ANNUAL PUBLIC REPORT 2022

VICTORIAN CARDIAC OUTCOMES REGISTRY

VCOR
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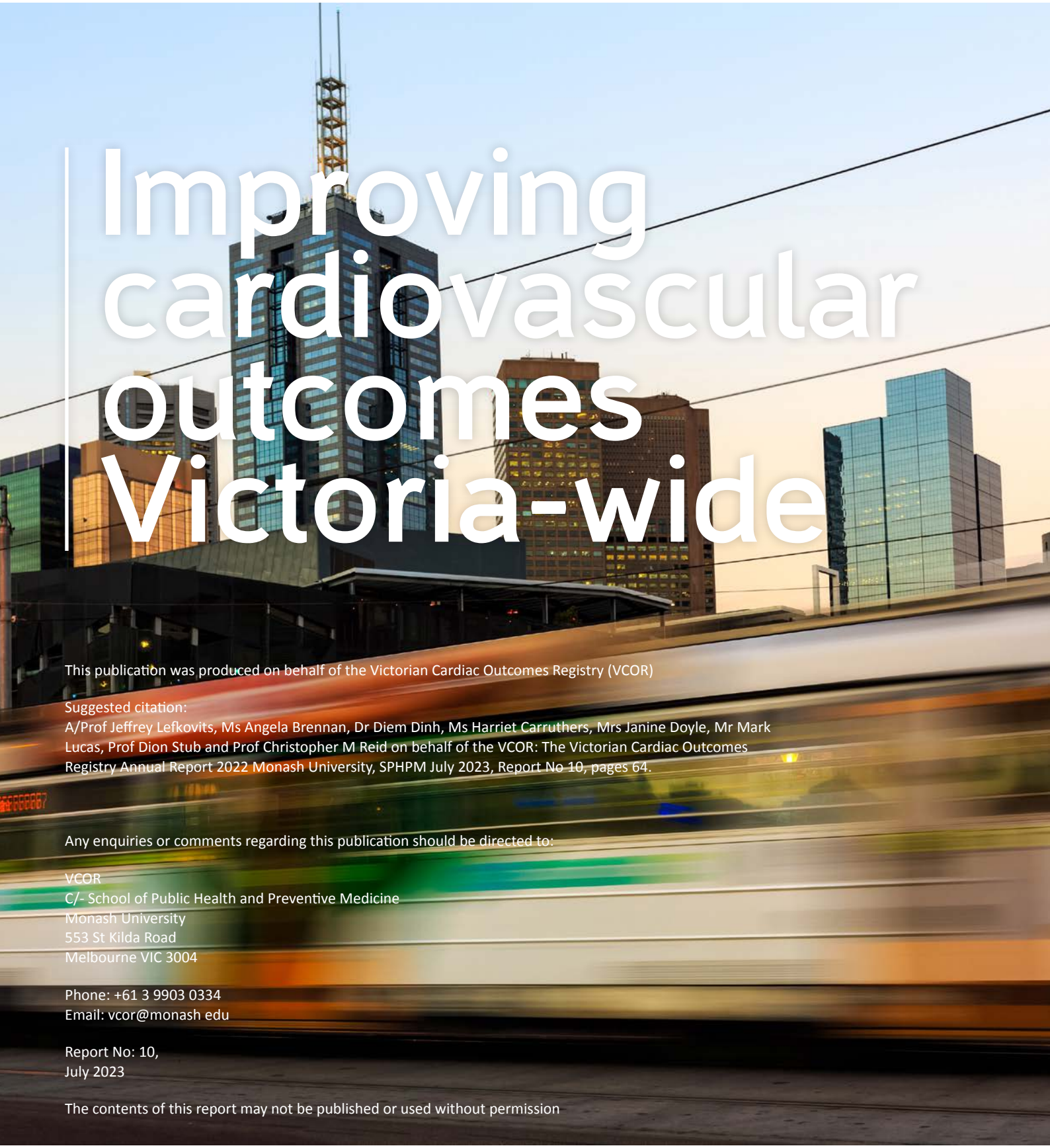

Improving cardiovascular outcomes Victoria-wide

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

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MONASH University

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Acknowledgements

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We gratefully acknowledge contributions made by the VCOR Steering Committee, the VCOR Clinical Quality Committee and the VCOR Data Research and Publications Committee. We also acknowledge the VCOR Registry Custodian - Prof Christopher M Reid, the VCOR Clinical Director - A/Prof Jeffrey Lefkovits and the Co-Director of the Centre of Cardiovascular Research and Education in Therapeutics - Prof Dion Stub. We also acknowledge the VCOR Data and Project Management Committee staff at SPHPM (Ms Angela Brennan, Dr Diem Dinh, Ms Harriet Carruthers, Mrs Janine Doyle and Mr Mark Lucas).

Prof Dion Stub is supported by National Heart Foundation and NHMRC Investigator grants – these provide salary support to contribute to initiatives such as the VCOR.

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

As the Chief Executive Officer at Safer Care Victoria, it gives me great pleasure to acknowledge the contribution the Victorian Cardiac Outcomes Registry (VCOR) makes to good patient outcomes in Victoria. The VCOR report contains an amazing range of detailed data pulled from both public and private hospitals across Victoria that provides an overview of the quality of cardiac care across the state. It represents the efforts and collaboration of healthcare professionals, researchers, policymakers, and patients working together with a common goal and is a great example of how collaboration delivers fantastic results.

A key goal of Safer Care Victoria is to improve the safety and quality of the health care system for all Victorians and to do this by continuously improving the way in which we deliver care to patients, their families and carers. As a starting point we need to understand what the quality of care currently is and where there is unwarranted variation in that care that can result in less than best outcomes for some. The VCOR provides that information in spades. The challenge for all of us now is how will we, the reader of this amazing and truly comprehensive report, now use the data to drive continuous improvement?

The annual VCOR report allows us to see what improvements have been made since the last report and where we now need to make further changes as part of a continuous improvement cycle. I give a commitment to the VCOR team and to the cardiac patients, carers and families that we will use these data in our work to inform our priorities in supporting hospital site improvement programmes. That same challenge is there for every policy maker, clinician, manager and patient who is privileged to read this report. The VCOR is the product of us all working together. Let us use this report to ensure that patients receive the best possible care regardless of where they live, their sex, disability or their cultural origins.

Finally, I would like to sincerely acknowledge those who continually contribute to VCOR and support hospitals to improve outcomes for people with heart disease. The passion, expertise, and commitment to excellence of everyone contributing to VCOR are the driving forces behind delivering the cardiac services the people of Victoria deserve.

Professor Mike Roberts

MB ChB MA MD FRCP ILTHE FAcadMEd

Chief Executive Officer, Safer Care Victoria
Chief Quality and Safety Officer, Victoria

Introduction

In 2022, the COVID-19 pandemic was still the predominant public health issue across Victoria, although with a substantial change compared with previous years. Victorians were now adjusting to living with COVID. What was dubbed as "COVID normal" meant that restrictions regarding work, social arrangements, public gatherings, mandatory vaccinations and mask wearing were all gradually reduced. However, people's lives had changed – they were now managing with COVID-19 as part of the routine of their day-to-day lives.

The year 2022 was also notable in that it was the 10th year that the VCOR registry had been operational as a clinical quality registry, collecting data on virtually all PCI procedures performed across the state of Victoria. We are proud that it now appears that the Victorian cardiology community is in a "PCI clinical quality registry normal" state, with quality assurance activities firmly embedded in the day-to-day activities of all PCI hospitals in Victoria - across both the public and private hospital sectors.

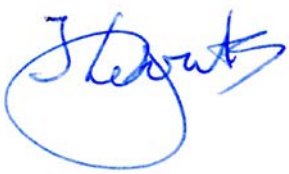
With well over 100,000 cases of PCI now in the registry, VCOR has made a substantial contribution to the process of continuous quality improvement among the state's PCI hospitals. With access to patient-level data, participating sites are able to routinely and regularly benchmark their performance and outcomes against their peers and ensure that the highest quality standards of care are being provided to their patients in an equitable and consistent fashion. In the past few years, VCOR has also extended its activities to hospitals in Tasmania, providing that state's clinicians with clinical quality data and benchmarking analyses against Victorian hospitals allowing them to engage in meaningful quality assurance activities around benchmarking and performance assessment.

VCOR continues to maintain a second registry module on cardiac implantable electronic devices (CIED), mainly addressing the needs of patients with cardiomyopathy who are at risk of heart failure and potentially lethal arrhythmias. However, in contrast to our PCI module, the CIED module still only represents a fraction of the number of the cases performed in Victoria, with the participation of 14 hospitals across the public and private sectors. We are not quite "CIED registry normal" yet, with further expansion of this module currently limited by funding constraints.

Among its many and varied activities including quality assurance, research, government and other health provider consultation and health advocacy, VCOR works closely with the National Cardiac Registry (NCR). This Commonwealth government initiative aims to provide a national platform for quality assurance in cardiovascular therapies, with an initial focus also on PCI. VCOR is closely aligned with the aspirations and goals of the NCR and is committed to ongoing collaboration with this national clinical quality registry.

