

A stylized ECG (heart rate) line in a light blue color runs across the top and bottom of the page. The line features several peaks and troughs, with the most prominent peaks occurring on the right side of the page. The background is a solid, light blue color.

ANNUAL PUBLIC REPORT 2020

VICTORIAN CARDIAC OUTCOMES REGISTRY

Improving cardiovascular outcomes Victoria-wide

This publication was produced on behalf of the Victorian Cardiac Outcomes Registry (VCOR).

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VCOR 2020 Annual Report



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VCOR would not be possible without the efforts of doctors, nurses, data managers and other relevant hospital staff who manage VCOR data related activities.

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

Foreword

It gives me great pleasure to present the foreword for the Victorian Cardiac Outcomes Registry (VCOR) 2020 Annual Report.

What a year 2020 transpired to be.

We first heard the word ‘unprecedented’ used in early 2020 to describe the bushfires that swept across many parts of rural and regional Victoria causing mass destruction and devastation. As the state rallied to support the bushfire recovery efforts, we did not realise what was to come- the global Coronavirus (COVID-19) pandemic. COVID-19 has since changed every aspect of our lives. It has challenged the way we deliver care and has tested the agility and responsiveness of our healthcare workforce like never before. Throughout the course of 2020, sadly 820 Victorians lost their lives to COVID-19, public health measures kept us all apart and the pandemic has taken an immeasurable toll on so many elements of society.

In responding to the events of 2020, the Victorian healthcare system worked in ‘unprecedented’ ways. We saw novel ways of working, adoption of new technologies and partnerships formed between health services and across public-private sector divides. We were tested by not only responding to the new challenges, but also to continue to provide high-quality, safe routine care to those in need across our state. This included the need to continue providing world-class cardiovascular care, in the face of the challenges posed by COVID-19.

The past year has highlighted, more than ever, the importance of pursuing data driven healthcare interventions and the use of robust data to inform continuous quality improvement. Since its establishment in 2011, VCOR has provided a central repository of high-quality data aimed at improving health outcomes for patients with cardiovascular disease. It provides the tools to benchmark our performance locally and globally. It also identifies key areas of variation, allowing healthcare providers and governments to evaluate the quality of cardiovascular care being provided in Victoria. We cannot understand the true impact of COVID-19 on the outcomes of cardiovascular care delivered during 2020 without careful consideration of the clinical, patient experience and outcome data outlined in the VCOR report.

The 2020 Annual report highlights the impacts of the COVID-19 pandemic on key indicators such as increases in hospital presentation time for STEMI patients and in door to balloon time. At a time where COVID-19 remains a threat to our system, these data are vital in informing future models of cardiovascular care to guide continuous improvement for the benefit of all Victorians. The Victorian Department of Health is proud to partner with and support VCOR in achieving safer, more effective, person-centred care for all cardiac patients across the state.

I thank VCOR for its ongoing commitment as the lead quality clinical registry and congratulate the whole team on this insightful and important report.

Prof Andrew Wilson

Chief Medical Officer
Safer Care Victoria



Executive Summary

With the COVID-19 pandemic reaching its peak for rates of infection, hospital admissions and deaths in 2020, health providers' and the general community's focus on health-related consequences has never been more front-of-mind. The current health crisis has sheeted home the importance of measuring health outcomes so that we can know and understand what is happening to us. It has also highlighted the critical role for strategies to improve the health-related safety of our environments and limit the health risks that we encounter. We were fortunate in Victoria that when faced with up to 700 new COVID-19 infections per day, our political, health bureaucrat and medical leaders were successful in introducing processes and measures that effectively controlled further spread of the virus and its feared sequelae. However, this came at considerable cost- on many levels- and introduced us all to yet another fundamental concept in public health of trying to strike the right balance between the costs and benefits of health interventions. One of the long-term aims of the Victorian Cardiac Outcomes Registry (VCOR) has always been to promote and support the embedding of quality assurance activities into day-to-day medical practice. Perhaps one of the unanticipated benefits of the COVID-19 pandemic will be increased acceptance at funder and health provider levels of the need for routine performance benchmarking and measurement of outcomes.

The VCOR Annual Report has been designed to reflect our commitment to the guiding principles of clinical quality registries - the assessment of key process and outcome measures, benchmarking performance and the identification of variation in clinical practice. In this year's report, we once again present comprehensive data and analysis on a wide array of quality-related issues pertaining

to the practice of percutaneous coronary intervention (PCI) in Victoria. We are proud to have all public and private hospitals in the state that perform PCI participating in the registry. This year we have added a special section on the perceived effects of the COVID-19 pandemic and the associated aggressive containment strategies implemented by the state government on PCI numbers, case mix and key outcome measures. We have also expanded our analysis of key issues and outcomes regarding women undergoing PCI. There are a number of local and international studies now that suggest women do not have equal access to PCI services and that their outcomes are often not as good as men's results. There still is uncertainty about this though and we have endeavored to assess whether there is any sex bias in PCI practice in Victoria.

VCOR also conducts a second registry module on cardiac implantable electronic devices (CIEDs) - a device-based therapy primarily used in patients with weakened heart conditions (cardiomyopathy) to treat heart failure and life-threatening arrhythmias. The module commenced data collection in 2018 and has gradually been rolled out to 13 hospitals across Victoria so far. Further expansion with participation of additional hospitals has been difficult to achieve due to a number of factors including sites' capacity constraints with data collection and funding limitations at the registry level. However, for the hospitals that are currently engaged, and the cardiology community more broadly, this report provides worthwhile information on CIED quality-related issues, including appropriateness and procedural outcomes.

Key findings in this report relating to PCI and CIED implantation in Victoria in 2020 are presented on the following pages.

Key Findings

PCI Registry

- In 2020, all 32 Victorian PCI hospitals contributed to the registry, representing 14 public and 18 private hospitals. A total of 12,349 procedures were performed on 10,895 patients. 59% of cases were managed in the public system.
- The majority of patients undergoing PCI were male (76%). The mean age was 67 years. Patients treated in private hospitals were six years older on average than public patients.
- Mean age was similar among patients with low and high socio-economic status (SES), but higher rates of severe obesity, ACS presentation and the proportions treated in the public sector were observed in the low SES group. Patients residing in non-metropolitan centres were older and more likely to have severe obesity, be treated for an acute coronary syndrome (ACS) and undergo PCI in the public sector compared to metropolitan patients.
- A total of 19% 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 91% of those were in the public sector.
- Just over half the PCI cases in 2020 presented with ACS, reversing a trend over the previous 2 years when non-ACS cases were in the majority. ACS cases accounted for two-thirds of the public sector's caseload and one-third of the private sector's.
- For non-ACS PCI cases, the indication for the procedure was defined by 3 key clinical factors - the presence of ischaemic symptoms, functional ischaemia on stress testing and the presence of high-grade coronary stenosis. The vast majority of cases (90%) had at least 2 of these key clinical factors. The proportion of cases with no or just 1 key clinical factor has been trending downwards over time (19% in 2017, 13% in 2018, 11% in 2019 and 10% in 2020).
- Particular lesion subsets including unprotected left main cases (2.3%), chronic total occlusions (3.9%) and in-stent restenosis (4.7%) were performed in similar numbers to previous years.
- The number of patients presenting with cardiogenic shock or intubated out-of-hospital cardiac arrest was lower than in previous years. High-volume public hospitals generally treated these high-acuity cases. Private hospitals managed only small numbers of shock and cardiac arrest cases.
- Almost all stents (99.8%) implanted in 2020 were drug-eluting stents. The gap between public and private hospital DES usage has disappeared.
- Use of the radial artery for arterial access has increased to 75% of cases. Rates varied among hospitals and were higher in public hospitals (79% public vs 69% private), although the gap between the two sectors is closing. Lower rates were seen in the elderly (63% >80 years vs 77% ≤80 years).
- In 2020, 21% of patients underwent PCI for STEMI, of whom 75% had primary PCI. Other categories of PCI for STEMI including rescue PCI (4.7%) and pharmaco-invasive PCI (6%). Patients with STEMI were younger, had fewer cardiac risk factors such as diabetes and peripheral vascular disease, and had lower rates of previous revascularisation procedures.
- Primary PCI accounted for 13% of the total PCI caseload. The majority were treated in the public sector (89%). Radial access was used in 79% of cases. The median time taken from patient arrival at the hospital to the first inflation of the balloon (door-to-balloon time) was 62 minutes. This represents an increase compared to the previous two reporting periods and was likely influenced by the impact of the COVID-19 pandemic on medical service delivery in the acute hospital setting. Less than 50% of hospitals achieved a DBT ≤90 minutes in greater than 75% of primary PCI cases, representing a decline compared to the previous year.
- The in-hospital mortality rate was 1.5% for the overall cohort. The rate was higher among patients presenting with STEMI (5.4%), and highest for patients with cardiogenic shock or intubated out-of-hospital cardiac arrest (36%). Excluding these two high-risk groups, the unadjusted in-hospital mortality rate for the rest of the cohort was 0.4%.

Key Findings continued

PCI Registry

- The signature key performance indicator of risk-adjusted 30-day mortality for the overall PCI cohort in 2020 was 2.2%. There were no outlier hospitals.
- The median in-hospital major bleeding rate was 0.6% - lower among radial access cases (0.3% radial vs 1.4% femoral) and 1% in PCI for STEMI. There was one outlier hospital with a higher than expected major bleeding rate.
- The mean 30-day unplanned cardiac rehospitalisation rate was 3.5%, with similar rates in the public and private sectors. Rates of other major adverse cardiac outcomes were lower and similar to previous years.

CIED Registry

- Thirteen health services across the state (9 public and 4 private hospitals) participated in the 2020 CIED module, with a total of 649 procedures performed on 633 patients.
- The majority of patients were males (75%), and the mean age was 67 years. Overall, 55% were patients undergoing their first device implant and 40% of cases were generator replacements. Other procedure categories included insertion of a new lead (2%), removal of device without replacement (3%) and revision procedures (1%).
- ICD devices (ICD, CRT-D or S-ICD) accounted for 82% of first implants and 77% of generator replacements.
- 38% of patients undergoing any ICD (ICD, CRT-D or S-ICD) had an underlying ischaemic cardiomyopathy. Almost half (48%) of ICDs were implanted for primary prevention.
- For CRT-P devices, an ischaemic aetiology was reported in 19% of cases and 55% had an idiopathic cardiomyopathy.
- For patients receiving a CRT-D device, 89% had a QRS width ≥ 120 msec, 93% had NYHA Class $\geq$ II symptoms and 73% had severe left ventricular dysfunction. For CRT-P devices, 77% had a QRS width ≥ 120 msec, 92% had NYHA Class $\geq$ II symptoms and there was more variability in the degree of left ventricular impairment.
- For ICD cases, 95% had a strong or medium indication for a defibrillator. In contrast, the strength of indication for CRT functionality was not as uniform, with 24% of CRT-D and CRT-P cases having a weak indication for CRT.
- In 2020, there were 2 in-hospital cardiac mortalities. The unadjusted 30-day mortality rate was 0.5% with 3 deaths recorded within 30 days of hospital discharge. The overall 30-day unplanned cardiac readmission rate was 2.9% and device related re-operation rate was 1.1%. The rate of 30-day device related infection was 0.8%. All hospitals were within control limits for each of these key performance endpoints.

Key Findings continued

In addition to our primary focus on quality of care, hospital performance and patient outcomes, VCOR has maintained strong links with researchers both within and outside our organisation. In 2020, we saw the largest number of publications and abstract presentations in any year to date since the start of the registry and we look forward to building on and expanding this solid research base in coming years.

Finally, this report has only been possible as a result of the dedication, professionalism and devotion of the registry management team and I would like to thank them for all their hard work. I would also like to acknowledge the support, commitment and collegiality of all the site leads from the PCI and CIED modules, the effort and diligence of the data collectors at each participating site and the patronage of the hospital executives and quality assurance personnel. Finally, VCOR would like to express its gratitude to the Victorian Government for its vision and staunch support for high-quality and safe cardiovascular health care being delivered equitably to all Victorians.

On behalf of the VCOR organisation, I hope you find this year's report interesting and informative.

Yours sincerely,



A/Prof Jeffrey Lefkovits
VCOR Clinical Director

Introduction

This eighth annual report from the Victorian Cardiac Outcomes Registry (VCOR) once again highlights the registry's activities, designed to monitor the quality and safety of cardiovascular care in Victoria. VCOR is now embedded in all hospitals in the state that perform PCI, facilitating the routine collection of patient-level, health-related information. These data are analysed, used for benchmarking and performance assessment and reported to clinicians, hospitals, government and the general public. Our quality assurance activities help identify variation in clinical practice and drive continuous quality improvement among the state's providers of cardiovascular care.

The collection of PCI information is VCOR's primary module, which extended to 32 hospitals in 2020. Due to the COVID pandemic there was a delay in opening a new PCI service in Gippsland in regional Victoria and that is now scheduled for 2021. VCOR's other current module focuses on the utilisation of cardiac implantable electronic devices (CIEDs). This module was launched in 2018, with the number of contributing hospitals gradually increasing since then. However, there are still several CIED implanting services in Victoria that have not yet committed to this quality assurance activity.

VCOR is also engaged with the recently established National Cardiac Registry (NCR)- an Australian federal government-funded clinical quality registry relating to cardiovascular care. NCR commenced their planning and initiation phase in 2018 and will provide its first full year of data collection in 2021. VCOR has committed to contributing PCI data to the NCR, undertaking all relevant governance requirements and updating its own PCI data collection module to ensure data definition harmonisation and compliance. The NCR is modelled on a federated system, with each state and territory responsible for their own data collection and submission. VCOR collaborates with the NCR to assist in all aspects of its implementation and will provide ongoing support as the newly formed registry moves into its primary operational phase of data collection, analysis and reporting.

Additionally, VCOR has a close and collaborative data sharing agreement with Ambulance Victoria. This ensures a comprehensive analysis of a patient's treatment pathway for time-critical STEMI therapy is captured for all Victorians. As well as the sharing of data between the two organisations, there have been a number of combined VCOR and Ambulance Victoria research initiatives in 2020 aimed at minimising treatment delays. These include exploring the role of opioids in STEMI, safety of pre-hospital heparin, and gender differences in STEMI care.

Registry Governance and Structure

VCOR's governance structure and processes have been previously outlined in detail [1, 2]. VCOR conforms to the Australian Health Ministers' Advisory Councils Framework for Australian Clinical Quality Registries [3] including all relevant standards related to security and protection of data. VCOR also abides by the National Operating Principles for Clinical Quality Registries as set out by the Australian Commission on Safety and Quality in Health Care [4].

Steering Committee

The Steering Committee (SC) membership comprises representatives from participating hospitals, the clinical leads of the various modules, a representative from Safer Care Victoria, a consumer representative and representatives from the Department of Epidemiology & Preventive Medicine at Monash University. In 2020, the SC ratified an updated study protocol that encompassed several changes. These included an update to the 'Clinical Quality Reporting and Communication of Variance Policy', an update to the data linkage activities undertaken and the addition of a section related to the National Cardiac Registry. Meetings continue to be held on a quarterly basis with excellent attendance across 2020.

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. For PCI, the committee undertakes quarterly and biannual review of hospital key performance indicators (KPIs) and other data. Review of results and outcomes pertaining to the CIED module are also undertaken. Regular reports are provided to participating hospitals in both registry modules. The CQC continues to assist hospitals with the management of any outliers including providing feedback and review as requested, including formal meetings with the Principal Investigator. The CQC also oversaw the updating of the Clinical Reporting and Communication of Variance Policy that was subsequently ratified by the SC. Routine meetings continued to be held on a quarterly basis.

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. The DRP reviewed and approved numerous requests for data (n=9), all of which were collaborative projects, many of which are ongoing. The DRP oversaw abstract development and publications that utilised VCOR data. The various reports and research papers are outlined in the Publications and Presentations section of this report. Regular DRP meetings were held on four occasions in 2020 and in June 2020, an extraordinary meeting was held related to COVID-19 potential research activities.

Percutaneous Coronary Intervention (PCI)

Registry Module Activity

This report covers PCI activity in Victoria for the 2020 calendar year from January 1 to December 31. It includes comparative analyses with previous years and presents longer term outcomes utilising linkage with the National Death Index (NDI). In 2020, all 32 hospitals that perform PCI in Victoria contributed data, comprising 14 public and 18 private hospitals (Table 1). Latrobe Regional Hospital postponed the commencement of their PCI service in 2020 and will commence in 2021.

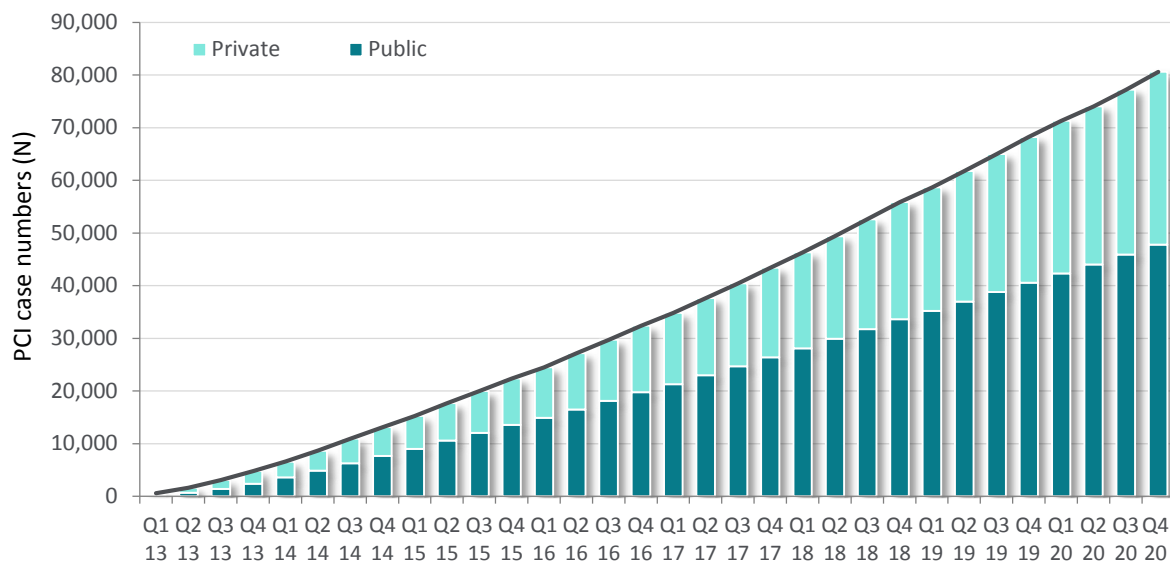
Table 1: Participating Victorian PCI hospitals

Victorian PCI hospitals	Hospital type	2013	2014	2015	2016	2017	2018	2019	2020
Albury Hospital	Public	N/A	N/A	N/A	N/A	N/A	N/A	●	●
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	●	●	●	●	●	●	●	●
Latrobe Regional Hospital	Public	N/A	N/A	N/A	N/A	N/A	N/A	N/A	○
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	●	●	●
The Royal Melbourne Hospital	Public	●	●	●	●	●	●	●	●
Sunshine Hospital	Public	N/A	N/A	●	●	●	●	●	●
The University Hospital, Geelong	Public	●	●	●	●	●	●	●	●
Warringal Private Hospital	Private				○	●	●	●	●
Western Private Hospital	Private	●	●	●	●	●	●	●	●

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

As at December 31 2020, 80,574 PCI cases had been entered into the registry. The cumulative rate of recruitment since commencement by quarter and by hospital sector is shown in Figure 1. The lost-to-follow up rate in 2020 was 0.6%, with the overall rate across the registry since its commencement being 1.2%. The number of requests from patients to opt-off from inclusion in the registry remains low – being 0.12% in 2020, compared to the overall rate of 0.16% since registry commencement. In comparison to other Australian registries that publish opt-off information, the rate of opt-off in VCOR is very low indeed (Breast Device- 1.5%, Bariatric Device- 2.97% and Prostate Cancer- 3%, opt-off rates respectively in published 2019 Annual Reports).

Figure 1: Cumulative case numbers by quarter: 2013-2020



In addition to the registry's primary role as a clinical quality registry for cardiovascular care in the state of Victoria, VCOR now also provides registry services to Tasmania. A collaborative agreement was formalised with the Tasmanian Government in 2019 to collect, analyse and report on cardiovascular procedures performed in that state. Participation in VCOR provides Tasmanian hospitals with valuable data on process and outcome measures and importantly, allows them to benchmark their performance against peer hospitals in a neighbouring state. By the end of 2020, 2 Tasmanian public hospitals were contributing data on their PCI cases and 1 hospital was participating in the CIED module. They had entered 1,446 cases into their PCI module and 97 cases into their CIED module.

Data Quality

VCOR is committed to ensuring the accuracy, completeness and quality of its data and has implemented various quality control processes as outlined below. Ensuring data accuracy is a key operational activity of clinical quality registries [5].

Up until 2019, VCOR routinely undertook two types of audits for the PCI module:

- Ascertainment: this type of audit assessing whether all eligible cases are entered into the registry (except those that have opted off). This type of audit is undertaken annually for each hospital.
- Brief audits: accuracy of data is determined by review of the hospital's source records. Five percent of case records are randomly selected for comparison with the hospital medical records. This type of audit is undertaken at all sites after the first year of VCOR participation and then subsequently every three to five years.

For the CIED module, only ascertainment audits are undertaken.

Due to the COVID-19 pandemic VCOR was unable to attend hospitals to perform any audits. In terms of case ascertainment to ensure that 2020 case numbers were accurate, VCOR implemented a program whereby hospitals self-audited. To achieve this, all PCI and CIED hospitals' monthly total of case numbers that were entered into the registry were supplied and hospitals were requested to review internal systems and confirm against source documents. The results were consistent with VCOR conducted audits, with very low numbers of missing cases:

- The rate of missing PCI cases for 2020 was 0.3%.
- The rate of missing CIED cases for 2020 was 0.15%

To ensure data accuracy in 2020, VCOR continued monitoring and assessing the data through other quality control measures including implementing several new processes. We believe that data quality has been maintained with this adaptive type of auditing.

These include:

- Validation rules and mandatory fields in the VCOR online system that reduce inaccuracies in data collection
- Detailed data definitions supplied to all sites and available online to aid data collection
- Comprehensive training provided to all new data managers prior to commencement of data collection
- Regular emails, newsletters and bulletins to all system users for reminders, updates and clarification of new or existing data elements.
- Detailed PCI quarterly reports - Data are reviewed by the VCOR team between 30 and 45 days after the end of the quarterly period (to allow time to submit follow-up data, where relevant).
- Regular alerts to sites regarding data deadlines and data completeness assessments - VCOR runs internal data reports to provide continuous feedback to sites to circumvent any data collection issues that may occur.
- Data queries are sent to all sites for clarification and amendment of data

Patient Characteristics

In 2020, 12,349 PCI procedures were performed on 10,895 patients. Twelve percent (n=1,454) of patients underwent multiple procedures. A total of 7,240 cases (58.6%) were performed in public hospitals. Overall, 75.5% of cases were performed on male patients. The median age for males was 66 years (IQR: 58, 74) and for females was 72 years (IQR: 63, 79). Males were one year younger on average and females one year older than in previous years. The peak frequency of PCI procedures occurred in the seventh decade for males and the eighth decade for females (Figure 2).

Figure 2: Age and sex distribution of patients undergoing PCI

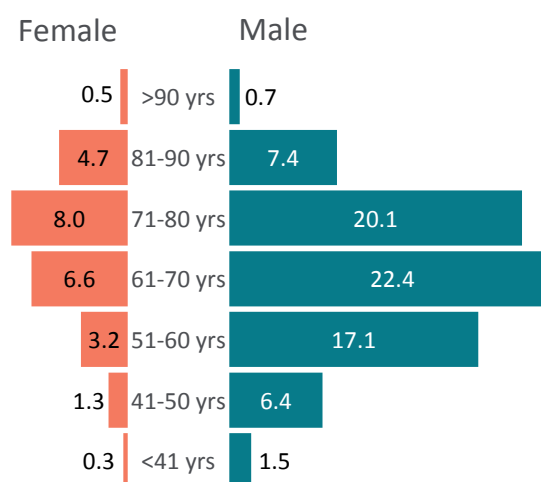


Table 2 compares selected patient demographic information for the period from 2015 to 2020. There were only minor variations in the prevalence of the various characteristics over the 6 year period, although the number of patients with previous coronary artery bypass grafting (CABG) has declined in recent years.

Table 2: Comparison of selected patient characteristics: 2015-2020

Patient characteristics	2015 (N=9229)	2016 (N=10035)	2017 (N=11007)	2018 (N=12463)	2019 (N=12355)	2020 (N=12349)
Age- years (Mean ±SD)	65.6 (±12.0)	66.0 (±12.0)	66.5 (±11.9)	66.7 (±11.7)	67.2 (±11.7)	66.9 (±11.9)
	%	%	%	%	%	%
Sex - female	22.8	23.5	24.4	23.7	24.5	24.5
Diabetes	23.0	21.6	21.7	22.6	23.2	23.8
PVD history	3.6	3.4	3.4	3.4	3.6	3.4
CBVD history	4.0	3.3	3.9	3.4	3.8	3.5
Previous PCI	32.9	32.7	32.8	33.4	33.1	33.6
Previous CABG	7.6	7.6	7.3	7.2	6.8	5.9

The overall rate of severe obesity (BMI $\geq 35\text{kg/m}^2$) was 11.7%, with 10.5% of males and 15.3% of females falling into this group. The prevalence of severe obesity was similar to 2019, but did vary by hospital sector, with the public sector having a greater proportion of patients with severe obesity (Table 3). Furthermore, the gap between public and private hospital-treated patients with severe obesity has increased compared with the previous year (3.4% difference in 2020 vs 2.3% difference in 2019). We also observed that the subgroup of very elderly females (≥ 80 years) had a rate of severe obesity (9.5%), almost double its rate in 2018 (5%). This observed increase in rate is potentially concerning given that severe obesity is associated with poorer outcomes [6].

A comparison of selected patient characteristics by hospital sector is shown in Table 3. Private sector patients were, on average, 6 years older than public hospital patients, although the average age of patients within each sector was largely unchanged from previous years. The prevalence of diabetes was lower among private patients, but that group had higher proportions of patients with a previous history of coronary revascularisation (PCI or CABG). But of note, the proportion of patients with prior cerebrovascular disease had increased in the private sector (3.2% in 2020 vs 2.5% in 2019) and decreased in the public sector (3.8% in 2020 vs 4.8% in 2019).

