cardiac Clinical Informatics Unit

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Mr Marcus Prior

Dr Ian Smith, PhD

Mr William Vollbon

6 Future plans

Continual progress with expanded analyses and uses of clinical data has been a focus for QCOR in 2018. This is evident through new report elements encompassing thoracic surgery and extended examination of patients undergoing thrombolysis for myocardial infarction. Similarly, obesity and cardiac surgery have been examined and have unveiled key findings that are highly relevant given the increasing incidence of obesity within the general population. Intending to provide clinically relevant analysis, the future work of QCOR is exciting.

The utilisation of linkage data provided by administrative datasets continues to enable and assist QCOR data collections. These data enable information from different sources to be brought together to create a new, richer dataset. Examples of future opportunities for the use of supplementary datasets are medication detail from discharge summaries and pathology investigations undertaken within public Queensland facilities. With access to these expanded data collections, there are opportunities to be seized across many fronts including enhanced risk adjustment options, expanded clinical indicator programs and streamlined participation in national registry activities. Furthermore, this will enable efficiencies in data collections where elements are either not available or practical for collection at the point-of-care, and thereby reduce duplication of entry across clinical systems.

Opportunities exist to better integrate QCOR clinical applications with enterprise systems such as the acclaimed Queensland Health application, The Viewer. It is envisaged that cardiac rehabilitation referrals and assessment forms will be incorporated within the patient record, along with procedure reports generated by the upcoming QCOR structural heart disease application. These developments are set to complement the existing report sharing functionality present within the QCOR electrophysiology system. Further opportunities have been flagged across the heart failure support services and cardiothoracic surgery space to enhance these applications to meet the bespoke requirements of the clinical specialty areas. By embracing opportunities to share valuable clinical data kept in various QCOR systems, investment in QCOR applications will be further realised and valued.

Continual development, revision, and optimisation of clinical indicator programs is essential to the ongoing relevance of the Registry. QCOR will continue to collaborate with experts in all clinical domains to expand the scope of our existing analyses. This will be undertaken with a view to maintain and enhance the quality of reporting and improve the timeliness and relevance of the information provided for clinical leads. Such areas where reporting will be enhanced for next year's Annual Report include:

- Time to angiography for patients receiving thrombolysis
- Expanded radiation safety analyses for diagnostic and interventional cardiology
- Review of risk adjustment models for interventional cardiology
- EuroSCORE II risk adjustment for cardiac surgery patients
- MRA prescription rates for HFrEF patients
- CR referrals rates following cardiac intervention

QCOR is actively investigating opportunities within several areas including the implementation of new patient-reported outcomes and quality-of-life measures and realising further efficiencies concerning statewide procurement of medical devices. New areas of research and research partners and opportunities to contribute to works underway across Queensland Health, and at a national level, are continually being pursued and engaged.

7 Facility profiles

7.1 Cairns Hospital

Figure 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

7.2 The Townsville Hospital

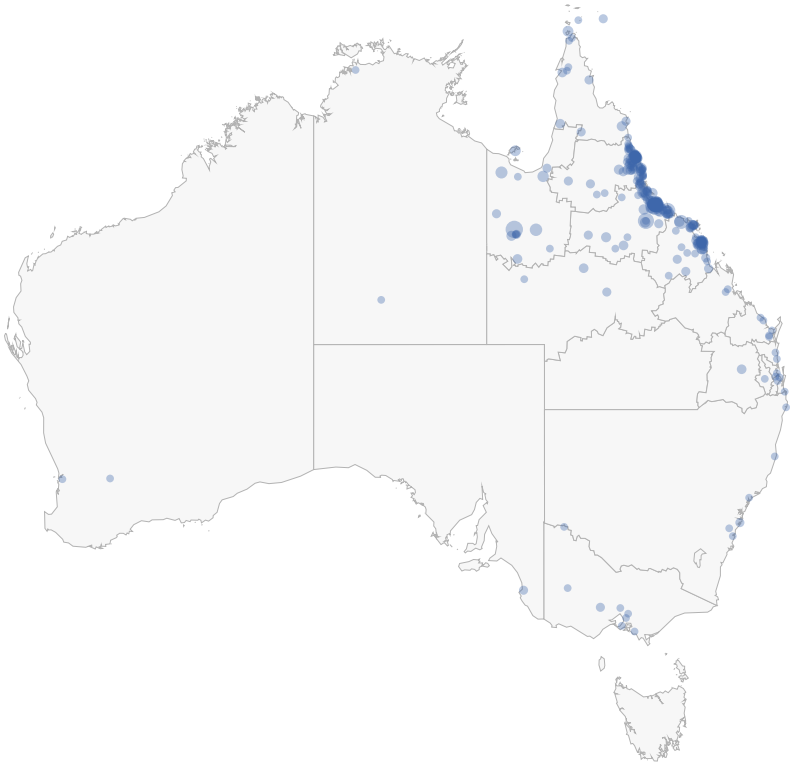


Figure 2: The Townsville Hospital

- 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 The Townsville Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Cardiothoracic surgery

7.3 Mackay Base Hospital

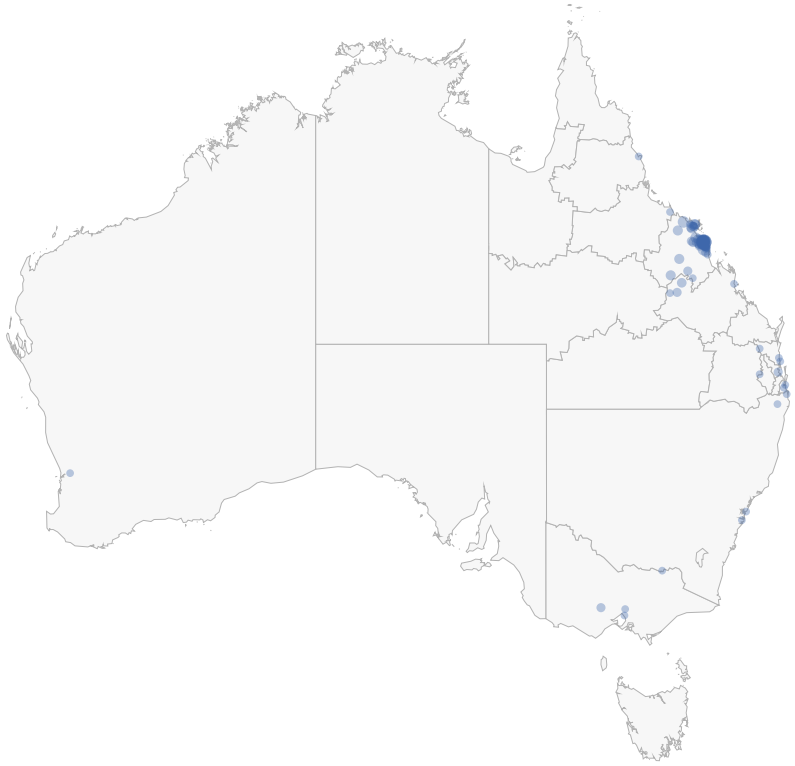


Figure 3: Mackay Base Hospital

- 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
  - Pacemaker and defibrillator implants

7.4 Sunshine Coast University Hospital

Figure 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

7.5 The Prince Charles Hospital

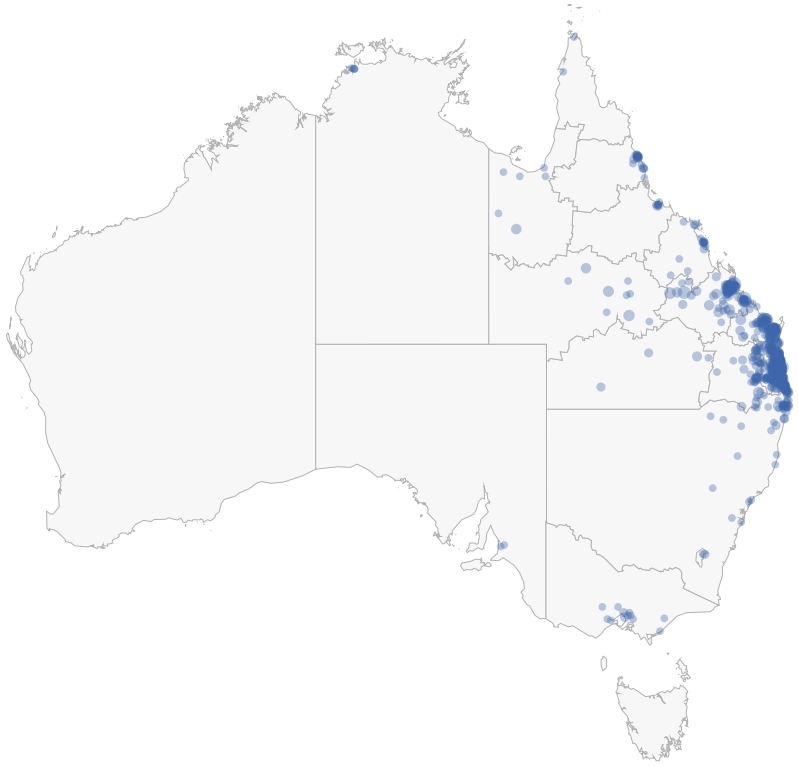


Figure 5: The Prince Charles Hospital

- 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 and Women's Hospital)
- Public tertiary level invasive cardiac services provided at The Prince Charles Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Cardiothoracic surgery
  - Heart/lung transplant unit
  - Adult congenital heart disease unit

7.6 Royal Brisbane and Women's Hospital

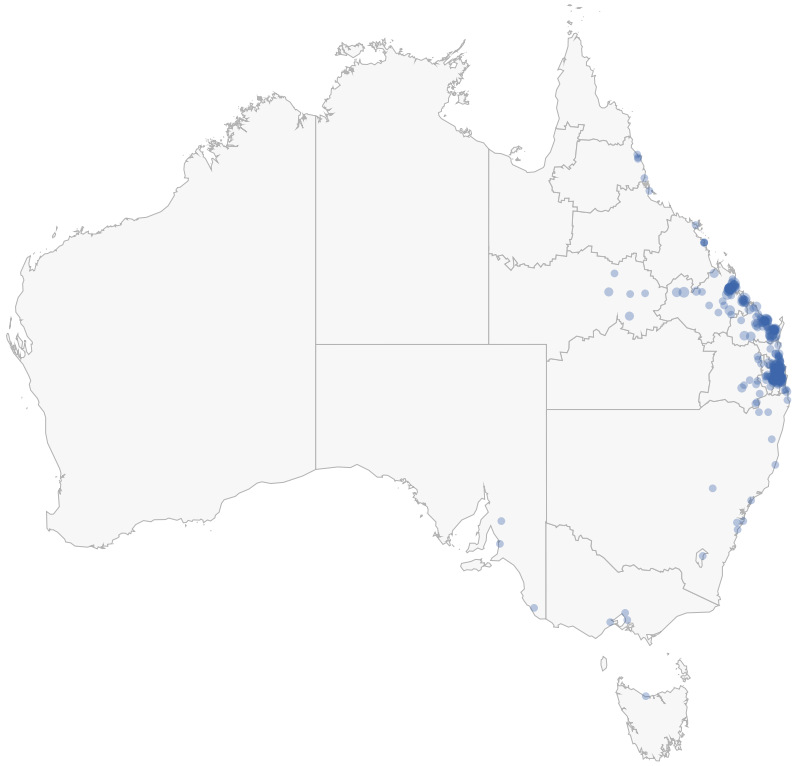


Figure 6: Royal Brisbane and Women's Hospital

- 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 and Women's Hospital include:
  - Coronary angiography
  - Percutaneous coronary intervention
  - Structural heart disease intervention
  - Electrophysiology
  - ICD, CRT and pacemaker implantation
  - Thoracic surgery

7.7 Princess Alexandra Hospital

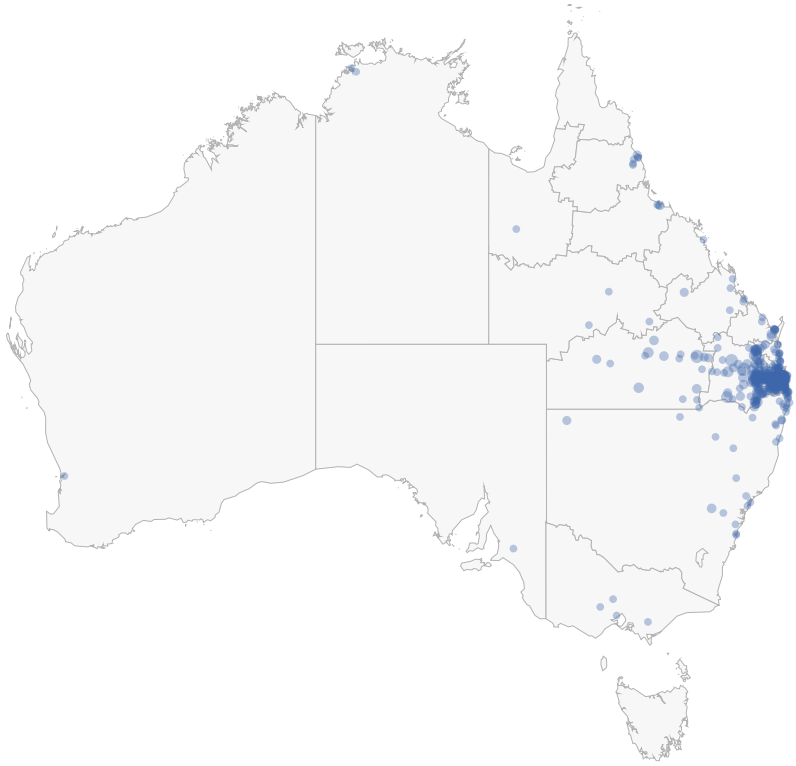


Figure 7: Princess Alexandra Hospital

- 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

7.8 Gold Coast University Hospital

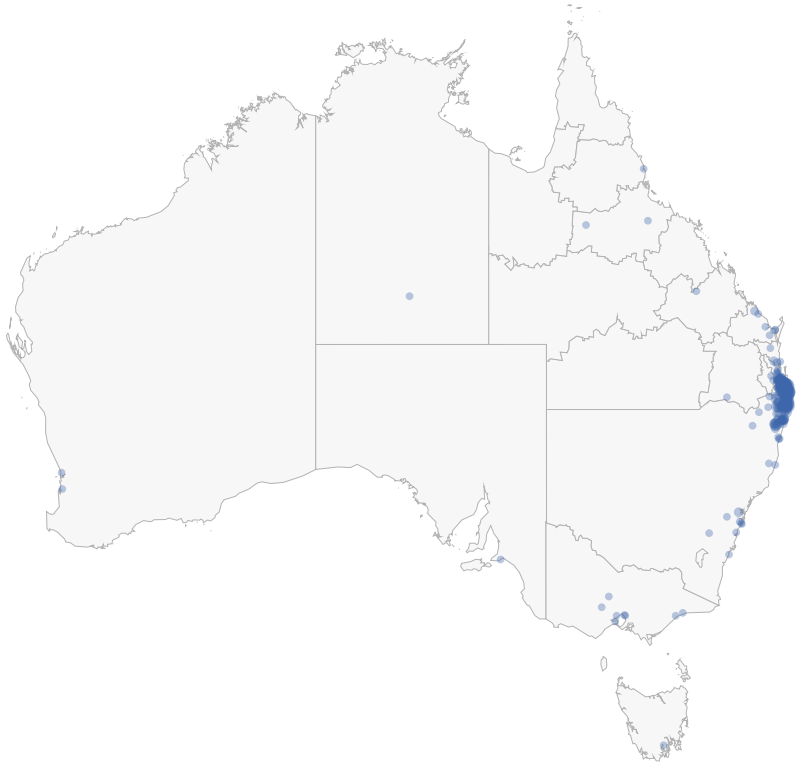
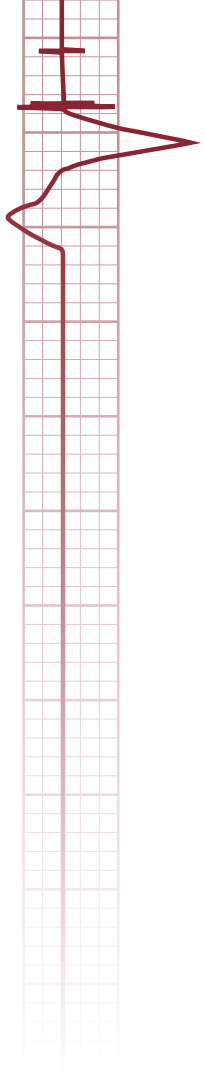