This Annual Report and the full range of activities of VCOR have only come about as a result of the dedication and tireless effort of the registry management team. Their enthusiasm and professionalism have ensured that VCOR is seen as a valued exemplar of a clinical quality registry, positively influencing the delivery of high-quality cardiovascular care throughout the state over the last decade. VCOR is grateful for the support of the Victorian State Government and its commitment to clinical quality registries being embedded into routine healthcare practice. The registry would like to acknowledge the commitment and support of the clinicians, hospital executive teams and health provider organisations whose belief in the concept and role of clinical quality registries in day-to-day patient management has allowed VCOR to become a "normal" part of PCI practice.

In this 10th year of VCOR, the 2022 Annual Report highlights the significant strides made in monitoring and improving PCI outcomes and CIED therapy. VCOR's valuable contributions to clinical research and epidemiology continue to be showcased through publications and conference presentations. As we move forward, the registry remains committed to its mission of enhancing the quality and safety of cardiac care in Victoria, with this report serving as an essential resource, empowering healthcare professionals and stakeholders to provide the highest standard of care and improve the health outcomes of all Victorians.



A/Prof Jeffrey Lefkovits
VCOR Clinical Director

Registry Governance and Structure

VCOR's governance structure and processes have been previously outlined in detail. VCOR conforms to the Australian Health Ministers Advisory Councils Framework for Australian Clinical Quality Registries. 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.

Steering Committee

The Steering Committee (SC) comprises representatives from all participating hospitals, a representative from Safer Care Victoria, a consumer representative, and representatives from the School of Public Health and Preventive Medicine at Monash University. The SC is chaired by A/Prof Jeffrey Lefkovits.

Clinical Quality Committee

The Clinical Quality Committee (CQC) has responsibility for the oversight, analysis, interpretation, and release of hospital performance data. The CQC is central to VCOR's overall function as a clinical quality registry. For the PCI module the CQC undertakes quarterly and biannual review of hospital Key Performance Indicators (KPIs) and other relevant data. Results and outcomes pertaining to the CIED module are also undertaken and presented to the CIED Expert Working Group. Relevant and meaningful reports are sent to participating hospitals and the government.

Data, Research and Publications Committee

The Data, Research and Publications Committee (DRP) has an important and complementary role in VCOR. The DRP reviews and approves research requests, including for access to and analysis of group aggregate de-identified data.

Data Quality

Ensuring data quality is a key operational activity of clinical quality registries, this is achieved by yearly hospital audits, quarterly reporting, data cleaning and data queries. In 2022, VCOR resumed onsite audits, undertaking 33 PCI audits. The rate of missing PCI cases was 1.7%, data accuracy was achieved in 99.7% of cases across audit of 29 selected data fields.

