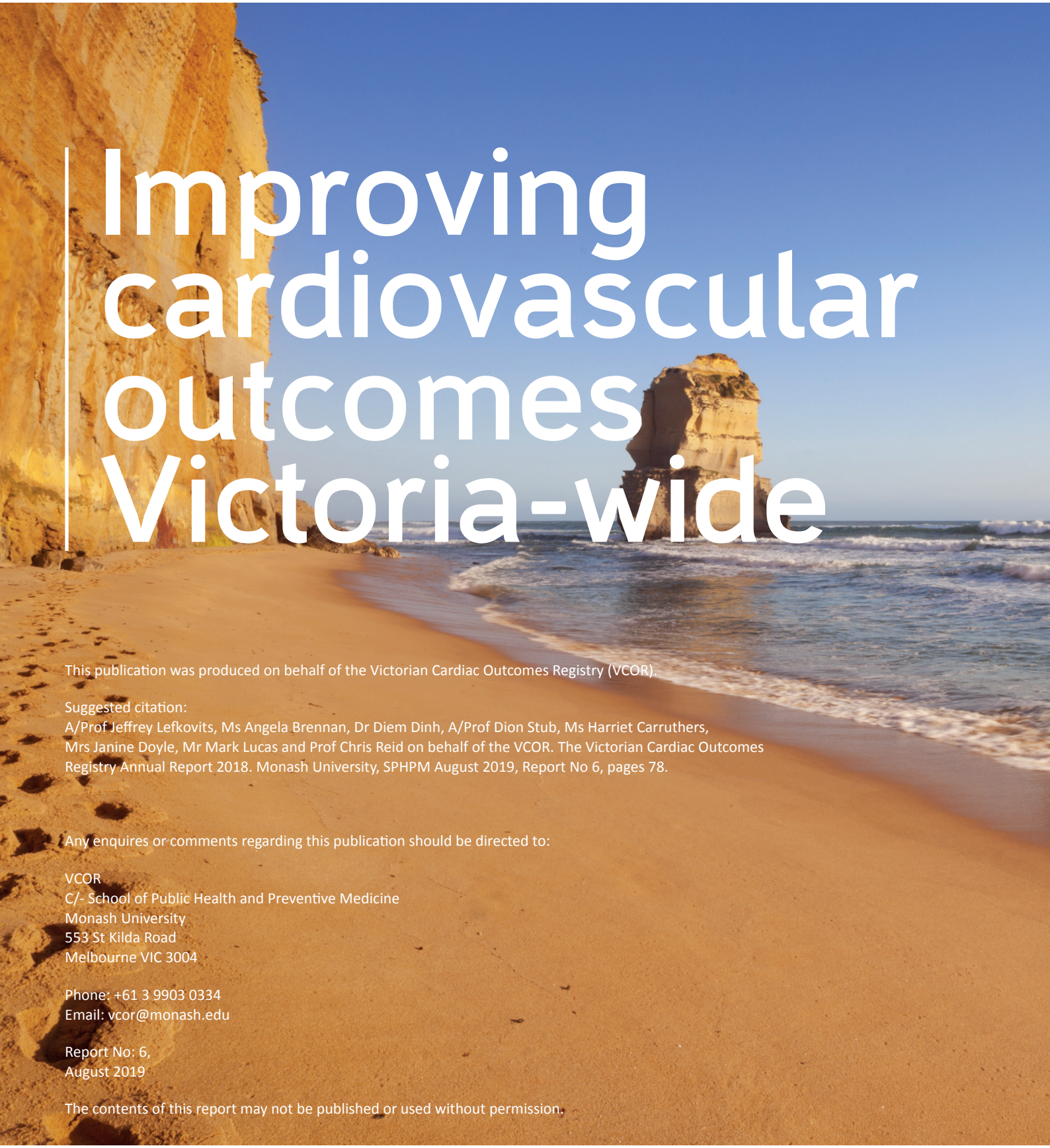
ANNUAL PUBLIC REPORT 2018

VICTORIAN CARDIAC OUTCOMES REGISTRY

VCOR
VICTORIAN CARDIAC OUTCOMES REGISTRY



Improving cardiovascular outcomes Victoria-wide

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This report would not have been possible without the efforts of doctors, nurses, data managers and other relevant hospital staff who contribute data to the VCOR.

Lead clinical staff from the hospitals participating in the VCOR are also gratefully acknowledged.

Foreword

It is my great pleasure to provide a foreword for the Victorian Cardiac Outcomes Registry (VCOR) Annual Report for 2018.

Heart disease remains one of Australia's greatest sources of premature death and morbidity, and is among the largest contributors to health care costs. Health care expenditure is a major proportion of GDP in Australia and worldwide. It is therefore very important that our patients, health care providers and governments have the tools to measure the quality of health care being delivered.

Robust, clinician-led clinical registries, are at the forefront of our evaluation of health care delivery. They provide global assessments of our performance, but also provide increasingly granular assessments of the performance of states, territories, districts and individual facilities. As such they provide the tools for benchmarking performance. They also provide the means for tracking variations in the performance of established and emerging technologies as they are delivered in the real world. Registries give us unique insights into the outcomes of patients who are more frail and have more comorbidities than patients included in many clinical trials. Most importantly, they are a platform for us to continuously review and improve our local services, prevent morbidity and save lives.

For many years, the VCOR group have been leaders in the provision of important registry data in relation to heart disease. The report for 2018 builds on previous outputs and measures such as outcomes after myocardial infarction, now including data on the very important area of implantable cardiac devices. The data are of very high quality, and their analysis and discussion are thoughtful and considered.

The Cardiac Society of Australia and New Zealand (CSANZ) has always strongly endorsed the role of registries in providing high quality, contemporaneous, real world outcome data. We anticipate national approaches to collecting registry data for patients with heart disease and its treatment are not far away in Australia. Such approaches are only possible because of the initiative and constructive engagement of VCOR, and related groups from other states and territories, around Australia.

I congratulate Associate Professor Lefkovits, the leadership team of VCOR, contributing clinicians, data managers, health services and funding bodies who made this report possible.

Professor Len Kritharides

President
Cardiac Society of Australia and New Zealand

Executive Summary

We are now clearly in an era where monitoring health outcomes, maintenance of a culture of continuous quality assurance and a concentrated focus on patient-oriented care are all key principles in health care planning and delivery. Clinical quality registries, like the Victorian Cardiac Outcomes Registry (VCOR), play a strategic role in this approach by systematically monitoring, analysing and reporting on the appropriateness and effectiveness of health care.

Support for clinical quality registries is present at both federal and state government levels. In the 2016 report by the Australian Commission on Quality and Safety in Health Care (ACSQHC) on a Prioritised List of Clinical Domains for Clinical Quality Registry Development: Final Report (1), cardiovascular disease was rated the highest priority area for attention. The federal government is now in the final stages of completing and releasing its 10-year National Strategy to Maximize the Potential of Australian Clinical Quality Registries. This strategy will be overseen by the Australian Ministers' Advisory Council and its implementation led by the ACSQHC and state/territory governments. In Victoria, the Victorian Agency for Health Information (VAHI) and Safer Care Victoria (SCV) are two bodies linked to the Department of Health and Human Services (DHHS) charged with ensuring and promoting the safety and quality of care in the state, sharing information to encourage these aims and partnering with clinicians, patients and other stakeholders for governance, clinical improvement and innovation. Their support and oversight, together with the Victorian Cardiac Clinical Network, have allowed VCOR to continue its quality assurance activities.

In this Annual Report, VCOR presents information on the activities of three registry modules. These include percutaneous coronary intervention (PCI), the management of ST elevation myocardial infarction (STEMI) in regional settings and for the first time, cardiac implantable electronic devices (CIED). The first two directly relate to management of acute coronary artery disease, while the third focuses on cardiac devices primarily utilised in patients with heart failure and/or potentially life-threatening arrhythmias.

For the PCI module, all 31 hospitals (13 public and 18 private) in Victoria that perform PCI were engaged with VCOR in 2018. The report includes 12,447 PCI cases, representing virtually all the PCI cases performed in Victoria in that year. Trends that have continued include a difference in the types of cases performed in public and private sectors, with a greater proportion of cases with an acute coronary syndrome in public and more elective non-urgent cases in private. Most cases involved single vessel PCI and more complex cases such as left main coronary artery stenting and chronic total occlusion PCI were still being done in low numbers. However, the use of radial artery access continued its growth. Overall hospital performance remained excellent with no outlier hospitals in any of the key performance outcome measures in 2018.

This year's report on the Early STEMI Management module will be the final one, as the module was closed in September 2018. Over its 5-year course, the module provided some positive information regarding the care STEMI patients received in Victorian rural and regional centres. However, a number of process measures did not reach satisfactory threshold levels (particularly, door-to-needle time). This year, only 1 of 9 hospitals managed to achieve recommended target times for administration of the time-critical treatment of thrombolysis. On the other hand, treatment outcomes were good, with no major complications related to thrombolysis and near 100% compliance with early transfer of patients from regional centres to PCI-capable hospitals. With the completion of this module in 2018, the principal lesson learnt is that feedback of results – both good and bad – is not necessarily enough to bring about positive change. Ongoing and meaningful engagement of sites is also a key ingredient. Clinicians need to be invested in the quality assurance activity to bring about change and VCOR has learnt that more is needed from a clinical quality registry than just data collection and outcomes reporting.

While 2018 was the last year of the Early STEMI Management module, it was the first for the cardiac implantable electronic devices (CIED) module. During this year, this module was conducted in pilot phase with just seven sites, in order to ascertain the viability of the module, refine the data elements for collection, set up appropriate data analysis tools and design and test the format and content of the reports. The underlying aim of this module is to report on the appropriate use, safety and quality of care of patients receiving CIEDs. This year's report included 430 cases from six public and one private hospital.

The key findings from the various modules in 2018 are presented on the following pages.

Key Findings

PCI Registry

- All 31 Victorian PCI hospitals contributed to the registry in 2018, representing 122 interventional cardiologists. A total of 12,447 completed procedures were collected on 11,036 patients. 58% of cases were managed in the public system.
- The majority of patients undergoing PCI were male (76%). The mean age was 66 years. Patients treated in private hospitals were six years older on average than public patients. The rate of severe obesity (BMI≥35kg/m^2) among the PCI cohort was twice the national average (12.2% vs 6%).
- Approximately 20% of cases were performed outside normal working hours in both the public and private hospital systems. Just over half of all STEMI cases were after-hours and 90% of those were in the public sector.
- Just under half the PCI cases in 2018 presented with an acute coronary syndrome (ACS), with the majority (76%) treated in public hospitals. ACS cases accounted for two-thirds of the public sector's caseload and one-third of the private sector's. PCI for acute STEMI (including pharmaco-invasive PCI and rescue PCI) took up 27% of the PCI workload in the public sector and 5% in private.
- For patients with stable (non-ACS) disease, 58% had an indication of stable angina. A high-grade stenosis was noted in 92% and positive functional test in 60%. A total of 87% of non-ACS patients had at least two of these three key clinical factors.
- Particular lesion subsets including unprotected left main cases (1.6%), chronic total occlusions (3.6%) and in-stent restenosis (4.3%) were performed in similar numbers to previous years.
- The number of patients presenting with cardiogenic shock or out-of-hospital cardiac arrest was similar to previous years. High-volume public hospitals tended to have these high-acuity cases constitute a greater proportion of their overall caseload than lower-volume public centres. Private hospitals generally managed only small numbers of shock and cardiac arrest cases.
- Drug-eluting stent (DES) use continues to increase year-on-year, now accounting for 92% of all PCI cases. For the first time since VCOR commenced data collection in 2013, the rate of DES use in the public sector matched the private sector (92% for both public and private sectors).
- The preference for radial artery access has increased to 66% of cases. Rates varied among hospitals and were higher in public hospitals (72% public vs 59% private). Lower rates were seen in females than males (61% vs 68%) and in the elderly (53% >80 years vs 68% <80 years).
- Emergency treatment for acute STEMI (primary PCI) accounted for 13% of the overall PCI workload. The majority were treated in the public sector (89%). Radial access was used in 63% of cases. The median time taken from patient arrival at the hospital to the first inflation of the balloon (door-to-balloon time) was 58 minutes - reflecting a continued improvement over the past 4 years. A door-to-balloon time of ≤90 mins was achieved in 81% of cases, which was above the international benchmark target of 75%. The number of hospitals that surpassed the 75% target was higher in 2018 than in previous years.
- The unadjusted in-hospital mortality rate was 1.4% overall. The rate was higher among patients presenting with STEMI (4.7%), and highest for patients with cardiogenic shock or out-of-hospital cardiac arrest at 35.1%. Excluding these two high-risk groups, the unadjusted in-hospital mortality rate for the rest of the cohort was 0.3%.
- The signature key performance indicator of risk-adjusted 30-day mortality for the overall PCI cohort in 2018 was 1.7%. There were no outlier hospitals.
- The median in-hospital major bleeding rate was 0.7%, lower among radial access cases (0.5% radial vs 1.1% femoral) and highest in STEMI (2%). The median 30-day unplanned cardiac readmission rate was 3.7%, with similar rates in the public and private sectors. Rates of other major adverse outcomes were low and similar to previous years.

Key Findings continued ...

CIED Registry

- Seven health services across the state participated in the 2018 CIED pilot project, with a total of 430 procedures performed on 416 patients.
- The majority of patients were males (79%), and the mean age was 63 years. Overall, 57% were first implants and 34% of cases were generator replacements. Other procedure types were new lead (3%), removal of device without replacement (3%) and revision procedures (3%). Around half the first implants (55%) and generator replacements (49%) were ICD devices (ICD, CRT-D or S-ICD).
- A large minority (41%) of patients undergoing any ICD (ICD, CRT-D or S-ICD) had an ischaemic cause. For CRT-P devices, an ischaemic cause was documented less commonly at 24% of cases while an idiopathic cause was found in 26%.
- For patients receiving a CRT-D device, 91% had a QRS width ≥120msec, 84% had severe left ventricular dysfunction and 94% NYHA Class ≥II symptoms. Combining these inclusion criteria, 84% had all 3 criteria and 3% had 2 of 3 criteria. In contrast, the compliance with CRT inclusion criteria was lower among CRT-P patients. Only 38% had a QRS width ≥120msec and there was more variability in the degree of left ventricular impairment and heart failure symptoms.
- The most common indication for CIED replacement was elective generator replacement for battery depletion (58%). Almost a third of replacements were device upgrade (31%). Erosion or infection accounted for 7%.
- In 2018, there were no in hospital mortalities documented in the CIED registry. The unadjusted 30-day mortality rate was 0.5% with 2 deaths recorded within 30 days from hospital discharge. The overall 30-day unplanned cardiac readmission rate was 7.7% and device related re-operation rate was 2.3%. The rate of 30-day device related infection was 1.2%.

Management of Early STEMI in Regional Victoria

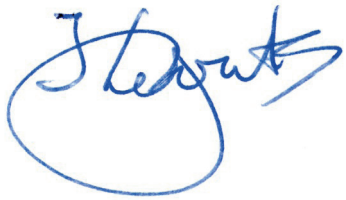
- The 2018 cohort comprised 141 patients with suspected STEMI, presenting to nine regional health services across Victoria. A total of 35 patients (25%) were ineligible for thrombolysis. Twenty-one were triaged to primary PCI and transferred to a PCI capable hospital. The remaining 84 patients all received thrombolysis, either at the treating hospital (n=75) or prior to arrival via ambulance-initiated pre-hospital thrombolysis (n=9). One patient was eligible, but did not receive thrombolysis.
- Only 57% of patients were transported by ambulance to hospital, while 35% were driven in by friends or family (self-presenters). Most patients (86%) were located within 50km of their treating hospital at symptom onset.
- The median time from pain onset to first medical or ambulance contact was 103 minutes. The median time taken for an ambulance to arrive was 14 minutes and the time to transfer to hospital was 46 minutes.
- The median time taken from hospital arrival to the recording of the first ECG was 10 minutes – compliant with guideline recommendations.
- The median door-to-needle time (time from patient arrival to administration of thrombolytic drug) was 44 minutes (IQR: 25, 75). Only 1 of 9 hospitals managed to achieve a median door-to-needle time within the Australian guidelines recommendation of ≤30 minutes, and overall, only 31% of cases were managed within this benchmark rate.
- The in-hospital mortality (before transfer) for the overall cohort was 8%, and has remained low over the last 5 years. Mortality was higher among patients with cardiogenic shock (17 patients, 8 deaths (47%)). There were no cases of major bleeding or acute stroke among treated patients.

Key Findings continued ...

Management of Early STEMI in Regional Victoria

- Nearly all patients treated with thrombolysis (98%) were subsequently transferred to a PCI-capable hospital within 24 hours. The median time from referral for transfer to actual transfer was 2 hours (IQR: 1, 3).

Finally, 2018 was the most productive year in relation to research and publications. As the registry has grown and matured, VCOR has been able to forge links with internal and external researchers interested in a wide array of research topics. A list of publications and presentations for 2018 is provided at the end of this report.



A/Prof Jeffrey Lefkovits
VCOR Clinical Director

Introduction

Now in its seventh year of operation, the Victorian Cardiac Outcomes Registry (VCOR) continues to fulfil its mandate to monitor the quality and safety of cardiac-related health care in Victoria. VCOR routinely collects, analyses and reports health-related information to clinicians, hospitals, government and the general public. As a clinical quality registry, VCOR undertakes benchmarking of hospitals' performance and outcomes, reporting its findings back to sites in a timely fashion. The assessment and reporting of variation in practice and outcomes drives quality improvement.

VCOR has been set up with a modular design. Its principal module is percutaneous coronary intervention (PCI) and has been collecting data on this procedure since registry commencement in 2013. VCOR also collected information on the management of early ST elevation myocardial infarction in regional Victoria. The module commenced operation in 2013 and closed in September 2018. This is the second module to close, with a module related to acute hospital treatment of heart failure having closed in 2017 after 4 years of data collection. In 2018, VCOR's fourth and newest module on the management of cardiac implantable electronic devices (CIED) commenced data collection, and is reported on for the first time in this report. The overall registry and its current modules encompass hospitals from both the public and private sectors.

VCOR complies with the Australian Health Ministers' Advisory Councils Framework for Australian Clinical Quality Registries (2). It adheres to the relevant standards related to security and protection of data as well as to the technical and operating standards for Australian clinical quality registries.

Registry Governance and Structure

The governance of VCOR has been previously outlined in detail (3, 4). VCOR continues to conform to the National Operating Principles for Clinical Quality Registries as set out by the Australian Commission on Safety and Quality in Health Care (5).

Steering Committee

The Steering Committee membership comprises representatives from participating hospitals, the clinical leads of the various modules, a representative from the Victorian Cardiac Clinical Network, a consumer representative and representatives from the Department of Epidemiology & Preventive Medicine at Monash University. Meetings are held on a quarterly basis. Additional activities this year included the convening of a Registries Colloquium. For the first time in 2018, under the guidance of the Steering Committee, VCOR held this meeting to raise the profile and highlight the roles of clinical quality registries in cardiovascular disease and its treatment. The meeting was on September 13, 2018 and national speakers included Prof John McNeil (Monash University), Prof John Beltrame (CADOSA registry, South Australia), Dr Paul Garrahy (QCOR registry, Queensland) and A/Prof Tom Briffa (University of WA), with over 100 attendees from across Australia.

Clinical Quality Committee

The Clinical Quality Committee (CQC) has responsibility for the oversight, analysis, interpretation and release of hospital performance data. Its role is central to VCOR's overall function as a clinical quality registry. Quarterly review of hospital key performance indicators (KPIs) and other data continued in 2018. Regular reports were provided to participating sites in each of the three registry modules. The CQC was active in identifying outlier performance and assisting hospitals with the management of their outcomes, including providing feedback and review as requested.

Data, Research and Publications Committee

The role of the Data, Research and Publications Committee (DRP) is to review requests for access to and analysis of aggregate group de-identified data for research projects. In 2018, the DRP reviewed and approved numerous requests for data, including six collaborative projects. The DRP oversaw abstract development and publications that utilised VCOR data. The various reports and research papers are outlined in the Publication and presentation section of this report.

Percutaneous Coronary Intervention (PCI)

Registry Module Activity

This report covers PCI activity in Victoria for the 2018 calendar year from January 1 to December 31. In addition to the information for the 2018 calendar year, this report also presents trends in practice and outcomes over the preceding 5 years where relevant. The hospitals that participated in the registry since its commencement are listed in Table 1. In 2018, all 31 hospitals in Victoria that perform PCI contributed data- 13 public and 18 private hospitals. Geelong Private Hospital is not included on the list as it ceased its PCI program in 2018 and is no longer part of VCOR. The Valley Private Hospital was renamed in 2018 and now appears as Mulgrave Private Hospital. St John of God and St Vincent's Private hospital groups both opened new PCI services at Berwick and Werribee respectively and both joined VCOR during this reporting period.

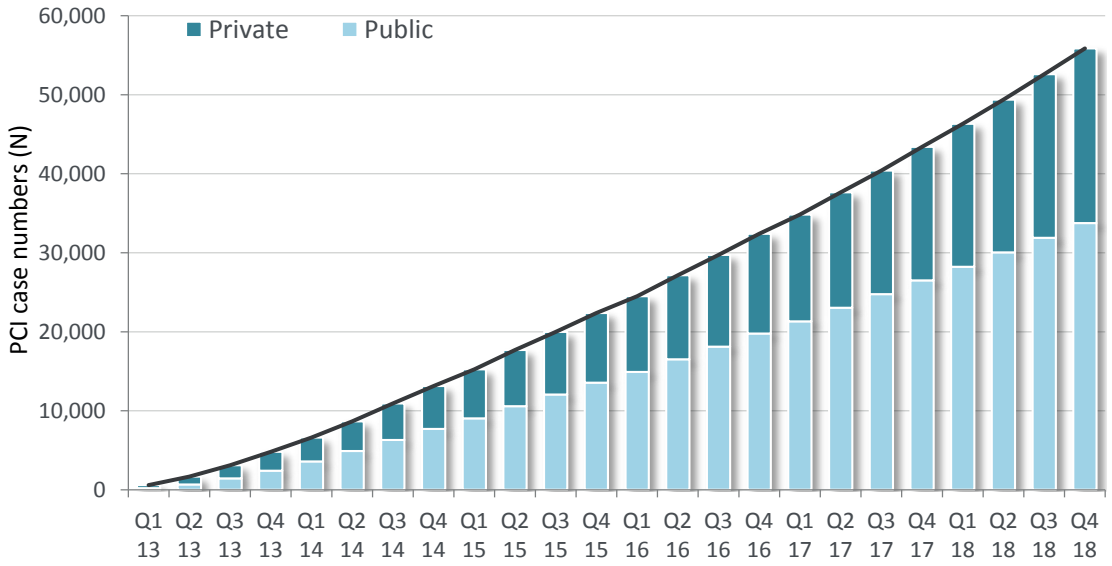
Table 1: Participating Victorian PCI hospitals

Victorian PCI hospitals	Hospital type	2013	2014	2015	2016	2017	2018
Alfred Hospital	Public	●	●	●	●	●	●
Austin Hospital	Public	●	●	●	●	●	●
Ballarat Base Hospital	Public	●	●	●	●	●	●
Bendigo Hospital	Public	●	●	●	●	●	●
Box Hill Hospital	Public	●	●	●	●	●	●
Cabrini Hospital Malvern	Private	●	●	●	●	●	●
Epworth Hospital Eastern	Private		●	●	●	●	●
Epworth Hospital Geelong	Private				●	●	●
Epworth Hospital Richmond	Private	●	●	●	●	●	●
Footscray Hospital	Public	●	●	●	●	●	●
Frankston Hospital	Public	●	●	●	●	●	●
Holmesglen Private Hospital	Private				N/A	●	●
Jessie McPherson Private Hospital	Private	●	●	●	●	●	●
Knox Private Hospital	Private	●	●	●	●	●	●
Melbourne Private Hospital	Private		●	●	●	●	●
Monash Heart	Public	●	●	●	●	●	●
Mulgrave Private Hospital	Private				●	●	●
The Northern Hospital	Public	●	●	●	●	●	●
Peninsula Private Hospital	Private				○	●	●
St John of God Hospital (Ballarat)	Private			○	○	●	●
St John of God Hospital (Bendigo)	Private			●	●	●	●
St John of God Hospital (Berwick)	Private	N/A	N/A	N/A	N/A	N/A	●
St John of God Hospital (Geelong)	Private			○	●	●	●
St Vincent's Hospital Melbourne	Public	●	●	●	●	●	●
St Vincent's Private Hospital	Private	●	●	●	●	●	●
St Vincent's Private Hospital (Werribee)	Private	N/A	N/A	N/A	N/A	N/A	●
Sunshine Hospital	Public	N/A	N/A	●	●	●	●
The Royal Melbourne Hospital	Public	●	●	●	●	●	●
The University Hospital, Geelong	Public	●	●	●	●	●	●
Warringal Private Hospital	Private				○	●	●
Western Private Hospital	Private	●	●	●	●	●	●

Table Legend: ● = contributing data; ○ = engaged but not yet contributing

The lost-to-follow-up (LTF) rate in 2018 was 0.7%, and the overall LTF rate for the entire registry since its commencement is 1.3%. As of December 31, 2018, the registry had 55,853 cases entered as shown in Figure 1.