Figure 8: Gold Coast University Hospital

- 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

Electrophysiology and Pacing Audit



1 Message from the QCOR Electrophysiology and Pacing Committee Chair

The 2018 QCOR report includes a more complete dataset than its predecessor, allowing some year-to-year comparisons of data for the first time, as well as data describing procedural success over time and other clinical indicators. Importantly in this report, unmet need is now reflected by waiting times for cardiac electrophysiology and pacing procedures. Profiling continues regarding demographics, activity and quality for these procedures which prolong life (implantable cardioverter defibrillator, ICD), compensate pathology of slow heart rhythm (pacemakers) and heart failure (cardiac resynchronisation therapy), cure most fast heart rhythms or palliate and reduce hospitalisations the remainder (ablation for atrial fibrillation and ventricular tachycardia). Recently the introduction of an additional Medicare Benefits Schedule item number for implantable ECG loop recorders (ILRs) in the investigation of cryptogenic stroke has resulted in a very large increase in demand for these devices, mandating formulation of rational, evidence-based, multi-disciplinary strategy to address that demand.

All of these procedures can enhance quality of life and reduce burden of disease for the community. However, they require adequate infrastructure and adequate specialised workforce. Deficiencies here are longstanding and increasing, as we continue to face the increasing, mutually-exacerbating epidemics of atrial fibrillation and heart failure. There is nil scope for 'increased efficiency' when staff are too few and overworked. Again the 2018 report contains authoritative activity and quality mapping, now with documentation of waiting times to reflect unmet need which must guide planning to address these deficiencies urgently.

In the background, the increasing, aging population shows improved survival of other cardiovascular procedures, continues to exhibit adverse lifestyle trends and demands technological advances. In the larger centres, capacity to perform ablation procedures continues to be choked by ever-increasing demand for pacemaker and ICD device procedures. While these device procedures should always have priority, in Queensland Health they are usually performed by operators with expertise in cardiac electrophysiology and ablation, on patients who benefit from that expertise. If ablation is imperilled to wither on a vine of indifference and inaction, loss of that expertise will compromise:

- outcomes across the service,
- patient access to ablation which is already tenuous and embarrassingly meagre when compared to access to ablation in the private health system, and
- specialised training in cardiac electrophysiology.

Analysis of this and future reports will yield very important learnings about the journeys of public patients who undergo procedures for heart rhythm disorders. I wish to acknowledge the hard work of QCOR administrative staff, and all contributors to the dataset including cardiac scientists and clinical colleagues who apply integrity, co-operation and passion to their work in heart rhythm management.

Associate Professor John Hill
Chair
QCOR Electrophysiology and Pacing Committee

2 Key findings

This Electrophysiology and Pacing Audit describes baseline demographics, risk factors, procedures performed and outcomes for 2018.

Key findings include:

- Across Queensland, 8 public sites contributed to the registry with 7 sites contributing a complete year of data. Gold Coast University Hospital began direct data entry on 29 January 2018.
- 4,474 electrophysiology and pacing cases were including 3,136 device procedures and 1,061 electrophysiology procedures.
- The majority of all patients were aged over 60 years (70%) with a median age of 69 years.
- The overall proportion of Aboriginal and Torres Strait Islander patients was 3.7%.
- The vast majority of patients (72%) were classed as having an unhealthy body mass index (BMI) of greater than 30 kg/m^2.
- The majority of procedures (61%) were classified as high-urgency procedures that are clinically indicated within 30 days.
- Outpatient procedures accounted for 54% of all cases.
- There were 520 standard electrophysiology procedures performed with a further 568 complex procedures undertaken, which utilise three-dimensional mapping technology, involve pulmonary vein isolation or ventricular arrhythmias.
- Radiofrequency ablation was the energy source utilised in the vast majority of ablation cases (85%).
- Atrial flutter, pulmonary vein isolation (atrial fibrillation) and atrioventricular node re-entry tachycardia ablations accounted for 81% of all ablation cases.
- The reported complication rate for all device procedures was 2.9%, while electrophysiology procedures had a 3.2% complication rate.
- There was a 0.3% procedural tamponade rate reported for all cases.
- The statewide median wait time for complex ablation was 81 days with 73% of cases meeting the 180 day benchmark.
- The 12 month device system loss rate due to infection was 1.4%.

3 Participating sites

In 2018, there were 8 public electrophysiology and pacing units spread across metropolitan and regional Queensland. All 8 of these entered data directly into the Queensland Cardiac Outcomes Registry (QCOR) electrophysiology and pacing application. The eighth site, Gold Coast University Hospital began direct entry in early 2018.