Figure 1: VCOR Governance Structure

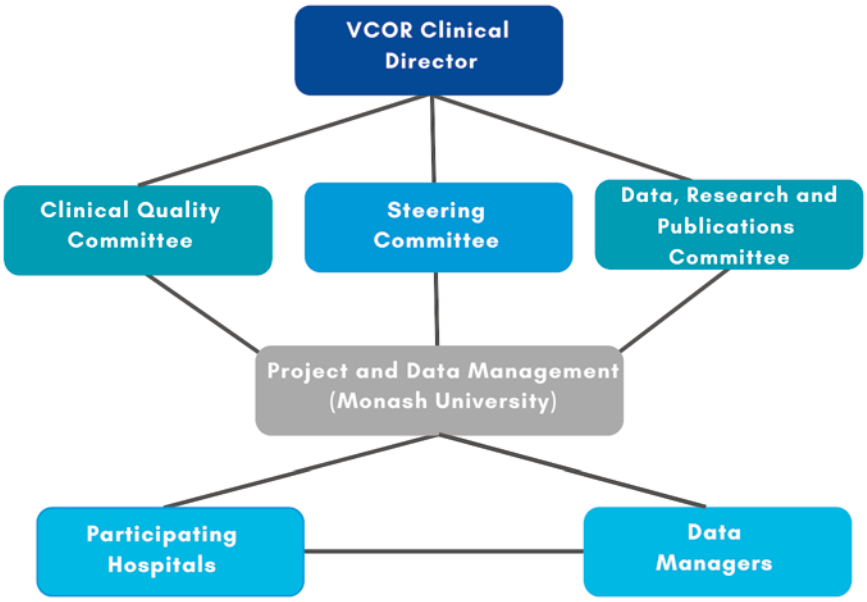
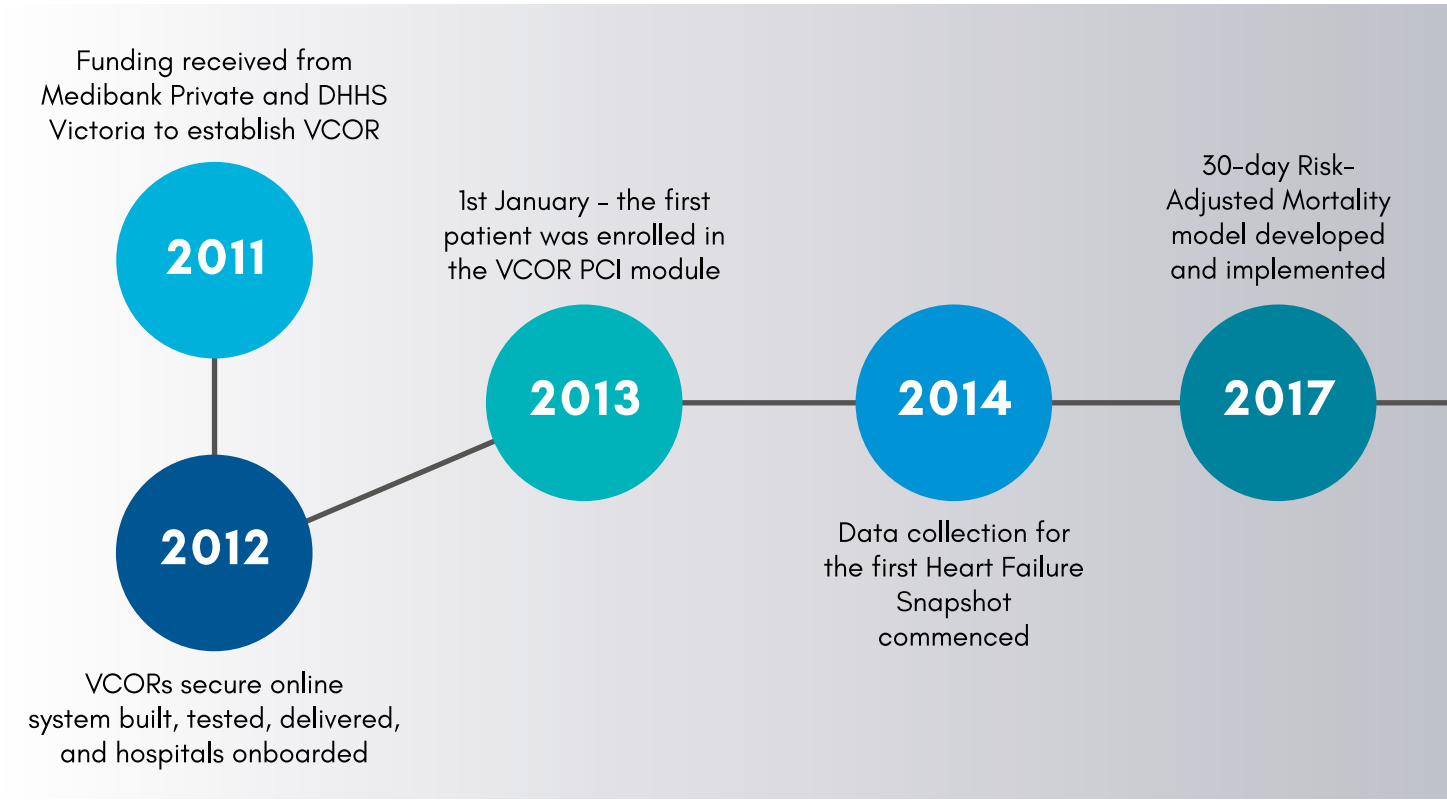
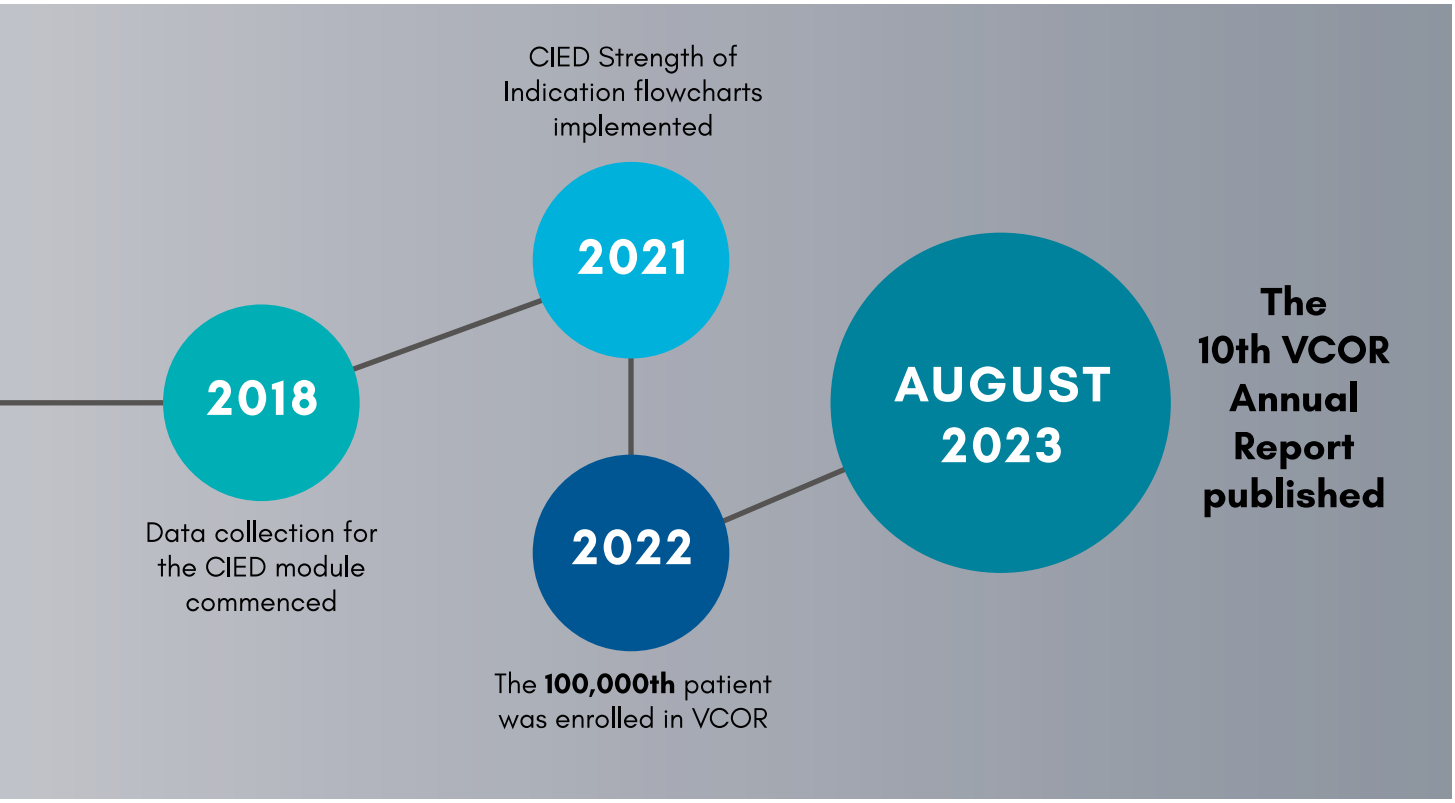
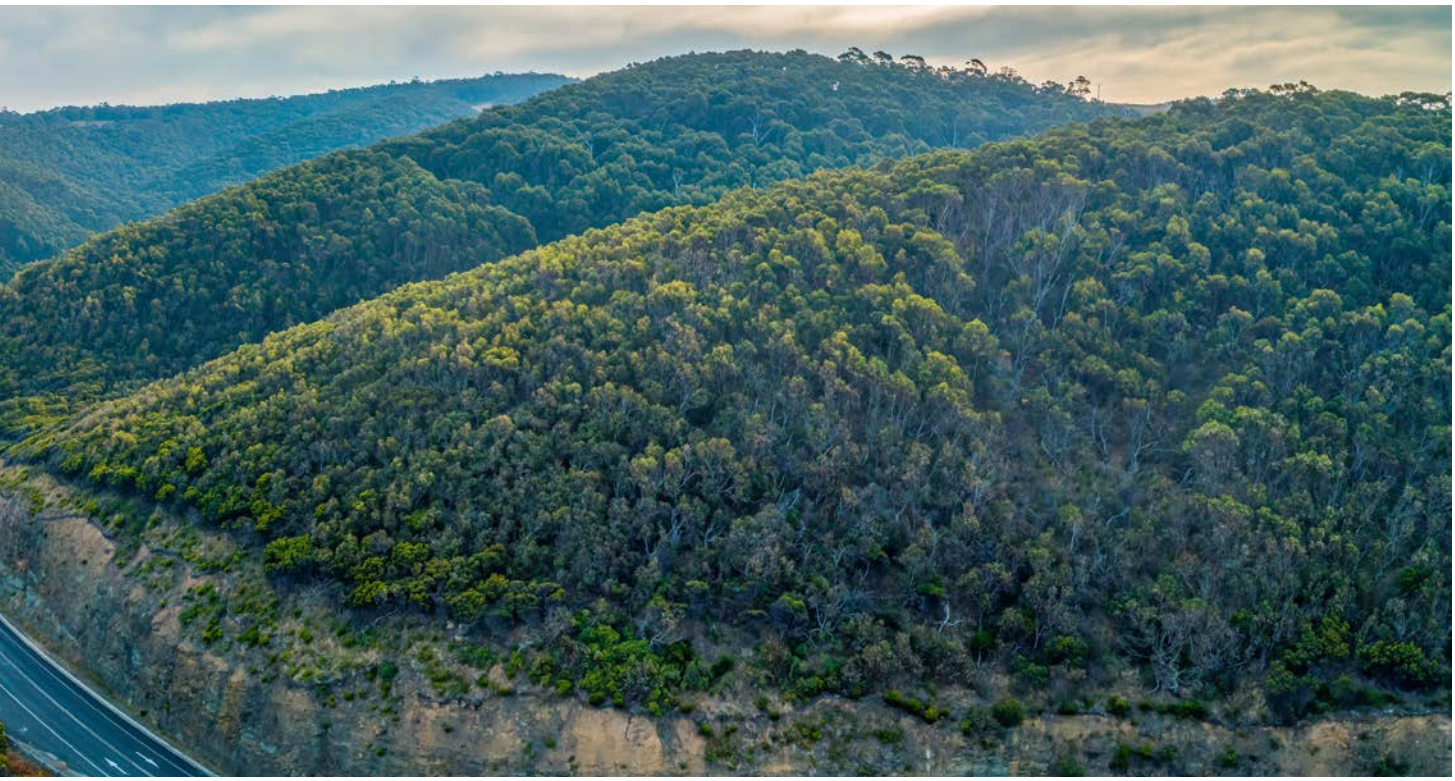