Table 3: Selected patient characteristics by hospital sector

Patient characteristics	Public (n=7240)	Private (n=5109)
Age- years (Mean $\pm$ SD)	64.3 ($\pm$ 12.0)	70.6 ($\pm$ 12.0)
	%	%
Sex - female	24.3	24.7
Diabetes	25.7	20.9
PVD history	3.2	3.5
CBVD history	3.8	3.2
Previous PCI	27.5	42.2
Previous CABG	4.5	7.8
Body Mass Index (BMI) $\geq 35\text{kg/m}^2$	13.1	9.7

Socio-economic status (SES) was determined using the Socio-Economic Indexes for Areas (SEIFA) score, a well-validated system developed by the Australian Bureau of Statistics from data collected in the national Census in 2011. Low SES was defined as SEIFA deciles 1 to 4 and high SES was defined as SEIFA deciles 5 to 10. Mean age was similar among patients with low and high SES, but there were differences in the rates of severe obesity, ACS presentation and the proportions treated in the public sector (Table 4).

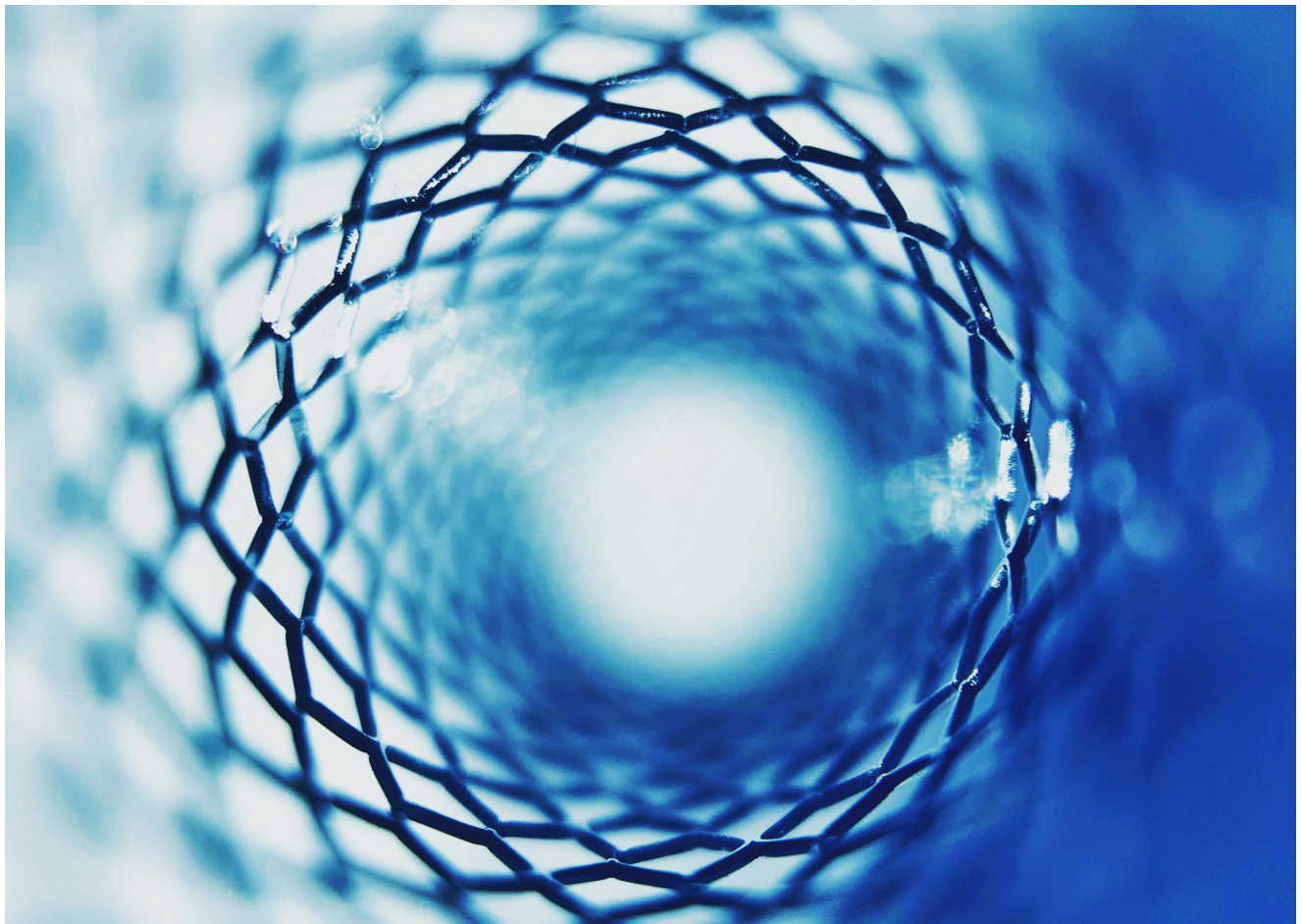
Table 4: Characteristics of patients undergoing PCI by socio-economic status

Patient characteristics	Low SES (n= 2778)	High SES (n= 9571)
Age- years (Mean $\pm$ SD)	67.2 ($\pm$ 11.8)	66.8 ($\pm$ 12.0)
	%	%
Sex- female	26.3	23.9
Body Mass Index (BMI) $\geq 35\text{kg/m}^2$	15.1	10.7
ACS indication	53.3	50.3
Public hospital	70.7	55.1

When comparing demographic trends according to a patient's location of residence, geographic remoteness was determined by the patient's postcode and the Accessibility and Remoteness Index of Australia (ARIA) – a geographic accessibility index available through the Australian Bureau of Statistics. Categories of remoteness reflect relative access to services in non-metropolitan areas by determining road distance to the nearest urban centre. Two groups were categorised - metro (major city) and non-metro (inner regional, outer regional, remote or very remote). In contrast to patients residing in metropolitan centres, non-metro patients were older and more likely to have severe obesity, be treated for an ACS and undergo PCI in the public sector (Table 5).

Table 5: Characteristics of patients undergoing PCI in non-metro vs metro

Patient characteristics	Non-metro (n= 3288)	Metro (n= 8942)
Age - years (Mean $\pm$ SD)	67.3 ($\pm$ 11.5)	66.8 ($\pm$ 12.2)
	%	%
Sex - female	24.1	24.6
Body Mass Index (BMI) $\geq$ 35kg/m ²	13.4	11.1
ACS indication	52.3	50.2
Public hospital	65.6	55.6



Resource Utilisation

The proportion of cases performed out-of-hours and delays to timely reperfusion for patients with ACS are important indicators that can be used to measure the efficiency of and demands on health service resource utilisation. The monitoring of trends in these process measures can assist hospitals in determining the appropriate allocation of both human and facility resources and potentially improve hospitals' efficiency and performance.

In-hours vs out-of-hours cases

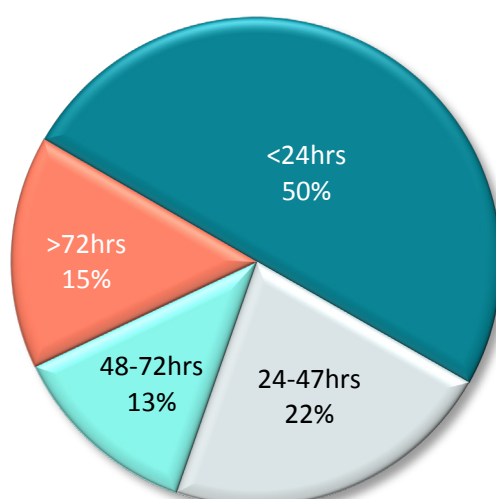
A total of 2,365 cases (19.2% of total cases) were performed out-of-hours, the majority of which were for STEMI (n=1,421, 60% of out-of-hours cases), and a further 944 cases (40% of out-of-hours cases) were for NSTEMI or unstable angina). The proportion of NSTEMI cases treated out-of-hours has decreased (67.1% in 2020 vs 71.3% in 2019), while there was a 3.5% increase in out-of-hours STEMI compared to the previous year. The remainder of cases (20.8%) were performed for non-ACS indications, with this rate more than double the rate of 8.9% in 2019.

The out-of-hours workload in the public sector was 21.2% of its cases and this rate was similar to previous years. In contrast, the after-hours workload in the private sector was 16.3% - an absolute decrease of 3% compared to 2019.

Time delays to PCI for NSTEMI-ACS

Australian guidelines for the management of ACS encourage early coronary angiography and percutaneous revascularisation for appropriate patients presenting with NSTEMI-ACS [7], and hospital services generally aim to utilise hospital resources in the most efficient ways to minimise delays to revascularisation. Figure 3 presents time delays from hospital admission to PCI for NSTEMI-ACS cases divided into various time categories. Across the entire cohort, half of NSTEMI-ACS cases were treated in less than 24 hours. The proportion of NSTEMI-ACS cases whose treatment was delayed for more than 72 hours was similar to the previous year (15.4% in 2020 vs 15.9% in 2019), and 3% lower than in 2014.

Figure 3: Time delays from hospital admission to PCI for NSTEMI-ACS cases



VCOR benchmarks hospitals' performance in relation to time delays to PCI for NSTEMI-ACS with hospitals compared against a performance target of $\geq 75\%$ of NSTEMI-ACS PCI cases completed within 72 hours of hospital admission (Figure 4). Performance was better in 2020, with only 2 hospitals failing to meet this benchmark, compared to 2019 when 5 hospitals did not meet this benchmark.

Figure 4: Time delays from hospital admission to PCI for NSTEMI-ACS cases by hospital

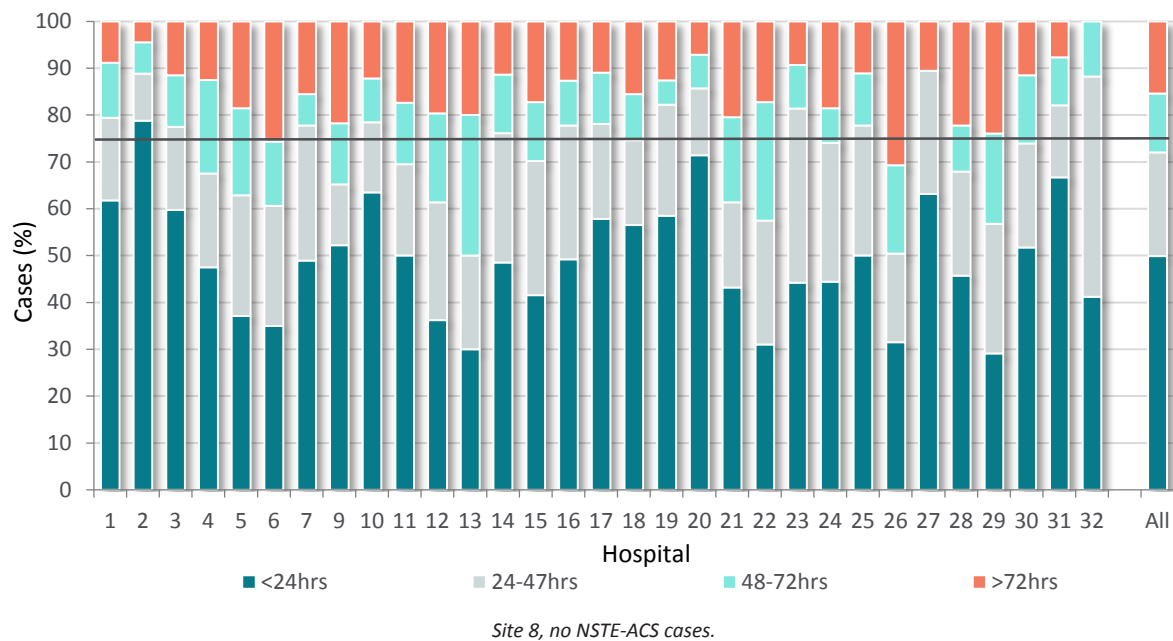


Table 6 examines time delays to PCI for NSTEMI-ACS by hospital sector. As noted in previous years, a greater proportion of cases were treated within 24 hours and the overall proportion of cases treated within 72 hours was higher in the public sector.

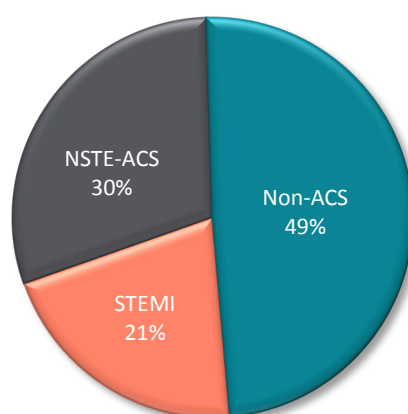
Table 6: Time delays from hospital admission to PCI for NSTEMI-ACS cases by hospital

	All sites (N=3695)	Public (n=2526)	Private (n=1169)
	N (%)	N (%)	N (%)
<24hrs	1844 (49.9)	1325 (52.5)	519 (44.4)
24-47hrs	816 (22.1)	524 (20.7)	292 (25.0)
48-72hrs	467 (12.6)	300 (11.9)	167 (14.3)
>72hrs	568 (15.4)	377 (14.9)	191 (16.3)

Clinical Presentation

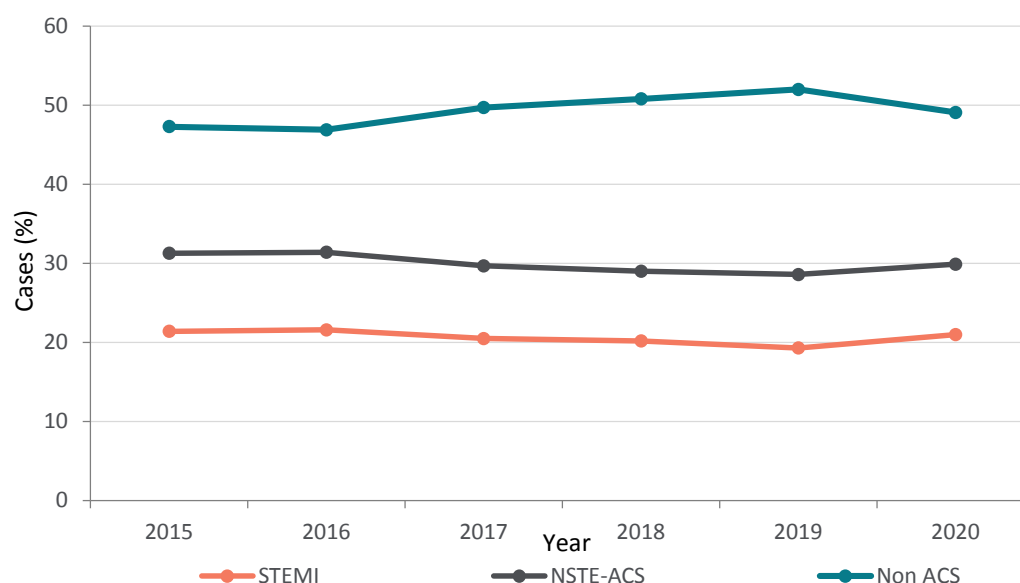
In 2020, just over half the PCI cases were for treatment of an ACS (Figure 5), reversing a trend over the previous 2 years when non-ACS cases were in the majority (non-ACS cases 52% in 2019 and 51% in 2018).

Figure 5: Procedures by clinical presentation



Trends in case rates by clinical presentation over time is shown in Figure 6. Up until 2016 not all private hospitals were contributing. The rise in the proportion of non-ACS cases between 2017 to 2019 likely reflects the more complete data from the private sector. The dip in non-ACS case proportions in 2020 may be due to a number of factors including the COVID pandemic and the restrictions it placed on elective and non-urgent cases. This is discussed more fully later in this report.

Figure 6: Trends in procedural rates by clinical presentation: 2015-2020



A comparison of the casemix among the hospitals (Figure 7) shows marked variation in the proportion of work taken up with treatment of ACS. Some hospitals treated relatively few ACS cases, including one who treated no ACS cases at all, while for a number of hospitals, ACS cases accounted for more than 70% of their workload.

Figure 7: ACS and non-ACS cases by hospital

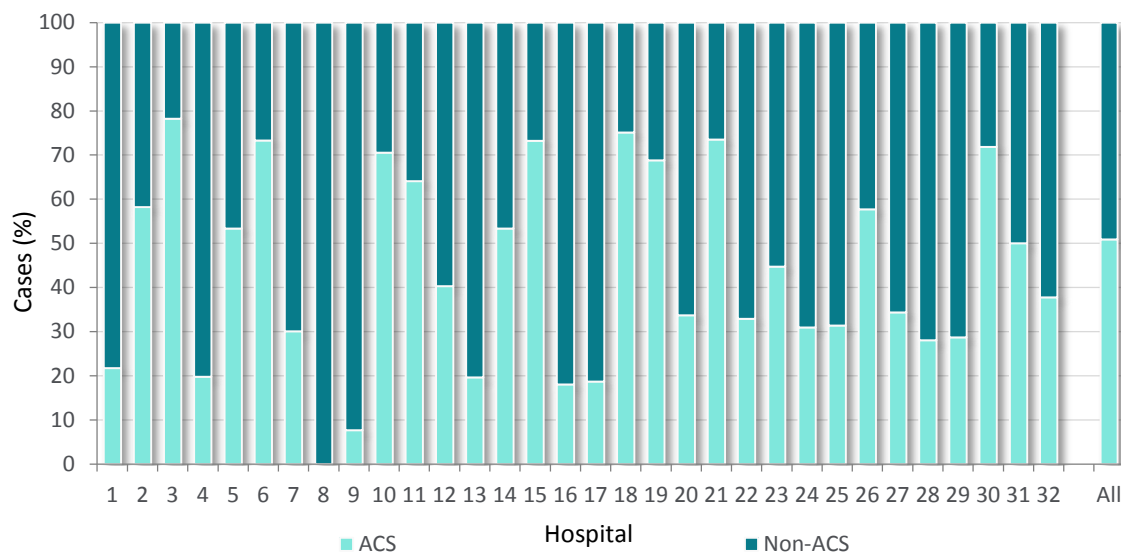
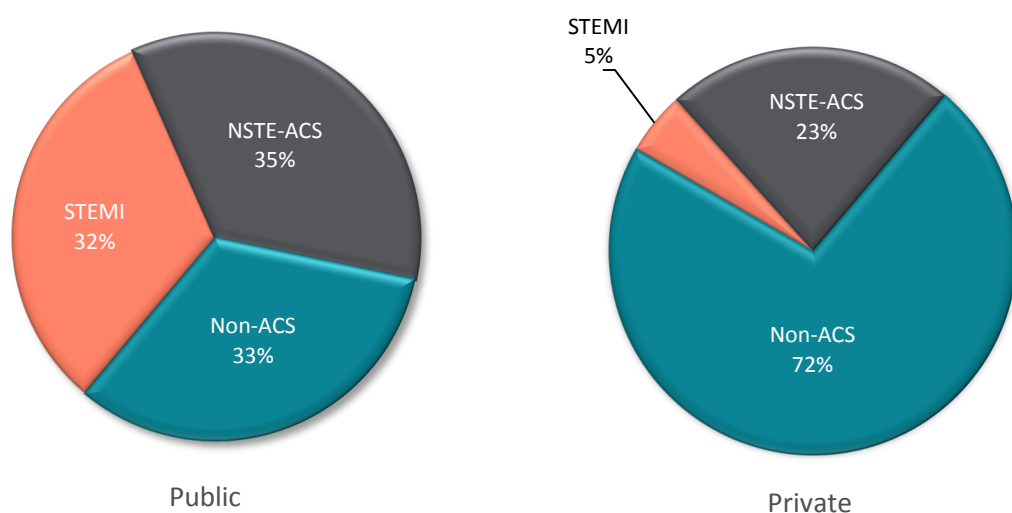


Figure 8 underscores differences in the workload casemix between the public and private sectors. As in previous years, the majority of public work was ACS-related, whereas private sector activity mostly dealt with non-ACS cases. In 2020, the ACS case workload increased in both sectors compared with the previous year (5% increase in public and 1% increase in private sector).

Figure 8: Procedure by clinical presentation by hospital sector



Indications for PCI

PCI is undertaken for a variety of indications and VCOR categorises these indications into various groupings. The purpose is to ascertain if procedures are undertaken for appropriate reasons. It is generally accepted that PCI performed for patients with an acute coronary syndrome is clinically appropriate and this is supported by Australian practice guidelines [7]. In 2020, the proportion of patients undergoing PCI for an ACS (including non-myocardial infarction-related cardiogenic shock and/or intubated OHCA and recent ACS within the last 8-30 days) was 53.7% - an increase of 2.8% over the previous year. Table 7 outlines PCI indications by ACS category, further subdivided into hospital sector. In the private sector, primary PCI cases were less common in 2020, (12.4% in 2020 vs 14.6% in 2019), while the proportions of cases for unstable angina or recent ACS remained several times higher than in the public setting.

Table 7: PCI indications by ACS category and hospital sector

PCI indications	All sites (N=6632)	Public (n=4968)	Private (n=1664)
ACS Category	N (%)	N (%)	N (%)
Primary PCI*	1934 (29.2)	1728 (34.8)	206 (12.4)
STEMI PCI 12-24 hours after symptom onset	259 (3.9)	231 (4.6)	28 (1.7)
Pharmaco-invasive PCI	199 (3.0)	187 (3.8)	12 (0.7)
Rescue PCI	116 (1.7)	112 (2.3)	4 (0.2)
PCI for OHCA/shock (non-MI)	43 (0.6)	34 (0.7)	9 (0.5)
PCI for NSTEMI-ACS	4081 (61.5)	2676 (53.9)	1405 (84.4)
NSTEMI-ACS sub-category	N (%)	N (%)	N (%)
NSTEMI	2882 (43.5)	2159 (43.5)	723 (43.4)
UAP	787 (11.9)	346 (7.0)	441 (26.5)
Recent ACS 8-30 days ago	412 (6.2)	171 (3.4)	241 (14.5)

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

A total of 5,717 cases were undertaken for non-ACS indications in 2020. The majority of these were for stable angina (65.8%) and a small proportion (5.0%) undertaken for prognostic reasons (no symptoms or abnormal functional test) (Table 8). This latter indication is generally considered a relatively weak indication for PCI and the proportion of patients with this indication has decreased over time (5.0% in 2020, 5.4% in 2019 and 15.4% in 2018).

The indication of staged PCI refers to patients with multi-vessel disease undergoing a second (or subsequent) PCI and is further categorised according to the indication of the original procedure (Table 8). The proportion of patients having staged PCI after ACS (≤ 30 days after first procedure) increased in 2020 (15.6% in 2020 vs 12.9% in 2019), with the increase apparent across both public and private sectors.

Table 8: Non-ACS PCI indications

PCI indications	All sites (N=5717)	Public (n=2272)	Private (n=3445)
	N (%)	N (%)	N (%)
Stable angina	3760 (65.8)	1396 (61.4)	2364 (68.6)
No symptoms and no functional test	285 (5.0)	172 (7.6)	113 (3.3)
No symptoms and positive functional test	551 (9.6)	165 (7.3)	386 (11.2)
Staged PCI after ACS (≤ 30 days after first procedure)	890 (15.6)	424 (18.7)	466 (13.5)
Staged PCI after ACS (> 30 days after first procedure)	164 (2.9)	86 (3.8)	78 (2.3)
Staged PCI after original non-ACS indication	67 (1.2)	29 (1.3)	38 (1.1)

The assessment of clinical factors that determine the appropriateness of non-ACS PCI procedures is shown in Table 9. These clinical factors include the presence or absence of symptoms, the severity of the coronary lesion(s) and demonstration of functional ischaemia. There has been a gradual decline in the proportion of non-ACS PCI cases with only one or no clinical factor present over time from 19% of cases in 2017 to 10.1% in 2020.

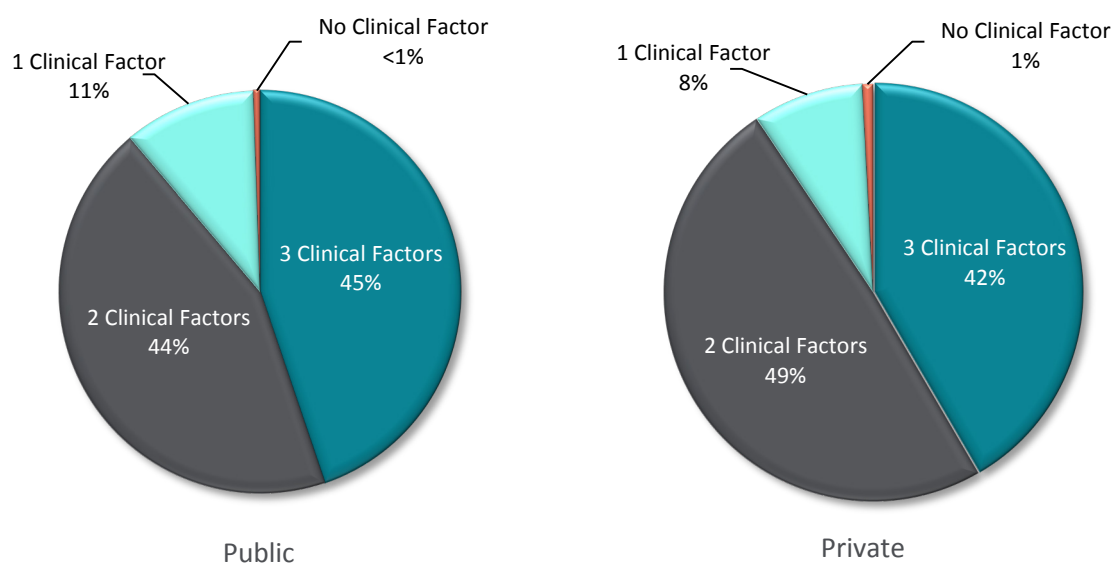
Table 9: Key clinical factors pertaining to non-ACS PCI indications

Symptoms	Positive functional test	High grade stenosis	Total
			N (%)
●	●	●	1967 (42.8)
○	●	●	507 (11.0)
●	●	○	211 (4.6)
●	○	●	1449 (31.5)
●	○	○	133 (2.9)
○	○	●	254 (5.5)
○	●	○	44 (1.0)
○	○	○	31 (0.7)
			4596 (100)

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

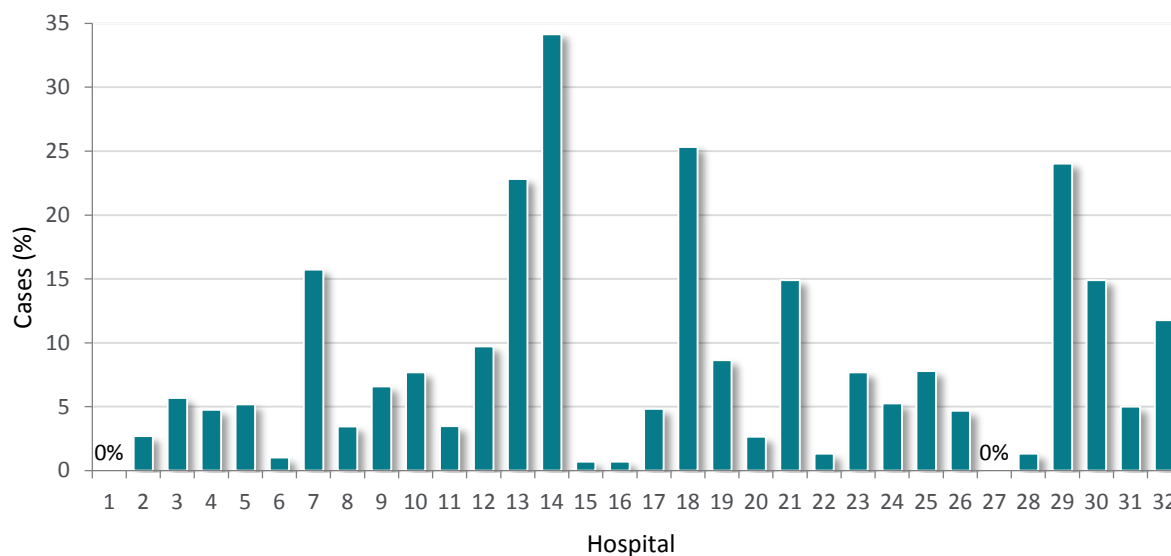
The public and private sectors had broadly similar proportions of non-ACS patients with 2 or 3 key clinical factors relating to appropriateness (Figure 9). The mean proportion of non-ACS PCI cases with just one or no key clinical factor was 11.1% in private and 9.4% in public. Differences in rates between public and private hospitals that were apparent in previous years- particularly the presence of all 3 clinical factors- have mostly resolved in 2020. The proportion of non-ACS PCI performed with only one clinical factor relating to appropriateness increased by 3% in the public sector and remained the same in the private sector for this reporting period.