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

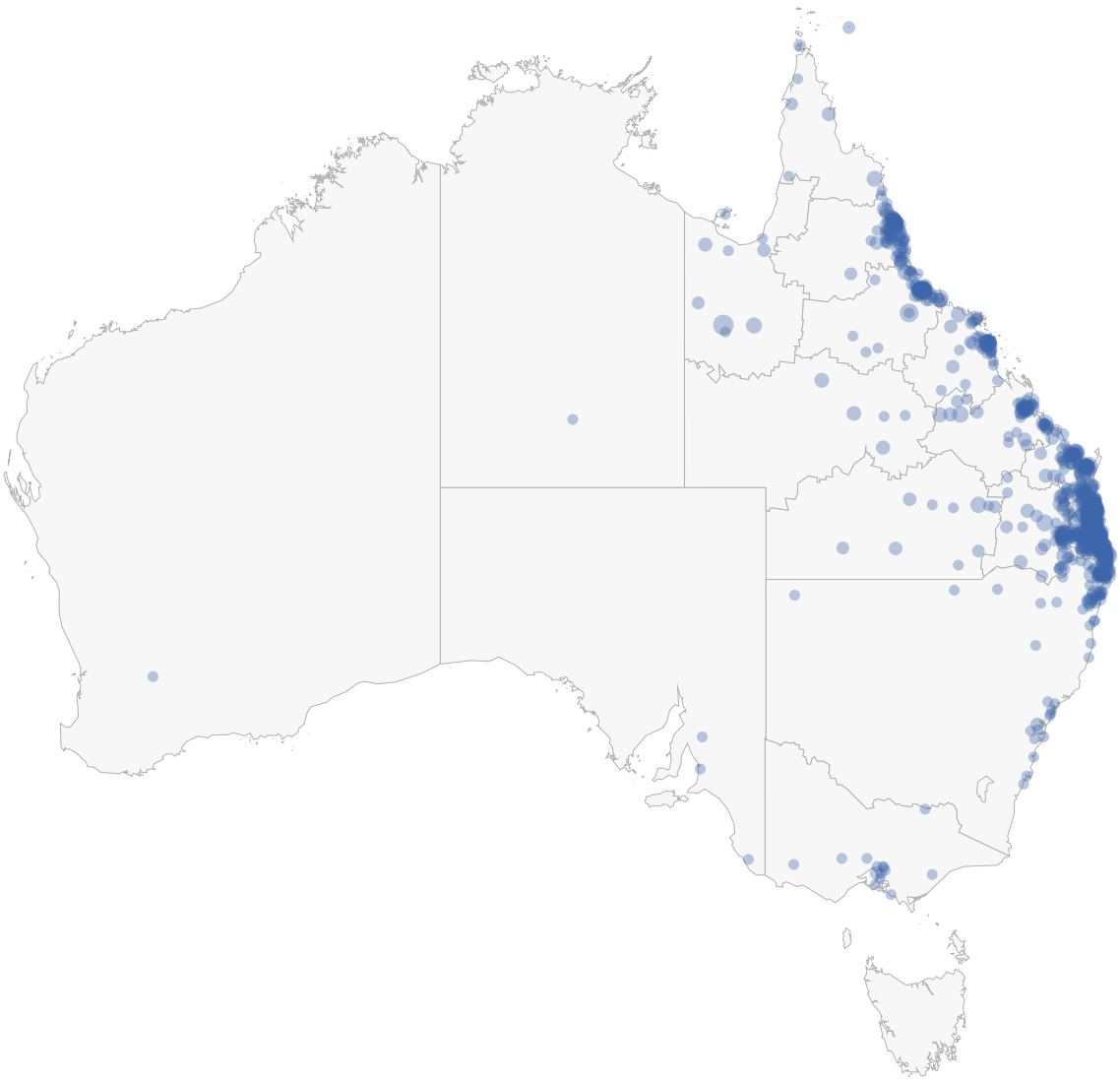


Figure 1: Electrophysiology and pacing cases by residential postcode

Table 1: Participating sites

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

Gold Coast University Hospital commenced direct data entry 29 January 2018

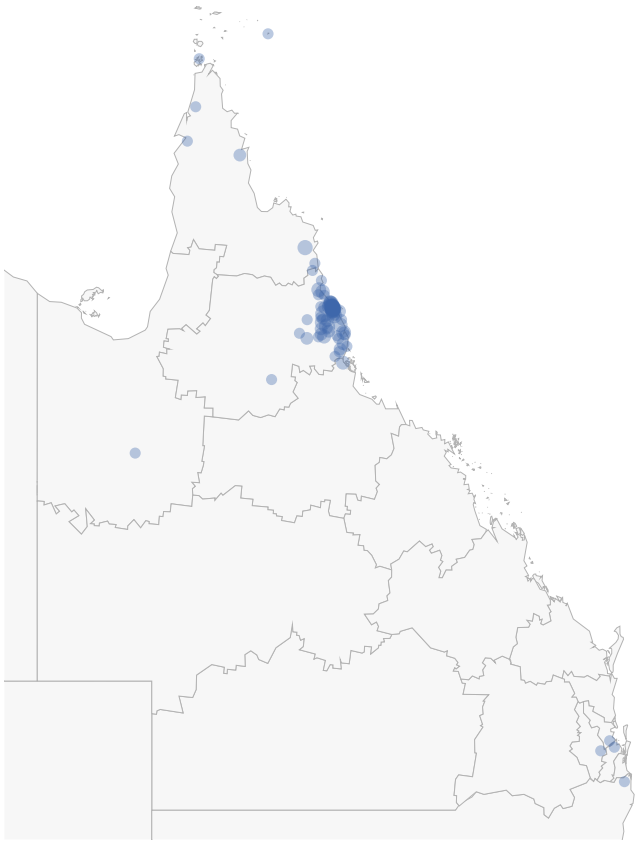


Figure 2: Cairns Hospital

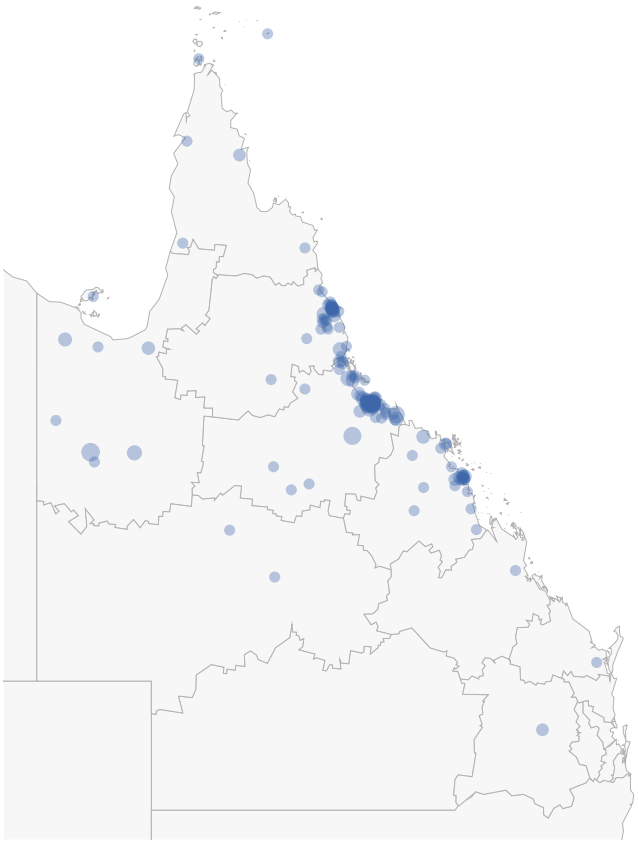


Figure 3: The Townsville Hospital

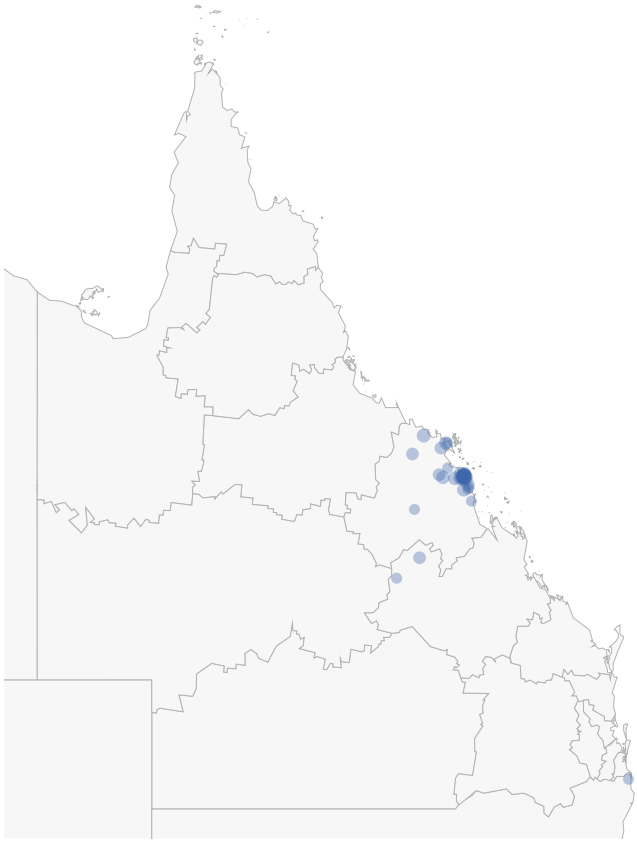


Figure 4: Mackay Base Hospital

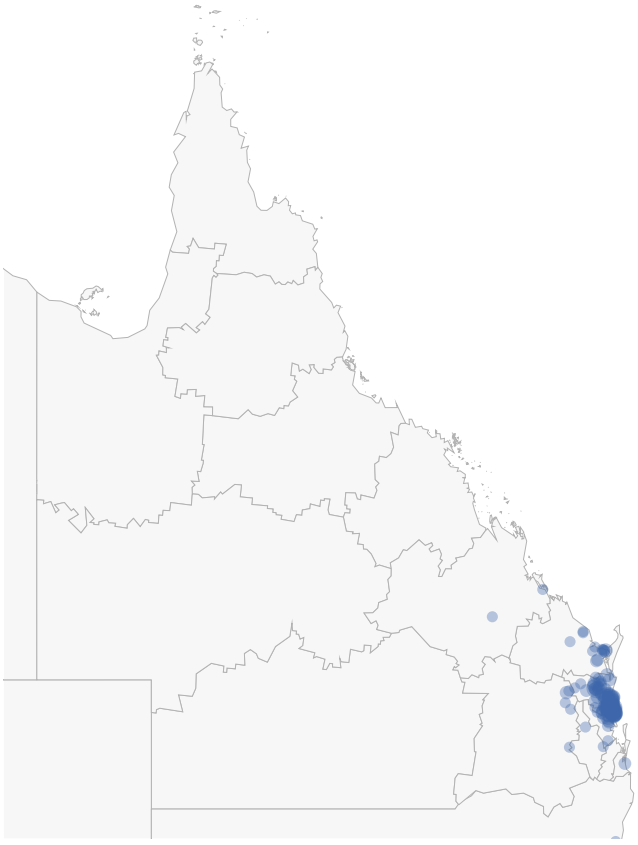


Figure 5: Sunshine Coast University Hospital

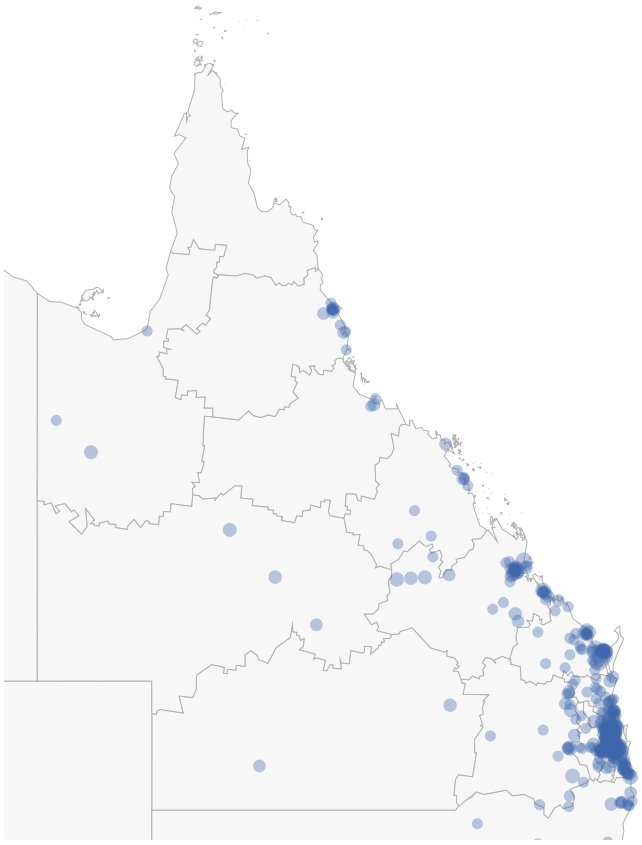


Figure 6: The Prince Charles Hospital

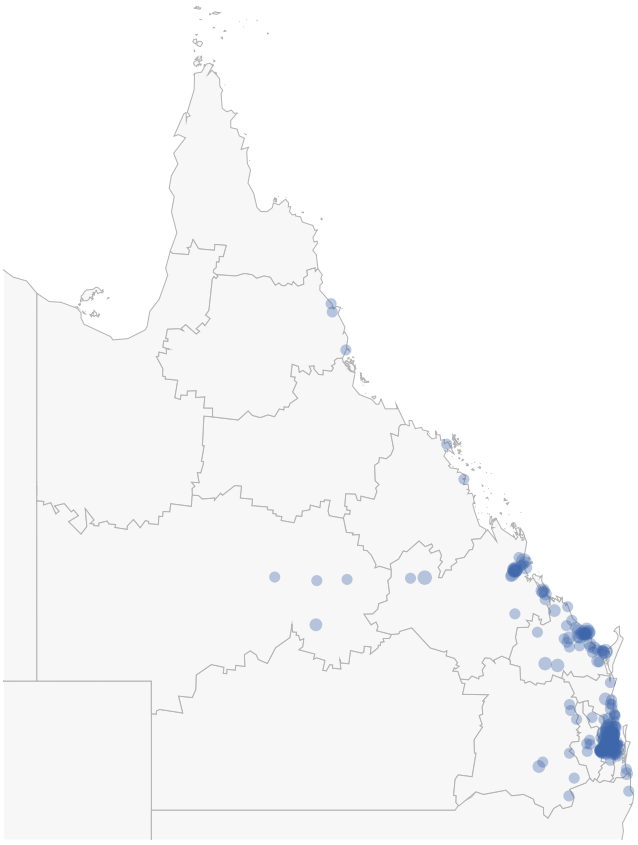


Figure 7: Royal Brisbane and Women's Hospital

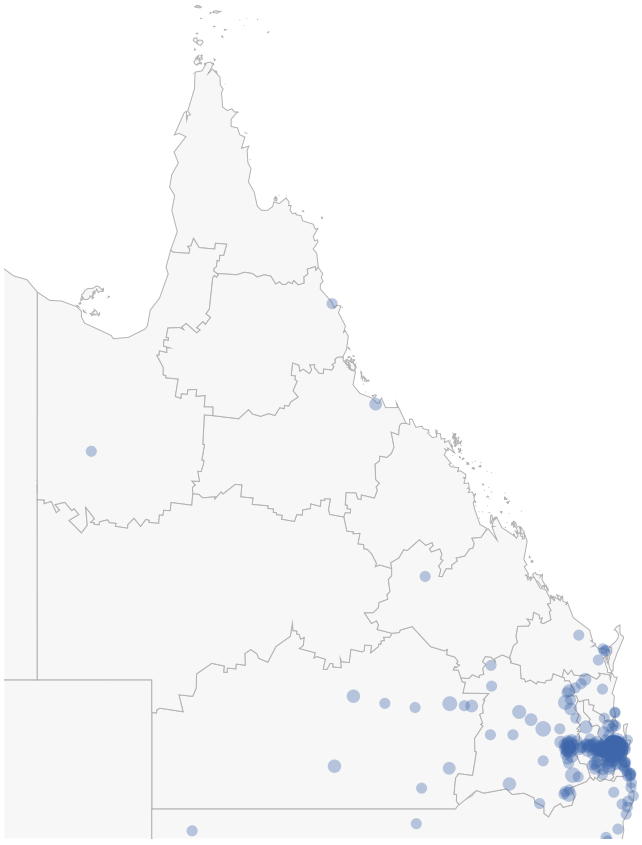


Figure 8: Princess Alexandra Hospital

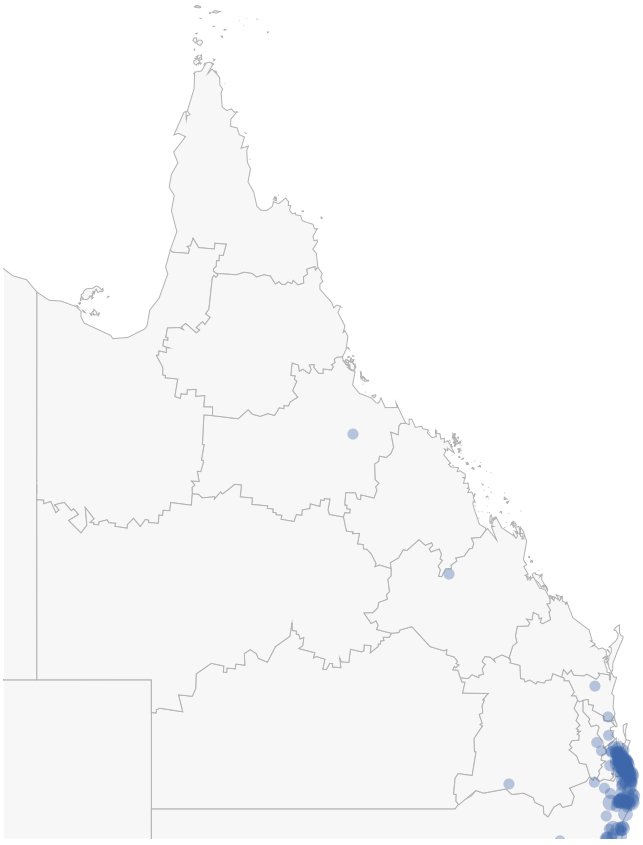


Figure 9: Gold Coast University Hospital

4 Case totals

4.1 Case volume

In 2018, 4,474 electrophysiology and pacing procedures were documented using the QCOR electrophysiology and pacing application. This number does not reflect the overall case totals as statewide uptake concluded in early 2018.

Table 2: Total cases by category

Procedure combination	Total cases n (%)	Category
Cardiac device procedure	3,098 (69.2)	Device
Cardiac device procedure + EP study	22 (0.5)	
Cardiac device procedure + other procedure	10 (0.2)	
Cardiac device procedure + EP study + ablation	4 (0.1)	
Cardiac device procedure + EP study + cardioversion	1 (<0.1)	
Cardiac device procedure + cardioversion	1 (<0.1)	
EP study + ablation	772 (17.2)	EP
EP study	184 (4.1)	
Ablation	50 (1.1)	
EP study + ablation + cardioversion	38 (0.8)	
EP study + cardioversion	11 (0.2)	
EP study + drug challenge	4 (0.1)	
EP study + ablation + other procedure	1 (<0.1)	
EP study + other procedure	1 (<0.1)	
Cardioversion	198 (4.4)	Other
Other procedure	46 (1.0)	
Drug challenge	32 (0.7)	
Cardioversion + other procedure	1 (<0.1)	
ALL	**4,474 (100.0)**	

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

4.2 Cases by category

The majority of cases performed were cardiac device procedures accounting for over two-thirds (70%) of documented procedures. The remainder of cases were electrophysiology and ablation procedures (24%) with the remainder categorised as other procedures (6%).

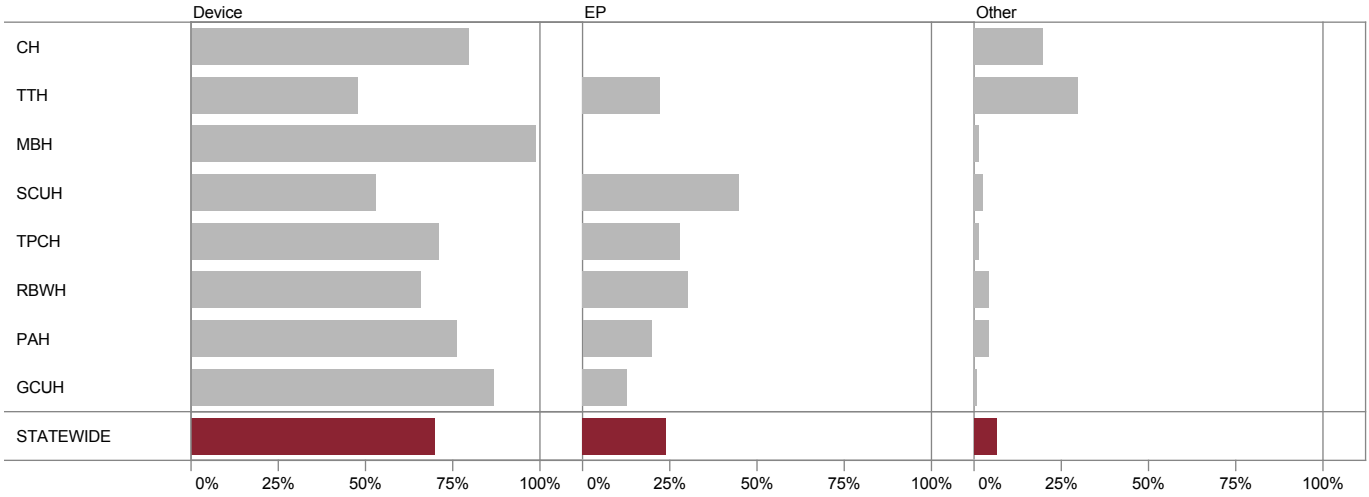


Figure 10: Proportion of cases by site and category

Table 3: Cases by case category

Site	Device n (%)	EP n (%)	Other n (%)	Total n (%)
CH	213 (6.8)	–	53 (19.1)	266 (5.9)
TTH	223 (7.1)	103 (9.7)	138 (49.8)	464 (10.4)
MBH	95 (3.0)	–	1 (0.4)	96 (2.1)
SCUH	275 (8.8)	231 (21.8)	12 (4.3)	518 (11.6)
TPCH	821 (26.2)	322 (30.3)	12 (4.3)	1,155 (25.8)
RBWH	352 (11.2)	161 (15.2)	22 (7.9)	535 (11.9)
PAH	680 (21.7)	174 (16.4)	37 (13.4)	891 (19.9)
GCUH	478 (15.2)	69 (6.5)	2 (0.7)	549 (12.3)
STATEWIDE	**3,136 (70.1)**	**1,061 (23.7)**	**277 (6.2)**	**4,474 (100.0)**