Figure 2: VCOR 10 Year Timeline

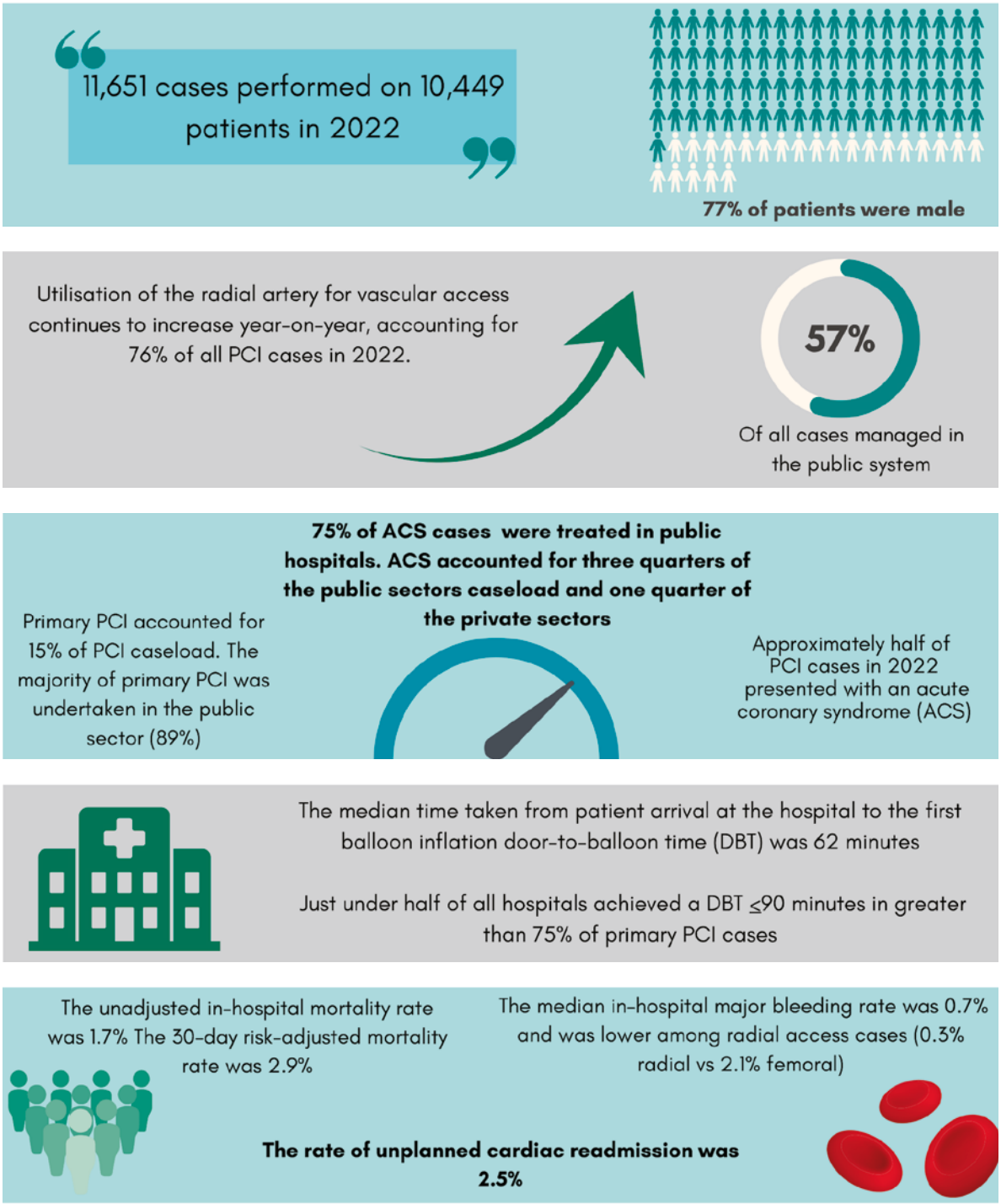



CIED Strength of Indication flowcharts implemented
2021
2018
Data collection for the CIED module commenced
2022
The 100,000th patient was enrolled in VCOR
AUGUST 2023
The 10th VCOR Annual Report published



Key Findings PCI Module

Figure 3: PCI Key Findings



Percutaneous Coronary Intervention (PCI)

Registry Module Activity

This report covers PCI activity in Victoria for the 2022 calendar year from January 1 to December 31. For the last six years all hospitals that perform PCI in Victoria have contributed data. This encompasses 33 hospitals in total comprising 15 public and 18 private hospitals (Table 1).

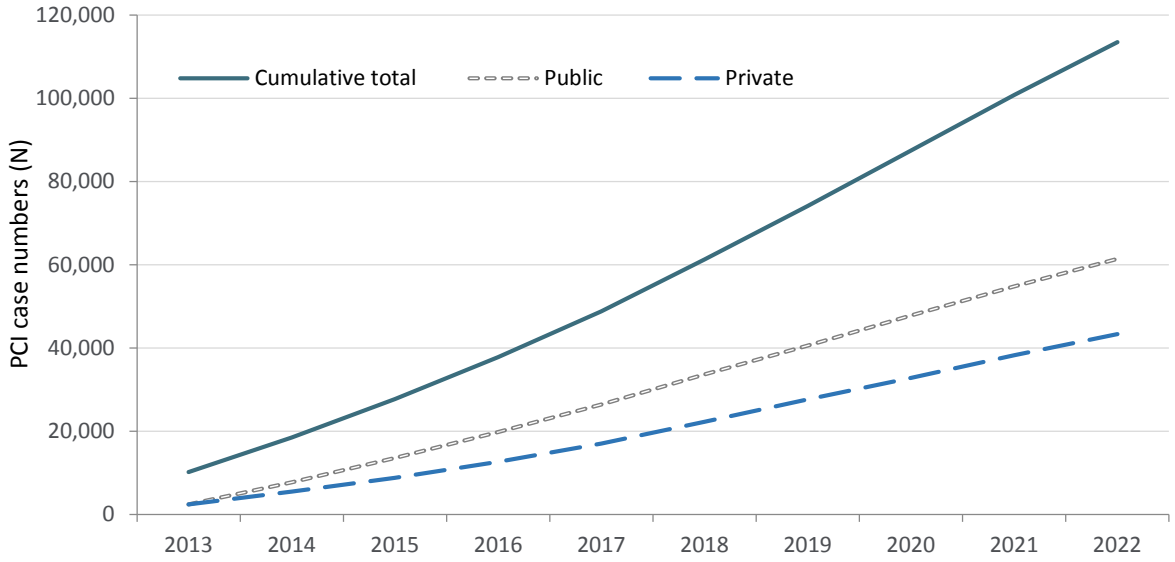
Table 1: Participating Victorian PCI hospitals

Victorian PCI hospitals	Hospital type	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
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.

In 2022, 11,651 cases were entered into VCOR. As of December 31, 2022, the registry contained a total of 108,114 PCI cases. The cumulative rate of recruitment since commencement by year and by hospital sector is shown in Figure 4. The lost-to-follow-up rate in 2022 was 1.0%, with an overall rate for the entire registry since its commencement of 1.1%. The number of requests from patients to opt-off from inclusion in the registry remains low – 0.14% in 2022 and 0.11% since registry commencement.

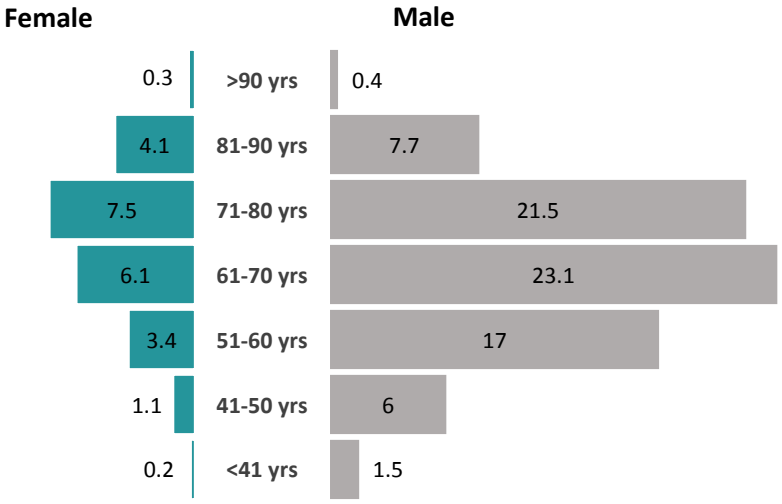
Figure 4: Cumulative case numbers by year: 2013 - 2022



Patient Characteristics

The total of 11,651 PCI procedures that were captured in 2022 were performed on 10,449 patients with 1,202 patients undergoing more than one procedure. A total of 6,615 cases (57%) were undertaken in public hospitals. Overall, 77% of cases were undertaken on male patients, a 2% increase since the previous year. The median age for males was 67 years (IQR: 58, 75) and for females was 71 years (IQR: 62, 79). As in previous years, the peak frequency of PCI procedures occurred in the seventh decade for males and the eighth decade for females (Figure 5).

Figure 5: Age and sex distribution of patients undergoing PCI



Selected patient demographic characteristics over a six-year period are shown in Table 2. Only minor variations among the various demographic characteristics have been observed over time.

Table 2: Comparison of selected patient characteristics: 2018 - 2022

Patient characteristics	2018 (N=12,463)	2019 (N=12,355)	2020 (N=12,349)	2021 (N=12,478)	2022 (N=11,651)
Age- years (Mean ±SD)	66.7 ±11.7	67.2 ±11.7	66.9 ±11.9	67.3 ±11.9	66.9 ±11.7
	%	%	%	%	%
Sex - female	23.7	24.5	24.5	25.2	22.8
Diabetes	22.6	23.2	23.8	23.6	24.1
Peripheral Vascular Disease	3.4	3.6	3.4	3.4	3.2
Cerebrovascular Disease	3.4	3.8	3.5	3.0	2.8
Previous PCI	33.4	33.1	33.6	32.7	31.3
Previous CABG	7.2	6.8	5.9	6.0	5.4

Patient characteristics by hospital sector are shown in Table 3. The prevalence of severe obesity (BMI ≥35kg/m^2) was greater among public sector patients and overall was higher in females (14.7%) compared to males (10.5%). Further, female patients under 60 years of age had the highest rate of severe obesity at 21.1%. Overall, 11.5% of cases were severely obese.

Table 3: Selected patient characteristics by hospital sector

Patient characteristics	Public (n=6,615)	Private (n=5,036)
Age- years (Mean ±SD)	64.5 ±12.0	70.3 ±10.3
	%	%
Sex - female	22.9	22.6
Diabetes	25.7	21.8
Peripheral Vascular Disease	3.3	3.2
Cerebrovascular Disease	2.9	2.6
Previous PCI	25.6	38.7
Previous CABG	4.3	6.8
Hypertension	61.9	72.0
Chronic Lung Disease	12.5	12.0
Body Mass Index (BMI) ≥35kg/m^2	13.1	9.3

Case Presentation

Just under one fifth of the workload (n=2,237, 19.2%, of total cases) were performed out-of-hours, the majority of which were for STEMI (n=1,379, 61.6% of out-of-hours cases), a further 427 cases (19.1% of out-of-hours cases) were for NSTE-ACS and the remainder of cases (n= 431, 19.3% of out-of-hours cases) were performed for non-ACS indications. The majority of the after-hours workload was performed in the public sector (n=1,553, 69.4% out-of-hours cases).

Figure 6 presents time delays from hospital admission to PCI for NSTE-ACS cases grouped into four time categories. Just under half of NSTE-ACS were treated in less than 24 hours and 15% of cases whose treatment was delayed for more than 72 hours.