Figure 9: Key clinical factors in non-ACS patients by hospital sector



A comparison of the proportion of cases with just one or no key clinical factor by hospital is shown in Figure 10. While there was variation among hospitals (range 0%-34%), 14 out of 32 hospitals (43%) had <5% of its non-ACS cases linked with only 0-1 clinical factor. This was an improvement over 2019, where just 9 out of 32 hospitals (22%) had <5% of its non-ACS cases linked with only 0-1 clinical factor. For the 462 cases that had either no or one key clinical factor, 270 (58%) were in the private sector.

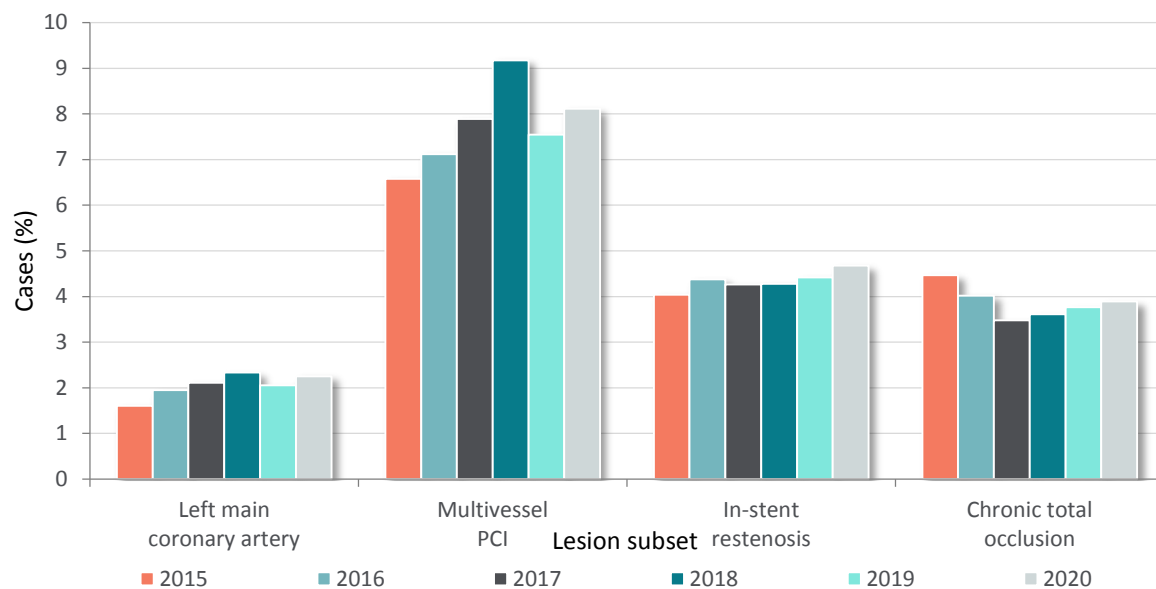
Figure 10: Proportion of non-ACS cases with 0-1 indicator for PCI by hospital



Lesion and Clinical Subsets

Selected lesion subsets among the PCI cases over the period from 2015 to 2020 are shown in Figure 11. The proportion of cases involving the left main coronary artery or in-stent restenosis have remained fairly constant over time. More variation is noted in the rates of multivessel PCI, although the range is relatively narrow between 8.1% (in 2020) and 7.5% (in 2019). The proportion of cases involving chronic total occlusions has not substantially increased over the 6-year period, despite the growing use of advanced techniques and the availability of specialised equipment for this lesion subset. The rate of adjunctive imaging with intravascular ultrasound (IVUS) or optical coherence tomography (OCT) in left main coronary artery PCI was 37.7%. While this was an increase from the 2019 rate of 34.7%, it is still substantially lower than rates reported in international registries [8]. Proportions of the various lesion subsets were similar among public and private hospitals, apart from in-stent restenosis which has proven to generally be a more common lesion subset in the private sector than in public (4.0% public hospitals vs 5.6% private hospitals in 2020). PCI in bypass grafts remains similar to previous years (1.7% in 2020, 1.4% in 2019 and 1.6% in 2018).

Figure 11: Comparative trends in PCI for selected lesion subsets: 2015-2020



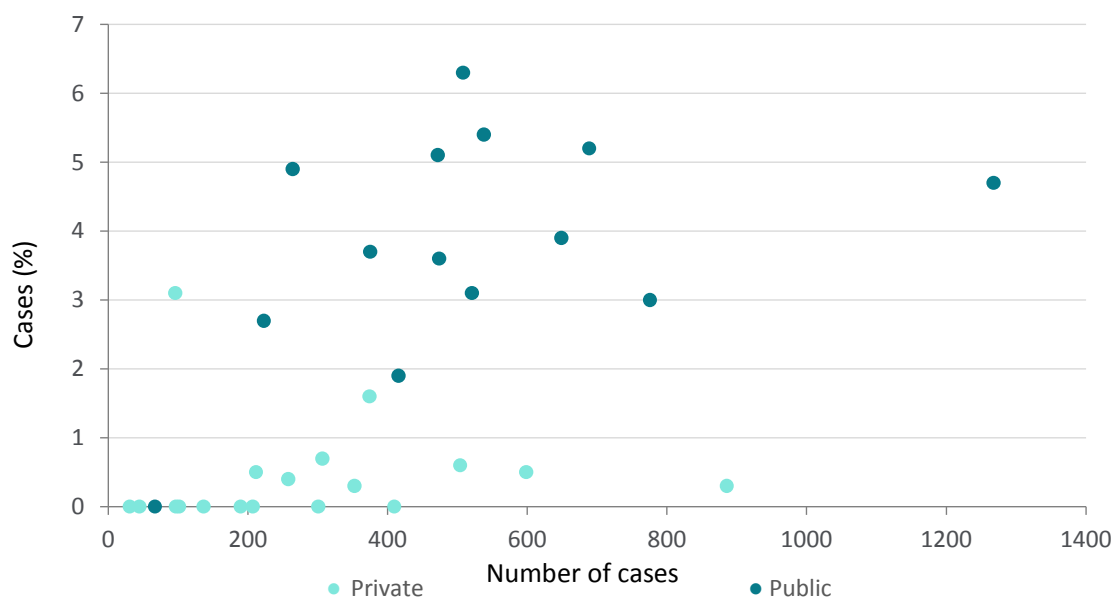
The proportions of cases treated with cardiogenic shock, intubated OHCA or cardiogenic shock and/or intubated OHCA have remained constant over time (Table 10). While case numbers with these conditions are relatively small, they have much higher rates of morbidity and mortality compared with the rest of the PCI cohort [9, 10].

Table 10: Rates of cardiogenic shock and intubated out-of-hospital cardiac arrest (OHCA): 2015-2020

Presentation type	2015 (N=9229)	2016 (N=10035)	2017 (N=11007)	2018 (N=12463)	2019 (N=12354)	2020 (N=12347)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Cardiogenic shock	223 (2.4)	278 (2.8)	258 (2.3)	266 (2.1)	269 (2.2)	273 (2.2)
Intubated OHCA	108 (1.2)	126 (1.3)	142 (1.3)	137 (1.1)	151 (1.2)	129 (1.0)
Shock and/or intubated OHCA	253 (2.7)	309 (3.1)	310 (2.8)	329 (2.6)	320 (2.6)	326 (2.6)

The majority (93%) of the high-acuity cases of shock and/or intubated OHCA were managed in public hospitals and comprised 4.2% of the public sector's workload compared to 0.5% in the private sector. Figure 12 plots individual hospitals' rates of shock and/or intubated OHCA as a percentage of their total volume. This analysis shows that among public hospitals, the higher volume hospitals tended to have a greater proportion of their workload taken up with these complex high-risk cases. In contrast, there was no such relationship evident among private hospitals, with the proportion of their overall workload taken up with these cases remaining low and unaffected by hospital PCI volume. This suggests that the burden of caring for these high-acuity conditions falls mainly on higher volume public hospitals and may have implications for future health service design and healthcare delivery.

Figure 12: Shock and/or intubated OHCA cases by hospital volume and hospital sector



Coronary Device Use

Coronary stent implantation is now almost ubiquitous in PCI with 94% of PCI cases in 2020 having at least one stent implanted. The majority of patients (65%) received a single stent; one fifth (21%) received 2 stents; 5.5% received 3 stents and 1.4% received ≥ 4 stents. Stent implantation rates were similar among public and private hospital treated patients. Neither the average summed total length of stents deployed per case (15-34mm in 2020), nor the median total stent length per case (23mm in 2020) has changed over time. Balloon angioplasty alone was undertaken in 4.3% of cases, similar to the previous year, although there was a small increase in the use of drug-eluting balloons for the management of in-stent restenosis (22% in 2020 vs 20% in 2019).

Drug-eluting stents

Virtually all stents (99.8%) implanted in 2020 were drug-eluting stents, culminating in a trend of increasing DES use that has been observed across Victorian hospitals since the registry's commencement. In 2014, 75% of stents implanted were DES, with a substantial difference in rates between public and private hospitals (85% private sector vs 68% public sector in 2014). In addition to the overall DES rate now approaching 100%, the gap between public and private hospital DES usage has disappeared. The near universal use of DES across Victoria is consistent with trends observed among other states and internationally [8].

Adjunctive devices and drugs

Table 11 shows the usage rates for the most common adjunctive devices, further divided by hospital sector. Overall, these devices were used in small proportions. There were small increases in IVUS and OCT case numbers compared with the previous year. Notably, the number of PCI cases that included an estimation of fractional flow reserve (FFR) actually fell in 2020, but the numbers reported here only refer to cases that had both an FFR and a PCI during the one procedure. Total FFR case numbers are likely to be significantly higher, as many FFR cases do not go on to PCI at the same sitting and are therefore not recorded in VCOR. FFR (with PCI) and rotational atherectomy were more commonly performed in the private sector, while IVUS, OCT and IABP were utilised more frequently in the public setting. All patients requiring ECMO (n=13) were treated in the public sector.

Table 11: Adjunctive device use by hospital sector

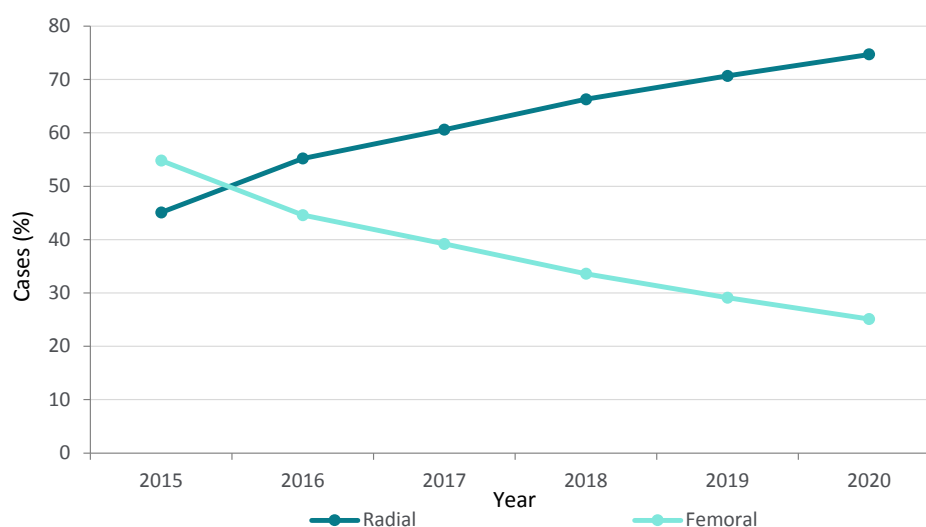
Adjunctive device type	All sites (N=12349)	Public (n=7240)	Private (n=5109)
	N (%)	N (%)	N (%)
Intravascular ultrasound	327 (2.6)	200 (2.8)	127 (2.5)
Optical coherence tomography	163 (1.3)	130 (1.8)	33 (0.6)
Thrombus aspiration device	194 (1.6)	173 (2.4)	21 (0.4)
Rotational atherectomy	220 (1.8)	101 (1.4)	119 (2.3)
Fractional flow reserve	466 (3.8)	160 (2.2)	306 (6.0)
IABP	45 (0.4)	37 (0.5)	8 (0.2)
ECMO	13 (0.1)	13 (0.2)	0 (0.0)

Glycoprotein (GP) IIb/IIIa receptor inhibitor use has continued to decline (5.5% in 2020 vs 6% in 2019). These potent intravenous antiplatelet agents were still primarily used in the setting of acute STEMI, accounting for 69.6% of their total use in 2020. They were administered to 475 STEMI patients undergoing PCI.

Arterial access

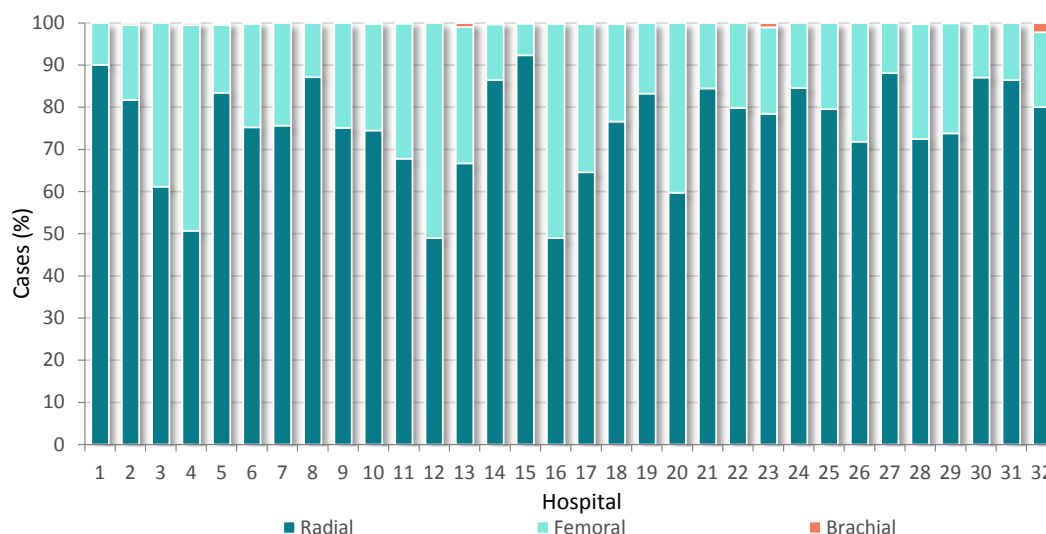
Radial artery vascular access in PCI is now widely acknowledged as being superior to femoral access due to lower rates of serious bleeding [11], particularly in patients undergoing PCI for STEMI [12]. In 2020, the radial artery was used for vascular access in 74.7% of cases, and this has increased over time (Figure 13). Radial access rates remain higher in the public sector than in the private sector (78.7% vs 69.1%), although the gap between the two sectors is closing. Over the past 6 years, the rate of radial vascular access in the private sector has nearly doubled from 35% in 2015 to 69.1% in 2020. Over the same period, the rate in the public sector has increased from 51% in 2015 to 78.7% in 2020.

Figure 13: Trends in arterial access: 2015-2020



Rates of radial and femoral access by hospital are shown in Figure 14. Radial access rates range from 49% to 90% and although there is significant variation across hospitals, a larger proportion of sites have a radial vascular access rate above 80% compared to the previous year (44% in 2020 vs 28% in 2019).

Figure 14: Arterial access route by hospital



The use of radial access in the very elderly (>80 years) was 63% in 2020 and remains similar to the previous year. Radial artery access use by sex will be further explored in a later section of this report.

PCI for STEMI

PCI is a highly effective reperfusion strategy for patients presenting with ST elevation myocardial infarction (STEMI). Several subcategories of PCI exist for this condition, with the commonest being primary PCI- where PCI is performed as the primary reperfusion therapy for patients within the first 12 hours after symptom onset. In 2020, a total of 2,592 patients underwent PCI for STEMI, of whom 1,934 (75%) had primary PCI.

Table 12 lists other categories of PCI for STEMI including rescue PCI- where PCI is undertaken in patients who have had a STEMI within the previous 24 hours, received thrombolysis as the initial reperfusion treatment but have ongoing signs of ischaemia or failed reperfusion. PCI can also be performed as part of a pharmaco-invasive strategy whereby patients, who have had a STEMI and received thrombolysis, undergo PCI routinely (rather than because of ongoing ischaemia) within the first 24 hours. Patients who undergo PCI beyond the 12-hour window for reperfusion and who did not receive any other form of reperfusion therapy are also considered in this section and are labelled as PCI >12 hours after STEMI.

PCI for STEMI accounted for 21% of the total PCI caseload (n=2,592) across Victoria in 2020 and was similar to previous years (n=2,388 in 2019 and 2,515 in 2018).

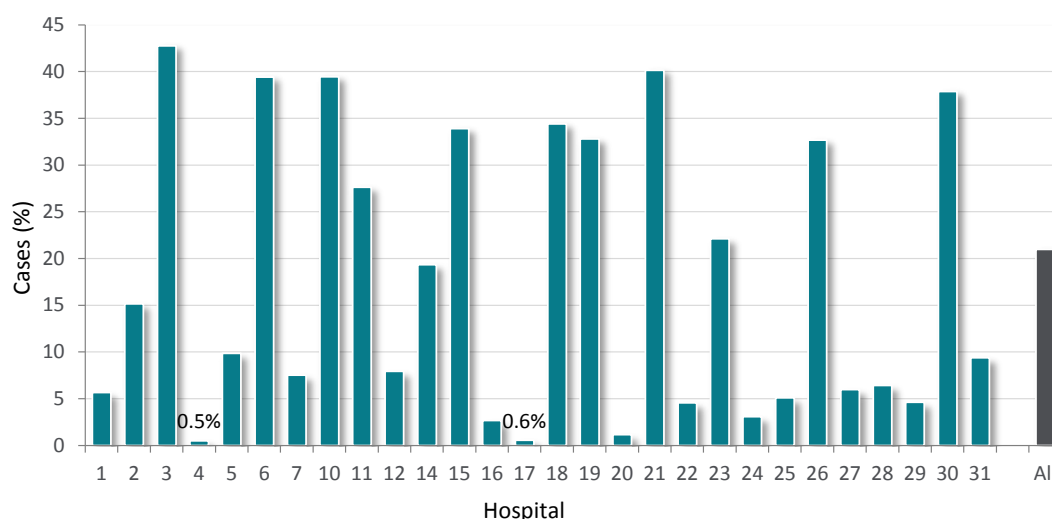
Table 12: Sub-categories of patients undergoing PCI for STEMI

PCI for STEMI sub-categories	All sites (N=2592)	Public (n=2338)	Private (n=254)
	N (%)	N (%)	N (%)
Primary PCI* (<12 hrs, no thrombolysis)	1934 (74.6)	1728 (73.9)	206 (81.1)
Rescue PCI (<24 hrs, previous thrombolysis, unstable)	116 (4.7)	112 (4.8)	4 (1.6)
Pharmaco-invasive PCI (<24 hrs, previous thrombolysis, stable)	156 (6.0)	146 (6.2)	10 (3.9)
PCI for STEMI >12 hrs (no thrombolysis)	386 (14.7)	352 (15.1)	34 (13.4)

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

The proportion of STEMI cases by hospital is shown in Figure 15. Nine hospitals' caseload of STEMI PCIs was greater than a third overall, compared to others with a low proportion of STEMI PCI. Excluding those who did not do any STEMI PCI, the range was 0.5% to 43%.

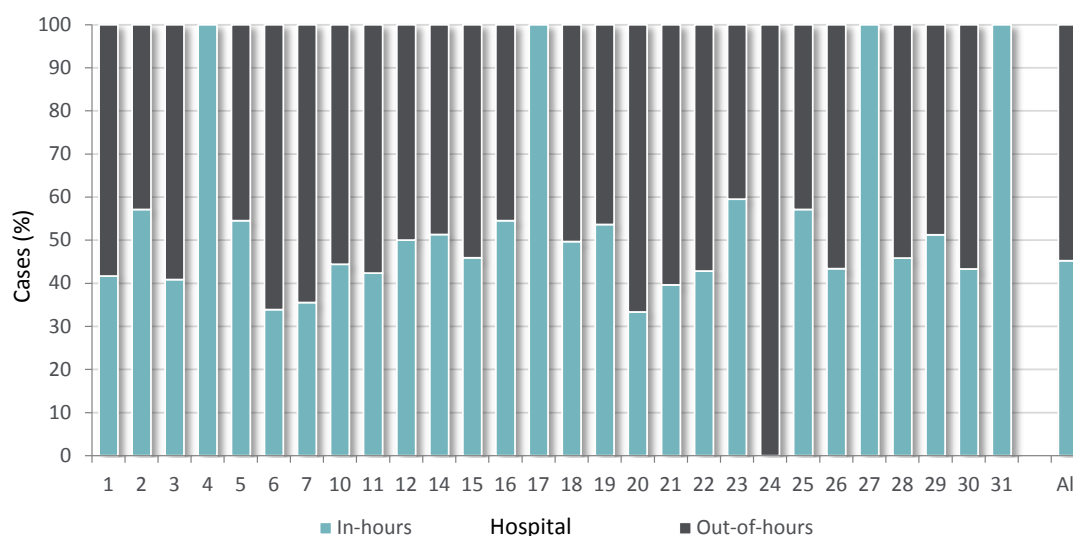
Figure 15: STEMI cases as a proportion of overall case numbers by hospital



Hospitals 8, 9, 13 & 32 had no STEMI; Hospitals 4, 17, 20, 24 & 27 had STEMI<5.

The distribution of STEMI cases done in-hours and out-of-hours by hospital is shown in Figure 16. Overall, 55% of PCI cases for STEMI were done out-of-hours. However, there was significant variation in out-of-hours case numbers by hospital (range 0%-66%). Five hospitals treated <5 cases of STEMI. Four hospitals (all of which had low case numbers) performed all their STEMI PCIs in-hours.

Figure 16: STEMI cases in-hours and out-of-hours by hospital



Hospitals 8, 9, 13 & 32 had no STEMI. Hospitals 4, 17, 20, 24 & 27 had STEMI<5.

In-hours: 8.00am - 6.00pm (Mon-Fri excluding public holidays)

Out-of-hours: 6.00pm - 8.00am (Mon-Fri, public holidays and weekends)

The demographic profile of the patients presenting with STEMI differed from the rest of the PCI cohort. Patients with STEMI were younger overall (63 ± 12.6 years vs 67.7 ± 11.7 years), had fewer traditional cardiac risk factors such as diabetes (18.7% vs 24.9%), peripheral vascular disease (2.1% vs 3.6%) and had lower rates of previous revascularisation procedures- including previous PCI (13.4% vs 38%) and coronary artery bypass grafting (1.4% vs 6.9%). There were also differences in the demographic profiles among STEMI patients treated in the public and private sectors. Those in the private sector were older (62.6 ± 12.6 years public vs 69 ± 11.6 years private), had fewer previous strokes (3% public vs 1.4% private), more previous PCIs (12.8% public vs 18.6% private) and more previous coronary artery bypass grafting operations (1.2% public vs 2.7% private).

Primary PCI

In 2020, 1,934 patients underwent primary PCI. Of those, 1,623 patients presented to the treating hospital with acute STEMI- either by ambulance or as self-presenters to the emergency department. The remaining 311 patients either developed a STEMI while already an in-patient or initially presented to an outside hospital and were transported to the treating hospital as an inter-hospital transfer. Further analysis on treatment delays, pre-hospital notification and other aspects relating to reperfusion therapy in the following sections excludes in-hospital and inter-hospital transfer STEMI patients because they are not influenced by time and other system delays in the same way as emergency presenters are.

Door-to-balloon times

The process measure of door-to-balloon time (DBT) is a frequently reported quality indicator for health services and is defined as the time delay from a patient's arrival to hospital to successful re-opening of their occluded infarct-related coronary artery. It is primarily applicable to cases that present to the hospital with a suspected myocardial infarction via the ambulance service or as self-presenters to the emergency department. It is not generally used as a quality indicator in cases where the STEMI develops in a patient who is already an in-patient in the hospital or who is an inter-hospital transfer after presenting to an outside hospital first.