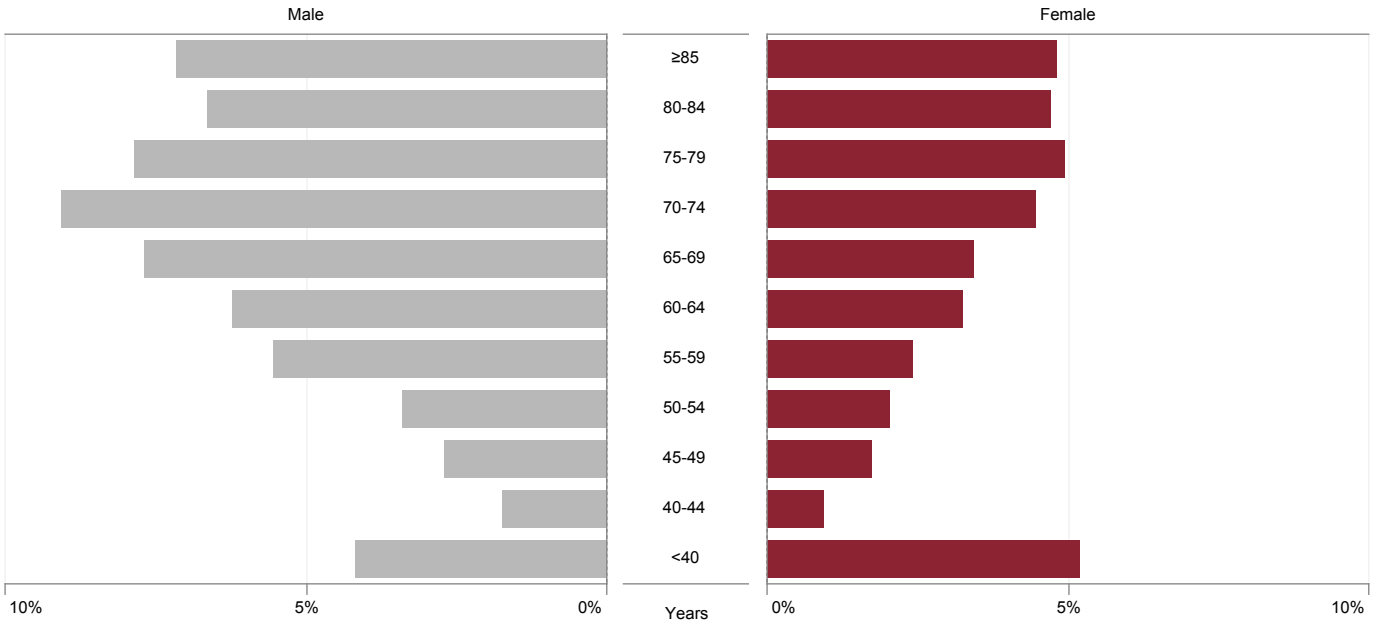
Case totals do not reflect all 2018 activity for GCUH

5 Patient characteristics

5.1 Age and gender

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

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



% of total (n=4,474)

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

Table 4: Median age by gender and case category

	Total cases n	Male years	Female years	ALL years
Device	3,136	72	74	73
EP	1,061	60	55	58
Other	277	62	66	63
Total	**4,474**	**69**	**69**	**69**

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

Overall, 62% of patients were male with a similar distribution across all procedure categories. The largest proportion of females was represented in the electrophysiology category (41%).

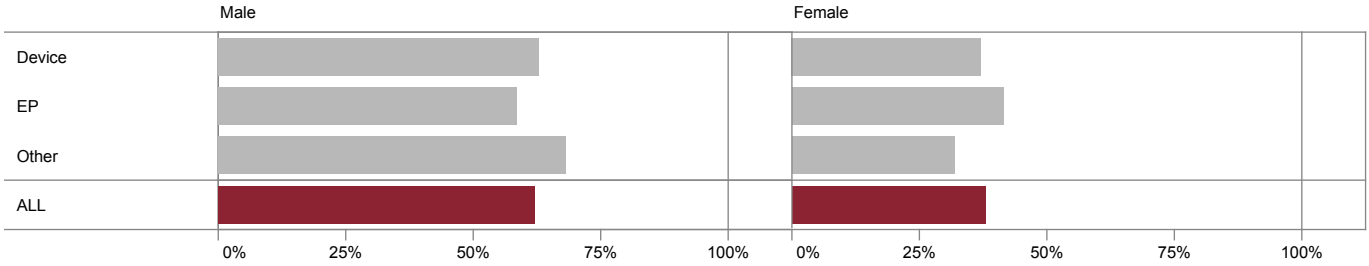


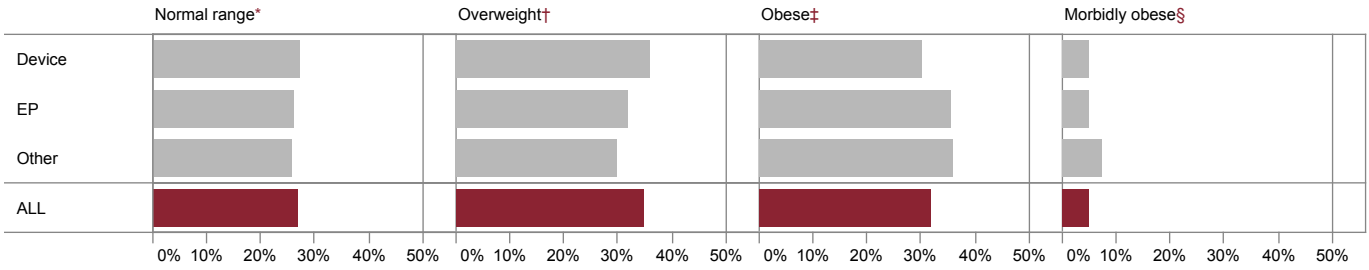
Figure 12: Proportion of cases by gender and category

Table 5: Proportion of cases by gender and category

	Total cases n	Male n (%)	Female n (%)
Device	3,136	1,968 (62.8)	1,168 (37.2)
EP	1,061	622 (58.6)	439 (41.4)
Other	277	189 (68.2)	88 (31.8)
ALL	**4,474**	**2,779 (62.1)**	**1,695 (37.9)**

5.2 Body mass index

Patients classed as having a body mass index (BMI) category of overweight (35%), obese (32%) or morbidly obese (5%) represented almost three-quarters of all electrophysiology and pacing patients. Patients classed as underweight represented 2% of all cases.



Underweight category (2%) not displayed

* BMI 18.5–24.9 kg/m^2

† BMI 25–29.9 kg/m^2

‡ BMI 30–39.9 kg/m^2

§ BMI ≥40 kg/m^2

Figure 13: Proportion of cases by BMI and case category

5.3 Aboriginal and Torres Strait Islander status

Overall, the proportion of identified Aboriginal and Torres Strait Islander patients undergoing electrophysiology and pacing procedures was 3.7%. This correlates closely to the estimated proportion of Aboriginal and Torres Strait Islander persons within Queensland (4.6%).[2] There was large variation between units, with the North Queensland sites seeing a larger proportion of Aboriginal and Torres Strait Islander patients (Figure 14).

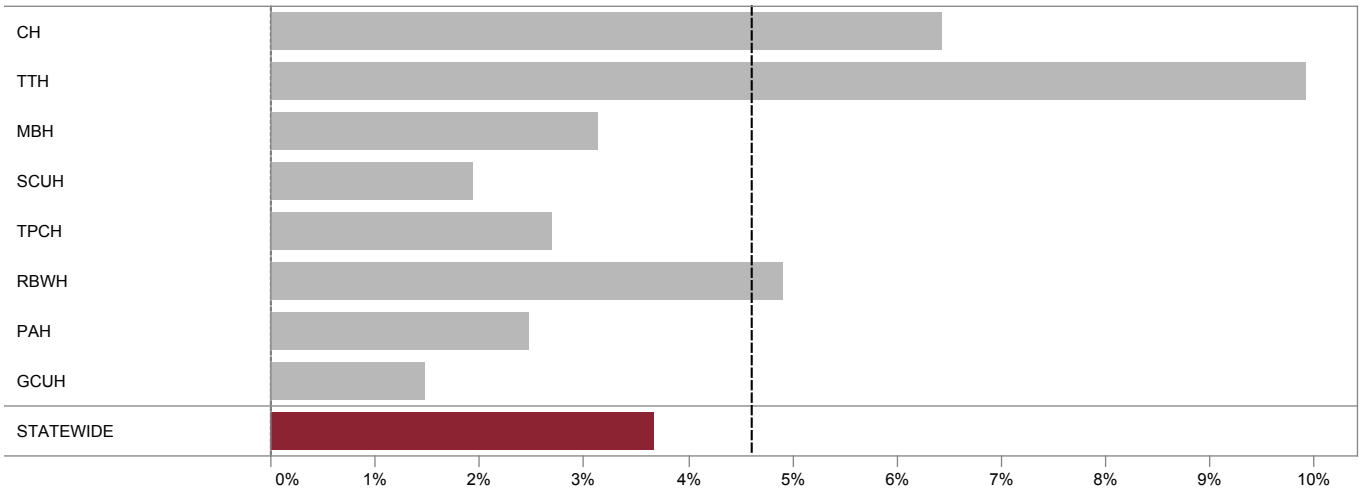
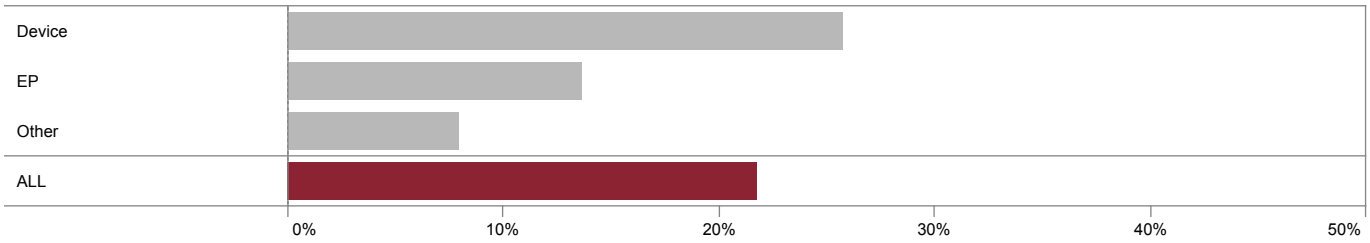


Figure 14: Proportion of cases by identified Aboriginal and Torres Strait Islander status and site

6 Risk factors and comorbidities

6.1 Coronary artery disease

Across the state, 26% of device procedure patients were reported to have a history of coronary artery disease. This figure was far lower among the electrophysiology cohort (14%).

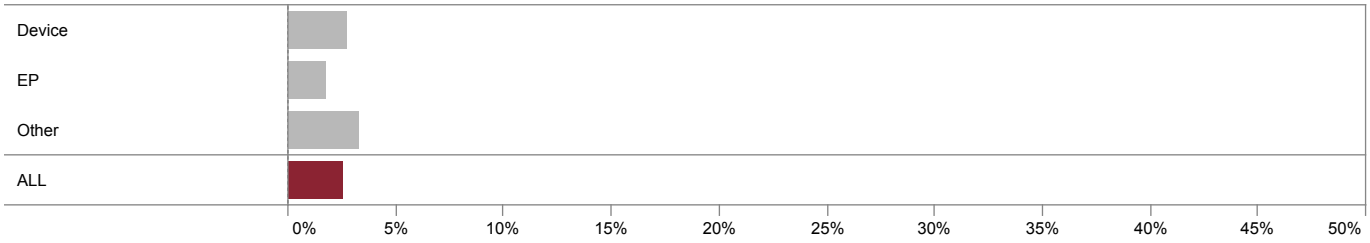


Excludes missing data (27%)

Figure 15: Proportion of cases by coronary artery disease history and case category

6.2 Family history of sudden cardiac death

During the surveyed period, 3% of patients who underwent other procedures such as cardioversion and drug challenges had a documented family history of sudden cardiac death. Similarly, 3% of device patients also had this risk factor.

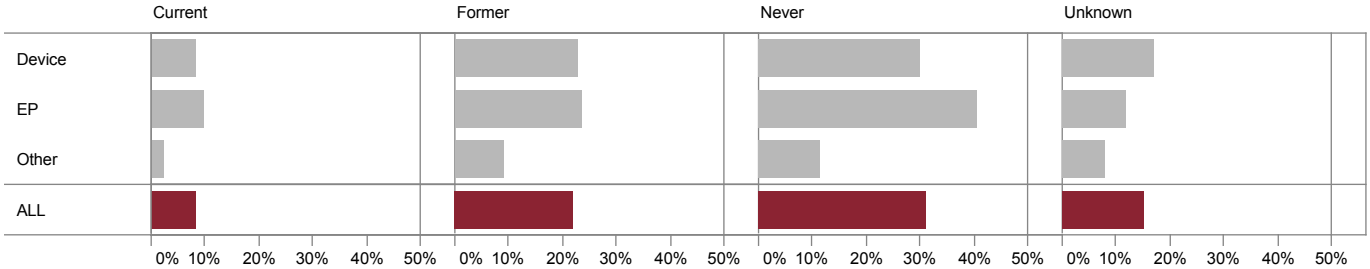


Excludes missing data (31%)

Figure 16: Proportion of cases by sudden cardiac death history and case category

6.3 Smoking history

Overall, 30% of patients had a history of smoking, including 8% who were documented as being current smokers and 22% former smokers. There were 31% of patients who reported never having smoked and 15% with an unknown smoking history.

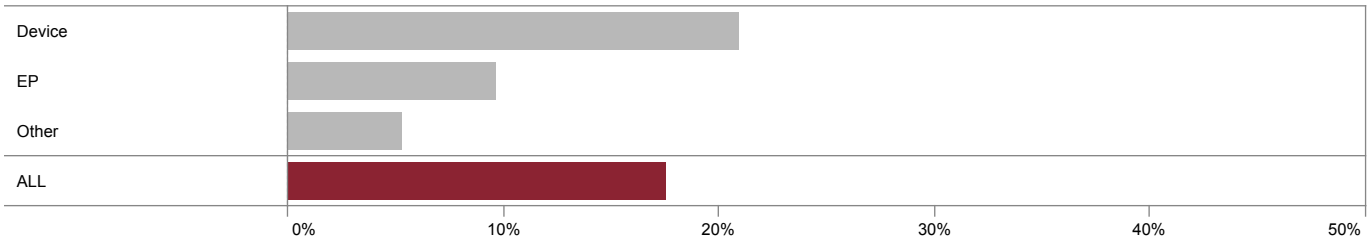


Excludes missing data (24%)

Figure 17: Proportion of cases by smoking status and case category

6.4 Diabetes

The prevalence of diabetes was highest in the cardiac device procedure group, with 21% of patients known to be diabetic. Overall, 18% of the cohort had some form of diabetes under treatment.