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

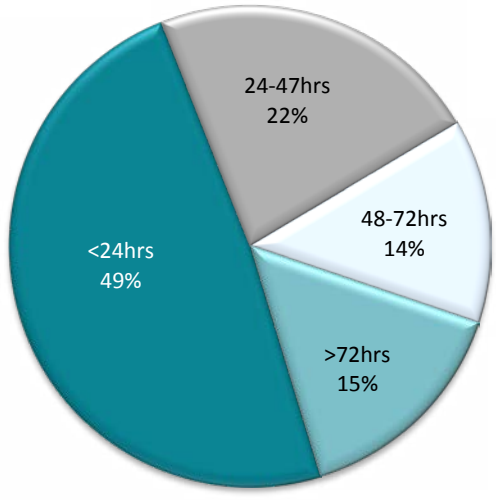


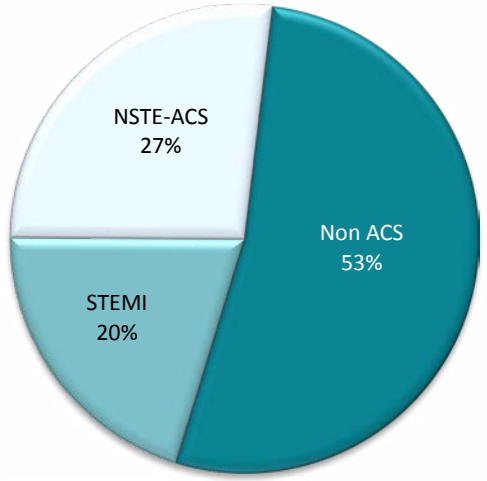
Table 4 examined time delays to PCI for NSTE-ACS by hospital sector. The overall proportion of cases treated within 72 hours was higher in public sector hospitals.

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

	All sites (N=3,118)	Public (n=2,206)	Private (n=912)
	N (%)	N (%)	N (%)
<24hrs	1,518 (48.7)	1,104 (50.0)	414 (45.4)
24-47hrs	700 (22.5)	492 (22.3)	208 (22.8)
48-72hrs	428 (13.7)	296 (13.4)	132 (14.5)
>72hrs	472 (15.1)	314 (14.2)	158 (17.3)

PCI for non-ACS indications accounted for just over half the number of cases at 53%. This pattern has been observed for a number of years now, since the registry achieved near complete capture of all PCI cases in Victoria (Figure 7).

Figure 7: Procedures by clinical presentation



There was significant variation in the proportion of ACS cases across Victorian PCI hospitals. Some hospitals treated relatively few ACS cases including one that did not have any ACS cases. In contrast, in a number of hospitals ACS accounted for a majority of their PCI workload, including five hospitals where ACS accounted for >70% of their caseload.

Indications for PCI

The indications for PCI among the ACS patient cohort by hospital sector are shown in Table 5.

Table 5: PCI indications by ACS category and hospital sector

PCI indications	All sites (N=5,982)	Public (n=4,634)	Private (n=1,348)
ACS Category	N (%)	N (%)	N (%)
Primary PCI*	1,762 (29.5)	1,575 (34.0)	187 (13.9)
STEMI PCI 12-24 hours after symptom onset	139 (2.3)	128 (2.8)	11 (0.8)
Pharmaco-invasive PCI	88 (1.5)	84 (1.8)	4 (0.3)
Rescue PCI	193 (3.2)	185 (4.0)	8 (0.6)
PCI For STEMI (1-7 Days no prior lysis)	116 (1.9)	105 (2.3)	11 (0.8)
PCI For STEMI (1-7 Days following lysis)	83 (1.4)	76 (1.6)	7 (0.5)
PCI for OHCA/shock (non-MI)	42 (0.7)	38 (0.8)	4 (0.3)
PCI for NSTE-ACS	3,559 (59.5)	2,443 (52.7)	1,116 (82.8)
NSTE-ACS sub-category	N (%)	N (%)	N (%)
NSTEMI	2,697 (75.8)	2,010 (82.3)	687 (61.6)
UAP	421 (11.8)	196 (8.0)	225 (20.2)
Recent ACS 8-30 days ago	441 (12.4)	237 (9.7)	204 (18.3)

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

The indications for PCI in the non-ACS patient cohort by hospital sector are shown in Table 6.

Table 6: Non-ACS PCI indications

PCI indications	All sites (N=5,668)	Public (n=1,980)	Private (n=3,688)
	N (%)	N (%)	N (%)
Stable angina	4,106 (72.4)	1,444 (72.9)	2,662 (72.2)
No symptoms and positive functional test	443 (7.8)	76 (3.8)	367 (10.0)
No symptoms and no functional test	221 (3.9)	77 (3.9)	144 (3.9)
Staged PCI after ACS (≤30 days after first procedure)	452 (8.0)	275 (13.9)	177 (4.8)
Staged PCI after ACS (>30 days after first procedure)	132 (2.3)	59 (3.0)	73 (2.0)
Staged PCI after original non-ACS indication	314 (5.5)	49 (2.5)	265 (7.2)

An assessment of the presence or absence of clinical factors that determine the appropriateness of non-ACS PCI procedures is shown in Table 7. These clinical factors include the presence of symptoms, the severity of the coronary lesion(s) and demonstration of functional ischaemia. In 2022, a total of 92.1% of patients had at least 2 key clinical factors present and 52.3% of cases had all 3 clinical factors. There has been a gradual decline over time in the proportion of non-ACS PCI cases with one or no key clinical factor present (7.9% in 2022 vs 9.2% in 2021 vs 10.1% in 2020).

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

Symptoms	Positive functional test	High grade stenosis	Total
			N (%)
●	●	●	2,495 (52.3)
○	●	●	408 (8.6)
●	●	○	256 (5.4)
●	○	●	1,236 (25.9)
●	○	○	119 (2.5)
○	○	●	206 (4.3)
○	●	○	35 (0.7)
○	○	○	15 (0.3)
			4,770 (100)

When hospital sectors are compared, the proportion of cases with at least 2 clinical factors relating to appropriateness was 93% in the public sector and 92% in the private sector (Figure 8). The presence of all 3 clinical factors increased in both sectors compared to previous years (56% in 2022 vs 54% in 2021 vs 45% in 2020 in the public sector and 51% in 2022 vs 47% in 2021 vs 42% in 2020 in the private sector). There has also been a corresponding decrease in the proportion of cases with just one or no key clinical factor in public hospitals over the same 3 year period (7% in 2022 vs 9% in 2021 vs 12% in 2020), while proportions in the private sector have been similar (8% in 2022 vs 10% in 2021 vs 9% in 2020).

Figure 8: Key clinical factors in non-ACS patients by hospital sector

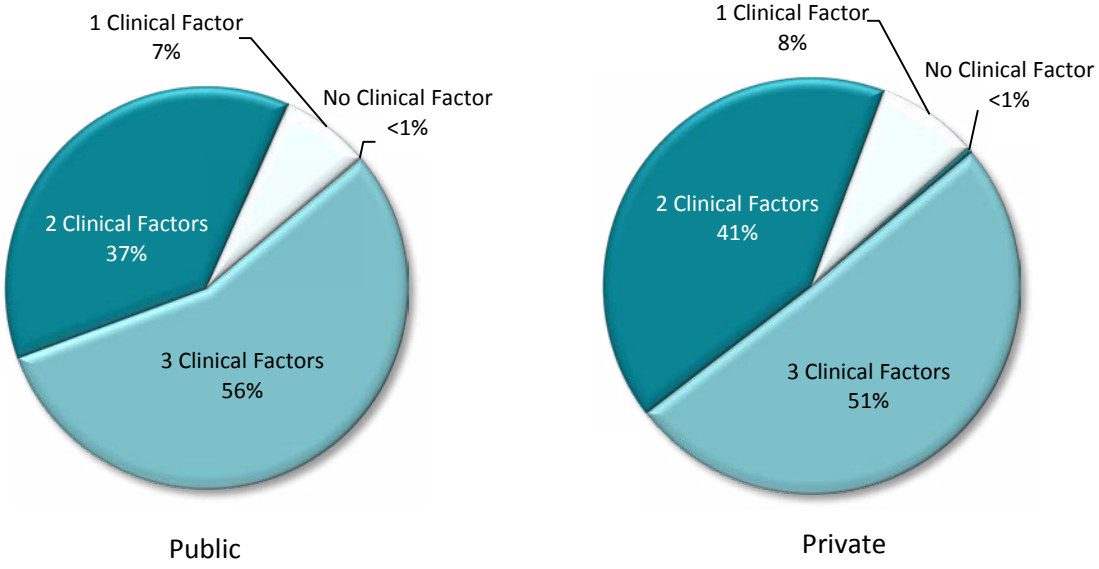
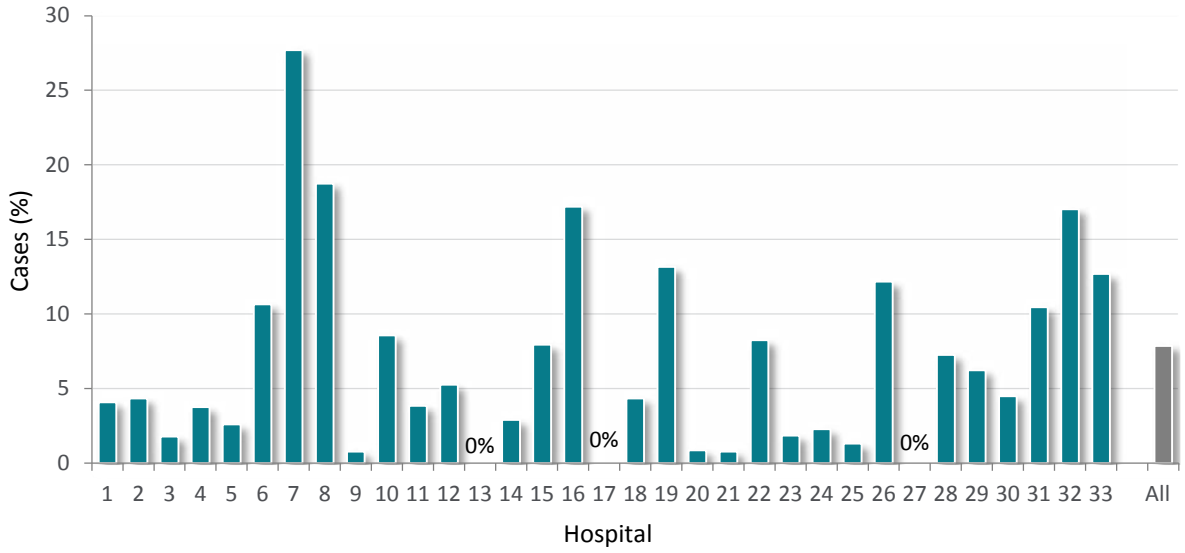