Door-to-balloon time is utilised when benchmarking hospitals' performance in the acute management of patients with STEMI. Both Australian and international guidelines now recommend that the target maximum delay time should ideally be changed from the longstanding benchmark of ≤ 90 minutes to ≤ 60 minutes and that the delay should be measured from the time of first medical contact rather than hospital arrival [7, 13]. Notwithstanding these recommendations, VCOR currently still reports on outcomes benchmarked against a DBT ≤ 90 minutes to remain consistent with and relevant to the majority of participant hospitals who still retain this benchmark value for their own hospital quality assurance processes [14]. In 2020 work was undertaken to facilitate future reporting and site benchmarking that includes the process measure of time from first medical contact to balloon inflation.

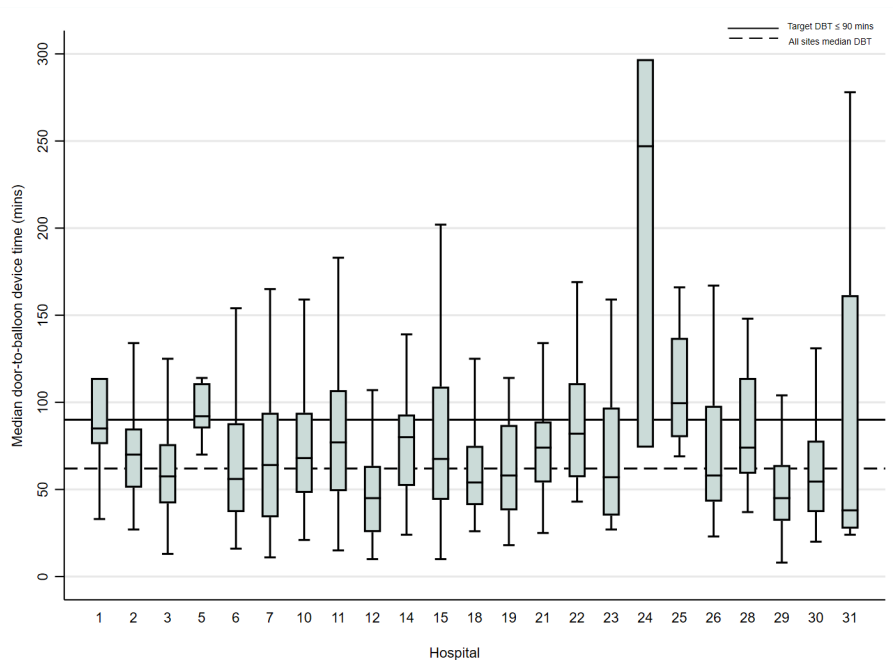
Table 13: Door-to-balloon times for primary PCI cases: 2015-2020

Door-to-balloon time	2015	2016	2017	2018	2019	2020
	(N=1168)	(N=1303)	(N=1423)	(N=1596)	(N=1495)	(N=1623)
Median – mins (IQR)	72 (48, 103)	67 (47, 96)	63 (44, 89)	58 (39, 83)	58 (40, 84)	62 (43, 91)
Proportion of cases ≤ 90 mins (%)	66.4	71.9	77.3	80.5	80.8	74.7

In 2020, the median DBT was 62 minutes (IQR: 43, 91) - representing an increase compared to the previous two reporting periods and a reversal of the strong trend of sequential falls in DBT observed in the period from 2015 to 2019 (Table 13). We believe the median DBT in 2020 has been influenced by the impact of the COVID-19 pandemic on medical service delivery in the acute hospital setting. This is discussed in more detail in a later section of this report.

In contrast to 2019 when all hospitals achieved a median DBT time of ≤ 90 minutes, 3 hospitals did not meet this benchmark in 2020. However, despite the effects of the COVID-19 pandemic on hospital service delivery, 10 hospitals still managed to achieve a median DBT of ≤ 60 minutes (Figure 17).

Figure 17: Door-to-balloon time for primary PCI cases by hospital

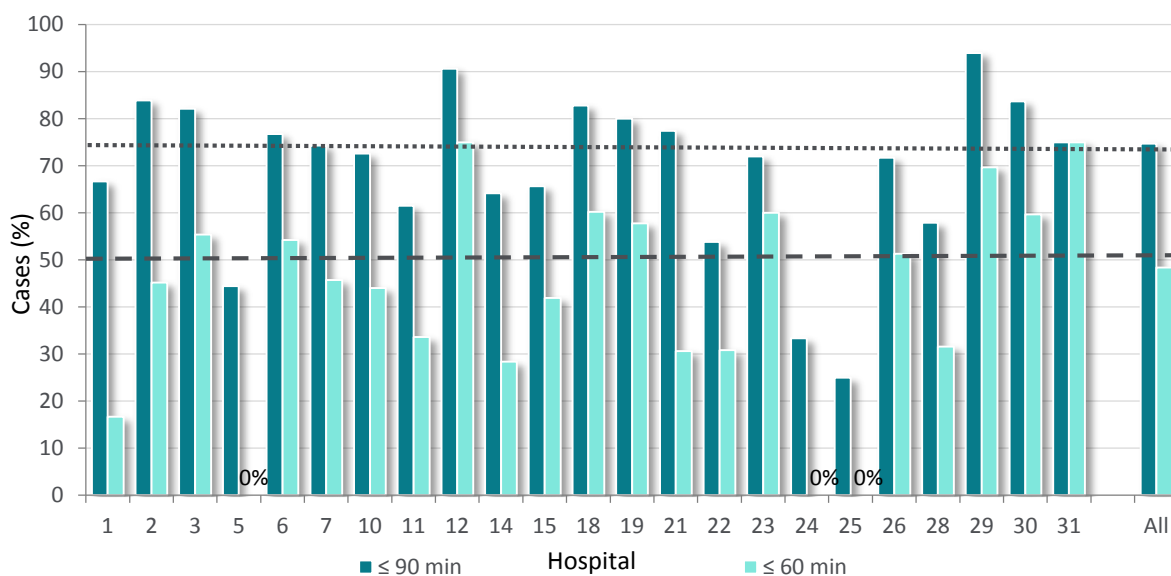


Hospitals 4, 8, 9, 13, 16, 17, 20, 32 had no Primary PCI; Hospital 27 excluded as Primary PCI < 3.

Hospitals were assessed on their compliance at achieving a DBT ≤ 90 minutes in at least 75% of their primary PCI cases – an internationally recognised performance benchmark [15] that arguably provides more meaningful information about how a hospital is performing. In 2020, the average rate of compliance with a DBT ≤ 90 minutes by hospital was 74.7% compared to 80.8% in 2019. Again, we believe that this drop off in performance in 2020 is a consequence of the influence of COVID-19 on the delivery of health services across the state during that year. The compliance rate among hospitals is shown in Figure 18 and ranges from 25% to 93.9%. Fewer than 50% of the hospitals achieved a DBT ≤ 90 minutes in greater than 75% of primary PCI cases, representing a significant decline compared to the previous year (43% in 2020 vs 62% in 2019).

In line with current Australian practice guideline recommendations, VCOR now also provides benchmarking data for hospitals' compliance with a DBT ≤ 60 minutes (Figure 18). There was no improvement in performance compared to the previous year with just 2 hospitals managing to achieve a 75% compliance rate with the stricter ≤ 60 minute benchmark. When applying this stricter benchmark, VCOR considers that a more relevant and achievable benchmark compliance rate for hospitals is $>50\%$ of cases. When this benchmark was applied to the 2020 cohort, 10 of 24 hospitals were compliant - showing that it is an achievable and potentially reachable target for all hospitals.

Figure 18: Proportion of primary PCI cases with door-to-balloon time ≤ 90 minutes and ≤ 60 minutes by hospital



Hospitals 4, 8, 9, 13, 16, 17, 20, 32 had no Primary PCI; Hospital 27 excluded as Primary PCI < 3.

Treatment delays in primary PCI were also influenced by patients' socio-economic status and geographical remoteness. Time from symptom onset to hospital presentation (SDT) was substantially longer among patients with low SES- with this metric predominantly being patient-determined (how long patients wait before seeking medical attention). In contrast, the door-to-balloon time (hospital-determined metric) was similar between patients with low and high SES. As a result, overall treatment delay (symptom to balloon time - SBT) was longer in the low SES group due to patient-related rather than hospital-related factors (Table 14).

Similar trends were found with geographic remoteness. Not unexpectedly, patients in non-metro areas had longer symptom-to-door times. However, this may in part be due to longer travel times to hospital and therefore not wholly a reflection of patient-determined delay in seeking medical help. Door-to-balloon times were similar for metro and non-metro patients, with the longer treatment delay (SBT) in non-metro patients accounted for by the longer delays in presenting to hospital (Table 14).

Table 14: Treatment delays in primary PCI by socio-economic status and geographic remoteness

	Socio-economic status		Geographic remoteness	
	Low (n=2778)	High (n=9571)	Non-metro (n=3288)	Metro (n=8941)
Median SDT- mins	127	104	135	101
Median DBT- mins	64	62	61	63
Median SBT- mins	196	175	209	174

Pre-hospital notification (PHN)

Pre-hospital notification (PHN) of the pending arrival of a patient with STEMI by Ambulance Victoria to the receiving hospital allows those hospitals to activate the cardiac catheterisation laboratory team before the patient actually arrives. PHN facilitates direct transfer to the catheter laboratory, minimises delays in transfer and starting times and has been proven to shorten door-to-balloon times. All Victorian hospitals that perform primary PCI have PHN arrangements set up with Ambulance Victoria. In 2020, PHN was utilised in 72.6% of primary PCI cases. As has been seen with all previous VCOR reports, its use resulted in significant reductions in median DBT (Table 15).

Table 15: Door-to-balloon times for primary PCI cases by pre-hospital notification status

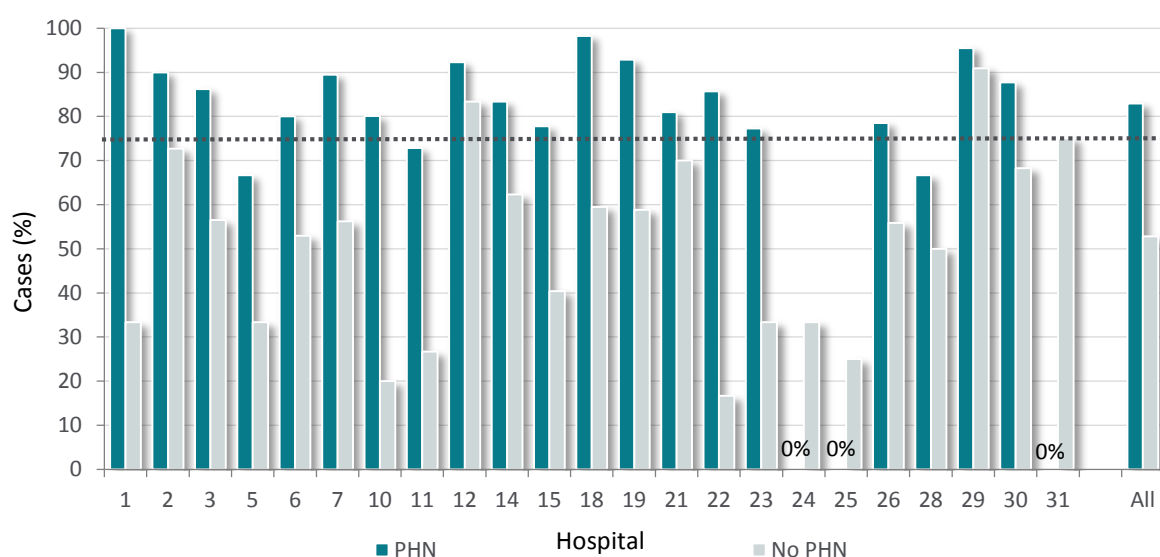
Door-to-balloon time	Primary PCI*	Primary PCI* (PHN only†)	Primary PCI* (no-PHN†)
	(N=1623)	(n=1178)	(n=445)
Median – mins (IQR)	62 (43, 91)	55 (40, 79)	87 (60, 120)
Proportion of cases ≤90mins (%)	74.7	82.9	52.8

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

†Pre-hospital notification (PHN).

Figure 19 shows rates of compliance with a DBT ≤90 minutes by hospital, according to whether their cases utilised PHN or not. All hospitals demonstrated that their performance suffers if PHN is not utilised. However, PHN did not guarantee high compliance rates, with 3 hospitals failing to achieve the target of ≥75% cases with DBT≤90 minutes with PHN, compared to a single hospital last year.

Figure 19: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes – pre-hospital notification (PHN) vs no pre-hospital notification

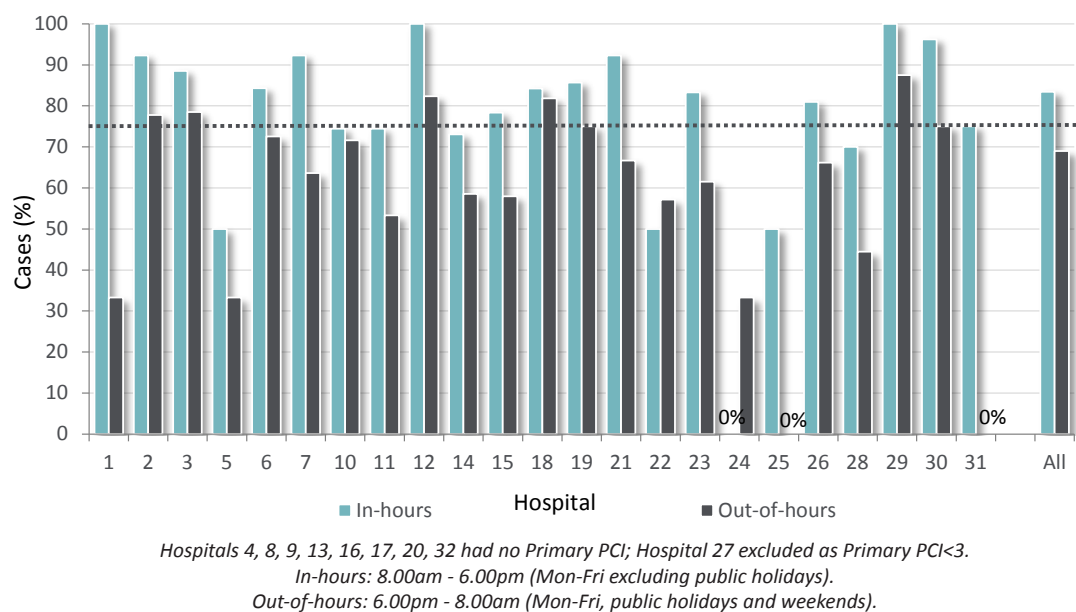


Hospitals 4, 8, 9, 13, 16, 17, 20, 32 had no Primary PCI; Hospital 27 excluded as Primary PCI<3.

In-hours versus out-of-hours presentation

In 2020, 984 primary PCI cases (60.6%) were treated out-of-hours, unchanged from the previous year. There was marked variation in the proportion of cases treated out-of-hours among hospitals. For hospitals that performed at least 5 primary PCIs in the 12-month period, the percentage range of cases done out-of-hours was 33%-64% (Figure 20). Reversing a trend of improvements in DBT compliance rates year-on-year for out-of-hours cases, the compliance rate with a DBT≤90 minutes for out-of-hours cases declined in 2020 to 69%- likely a consequence of the COVID-19 pandemic effects on urgent healthcare delivery.

Figure 20: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes – in-hours vs out-of-hours presentation



Hospital Volumes and Door-to-balloon Time

It is generally accepted that the best results in primary PCI are achieved by experienced operators working in institutions that have an established and active program for primary PCI. The Cardiac Society of Australia and New Zealand (CSANZ) has provided guidelines for competency for primary PCI that recommend hospitals should perform at least 36 primary PCI procedures per year among a total PCI volume >200 cases per year to maintain competency in primary PCI [16].

In 2020, we identified that among the hospitals (both public and private sector) performing primary PCI, 12 sites had case volumes compliant with CSANZ guidelines for competency and 14 sites had volumes below the recommended standard. Table 16 shows DBT outcomes for various subgroups of primary PCI according to whether or not hospitals were compliant with CSANZ primary PCI competency guidelines.

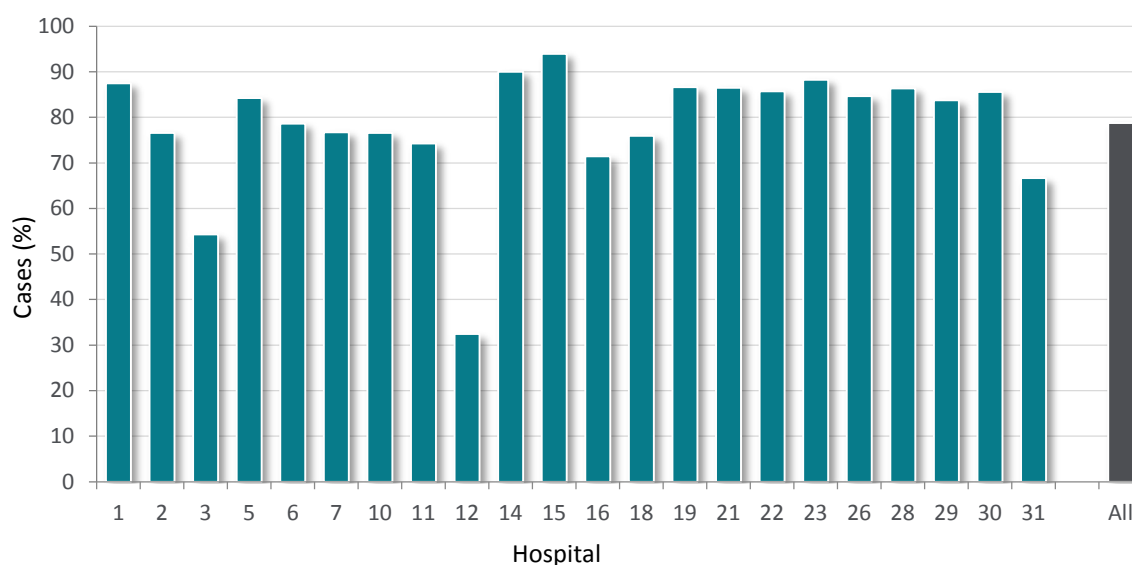
For all primary PCI cases, excluding in-hospital and inter-hospital transfer STEMI cases (n=1623), the median DBT among lower-volume hospitals (77 minutes) was longer than for higher-volume centres (62 minutes) and rates of compliance in achieving DBT≤90 minutes were lower among lower-volume sites. These differences in performance substantially narrowed with pre-hospital notification of the arriving STEMI patient. However, a substantial gap in performance between higher and lower volume hospitals was still evident with out-of-hours cases. The median DBT among lower-volume hospitals was 86 minutes - 18 minutes longer than higher-volume hospitals. These results provide some insight into areas of potential service improvement for hospitals with lower numbers of primary PCI cases and highlight the need for these services to engage in continuous quality improvement to ensure the facilitation of early recognition of STEMI, prompt activation of the catheterisation laboratory and the maintenance of experienced nursing and technical catheterisation staff with the appropriate training and skill sets.

Table 16: Door-to-balloon time outcomes by hospital case volumes

	All sites	Sites with ≥36 Primary PCI Site volume ≥200	Sites with <36 Primary PCI Site volume <200
All Primary PCI	(N=1623)	(n=1509)	(n=114)
Number of sites	26	14	12
Median DBT- mins (IQR)	62 (43, 91)	62 (43, 90)	77 (50, 103)
Proportion of cases ≤90mins (%)	75	75	66
PHN only	(N=1178)	(n=1114)	(n=64)
Median DBT- mins (IQR)	55 (40, 79)	55 (40, 79)	60 (41, 86)
Proportion of cases ≤90mins (%)	83	83	81
No PHN	(N=445)	(n=395)	(n=50)
Median DBT- mins (IQR)	87 (60, 120)	87 (59, 121)	92 (70, 119)
Proportion of cases ≤90mins (%)	53	54	46
Out-of-hours	(N=984)	(n=926)	(n=58)
Median DBT- mins (IQR)	69 (50, 98)	68 (49, 98)	86 (64, 114)
Proportion of cases ≤90mins (%)	69	70	57
In-hours	(N=639)	(n=583)	(n=56)
Median DBT- mins (IQR)	49 (35, 78)	48 (35, 77)	59 (36, 90)
Proportion of cases ≤90mins (%)	83	84	75

Radial access

The indication for the use of radial vascular access is strongest for patients presenting with acute STEMI [11]. Over the last several years, radial artery access in this group of patients has increased. In 2020, radial access was utilised in 78.8% of acute STEMI PCIs – 3% higher than in 2019 and over 20% higher than in 2017. Furthermore, the proportion of hospitals using the radial artery for vascular access in ≥75% of their acute STEMI cases has increased further (76% in 2020 vs 50% in 2019). However, variation still exists among hospitals, ranging from 32% to 94% of cases (Figure 21).

Figure 21: Radial access rates in acute STEMI by hospital


Hospitals 4, 8, 9, 13 & 32 had no acute STEMI; Hospital 17, 20, 24, 25 & 27 had acute STEMI<5.

Other Categories of PCI for STEMI

Beyond primary PCI, there were a further 658 patients who underwent PCI for STEMI. A total of 116 patients had rescue PCI, defined as PCI within 24 hours of STEMI onset for patients initially treated with thrombolysis as their primary reperfusion therapy, but with ongoing symptoms or other signs of failed reperfusion. Of those, 57 were treated within 6 hours and a further 53 were treated between 6-12 hours of symptom onset (symptom onset times missing for 6 cases). Anterior STEMI accounted for 45% and GP IIb/IIIa inhibitor therapy was used in 8.6%. Cardiogenic shock and/or intubated OHCA was present in 12.9% and an intra-aortic balloon pump was only used in 1 case. All but 4 of these cases were done in the public sector.

A further 156 patients underwent PCI for STEMI as part of a pharmaco-invasive approach. In this group, patients received thrombolysis as their initial reperfusion therapy, were still within the 24-hour period following onset of symptoms and were clinically stable. National practice guidelines provide a strong recommendation for treating these patients with angiography and PCI where appropriate within 24 hours of thrombolytic therapy to obtain the greatest clinical benefits. Among these patients, 46% (n=65) had their PCI within 12 hours and of those 12% (n=13) had their PCI within the first 4 hours. The most commonly treated infarct-related artery was the right coronary (49%). Adjunctive GP IIb/IIIa inhibitors were used in 1.9%.

A third category of STEMI patients were those who did not end up receiving reperfusion therapy (PCI or thrombolysis) in the first 12 hours. Although VCOR does not capture the reasons why these patients did not undergo reperfusion therapy, typical scenarios include late presentation by the patient, initial confusion or ambiguity about the diagnosis or contra-indications to thrombolysis among patients who presented to non-PCI hospitals. Of the 386 patients in this category, 137 received PCI within 24 hours, while the remainder had their PCI 1-7 days after symptoms onset, with a mean delay of 59±34 hrs. Among this group, 59 cases (36%) initially presented to an outside hospital and were inter-hospital transfers. There were 31 patients with cardiogenic shock and/or intubated OHCA and balloon pumps were used in 8 cases. Approximately 9% of these cases were performed in private.

COVID-19 Pandemic in 2020

For the majority of the period covered by this report, health services in the state of Victoria were significantly impacted by restrictions and limitations related to the COVID-19 pandemic. During the 2 lockdown periods from 30 March 2020 to 12 May 2020 and the much longer period from 9 July 2020 to 28 October 2020, cardiac services were severely curtailed with significant reductions in the number of elective admissions and procedures (up to 80%), as well as diagnostic studies and outpatient consultations. Furthermore, the use of personal protective equipment (PPE) and the protocols set up by hospitals in their emergency departments, catheterisation laboratories and cardiac wards collectively impacted on processes involved in patient care- resulting in increased difficulties in assessing patients and delays in commencing and administering treatment. With all these effects plus the likely negative influence on patient presentations to medical facilities and under-utilisation of hospital resources, this special section was added to this year's report, aimed at characterising the range of effects the pandemic had on PCI services in Victoria in 2020.



Active COVID-19 cases

In order to determine how many cases of PCI were performed on active COVID-19 cases in 2020, VCOR prospectively collected additional data fields to try to identify the COVID-19 status of patients undergoing PCI. Sites were asked to collect data on whether patients had active or probable COVID-19 infection and whether this was subsequently confirmed by testing. A total of 61 patients were identified as active or probable COVID-19 cases in the 2020 calendar year. However, it transpired that the field definition provided to sites was not precise enough and some sites considered patients who required full PPE (e.g. acute STEMI patients) as being a “probable” COVID-19 infection. Additionally, the follow-up question of how many of these patients actually were confirmed COVID-19 cases was not adequately collected. As a result, VCOR contacted all hospitals that recorded a potential COVID-19 PCI case and requested that data managers conduct their own site surveys to determine how many active COVID-19 patients were treated with PCI. Most, but not all sites completed this task and no case of PCI being performed on an active COVID-19 positive patient was found. We believe that these data provide a strong indication that either no or very few patients with known active COVID-19 infection received a PCI in Victoria during the 2020 calendar year.

Effects on case numbers

The pandemic did not significantly affect overall PCI case numbers in 2020. There was a total of 12,349 PCI cases in Victoria - very similar to the number of cases in 2019 (n=12,355) and 2018 (n=12,463). However, in 2020, the proportion of cases presenting with an ACS was just over 50%, reversing a trend in previous years when 50-52% of cases were for non-ACS indications. This change in casemix in 2020 was relatively modest, but is consistent with an effect resulting from the reduction in elective cases during the 2 lockdown periods in Victoria during this time. Additionally, there were proportionally fewer patients treated in the private sector, but no differences in the proportion of cases from metropolitan and non-metropolitan centres or between lower socio-economic and higher socio-economic groups (Table 17). STEMI numbers in 2020 did not appear to be affected by the pandemic, with a 6% increase over the previous year. However, there was a modest reduction in the proportion of STEMI patients managed in the private sector from 12% in 2019 to 10% in 2020.