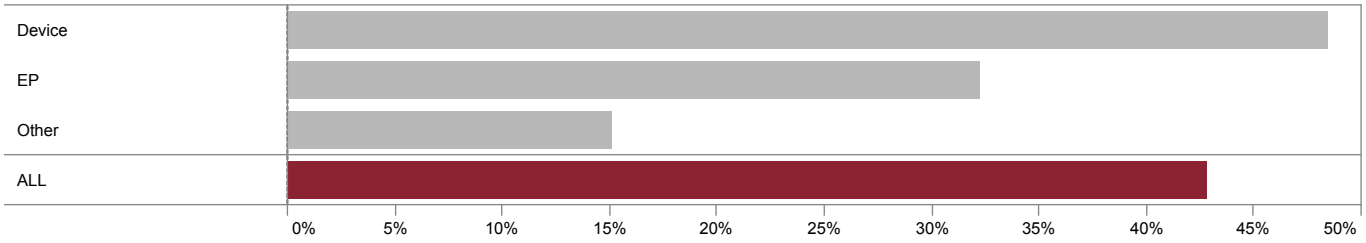


Excludes missing data (23%)

Figure 18: Proportion of cases by diabetes status and case category

6.5 Hypertension

Hypertension, defined as receiving antihypertensive medications at the time of case, was present in over 43% of patients irrespective of case type. Patients in the cardiac device procedure category had a greater incidence of hypertension (49%).

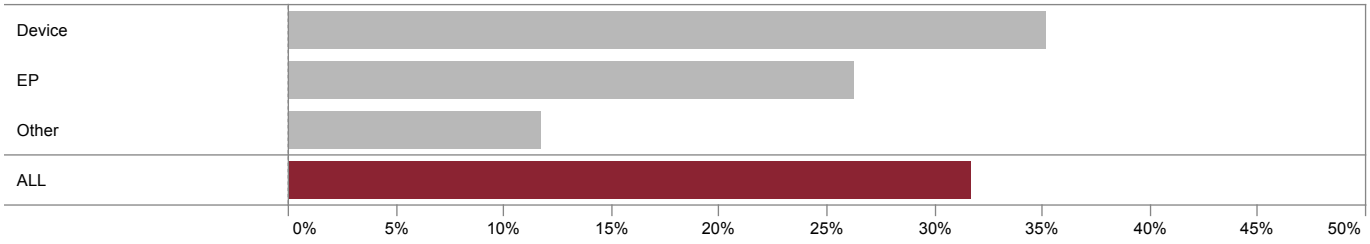


Excludes missing data (21%)

Figure 19: Proportion of cases by hypertension status and case category

6.6 Dyslipidaemia

Within this cohort, 32% of patients were treated with statins for dyslipidaemia at the time of case. This ranged from 35% for device procedures to 26% in the electrophysiology category.

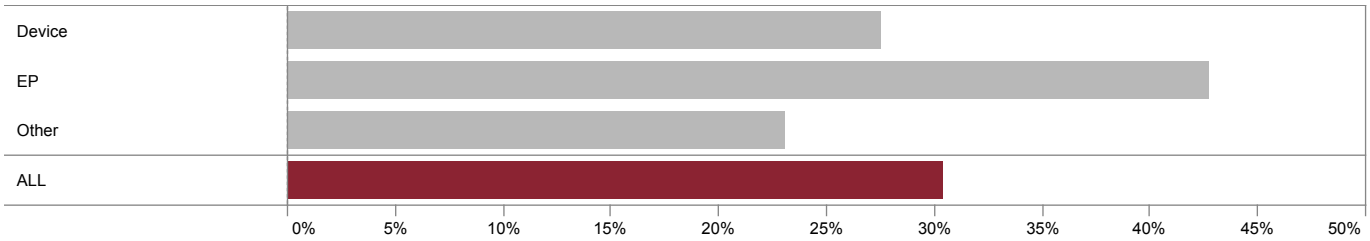


Excludes missing data (24%)

Figure 20: Proportion of cases by dyslipidaemia status and case category

6.7 Atrial arrhythmia history

Almost one-third of patients (30%) had a history of atrial arrhythmia (atrial fibrillation, flutter or other atrial arrhythmia). The prevalence of atrial arrhythmia ranged from 23% to 43% across procedure categories.

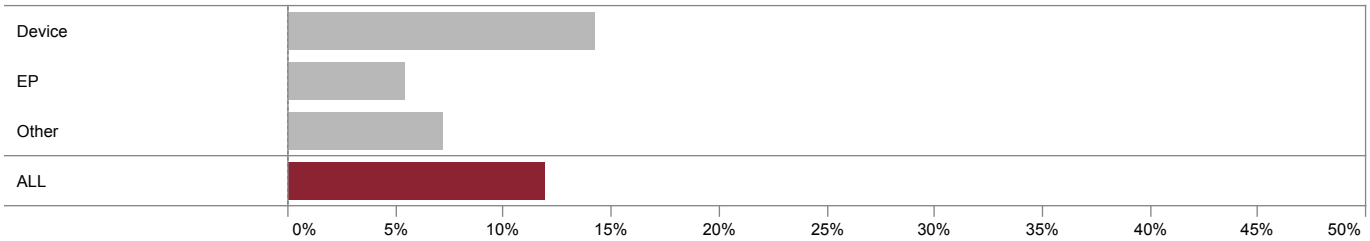


Excludes missing data (29%)

Figure 21: Proportion of cases by atrial arrhythmia status and case category

6.8 Heart failure

Overall, 12% of patients had a classification of heart failure at the time of case, ranging from 14% for device procedures to 5% in the electrophysiology category.

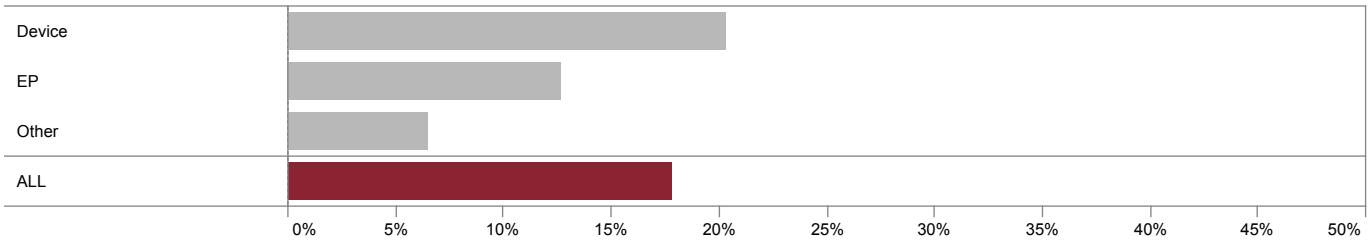


Excludes missing data (33%)

Figure 22: Proportion of cases by heart failure status and case category

6.9 Valvular heart disease

Valvular heart disease was documented for 18% of patients, ranging from 20% for device procedures to 13% in the electrophysiology category.

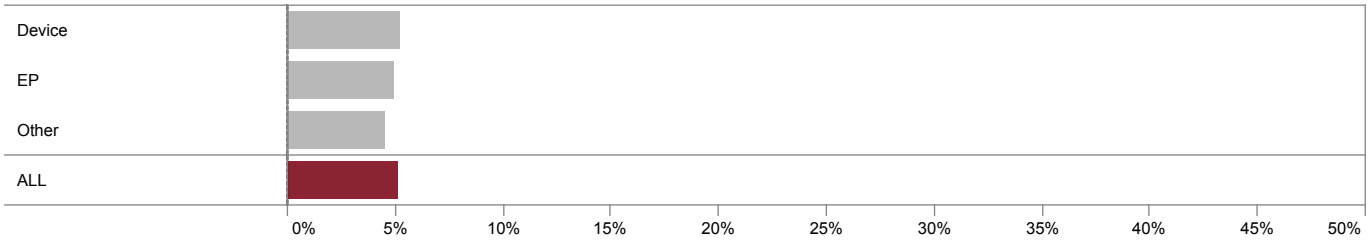


Excludes missing data (33%)

Figure 23: Proportion of cases by valvular heart disease and case category

6.10 Other cardiovascular disease and co-morbidities

Overall, 5% of patients had a form of other cardiovascular disease or co-morbidity at the time of case, with an even distribution across case categories.

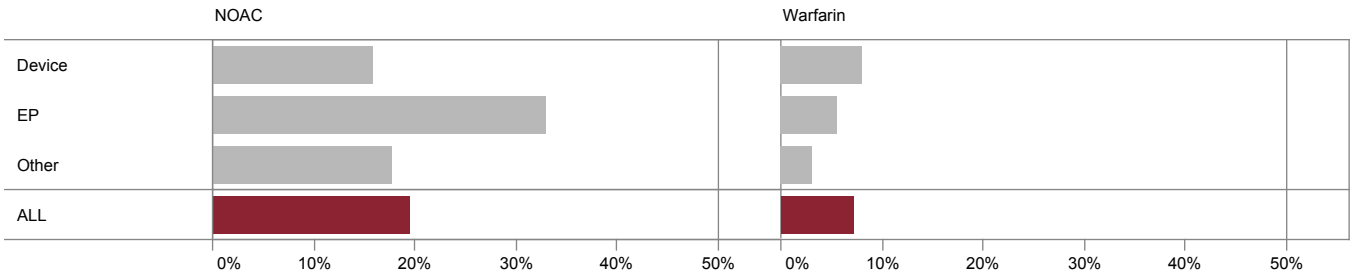


Excludes missing data (37%)

Figure 24: Proportion of cases by CV disease history and co-morbidity and case category

6.11 Anticoagulation

Patients were identified as being on anticoagulant therapy including either Warfarin or non-vitamin K antagonist oral anticoagulants (NOAC) at the time of case. Anticoagulated patients comprised 27% of the total cohort with patients in the electrophysiology category having the highest use of anticoagulants (39%).



Excludes missing data (39%)

Figure 25: Proportion of cases by anticoagulation status and case category

7 Care and treatment of patients

7.1 Urgency category

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

Across the state, category one cases formed the majority of procedures undertaken. Urgency category ranged widely between sites with category one cases varying from 28% to 90%. Further disparity was noted within category three, with these cases accounting for 1% to 37% of case volumes by site.

Table 6: Proportion of all cases by urgency category and site

	Total cases n	Category 1* n (%)	Category 2† n (%)	Category 3‡ n (%)
CH	266	217 (81.6)	37 (13.9)	7 (2.6)
TTH	464	246 (53.0)	51 (11.0)	13 (2.8)
MBH	96	59 (61.5)	34 (35.4)	2 (2.1)
SCUH	518	143 (27.6)	195 (37.6)	136 (26.3)
TPCH	1,155	791 (68.5)	254 (22.0)	110 (9.5)
RBWH	535	229 (42.8)	107 (20.0)	199 (37.2)
PAH	891	443 (49.7)	263 (29.5)	184 (20.7)
GCUH	549	496 (90.3)	45 (8.2)	5 (0.9)
STATEWIDE	**4,474**	**2,624 (58.6)**	**986 (22.0)**	**656 (14.7)**

Includes missing data 4.7%

Case totals do not reflect all 2018 activity for GCUH

* Procedures that are clinically indicated within 30 days

† Procedures that are clinically indicated within 90 days

‡ Procedures that are clinically indicated within 365 days

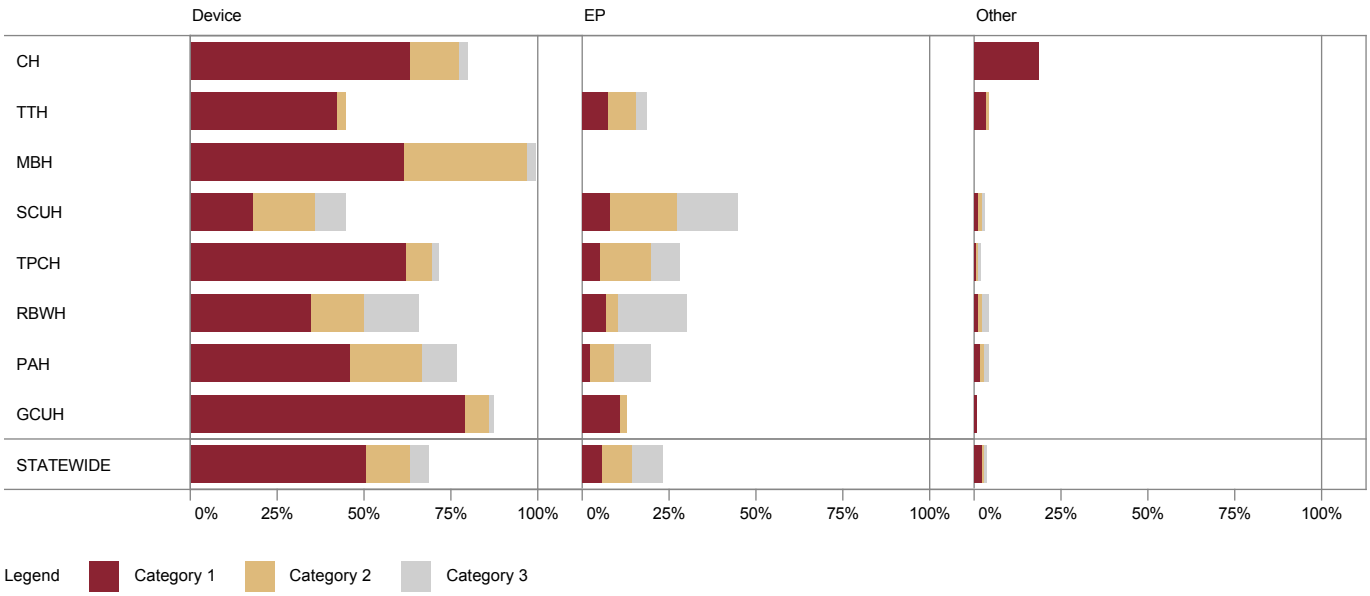


Figure 26: Proportion of all cases by urgency category, procedure category and site