Figure 9 benchmarks hospitals with respect to the proportion of their non-ACS cases with just one or no key clinical factor. There was considerable variation among hospitals (range 0%- 27.7%). A total of 375 cases had either no or just one key clinical factor with 69% (n=260) of these treated in the private sector.

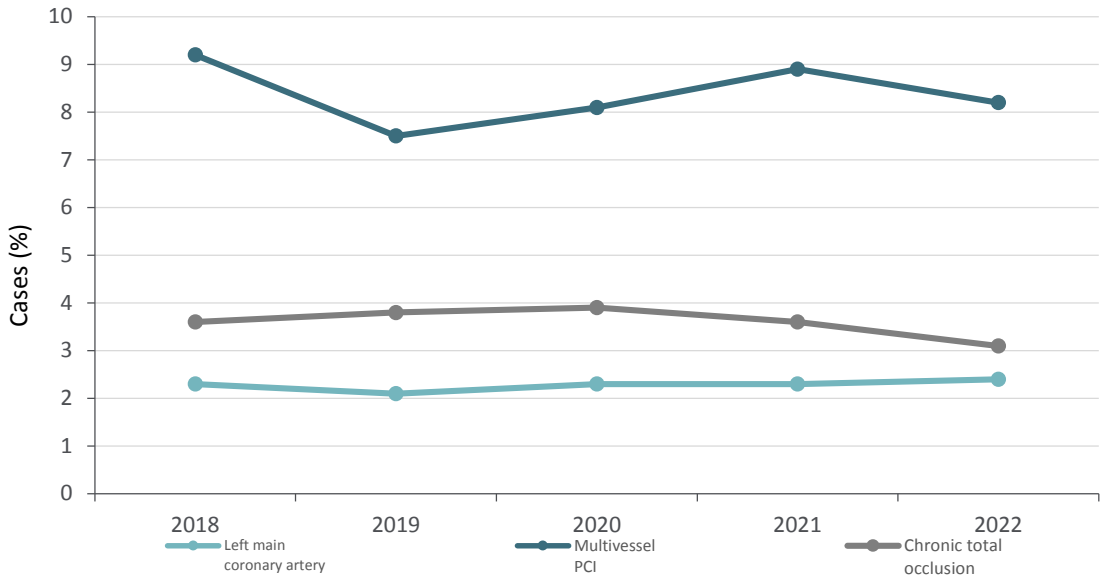
Figure 9: Proportion of non-ACS cases with 0 - 1 key clinical factor for PCI by hospital



Lesion and Clinical Subsets

The trends in rates of PCI for selected lesion subsets for the last five years is shown in Figure 10. Despite the cumulative evidence regarding the safety and efficacy of unprotected left main coronary artery (LMCA) stenting, numbers have remained relatively constant over time. Similarly, the number of CTO cases has not really shown any growth over the last 5 years despite significant advances in techniques and equipment. Rates of multivessel PCI remain broadly similar year-on-year, while balloon angioplasty without stenting (POBA) accounted for 4.6% of cases in 2022. For cases of in-stent restenosis, POBA was used in 38.3% of cases and treatment with a drug-coated balloon was performed in 27.7% of cases.

Figure 10: Comparative trends in PCI for selected lesion subsets: 2018 - 2022



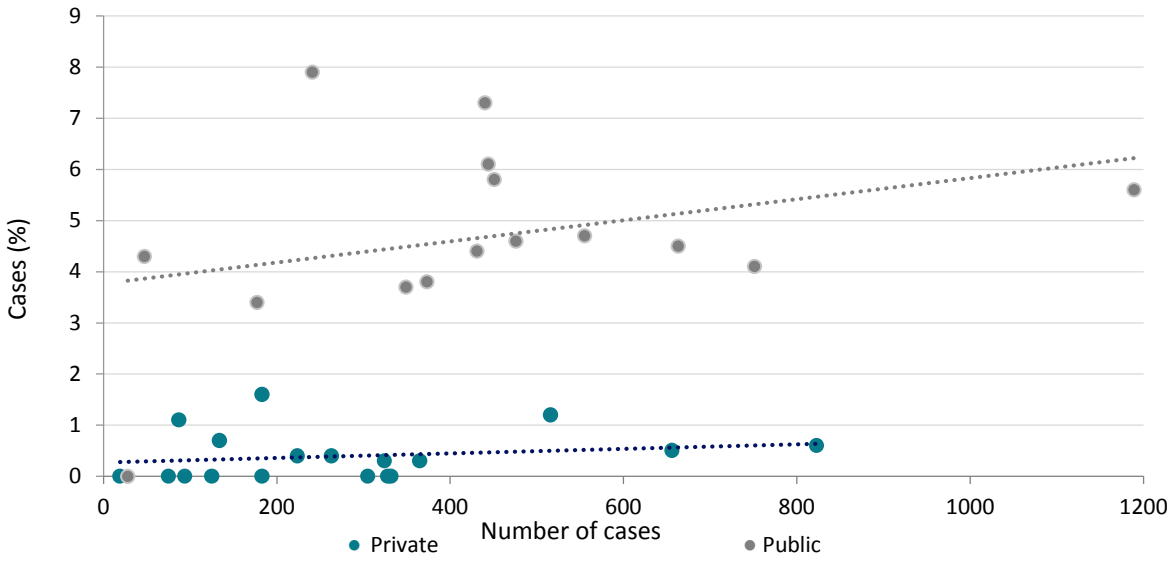
Trends in case numbers of cardiogenic shock and/or intubated out of hospital cardiac arrest (OHCA) over time are presented in Table 8. The majority of these cases were managed in the public sector, representing 5% of the total workload. In contrast, these high-acuity cases accounted for only 0.5% of the overall workload in the private sector.

Table 8: Rates of cardiogenic shock and/or intubated OHCA: 2018 - 2022

Presentation type	2018 (N=12,463)	2019 (N=12,354)	2020 (N=12,347)	2021 (N=12,478)	2022 (N=11,651)
	N (%)	N (%)	N (%)	N (%)	N (%)
Cardiogenic shock	266 (2.1)	269 (2.2)	273 (2.2)	246 (2.0)	305 (2.6)
Intubated OHCA	137 (1.1)	151 (1.2)	129 (1.0)	138 (1.1)	155 (1.3)
Shock and/or intubated OHCA	329 (2.6)	320 (2.6)	326 (2.6)	300 (2.4)	356 (3.1)

Figure 11 examines the relationship between hospital volume, hospital sector and the proportion of a hospitals workload occupied by high-acuity cases of cardiogenic shock and/or intubated OHCA. For public sector hospitals, there was a discernible trend towards higher volume hospitals having a greater proportion of their workload taken up with these high-risk cases. In contrast, among private sector hospitals, there was no such trend, with rates of cardiogenic shock and/or intubated OHCA cases fairly constant among both low and high volume hospitals.