Table 17: Characteristics of patients undergoing PCI comparing the 2020 ‘COVID-19 year’ to the 2019 ‘pre-COVID year’

	Pre-COVID year 2019 (N=12355)	COVID year 2020 (N=12349)
Demographics/presentation	%	%
ACS indication	48.0	51.0
Public hospital treatment	56.4	58.6
Low SES	23.0	23.0
Non-metro hospital treatment	28.0	27.0
Median DBT (mins)	58	62
Achieved DBT ≤90mins	80.8	74.7
Median SBT (mins)	171	181
Median SDT (mins)	110	115
Outcomes	%	%
Procedural success	92.0	93.0
In hospital mortality	1.7	1.4
30-day MACE	4.0	3.0
30-day stroke	0.4	0.4

Effects on treatment of acute STEMI

Lockdown-related social restrictions, fear of presenting hospitals and general concern about virus exposure may have all played a part in discouraging patients to present early with symptoms of suspected heart attack during the COVID-19 period. Among patients with STEMI, there was a small increase in the time taken from symptom onset to hospital presentation in 2020 and as a consequence, there was additional delay from onset of the STEMI to reperfusion with primary PCI (symptom-to-balloon time) (Table 17). This effect was more pronounced in some institutions, with one Victorian hospital reporting a fourfold increase in symptom-to-door time and up to 6 hours additional delay to hospital presentation during the COVID-19 period [17].

As outlined earlier in this report, modest increases in door-to-balloon time compared to the previous year were also observed, representing a reversal of the trend of sequential falls in DBT from 2015 to 2019 (Table 13). Three hospitals did not manage to achieve a median DBT ≤ 90 minutes, whereas all hospitals reached this benchmark in 2019. Furthermore, fewer than 50% of the hospitals achieved a DBT ≤ 90 minutes in greater than 75% of primary PCI cases, representing a significant decline compared to the previous year (43% in 2020 vs 62% in 2019). We believe that findings with primary PCI were to be expected to allow for appropriate COVID-19 assessment and infection control measures in a high-risk, high exposure environment such as the catheterisation laboratory.

Effects on procedural and clinical outcomes

Overall, the procedural and clinical outcomes of PCI in 2020 were broadly similar to previous years and on a number of performance measures, outcomes were actually better in 2020 than in 2019. There were no signals of worse outcomes in any outcome measure that could be related to the effects of the COVID-19 pandemic on patient-related behaviour or hospital-related management. Actual procedural outcomes were unchanged from the previous years. Rates of complex procedures and high-risk cases were similar. Procedural complications such as the need for emergency CABG surgery were half the rate of the previous year.

With respect to key performance indicators, there was no excess in in-hospital mortality in 2020 compared with previous years. In fact, for all major clinical subgroups - STEMI, NSTEMI-ACS, shock and/or intubated OHCA and non-ACS - in-hospital mortality rates were lower than in 2019. Despite a strong push from hospital administrators and health bureaucrats to minimise the duration of hospital admissions, there were no substantive changes in length of stay metrics and notably, no increase in rates of same day discharge following PCI. The 30-day risk-adjusted mortality rate was lower than in 2019 and despite longer times to presentation and longer delays with door-to-balloon time, there was no change in 30-day mortality for STEMI compared with previous years. Finally, patient-reported measures of quality of life showed that rates of anxiety and depression at follow-up were unchanged in 2020.

Women undergoing PCI

Despite there being no sex-related differences in the approach to treatment of coronary artery disease, national and international research consistently demonstrate that women appear less likely to receive appropriate treatment such as guideline-recommended drug therapy, access to coronary angiography and timely reperfusion for acute myocardial infarction [18, 19]. Differences with revascularisation rates with percutaneous coronary intervention have also been noted, despite women typically presenting at an older age and with more comorbidities. It is not as clear though whether outcomes for women are poorer, with some studies suggesting worse short-term outcomes while others have suggested that longer-term outcomes are actually improved in women [20]. This year's report has included a special section about women undergoing PCI to gain more insights regarding the interactions between sex and PCI in Victoria as currently practiced.

Table 18 shows trends over time in patient characteristics by sex. The rate of PCI in both females and males over the age of 70 years has steadily increased over time, although elderly females (>70 years of age) remain disproportionately represented within this patient subgroup. The prevalence of severe obesity and diabetes and the proportions of patients treated in the private sector have been similar among the sexes and not substantially changed in the last 6 years. With respect to the type of presentation, there has been little difference in the proportions of cases that present with ACS among men and women. Similarly, for indications for non-ACS PCI, there were only low numbers of cases with either no or only 1 key clinical factor for PCI (anginal symptoms, positive functional test and/or significant coronary stenosis), although proportions of these cases did appear a little lower among men. There were no substantive sex differences over time in the proportions of patients that were metropolitan-based or had lower socio-economic status.

Table 18: Trends over time in patient characteristics and types of presentation by sex

Patient characteristics & presentation	Trends in women							Trends in men						
	2015 (n=2128)	2016 (n=2359)	2017 (n=2689)	2018 (n=2949)	2019 (n=3021)	2020 (n=3021)	Total (N=16,167)	2015 (n=7101)	2016 (n=7676)	2017 (n=8318)	2018 (n=9514)	2019 (n=9334)	2020 (n=9328)	Total (N=51,271)
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Age >70yrs	48.8	48.4	50.7	52.1	52.8	53.7	51.3	32.4	33.7	34.8	36.0	37.7	37.3	35.5
Body Mass Index (BMI) ≥35kg/m ²	16.0	14.0	16.4	14.0	15.7	15.3	15.2	10.7	11.4	10.6	10.6	10.6	10.5	10.7
Diabetes	25.1	24.8	24.8	23.9	25.3	24.7	24.8	22.3	20.7	20.7	22.2	22.5	23.4	22.0
Private hospital	37.2	40.1	40.7	44.6	44.3	41.7	41.7	36.3	37.3	39.3	41.6	43.3	41.3	40.1
ACS indication	53.6	54.0	52.5	48.7	49.0	53.8	51.7	52.5	52.8	49.6	49.4	47.6	50.0	50.1
0-1 key clinical factors for non-ACS indication				12.4	12.2	12.3	12.3				12.9	10.6	9.4	11.0
Metropolitan hospital	70.5	71.9	70.8	72.9	71.1	73.5	71.9	72.4	71.3	72.2	72.2	72.8	73.0	72.3
Low SES	27.1	27.5	26.3	26.2	24.3	24.2	25.8	24.7	24.8	24.8	22.9	22.6	21.9	23.5

When examining selected features relating to the PCI procedure, Table 19 demonstrates that the use of radial artery access has significantly increased in both sexes over the last 6 years, although, as Australian research has shown, women have lower rates than men at each time point [21]. Rates of complex PCI (left main disease and multivessel PCI and CTO) were similar among men and women, as was the use of adjunctive imaging techniques such as IVUS and OCT. For patients presenting with STEMI, PHN was utilised in similar proportions. There has been a trend towards shorter DBT over time - equally among men and women - and DBT have been more or less equivalent in length for both sexes. In contrast, women have generally taken longer to present after symptom onset (SDT), and the gap between the sexes with this measure has not improved.

Table 19: Trends over time in procedural characteristics by sex

Procedural characteristics	Trends in women							Trends in men						
	2015 (n=2128)	2016 (n=2359)	2017 (n=2689)	2018 (n=2949)	2019 (n=3021)	2020 (n=3021)	Total (N=16,167)	2015 (n=7101)	2016 (n=7676)	2017 (n=8318)	2018 (n=9514)	2019 (n=9334)	2020 (n=9328)	Total (N=51,271)
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Radial access	39.7	47.9	55.2	60.7	64.2	68.8	57.3	46.7	57.5	62.4	68.0	72.9	76.7	65.0
Left main PCI	1.7	1.7	2.2	2.2	2.4	2.2	2.1	1.6	2.0	2.1	2.4	2.0	2.3	2.1
Multivessel PCI	6.3	6.0	7.6	8.4	7.5	7.4	7.3	6.7	7.5	8.0	9.4	7.6	8.4	8.0
Chronic total occlusion	3.5	3.6	2.6	2.9	3.0	3.0	3.1	4.8	4.1	3.8	3.8	4.0	4.2	4.1
IVUS or OCT	1.3	1.7	1.6	1.8	3.0	4.0	2.3	1.8	1.8	1.7	2.2	2.7	3.9	2.4
Primary PCI cases only	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Pre-hospital notification	48.0	53.0	53.0	70.0	74.0	72.0	63.0	52.0	55.0	58.0	68.0	73.0	73.0	64.0
Proportion of cases DBT ≤90mins	62.6	69.1	74.4	78.6	81.6	73.7	74.1	67.3	72.5	77.6	80.9	80.5	75.0	76.0
Median DBT (mins)	77	70	65	59	57	66	64	71	66	63	58	58	61	62
Median SDT (mins)	117	130	115	113	118	127	120	100	107	110	108	104	104	105

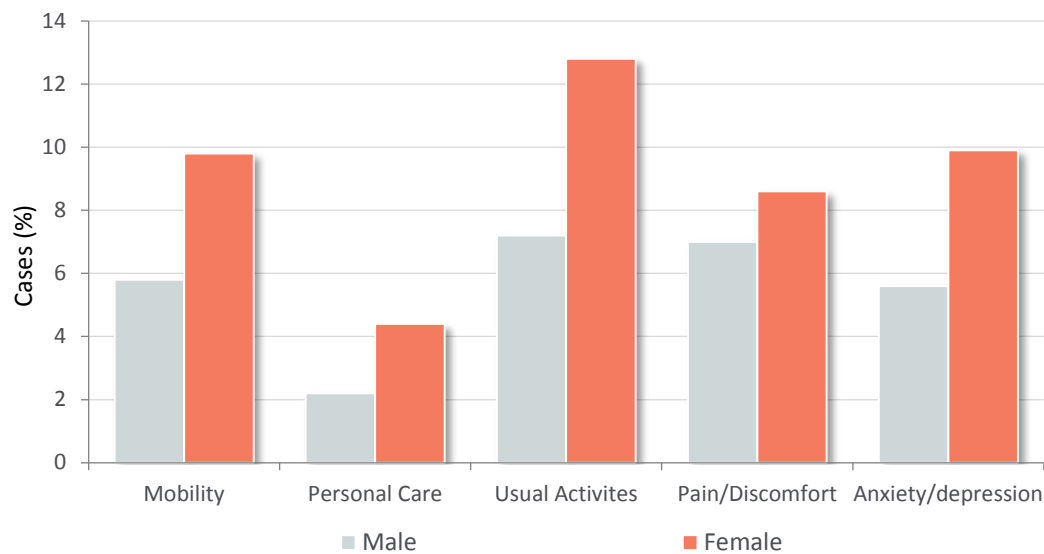
Procedural success rates were similar between the sexes, as were the use of guideline-recommended medications and referrals to cardiac rehabilitation. Length of stay appeared to be longer for women - a trend that was evident over time. Rates for in-hospital mortality and major bleeding appeared to favour men, with lower rates than women year-on-year. In contrast, unplanned revascularisation rates and in-hospital mortality for cases of shock and/or intubated OHCA were similar among men and women. At 30 days, MACE rates were lower among men but the incidence of stroke was similar (Table 20).

Table 20: Trends over time in procedural outcomes by sex

Procedural outcomes	Trends in women							Trends in men						
	2015 (n=2128)	2016 (n=2359)	2017 (n=2689)	2018 (n=2949)	2019 (n=3021)	2020 (n=3021)	Total (N=16,167)	2015 (n=7101)	2016 (n=7676)	2017 (n=8318)	2018 (n=9514)	2019 (n=9334)	2020 (n=9328)	Total (N=51,271)
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Procedural success	89.0	90.8	91.0	90.8	91.4	92.5	91.0	90.3	91.3	91.2	91.6	92.6	93.0	91.7
Discharged on 4-5 recommended medications	82.0	82.0	81.0	81.0	79.0	80.0	81.0	83.0	84.0	83.0	82.0	81.0	82.0	82.0
Referral to cardiac rehabilitation	84.4	82.2	80.5	83.8	84.0	83.0	83.0	85.0	83.5	82.3	83.9	84.0	85.7	84.1
Median LOS (days)	3.0	3.0	3.0	3.0	2.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
In hospital mortality	2.2	2.3	2.2	1.5	2.2	1.6	2.0	1.5	1.7	1.6	1.3	1.5	1.4	1.5
In hospital major bleeding	1.5	1.7	0.9	1.2	1.1	1.1	1.2	0.9	0.7	0.5	0.5	0.5	0.4	0.6
In hospital unplanned revascularisation	0.7	1.0	0.6	0.7	0.4	0.5	0.6	0.8	0.6	0.7	0.6	0.6	0.4	0.6
In hospital mortality-shock/OHCA patients	47.0	42.0	47.0	33.0	46.0	33.0	41.0	37.0	36.0	40.0	35.0	42.0	35.0	37.0
30-day MACE	4.8	4.9	4.7	4.3	4.3	3.4	4.4	3.9	3.7	3.8	3.2	3.5	3.3	3.7
30-day stroke	0.4	0.4	0.3	0.3	0.5	0.6	0.4	0.3	0.5	0.4	0.4	0.3	0.4	0.4

Sex differences in responses to quality-of-life (QoL) questionnaires were also examined. For each domain of the QoL survey (mobility, personal care, usual activities, pain/discomfort, anxiety/depression), at least “some problem” was more commonly reported among women than men (Figure 22). This is consistent with previous reports. However, the initial clinical presentation (ACS vs non-ACS) did not influence responses.

Figure 22: Quality of life metrics: Reporting of some problem by sex



Outcomes

Lesion and procedure success rates

The successful treatment of a coronary lesion is defined as having a residual stenosis of <10% following stent placement and <50% following balloon angioplasty alone. In 2020, the mean lesion success rate was similar to the previous year (95.3% in 2020 vs 94.9% in 2019) but varied among hospitals (range 82%-98%). The procedural success rate is defined as the successful treatment of all lesions and the absence of any major in-hospital complications. For 2020, the mean procedural rate was 92.8%, with the range among hospitals of 82%-98%. These measures of success have remained largely stable over the last several years.

A comparison of selected clinical and lesion features associated with procedural success and failure is shown in Table 21. Unsuccessful procedures were more commonly associated with particular comorbidities including moderate and severe left ventricular impairment, cardiogenic shock and chronic total occlusion (CTO) lesions. A higher rate of failed procedures occurred out-of-hours.

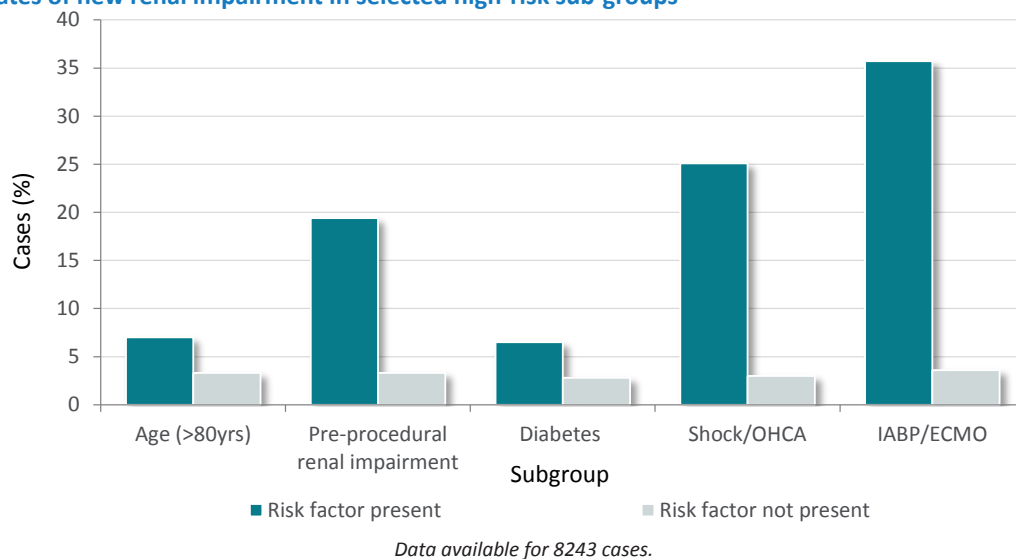
Table 21: Comparison of clinical and lesion features among successful and failed PCI cases

Clinical and lesion characteristics	Successful procedures (n=11465)	Failed procedures (n=884)
Age- years (Mean ± SD)	66.8 (±12.0)	68.2 (±12.2)
	N (%)	N (%)
Sex- female	2794 (24.4)	227 (25.7)
Diabetes	2678 (23.4)	256 (29.0)
PVD history	368 (3.2)	47 (5.3)
CBVD history	388 (3.4)	47 (5.3)
Previous PCI	3854 (33.6)	293 (33.2)
Previous CABG	661 (5.8)	64 (7.2)
eGFR≤45/Renal replacement therapy	973 (8.5)	161 (18.2)
Normal LVEF (≥50%)	7498 (70.5)	407 (52.4)
Mild LVEF (45-49%)	1679 (15.8)	119 (15.3)
Moderate LVEF (35-44%)	989 (9.3)	118 (15.2)
Severe LVEF (<35%)	466 (4.4)	133 (17.1)
Shock and/or intubated OHCA	163 (1.4)	163 (18.4)
Out-of-hours	2127 (18.6)	238 (26.9)
Public hospital	6647 (58.0)	593 (67.1)
Chronic total occlusion	319 (2.8)	162 (18.3)
ACC/AHA B2/C lesion	7005 (61.1)	726 (82.1)

New renal impairment

New renal impairment (NRI) is defined as serum creatinine rise $>44.2 \mu\text{mol/L}$ or 25% above pre-procedural value within 5 days of a PCI procedure. It occurs more commonly in patients with cardiogenic shock and other known high-risk sub-groups [22] (Figure 23). The overall rate of NRI in 2020 was 3.8%, similar to the previous year. NRI rates were especially high among patients with shock and/or intubated OHCA and those needing mechanical support (25% and 31% respectively). For the subgroup of patients with pre-existing renal impairment, the rate of worsening renal impairment post-PCI was 19% - higher than in 2019 when it was 14%.

Figure 23: Rates of new renal impairment in selected high-risk sub-groups



When assessing the rate of NRI by clinical presentation, patients with acute STEMI had the highest incidence, with a rate of 7%. Patients with NSTEMI-ACS had a lower rate of 3.2% and non-ACS patients had a rate of 2%. It is noteworthy that these results are based on a subgroup of the entire patient cohort, as 33% of PCI procedures did not have post-PCI renal function actually measured.

Referral to cardiac rehabilitation

Australian practice guidelines strongly recommend patients undergoing PCI for any indication be referred to a cardiac rehabilitation/secondary prevention program [13, 23]. Referral rates have generally been high among Victorian hospitals, and in 2020, the rate was 85% overall, varying with clinical presentation (Table 22). Rates were higher among patients presenting with acute coronary syndromes. As in previous years, referral rates among patients treated in the private sector were lower (89.5% public vs 79.3% private).

Table 22: Rates of referral to cardiac rehabilitation by clinical presentation

Clinical presentation	Cases with data available	Rehabilitation referral rate
	N	N (%)
STEMI	2066	1942 (94.0)
NSTEMI-ACS	3057	2680 (87.7)
Non-ACS	5160	4122 (79.9)
All cases	10283	8744 (85.0)

Compliance with guideline-recommended medications at discharge

Several classes of medication have a strong evidence base for usage post-PCI, including dual antiplatelet therapy (DAPT) and statins [7]. Rates of DAPT use remain high in 2020- across both public and private sectors. Overall statin use was also high, although a gap between public sector and private sector prescriptions of statins remains a persistent observation over time (Table 23). This gap may be a reflection of the differences in demographic profiles between public and private sector patients, particularly the older age range in private.

Table 23: Rates of prescription of dual antiplatelet therapy and statins at discharge

Medications	All sites	Public	Private
	N (%)	N (%)	N (%)
Dual antiplatelet therapy*	11518 (95.0)	6780 (96.4)	4738 (93.1)
Statin	11202 (92.7)	6730 (95.9)	4472 (88.4)

* DAPT is aspirin plus another antiplatelet drug.

Beta blockers and ACE inhibitors/angiotensin receptor blockers (ARB) are also guideline-recommended for patients presenting with an acute coronary syndrome [24]. The rates of use of these medications by clinical presentation are shown in Table 24. As expected, patients presenting with STEMI had the highest rates of prescription at discharge, while the lowest rates were seen in patients undergoing PCI for non-ACS conditions.

Table 24: Rates of prescription of selected medications at discharge by clinical presentation

Clinical presentation	DAPT	Statin	BB	ACE-I/ARB
	%	%	%	%
STEMI	96.1	97.4	87.0	84.7
NSTE-ACS	95.7	93.8	71.1	72.9
Non-ACS	94.1	90.2	54.8	62.5

As a quality measure, the number of patients discharged with prescriptions for at least 4 of the 5 evidence-based medications (aspirin, second antiplatelet agent, statin, beta blocker and ACE inhibitor/ARB) was assessed. In 2020, 93% of STEMI patients were discharged on at least 4 of the 5 recommended medications and 86% among NSTE-ACS patients.

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 [25]
- 30-day major adverse cardiac and cerebrovascular event (MACCE)

In-hospital mortality

The overall unadjusted in-hospital mortality rate for 2020 was 1.5%, slightly lower than in the previous year. Table 25 outlines the in-hospital mortality rates for selected clinical groups and as expected, mortality varied with patient acuity. Patients with cardiogenic shock and/or intubated OHCA patients had the highest rate of in-hospital mortality. Compared with the previous year, 2020 rates of shock and/or intubated OHCA (35.6% in 2020 vs 42.8% in 2019) and STEMI (5.4% in 2020 vs 6.2% in 2019) were lower. When high-acuity cases were excluded from the analysis, the in-hospital death rate fell to a rate of 0.4%.

Table 25: Unadjusted in-hospital mortality rates for selected patient groups

Patient category	Total	In-hospital mortality rate
	N	N (%)
All PCI patients	12349	184 (1.5)
STEMI	2592	140 (5.4)
Shock and/or intubated OHCA	326	116 (35.6)
NSTE-ACS	3695	19 (0.5)
Non-ACS	6062	25 (0.4)

Trends in the rates of in-hospital mortality over time are shown in Table 26. In 2020, in-hospital mortality in lower acuity cases such as NSTE-ACS and non-ACS were the lowest they have been in 6 years.

Table 26: Trends in in-hospital mortality rates for selected clinical presentations: 2015-2020

Patient category	2015 (N=9229)	2016 (N=10035)	2017 (N=11007)	2018 (N=12463)	2019 (N=12355)	2020 (N=12349)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
All PCI patients	155 (1.7)	193 (1.9)	204 (1.9)	174 (1.4)	212 (1.7)	184 (1.5)
STEMI	113 (5.7)	138 (6.4)	145 (6.4)	119 (4.7)	148 (6.2)	140 (5.4)
Shock and/or intubated OHCA	102 (40.3)	119 (38.5)	133 (42.9)	116 (35.3)	138 (43.1)	116 (35.6)
NSTE-ACS	25 (0.9)	29 (0.9)	34 (1.0)	29 (0.8)	27 (0.8)	19 (0.5)
Non-ACS	17 (0.4)	26 (0.6)	25 (0.5)	26 (0.4)	37 (0.6)	25 (0.4)

In-hospital mortality related to primary PCI was also examined by hospital volume (Table 27). Despite lower volume hospitals showing greater treatment delays, in-hospital outcomes were either similar or actually better than hospitals with busier STEMI services, even when cases of shock or intubated OHCA were excluded. However, at 30 days the trend was not quite as clear. While overall (unadjusted) mortality was lower in lower volume hospitals, this trend was reversed when cases of shock or intubated OHCA were excluded. This implies that there may be some biases present, with lower-volume hospitals having proportionally fewer high-risk cases - particularly shock and intubated OHCA (Figure 12) - skewing their overall results towards more favourable outcomes. Similar findings were seen when overall 30-day MACCE rates and 30-day MACCE rates excluding shock and intubated OHCA were compared (Table 27).

Table 27: Outcomes for primary PCI by hospital volume

	All sites	Sites with ≥36 Primary PCI Site volume ≥200	Sites with <36 Primary PCI Site volume <200
	(N=1623)	(n=1509)	(n=114)
Median LOS- days	4.0	4.0	4.0
	%	%	%
In hospital mortality	5.5	5.7	3.6
In hospital mortality excl shock and/or intubated OHCA	2.4	2.5	2.0
In hospital unplanned revascularisation	2.1	2.1	0.9
In hospital major bleeding	0.8	0.9	0.0
30-day mortality	6.1	6.2	5.4
30-day mortality excl shock and/or intubated OHCA	3.1	3.0	3.9
30-day MACCE	9.4	9.5	7.0
30-day MACCE excl shock and/or intubated OHCA	5.1	5.1	5.6

This analysis demonstrated that the relationships between primary PCI case volume and outcomes can be quite complex, with no obvious disadvantage for lower-volume centres with some process and outcome measures, and poorer performance by other measures. VCOR will continue to monitor these interrelationships in future reports.

In-hospital major bleeding

Utilising the standardised bleeding definitions of the Bleeding Academic Research Consortium (BARC)[26], major bleeding events recorded in VCOR comprise BARC Type 3 and Type 5 bleeding. In 2020, the in-hospital major bleeding rate was 0.6% - the same value as the previous year. Major bleeding rates for selected patient subgroups are presented in Table 28. STEMI remains the clinical presentation associated with the highest in-hospital bleeding rate although it has declined over recent years (1% in 2020 vs 1.3% in 2019 and 2.0% in 2018). No major bleeding was observed in patients who required ECMO (n=12), contrasting with previous years when bleeding in this very high-acuity cohort ranged from 20-43%. The major in-hospital bleeding rate for women was almost 3 times the rate for men. Femoral arterial access was associated with a greater than fourfold increase in major in-hospital bleeding compared with radial access.