7.2 Admission source

The majority of all cases were performed on patients classed as outpatients (54%). Non-admitted inter-hospital transfers accounted for less than 1% of all case volume

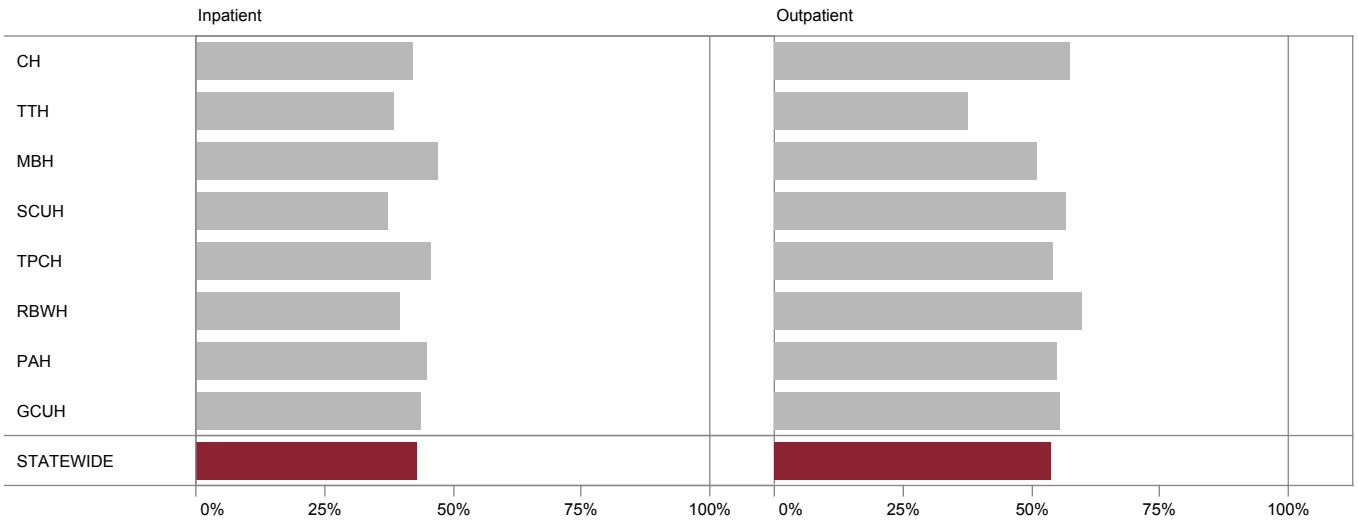


Figure 27: Admission source by site

Table 7: Admission source by site

	Total cases n*	Inpatient n (%)	Outpatient n (%)	Non-admitted inter-hospital transfer n (%)
CH	266	112 (42.1)	153 (57.5)	–
TTH	464	179 (38.6)	175 (37.7)	–
MBH	96	45 (46.9)	49 (51.0)	2 (2.1)
SCUH	518	192 (37.1)	293 (56.6)	–
TPCH	1,155	530 (45.9)	624 (54.0)	1 (0.1)
RBWH	535	213 (39.8)	321 (60.0)	1 (0.2)
PAH	891	402 (45.1)	489 (54.9)	–
GCUH	549	239 (43.5)	305 (55.6)	5 (0.9)
STATEWIDE	**4,474**	**1,912 (42.7)**	**2,409 (53.8)**	**9 (0.2)**

* Includes missing data 3.2%

Case totals do not reflect all 2018 activity for GCUH

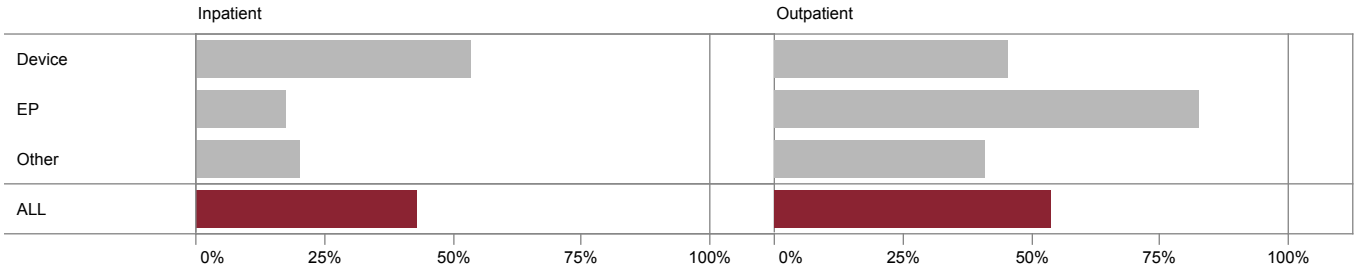


Figure 28: Admission source by case category

7.3 Admission source and urgency category

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

Table 8: Outpatient cases by urgency category

Outpatient site	Total cases n*	Category 1 n (%)	Category 2 n (%)	Category 3 n (%)
CH	153	109 (71.2)	32 (20.9)	7 (4.6)
TTH	175	103 (58.9)	40 (22.9)	13 (7.4)
MBH	49	15 (30.6)	32 (65.3)	2 (4.1)
SCUH	293	42 (14.3)	113 (38.6)	128 (43.7)
TPCH	624	290 (46.5)	229 (36.7)	105 (16.8)
RBWH	321	32 (10.0)	96 (29.9)	193 (60.1)
PAH	489	114 (23.3)	225 (46.0)	150 (30.7)
GCUH	305	263 (86.2)	36 (11.8)	4 (1.3)
STATEWIDE	**2,409**	**968 (40.2)**	**803 (33.3)**	**602 (25.0)**

* Includes 1.5% missing data

Case totals do not reflect all 2018 activity for GCUH

Table 9: Inpatient cases by urgency category

Inpatient site	Total cases n*	Category 1 n (%)	Category 2 n (%)	Category 3 n (%)
CH	112	108 (96.4)	4 (3.6)	–
TTH	179	143 (79.9)	10 (5.6)	–
MBH	45	42 (93.3)	2 (4.4)	–
SCUH	192	100 (52.1)	66 (34.4)	8 (4.2)
TPCH	530	501 (94.5)	25 (4.7)	4 (0.8)
RBWH	213	196 (92.0)	11 (5.2)	6 (2.8)
PAH	402	329 (81.8)	38 (9.5)	34 (8.5)
GCUH	239	228 (95.4)	9 (3.8)	1 (0.4)
STATEWIDE	**1,912**	**1,647 (86.1)**	**165 (8.6)**	**53 (2.8)**

Case totals do not reflect all 2018 activity for GCUH

7.4 Device procedures

Case types and procedure combinations varied across the state and is driven primarily by services offered at individual sites. Single and dual chamber pacemaker implants/generator changes accounted for the majority of cases across the state. There were 7 sites across the state offering biventricular pacemaker (BiV)/ implantable cardioverter defibrillator insertion with three sites providing leadless pacemaker implants.

Table 10: Cardiac device case types by site

Site	Procedure type	Case n (%)
CH	Pacemaker implant/generator change	121 (56.8)
	Loop recorder implant/explant	59 (27.7)
	ICD implant/generator change/upgrade	18 (8.5)
	Lead revision/replacement/pocket revision	5 (2.3)
	BiV ICD implant/generator change/upgrade	4 (1.9)
	BiV pacemaker implant/generator change/upgrade	4 (1.9)
	Device explant	1 (0.5)
	Insertion of epicardial lead	1 (0.5)
TTH	Pacemaker implant/generator change	99 (44.4)
	ICD implant/generator change/upgrade	49 (22.0)
	BiV ICD implant/generator change/upgrade	38 (17.0)
	Loop recorder implant/explant	16 (7.2)
	Lead revision/replacement/pocket revision	10 (4.5)
	BiV pacemaker implant/generator change/upgrade	6 (2.7)
	Device explant	4 (1.8)
	Temporary pacing system	1 (0.4)
MBH	Pacemaker implant/generator change	51 (53.7)
	Loop recorder implant/explant	30 (31.6)
	Temporary pacing system	12 (12.6)
	ICD implant/generator change/upgrade	2 (2.1)
SCUH	Pacemaker implant/generator change	183 (66.8)
	ICD implant/generator change/upgrade	38 (13.9)
	Loop recorder implant/explant	22(8.0)
	BiV pacemaker implant/generator change/upgrade	13 (4.7)
	BiV ICD implant/generator change/upgrade	10 (3.6)
	Lead revision/replacement/pocket revision	5 (1.8)
	Device explant	2 (0.7)
	Temporary pacing system	1 (0.4)
TPCH	Pacemaker implant/generator change	374 (45.6)
	ICD implant/generator change/upgrade	160 (19.5)
	Device explant	76 (9.3)
	BiV ICD implant/generator change/upgrade	72 (8.8)
	Loop recorder implant/explant	60 (7.3)
	BiV pacemaker implant/generator change/upgrade	29 (3.5)
	Lead revision/replacement/pocket revision	25 (3.0)
	Leadless pacemaker implant	12 (1.5)
	Temporary pacing system	10 (1.2)
	Defibrillation threshold testing	2 (0.2)
	Insertion of epicardial lead	1 (0.1)
RBWH	Pacemaker implant/generator change	135 (38.4)
	Loop recorder implant/explant	93 (26.4)
	ICD implant/generator change/upgrade	62 (17.6)
	BiV ICD implant/generator change/upgrade	24 (6.8)
	BiV pacemaker implant/generator change/upgrade	23 (6.5)
	Lead revision/replacement/pocket revision	11 (3.1)
	Temporary pacing system	2 (0.6)
	Device explant	1 (0.3)
	Insertion of epicardial lead	1 (0.3)

PAH	Pacemaker implant/generator change	445 (65.4)
	ICD implant/generator change/upgrade	113 (16.6)
	Loop recorder implant/explant	44 (6.5)
	BiV ICD implant/generator change/upgrade	31 (4.6)
	Lead revision/replacement/pocket revision	14 (2.1)
	BiV pacemaker implant/generator change/upgrade	10 (1.5)
	Temporary pacing system	8 (1.2)
	Leadless pacemaker implant	6 (0.9)
	Device explant	5 (0.7)
	Defibrillation threshold testing	4 (0.6)
GCUH	Pacemaker implant/generator change	287 (60.0)
	ICD implant/generator change/upgrade	94 (19.7)
	Loop recorder implant/explant	38 (7.9)
	Lead revision/replacement/pocket revision	29 (6.1)
	BiV ICD implant/generator change/upgrade	13 (2.7)
	Device explant	6 (1.3)
	BiV pacemaker implant/generator change/upgrade	4 (0.8)
	Leadless pacemaker implant	3 (0.6)
	Defibrillation threshold testing	2 (0.4)
	Insertion of epicardial lead	1 (0.2)
	Temporary pacing system	1 (0.2)
STATEWIDE		**3,136**

Case totals do not reflect all 2018 activity for GCUH

7.5 Electrophysiology studies/ablations

Electrophysiology studies including radiofrequency ablation were the most common individual procedure performed across all sites, ranging from 60% of case volume at TTH to 83% at PAH.

Table 11: Electrophysiology study/ablation types by site

Site	Procedure type	Case n (%)
TTH	Radiofrequency ablation	62 (59.6)
	Cryotherapy ablation	22 (21.2)
	Electrophysiology study	19 (18.3)
	Radiofrequency and cryotherapy ablation	1 (‹1.0)
SCUH	Radiofrequency ablation	141 (60.5)
	Cryotherapy ablation	48 (20.6)
	Electrophysiology study	42 (18.0)
	Electrophysiology study with drug challenge	2 (0.9)
TPCH	Radiofrequency ablation	228 (67.9)
	Electrophysiology study	66 (19.6)
	Cryotherapy ablation	35 (10.4)
	Electrophysiology study with drug challenge	4 (1.2)
	Radiofrequency and cryotherapy ablation	3 (0.9)
RBWH	Radiofrequency ablation	103 (61.7)
	Electrophysiology study	47 (28.1)
	Cryotherapy ablation	8 (4.8)
	Radiofrequency and cryotherapy ablation	8 (4.8)
	Electrophysiology study with drug challenge	1 (0.6)
PAH	Radiofrequency ablation	147 (83.1)
	Electrophysiology study	24 (13.6)
	Cryotherapy ablation	6 (3.4)
GCUH	Radiofrequency ablation	54 (76.1)
	Electrophysiology study	17 (23.9)
STATEWIDE		**1,088**

Case totals do not reflect all 2018 activity for GCUH

7.5.1 Standard vs complex electrophysiology

Complex electrophysiology cases involving three-dimensional mapping technology, ventricular arrhythmias or pulmonary vein isolation accounted for 52% of all electrophysiology cases.

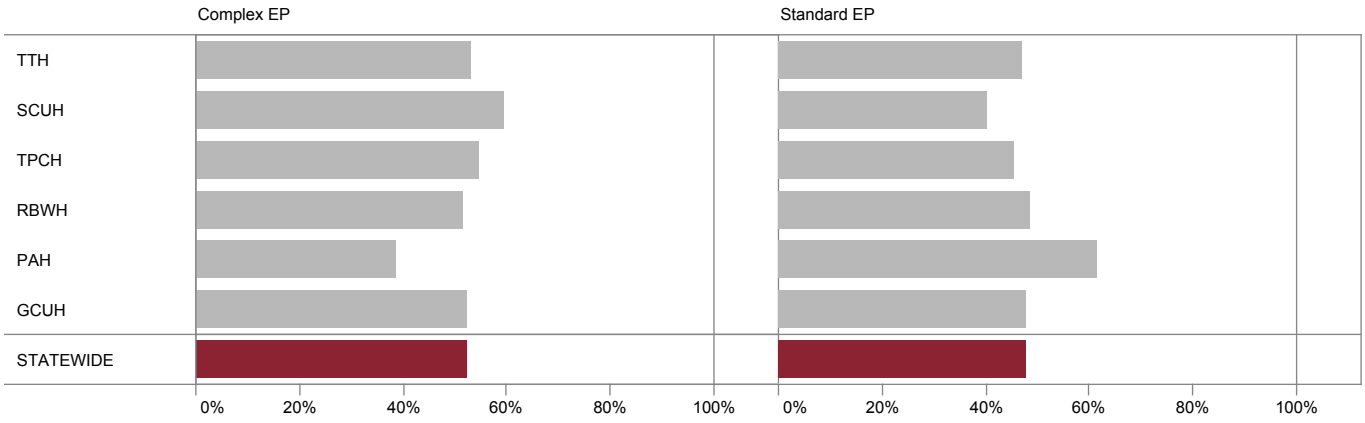


Figure 29: Complexity of electrophysiology procedures by site

Table 12: Proportion of standard and complex electrophysiology procedures by site

Site	Procedure type	Total n	Complex EP n	Standard EP n
TTH	Radiofrequency ablation	62	28	34
	Cryotherapy ablation	22	22	–
	Electrophysiology study	19	4	15
	Radiofrequency and cryotherapy ablation	1	1	–
SCUH	Radiofrequency ablation	141	74	67
	Cryotherapy ablation	48	45	3
	Electrophysiology study	42	19	23
	Electrophysiology study with drug challenge	2	1	1
TPCH	Radiofrequency ablation	228	117	111
	Electrophysiology study	66	27	39
	Cryotherapy ablation	35	35	–
	Electrophysiology study with drug challenge	4	1	3
	Radiofrequency and cryotherapy ablation	3	3	–
RBWH	Radiofrequency ablation	103	63	40
	Electrophysiology study	47	14	33
	Cryotherapy ablation	8	6	2
	Radiofrequency and cryotherapy ablation	8	3	5
	Electrophysiology study with drug challenge	1	–	1
PAH	Radiofrequency ablation	147	64	83
	Electrophysiology study	24	4	20
	Cryotherapy ablation	6	–	6
GCUH	Radiofrequency ablation	54	33	21
	Electrophysiology study	17	4	13
STATEWIDE		**1,088**	**568**	**520**

Case totals do not reflect all 2018 activity for GCUH

7.5.2 Three-dimensional mapping system

The total proportion of electrophysiology cases utilising three-dimensional mapping systems across sites, and distribution across vendors is shown in Table 13. Two vendors accounted for 85% of all three-dimensional mapping systems used.