Figure 11: Cardiogenic shock and/or intubated OHCA cases by hospital volume and hospital sector



Coronary Device Use

Stents were deployed in 93.3% of cases. Bare metal stents are virtually no longer used across Victoria, with drug-eluting stents accounting for 99.8% of stent cases. A single stent was deployed in two-thirds of cases. Commonly used adjunctive devices are detailed in Table 9. Use of the imaging modalities of IVUS and OCT remains quite low but is more common in the public sector. In contrast, adjunctive devices that attract reimbursement in the private sector, such as rotational atherectomy and pressure wires had higher usage rates in this sector. For the specific clinical subset of left main PCI, adjunctive imaging with IVUS or OCT was used in 44% of cases. Use of the recently introduced technology of coronary intravascular lithotripsy almost doubled compared to the previous year (86 cases in 2022 vs 47 cases in 2021). Glycoprotein IIb/IIIa receptor inhibitor use was 6.4% overall, with the majority of its use in the STEMI patient cohort.

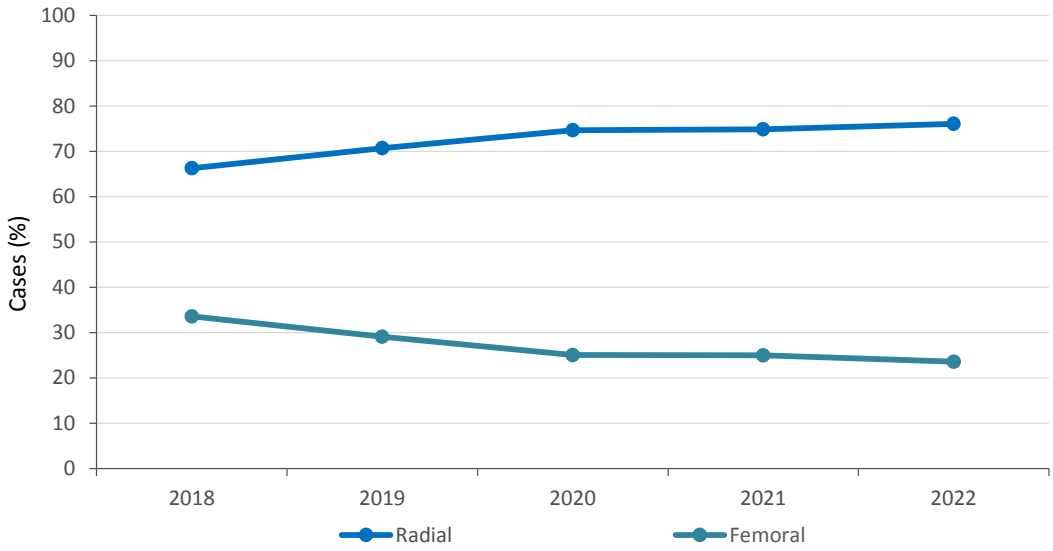
Table 9: Adjunctive device use by hospital sector

Adjunctive device type	All sites (N=11,651)	Public (n=6,615)	Private (n=5,036)
	N (%)	N (%)	N (%)
Intravascular ultrasound	421 (3.6)	269 (4.1)	152 (3.0)
Optical coherence tomography	313 (2.7)	227 (3.4)	86 (1.7)
Thrombus aspiration device	222 (1.9)	203 (3.1)	19 (0.4)
Rotational atherectomy	220 (1.9)	89 (1.3)	131 (2.6)
Pressure wire	723 (6.2)	234 (3.5)	489 (9.7)
IABP	43 (0.4)	32 (0.5)	11 (0.2)
ECMO	22 (0.2)	21 (0.3)	1 (<0.1)

Arterial access

The overall rate of radial artery vascular access was 76.1%, and this proportion seems to have mostly plateaued over the last 3 years (Figure 12). This contrasts with a rapid rise in radial artery access observed last decade, with an 80% increase in the proportion of radial cases between 2014 and 2018. Radial access rates continue to be higher in the public sector (77.9%) compared to the private sector (73.7%) and is higher in males (78% in males vs 69% in females).

Figure 12: Trends in arterial access: 2018 - 2022



PCI for STEMI

In 2022, a total of 2,381 patients underwent PCI for ST-elevation myocardial infarction (STEMI) of whom 1,762 (74%) had primary PCI. The various subcategories of PCI for STEMI are shown in Table 10. Excluding hospitals that did not do any STEMI PCI, the range for STEMI PCI caseload by hospital was 0.3% to 48%. Overall, 58% of PCI cases for STEMI were performed out-of-hours.

Table 10: Subcategories of patients undergoing PCI for STEMI

PCI for STEMI categories	All sites (N=2,381)	Public (n=2,153)	Private (n=228)
	N (%)	N (%)	N (%)
Primary PCI* (<12 hrs, no thrombolysis)	1,762 (74.0)	1,575 (73.2)	187 (82.0)
PCI for STEMI 12-24 hours (no thrombolysis)	139 (5.8)	128 (5.9)	11 (4.8)
Pharmaco-invasive PCI (<24 hrs, previous thrombolysis, stable)	88 (3.7)	84 (3.9)	4 (1.8)
Rescue PCI (<24 hrs, previous thrombolysis, unstable)	193 (8.1)	185 (8.6)	8 (3.5)
PCI for STEMI 1-7 days following lysis	116 (4.9)	105 (4.9)	11 (4.8)
PCI for STEMI 1-7 days no prior lysis	83 (3.5)	76 (3.5)	7 (3.1)

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

Patients treated for STEMI differed from the rest of the PCI cohort in that they were younger (mean age 63.6 ± 12.6 years vs 67.9 ± 11.3 years), had fewer traditional cardiac risk factors such as diabetes (20.5% vs 25.0%) and peripheral vascular disease (2.1% vs 3.5%) and had lower rates of previous revascularisation procedures - including previous PCI (13.0% vs 36.0%) and coronary artery bypass grafting (1.7% vs 6.3%).

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 (63.1 ± 12.6 years public vs 68.1 ± 12.1 years private), had fewer previous strokes (2.3% public vs 0.9% private), more previous PCIs (12% public vs 21.9% private), more PVD (1.9% public vs 4.4% private) and more previous coronary artery bypass grafting operations (1.5% public vs 3.1% private).

Figure 13: STEMI patient characteristics

Time Delays to Treatment

The key performance measure of door-to-balloon time (DBT) is utilised to benchmark hospitals performance in the acute management of patients with STEMI. Traditionally, hospital performance has been measured by their compliance with a DBT≤90 minutes. However, Australian and international guidelines now recommend compliance with the more stringent DBT≤60 minutes when patients present to a PCI-capable hospital. We therefore have presented data for both performance metrics as shown in Table 11. Compliance with both DBT metrics reached a peak in 2019 but has declined in the years 2020-2022, corresponding to the COVID-19 pandemic. We have shown in previous reports that the main effect of the COVID-19 pandemic on PCI outcomes was a lengthening of the DBT, and this effect was still apparent in the 2022 STEMI cohort.

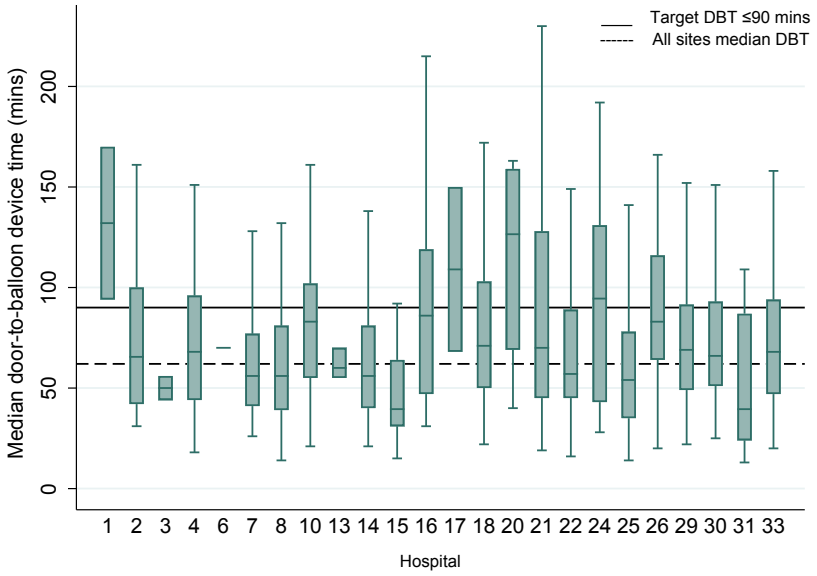
Table 11: Door-to-balloon times for primary PCI cases: 2019 - 2022

Door-to-balloon time	2019	2020	2021	2022
	(N=1,495)	(N=1,623)	(N=1,565)	(N=1,469)
Median – mins (IQR)	58 (40, 84)	62 (43, 91)	61 (43, 92)	62 (43, 90)
Proportion of cases ≤90mins (%)	80.8	74.7	74.4	75.2
Proportion of cases ≤60mins (%)	54.0	48.4	49.3	47.6

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

The DBT times by hospital are presented in Figure 14. Nine hospitals achieved a median DBT≤60 minutes.