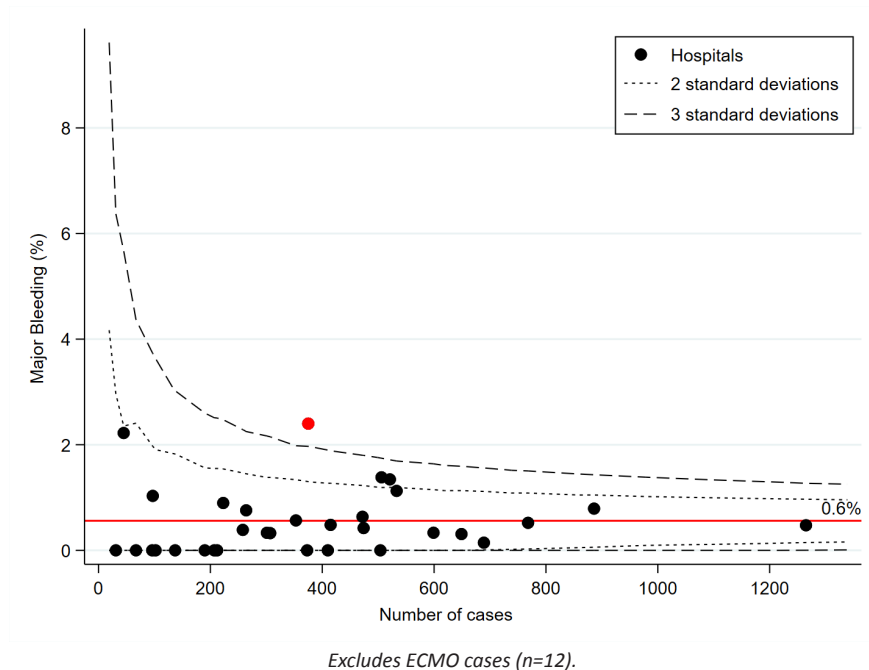
Table 28: In-hospital major bleeding rates for selected patient groups

Sub-group	N	Major bleeding rate
Clinical Presentation		N (%)
STEMI	2589	27 (1.0)
NSTE-ACS	3692	15 (0.4)
Non-ACS	6060	27 (0.4)
Sex		N (%)
Male	9321	37 (0.4)
Female	3020	32 (1.1)
Arterial Access Route		N (%)
Radial access	9224	25 (0.3)
Femoral access	3093	43 (1.4)
Brachial access	24	1 (4.2)
Total	12341	69 (0.6)



Major bleeding rates by hospital are presented in Figure 24. In 2020, one hospital was identified as an outlier, with a major bleeding rate of 2.5% that was >3 standard deviations beyond the mean. In accordance with VCOR's Clinical Quality Reporting and Communication of Variance Policy, timely notification of the result was provided to the hospital's Principal Investigator and Hospital Executive. In turn, the hospital had an opportunity to review its results to ensure data accuracy before its outlier status was confirmed and the VCOR Steering Committee and the Victorian Department of Health and Human Services notified.

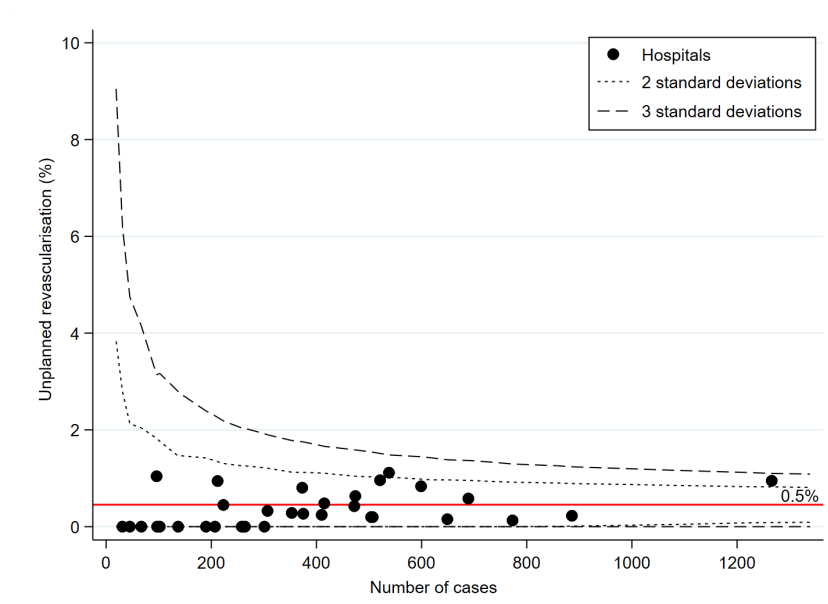
Figure 24: Rates of in-hospital major bleeding by hospital



In-hospital unplanned revascularisation

A revascularisation procedure (PCI or CABG surgery) performed after the initial PCI is considered “unplanned” if it is unexpected and not pre-arranged. Unplanned revascularisation generally occurs in the setting of a post-PCI complication such as stent thrombosis, coronary artery perforation or dissection and is a recognised indicator of hospital performance. Overall, the rate of in-hospital unplanned revascularisation was 0.5%. All participating hospitals had rates of unplanned revascularisation that were within control limits (Figure 25).

Figure 25: Rates of in-hospital unplanned revascularisation by hospital



A total of 14 cases required emergency or urgent cardiac surgery. This is half the number recorded in 2019 and almost one-third the number in 2018. Table 29 presents selected clinical features and outcomes that were associated with emergency cardiac surgery following PCI. The majority had complex coronary lesions (Type C) and 6 cases were in the setting of acute STEMI. Three PCI cases that required emergency cardiac surgery were performed in centres without on-site surgical backup, with those patients requiring inter-hospital transfer before undergoing surgery. This number was lower than in previous years (8 patients in 2019 and 4 patients in 2018). Mortality and major bleeding rates were significantly higher among the emergency cardiac surgery patients compared to the overall cohort.

Table 29: Selected clinical features and outcomes associated with emergency CABG surgery

Presentation	Emergency CABG (N=14)
	N (%)
STEMI	6 (42.9)
Shock and/or intubated OHCA	1 (7.1)
Complex lesions (Type C)	12 (85.7)
Chronic total occlusion	2 (14.3)
Unprotected left main PCI	2 (14.3)
PCI performed in hospitals without on-site surgery	3 (21.4)
In-hospital outcomes	N (%)
Mortality	1 (7.7)
New MI	2 (15.4)
Major bleeding	1 (7.7)
Stroke	1 (7.7)
Definite and probable stent thrombosis	1 (7.7)

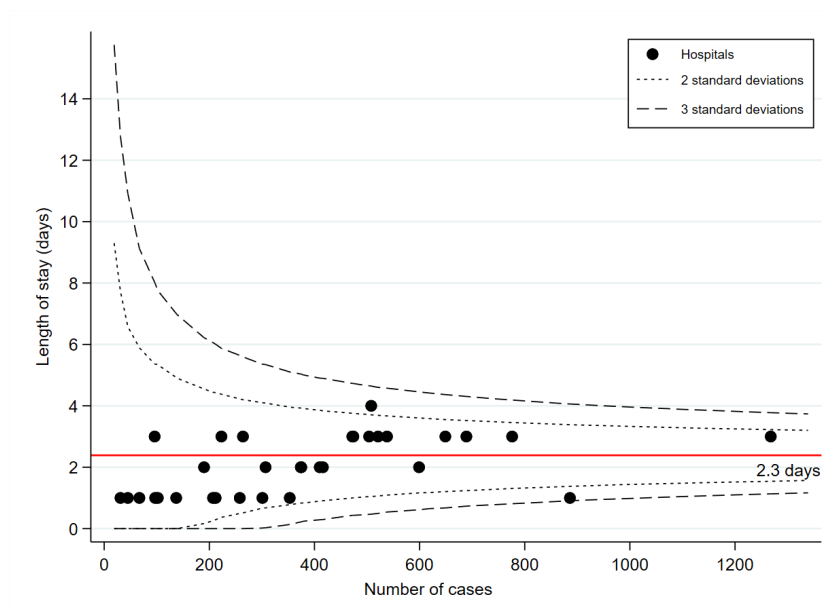
Length of stay

The median length of stay varied by clinical presentation, ranging from 4 days for STEMI PCI cases to 1 day for patients undergoing PCI for elective non-ACS indications. PCI cases for NSTEMI and unstable angina had a median length of stay of 3 days. Median length of stay was shorter among patients treated in private hospitals (3 days public vs 2 days private). These data are largely unchanged from previous years.

A total of 308 PCI cases (2.5%) were discharged on the same day, mostly involving patients treated in the public sector (82.8% public patients). The rate of same-day discharge in the public sector was 3.5% and 1% in the private sector, with this difference potentially reflecting the different funding arrangements for the 2 sectors. The uptake of same-day discharge has not substantially increased over time, ranging between 1.5%-2.5% over the last 7 years [27] with rates much lower than seen in international practice [28].

Figure 26 compares the median length of stay by hospital. All hospitals' median length of stay were within control limits and no site was identified as an outlier. Further, there was no apparent relationship between median length of stay and hospital volume.

Figure 26: Median length of stay by hospital



As most of the variation in length of stay is likely to occur among non-elective admissions for ACS conditions, comparative hospital length of stay was also examined by clinical presentation. Figure 27 shows median length of stay for ACS cases (STEMI, NSTEMI and unstable angina) for all hospitals. The range was 2-5 days and all hospitals were within control limits. For non-ACS cases, the length of stay range was 1-2 days, and again, there were no outlier hospitals (Figure 28).

Figure 27: Length of stay by clinical presentation ACS cases

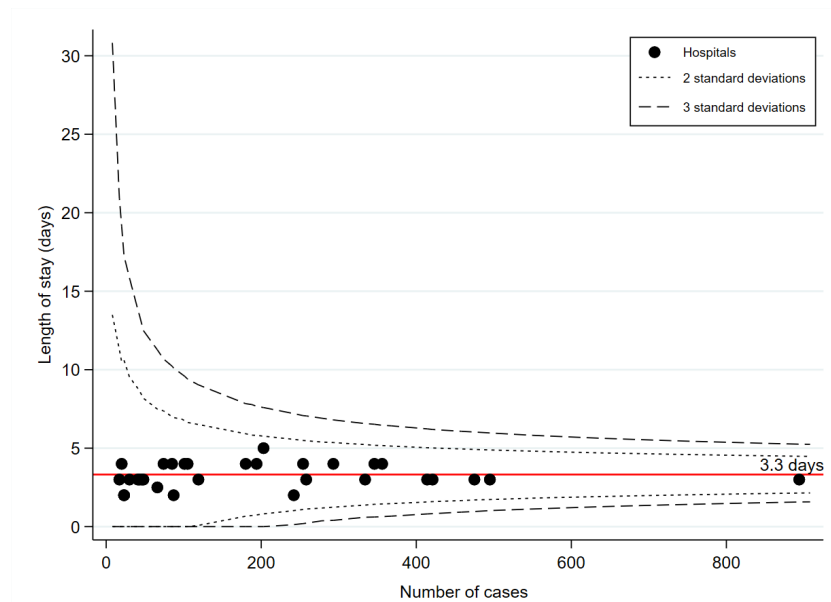
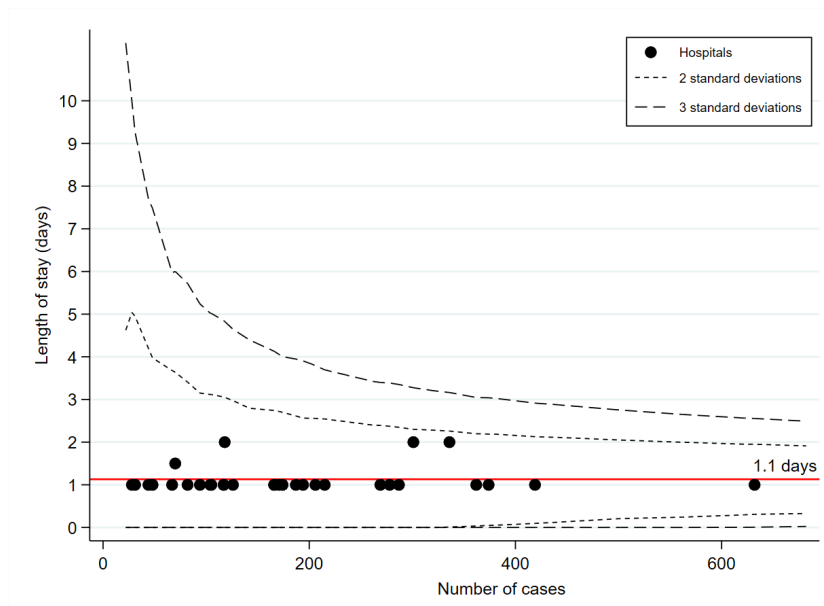


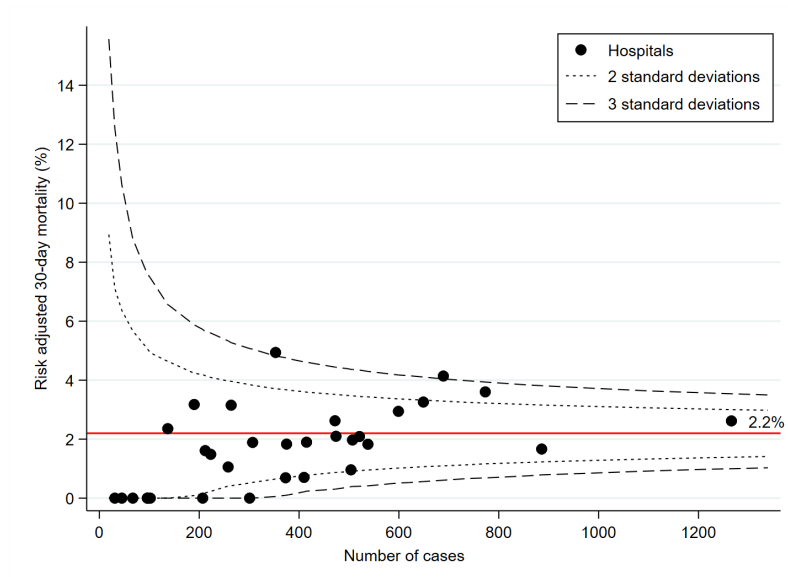
Figure 28: Length of stay by clinical presentation non-ACS cases



30-day risk-adjusted mortality

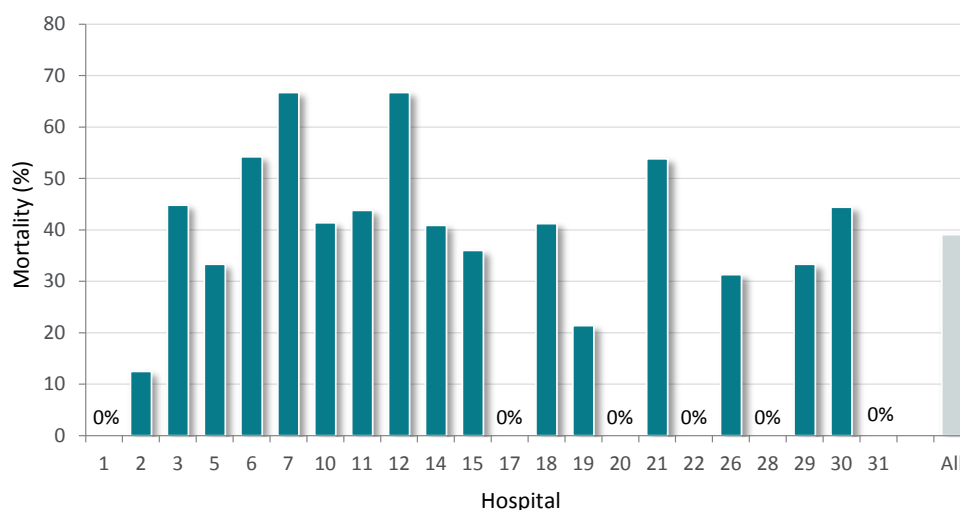
The risk-adjusted 30-day mortality across the 2020 cohort was 2.2%. All participating hospitals had rates of risk-adjusted 30-day mortality that were within control limits (Figure 29). There was no apparent relationship between risk-adjusted mortality and hospital volume evident.

Figure 29: Risk-adjusted 30-day mortality rates by hospital



The unadjusted 30-day mortality rates for shock and/or intubated OHCA cases by hospital are shown in Figure 30. The mean mortality rate was 39%. Multiple hospitals did not treat any shock and/or intubated OHCA cases, while several who treated these patients had zero mortality. As observed in previous reports, the hospitals with either very low or high mortality tended to have low numbers of shock and/or intubated OHCA cases.

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

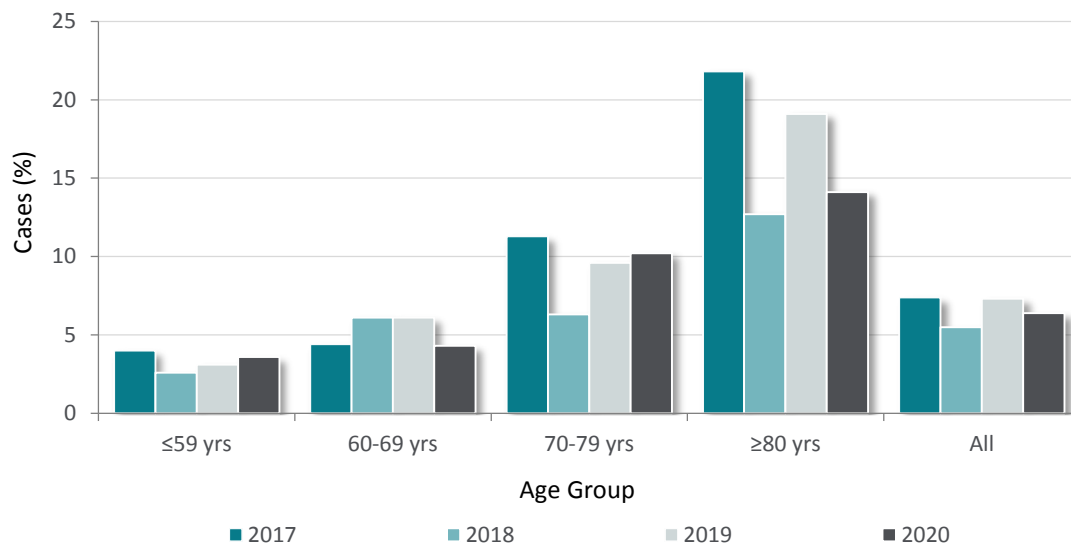


Hospital	1	2	3	5	6	7	10	11	12	14	15	17	18	19	20	21	22	26	28	29	30	31	ALL
Cases (N)	1	8	29	6	24	3	58	16	3	22	25	1	17	14	1	13	2	32	5	3	36	3	322

Hospitals 4, 8, 9, 13, 16, 23, 24, 25, 27 & 32 had no shock or intubated OHCA cases.

For patients who presented with STEMI, the overall 30-day mortality rate was 6.4% - a reduction of just under 1% over the previous year and comparable to large international series [8]. A comparison of 30-day mortality rates for STEMI by age over a 4-year period is shown in Figure 31. Greatest variation in mortality was seen in the ≥ 80 yrs age group, which also had the highest mortality overall.

Figure 31: 30-day mortality for STEMI by age group



30-day major cardiac and cerebrovascular events (MACCE)

The composite endpoint of major adverse cardiac and/or cerebrovascular events (MACCE) comprises the adverse outcomes of death, new or recurrent myocardial infarction or stent thrombosis, target vessel revascularisation or stroke. Overall, the 30-day MACCE rate in 2020 was 3.6% (Table 30), a slight decline from the previous year. When the high-risk conditions of cardiogenic shock or out-of-hospital cardiac arrest were excluded, the MACCE rate declined to 2.6%.

Table 30: Major adverse cardiac and cerebrovascular event rates

MACCE component**	In-hospital events	30-day events*
	N (%)	N (%)
Mortality	178 (1.4)	231 (1.9)
Myocardial infarction	46 (0.4)	109 (0.9)
Stroke	38 (0.3)	52 (0.4)
Definite stent thrombosis	18 (0.1)	30 (0.2)
Probable stent thrombosis	1 (<0.1)	4 (<0.1)
Target vessel revascularisation (TVR) [†]	56 (0.5)	147 (1.2)
MACCE	279 (2.3)	448 (3.6)

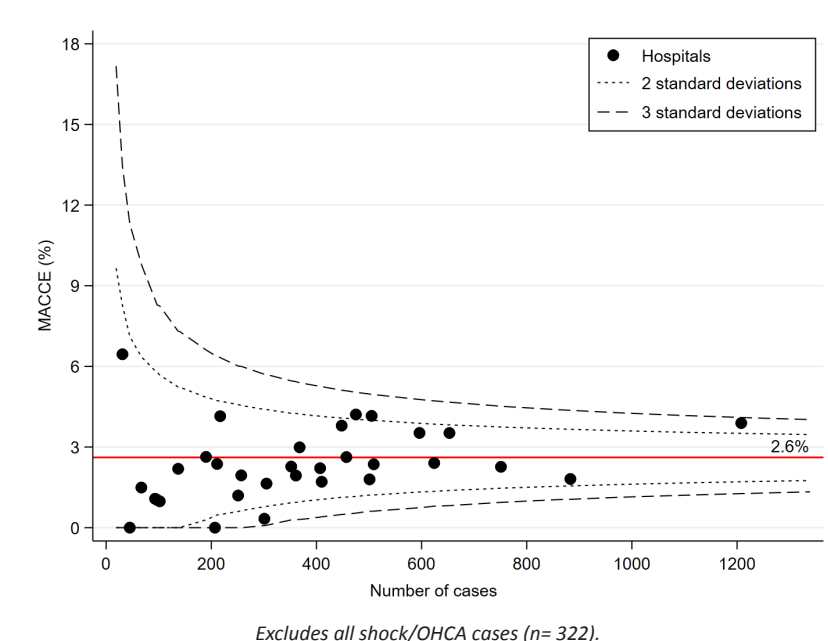
*30-day events reported include in-hospital events.

[†]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=10). Categories are not mutually exclusive.

A comparison of 30-day MACCE rates by hospital is shown in Figure 32. All hospitals were within control limits.

Figure 32: 30-day MACCE (excluding shock/OHCA) rates by hospital



30-day stent thrombosis

Stent thrombosis is defined and reported on as a “definite” event (acute coronary syndrome presentation 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). Table 30 presents the 30-day stent thrombosis rates which remain low, with a decline in case numbers compared with previous 5 years.

30-day rehospitalisation

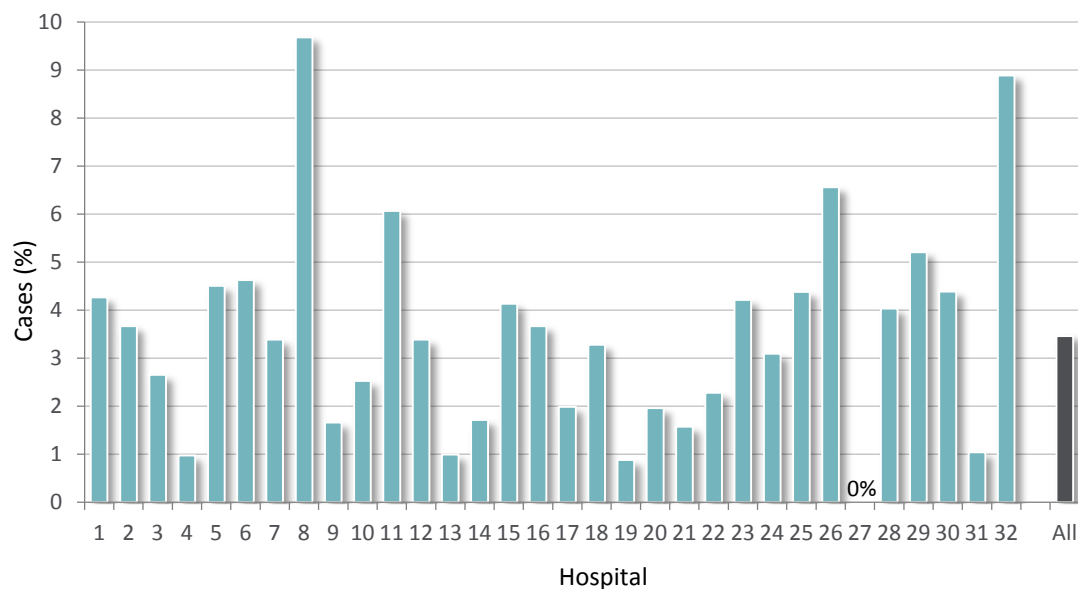
Rehospitalisation within 30 days of discharge following PCI declined across the entire cohort (12% in 2020 vs 13.3% in 2019). Cardiac conditions accounted for 68.2% of rehospitalisations, with almost two-thirds of these being planned rehospitalisations (Table 31). The mean 30-day rehospitalisation rate of 14.3% in the private sector was higher than the cohort mean.

Table 31: Rehospitalisation rates by hospital sector

	All patients (N=12090)	Public (n=7005)	Private (n=5085)
	N (%)	N (%)	N (%)
Rehospitalisations	1454 (12.0)	729 (10.4)	725 (14.3)
Non-cardiac rehospitalisations	463 (3.8)	298 (4.3)	165 (3.2)
Cardiac rehospitalisations	991 (8.2)	431 (6.2)	560 (11.0)
Unplanned cardiac rehospitalisations	418 (3.5)	244 (3.5)	174 (3.4)
Planned cardiac rehospitalisations	573 (4.7)	187 (2.7)	386 (7.6)

The rate of unplanned cardiac rehospitalisation by hospital is shown in Figure 33. This metric can be used as an indicator of hospital performance in relation to PCI. While the overall rate of unplanned cardiac rehospitalisation was low (3.5%), there was variation across hospitals (0% to 9.75%).

Figure 33: 30-day unplanned cardiac rehospitalisation rates by hospital

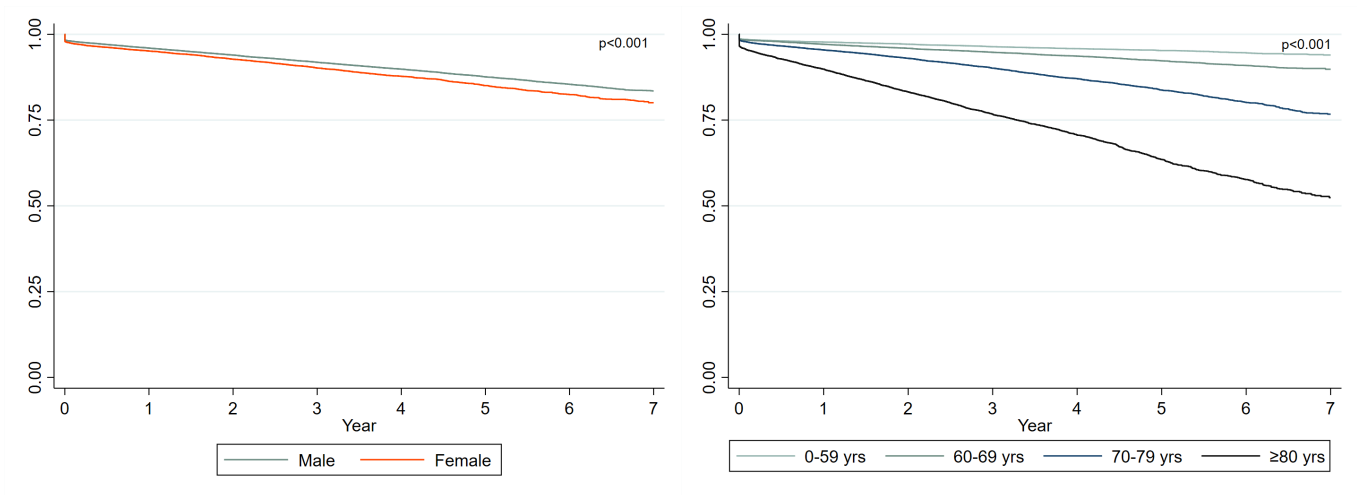


Long-term mortality

VCOR undertakes annual linkage to the National Death Index (NDI) to analyse and report on long-term survival after PCI. For the period between 2014-2020, the registry had a total of 75,765 patients who underwent PCI. At the end of 2020, 7,353 patients (9.7%) had died. As ongoing linkages are undertaken, it is expected that the number of deaths will increase as the overall cohort ages.