Table 13: Three dimensional mapping system type by site

	Total cases n	CARTO n (%)	ESI n (%)	Rhythmia n (%)	ESI + Rhythmia n (%)	Other n (%)
TTH	29	7 (24.1)	22 (75.9)	–	–	–
SCUH	81	–	35 (43.2)	44 (54.3)	–	2 (2.5)
TPCH	131	41 (31.3)	78 (59.5)	11 (8.4)	1 (0.8)	–
RBWH	77	7 (9.1)	65 (84.4)	–	–	5 (6.5)
PAH	57	32 (56.1)	25 (43.9)	–	–	–
GCUH	32	21 (65.6)	11 (34.4)	–	–	–
STATEWIDE	**407**	**108 (26.5)**	**236 (58.0)**	**55 (13.5)**	**1 (0.2)**	**7 (1.7)**

Case totals do not reflect all 2018 activity for GCUH

7.6 Ablation type

Radiofrequency ablation is the principal method across all sites with 85% of all cases utilising this energy. There was variation in the proportionate use between sites with some more likely to use multiple types which is possibly a function of equipment availability. A small proportion of cases (1%) utilised two energy types.

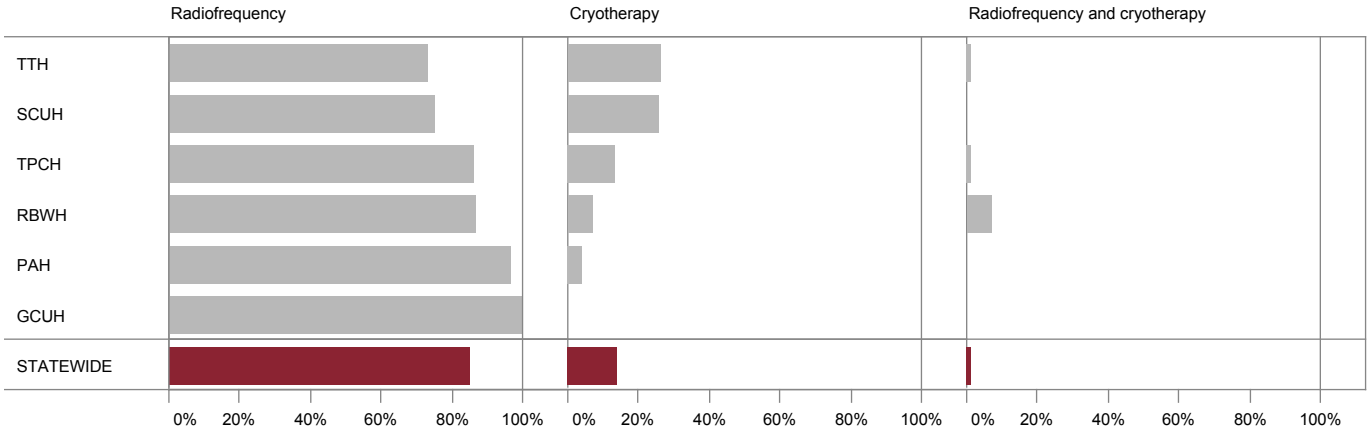


Figure 30: Ablation type by site

Table 14: Ablation type by site

	Total cases n	Radiofrequency n (%)	Cryotherapy n (%)	Radiofrequency + Cryotherapy n (%)
TTH	85	62 (72.9)	22 (25.9)	1 (1.2)
SCUH	189	141(74.6)	48 (25.4)	–
TPCH	265	227 (85.7)	35 (13.2)	3 (1.1)
RBWH	119	103 (86.6)	8 (6.7)	8 (6.7)
PAH	153	147 (96.1)	6 (3.9)	–
GCUH	54	54 (100.0)	–	–
STATEWIDE	**865**	**734 (84.9)**	**119 (13.8)**	**12 (1.3)**

Case totals do not reflect all 2018 activity for GCUH

7.6.1 Ablation type/arrhythmia

The most frequently ablated clinical arrhythmia was atrial fibrillation (pulmonary vein isolation), which accounted for 34% of ablations across all sites. This was followed by atrial flutter (21%) and atrioventricular nodal re-entry tachycardias (AVNRT) (20%).

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. These details are further expanded in Table 15.

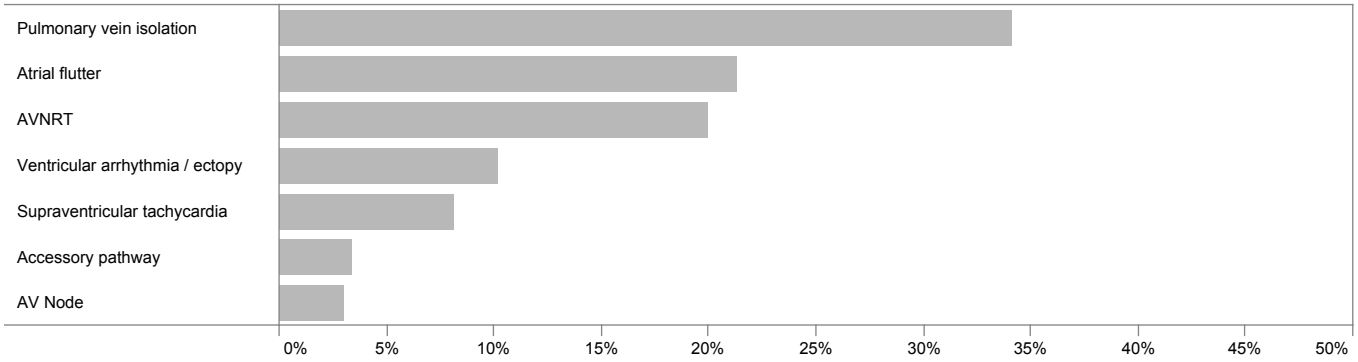


Figure 31: Proportion of arrhythmias ablated

Table 15: Median age and gender by ablation type

Ablation type	Gender	Total cases n (%)	Median age years
Pulmonary vein isolation	Male	189 (64.1)	58
	Female	106 (35.9)	62
Atrial flutter	Male	138 (75.0)	65
	Female	46 (25.0)	62
AVNRT	Male	66 (38.2)	59
	Female	107 (61.8)	46
Ventricular arrhythmia/ectopy	Male	58 (65.9)	66
	Female	30 (34.1)	49
Supraventricular tachycardia	Male	28 (40.0)	44
	Female	42 (60.0)	44
Accessory pathway	Male	17 (58.6)	30
	Female	12 (41.4)	26
AV node	Male	13 (50.0)	78
	Female	13 (50.0)	76
ALL		**865 (100.0)**	**59**

Table 16: Arrhythmia type by site

Site	Ablation type	Count n (%)
TTH	Pulmonary vein isolation	25 (29.4)
	AVNRT	20 (23.5)
	Atrial flutter	18 (21.2)
	Ventricular arrhythmia/ectopy	9 (10.6)
	Accessory pathway	6 (7.1)
	Supraventricular tachycardia	5 (5.9)
	AV node	2 (2.4)
SCUH	Pulmonary vein isolation	93 (49.2)
	Atrial flutter	57 (30.2)
	AVNRT	16 (8.5)
	AV node	9 (4.8)
	Ventricular arrhythmia/ectopy	6 (3.2)
	Supraventricular tachycardia	6 (3.2)
	Accessory pathway	2 (1.1)
TPCH	Pulmonary vein isolation	79 (29.8)
	AVNRT	53 (20.0)
	Atrial flutter	45 (17.0)
	Ventricular arrhythmia/ectopy	45 (17.0)
	Supraventricular tachycardia	29 (10.9)
	Accessory pathway	8 (3.0)
	AV node	6 (2.3)
RBWH	Pulmonary vein isolation	33 (27.7)
	AVNRT	33 (27.7)
	Atrial flutter	26 (21.8)
	Supraventricular tachycardia	11 (9.2)
	Ventricular arrhythmia/ectopy	10 (8.4)
	Accessory pathway	5 (4.2)
	AV node	1 (0.8)
PAH	Pulmonary vein isolation	48 (31.4)
	AVNRT	47 (30.7)
	Atrial flutter	25 (16.3)
	Supraventricular tachycardia	12 (7.8)
	Ventricular arrhythmia/ectopy	9 (16.7)
	Accessory pathway	7 (4.6)
	AV node	5 (3.3)
GCUH	Pulmonary vein isolation	17 (31.5)
	Atrial flutter	13 (24.1)
	Ventricular arrhythmia/ectopy	9 (16.7)
	Supraventricular tachycardia	7 (13.0)
	AVNRT	4 (7.4)
	AV node	3 (5.6)
	Accessory pathway	1 (1.9)
STATEWIDE		**865**

Case totals do not reflect all 2018 activity for GCUH

7.7 Other procedures

The most common forms of other procedure were cardioversions (72%). 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 application.

Table 17: Other procedures

	Total n	Cardioversion n (%)	Drug challenge n (%)	Other n (%)
CH	53	45 (84.9)	2 (3.8)	6 (11.3)
TTH	138	118 (85.5)	5 (2.9)	15 (10.9)
MBH	1	–	–	1 (100.0)
SCUH	12	–	10 (83.3)	2 (16.7)
TPCH	12	2 (16.7)	–	10 (83.3)
RBWH	22	1 (4.5)	13 (59.1)	8 (36.4)
PAH	37	33 (89.2)	1 (2.7)	3 (8.1)
GCUH	2	1 (50.0)	–	1 (50.0)
STATEWIDE	**277**	**200 (72.2)**	**31 (11.2)**	**46 (16.6)**

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

8 Procedural complications

Lead complications were the most frequently encountered complication for device procedures and pericardial effusions were the most commonly observed complication across electrophysiology procedures. The summary of complications below denotes events observed during the procedure as well as post. The QCOR electrophysiology application is predominantly utilised for procedural detail reporting, and as such documentation of procedural complications is the responsibility of site practitioners.

The complication rates for procedures in Tables 18 and 19 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 2.9%, while electrophysiology procedures had a 3.2% complication rate.

Table 18: Cardiac device procedure complications

Procedure type	Complication	Total n (%)
Pacemaker implant/generator change	Lead complication	14 (0.5)
	Other	11 (0.4)
	Pneumothorax	7 (0.2)
	Pericardial effusion with or without tamponade	5 (0.2)
	Haematoma	4 (0.1)
	Infection	4 (0.1)
	Cardiac arrest	2 (<0.1)
Loop recorder implant/explant	Device migration/erosion	2 (<0.1)
	Drug reaction	2 (<0.1)
	Other	1 (<0.1)
ICD implant/generator change/upgrade	Lead complication	3 (0.1)
	Other	3 (0.1)
	Bleeding	2 (<0.1)
	Haematoma	2 (<0.1)
	Infection	2 (<0.1)
	Cardiac arrest	1 (<0.1)
	Drug reaction	1 (<0.1)
	Pneumothorax	1 (<0.1)
BiV ICD implant/generator change/upgrade	Lead dislodgement	3 (0.1)
	Conduction block	2 (<0.1)
	Coronary sinus dissection	2 (<0.1)
	Pericardial effusion without tamponade	2 (<0.1)
	Bleeding	1 (<0.1)
BiV pacemaker implant/generator change/upgrade	Coronary sinus dissection	3 (0.1)
	Coronary sinus perforation	1 (<0.1)
	Lead complication	1 (<0.1)
	Pericardial effusion without tamponade	1 (<0.1)
Device explant	Lead complication	1 (<0.1)
Lead revision/replacement/pocket revision	Lead complication	5 (0.2)
	Pericardial effusion with tamponade	1 (<0.1)
	Pneumothorax	1 (<0.1)
	Vascular injury	1 (<0.1)
ALL		**90 (2.9)**

Table 19: Electrophysiology procedure complications by study type and complexity

Procedure type	Complexity	Complication	Total n (%)
Electrophysiology study	Complex EP	Conduction block	1 (<0.1)
		Pericardial effusion with tamponade	1 (<0.1)
Cryotherapy ablation	Standard EP	Arrhythmia returned	2 (0.2)
		Conduction block	1 (<0.1)
	Complex EP	Pericardial effusion with tamponade	1 (<0.1)
		Phrenic nerve injury	1 (<0.1)
Radiofrequency ablation	Standard EP	Conduction block	2 (0.2)
		Atrial arrhythmia requiring DCCV	1 (<0.1)
		Ventricular arrhythmia	1 (<0.1)
	Complex EP	Pericardial effusion with tamponade	8 (0.8)
		Arrhythmia returned	7 (0.7)
		Pericardial effusion	3 (0.3)
		Infection	2 (0.2)
		Other	2 (0.2)
		Bleeding	1 (<0.1)
ALL			**34 (3.2)**

9 Clinical indicators

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

The quality and safety indicators which have been nominated by the statewide electrophysiology working group are outlined in Table 20.

Table 20: Electrophysiology and pacing clinical indicators

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

9.1 Waiting time from referral date to procedure by case category

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

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

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

9.1.1 Elective pacemaker

Examination of the waiting time for elective pacemaker procedures is below. Of the 227 cases with complete data, the median wait time was 17 days.