Figure 1: Cumulative case numbers by quarter: 2013-2018



Data Quality

VCOR has implemented various quality control processes outlined below to ensure the accuracy, completeness and quality of its data. The registry is committed to ensuring data accuracy as this is a key operational activity of clinical quality registries (6).

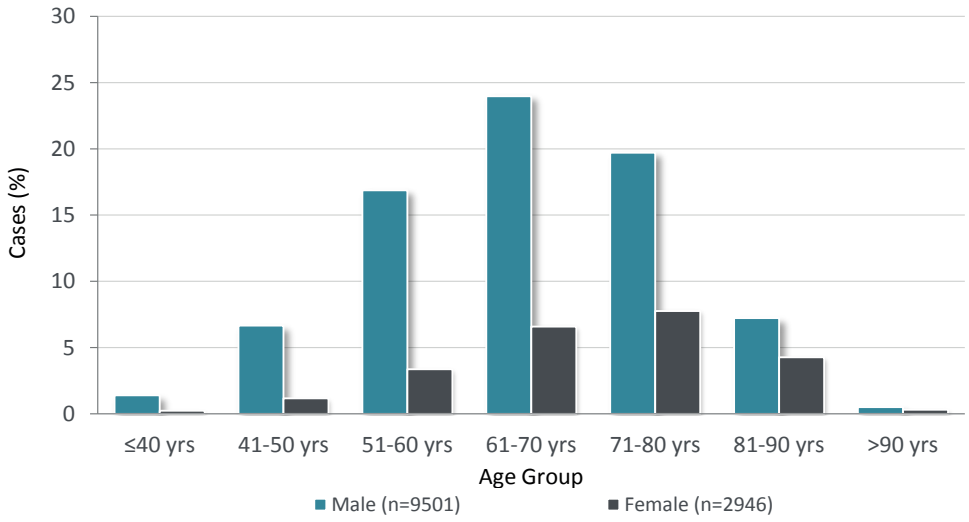
VCOR quality control processes:

- Online system – The VCOR online system has mandatory fields and validation rules to reduce inaccuracies in data collection.
- Data definitions – Detailed data descriptions supplied to all sites and available on the online system to aid with data collection.
- Comprehensive training – All new data managers are trained by VCOR staff prior to commencement of data collection.
- Quarterly data cleaning and data completeness – Sites are routinely updated regarding their data completeness and alerted to quarterly data deadlines. Data are then analysed and queries that arise are presented to sites for clarification and amendment when needed. Detailed quarterly reports are sent to all sites.
- Data auditing – Case ascertainment audits (assessing whether all eligible cases are entered into the registry) are conducted at all sites on a yearly basis. Sites' performance tends to improve with successive audits.
- Brief audits – (accuracy of data determined by review of the sites' source data) are undertaken at all sites after the first year and then subsequently every 3 years. 5% of case records are randomly selected for comparison with the hospital medical record.
- The overall agreement rate between VCOR data and the hospital medical record was 98.6% from 47 completed brief audits, indicating generally high-quality data collection across the registry. This rate compared favourably with other national and international registries (7, 8).
- Newsletters and bulletins – VCOR circulate regular emails, newsletters and bulletins to all system users for reminders, updates and clarification of new or existing information.
- Annual data manager meeting – This meeting provides a forum for data managers to meet and engage, promoting an important communication network among the VCOR community.

Patient Characteristics

In 2018, 12,447 PCI cases performed on 11,036 patients were entered into VCOR. Of those, 1,411 (11%) underwent multiple procedures. Public sector treatment accounted for 7,261 cases (58.3%) and 5,186 (41.7%) were treated in the private sector. The median age for males was 66 years (IQR: 58, 74) and for females, 71 years (IQR: 63, 79), comparable to previous years. The distributions of cases by age and gender are shown in Figure 2. As in previous years, the peak frequency of PCI procedures occurred in the seventh decade for males and the eighth decade for females. Males accounted for 76.3% of cases overall.

Figure 2: Age and gender distribution of patients undergoing PCI



Selected patient demographic information across a 5-year period (2014-2018) are shown in Table 2. There was a gradual decrease in the number of patients with previous coronary artery bypass grafting (CABG). Otherwise, the demographic profiles of patients remained similar over time.

Table 2: Comparison of selected patient characteristics: 2014-2018

Patient characteristics	2014 (N=8329)	2015 (N=9230)	2016 N=10036)	2017 (N=11002)	2018 (N=12447)
Age- years (Mean ±SD)	65.3 (±11.9)	65.6 (±12.0)	65.9 (±12.0)	66.4 (±11.9)	66.7 (±11.7)
Gender – female	23.1	23.1	23.5	24.4	23.7
Diabetes	21.6	23.0	21.6	21.7	22.6
PVD history	3.8	3.6	3.4	3.4	3.4
CVD history	3.7	4.0	3.3	3.9	3.4
Previous PCI	31.9	32.9	32.7	32.8	33.5
Previous CAGB	8.4	7.6	7.6	7.3	7.2

Obesity is a major public health concern in Australia, with an increasing proportion of the population classified as either overweight or obese (9). For the first time, VCOR examined the prevalence of severe obesity (BMI≥35kg/m^2) among the PCI patient cohort. The rate of severe obesity was twice the national average (12.2% vs 6%) (10), with women more commonly affected than males in all age groups (Figure 3).

Figure 3: Body Mass Index (BMI) ≥35kg/m^2 by age and sex

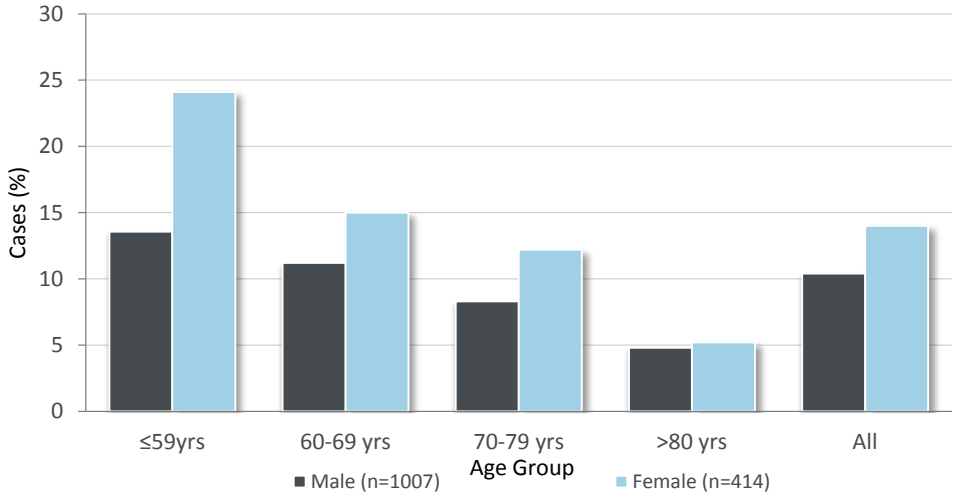


Table 3 outlines a comparison of selected patient demographics by hospital sector. Patients treated in the private sector tended to be older and had more previous cardiac interventions (PCI and CABG). With respect to age differences between sectors, the peak frequency of PCI procedures in the private sector was in the 71-80 year subgroup (34.7% of cases) compared with the public sector where the peak frequency (22.3% of cases) was in the 61-70 year age bracket.

Table 3: Selected patient characteristics by hospital sector

Patient characteristics	Public (n=7261)	Private (n=5186)
Age- years (Mean ±SD)	64.4 (±12.0)	70.0 (±10.4)
Gender – female	22.8	24.9
Diabetes	23.8	20.8
PVD history	3.7	2.9
CVD history	4.1	2.3
Previous PCI	27.8	41.4
Previous CAGB	5.9	9.0
Body Mass Index (BMI) ≥35	7.3	4.1

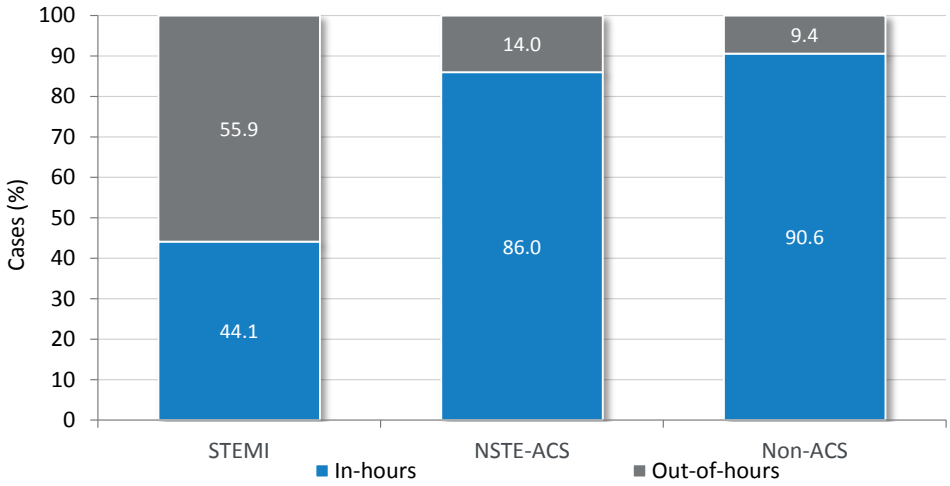
Resource utilisation

Analysis of the timing of cases (in-hours vs out-of-hours) and delays to PCI can help clinicians, hospitals and funders in their resource allocation and financial planning.

In-hours vs out-of-hours cases

In 2018, 20.1% of PCI cases were performed outside normal working hours. As in previous years, clinical activity performed out-of-hours was predominantly for the treatment of ACS (76.3%) – primarily STEMI. Most STEMI cases were treated out of normal working hours (Figure 4). The proportion of NSTE-ACS and non-ACS cases treated after-hours was much lower, reflecting the less urgent nature of these cases.

Figure 4: Proportion of cases in-hours and out-of-hours

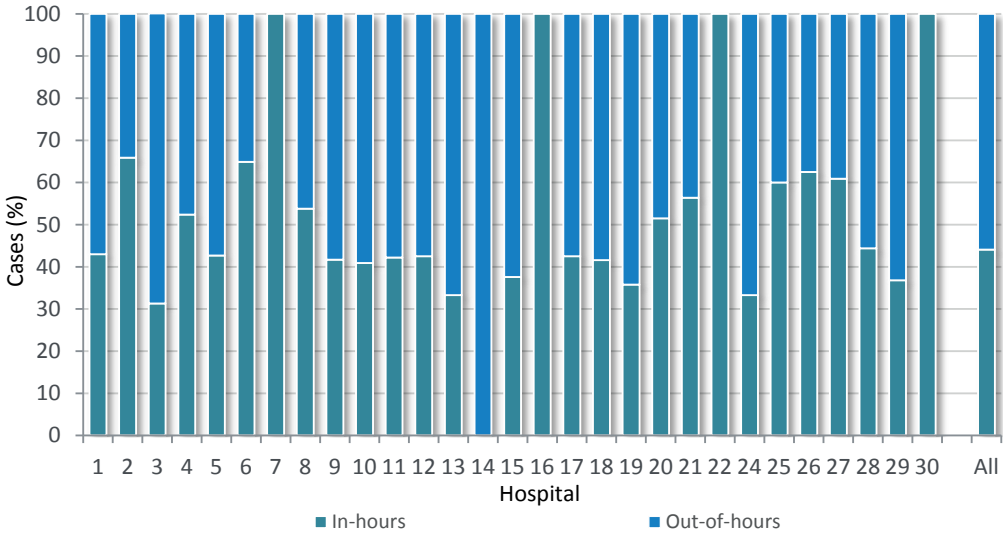


In hours: 8.00am – 6.00pm (Mon – Fri excluding public holidays). Out-of-hours: 6.00pm – 08.00am (Mon – Fri, public holidays and weekends).

The after-hours workloads for public and private sectors were similar (20.1% public and 19.5% private), and have remained consistently around this level for the last 5 years. However, as in previous years, the public sector mostly dealt with emergency cases after hours with 84.4% of its workload taken up with STEMI. In contrast, the makeup of after-hours cases in private included non-ACS cases (54.0%), NSTE-ACS (31.8%) and a much smaller proportion of STEMI cases (14.2%). These differences in after-hours case mix may partly reflect some private hospitals' practice of working extended hours during weekdays. When weekend cases only were compared by hospital sector, the case mix profiles of public and private hospitals were more similar (47.2% ACS cases in public vs 31.8% ACS cases in private).

While the majority of STEMI cases were treated outside normal working hours overall, Figure 5 shows that there was marked variation among hospitals in terms of their out-of-hours STEMI workload.

Figure 5: STEMI cases in-hours and out-of-hours by hospital

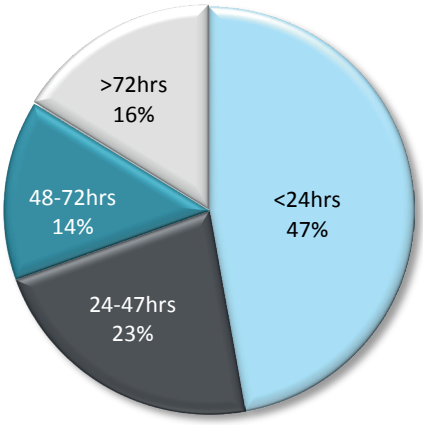


Hospitals 7, 14, 22, 24, & 30 low STEMI numbers (n<5) Hospitals 23 & 31 NIL STEMI cases.

Time delays to PCI for NSTE-ACS

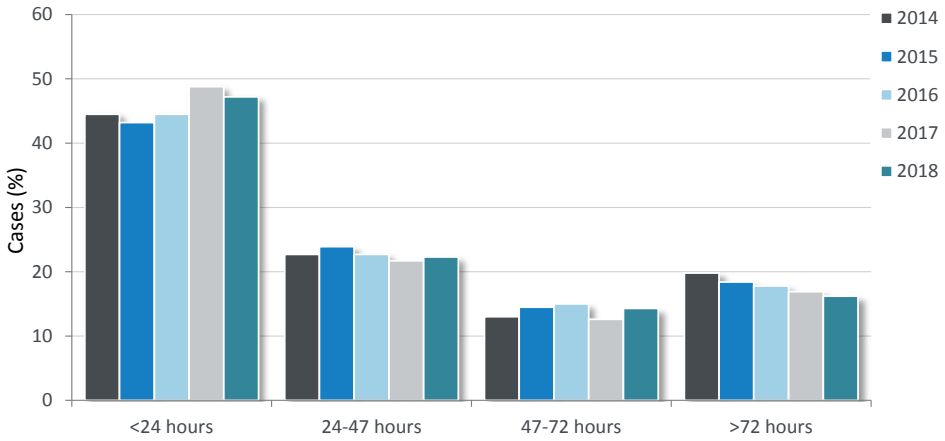
For NSTE-ACS patients, Australian guidelines recommend proceeding to coronary angiography and potential revascularisation as early as practicable (11), as it has now been established that there is little to be gained with an initial period of medical stabilisation. Delays to PCI therefore represent a measure of the processes and efficiency of hospitals in dealing with this condition in a timely and appropriate manner. In 2018, almost half the cases of PCI for NSTE-ACS were managed within 24 hours of hospital admission and 84% were treated within 72 hours (Figure 6).

Figure 6: Time delays from hospital admission to PCI for NSTE-ACS cases



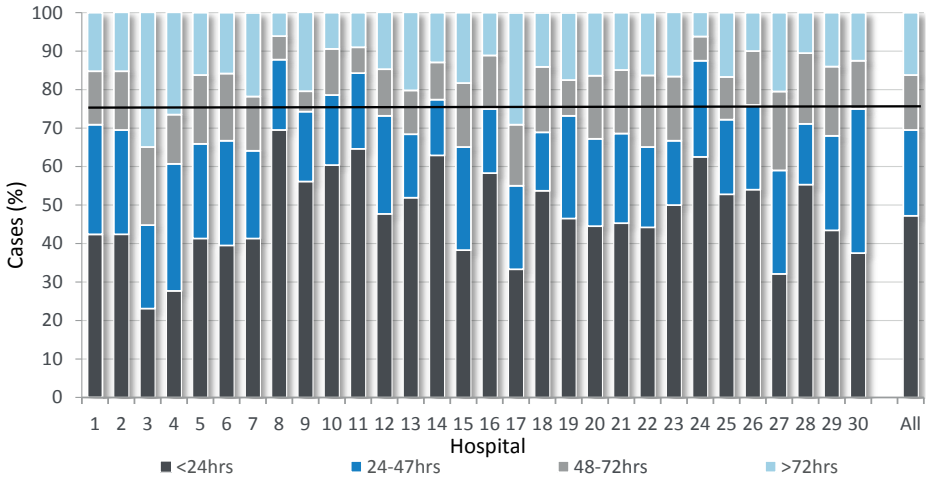
Over the 5-year period from 2014-2018, the proportion of cases whose treatment was delayed for more than 72 hours has tended to decline – from 19.8% in 2014 to 16.2% in 2018 (Figure 7).

Figure 7: Trends in time delays from hospital admission to PCI for NSTE-ACS cases by year



A comparison of hospitals' performance in relation to time delays to PCI for NSTE-ACS is shown in Figure 8. When time delays were examined by hospital sector, cases tended to be treated earlier in the public sector – 85.5% within 72 hours in public vs 80.1% in private (Table 4).

Figure 8: Time delays from hospital admission to PCI for NSTE-ACS cases by hospital



VCOR nominated a benchmark target of at least 75% of cases completed within 72 hours. Two hospitals did not meet this 75% benchmark – one public and one private.

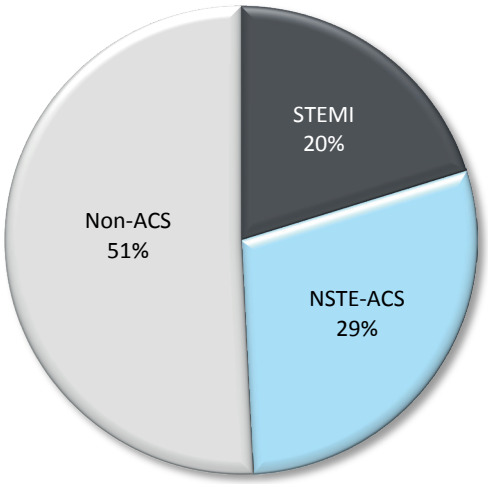
Table 4: Time delays from hospital admission to PCI for NSTE-ACS cases by hospital sector

	All sites (N=3611)	Public (N=2455)	Private (N=1156)
	N (%)	N (%)	N (%)
<24hrs	1704 (47.2)	1195 (48.7)	509 (44.0)
24-48hrs	807 (22.3)	551 (22.4)	256 (22.1)
48-72hrs	515 (14.3)	354 (14.4)	161 (13.9)
>72hrs	585 (16.2)	355 (14.5)	230 (19.9)

Clinical Presentation

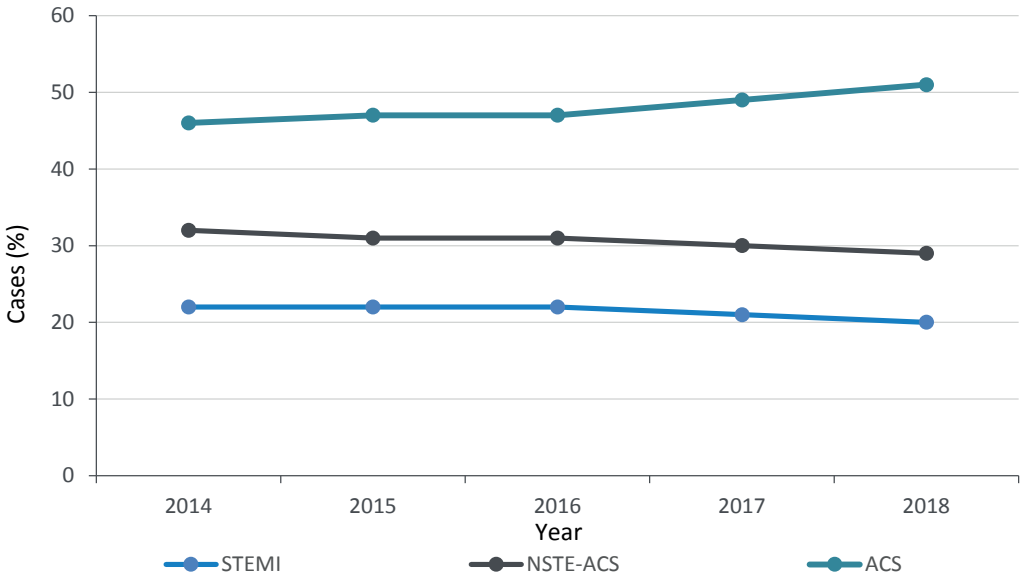
For the first time since VCOR started collecting data in 2013, the majority of clinical presentations for PCI across the state were non-ACS cases (51%) (Figure 9). When examining trends over the last 5 years, there has been a small but steady increase in non-ACS case numbers, particularly in the last 2 years (Figure 10).

Figure 9: Procedures by clinical presentation



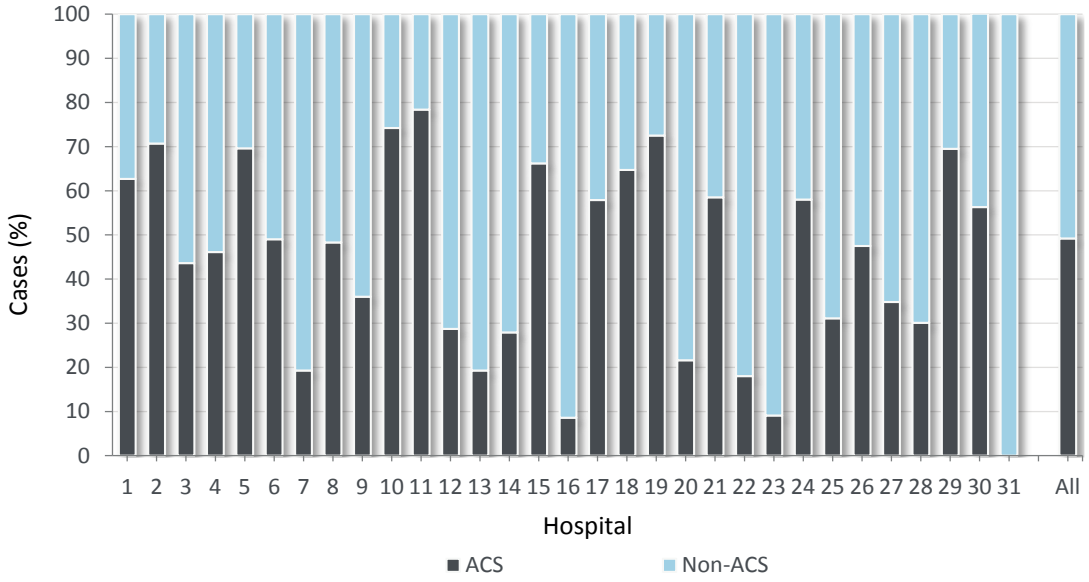
This pattern of change parallels the growth in the number of private hospitals participating in VCOR. In 2017, 2 higher volume private sites commenced collection, and in 2018, all private hospitals performing PCI were contributing to VCOR. Private hospitals generally treat greater numbers of non-ACS cases, and the proportions of non-ACS and ACS cases in 2018 are probably the most representative they have been, as there is now virtually complete capture of all PCI cases across Victoria.

Figure 10: Trends in procedural rates by clinical presentation: 2014-2018



A comparison of the case mix by hospitals shows that the proportion of ACS cases among sites varied. Some hospitals treated few ACS cases, while for others, ACS accounted for more than 75% of their work (Figure 11). The burden of ACS presentations was primarily dealt with in the public sector – 76% of ACS cases overall and 90% of STEMI cases.