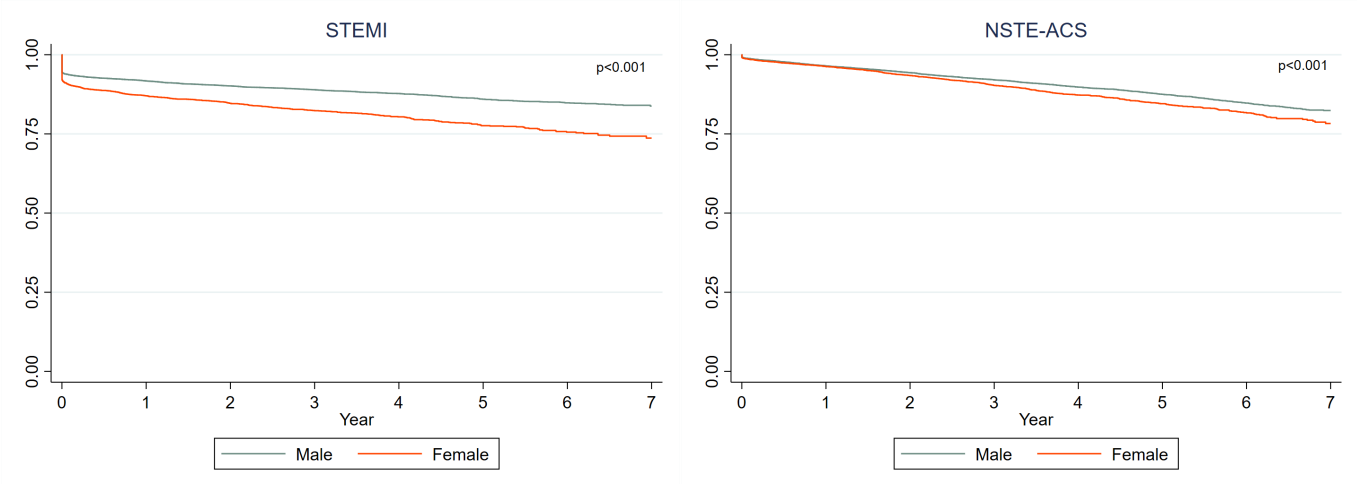
Figure 34 compares long-term survival by sex and separately by various age groupings. Females had worse long-term survival out to 7 years compared to men. At the 7-year post PCI mark, there were 1,993 deaths (11%) among females and 5,360 deaths (9.3%) in males ($p < 0.001$). These results are consistent with several other long-term sex-based series [29], although a recent report suggests that this may be related to baseline age and comorbidities of females rather than an additional sex-specific factor [30]. As expected, there were significant differences in long-term survival with respect to advancing age ($p < 0.001$), with the most rapid decline in long-term survival seen among the elderly (≥ 80 years).

Figure 34: Kaplan-Meier survival curves by sex and age



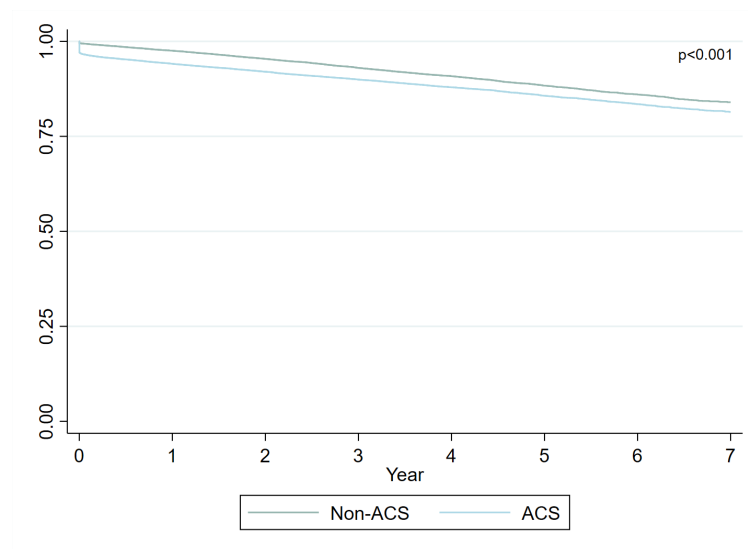
Long-term survival plots in the STEMI and NSTEMI-ACS cohorts by sex are presented in Figure 35. In both groups, long term outcomes were worse for females. For the STEMI cohort (n=15,749) there were 647 deaths (18.6%) among females and 1,454 deaths (11.8%) among males (p<0.001). In the NSTEMI-ACS cohort (n=22,848) there were 662 deaths (11.1%) among females and 1,601 deaths (9.5%) in males (p<0.001).

Figure 35: Kaplan-Meier survival curves by clinical presentation: STEMI and NSTEMI-ACS



We further assessed long-term survival by initial presentation (ACS vs non-ACS). Long-term survival was lower in the ACS cohort (n=38,597) compared with non-ACS patients (n=37,166), with 4,364 deaths (11.3%) in the ACS group and 2,989 deaths (8%) in the non-ACS group ($p<0.001$) (Figure 36).

Figure 36: Kaplan-Meier survival curves by clinical presentation: ACS and Non-ACS

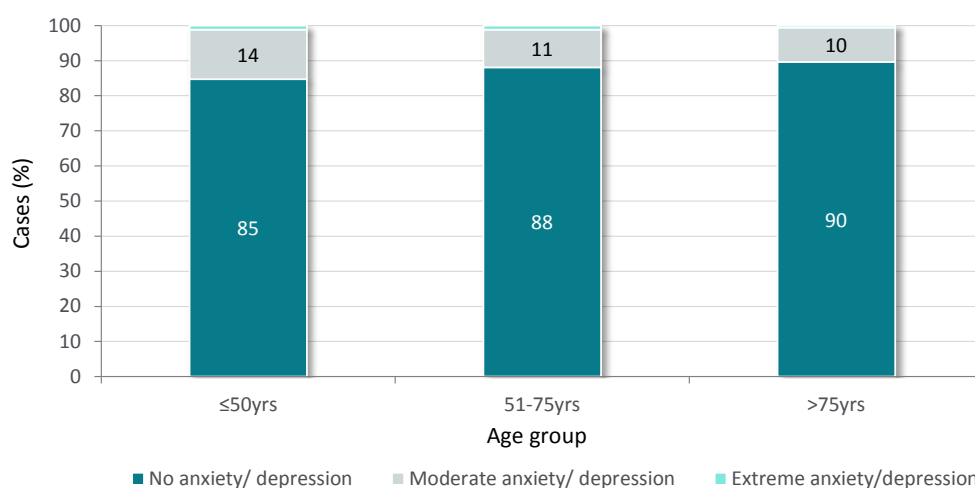


Quality of Life

VCOR utilises the EQ-5D – a validated patient self-assessed Quality of Life (QoL) tool to assess health related QoL at 30-day follow-up [31]. Responses were completed in 72% of cases, with a number of hospitals unable to conduct the questionnaire due to resource constraints. Patients were asked to assess 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 median rating score for a patient's own health status at 30 days post discharge was 80 out of 100 (IQR: 70, 90), unchanged since the previous report. However, just over one-third of patients reported experiencing at least some anxiety/depression, lower than in the previous year (37% in 2020 vs 46% in 2019). Overall, 10.8% of patients reported moderate rates of anxiety/depression and 1.1% reported extreme anxiety/ depression (Figure 37).

Figure 37: EQ-5D responses to anxiety/depression by age group



Socio-economic status influenced the results of quality of life assessment, with higher perceived problem rates for several domains seen among patients with lower SES. However, somewhat paradoxically, patients' assessment of the quality of their own health status was better in the lower SES group, suggesting that overall feelings of well-being are not simply a sum or reflection of the various putative components of good health and happiness (Table 32).

Table 32: Patients reported experience by socio-economic status

Quality of Life components	Low SES (n=1685)	High SES (n=5738)
	%	%
Some problem with mobility	11.8	8.4
Some problem with personal care	4.1	3.6
Some problem with usual activity	13.6	10.9
Moderate pain/discomfort	11.3	9.6
Moderate/extreme anxiety/depression	13.8	11.3
Assessment of own health status (score 0-100)	70.0	62.1

Patients with greater geographic remoteness tended to report worse self-perceived quality-of-life outcomes than metropolitan patients for a number of measures. However, as with patients with low SES, people who were more geographically remote reported higher ratings for their own health status, despite feeling worse with respect to individual components of well-being and happiness (Table 33).

Table 33: Patients reported experience in non-metro vs metro

Quality of Life components	Non-metro (n=2030)	Metro (n=5345)
	%	%
Some problem with mobility	12.1	8.1
Some problem with personal care	3.8	3.6
Some problem with usual activity	14.1	10.6
Moderate pain/discomfort	11.0	9.5
Moderate/extreme anxiety/depression	13.8	11.2
Assessment of own health status (score 0-100)	70.9	61.2

Cardiac Implantable Electronic Devices (CIED)

Background

In 2018 VCOR commenced data collection for cardiac implantable electronic devices (CIEDs), specifically implantable cardiac defibrillators (ICD) and cardiac resynchronisation therapy (CRT). There is limited information in Australia regarding quality assurance with respect to these devices. Initially, 7 Victorian sites commenced data collection, and in 2020, 13 hospitals contributed to this module, including 9 public and 4 private (Table 34). ICDs are an effective treatment for abnormal rapid and potentially lethal heart rhythms. CRTs allow for the synchronised pacing of both the left and right ventricles of the heart, resulting in improved pumping function in patients with diseased heart muscle (cardiomyopathy). Both these device types have clear indications and well-defined appropriate use criteria. Some implanted devices have both ICD and CRT functionality and are included in this registry. However, pacemaker devices that do not have CRT functionality are not currently included due to the much larger number of these devices being implanted and resource limitations in collecting the extra data.

Table 34: Participating Victorian CIED hospitals

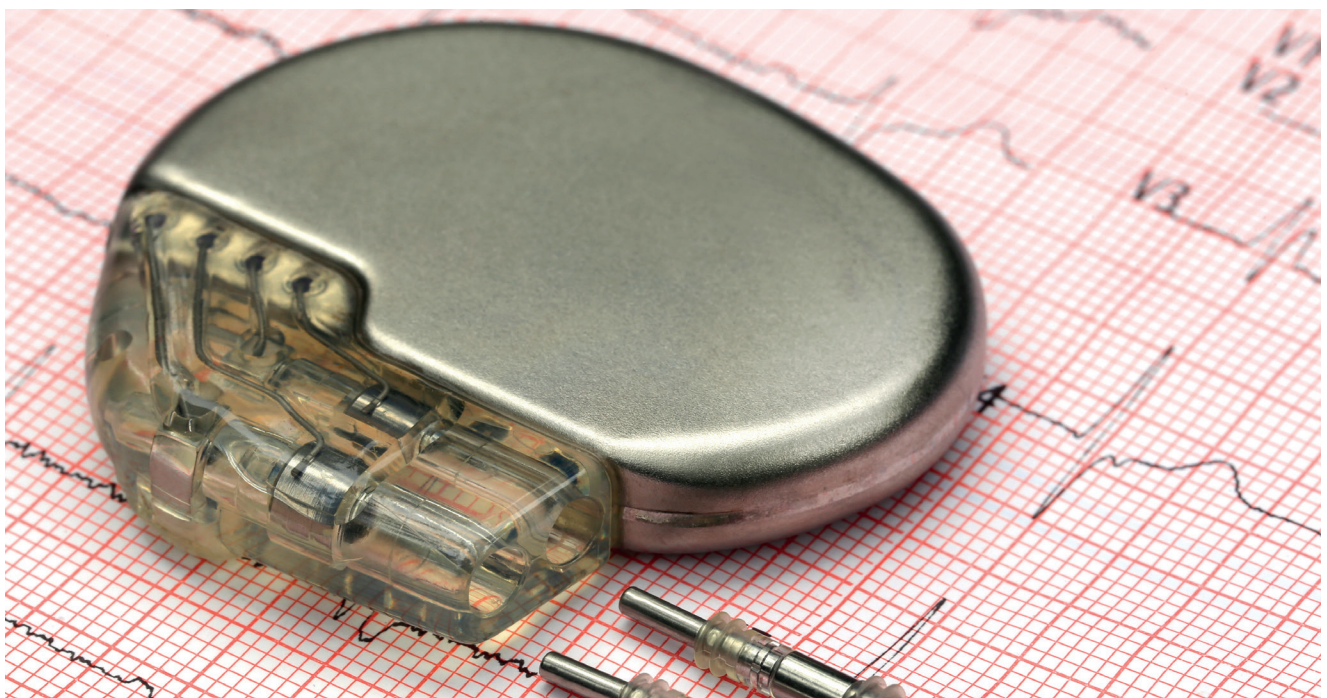
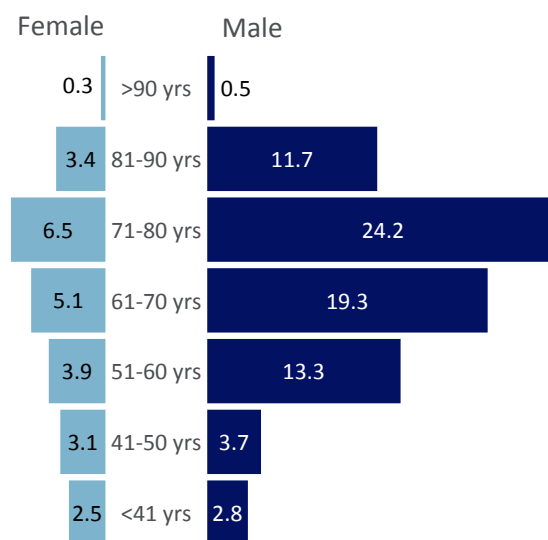
Victorian CIED hospitals	Hospital type	2018	2019	2020
Alfred Hospital	Public	•		
Austin Hospital	Public	•	•	•
Ballarat Base Hospital	Public		•	•
Bendigo Hospital	Public		•	•
Box Hill Hospital	Public		•	•
Cabrini Hospital Malvern	Private		•	•
Footscray Hospital	Public	•	•	•
Frankston Hospital	Public		•	•
Jessie McPherson Private Hospital	Private		•	•
Monash Heart	Public	•	•	•
Mulgrave Private Hospital	Private	•	•	•
The Royal Melbourne Hospital	Public	•	•	•
Sunshine Hospital	Public	•	•	•
Western Private Hospital	Private			•

Table Legend: • = contributing data

Patients and Procedures

In 2020, 649 CIED procedures were performed on 633 patients - these case numbers are very similar to the previous year. Figure 38 shows the distribution of CIED procedures by age and sex. The average age was 67 ± 14 years and 75% of patients were male. The majority (69.3%) of cases were performed electively, with 54.5% being first implants. Generator replacements and/or lead replacements accounted for 39.6% of procedures. The remainder of cases were for new leads (2.2%), system explants (2.5%) and revisions (1.2%).

Figure 38: Age and sex distribution of patients undergoing CIED



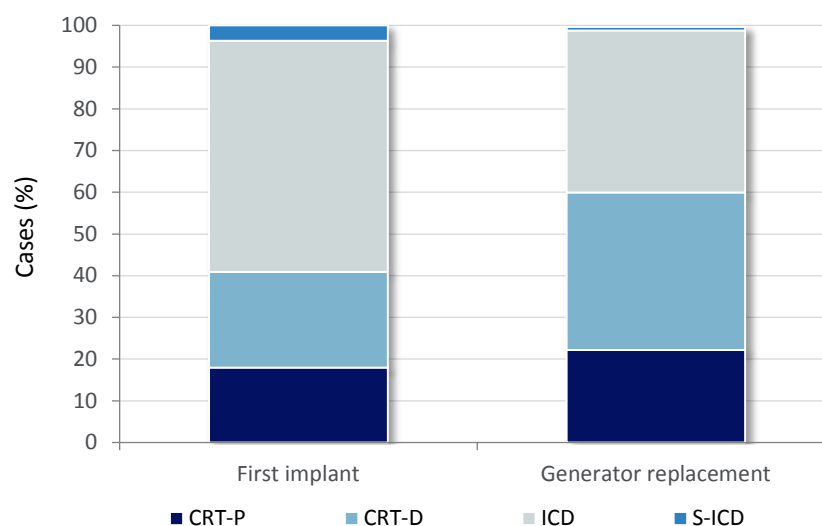
Device Types

Four types of CIED devices are included:

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

ICD devices (CRT-D, ICD or S-ICD) represented 82% of first implants and 77.4% of generator replacements (Figure 39). The majority of devices utilising CRT (CRT-D or CRT-P) were implanted in the left pre-pectoral region (91.7%). The remainder were implanted in either the right pre-pectoral region (4.3%) or the left sub-pectoral region (3.1%). The majority (90.6%) of ICDs without CRT were placed in the left pre-pectoral region.

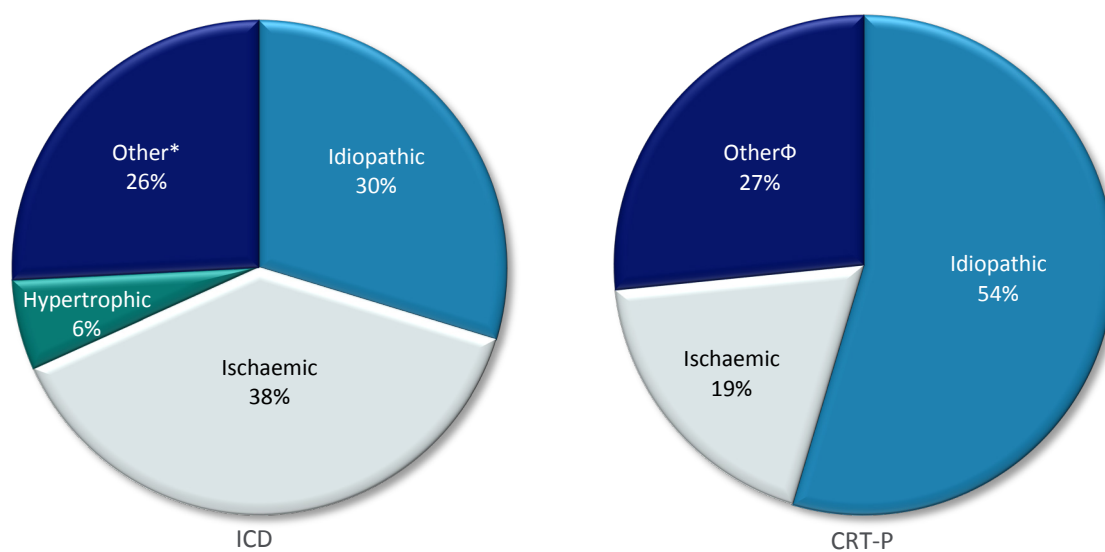
Figure 39: Device type – first implant vs generator replacement



Aetiology of Underlying Cardiomyopathy

The vast majority of patients requiring either ICD or CRT devices have an underlying cardiomyopathy. However, the aetiology of the cardiomyopathy in patients undergoing their first CIED implant varies between ICDs and CRT-P (Figure 40). With ICD devices (ICD, CRT-D or S-ICD), 38% of patients had an ischaemic cause, whereas for CRT-P devices, the most common underlying cardiomyopathy aetiology was idiopathic or unknown (54%), with an ischaemic cause being less common at 19%.

Figure 40: Aetiology in patients undergoing first CIED implant



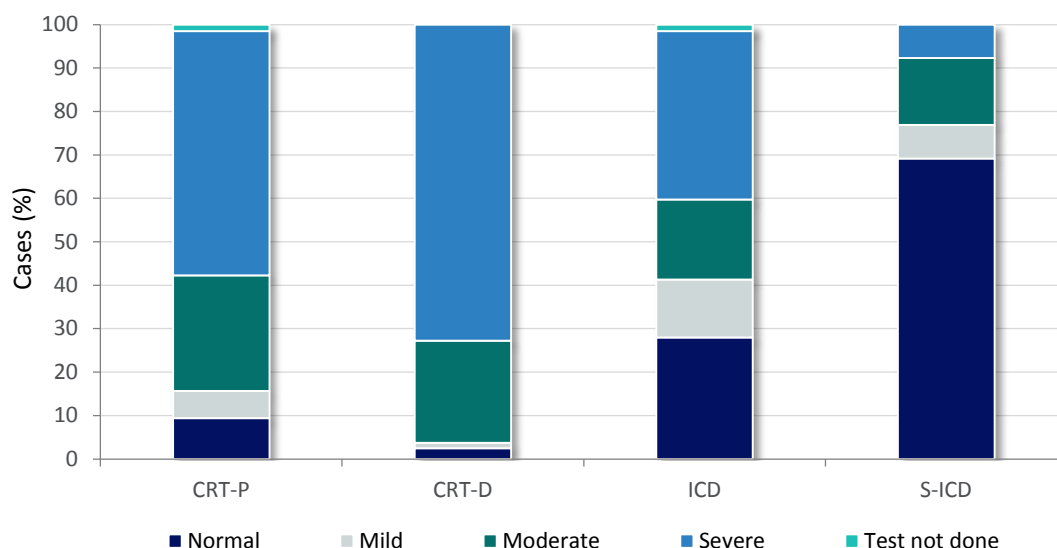
* Includes Familial/congenital & Idiopathic ventricular fibrillation.
 Φ Includes Valvular, Familial/congenital & Structural normal heart.

Left Ventricular Function

Left ventricular ejection fraction (LVEF) is a measure of the left ventricle's pumping ability and generally is graded as normal or having mild, moderate or severe impairment. Both national [32] and international guidelines [33, 34] utilise LVEF when providing detailed indications and appropriate use criteria for ICDs and CRT devices. However, several other factors are also taken into account, including the underlying cardiac condition, severity of heart failure symptoms, a history of previous cardiac arrest and the presence of certain ECG changes.

Left ventricular function grades by CIED type (first implants only) is shown in Figure 41. CRT-P devices are generally only recommended in patients with a reduced LVEF and the majority of these patients had moderate or severe left ventricular impairment, with an increase compared to the previous year (83% in 2020 vs 68% in 2019). For patients undergoing CRT-D implantation, 96% had moderate or severely impaired LVEF. Of note, the proportions of patients without an LVEF estimation pre-implantation across all CIED subgroups is much lower in 2020 than in previous years, in line with better and more appropriate patient assessment.

Figure 41: Left ventricular function by CIED type (first implants only)



Indications for CIED Therapy

ICDs

ICD's (with or without CRT functionality) are typically implanted for primary or secondary prevention of sudden cardiac death. In 2020, almost half (48%) of ICDs were implanted for primary prevention, with ischaemic cardiomyopathy the underlying condition in 43% of these cases. Just over half (53%) of ICD implants for secondary prevention were for ventricular tachycardia and a further 40% were for prior ventricular fibrillation.

Cardiac resynchronisation therapy

National practice guidelines stipulate that appropriate criteria for CRT use include QRS width ≥ 120 milliseconds, severe left ventricular dysfunction and New York Heart Association (NYHA) Class II-III symptoms. In 2020, 89% of CRT-D patients had a QRS width ≥ 120 milliseconds, 73% had severe left ventricular dysfunction and 93% had an NYHA Class score of II or greater. Compliance with the CRT inclusion criteria was lower among the CRT-P implant group (Table 35). These results were similar to the previous year.

Table 35: Inclusion criteria for CRT by device type

Strength of Indication	CRT-D (N=81)	CRT-P (N=64)
	N (%)	N (%)
QRS WIDTH ≥ 120 msec	72 (89)	49 (77)
Severe left ventricular dysfunction (LVEF $< 35\%$)	59 (73)	36 (57)
NYHA Class II or greater	75 (93)	59 (92)

Assessing the strength of indication for CIED therapy

VCOR provides information to participating sites regarding the strength of the indication for each CIED implanted, based on established national and international guidelines and appropriate use criteria [35]. As previously reported, VCOR has developed a series of 8 evidence-based flow charts that encompass all likely clinical presentations combined with relevant inclusion and exclusion criteria. Based on these flowcharts, the strength of the indication for each CIED implantation (weak, medium or strong indication) is determined. A list of the 8 flow chart scenarios (5 for ICD therapy and 3 for CRT therapy) that are utilised are as follows-

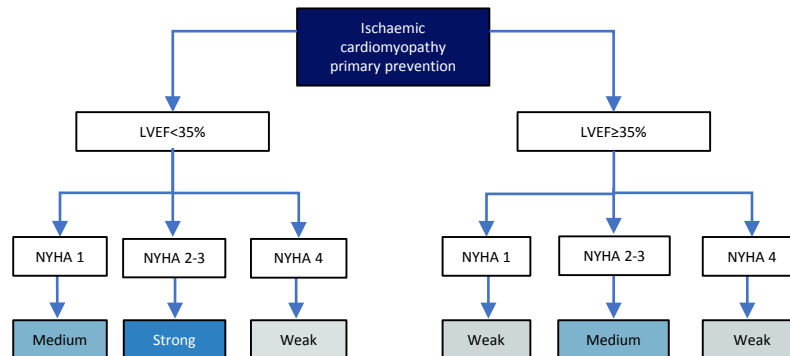
ICD therapy: (CRT-D, ICD and S-ICD)

1. Ventricular fibrillation, sustained VT or cardiac arrest (secondary prevention)
2. Unexplained syncope
3. Ischaemic cardiomyopathy – primary prevention (Figure 42)
4. Non-ischaemic cardiomyopathy – primary prevention
5. Genetic condition – primary prevention

CRT therapy: (CRT-D and CRT-P)

6. CRT for ischaemic cardiomyopathy with LVEF $< 35\%$
7. CRT for non-ischaemic cardiomyopathy with LVEF $< 35\%$
8. CRT for pre-existing or anticipated need for RV pacing

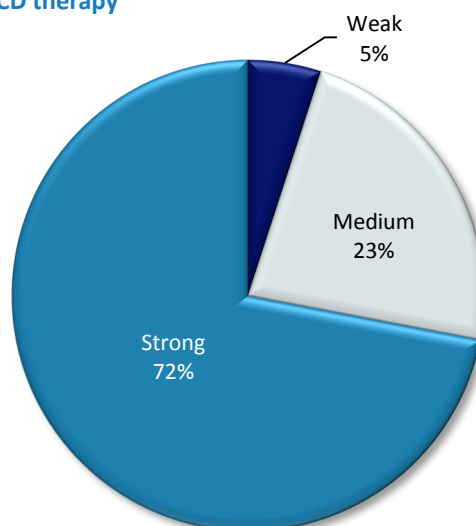
Figure 42: Strength of indication flowchart: ischemic cardiomyopathy – primary prevention



It should be noted that if a CIED implant is determined to have a weak indication for implantation, this is not meant to imply that the device should not have been implanted. The complexity of individual patient and clinical factors that influence clinical decision-making cannot be adequately represented in flow charts. There will be many circumstances where it is entirely appropriate to implant a CIED even when the formal assessment of the indication for its implantation receives a weak designation. Rather, grading the strength of indication for CIED therapy is intended as a quality assurance tool for hospitals and clinicians to monitor the quality of their practice and to provide an overall evaluation of the appropriateness of their practices.