Table 21: Elective pacemaker wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
Statewide	349	227	17	1–34

9.1.2 Elective ICD wait time and proportion within 28 days

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

Table 22: Elective ICD wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
Statewide	217	120	33	7–53	44

9.1.3 Standard ablation

Waiting times for standard ablation procedures are presented below. Of the 208 cases eligible for analysis, the median wait time was 91 days. One-quarter of patients had a wait time of 159 days or more.

Table 23: Elective standard ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days
Statewide	297	208	91	47–159

9.1.4 Complex ablation (with proportion within 180 days or less)

Complex ablations are defined as cases using three-dimensional mapping technology or involving ventricular arrhythmia or pulmonary vein isolation. This indicator examines the waiting time for these procedures and the proportion adhering to the benchmark of 180 days or less. This indicator is reported at a site level and investigates those sites with >20 cases with data for analysis.

A median wait time of 81 days was observed with a large interquartile range demonstrating that there are a number of patients with considerably long waits.

Table 24: Elective complex ablation wait time analysis

	Total cases n	Total cases analysed n	Median wait time days	Interquartile range days	Met target %
TTH	27	0	N/A	N/A	N/A
SCUH	102	7	N/A	N/A	N/A
TPCH	144	140	127	55–233	64
RBWH	67	67	28	18–43	99
PAH	43	42	121	50–354	60
GCUH	28	1	N/A	N/A	N/A
STATEWIDE	**411**	**225**	**81**	**35–193**	**73**

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

9.2 Procedural tamponade rates

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

Table 25: Procedural tamponade analysis

Procedure category	Total cases analysed n	Procedural tamponade observed n	Procedural tamponade rate %
Device	3,136	4	0.1
EP	1,061	10	0.9
ALL	**4,197**	**14**	**0.3**

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

This indicator identifies the number of cases where lead dislodgement was observed within one year of lead insertion. The cases included in this indicator were all new device implants or upgrades where a new lead/s had been implanted and a lead revision or replacement was subsequently required due to dislodgement. Index implant procedures were cases performed within Queensland Health implanting facilities in the 2017 calendar year.

The analysis showed 26 cases (1.8%) where reintervention was required within 12 months of the index procedure. Higher rates of reintervention were noted in the biventricular device category which may reflect the greater complexity of these systems.

Of these 26 cases, 9 atrial and 17 ventricular lead dislodgements were noted. Septal and apically positioned ventricular leads were the most commonly observed lead dislodgement sites (7 each) followed by right ventricular outflow tract (n=2) and His bundle sites (n=1).

These results compare favourably with international cohorts where observed dislodgement rates for pacemaker system implants vary from 1.0 to 2.7%[21].

Table 26: Reintervention due to lead dislodgement analysis

	Cases analysed n	Atrial lead n	Ventricular lead n	12 month lead dislodgement n	12 month lead dislodgement rate %
Pacemaker implant	968	8	11	19	2.0
ICD implant	301	1	2	3	1.0
Any BiV implant	155	0	4	4	2.6
All 2017 device cases	**1,424**	**9**	**17**	**26**	**1.8**

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

One of the most serious long-term complications related to mortality and morbidity for patients with cardiac implantable electronic devices is infection. Complete removal of all hardware is the recommended treatment for patients with established device infection because infection relapse rates due to retained hardware are high.

A 1.4% system loss rate was observed at 12 months which is reassuring when compared to international literature which suggests infection rates necessitating explant of approximately 2.4%[22].

Table 27: Rehospitalisation with device loss analysis

	Cases analysed n	12 month system loss due to infection n	12 month system loss rate %
2017 device cases	1,765	25	1.4

9.5 12 month all-cause mortality for cardiac device procedures

12 month all-cause mortality is examined for patients with cardiac devices procedures in 2017. It is important to note that patients undergoing these procedures are often of an advanced age, have advanced symptomatology (advanced heart failure in patients with biventricular pacing) and often have multiple comorbidities and risk factors.

Table 28: 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	189	12	6.3	71	63–77
ICD procedure	422	15	3.6	62	53–71
Pacemaker procedures	1,154	85	7.4	77	69–84
All 2017 device cases	**1,765**	**112**	**6.3**	**74**	**64–81**

10 Conclusions

The 2018 QCOR Annual Report has demonstrated significant advances in analysis of activity and outcomes in cardiac electrophysiology. Reference to QCOR data has improved the cost-effectiveness of procurement of cardiac electronic implantable devices. The savings realised thereby have permitted funding to be redirected to other areas of need. With continued clinical input and focus, QCOR data and reporting will be able to inform clinicians not only of performance and quality but also to provide unprecedented insight into service capacity and throughput. It is unusual for such insight to be available to clinicians beyond Queensland Health, nationally or internationally. Indeed, the detail and rigour of QCOR data exemplifies what is possible with an engaged clinical group.

It is mandatory that QCOR data, which is accurate and contextualised, should inform planning for sustained and appropriate growth of infrastructure and specialised workforce across the state. Enhancement of reporting of clinical quality indicators has highlighted further the unmet demand for cardiac ablation procedures, expressed most particularly as unacceptable wait times at TPCH and PAH. While the median statewide wait time in 2018 for complex ablation procedures was 81 days, the corresponding mean wait time for ablation for atrial fibrillation at PAH was 336 days, and 171 days for complex ablation at TPCH. This disparity speaks to issues of prioritisation for laboratory building and workforce recruitment now, but also underlines the need to mitigate, with vision guided by QCOR data, future increase of unmet need at newer sites. The nature of wait time data available from some sites beyond Brisbane remains heterogeneous, still requiring collation and interpretation to ensure consistency in measurement and presentation. It should be recognised that wait times recorded do not include outpatient waiting times for a patient to be assessed by (the too few) heart rhythm specialists. No measure of unmet need can account for the reluctance to refer patients for complex ablation by general practitioners and even colleague cardiologists who are aware of long, unsatisfactory wait times.

Trends in QCOR data support the premise that when plans are considered for building of an additional laboratory for coronary angiography/PCI, provision should be made for a cardiac electrophysiology laboratory to be built in tandem – this makes sense in terms of economy of scale for building and in view of ever-rising demand for EP-pacing services, itself partly consequent on the additional, invasive coronary activities. It is axiomatic that planning for infrastructure should proceed in parallel with planning for expansion of specialised workforce. These concepts are being examined by the Systems Planning Branch.

Clinical indicators highlight that only 44% of elective ICD procedures were undertaken within 30 days. This represents unsatisfactory delay which must be addressed. Issues of inadequate workforce and deficient laboratory infrastructure will have contributed. Procedural tamponade rates are satisfactory at 0.2%, while device lead dislodgments are likely under-reported. Device loss at 1 year due to infection is probably satisfactory at 1.2%, but there is no room for complacency here.

Where 12 month all-cause mortality after device procedure exceeded age-matched population background rates in 2018, it was noted that small number of deaths in younger patients were statistically insignificant, while data captured for elderly patients likely represented death in spite of, not because of, their procedures.

The QCOR initiatives have underscored the importance of quality data capture and the indispensable nature of clinical input to guide useful and relevant reporting. With further focus on data completeness and integrity, the power of the QCOR cardiac electrophysiology registry will continue to inform improvement of service provision and delivery of quality, timely clinical care for Queensland Health patients who have cardiac rhythm disorders. Such improvement necessitates immediate repair of infrastructure and workforce deficiencies to create a sustainable, adequate foundation from which to launch the exciting future of cardiac electrophysiology.

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Glossary

6MWT	Six Minute Walk Test
ACC	American College of Cardiology
ACEI	Angiotensin Converting Enzyme Inhibitor
ACOR	Australasian Cardiac Outcomes Registry
ACS	Acute Coronary Syndromes
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
ATSI	Aboriginal and Torres Strait
AV	Atrioventricular
AVNRT	Atrioventricular Nodal Re-entry Tachycardia
BCIS	British Cardiovascular Intervention Society
BiV	Biventricular
BMI	Body Mass Index
BMS	Bare Metal Stent
BNH	Bundaberg Hospital
BSSLTX	Bilateral Sequential Single Lung Transplant
BVS	Bioresorbable Vascular Scaffold
CABG	Coronary Artery Bypass Graft
CAD	Coronary Artery Disease
CBH	Caboolture Hospital
CCL	Cardiac Catheter Laboratory
CH	Cairns Hospital
CHF	Congestive Heart Failure
CI	Clinical Indicator
CR	Cardiac Rehabilitation
CRT	Cardiac Resynchronisation Therapy
CS	Cardiac Surgery
CV	Cardiovascular
CVA	Cerebrovascular Accident
DAOH	Days Alive and Out of Hospital
DES	Drug Eluting Stent
DOSA	Day Of Surgery Admission
DSWI	Deep Sternal Wound Infection
ECG	12 lead Electrocardiograph
ECMO	Extracorporeal Membrane Oxygenation
ED	Emergency Department
eGFR	Estimated Glomerular Filtration Rate
EP	Electrophysiology
FdECG	First Diagnostic Electrocardiograph
FTR	Failure To Rescue
GAD	Generalized Anxiety Disorder
GCCH	Gold Coast Community Health
GCUH	Gold Coast University Hospital
GLH	Gladstone Hospital
GP	General Practitioner
GYH	Gympie Hospital
HBH	Hervey Bay Hospital (includes Maryborough)
HF	Heart Failure
HFpEF	Heart Failure with Preserved Ejection Fraction
HFrEF	Heart Failure with Reduced Ejection Fraction
HFSS	Heart Failure Support Service
HHS	Hospital and Health Service
HOCM	Hypertrophic Obstructive Cardiomyopathy
HSQ	Health Support Queensland
IC	Interventional Cardiology
ICD	Implantable Cardioverter Defibrillator
IHT	Inter-hospital Transfer
IPCH	Ipswich Community Health
LAA	Left Atrial Appendage
LAD	Left Anterior Descending Artery
LCX	Circumflex Artery
LGH	Logan Hospital
LOS	Length Of Stay
LV	Left Ventricle
LVEF	Left Ventricular Ejection Fraction
LVOT	Left Ventricular Outflow Tract
MBH	Mackay Base Hospital
MI	Myocardial Infarction
MIH	Mt Isa Hospital
MRA	Mineralocorticoid Receptor Antagonists
MTHB	Mater Adult Hospital, Brisbane
NCDR	The National Cardiovascular Data Registry
NOAC	Non-Vitamin K Antagonist Oral Anticoagulants
NP	Nurse Practitioner
NRBC	Non-Red Blood Cells
NSTEMI	Non ST-Elevation Myocardial Infarction
OR	Odds Ratio
PAH	Princess Alexandra Hospital
PAPVD	Partial Anomalous Pulmonary Venous Drainage
PCI	Percutaneous Coronary Intervention
PDA	Patent Ductus Arteriosus
PFO	Patent Foramen Ovale
PHQ	Patient Health Questionairre
QAS	Queensland Ambulance Service
QCOR	Queensland Cardiac Outcomes Registry
QEII	Queen Elizabeth II Hospital
QH	Queensland Health
QHAPDC	Queensland Hospital Admitted Patient Data Collection
RBC	Red Blood Cells
RBWH	Royal Brisbane and Women's Hospital
RCA	Right Coronary Artery
RDH	Redcliffe Hospital
RHD	Rheumatic Heart Disease
RKH	Rockhampton Hospital
RLH	Redland Hospital
SCCIU	Statewide Cardiac Clinical Informatics Unit
SCCN	Statewide Cardiac Clinical Network
SCUH	Sunshine Coast University Hospital
SHD	Structural Heart Disease
STEMI	ST-Elevation Myocardial Infarction
STS	Society of Thoracic Surgery
TAVR	Transcatheter Aortic Valve Replacement
TMVR	Transcatheter Mitral Valve Replacement
TNM	Tumour, Lymph Node, Metastases
TPCH	The Prince Charles Hospital
TPVR	Transcatheter Pulmonary Valve Replacement
TTH	The Townsville Hospital
TWH	Toowoomba Hospital
VAD	Ventricular Assist Device
VATS	Video-Assisted Thoracic Surgery
VCOR	Victorian Cardiac Outcomes Registry
VF	Ventricular Fibrillation
VSD	Ventricular Septal Defect

Ongoing initiatives

Whilst continually refining and improving data collection and reporting practices for the benefit of public facilities, QCOR is also beginning the investigation of a method to collect and analyse clinical data for private healthcare facilities. Following interest from various private providers, QCOR is looking to extend its quality and safety focus to accommodate the requirements of these facilities. It is anticipated that QCOR will provide a role in the delivery of reports and benchmarking activities whilst also acting as a conduit to the various national registries in existence and development.

Cardiac outreach continues to expand in Queensland with formalised and newly funded services having commenced between Cairns and Hinterland and Torres and Cape Hospital and Health Service intending to provide cardiac care in many of these communities for the first time. Services will commence in January 2020 between Townsville and North West. The forward plan for the rollout of this model across the state has been developed in partnership with consumers and clinicians. A new system, the QCOR Outreach application has been developed to track activity, service provision and patient outcomes. This ground-up development specifically for cardiac outreach finished testing and goes live for use in late 2019.

The QCOR Structural Heart Disease module is currently in advanced stages of development with wider deployment expected in 2020. This QCOR module has been developed to provide superior procedure reporting capabilities for structural heart disease interventions, device closure, and percutaneous valve replacement and repair procedures. It will enable participation in national quality and safety activities for transcatheter aortic valve replacement as well as allow clinicians to utilise the application for collecting pre and post-procedural data in unprecedented detail. The application has been through rigorous testing with user training and further enhancements planned for the near future.

The ECG Flash initiative of the SCCN has continued to be implemented at several sites throughout 2018 and 2019. Deployment of hardware to spoke sites has been via a staged approach with uptake being varied based on local site workload and workforce. Integration of ECG Flash with workflow within hub sites continues to evolve with sites now taking the initiative to embrace and feedback to sites regarding the appropriate use of the system. Analysis of the utility of the system is beginning to take place with a focus on clinical efficacy and benefit. It is anticipated that QCOR will be able to support this new initiative through procedural linkage and outcome monitoring for the subset of patients whose clinical path utilised ECG Flash and went on to subsequent investigation or management.

Opportunities for participation in the formative stages of national registries and initiatives have been embraced by Queensland clinicians. These important initiatives which are in various stage of development will be critical to the future of clinical registries in Australia. It is anticipated that with further involvement from local stakeholders that these entities will evolve into relevant and useful tools for patient-centred reporting and outcomes.

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