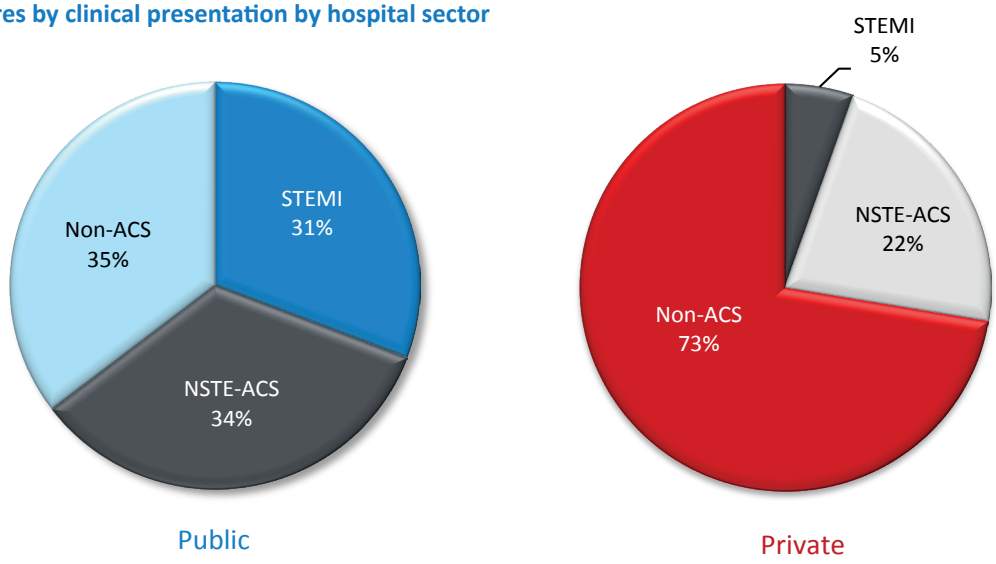
Figure 11: ACS and non-ACS cases by hospital



Hospital 31 low case numbers (n<5).

Figure 12 illustrates the different profiles of clinical presentation by hospital sector. As in previous years, the majority of public work was ACS-related, and in private, it was mostly for non-ACS conditions.

Figure 12: Procedures by clinical presentation by hospital sector



Indications for PCI

VCOR monitors the indications for PCI to ensure that procedures are done for appropriate reasons. In general, PCI is considered appropriate treatment for patients presenting with an acute coronary syndrome, as recommended in the Australian practice guidelines (11). Among the 2018 cohort, 49% of patients had the highly appropriate indication of ACS – mostly NSTEMI (42.8%). Previous reports have noted a trend towards falling rates of unstable angina indication (14.1% in 2015, 13.1% in 2016 and 12.3% in 2017). However, in 2018, the rate was slightly higher at 13.2% (Table 5).

Table 5: PCI indications by ACS category

	All sites (N=5881)	Public (n=4469)	Private (n=1412)
ACS Category	N (%)	N (%)	N (%)
Primary PCI*	1746 (29.7)	1552 (34.7)	194 (13.7)
STEMI PCI 12-24 hours after symptom onset	229 (3.9)	203 (4.5)	26 (1.8)
Pharmaco-invasive PCI	176 (3.0)	167 (3.7)	9 (0.6)
Rescue PCI	87 (1.5)	83 (1.9)	4 (0.3)
PCI for OHCA/shock (non-MI)	62 (1.1)	55 (1.2)	7 (0.5)
PCI for NSTE-ACS	3581 (60.9)	2409 (53.9)	1172 (83.0)
NSTE-ACS sub-category	N (%)	N (%)	N (%)
NSTEMI	2518 (42.8)	1882 (42.1)	636 (45.0)
UAP	779 (13.2)	403 (9.0)	376 (26.6)
Recent ACS 7-30 days ago	284 (4.8)	124 (2.8)	160 (11.3)

Primary PCI for STEMI presentations **including all inter-hospital transfer arrivals and patients with STEMI onset while a current in-patient.*

Among the 2018 cohort with non-ACS indications, 57.8% were treated for stable angina, an absolute decline of 7.4% compared to the previous year, and evident in both the public and private sectors. In contrast, PCI for prognostic indications, defined as the absence of symptoms (with or without demonstrable functional ischaemia) increased (15.4% in 2018 vs. 12.8% in 2017). The indication of staged PCI refers to patients with multi-vessel disease undergoing a second (and sometimes a third or fourth) PCI and is further categorised according to the indication of the original procedure. Staged PCI was undertaken more commonly in the public sector overall, which was a change from the previous year. Most of these cases were staged within 30 days of an initial ACS procedure. Among private hospitals, staged PCI was more commonly performed for non-ACS conditions (Table 6).

Table 6: Non-ACS PCI indications

	All sites (N=6566)	Public (n=2792)	Private (n=3774)
ACS Category	N (%)	N (%)	N (%)
Stable angina	3798 (57.8)	1693 (60.6)	2105 (55.8)
No symptoms and no functional test	1011 (15.4)	505 (18.1)	506 (13.4)
No symptoms and positive functional test	691 (10.5)	115 (4.1)	576 (15.3)
Staged PCI after ACS (≤30 days after first procedure)	477 (7.3)	304 (10.9)	173 (4.6)
Staged PCI after ACS (>30 days after first procedure)	132 (2.0)	99 (3.5)	33 (0.9)
Staged PCI after original non-ACS indication	457 (7.0)	76 (2.7)	381 (10.1)

For non-ACS patients, a number of key clinical factors are taken into account when considering the indication for the procedure. These include the presence or absence of symptoms, the severity of the coronary lesion(s) and demonstration of functional ischaemia. Symptoms of angina or its equivalent were reported in 77% of non-ACS patients; a high-grade stenosis was noted in 92.2% and a positive functional test was reported in 59.8% non-ACS cases – 10% more than in the previous year. A total of 87% of non-ACS patients had at least 2 of the 3 key clinical factors (Table 7).

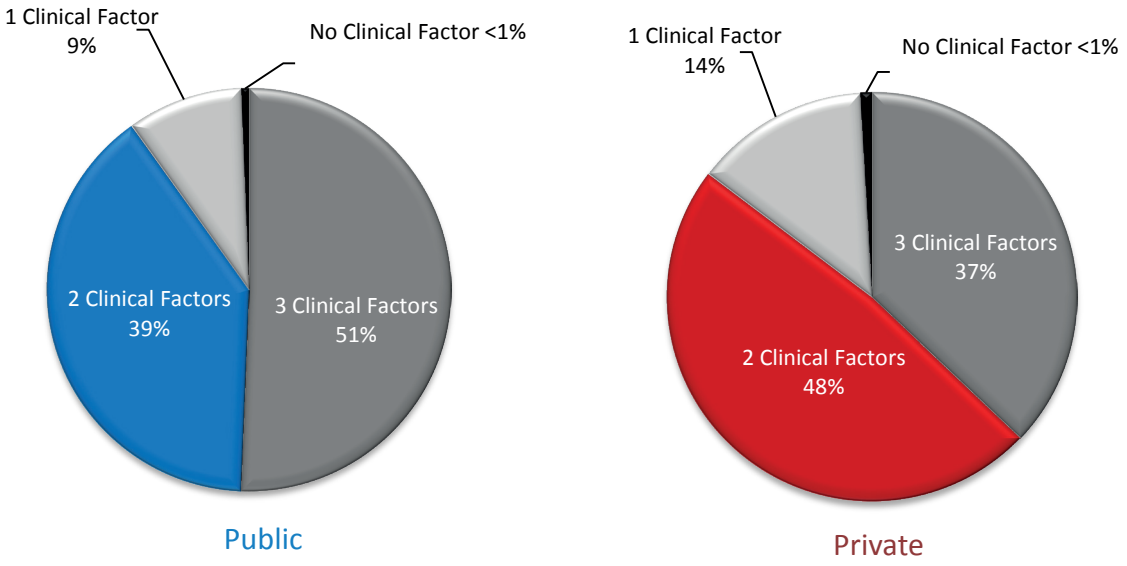
Table 7: Key clinical factors pertaining to non-ACS PCI

Symptoms	Positive functional test	High grade stenosis	Total
			N (%)
●	●	●	2096 (42.5)
○	●	●	639 (12.9)
●	●	○	162 (3.3)
●	○	●	1408 (28.5)
●	○	○	132 (2.7)
○	○	●	409 (8.3)
○	●	○	52 (1.1)
○	○	○	39 (0.8)
			4937 (100)

Table Legend: ● = clinical factor present; ○ = clinical factor not present.

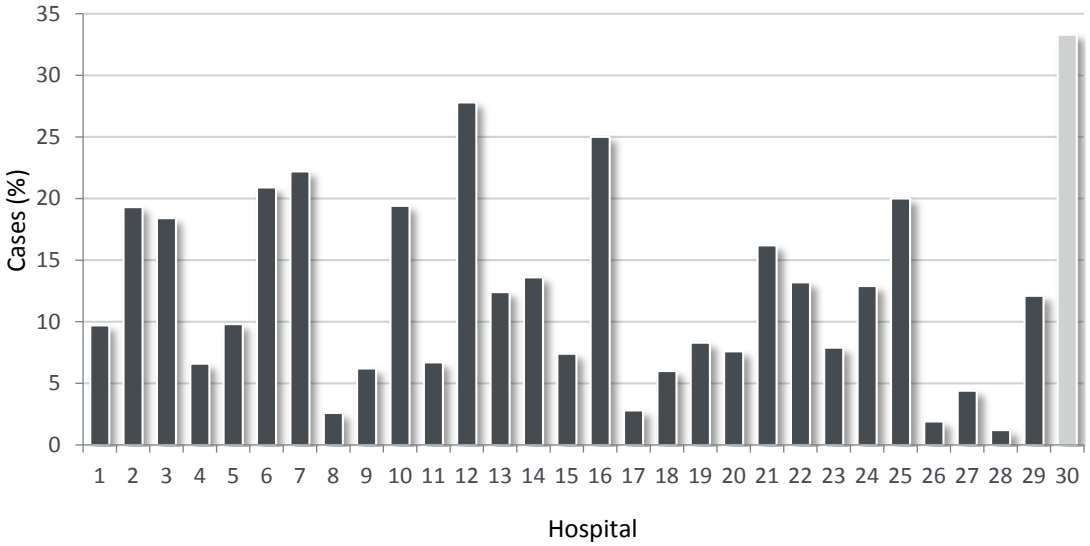
In an effort to monitor the appropriateness of non-ACS PCI, we examined patterns of cases with all 3 key clinical factors and different combinations of 2 and even 1 factor present. As found in previous years, these patterns varied by hospital sector, with a greater proportion of cases with 3 key clinical factors among public hospital patients. For private hospital patients, most had varying combinations of 2 key clinical factors (Figure 13). Both hospital sectors equally demonstrated a fall in the proportion of cases with just one or no key clinical factor. Among public hospitals, this proportion was 10% in 2018 vs 18% in 2017. In private, the rate was 15% in 2018 compared to 20% in 2017.

Figure 13: Key clinical factors in non-ACS patients by hospital sector



A comparison of cases with only 1 or no key clinical factor by hospital demonstrates considerable variation across sites (range 1% – 33%) (Figure 14). Hospitals that were above the cohort mean of 13% were equally distributed across the public and private sectors.

Figure 14: Proportion of non-ACS cases with 0-1 key clinical factor by hospital

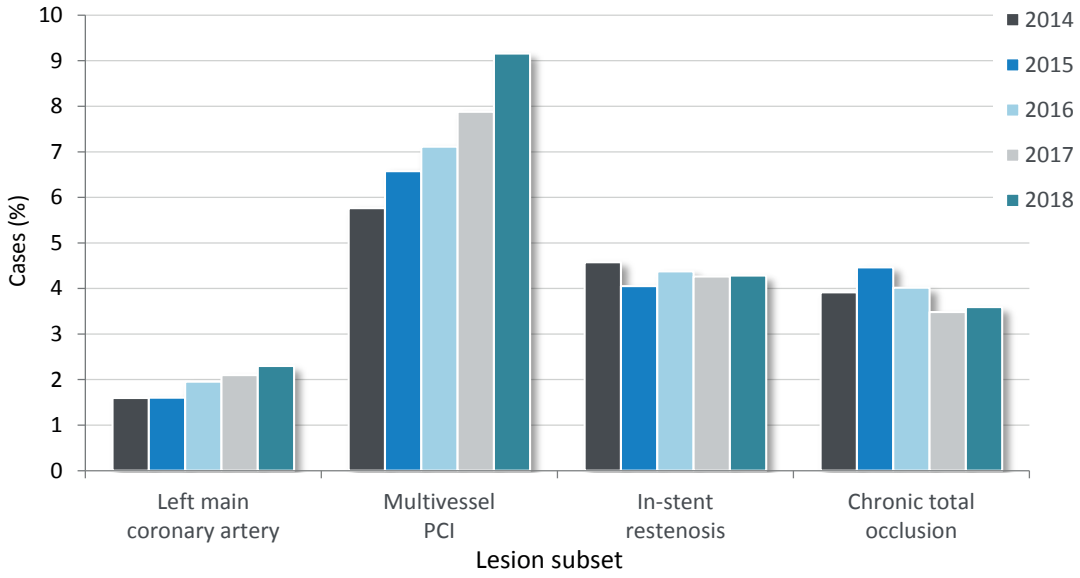


Hospital 31 excluded due to low non-ACS case numbers (n<5).

Lesion and Clinical Subsets

Five-year trends for selected coronary lesion subsets are shown in Figure 15. Despite the growing body of data regarding the safety and efficacy of unprotected left main coronary artery (LMCA) stenting, numbers have remained relatively stable over time. Adjunctive imaging with intravascular ultrasound (IVUS) or optical coherence tomography (OCT) was used in 25.2% of LMCA cases. In contrast to left main PCI, the proportion of multi vessel PCI (lesions treated in >1 coronary vessel) continues to increase (5.8% in 2014 to 9.2% in 2018). In-stent restenosis case rates remained low in the era of second and third generation drug-eluting stents. Interestingly, rates of PCI for chronic total occlusion (CTO) have remained relatively stable in the last 5 years, despite a rapid growth in the development of equipment and techniques for the treatment of this challenging lesion subset. Bypass graft PCI continues to represent a small number of cases and appears to be gradually declining (2.4% in 2014 to 1.6% in 2018). These overall trends were similar among public and private hospitals.

Figure 15: Comparative trends in PCI for selected lesion subsets: 2014-2018



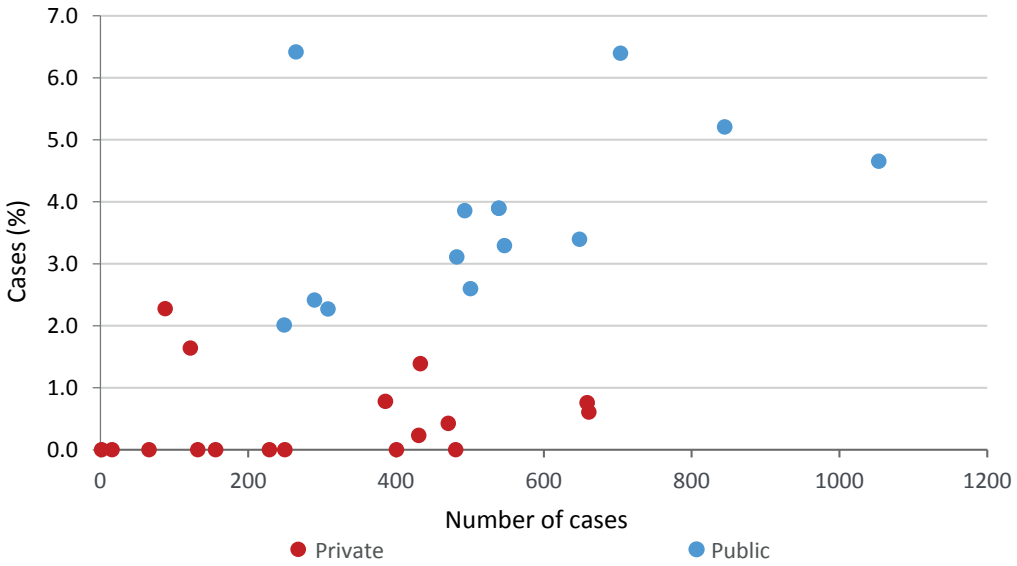
The clinical subset of cardiogenic shock and/or out-of-hospital cardiac arrest (OHCA) is associated with a high risk of death and other serious adverse outcomes (12, 13). Table 8 shows case numbers have remained low and stable over the last 5 years.

Table 8: Rates of cardiogenic shock or out-of-hospital cardiac arrest (OHCA): 2014-2018

Presentation type	2014 (N=8329)	2015 (N=9230)	2016 (N=10036)	2017 (N=11002)	2018 (N=12447)
	N (%)	N (%)	N (%)	N (%)	N (%)
Cardiogenic shock	198 (2.4)	223 (2.4)	278 (2.8)	258 (2.3)	263 (2.1)
Intubated OHCA	89 (1.1)	108 (1.2)	126 (1.3)	142 (1.3)	137 (1.1)
Shock and/or intubated OHCA	239 (2.9)	253 (2.7)	309 (3.1)	310 (2.8)	328 (2.6)

Some noteworthy trends emerged when the relationships between cardiogenic shock/OHCA case rates, hospital volume and hospital sector were examined. As in previous years, the overwhelming majority (90%) of these high acuity cases were managed in public hospitals – placing heavy demands on their resources. In 2018, this clinical subset made up 4.1% of public hospital work compared to 0.6% of private sector work.

Figure 16: Shock and/or OHCA cases by hospital volume and hospital sector



Furthermore, Figure 16 demonstrates that among public hospitals, there was an apparent association between hospital volume and the number of shock/OHCA cases that were dealt with. Higher volume hospitals took a proportionately greater share of the burden of these cases. In contrast, among private hospitals, there was no such association between overall hospital volume and shock/OHCA case numbers – the proportions were small and similar among low- and high-volume hospitals. Referral policies of Ambulance Victoria likely have a significant bearing on the predominance of public sector management of this patient subgroup.

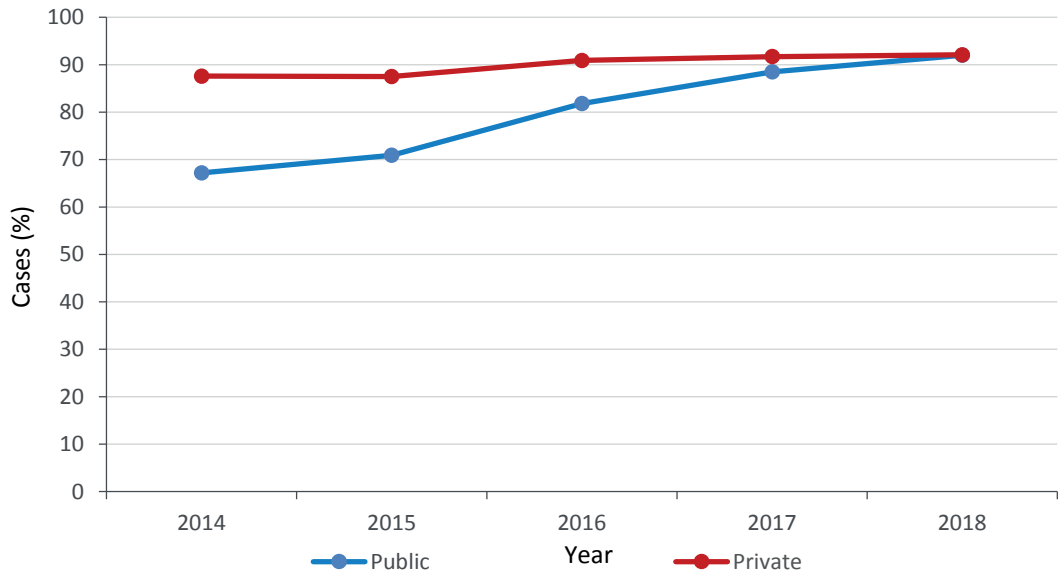
Coronary Device Use

Coronary stents were implanted in 93.9% of cases. The majority of patients (64%) received a single stent. The sum total length of stents deployed was most commonly between 11-30mm. A small number of patients (1.5%) received ≥4 stents in a single case. There were no differences in these stent-related metrics among public and private hospitals. Balloon angioplasty alone was performed in 3.7% of cases. The use of drug-eluting balloons had increased, accounting for 19.5% of balloon angioplasty cases and were mostly utilised to treat in-stent restenosis. While commercially available bioresorbable vascular scaffolds have largely been withdrawn from the Australian market (14), a handful (n=6) were still used in 2018, presumably in the context of ongoing clinical trials.

Drug-eluting stents

For the first time since VCOR commenced data collection in 2013, the rate of DES use in the public sector matched the private sector (Figure 17), although it remains to be seen if Victoria will ever achieve the near 100% penetration already reported in large European registries (15). Variation among hospitals persisted (range: 64-97%), with 2 hospitals still using DES in <75% of their cases.

Figure 17: Trends in DES usage by hospital sector: 2014 - 2018



Adjunctive devices

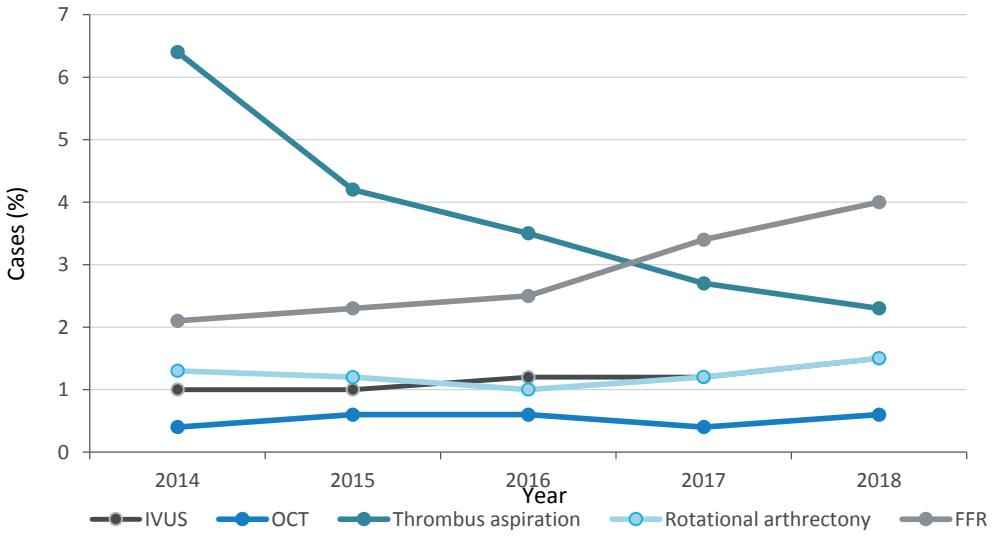
A selection of adjunctive devices to enhance and facilitate the performance of PCI is shown in Table 9. Intravascular ultrasound (IVUS) and optical coherence tomography (OCT) use has increased since the previous report but still involved small numbers. Interestingly, while neither IVUS nor OCT is currently eligible for Medicare reimbursement in the private sector, the older technology of IVUS rather than the newer OCT appears to have had a small surge in use in 2018 with 76 cases, compared with 33 cases in 2017 and 26 cases in 2016. Thrombus aspiration (catheter-based extraction of blood clots that occlude the coronary artery) numbers were about the same as the previous year and remained small (290 cases in 2018 and 291 cases in 2017). Its use has declined significantly in the last 5 years (Figure 18). There was a small increase in the use of rotational atherectomy compared with the previous 2 years. Intra-aortic balloon pumps and extracorporeal membrane oxygenation (ECMO) for patients with cardiogenic shock were used in very small numbers.

Table 9: Adjunctive device use by hospital sector

Adjunctive device type	All sites (N=12447)	Public (n=7261)	Private (n=5186)
	N (%)	N (%)	N (%)
Intravascular ultrasound	190 (1.5)	114 (1.6)	76 (1.5)
Optical coherence tomography	75 (0.6)	54 (0.7)	21 (0.4)
Thrombus aspiration device	290 (2.3)	250 (3.4)	40 (0.8)
Rotational atherectomy	186 (1.5)	92 (1.3)	94 (1.8)
Fractional flow reserve	500 (4.0)	226 (3.1)	274 (5.3)
IABP	54 (0.4)	44 (0.6)	10 (0.2)
ECMO	17 (0.1)	15 (0.2)	2 (<0.1)

A total of 500 cases had adjunctive fractional flow reserve (FFR) assessed at the time of the PCI, which was a small increase from the previous year (4% in 2018 vs. 3.5% in 2017). The use of this evidence-based technique to evaluate the haemodynamic significance of coronary lesions was likely to be higher than reported here, as the registry only captures cases of FFR that are conducted in the setting of a PCI and does not capture FFR done as part of diagnostic procedures.

Figure 18: Trends in use of adjunctive devices: 2014-2018



Glycoprotein IIb/IIIa receptor inhibitor use

Administration of intravenous anti-platelet glycoprotein (GP) IIb/IIIa receptor inhibitors in the catheterisation laboratory has been steadily declining over time. In 2018, a GP IIb/IIIa receptor inhibitor was administered in 872 cases (7%). As in previous years, these drugs were mainly used in patients with STEMI (n=615). This accounted for 70.5% of total GP IIb/IIIa receptor inhibitor use and 24.5% of STEMI cases. Concurrently, there was actually a small increase in use of GP IIb/IIIa inhibitors in NSTE-ACS cases (28% in 2018 vs. 20% in 2017).