Figure 43 presents the proportions of strong, medium and weak indications for ICD implantation (n=289), incorporating ICD, CRT-D and S-ICD for 2020. Either a strong or medium indication was present in 95% of cases of implantable defibrillator therapy.

Figure 43: Strength of indication for ICD therapy



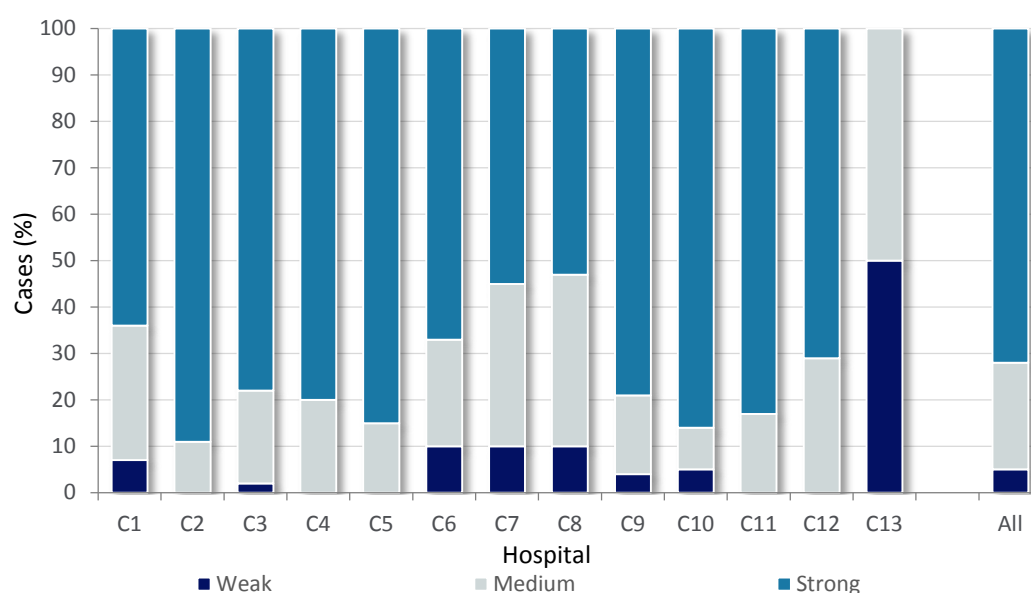
The strength of indication was analysed by type of ICD device (Table 36). Three-quarters of straightforward ICD implantations had a strong indication and only small numbers of cases with a weak indication for ICD or CRT-D devices. In contrast, subcutaneous ICDs had a different pattern with a greater proportion of cases with a medium strength rather than a strong indication for use. However, it is acknowledged that S-ICDs are most often used in a select group of patients - typically younger with no need for pacing backup or in patients with high risk of infection or no endovascular option. As a result, individual patient factors likely play a much larger role in selecting an S-ICD and these clinical decisions cannot be represented in our flow chart method for determining strength of indication. Additionally, S-ICD case numbers were low, so any interpretation of results needs to be done with caution.

Table 36: Strength of indication for ICD therapy by form of therapy

Strength of Indication	CRT-D (N=80)	ICD (N=196)	S-ICD (N=13)
	N(%)	N(%)	N(%)
Strong	55 (69)	148 (75)	5 (39)
Medium	23 (29)	37 (19)	6 (46)
Weak	2 (2)	11 (6)	2 (15)

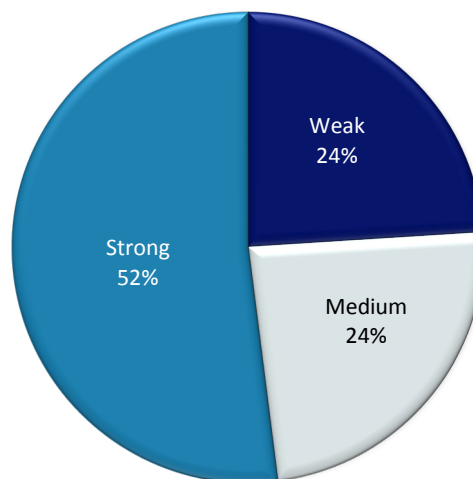
A comparison of the strength of indication for defibrillator therapy (CRT-D, ICD and S-ICD) by hospital is shown in Figure 44. Strong indications for ICD therapy ranged from 53%- 90% across the individual hospitals (Figure 44).

Figure 44: Strength of indication for ICD therapy by hospital



Turning to CRT devices (CRT-D and CRT-P), Figure 45 demonstrates a comparison of the strength of indication for CRT (n=143). Of note, 76% of CRT cases had a strong or medium strength indication for implantation.

Figure 45: Strength of Indication for CRT



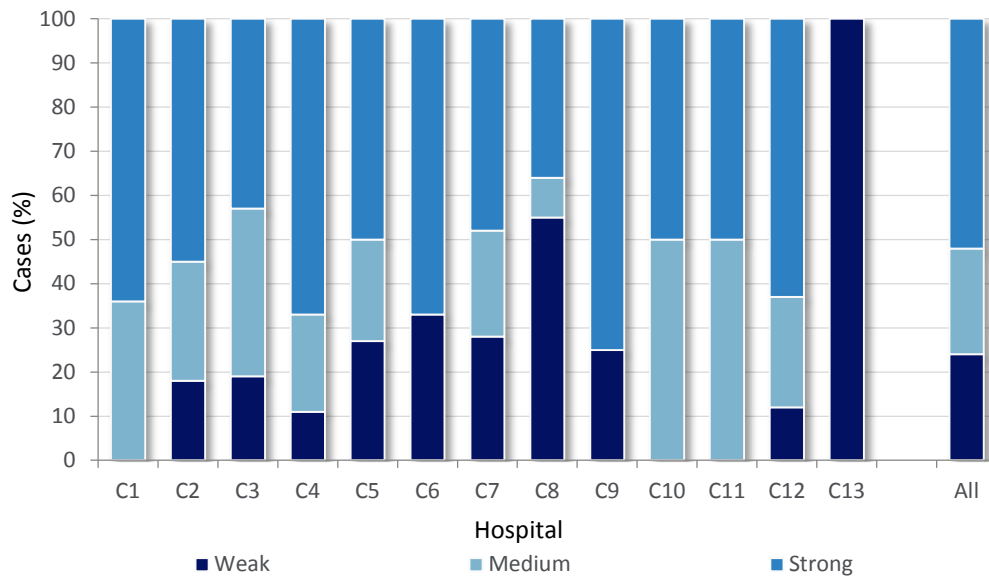
The strength of indication for CRT by device type is presented in Table 37. The proportion of CRT-D cases with a strong indication for use was higher compared to CRT-P. Overall, CRT devices had a greater proportion of cases with a weak indication compared to ICD devices.

Table 37: Strength of indication for CRT by device type

Strength of Indication	CRT-D (N=80)	CRT-P (N=63)
	N(%)	N(%)
Strong	45 (56)	29 (46)
Medium	15(19)	20 (32)
Weak	20 (25)	14 (22)

The strength of indication for CRT device implantation by hospital is presented in Figure 46. Similar to the previous year, there was variation among hospitals in the proportion of cases with a strong indication for implantation (range 0%-75%). However, some hospitals had very low case numbers, indicating that proportions should be interpreted with caution.

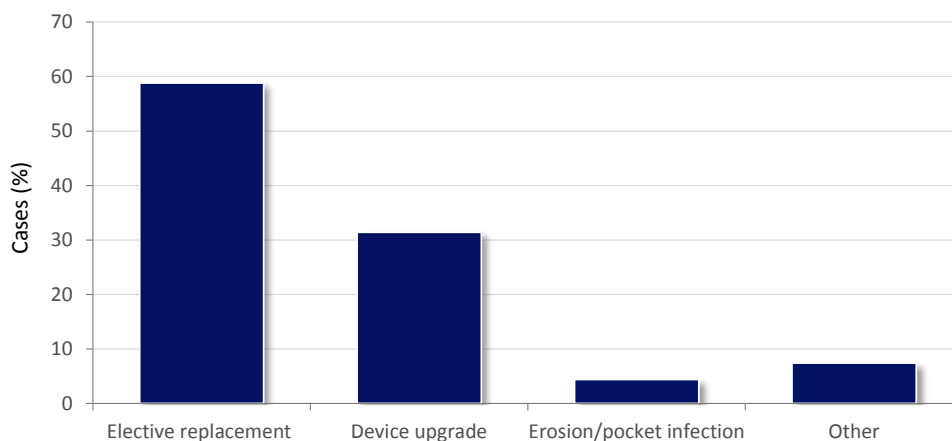
Figure 46: Strength of indication for CRT by hospital



Replacements and Revisions

ICED replacements were most commonly undertaken for elective replacement (59%). Upgrade of device accounted for 31% of generator replacements. More urgent replacements for erosion or infection accounted for a small proportion of procedures and were required less frequently than in the previous year (4.4% in 2020 vs 7.4% in 2019) (Figure 47).

Figure 47: Indications for generator replacement, explant or revision



Outcome Measures

The key performance indicators (KPIs) used to monitor and benchmark the outcomes of CIED therapy include:

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

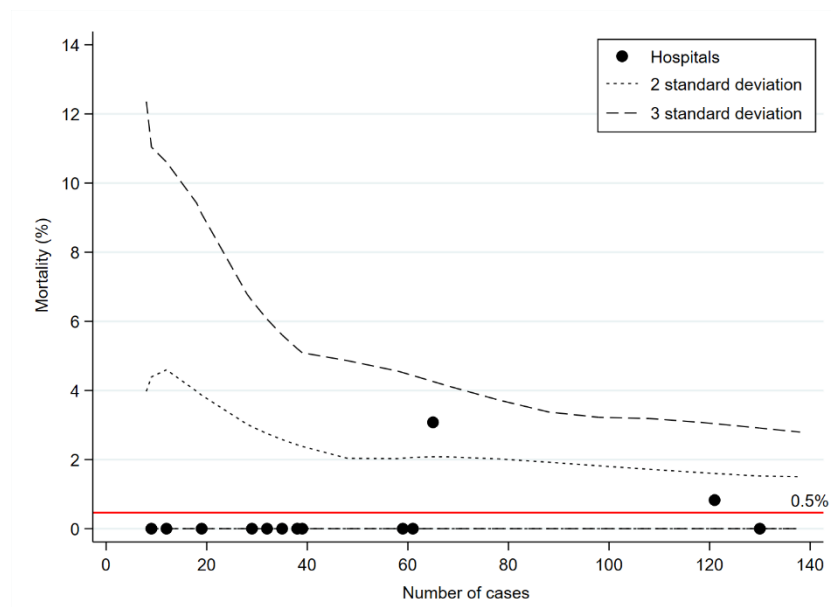
In-hospital mortality

There were two in hospital cardiac deaths which were not device-related.

30-day mortality

The 30-day mortality rate was 0.5% with three deaths recorded within 30 days of device implantation. All hospitals were within control limits for this outcome measure (Figure 48).

Figure 48: 30-day CIED related mortality



Successful device implantation without in-hospital complications

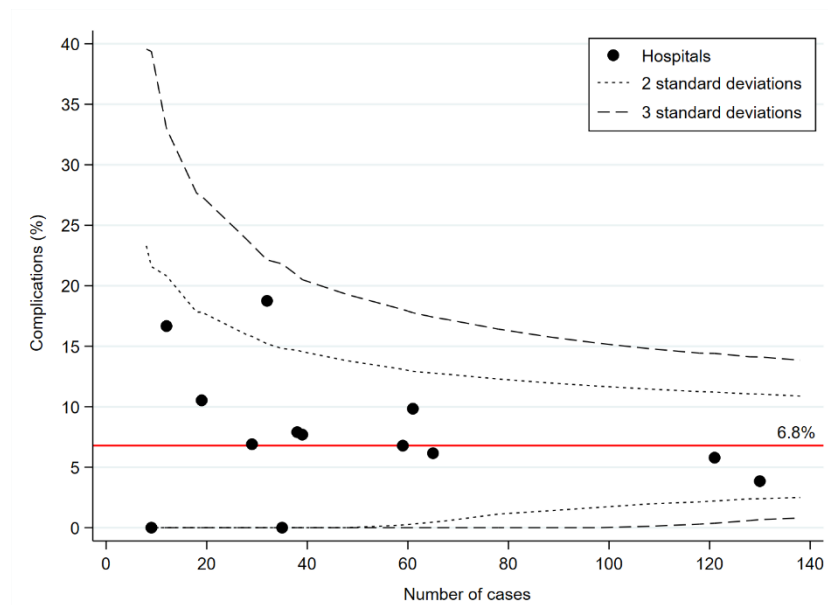
Overall, 93.2% of CIED devices were successfully implanted without any in-hospital complications. The complications that did arise included cardiac arrest, severe hypotension, wound haematoma, pericardial effusion, lead dislodgement and failure to position lead(s). The number of in-hospital complications that occurred at each hospital by device type is presented in Table 38. Of note, some hospitals did not implant certain device types.

Table 38: In-hospital complications by hospital and device type

Hospital	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	Total
	N	N	N	N	N	N	N	N	N	N	N	N	N	N (%)
CRT-P n (%)	0	0	1	0	0	0	4	0	0	0	0	0	0	5 (4.1)
CRT-D n(%)	1	0	0	5	2	2	2	1	0	1	1	2	0	17 (9.6)
ICD, n (%)	2	0	6	1	2	2	0	1	2	2	1	0	0	19 (6.4)

Hospitals were benchmarked by the frequency of complications, as presented in (Figure 49). There were no outliers for this outcome measure.

Figure 49: In-hospital rates of CIED related complications



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

The 30-day unplanned cardiac admission rate was 2.9% - lower than in the previous year (4.1% in 2019). The 30-day device related re-operation rate was 1.1% and the 30-day device related infections rate was 0.8%. Figures 50- 52 demonstrate that all hospitals were within control limits for each of these performance indicators.

Figure 50: 30-day rates of CIED related unplanned cardiac readmissions

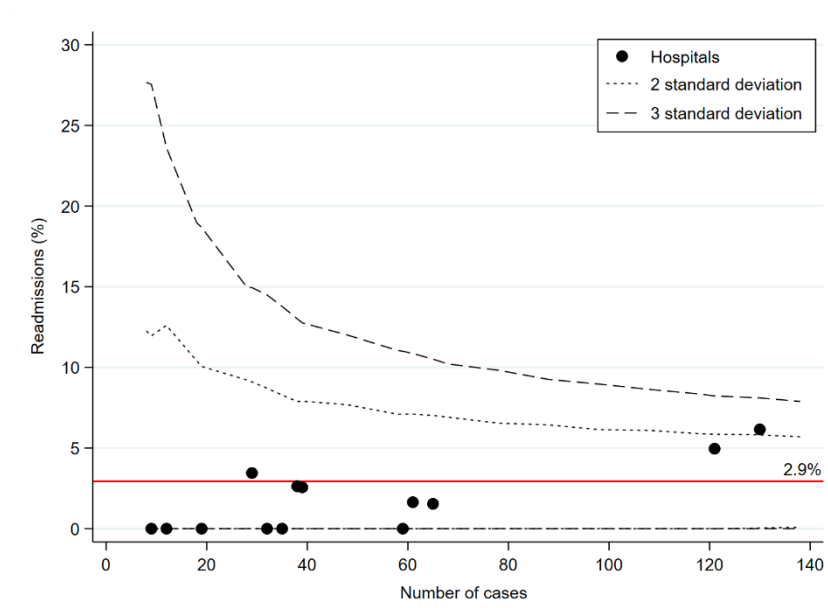


Figure 51: 30-day rates of CIED related reoperations

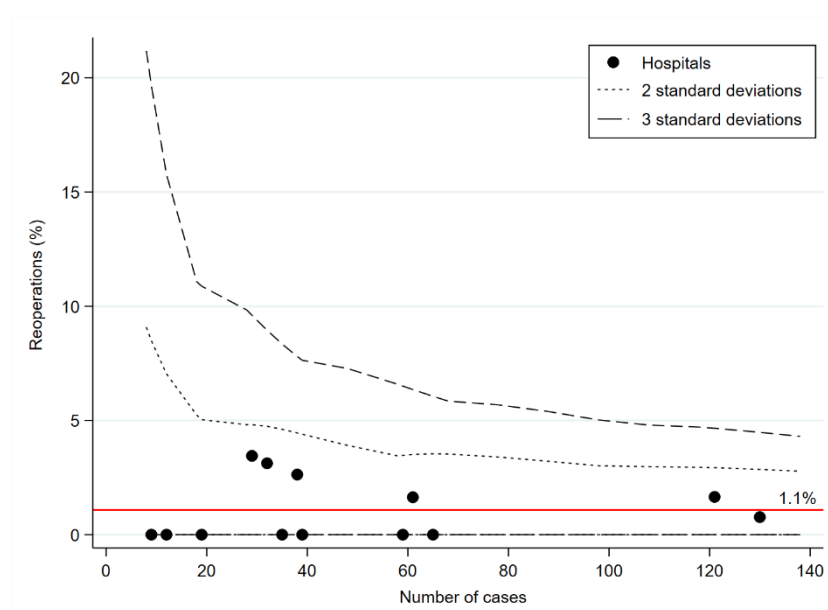
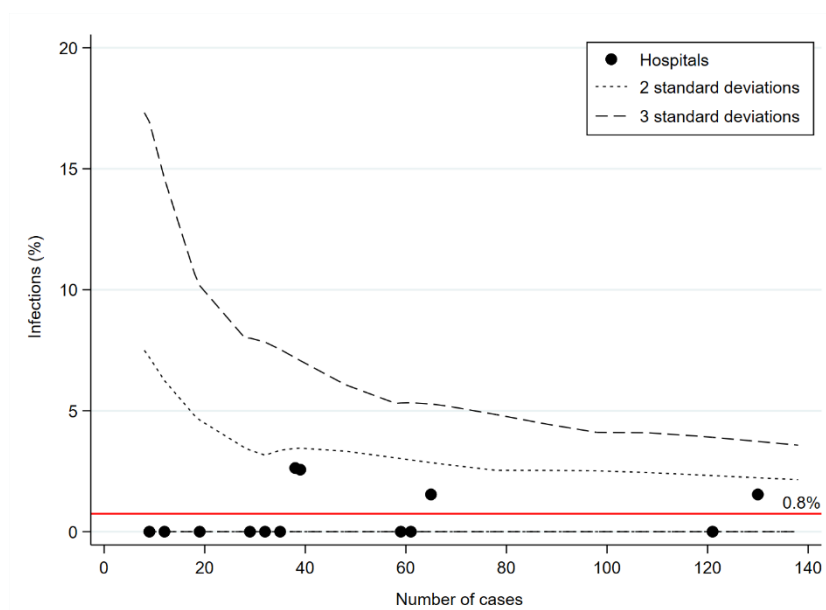


Figure 52: 30-day rates of CIED related infections



12-month mortality

Mortality rates at 12 months for registry patients with CIEDs implanted during the period from 2018-2020 were obtained through linkage with the National Death Index (NDI). The overall 12-month mortality rate was 1.6%. Death rates were higher in females (1.5% in males vs 2.0% in females). Among patients who had an ICD implanted, the 12-month mortality rates for various clinical conditions included 2.1% for ischaemic cardiomyopathy and 1.5% for idiopathic cardiomyopathy. No patients who had an ICD implanted for hypertrophic cardiomyopathy had died at 12 months. The 12-month mortality rates for CRT-P devices were notably higher, including patients with ischaemic cardiomyopathy (9.3%) and patients undergoing CRT-P for pre-existing or anticipated need for right ventricular pacing (5%).

Summary

This third annual CIED module report continues to provide participating sites with detailed reports on the volume and makeup of their CIED-related activity, assessment of the strength of the indications for the procedures and detailed benchmarking data on key process and outcome measures. Case volumes in 2020 were quite similar to the previous year with generally good adherence to practice guidelines in terms of procedural indications and inclusion criteria for device implantation. Overall, hospital outcomes were good, with low rates of complications for each device type. However, only 13 hospitals were participating in the registry module, resulting in low case numbers and limited utility of the benchmarking analysis in this report. VCOR aims to actively recruit more centres both in the public and private sectors in the coming year and will lobby the Victorian Department of Health and Human Services to secure funding support for this module's continuing activity and growth.

Future Directions

Looking towards 2021, the COVID-19 pandemic will continue to loom large over the community and the healthcare system. At the time of release of this report, there had been two further lockdowns in Victoria, with resultant influences on patient behaviour, access to medical services and hospital practices and processes. We expect that there will be further changes to cardiovascular care delivery as a result of the pandemic and we will continue to track these changes and their impact on the quality of care delivered to patients right across the state.

VCOR has worked closely with the Victorian Department of Health and two of its agencies- Safer Care Victoria (SCV) and the Victorian Agency for Health Information (VAHI). In early 2020, the Department of Health released its Strategic Plan 2020-23. It aims to improve healthcare across Victoria so it is safer, more effective and person-centered and will implement strategies reflecting the priorities of leadership, partnership, monitoring and improvement in 2021 and beyond. VCOR, along with other clinical quality registries that are funded by Safer Care Victoria, will be a critical component of this plan, with its ongoing activities enabling the Department of Health to achieve its goals for high quality and safe healthcare in Victoria.

The establishment in 2020 of a systematic approach to mechanical cardiac support with ECMO (extracorporeal membrane oxygenation), through the establishment of the Victorian ECMO Service, was a major advance for patients with cardiac arrest and cardiogenic shock [36]. Over the past 3 years, this life-saving but costly treatment has been used in conjunction with PCI in 15 patients per year on average. With the implementation of the new model of delivery outlined in the ECMO Service plan having commenced in 2020, we look forward to a more streamlined and effective service, focused on high-quality patient-centred care and one that supports clinicians to deliver best-practice and equitable care across both public and private sectors and throughout metropolitan, regional and rural Victoria.

In 2020, a comprehensive revision of all the data elements within the VCOR dataset was completed. Several elements were either updated or added and a small number were deleted. These new and revised elements have been incorporated into version 2.0 of the VCOR and this version will be rolled out to all participating sites in 2021.

VCOR is looking forward to building on its research activities in the coming year. In 2020, the registry proctored and participated in numerous research projects, resulting in the publication of 14 manuscripts in peer-reviewed journals and numerous abstracts and other presentations of VCOR-related research in national and international forums. Unfortunately, planned enrollment of a number of international PhD students had to be suspended in 2020 because of travel and immigration restrictions related to the COVID-19 pandemic, with these travel restrictions likely to affect enrollments in 2021 as well. However, VCOR will continue to seek out and collaborate with local students and researchers- both within and external to our organisation- with an interest in clinical quality registry-related research.

With all these various activities ahead of us, VCOR - as a clinical quality registry - will still maintain its focus in the coming year on its primary roles of monitoring and reporting on the performance of our hospitals, benchmarking hospitals, identifying variance in access to care and outcomes and highlighting areas for improvement in service delivery. We are committed to ensuring patient-centred high-quality and safe care at local and state levels and, through our engagement with the National Cardiac Registry, on the national stage as well. We look forward to further growth and development of the registry, and in particular, the integration of quality assurance activities into routine delivery of cardiovascular healthcare at both patient and system levels.

Glossary

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

Publications and presentations in 2020

Publications

- Ayton D, Soh S, Morello R, Ahern S, Earnest A, Brennan A, Lefkovits J, Evans S, Reid C, Ruseckaite R, McNeil J. Development of a Percutaneous Coronary Intervention Patient Level Composite Measure for a Clinical Quality Registry. *BMC Health Services Research*. 2020; 20(1): 44.
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 Austin Hospital, The
 Ballarat Base Hospital
 Bendigo Hospital
 Box Hill Hospital
 Cabrini Hospital Malvern
 Epworth Hospital Richmond
 Epworth Hospital Eastern
 Epworth Eastern, Geelong
 Footscray Hospital
 Frankston Hospital
 Holmesglen Private Hospital
 Jessie McPherson Private Hospital
 Knox Private Hospital
 Latrobe Regional Hospital
 Melbourne Private Hospital
 MonashHeart (Monash Medical Centre Clayton)
 Mulgrave Private Hospital
 Northern Hospital, The
 Peninsula Private Hospital
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Bendigo Hospital
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Table 39: VCOR Funding 2011 – 2020

Funding Body	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
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	\$365,218	\$516,793	\$283,916
Other Sources	-	-	-	-	-	-	-	-	-	\$230,150
Sub total	\$300,000	\$600,000	\$605,000	\$809,466	\$460,202	\$834,815	\$616,900	\$365,218	\$516,793	\$514,066
Total	\$5,622,460									

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