Arterial access

The use of the radial artery for vascular access in PCI has increased over the past 5 years (Figure 19). Radial access accounted for 66% of PCI cases overall, with a range of 30%-100% across hospitals (Figure 20). The gap in radial access rates between the public and private sectors also persisted (Figure 21), although both sectors have increased their radial artery use compared to previous years.

Figure 19: Trends in arterial access: 2014 - 2018

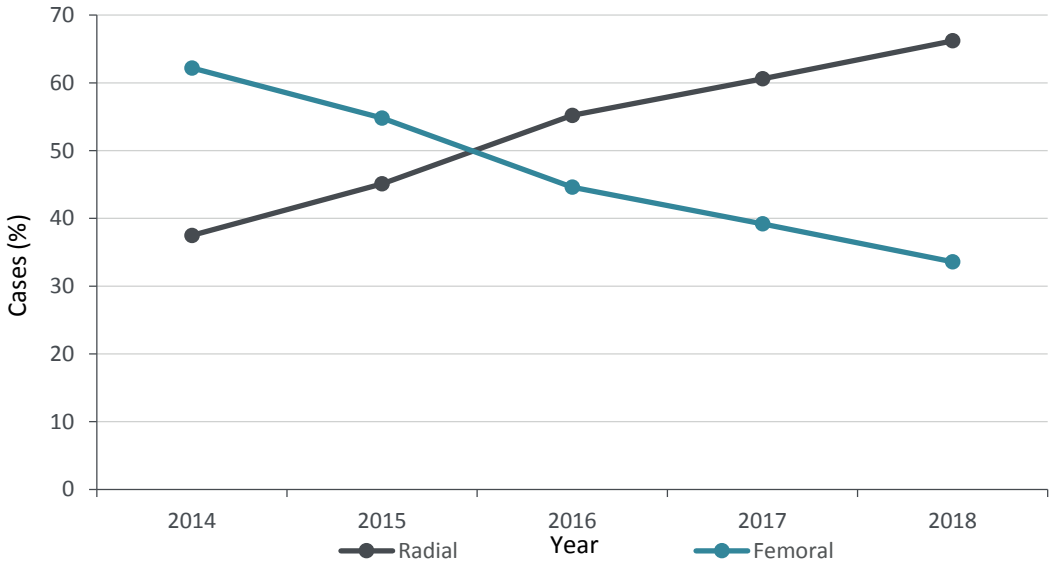
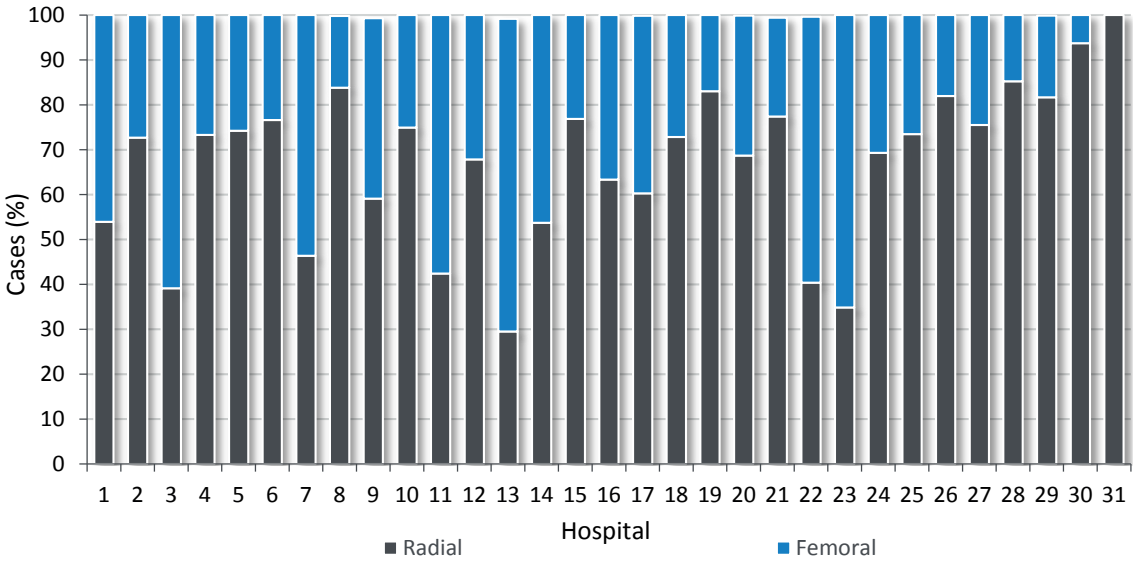


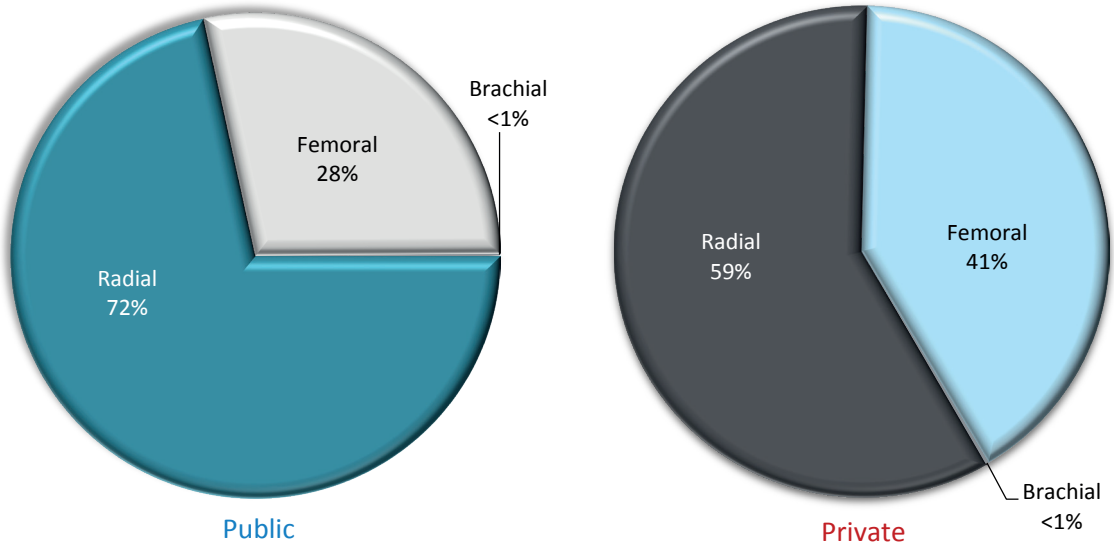
Figure 20: Arterial access route by hospital



Site 30 & 31 - low case numbers (n<20).

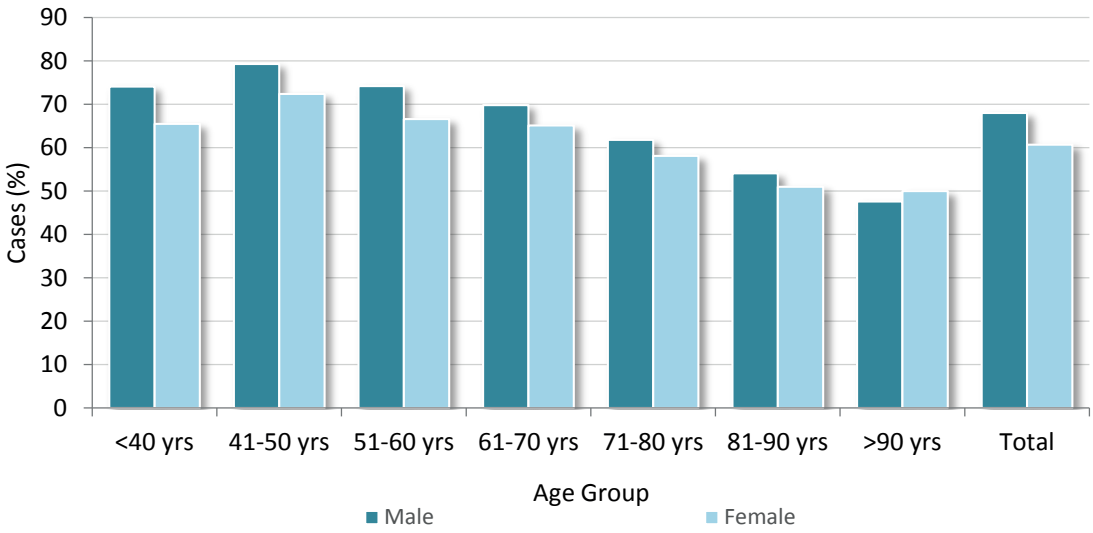
Radial access has a number of potential advantages over femoral access, including lower bleeding rates, increased patient comfort and improved outcomes – especially in STEMI. While overall rates continue to increase, radial rates in Victoria was still substantially lower than reported rates in international PCI registries (15, 16).

Figure 21: Arterial access routes in public and private hospitals



When assessing radial access by gender, rates have generally increased for both males and females over time, but it was still more commonly used in men (68%) than women (60.7%). Figure 22 illustrates that radial artery use was greater in males across all age groups, with the exception of the very elderly (>90 years) and that radial access rates declined with advancing age in both sexes.

Figure 22: Radial artery access by gender and age group



PCI for Acute STEMI

The time-critical nature of PCI for acute STEMI results in close scrutiny of performance for this PCI indication. Clinicians and hospitals are expected to comply with national performance benchmarks for timeliness of treatment, as minimal delays are associated with the best outcomes for patients. Yet, hospitals often face challenges to their ability to provide around-the-clock emergency service.

In 2018, 2,182 patients underwent PCI within 24 hours of the onset of an acute STEMI. Of these, 1,933 patients underwent primary PCI – defined as presenting within 12 hours of symptom onset and receiving PCI as primary reperfusion therapy. Numbers treated in other sub-categories are shown in Table 10 and include rescue PCI and pharmaco-invasive PCI. The number of primary PCI cases across Victoria increased by 13% from 1,706 cases in 2017 to 1,933 cases in 2018.

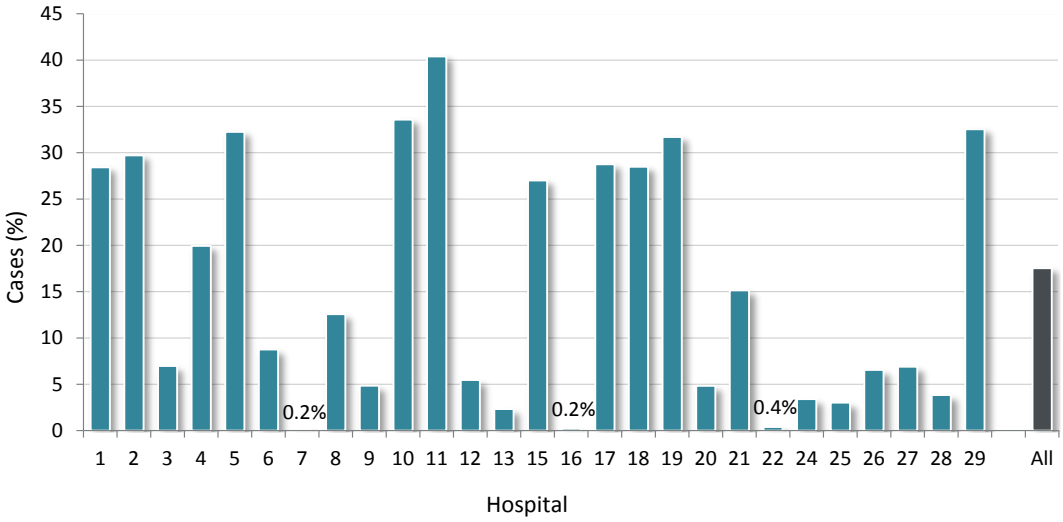
Table 10: Sub-categories of patients undergoing PCI for STEMI within 24 hours

PCI for acute STEMI sub-categories	All sites (N=2182)	Public (n=1936)	Private (n=246)
	N (%)	N (%)	N (%)
Primary PCI* (<12 hrs, no lytic)	1933 (88.6)	1702 (87.9)	231 (93.9)
Rescue PCI (<24 hrs, previous lytic, unstable)	101 (4.6)	95 (4.9)	6 (2.4)
Pharmaco-invasive PCI (<24 hrs, previous lytic, stable)	148 (6.8)	139 (7.2)	9 (3.7)

**Includes inter-hospital transfers and in-patient STEMIs.*

PCI for acute STEMI represented 17.5% of the total 2018 PCI caseload. Patients were predominantly treated in the public sector (90% of all STEMI cases), accounting for 27% of the public hospital workload and 5% in the private sector. Acute STEMI cases as a percentage of the overall caseload across hospitals is shown in Figure 23. Rates range from <1% to 40% of workload. A number of the smaller private hospitals either did not offer acute PCI services or treated very low numbers.

Figure 23: Acute STEMI cases as a proportion of overall case numbers by hospital



Hospitals 7, 16, 22, 24 & 25 had low Acute STEMI numbers (n<5). Hospitals 14, 23, 30 & 31 had Nil Acute STEMI cases.

Compared with the rest of the cohort, acute STEMI patients were younger (63.1 ± 12.4 years vs 67.5 ± 11.4 years), and had fewer traditional cardiac risk factors such as diabetes (17.4% vs 23.7%), and peripheral vascular disease (2.7% vs 3.5%). The acute STEMI cohort also had fewer previous revascularisation procedures, including previous PCI (13.7% vs 37.7%) and coronary artery bypass grafting (2.3% vs 8.3%). Patients with acute STEMI in the private sector were older (66.3 ± 12.1 private sector vs 62.7 ± 12.4 public sector), but had similar gender and risk profiles.

Door-to-balloon times

For patients undergoing primary PCI, the door-to-balloon time (DBT) is used as a standard process measure assessing health services' ability to deliver timely treatment. It is defined as the time taken from arrival to hospital to insertion of a device to unblock the vessel (typically a balloon catheter). For this report, VCOR has continued to use the benchmark target of DBT ≤90 minutes, even though recent Australian guidelines have set an ideal DBT target of ≤60 minute (11, 17). Most participating sites are still oriented towards the older DBT metric and expect data to be benchmarked to this target. Furthermore, the DBT is arguably being gradually replaced with the metric of first medical contact-to-balloon time, which VCOR cannot yet report on.

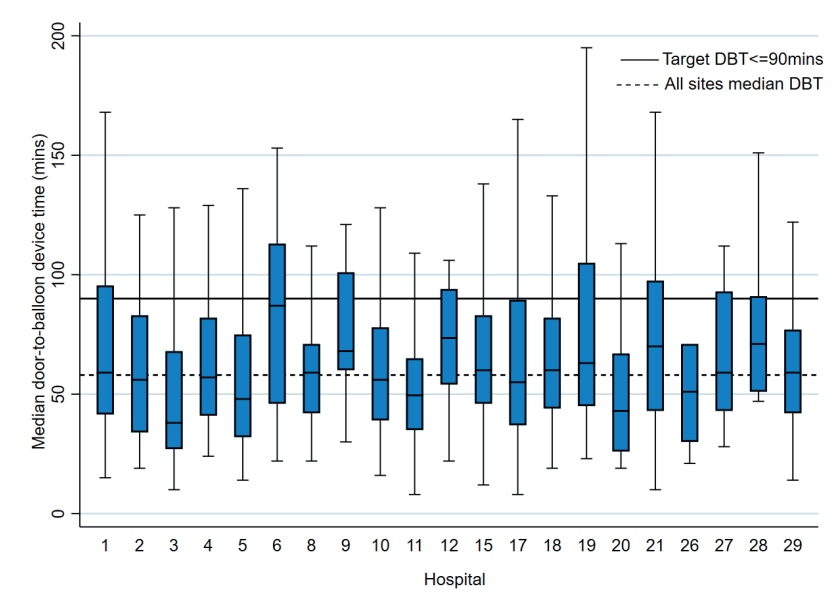
In 2018, the median door-to-balloon time was 58 minutes (IQR: 39, 83) (Table 11) – reflecting a continued improvement over the past 4 years (18). All hospitals once again achieved a median door-to-balloon time of ≤90 minutes, as they did in 2017 (Figure 24).

Table 11: Door-to-balloon times for primary PCI cases: 2014-2018

Door-to-balloon time*	2014	2015	2016	2017	2018
	(N=1102)	(N=1168)	(N=1303)	(N=1423)	(N=1596)
Median – mins (IQR)	68 (47, 95)	72 (48, 103)	67 (47, 96)	63 (44, 89)	58 (39, 83)
Proportion of cases ≤90mins (%)	70.5	66.4	71.9	77.3	80.5

Primary PCI for STEMI presentations **excluding all inter-hospital transfer arrivals and patients with STEMI onset while a current in-patient.*

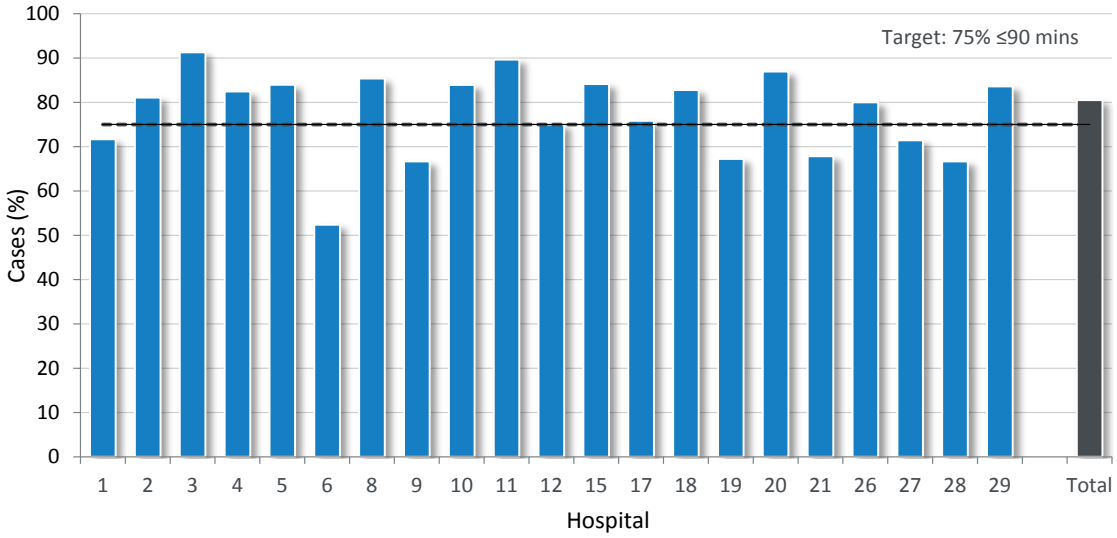
Figure 24: Door-to-balloon time for primary PCI cases by hospital



Hospitals 7, 13, 14, 16, 22, 23, 24, 25, 30 & 31 not included (Primary PCI cases n<5).

In addition to reporting median DBT, hospitals were benchmarked on their compliance at achieving a DBT ≤90 min in at least 75% of their primary PCI cases – an internationally recognised performance benchmark (19). Arguably, this benchmark provides a more realistic measure of a site's performance and is VCOR's preferred process measure. Across all hospitals, the average compliance rate was 80.5% of cases, but there was some variation among hospitals (range 52.3% to 91.3%) (Figure 25). That is, some hospitals managed to achieve a DBT≤90 min in over 90% of their cases, while others managed it in just over half their patients. The number of hospitals that reached or surpassed the 75% target was higher in 2018 than in previous years. Hospitals that did not reach the 75% benchmark tended to be smaller volume centres.

Figure 25: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes by hospital



Hospitals 7, 13, 14, 16, 22, 23, 24, 25, 30 & 31 not included (Primary PCI cases n<5).

Pre-hospital notification (PHN)

Pre-notification to hospitals of the imminent ambulance arrival of an acute STEMI patient allows hospitals to activate the cardiac catheterisation laboratory team and set up rapid transfer from hospital entrance to catheter laboratory to minimise delays to the commencement of the PCI. As in previous years, PHN clearly resulted in shorter door-to-balloon times and greater compliance in achieving at least 75% of cases with DBT ≤90min (Table 12). Moreover, DBT and 75% compliance rates have steadily improved over time among the PHN patient group. In contrast, there has been much less improvement in these performance measures over time in the no PHN group (median DBT values of 92 min in 2015, 87 min in 2016, 78 min in 2017 and 80 min in 2018).

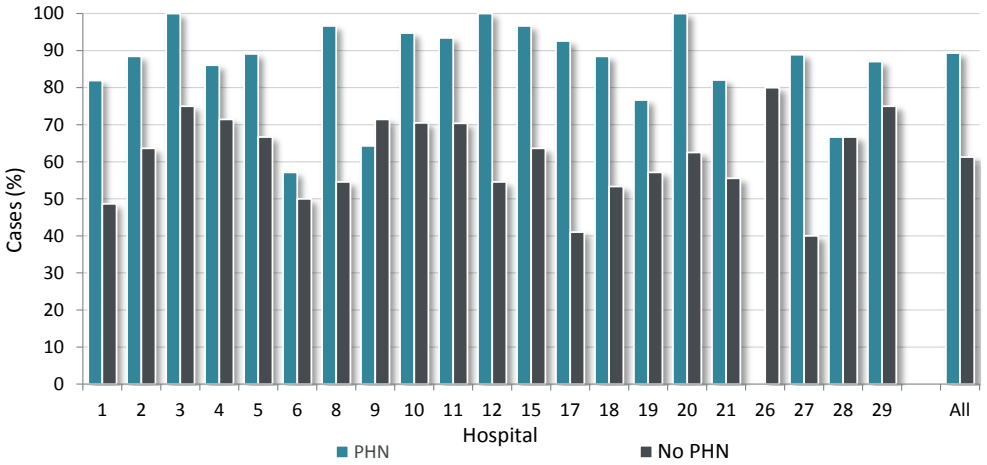
Table 12: Door-to-balloon times for primary PCI cases by pre-hospital notification status

Door-to-balloon time	Primary PCI* (all cases)	Primary PCI* (PHN only†)	Primary PCI* (no-PHN†)
	(N=1596)	(n=1095)	(n=501)
Median – mins (IQR)	58 (39, 83)	50 (36, 68)	80 (56, 112)
Proportion of cases ≤90mins (%)	80.5	89.3	61.3

**Primary PCI for STEMI presentations excluding all inter-hospital transfer arrivals and patients with STEMI onset while a current in-patient.*
†Pre-hospital notification (PHN).

All hospitals that performed primary PCI participated in PHN with Ambulance Victoria. Taking the average across all these sites, 69% of primary PCI patients were triaged with PHN. A comparison of hospitals' DBT results with and without PHN is shown in Figure 26. Three hospitals did not reach the target of ≥75% cases with DBT≤90mins even with pre-hospital notification.

Figure 26: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes – pre-hospital notification (PHN) vs no pre-hospital notification

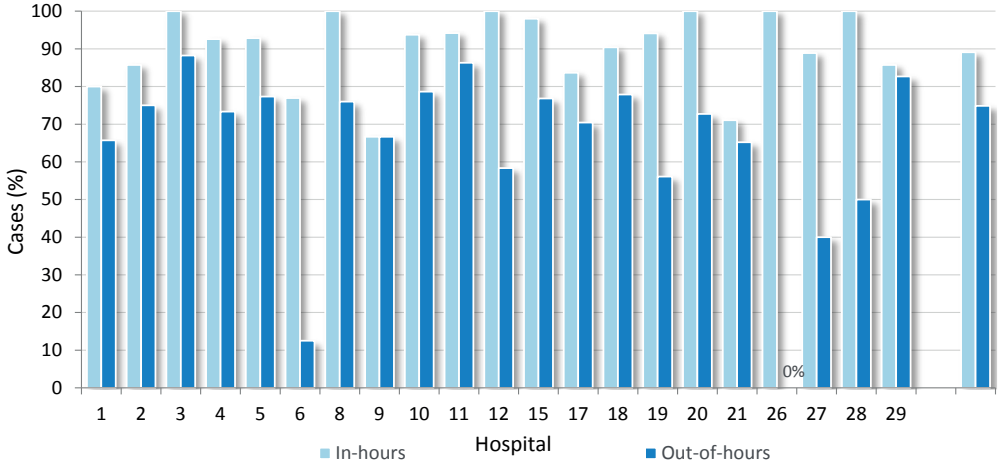


Hospitals 7, 13, 14, 16, 22, 23, 24, 25, 30 & 31 not included (Primary PCI cases n<5). Site 26 NIL PHN cases.

In-hours versus out-of-hours presentation

In 2018, 60% of STEMI cases were treated out-of-hours (range by hospital 20-71%). All but one hospital had longer delays to the commencement of the procedure after-hours (Figure 27). The gap in DBT performance of hospitals between their in-hours and after-hours cases tended to be smaller than in previous years. The overall compliance rate of ≥75% cases with DBT≤90mins out-of-hours also improved (74.9% in 2018 vs. 71.5% in 2017). Nine of the 21 sites achieved the DBT compliance benchmark of ≥75% cases out-of-hours a similar proportion to the previous report.

Figure 27: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes – in-hours vs out-of-hours presentation

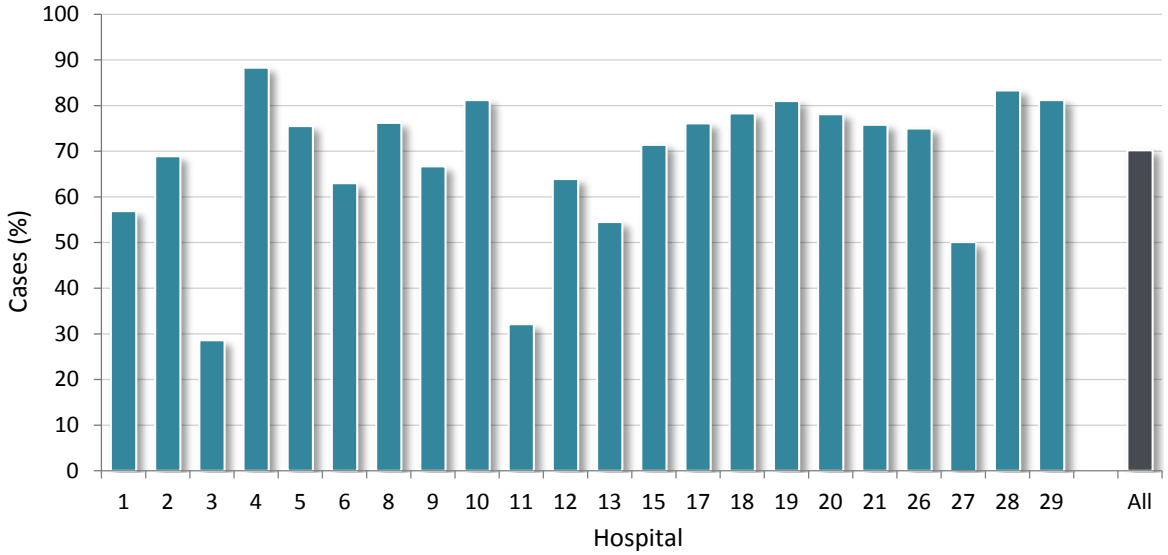


Hospitals 7, 13, 14, 16, 22, 23, 24, 25, 30 & 31 not included (Primary PCI cases n<5).
In hours: 8.00am – 6.00pm (Mon – Fri excluding public holidays).
Out-of-hours: 6.00pm – 08.00am (Mon – Fri, public holidays and weekends).

Radial access

In line with a strong evidence base of its benefits in STEMI (20), the use of radial vascular access in acute STEMI has continued to increase over the past 5 years. In 2018, the rate was the highest yet seen in VCOR at 70.2% of STEMI PCI cases, an absolute increase of 4% over the previous year. A comparison of radial access rates in STEMI PCI among hospitals shows that there was still wide variation across sites (28.6%- 88.3%), with only 5 hospitals managing to use the radial artery in ≥80% cases (Figure 28).

Figure 28: Radial access rates in acute STEMI by hospital



Sites 14, 23, 30 & 31 had NIL acute STEMI cases. Low rate of acute STEMI cases for hospitals 25, 26 & 28 (n<10).
Sites 7, 16, 22, 24 & 25 excluded due to low case numbers (n<5).

Outcomes

Lesion and procedure success rates

The mean lesion success rate (defined as treatment of a coronary lesion with a residual stenosis <10% following stenting or <50% following balloon angioplasty alone) was 95.1% for the 2018 cohort (range across hospitals 78.6%-98.7%). Procedural success requires both the successful treatment of all lesions and the absence of any major in-hospital complications. The mean procedural success rate was 91.4% (range across hospitals 79%-97%). Overall, the rates of lesion and procedural success have remained very stable over the period from 2014-2018.

Table 13 demonstrates differences in clinical and lesion features among successful and failed PCI cases. As in the previous year, unsuccessful procedures were more commonly associated with diabetes, previous stroke, poor renal function, poor left ventricular function and cardiogenic shock, but not age or gender. A history of peripheral vascular disease and previous CABG also emerged as conditions associated with failed procedures. Chronic total occlusion (CTO) lesions were nearly 8 times more commonly associated with failed procedures.

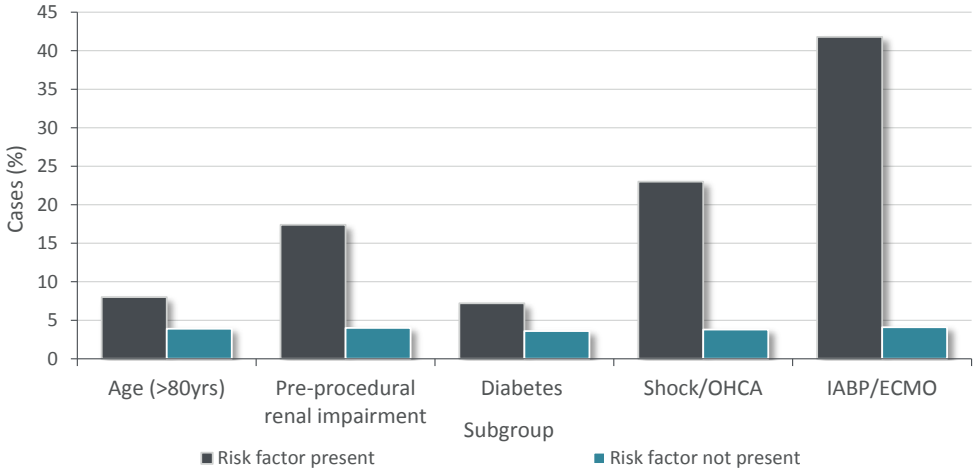
Table 13: Comparison of clinical and lesion features among successful and failed PCI cases

Patient characteristics	Successful procedure (n=11381)	Unsuccessful procedure (n=1065)
Age- years (Mean ± SD)	66.6 (±11.7)	68.3 (±11.8)
	N (%)	N (%)
Gender- female	2676 (23.5)	270 (25.4)
Diabetes	2555 (22.4)	256 (24.0)
PVD history	364 (3.2)	58 (5.4)
CVD history	365 (3.2)	53 (5.0)
Previous PCI	3808 (33.5)	356 (33.4)
Previous CABG	793 (7.0)	108 (10.1)
eGFR<45/Renal replacement therapy	970 (8.5)	164 (15.4)
Normal LVEF (>50%)	7311 (70.7)	544 (56.4)
Mild LVEF (45-50%)	1629 (15.7)	159 (16.5)
Moderate LVEF (35-44%)	963 (9.3)	126 (13.1)
Severe LVEF (≤35%)	442 (4.3)	136 (14.1)
Shock/OHCA	172 (1.5)	156 (14.6)
Out-of-hours	2193 (19.3)	311 (29.2)
Public hospital	6601(58.0)	660 (62.0)
Chronic total occlusion	257 (2.3)	190 (17.8)
ACC/AHA B2/C lesion	6821 (59.9)	840 (78.9)

New renal impairment

Acute renal impairment can arise following the use of angiographic contrast agents, especially in patients with pre-existing kidney disease, diabetes, hypertension or advanced age. In 2018, the overall rate of new renal impairment (NRI)- defined as a serum creatinine rise >44.2 µmol/L or 25% above pre-procedural value within 5 days of PCI procedure- was 4.4%. The incidence of NRI among known high-risk groups is shown in Figure 29. New renal impairment was more common in each of these subgroups – especially patients with cardiogenic shock and out-of-hospital cardiac arrest or those who required mechanical support.

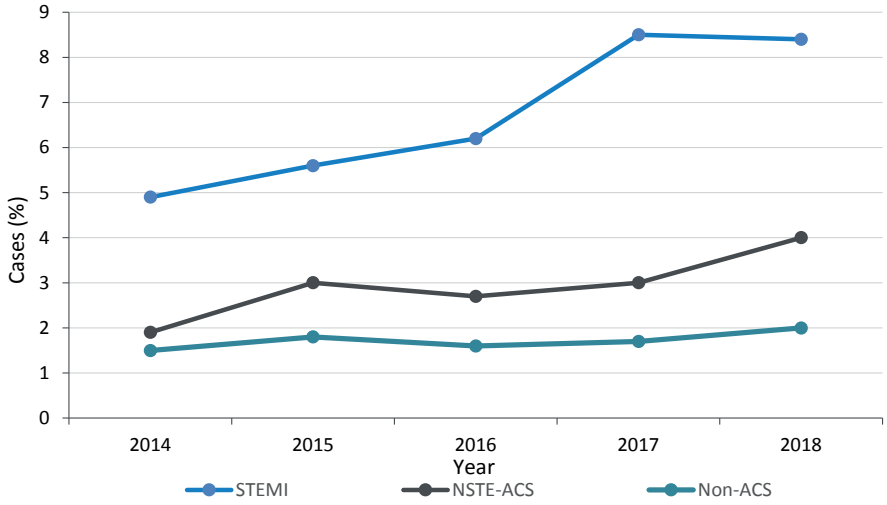
Figure 29: Rates of new renal impairment in selected high-risk sub-groups



Data available for 8949 cases.

When assessing NRI by clinical presentation, STEMI had the highest incidence of 8.4%. Rates in patients with NSTE-ACS (2.0%) and non-ACS (4.0%) may be underestimated as not all patients had renal function measured post-procedure. Figure 30 shows the trend in NRI in STEMI patients over the last 5 years. There was a notable rise in incidence over this period, although this rise plateaued in 2018.

Figure 30: Trends in rates of new renal impairment by clinical presentation: 2014-2018



Referral to cardiac rehabilitation

Referral to cardiac rehabilitation and/or secondary prevention programs following admission with acute coronary syndrome is strongly recommended by Australian guidelines (17). In 2018, the overall rate for referral to cardiac rehabilitation among VCOR hospitals following PCI was 75.9%- similar to previous years. Referral rates varied with clinical presentation, with ACS cases more often referred than non-ACS patients (Table 14). When examining referrals to cardiac rehabilitation by hospital sector, rates were lower in the private sector (69.2% in private vs 80.7% in public)- a trend noted in previous reports as well. However, referral rates did increase in both sectors compared with the previous year.

Table 14: Rates of referral to cardiac rehabilitation by clinical presentation

Clinical presentation	Cases with data available	Rehabilitation referral rate
	N	N (%)
STEMI	2394	2026 (84.6)
NSTE-ACS	3582	2824 (78.8)
Non-ACS	6297	4462 (70.9)
All cases	12273	9312 (75.9)

Compliance with guideline-recommended discharge medications

Among the medications used after PCI, dual anti-platelet therapy (DAPT) and statins receive the strongest recommendation in Australian guidelines (11). For this reporting period, DAPT and statin prescription were generally high (Table 15). The gap in statin use between public and private sectors observed this year was also apparent in the previous report and likely represents a real difference in prescribing patterns, although the reasons behind this remain uncertain.

Table 15: Rates of prescription of dual antiplatelet therapy and statins at discharge

	All sites	Public	Private
	N (%)	N (%)	N (%)
Dual antiplatelet therapy	11540 (94.2)	6824 (96.1)	4716 (91.4)
Statin	11302 (92.5)	6758 (95.4)	4544 (88.5)

Table 16 lists the main drug classes used in patients with ACS. The highest compliance rates were seen among patients presenting with STEMI. Keeping in mind that DAPT represents two medications, 81% of STEMI patients were discharged on at least 4 of the 5 recommended medications. Compliance rates with beta blockers and ACE inhibitors/angiotensin receptor antagonists declined with lower acuity clinical presentations.

Table 16: Rates of prescription of selected medications at discharge by clinical presentation

	DAPT	Statin	BB	ACE-I/ARB
	%	%	%	%
STEMI	95.6	96.6	86.3	84.0
NSTE-ACS	95.6	95.2	71.5	72.7
Non-ACS	92.8	89.4	55.8	63.4

Key Performance Indicators

VCOR reports on the following key performance indicators (KPIs):

- In-hospital mortality
- In-hospital major bleeding
- Length of stay
- In-hospital unplanned revascularisation
- Door-to-balloon/device time for STEMI patients
- 30-day risk-adjusted mortality
- 30-day major adverse cardiac and cerebrovascular event (MACCE)

VCOR has developed its own risk-adjustment model for 30-day all-cause mortality (21). Our model proved robust, even with the inclusion of extreme high-risk conditions of cardiogenic shock and out-of-hospital cardiac arrest. These cases were therefore not excluded during risk adjustment. The clinical characteristics used to construct the VCOR risk-adjustment model for 30-day mortality were:

- Cardiogenic shock
- Out-of-hospital cardiac arrest
- Glomerular filtration rate
- Left ventricular ejection fraction
- Acute coronary syndrome
- Mechanical ventricular support
- Age ≥80 years
- Complex lesions
- Percutaneous entry location
- Peripheral vascular disease

In-hospital mortality

The unadjusted in-hospital mortality rate for 2018 was 1.4%. As expected, the death rate for cases of cardiogenic shock or out-of-hospital cardiac arrest was much higher than any other clinical category. When STEMI and shock/out-of-hospital cardiac arrest cases were excluded, the mortality rate for the rest of the PCI cohort was also low at 0.3%. Table 17 provides in-hospital mortality data for selected clinical groups.

Table 17: Unadjusted in-hospital mortality rates for selected patient groups

Patient category	Total	In-hospital mortality rate
	N	N (%)
All PCI patients	12447	174 (1.4)
STEMI patients	2513	119 (4.7)
Shock/intubated OHCA patients	328	115 (35.1)
NSTE-ACS	3611	29 (0.8)
Non-ACS	6323	26 (0.4)

Table 18 provides trends for in-hospital mortality in selected patient groups. Overall, there has been a decline in in-hospital mortality over time. This is mainly accounted for by the acute STEMI cohort, whose rates fell from 7.6% in 2014 to 4.7% in 2018. The in-hospital death rates for lower-risk subgroups remained very low and stable over time.

Table 18: Trends in in-hospital mortality rates for selected clinical presentations: 2014-2018

Patient category	2014 (N=8329)	2015 (N=9230)	2016 (N=10036)	2017 (N=11002)	2018 (N=12447)
	N (%)	N (%)	N (%)	N (%)	N (%)
All PCI patients	174 (2.1)	155 (1.7)	193 (1.9)	204 (1.9)	174 (1.4)
STEMI	140 (7.6)	113 (5.7)	138 (6.4)	145 (6.4)	119 (4.7)
Shock and/or intubated OHCA	107 (44.8)	102 (40.3)	119 (38.5)	133 (42.9)	115 (35.1)
NSTE-ACS	16 (0.6)	25 (0.9)	29 (0.9)	34 (1.0)	29 (0.8)
Non-ACS	18 (0.5)	17 (0.4)	26 (0.6)	25 (0.5)	26 (0.4)

In-hospital major bleeding

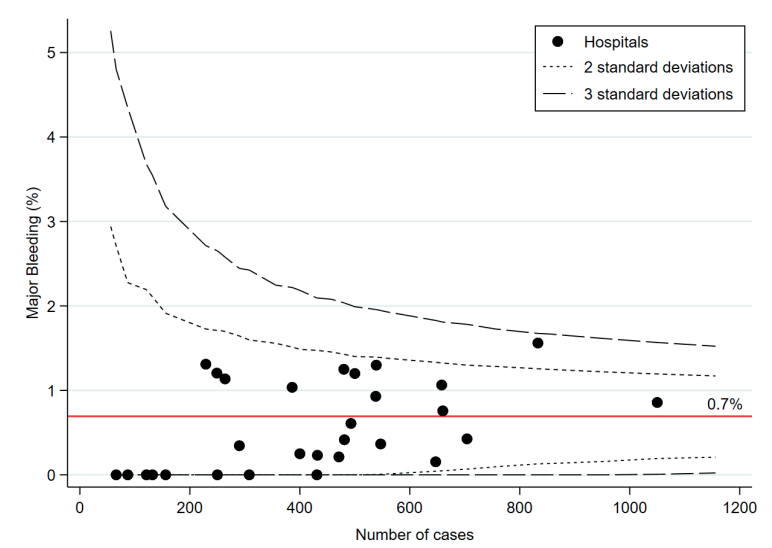
The overall in-hospital major bleeding rate in 2018 was 0.7%, similar to previous years. VCOR uses a definition of major bleeding based on the international Bleeding Academic Research Consortium (BARC) standardised bleeding definitions for cardiovascular clinical trials (22), and includes bleeding types 3 and 5. Various clinical subsets are detailed in Table 19. More bleeding was seen among STEMI patients, who usually receive the most intensive forms of antithrombotic therapy. Patients treated with ECMO had particularly high rates of bleeding (7 out of 16 patients, 43.8%). Major bleeding was also more common among females and when femoral access was used.

Table 19: In-hospital major bleeding rates for selected patient groups

Sub-group	N	Major bleeding rate
Clinical Presentation		N (%)
STEMI	2513	51 (2.0)
NSTE-ACS	3611	22 (0.6)
Non-ACS	6323	20 (0.3)
Gender		N (%)
Male	9501	59 (0.6)
Female	2946	34 (1.2)
Arterial Access Route		N (%)
Radial access	8244	45 (0.5)
Femoral access	4186	48 (1.1)
Brachial access	17	0 (0)
Total	12447	93 (0.7)

Benchmarking major bleeding rates by hospital demonstrated that all participating hospitals were within control limits with no outliers for the 2018 reporting period. Nor was there any association apparent between hospital volume and bleeding incidence (Figure 31).

Figure 31: Rates of in-hospital major bleeding by hospital

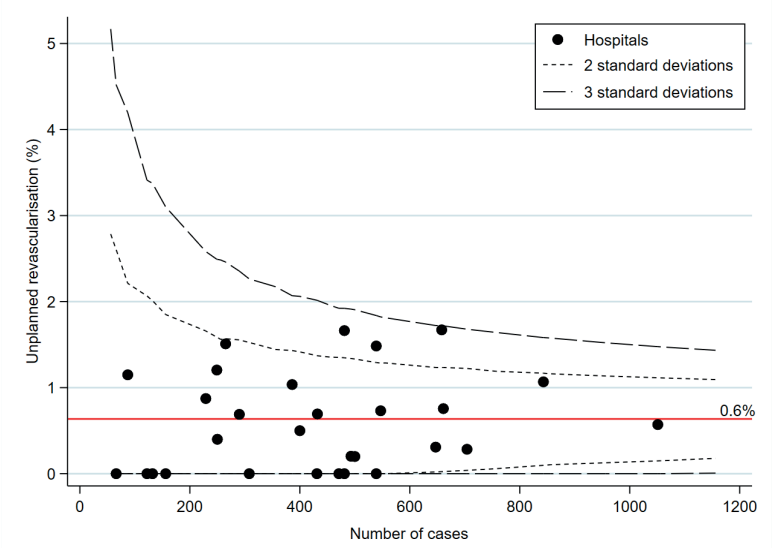


Hospitals excluded due to low PCI Numbers (n<20) sites 30 and 31. Excludes ECMO cases (n=17).

In-hospital unplanned revascularisation

In-hospital unplanned revascularisation refers to any unexpected revascularisation procedure (either PCI or CABG surgery) following the index PCI, and within the same admission. In 2018, the overall rate of in-hospital unplanned revascularisation was 0.6%. This rate has been consistent over time. All participating hospitals had rates of unplanned revascularisation within control limits (Figure 32).

Figure 32: Rates of in-hospital unplanned revascularisation by hospital



Hospitals excluded due to low PCI Numbers (n<20) sites 30 and 31.

Forty patients required emergency or urgent cardiac surgery during their admission for PCI. Selected clinical features and outcomes associated with emergency surgery are shown in Table 20. Just over half had underlying complex coronary lesions (Type C); 4 cases involved PCI for unprotected left main disease and 4 cases required urgent surgery following PCI for CTO. 10% of cases that ended up requiring urgent surgery were performed in centres without on-site surgical backup. Rates of adverse outcomes were higher in the emergency surgery group than in the overall patient cohort.

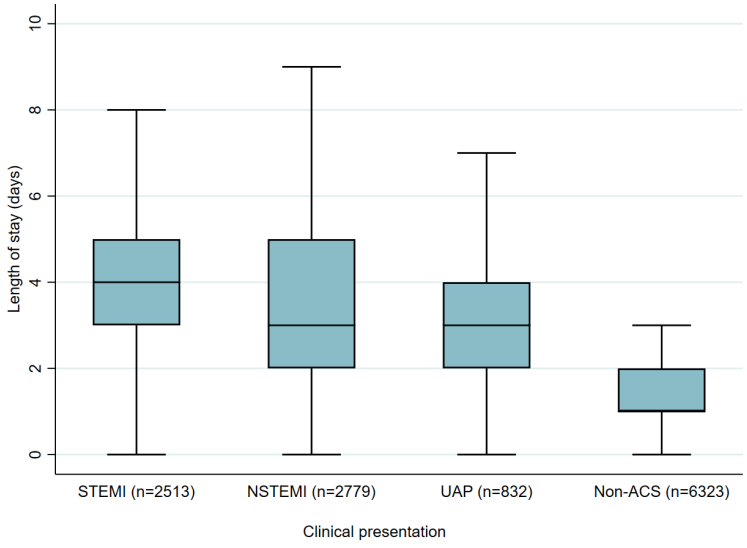
Table 20: Selected clinical features and outcomes associated with emergency CABG surgery

Presentation	Emergency CABG (N=40)
	N (%)
STEMI	15 (37.5)
Shock/OHCA	6 (15.0)
Complex lesions (Type C)	21 (52.5)
Chronic total occlusion	4 (10.0)
Unprotected left main PCI	4 (10.0)
PCI performed in hospitals without on-site surgery	4 (10.0)
In-hospital outcomes	N (%)
Mortality	2 (5.0)
New MI	7 (17.5)
Major bleeding	8 (20.0)
Stroke	3 (7.5)
Definite and probable stent thrombosis	3 (7.5)

Length of stay

Length of stay varied according to clinical presentation and was greatest among patients presenting with an acute coronary syndrome (Figure 33). Most elective PCI cases had a length of stay of one day. Median length of stay was shorter among patients treated in private hospitals (3 days public vs 2 days private). The proportion of cases discharged the same day as their procedure remained low (2.4%), consistent with the observed trend over the last 5 years, where same-day discharge rates following PCI ranged 1.6% to 2.4%. The vast majority of same-day discharges were from the public sector (222 of 293 cases, 75.8%).

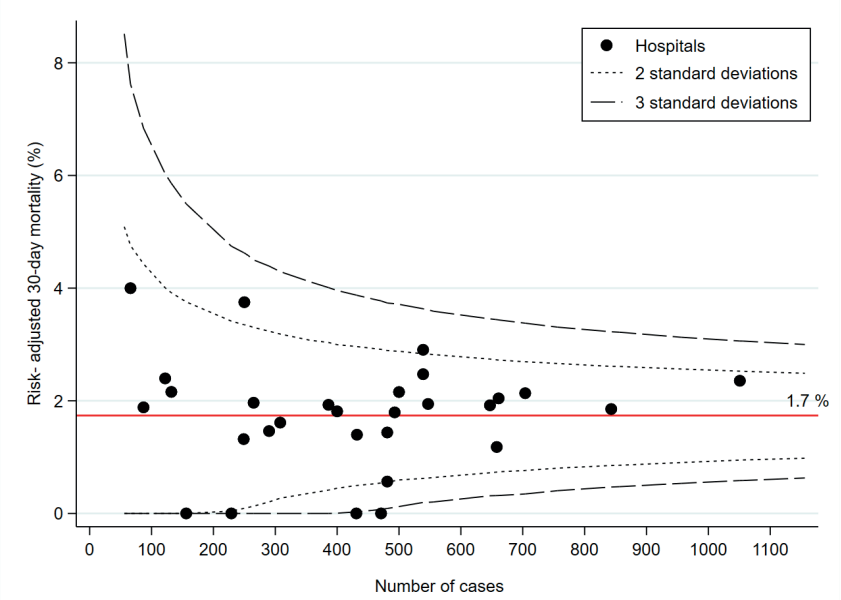
Figure 33: Length of stay by clinical presentation



30-day mortality

The risk-adjusted 30-day mortality for the overall cohort was 1.7%. All participating hospitals had risk-adjusted outcomes within control limits, with no outlier sites in the 2018 reporting period. Nor was there any obvious association between risk-adjusted mortality and hospital volume (Figure 34). Risk-adjusted 30-day mortality rates have gradually declined over the period from 2014-2018.

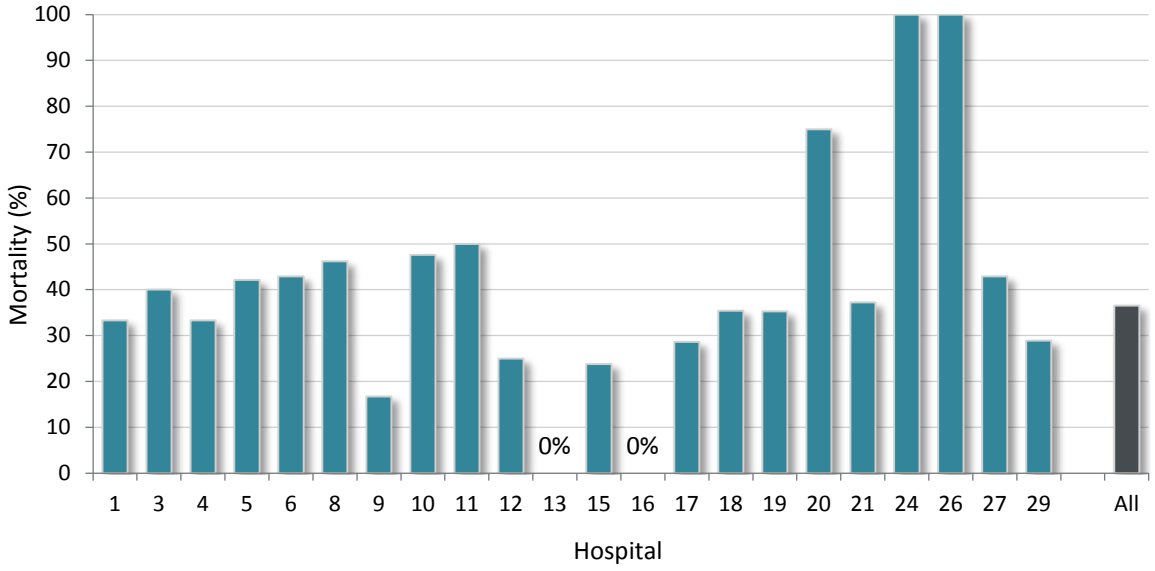
Figure 34: Risk-adjusted 30-day mortality rates by hospital



Hospitals excluded due to low PCI Numbers (n<20) sites 30 and 31.

Figure 35 compares unadjusted 30-day mortality rates for shock and/or OHCA by hospital. The majority of hospitals had mortality rates within the range of 25-50%. Hospitals with extremely low or high mortality tended to have very low numbers. Rates of 30-day mortality excluding shock and/or OHCA have remained stable over time.

Figure 35: 30-day mortality rates for cardiogenic shock and/or intubated OHCA patients by hospital

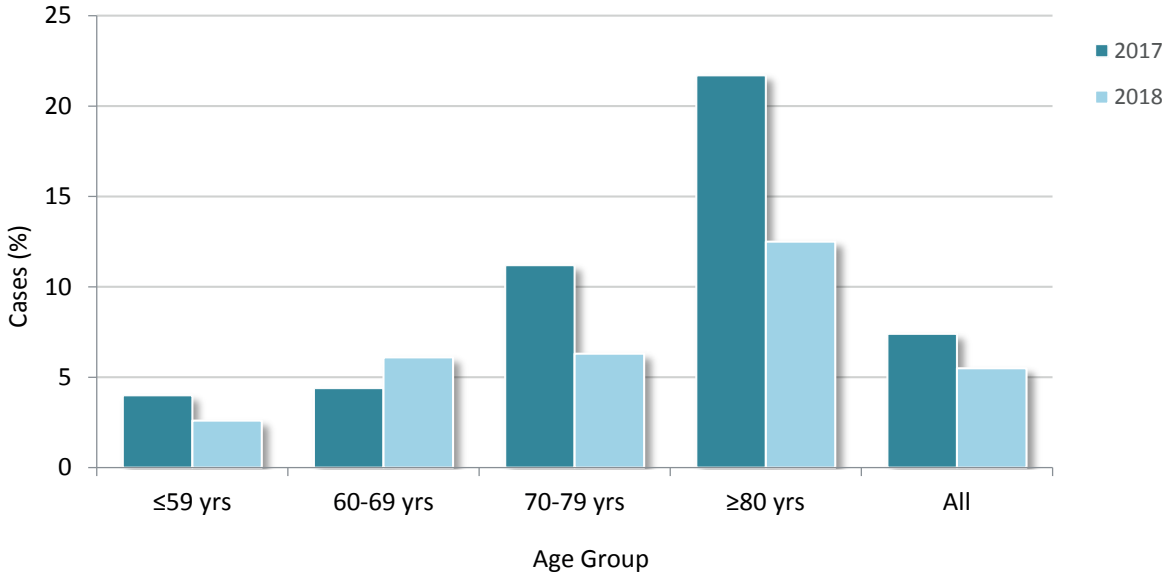


Hospital	1	3	4	5	6	8	9	10	11	12	13	15	16	17	18	19	20	21	24	26	27	29	ALL
Cases (N)	15	5	3	19	7	13	6	21	18	4	2	21	1	21	48	17	4	43	1	2	7	45	323

Hospitals 2, 7, 14, 22, 23, 25, 28, 30 & 31 had no shock or intubated OHCA cases.

There was a strong association between advancing age and 30-day mortality among STEMI patients. The 30-day mortality rate for the STEMI cohort ≥80 years was approximately double the rates for younger patients. Mortality rates were lower in 2018 than in the previous year overall (Figure 36).

Figure 36: 30-day mortality for STEMI by age group



30-day major cardiac cerebrovascular events (MACCE)

The composite endpoint of major adverse cardiac and/or cerebrovascular events (MACCE) is defined as all cases of death, new or recurrent myocardial infarction or stent thrombosis, target vessel revascularisation or stroke. The overall MACCE rate was 3.8% (Table 21). The rate dropped to 2.8% when the high-risk conditions of cardiogenic shock or out-of-hospital cardiac arrest were excluded (n=328 cases).

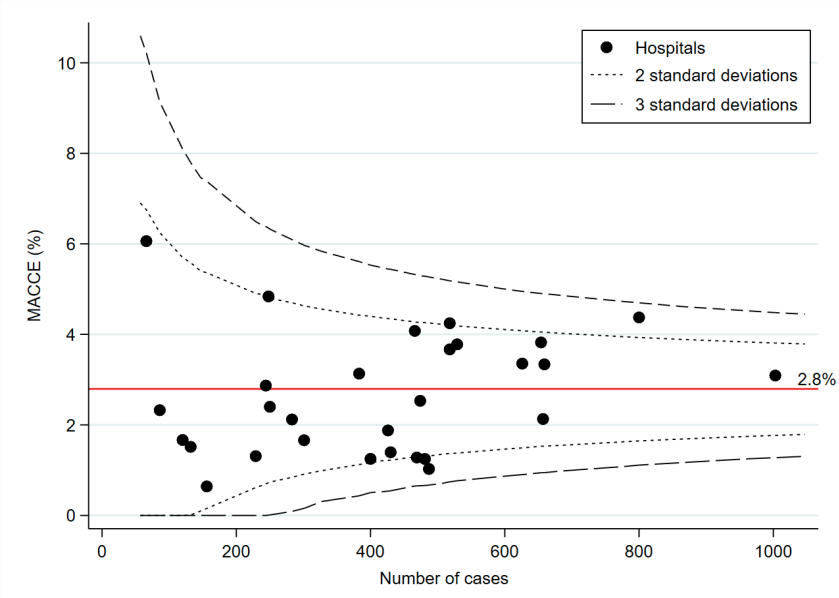
Table 21: Major adverse cardiac and cerebrovascular event rates

MACCE component**	In-hospital events	30-day events*
	N (%)	N (%)
Mortality	166 (1.3)	207 (1.7)
Myocardial infarction	86 (0.7)	142 (1.1)
Stroke	25 (0.2)	44 (0.4)
Definite stent thrombosis	31 (0.2)	47 (0.4)
Probable stent thrombosis	5 (<0.1)	6 (<0.1)
Target vessel revascularisation (TVR)†	79 (0.6)	153 (1.2)
MACCE	306 (2.5)	474 (3.8)

**30-day events reported include in-hospital events.*
+TVR refers to any 'unplanned' PCI or CABG revascularisation of the target vessel.
***Cases with multiple procedures were excluded to avoid mortality being counted more than once (n=11).*
Categories are not mutually exclusive.

For the benchmark analysis relating to MACCE, all hospitals had rates that were within control limits, with no outliers in the 2018 reporting period (Figure 37).

Figure 37: 30-day MACCE rates by hospital



Hospitals excluded due to low PCI Numbers (n<20) sites 30 and 31.
Excludes all shock/OCHA cases (n= 323).

30-day stent thrombosis

Stent thrombosis was reported as a "definite" event (symptoms suggestive of an acute coronary syndrome and angiographic or pathologic confirmation of stent thrombosis) or a "probable" event (unexplained death within 30 days or target vessel myocardial infarction without angiographic confirmation of stent thrombosis). The 30-day definite stent thrombosis rate was 0.4% as shown in Table 21. There were no major differences in stent thrombosis rates among participating sites or when public and private sectors were compared.

30-day rehospitalisation

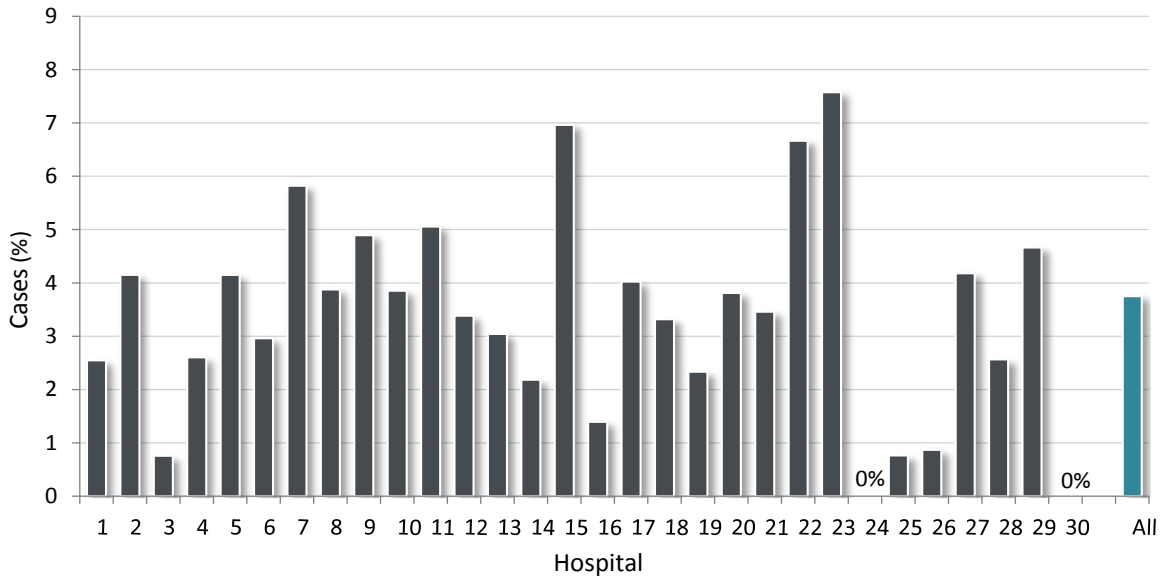
At 30 days, the overall rate of rehospitalisation was 13.6% and this rate has been remarkably constant over the previous 5 years. Of these, 4.8% were re-admitted more than once during that period. Half the readmissions were cardiac in nature and just over one third of cardiac admissions were unplanned. (Table 22).

Table 22: Rehospitalisation rates by hospital sector

Rehospitalisation type	All patients (N=12182)	Public (n=7057)	Private (n=5125)
	N (%)	N (%)	N (%)
Total readmissions	1662 (13.6)	810 (11.5)	852 (16.6)
Non-cardiac readmissions	486 (4.0)	289 (4.1)	197 (3.8)
Cardiac readmissions	1176 (9.6)	521 (7.4)	655 (12.8)
Unplanned cardiac readmissions	457 (3.7)	284 (4.0)	173 (3.4)
Planned cardiac readmissions	719 (5.9)	237 (3.4)	482 (9.4)

Unplanned 30-day readmission rates have become a key indicator of hospital performance and quality of care. Comparative rates of unplanned readmissions by hospital are shown in Figure 38. There were no major differences in 30-day unplanned readmission rates between public and private hospitals.

Figure 38: 30-day unplanned cardiac rehospitalisation rates by hospital

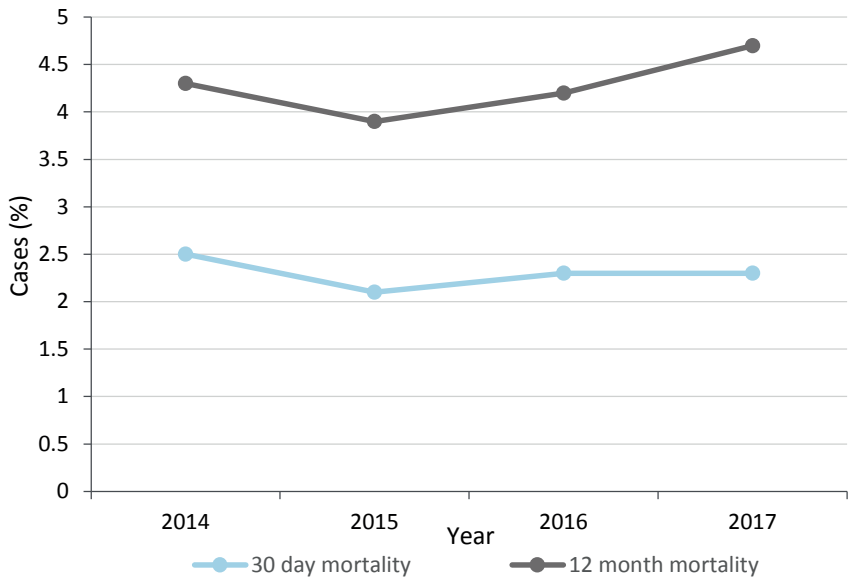


Sites 30 & 31 – Low case numbers (n<20). Site 31 NIL readmissions.

12-month mortality

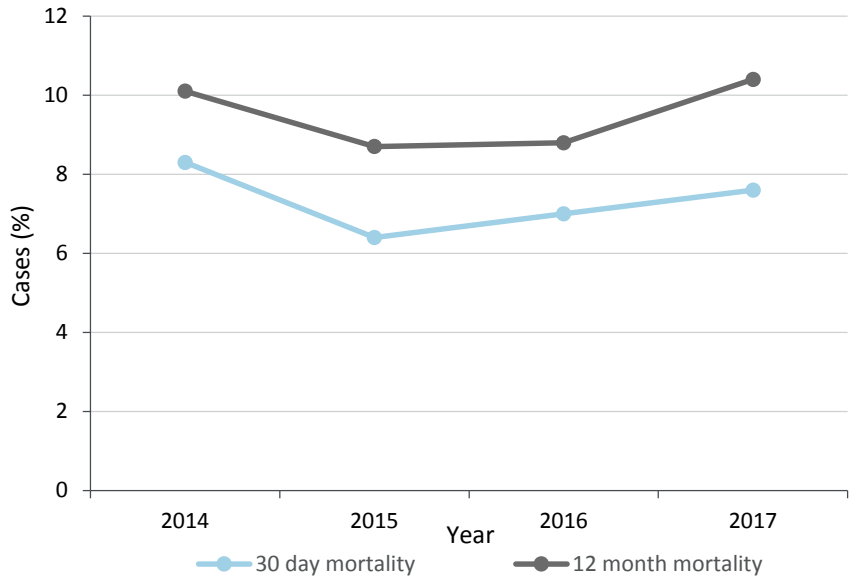
By linking VCOR data with the National Death Index (NDI), 12-month mortality outcomes are presented for the period of 2014-2017 (Figure 39). The unadjusted 12-month mortality rate for the 2017 cohort was 4.7%. Data for the 2018 cohort will be included in the next report. Twelve-monthly death rates have not varied significantly over a 4-year period.

Figure 39: Comparison of 30-day and 12-month mortality rates 2014-2017 – all PCI cases



For STEMI, 12-monthly mortality rates were approximately double the rate for the overall PCI cohort, but the variation in rates over time is quite similar (Figure 40). The 12-monthly mortality rate for STEMI patents who underwent PCI was 10.4% in the 2017 cohort.

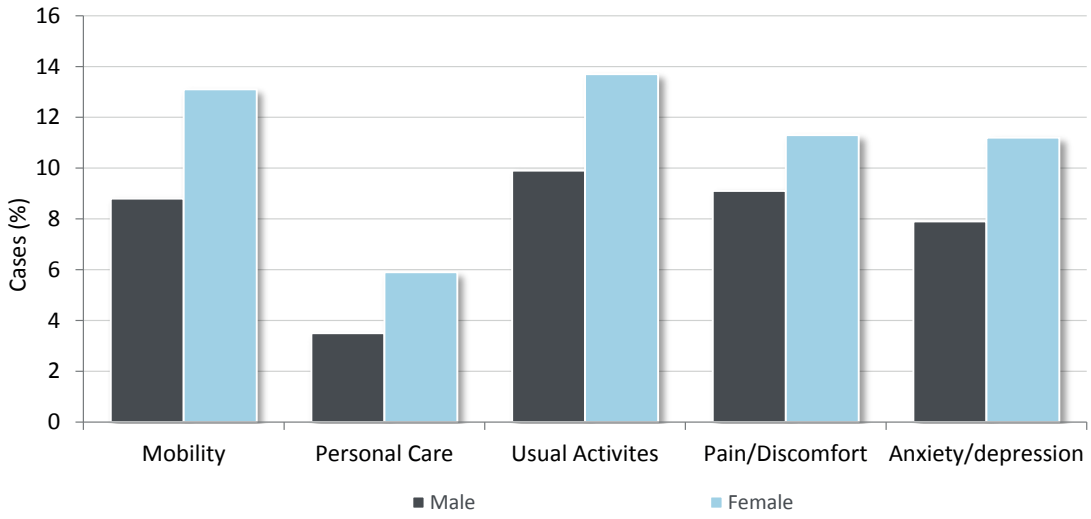
Figure 40: Comparison of 30-day and 12-month mortality rates 2014-2017 – STEMI cases



Quality of Life

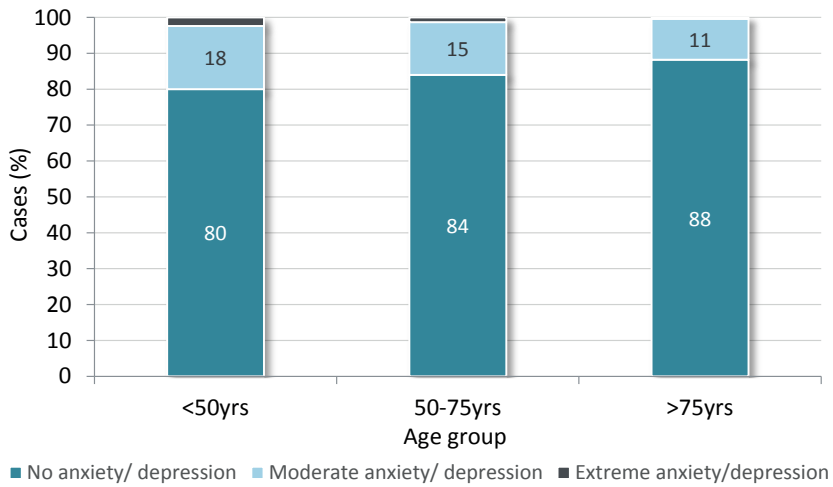
Patients were given an opportunity to rate their perceived quality of life at 30-day follow-up in a series of questions based on a standardised measure, the EQ-5D (23). Responses were obtained from 61.4% of patients, with a number of sites struggling to have the surveys completed due to follow-up method and resource constraints. Patients assessed their mobility, ability to perform usual domestic and personal care tasks, level of pain or discomfort and whether they experienced any anxiety or depression. The results are shown in Figure 41, where the proportions of patients reporting "some problem" are shown. For each domain, women more commonly reported a problem than men, while initial clinical presentation (ACS vs non-ACS) did not influence the ratings.

Figure 41: Quality of life metrics: Reporting "some problem" by gender



The median rating score for a patient's own health status was 80 out of 100 (IQR: 70, 90). Notably, just under half the patients reported experiencing at least some anxiety or depression within 30 days of their PCI procedure. Younger patients were more likely to report depression and/or anxiety in the moderate or severe range. Overall, 8.7% of patients reported moderate rates of anxiety/depression and 0.7% of patients reported extreme anxiety/depression (Figure 42).

Figure 42: EQ-5D responses to anxiety/depression by age group



Cardiac Implantable Electronic Devices (CIED)

Background

In 2017, VCOR secured funding from Safer Care Victoria (SCV) to undertake a pilot project involving cardiac implantable electronic devices (CIED). Little is known about quality assurance aspects of CIEDs in the local Australian setting. At the national level, Queensland and South Australia are collecting some data on CIED implantations and complications in the public hospital sector. However, there is still a need for a lot more information including variation in the clinical application of CIEDs, appropriateness of their use, patterns of practice in the private sector and the rigor of any outcome monitoring.

VCOR focused on two types of device therapy. The first was implantable cardioverter defibrillators (ICD)- an effective treatment for abnormal and potentially lethal heart rhythm disturbances that is used in patients with a previous history or increased risk of cardiac arrest. The second CIED type was cardiac resynchronisation therapy (CRT), which involves the synchronised pacing of both the left and right ventricles, achieved either with a pacemaker or defibrillator and additional pacing leads. This particular form of therapy is utilised in patients with the condition of diseased heart muscle (cardiomyopathy) and can result in marked improvement in symptoms and signs of heart failure. Both these device types have clear-cut indications for use, well-defined appropriate use criteria and measurable process and procedural outcomes – making them ideal procedures to follow in a clinical quality registry. Due to limitations in resources, we did not collect data on pacemakers without CRT functionality.

At an international level, there are a number of registries that collect data on CIED outcomes – some of whom have defined and reported on appropriateness and safety metrics (24). With these registries as background and input from key Victorian clinical leaders, key metrics relating to appropriateness, performance and safety were formulated. As with VCOR's other modules, only a limited number of process and outcome measures were chosen to keep the project easily achievable, yet meaningful to clinicians and other key stakeholders.

Registry Module Activity

The CIED Pilot Project collected data from February 12 to December 31, 2018. The pilot involved seven hospitals (six public and one private), with a total 430 procedures performed on 416 patients entered in the registry.

CIED cases were broadly categorised as first implants (new device for the patient), replacements, upgrades or explant procedures (removal of a device without any replacement). Cases that involved just the insertion of new leads or revision of existing leads were also included. The indication for insertion of an ICD (either with or without concomitant CRT) was for either primary or secondary prevention of sudden cardiac death. CRT pacemakers were used in patients with an underlying cardiomyopathy who required pacing or had a likelihood of worsening cardiac function with standard right ventricular pacing.

Patients and Procedures

The average age of patients was 63±15 years and 79% of patients were male, although women were commonly treated in the younger age groups (Figure 43). The majority (69.3%) of procedures were performed electively. Overall, 56.5% of cases were first implants, 34.2% of cases were generator replacements. Other procedure types included new lead (3.2%), revision procedures (3.3%) and removal of a device without replacement (explants) (2.8%).

Figure 43: Age and gender distribution of patients undergoing CIED

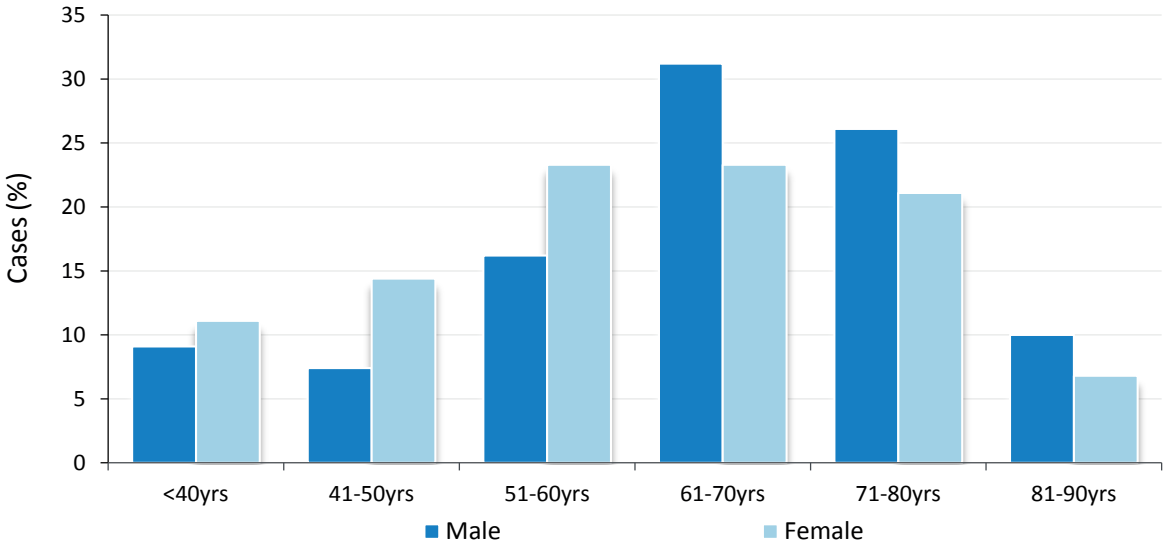
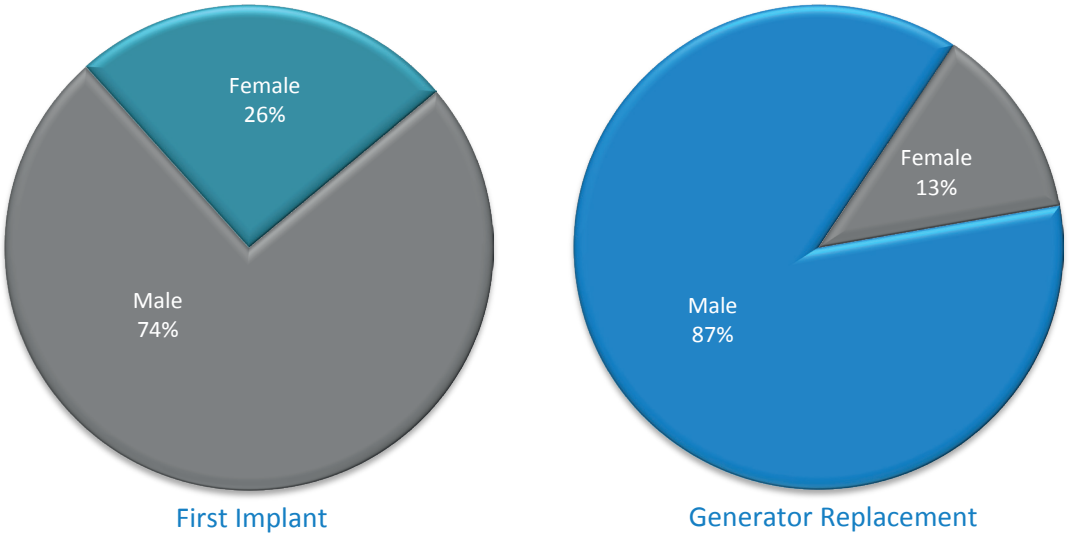


Figure 44: CIED Implant procedure type by gender



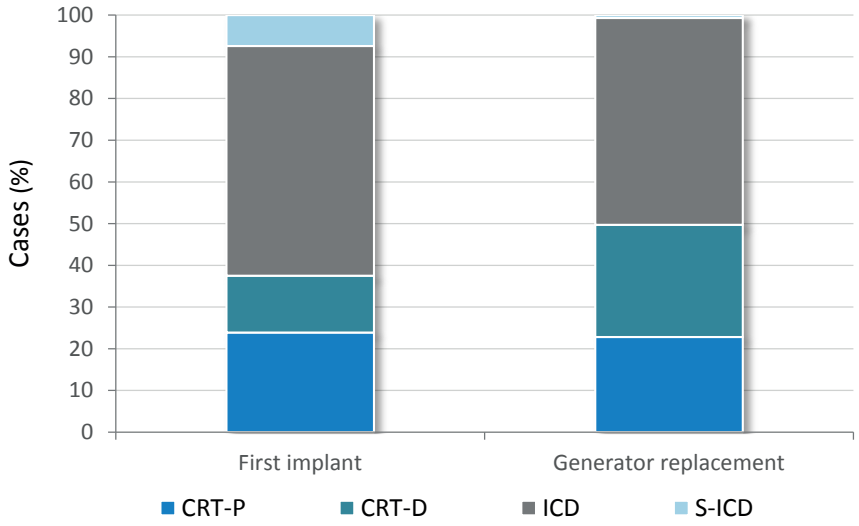
Device types

The types of devices included in the registry pilot were:

- ICD – implantable cardioverter defibrillator without any concomitant CRT
- CRT-D – implantable cardioverter defibrillator combined with CRT
- S-ICD – subcutaneous implantable cardioverter defibrillator (never combined with CRT)
- CRT-P – pacemaker combined with CRT

Figure 45 shows the proportions of device types implanted. Around half the first implants (55.1%) and generator replacements (49.0%) were ICD devices (ICD, CRT-D or S-ICD). The majority (93.4%) of devices utilising CRT (CRT-D and CRT-P) were implanted in the left pre-pectoral region. Only a small proportion (3.3%) were implanted in the right pre-pectoral region or sub-pectorally (3.3%). Similarly, most ICD generators without CRT were placed in the left pre-pectoral region (91.0%) and the remainder split between the right pre-pectoral region (3.7%) and the left sub-pectoral region (4.5%).

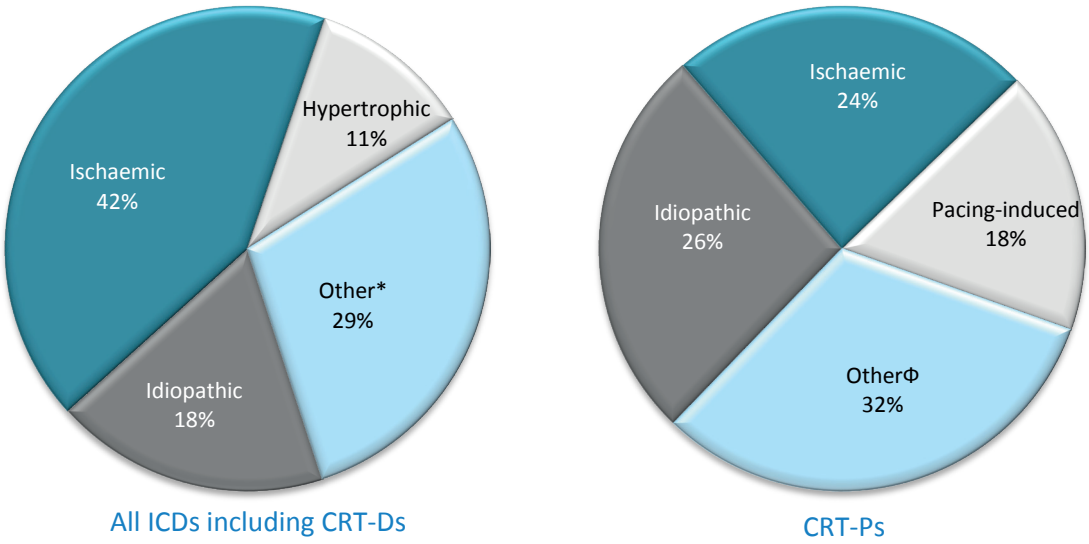
Figure 45: Device type – first implant vs generator replacement



Underlying cardiac aetiology

The underlying aetiology of the cardiac condition of patients undergoing any ICD (ICD, CRT-D or S-ICD) is shown in Figure 46. A large minority (42%) of cases had an ischaemic cause. For CRT-P devices, an ischaemic cause was documented less commonly at 24% of cases while an idiopathic (unknown) cause was found in 26% (Figure 46).

Figure 46: Aetiology of cardiac condition in patients undergoing first CIED implant



**Includes Familial/congenital & Idiopathic ventricular fibrillation.*
Φ Includes Valvular, Familial/congenital & Structural normal heart.

Left ventricular function

The left ventricular ejection fraction (LVEF) is a measure of the left ventricle's pumping ability and can be semi-quantitively graded as normal or impaired – with mild moderate or severe dysfunction.

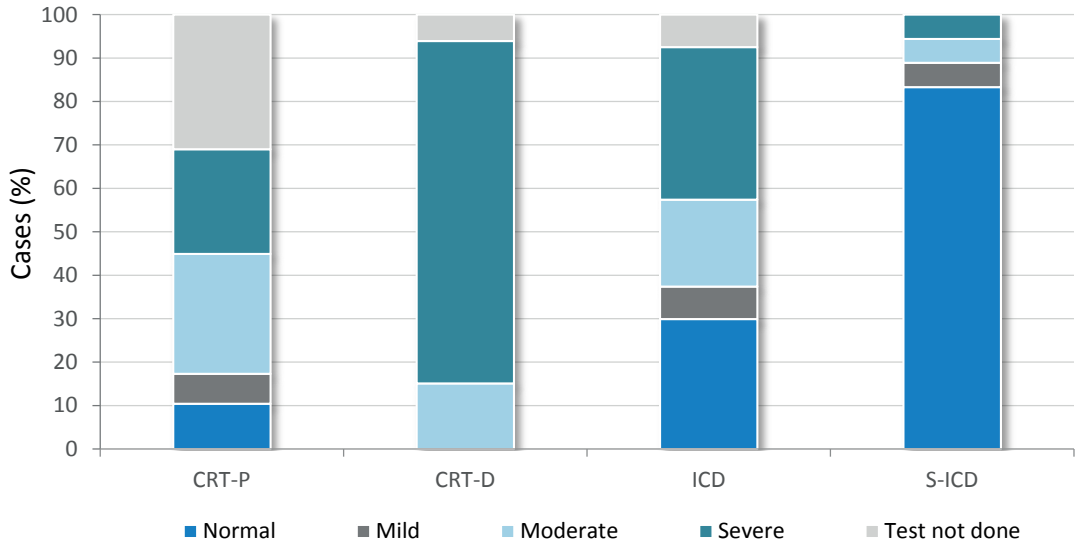
The measure has a strong influence on the choice of device, with national (25) and international guidelines (26, 27) detailing indications for ICDs and CRT based on LVEF and symptoms of heart failure, as well as other factors such as previous cardiac arrest.

It is beyond the scope of this report to present the details of these CIED guideline recommendations. However, in general, devices with ICD functionality are recommended in patients who have a past history of cardiac arrest or ventricular arrhythmias or who are at high risk of ventricular arrhythmias. Both these groups include people with and without severe left ventricular impairment. For devices that provide CRT capability (CRT-D and CRT-P), the main indication is in patients with reduced left ventricular function and symptoms of heart failure.

Figure 47 shows the proportions of patients with different levels of left ventricular dysfunction for each of the 4 CIED therapies included in the registry. There were marked differences among the 4 device types. Patients receiving the more conventional forms of defibrillators (ICD and CRT-D) had sizeable proportions of patients with severely impaired LVEF. In contrast, the newer form of defibrillator therapy – subcutaneous ICD – was primarily used in patients with normal left ventricular function. Admittedly, patient numbers in this group were low (n=18), but this device still has a fairly limited and specific use, concentrating on younger patients who only require defibrillator functionality without additional backup pacing or in whom the risk of endovascular infection is high.

CRT-P had a greater mix of LVEF grades, reflecting a different population of patients who have this device implanted rather than an ICD with CRT functionality.

Figure 47: Left ventricular function by CIED type (first implants only)



Criteria for cardiac resynchronisation therapy

As set out in national and international guidelines, the accepted criteria for CRT are:

- QRS width ≥120 milliseconds
- Presence of severe left ventricular dysfunction
- New York Heart Association (NYHA) Class II symptoms or greater

For CRT-D patients, 91% had a QRS width ≥120msec, 84% had severe left ventricular dysfunction and 94% NYHA Class II symptoms or greater. Combining these criteria, 84% had all 3 criteria and 3% had 2 out of 3 criteria. In contrast, the compliance with CRT inclusion criteria was lower among CRT-P patients. Only 38% had a QRS width ≥120msec and there was more variability in the degree of left ventricular impairment and heart failure symptoms (Figures 48 and 49). These differences may be a reflection of differing clinical profiles of patients that receive ICDs versus pacemakers. Nevertheless, it is expected that guidelines should be followed wherever possible for all device types and the registry will continue to monitor implanting sites' compliance with these recommended clinical indications.

Figure 48: Criteria for cardiac resynchronisation therapy: CRT-D

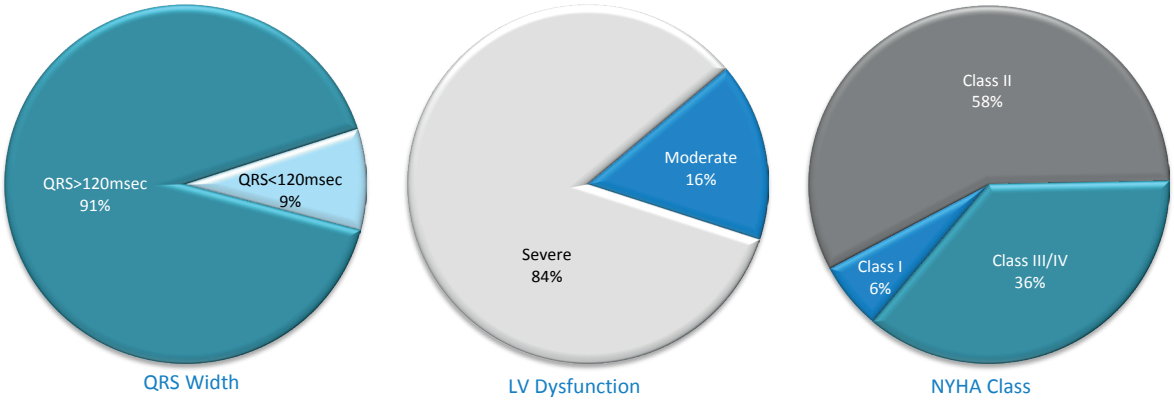
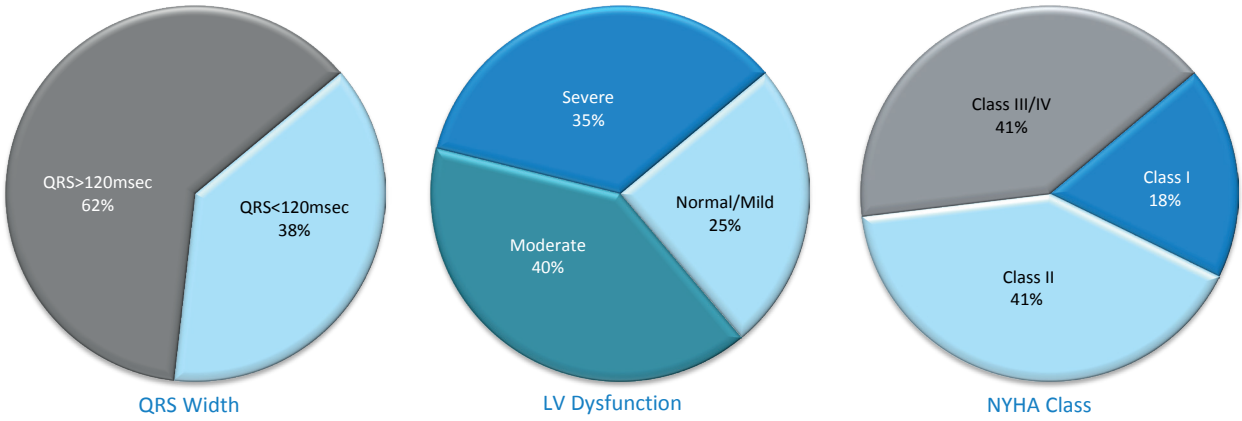


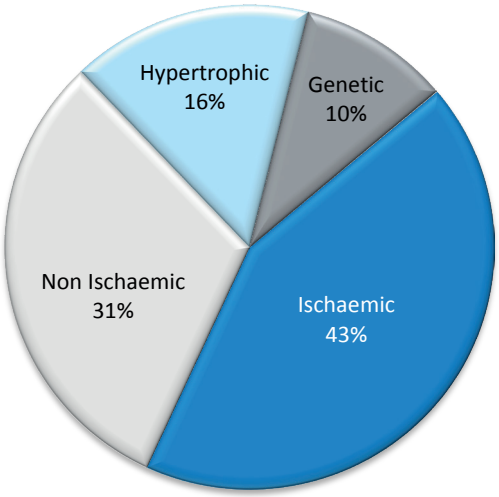
Figure 49: Criteria for cardiac resynchronisation therapy: CRT-P



ICD indications

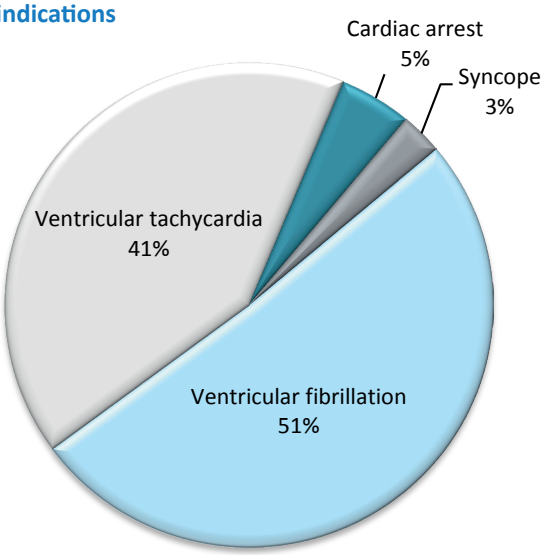
ICDs (with or without CRT functionality) are generally implanted either for primary or secondary prevention of sudden cardiac death. VCOR defines primary prevention as therapy for individuals who are at risk for, but have not had a known episode of sustained ventricular tachycardia, ventricular fibrillation, or resuscitated cardiac arrest. Patients with unexplained syncope in the absence of any documented ventricular arrhythmia are also considered as being treated for primary prevention. Secondary prevention is defined as ICD therapy in individuals who have survived one or more cardiac arrests, episodes of ventricular fibrillation or have had sustained ventricular tachycardia. Patients with syncope and non-sustained ventricular tachycardia have a secondary prevention indication.

Figure 50: Primary prevention ICD indications



Almost half (49.7%) of ICDs were implanted for primary prevention. The underlying conditions in these cases is shown in Figure 50. The remainder were for secondary prevention associated with a number of different medical indications, as detailed in Figure 51. Most secondary prevention devices (92.4%) were inserted following episodes of ventricular fibrillation or ventricular tachycardia.

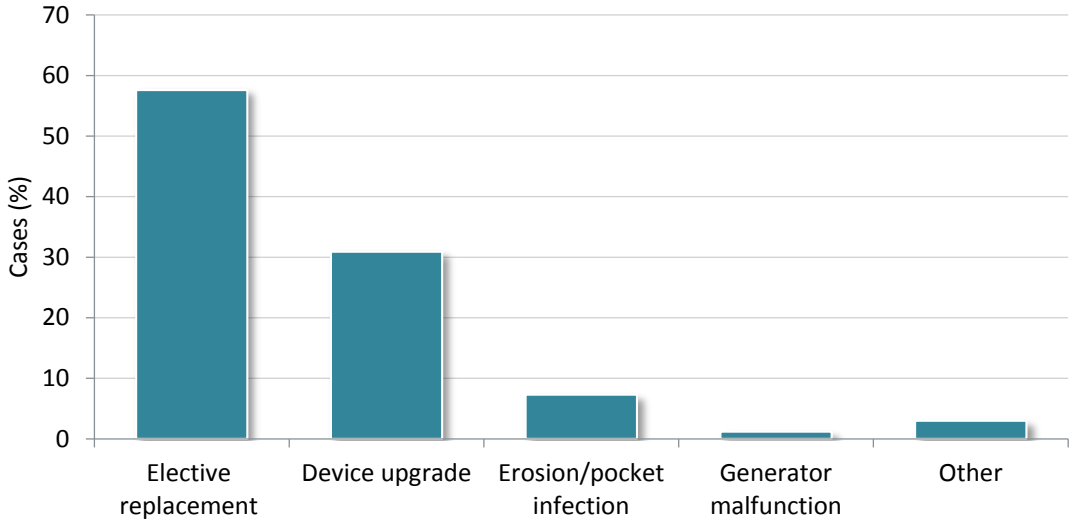
Figure 51: Secondary prevention ICD indications



Replacements and revisions

The most common indication for CIED replacement was elective replacement for battery depletion (57.6%). Almost a third of replacements were device upgrades – although some of these may have also been at a time when the pulse generator was nearing its end of life. Erosions or infection accounted for 7.3% of cases and there was a small number due to generator malfunction (1.2%) (Figure 52).

Figure 52: Indications for generator replacement, explant or revision



Outcome Measures

A number of key performance indicators (KPI's) were utilised to monitor and benchmark the performance of CIED implantation. These KPI's were based on clinically relevant process and outcome measures.

The key performance indicators (KPI's) for the CIED module are:

- In-hospital mortality
- 30-day mortality rate
- Successful device implantation without in-hospital complications
- 30-day unplanned cardiac readmissions
- 30-day device related re-operations
- 30-day device related infection rate

In-hospital mortality

There were no in hospital mortalities recorded in the CIED module for the 2018 year.

30-day mortality

The 30-day mortality rate was 0.5% with two deaths recorded within 30 days from hospital discharge.

Successful device implantation without in-hospital complications

Of the 430 devices entered into the CIED module, 95.4% were successfully implanted with no in-hospital complications identified. The small number of complications recorded included cardiac arrest, wound haematoma, severe hypotension and atrial tachyarrhythmia.

30-day unplanned cardiac readmissions, device–related re-operations and infections

The overall 30-day unplanned cardiac readmission rate was 7.7% (n=33) and the 30-day device related re- operation rate was 2.3% (n=10). The overall rate of 30-day device related infection was 1.2% (n=5) and included wound dehiscence (n=2), superficial wound infection (n=1) and pocket infection (n=2).

Table 23: In-hospital complications by hospital and device type

Hospital Total cases	C1 N=87	C2 N=24	C3 N=52	C4 N=57	C5 N=114	C6 N=90	C7 N=6	Total N=430
Any in hospital complications	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
CRT-P	1 (4.5)	0 (0)	2 (8.3)	1 (4.8)	0 (0)	0 (0)	0 (0)	4 (4.4)
CRT-D	0 (0)	1 (25)	0 (0)	1 (11.1)	3 (20)	0 (0)	0 (0)	5 (6.9)
ICD	2 (5.6)	0 (0)	0 (0)	2 (8.0)	6 (9.7)	0 (0)	0 (0)	10 (4.9)
S-ICD	0 (0)	0 (0)	0 (0)	0 (0)	1 (20)	0 (0)	0 (0)	1 (5.3)

Tables 23 and 24 provide outcomes for in-hospital complications and 30-day outcomes by hospital. Case numbers remain small and therefore benchmark comparisons should be interpreted with caution.

Table 24: 30-day outcomes by hospital

Hospital Total cases	C1 N=87	C2 N=24	C3 N=52	C4 N=57	C5 N=114	C6 N=90	C7 N=6	Total N=430
30 Day outcomes	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Mortality	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.9)	1 (1.1)	0 (0)	2 (0.5)
Unplanned cardiac re-admissions	5 (5.7)	3 (12.5)	3 (5.8)	1 (1.8)	14 (12.3)	6 (6.7)	1 (16.7)	33 (7.7)
Device related re-operations	2 (2.3)	0 (0)	2 (3.8)	1 (1.8)	3 (2.6)	2 (2.2)	0 (0)	10 (2.3)

Summary

The results of VCOR's pilot project on cardiac implantable electronic devices reported here focused on ICDs and cardiac resynchronisation therapy. The report monitored patient characteristics, indications for the procedure and compliance with appropriate use criteria. Results included both process and outcome measures, in-hospital and at 30 days follow-up. In this pilot study, a relatively small number of cases were collected, rendering benchmarking hospital performances potentially inaccurate. However, the pilot project did establish the feasibility of a clinical quality registry of CIEDs and demonstrated the utility of continuous monitoring of appropriateness and outcomes for these devices. VCOR plans to roll out this registry module to several more hospitals in 2019.

Management of Early STEMI in Regional Victoria

Background

Since its inception in 2013, VCOR has maintained a strong commitment to promoting comprehensive systems of cardiac care and equitable access to contemporary and timely management of acute coronary syndromes (ACS). It is well-recognised that patients presenting with ACS away from large metropolitan centres face significant additional challenges related to access to treatment. The VCOR Early STEMI Management module has collected data on STEMI patients managed in regional hospitals to assess important aspects of pre-hospital care, initial emergency department management and timeliness to coronary angiography and revascularisation when clinically appropriate.

Registry Module Activity

The Early STEMI Management module enrolled all patients with suspected STEMI presenting to the emergency department or as current in-patients at the index rural or regional hospital, irrespective of their chosen reperfusion strategy. As with all VCOR modules, a standard set of essential and epidemiologically sound variables was collected. Data elements included details on reperfusion therapy, in-hospital clinical events, and clinical outcomes.

The registry module completed operational activity in September 2018. Over the 5-year duration of the module, it expanded from the initial four sites in the Hume and Gippsland regions to include 10 regional health centres providing care to STEMI patients (Table 25). The module ultimately reported on more than 700 patients, providing a comprehensive assessment of processes and outcomes for patients in regional Victoria experiencing STEMI (Table 26).

STEMI care in regional Victoria is evolving due to significant increases in rates of pre-hospital thrombolysis administration. VCOR remains actively committed to monitoring and reporting outcomes in regional Victoria through its regular data linkage arrangement with the VCOR PCI module and Ambulance Victoria databases.

Table 25: Participating regional Victorian hospitals in Early STEMI Management module

Victorian Regional Hospital	Hospital type	2013	2014	2015	2016	2017	2018
Albury Wodonga Health (Albury Campus)	Public				●	●	●
Albury Wodonga Health (Wodonga Campus)	Public				●	●	●
Bairnsdale Regional Health Service	Public		●	●			
Bendigo Health	Public				●	●	●
Central Gippsland Health Service (Sale)	Public		●	●	●	●	●
Goulburn Valley Health (Shepparton)	Public	●	●	●	●	●	●
Latrobe Regional Health (Traralgon)	Public	●	●	●	●	●	●
Mildura Base Hospital	Public				●	●	●
Northeast Health (Wangaratta)	Public		●	●	○	●	●
West Gippsland Healthcare Group (Warragul)	Public	●	●	●	●	●	
Wimmera Base Hospital (Horsham)	Public				●	●	●

Table Legend: ● = contributing data; ○ = engaged but not yet contributing.

Patient Characteristics

From January 1, 2018 to September 2, 2018, a total of 141 patients presented with suspected STEMI to 9 participating regional hospitals. Of the 141 patients, 35 (25%) were ineligible for thrombolysis because of late presentation (n=11), significant comorbidities (n=5), uncertain diagnosis (n=3) or a contra-indication to thrombolysis (n=12). Twenty-one (15%) patients were transferred to a PCI capable hospital for primary PCI. The remaining 84 patients received appropriate thrombolytic therapy – divided into in-hospital thrombolysis (89%) or pre-hospital thrombolysis (11%). Only 1 patient was eligible for thrombolysis but did not receive it.

The average age for the 2018 regional STEMI cohort was 67 years and 47% were female. Eighty-one (57%) patients presented via ambulance and 49 (35%) self-presented to the regional emergency department. The remaining 11 (8%) were either inter-hospital transfers or inpatients at the time of their STEMI. Table 26 shows selected characteristics of the patients. The distance travelled by most patients was within 50km from the treating hospital (86%), although 14% of patients travelled more than 50kms for treatment.

Table 26: Trends in regional STEMI patient characteristics: 2014-2018

Patient Characteristics	2014 (N=64)	2015 (N=138)	2016 (N=148)	2017 (N=287)	2018 (N=141)
Age – years (Mean ±SD)	66 ±14	66 ±12	66 ±14	67 ±15	67 ±15
Presenting heart rate- BPM (Mean ±SD)	79.4 ±21.3	79.1 ±24.8	81.5 ±22.4	83±25.0	83±22.0
	%	%	%	%	%
Gender – female	31.3	34.1	33.1	35.9	47.0
Pre-hospital thrombolysis*	9.1	10.1	6.1	6.6	6.0
Site of infarction- anterior	34.4	40.6	33.8	40.0	41.0
Site of infarction- inferior	48.4	51.4	48.5	46.0	47.0
Site of infarction posterior	6.3	2.2	6.8	3.0	5.0
Site of infarction – other	10.9	5.1	10.9	11.0	8.0

**Ambulance presentations only.*

Time Delays to Transfer

Despite significant local and national efforts to raise awareness of the importance of timely presentation in STEMIs, the time from symptom onset to ambulance call has been persistently >70minutes over the last 4 years. Time intervals related to ambulance calls and pre-hospital times are noted in Table 27.

Table 27: Time intervals related to ambulance call, arrival and transfer: 2014-2018

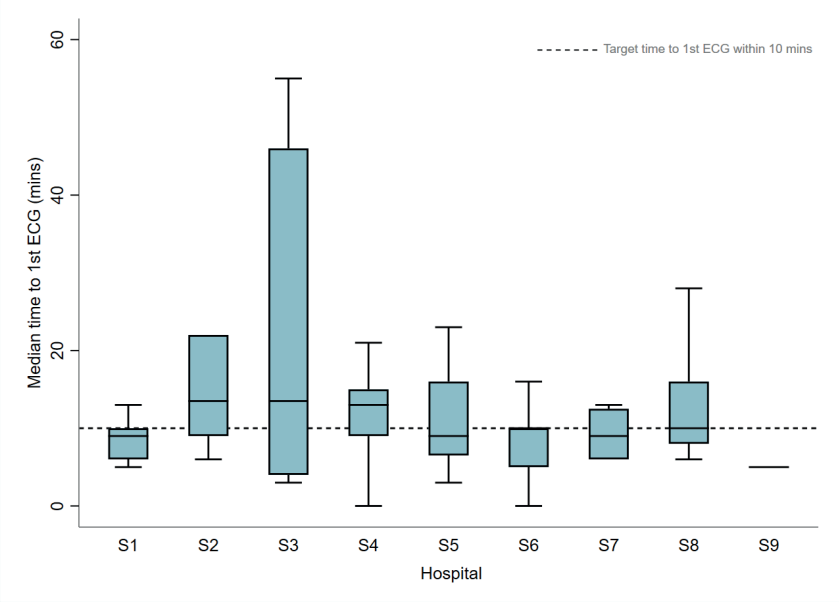
Ambulance Times	2014 (N=44)	2015 (N=99)	2016 (N=83)	2017 (N=148)	2018 (N=75)
	Mins (IQR)	Mins (IQR)	Mins (IQR)	Mins (IQR)	Mins (IQR)
Time from symptom onset to ambulance call	42 (13,130)	74 (23, 240)	90 (21, 263)	81 (27, 301)	72 (20, 176)
Time from call receipt to ambulance arrival	15 (10,20)	21 (12, 30)	14 (10, 24)	16 (11, 30)	14 (10, 24)
Time from ambulance arrival to hospital arrival	47 (37,64)	55 (39, 77)	50 (36, 71)	54 (38, 75)	46 (34, 69)

In-Hospital Process Times

System delays to reperfusion are correlated with higher rates of morbidity and mortality (28). Timely delivery of reperfusion therapy is a key performance outcome in the VCOR Early STEMI Management module and is evaluated with a number of specific process measures. These include the time from hospital arrival to first ECG and the time taken from hospital presentation to administration of thrombolytic drug, known as the door-to-needle time.

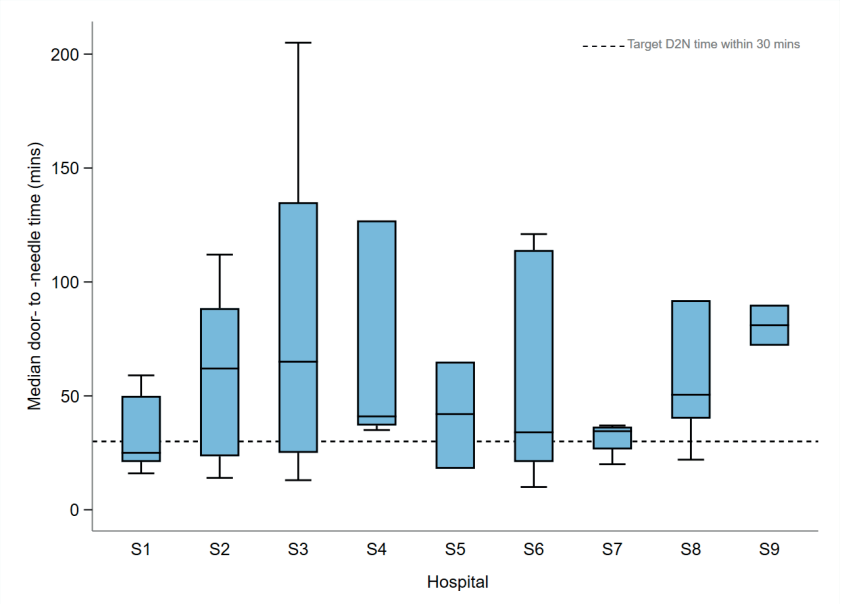
In the 2018 cohort, the median arrival-to-ECG time was at the recommended benchmark of ≤10 minutes across all sites (Figure 53).

Figure 53: Time from arrival to first ECG time by hospital (regional STEMI patients)



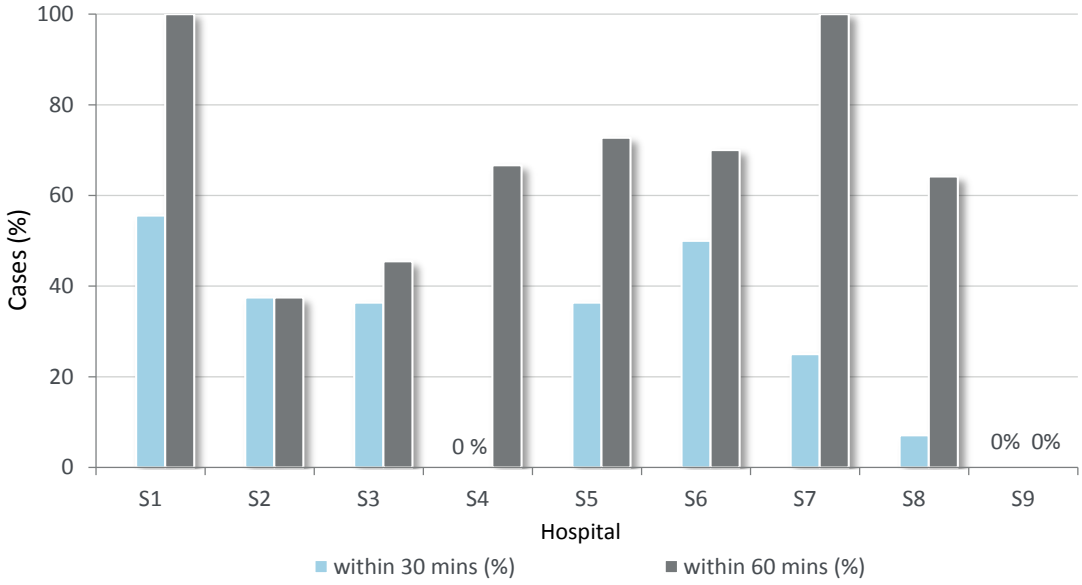
The ideal target door-to-needle time, recommended by Australian National Heart Foundation/Cardiac Society of Australia and New Zealand, in line with international guidelines, is ≤30 minutes (24). This is a challenging target, with many regions in Australia, Europe, Canada and America often reporting median door-to needle-times of 40-60 minutes (29-31). The median door-to-needle time for VCOR regional STEMI sites in 2018 was 44 minutes (IQR: 25-75). This ideal median target of ≤30 minutes was achieved by only one site in 2018 (Figure 54).

Figure 54: Door-to-needle times for regional STEMI patients by hospital



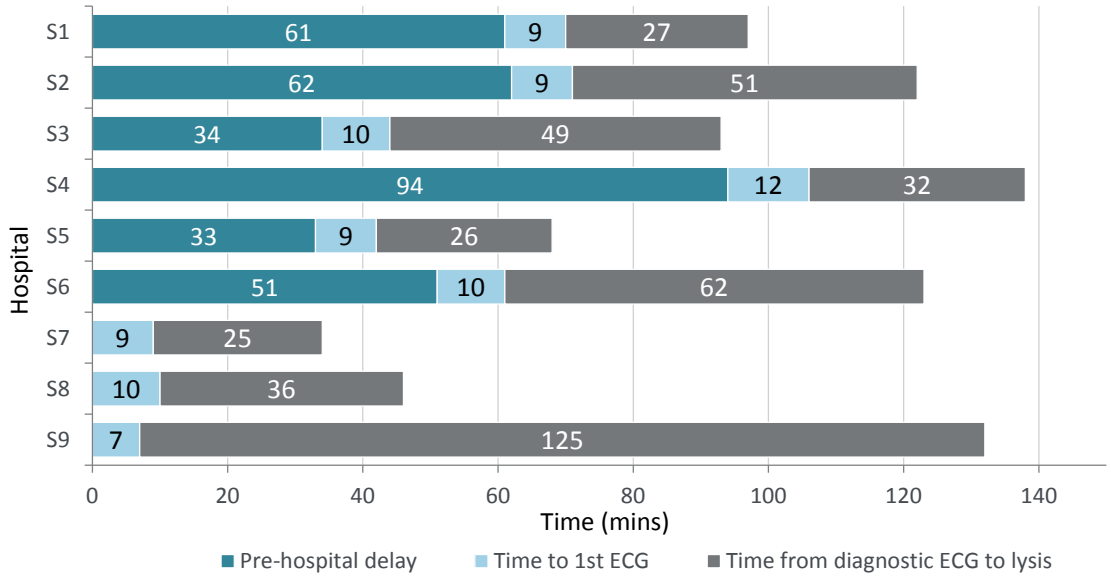
When hospital performance was analysed by compliance rates for door-to-needle times ≤30 min, 31% cases were managed within this benchmark rate. The proportion of compliant cases rose to 65% when a door-to-needle time delay of ≤60 minutes was applied (Figure 55).

Figure 55: Proportion of cases achieving door-to-needle times within 30 and 60 minutes



A comparison of the system delay (comprising pre-hospital delay plus door-to-needle time) for the participating hospitals is shown in Figure 56. The median system delay for the entire cohort was 70 minutes, substantially longer than the median door-to-needle time of 44 minutes. This measure is arguably a better performance metric than the door-to-needle time, as it emphasises the urgency of commencing treatment the moment the patient comes into contact with the medical system. International guidelines are now recommending ideal time delays from first medical contact to thrombolysis of <30 mins (32), underscoring the importance of continued development of pre-hospital thrombolysis programs to further reduce time delays from first medical contact to reperfusion.

Figure 56: System delay times by hospital

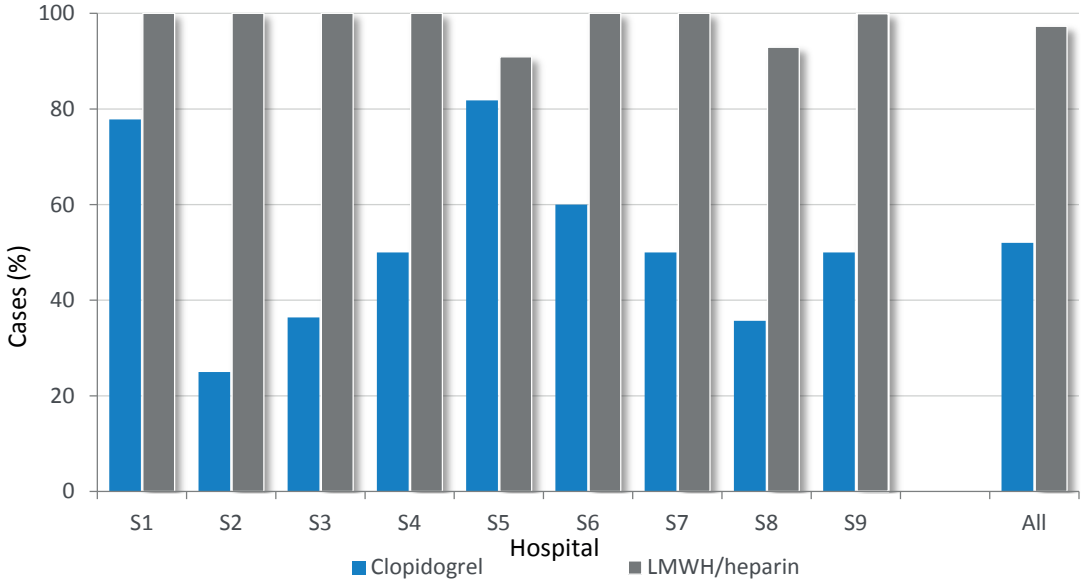


Adjunctive Therapies

National and international guidelines provide strong recommendations for adjunctive antithrombotic (unfractionated heparin or low molecular weight heparin) and antiplatelet agents in patients with STEMI following thrombolysis (17, 32). Traditionally, the second antiplatelet agent following thrombolysis has been clopidogrel.

Figure 57 shows very high rates of antithrombotic therapy (97%). In contrast, clopidogrel rates were a lot lower (52%), although this may be an underestimate of overall anti-platelet use. Administration of newer anti-platelets such as ticagrelor was not captured in VCOR but may have been prescribed as an alternative to clopidogrel, in line with recent evidence that utilisation of the newer antiplatelet agents in the setting of thrombolysis is safe (33).

Figure 57: Rates of antithrombotics and clopidogrel use by hospital



In-Hospital Outcomes and Transfer Rates

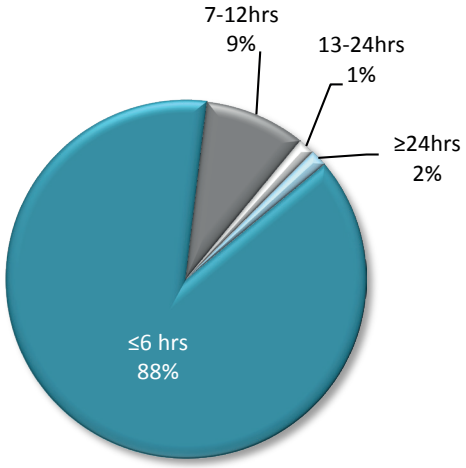
The rates of major adverse cardiac events among the Early STEMI Management module 2018 cohort are shown in Table 28. The mean unadjusted in-hospital mortality rate for the nine participating hospitals was 8%, comparable to international registries (34, 35). This rate has remained stable over the past 5 years. Patients with cardiogenic shock accounted for most of the deaths and other major adverse outcomes. Complications of thrombolytic therapy remained rare in 2018, with no cases of major bleeding or acute stroke among treated patients during their stay at the index hospital.

Table 28: In-hospital major adverse cardiac and cerebrovascular event rates: 2014-2018

In-hospital Outcomes	2014 (N=64)	2015 (N=138)	2016 (N=148)	2017 (N=287)	2018 (N=141)
	%	%	%	%	%
Total Mortality	7.8	3.6	6.1	5.9	8.0
Cardiogenic shock	12.5	13.8	8.8	11.1	12.0
Myocardial re-infarction	12.5	4.3	2.7	2.8	4.0
Major bleeding	0.0	0.0	2.0	0.3	0.0
Stroke	0.0	0.0	0.0	0.0	0.0

National guidelines recommend early transfer of STEMI patients treated with thrombolysis to a PCI-capable hospital. In 2018, nearly all (98%) of thrombolysis-treated patients were transferred within 24 hours. The median time from referral request to the actual transfer from regional STEMI sites to metropolitan PCI hospitals was relatively short at 2 hours (IQR: 1-3) (Figure 58)- exemplifying how well the system of STEMI care in Victoria can operate.

Figure 58: Patient transfer times from regional centre to metropolitan hospital



Conclusion

In this final report of the VCOR Early STEMI Management module, the outcomes of the 2018 cohort presented a mixed picture. There were some positive results with a number of process measures and clinical outcomes, while others did not reach satisfactory threshold levels (particularly, door-to-needle times). This has, in fact, been the pattern throughout the 5-year duration of this registry module. Looking back, participation in a clinical quality registry like VCOR did focus the attention of regional centres on quality assurance issues and the need for continuous quality improvement. However, the 5-year experience with the Early STEMI Management module also demonstrated that feedback of results – both good and bad – was not necessarily enough to bring about positive change. More is needed to actually improve practice, including sites' active engagement in their own quality assurance programs, the need for innovative projects to deal with areas of poorer performance and ongoing and meaningful support from clinical networks, governments, funders and other key stakeholders.

Future Directions

In line with an increasing emphasis on comprehensive processes ensuring patient safety and patient-centred care, both state and federal jurisdictions are signalling stronger commitment to clinical quality registries. It is in this context that VCOR anticipates further growth in its quality assurance activities and consolidation of its central role as an integral component of day-to-day high-quality cardiovascular care in the coming years.

VCOR has encountered some challenges in implementing a major upgrade to its database infrastructure over the previous year. However, it is envisaged that a comprehensive revision of its data elements and software design will be completed in the coming year. In the meantime, the registry will proceed with its regular functions including robust auditing activities, support for sites in their data collection activities and identification of key clinical issues that may benefit from further analysis and special reporting.

In 2019, VCOR will transition the CIED module out of its pilot phase and into regular module activity, with ongoing recruitment of new sites – both in the public and private sectors. The dataset will be refined and centred around the experience of the pilot phase and reports will be tailored to suit the needs of participating sites, based on their feedback and suggestions.

As foreshadowed in last year's report, the registry recently completed a special quality assurance survey of the use of bioresorbable scaffolds in VCOR. The survey was prompted by the voluntary withdrawal of the Abbott Vascular bioresorbable vascular scaffold in early 2017 because of patient safety concerns. There were over 200 cases of bioresorbable scaffold use in the registry and long-term follow-up and safety data have been collected. The report is planned for publication in mid-2019.

An exciting expansion of VCOR is being considered for 2019, following an approach by clinicians in Tasmania wishing to join the registry and take part in its quality assurance activities. VCOR is exploring the feasibility of including hospitals from interstate into the overall registry and supplying state-specific reports for benchmarking and performance assessment.

In mid-2018, VCOR became a key stakeholder in the design and setup of the National Cardiac Registry – a clinical quality registry, based on a federated model that aims to collect data and report on cardiac procedures and eventually diseases at a national level. The National Cardiac Registry is an initiative of the federal government and the Australian Department of Health and VCOR plans to be actively involved in this project in coming years.

VCOR welcomes further collaborations with researchers, following a successful year in a number of research areas including quality-of-life measures, patient reported outcomes and experiences and health economics. New areas of research and new research partners will be sought and engaged.

In the end though, VCOR's core purpose is to ensure that cardiac patients receive appropriate high-quality and safe care - irrespective of their location, insurance status or healthcare provider. The registry looks forward to another active year ahead, working with clinicians, hospitals, funders and other stakeholders to guarantee the best health outcomes for all Victorians.

Glossary

ACC/AHA	American College of Cardiology and the American Heart Association
ACEI	Angiotensin-Converting-Enzyme Inhibitors
ACS	Acute Coronary Syndrome
AF	Atrial Fibrillation
ARB	Angiotensin Receptor Blockers
BARC	British Academic Research Consortium
BB	Beta-adrenergic Blockers
BiPAP	Bi-level Positive Airway Pressure
BPM	Beats Per Minute
BVS	Bio-resorbable Vascular Scaffold
CABG	Coronary Artery Bypass Graft
CBVD	Cerebrovascular disease
CIED	Cardiac Implantable Electronic Devices
COPD	Chronic Obstructive Pulmonary Disease
CPAP	Continuous Positive Airway Pressure
CRT	Cardiac Resynchronisation Therapy
CTO	Chronic Total Occlusion
DAPT	Dual Antiplatelet Therapy
DEPM	Department of Epidemiology & Preventive Medicine
DES	Drug Eluting Stent
DHHS	Department of Health & Human Services
DBT	Door-to-balloon time
ECG	Electrocardiograph
ECMO	Extracorporeal Membrane Oxygenation
HF	Heart Failure
FFR	Fractional Flow Reserve
IABP	Inter Aortic Balloon Pump
ICD	Implantable Cardiac Defibrillator
IQR	Inter Quartile Range
IVUS	Intravascular Ultrasound
KPI	Key Performance Indicator
LTF	Lost to follow-up
LVEF	Left Ventricular Ejection Fraction
MACCE	Major Adverse Cardiac and Cerebrovascular Event
MI	Myocardial Infarction
NDI	National Death Index
NHF	National Heart Foundation
NHMRC	National Health & Medical Research Council
NRI	New Renal Impairment
NSTE-ACS	Non-ST Elevation Acute Coronary Syndrome
NSTEMI	Non-ST Elevation Myocardial Infarction
NYHA	New York Heart Association
OCT	Optical Coherence Tomography
OHCA	Out of Hospital Cardiac Arrest
PCI	Percutaneous Coronary Intervention
PHN	Pre-hospital notification
POBA	Plain Old Balloon Angioplasty
PVD	Peripheral Vascular Disease
SCV	Safer Care Victoria
SD	Standard Deviation
SDD	Same day discharge
STEMI	ST-Elevation Myocardial Infarction
TVR	Target Vessel Revascularisation
UAP	Unstable Angina Pectoris
VAED	Victorian Admitted Episodes dataset
VAHI	Victorian Agency for Health Information
VCOR	Victorian Cardiac Outcomes Registry

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Table 29: VCOR Funding 2011 – 2018

Funding Body	2011	2012	2013	2014	2015	2016	2017	2018
	$	$	$	$	$	$	$	$
Medibank Private	$100,000	$400,000	$400,000	$300,000	-	-	-	-
Department of Health & Human Services	$200,000	$200,000	$205,000	$509,466	$460,202	$834,815	$616,900	$350,469
Sub total	$300,000	$600,000	$605,000	$809,466	$460,202	$834,815	$616,900	$350,469
Total								$4,576,852

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