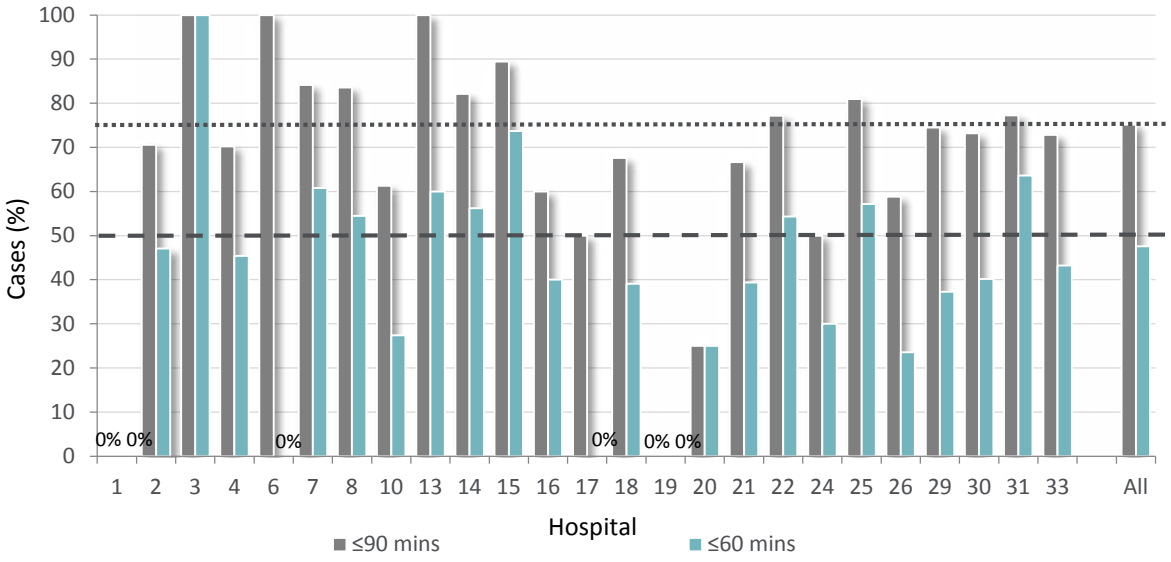
Figure 14: Door-to-balloon time for primary PCI cases by hospital



Primary PCI for STEMI presentations excluding all inter-hospital transfers and patients with STEMI onset whilst a current in-patient. Hospital 19 excluded due to low case numbers.

In Figure 15, hospitals own internal compliance with the two DBT metrics is compared, and hospitals benchmarked against their peers. All but one hospital showed lower compliance rates with the more stringent DBT metric of ≤60 minutes, and only a minority of hospitals achieved a DBT≤60 minutes in 75% of their cases. Even when the benchmark compliance threshold was lowered to 50% of cases, only nine of 25 hospitals managed to achieve this.

Figure 15: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes and ≤60 minutes by hospital



Primary PCI for STEMI presentations excluding all inter-hospital transfers and patients with STEMI onset whilst a current in-patient. Hospitals 1, 3, 6, 13, 17, 19 & 20 had low primary PCI cases ≤5. Hospitals 5, 9, 11, 12, 23, 27, 28 & 32 had no primary PCI cases.

Pre-hospital notification (PHN)

Pre-hospital notification (PHN) was utilised in 74.3% of primary PCI cases and resulted in significant reductions in median DBT (Table 12).

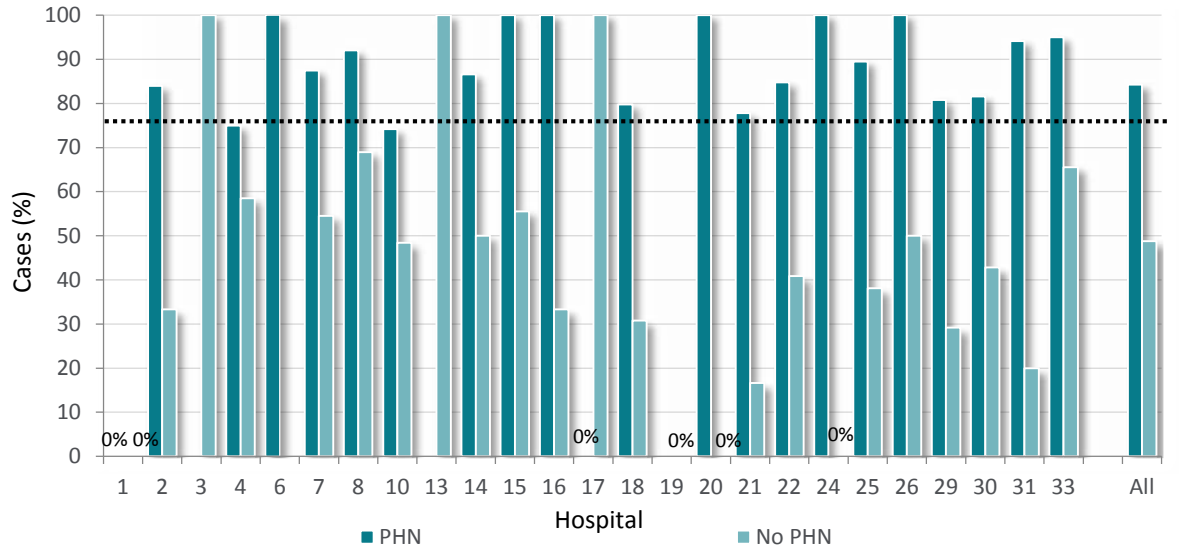
Table 12: Door-to-balloon times for Primary PCI cases by pre-hospital notification status

Door-to-balloon time	Primary PCI*	Primary PCI* (PHN only†)	Primary PCI* (no-PHN†)
	(N=1469)	(n=1092)	(n=377)
Median – mins (IQR)	62 (43, 90)	56 (39, 79)	93 (65, 130)
Proportion of cases ≤90mins (%)	75.2	84.2	48.8

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

Figure 16 demonstrates the influence of PHN on compliance in achieving a DBT ≤90 minutes. Despite the clear advantage of PHN on DBT, a number of hospitals still failed to achieve the compliance target of ≥75% cases with DBT≤90 minutes even with PHN.

Figure 16: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes – pre-hospital notification vs no pre-hospital notification

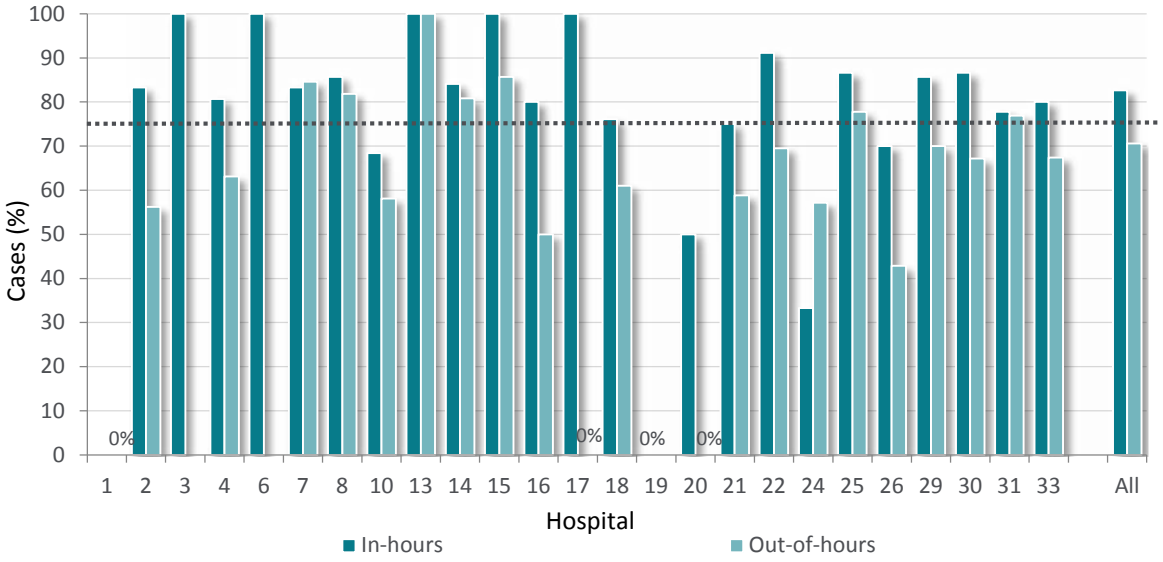


Primary PCI for STEMI presentations excluding all inter-hospital transfers and patients with STEMI onset whilst a current in-patient. Hospitals 3, 13 and 19 had no PHN cases. Hospitals 1, 3, 6, 13, 17, 19 & 20 had low primary PCI cases ≤5. Hospitals 5, 9, 11, 12, 23, 27, 28 & 32 had no primary PCI cases.

In-hours versus out-of-hours presentation

The proportion of primary PCI cases by in-hours vs out-of-hours is shown in Figure 17. The rate of primary PCI performed out-of-hours was similar to the previous year (62.3% in 2022 vs 60.6% in 2021). The proportion of out-of-hours cases among hospitals ranged from 0- 100%. The compliance with a door-to-balloon time of ≤90 minutes was achieved in 82.7% of cases in-hours vs 70.6% for cases performed out-of-hours.

Figure 17: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes – in-hours vs out-of-hours presentation



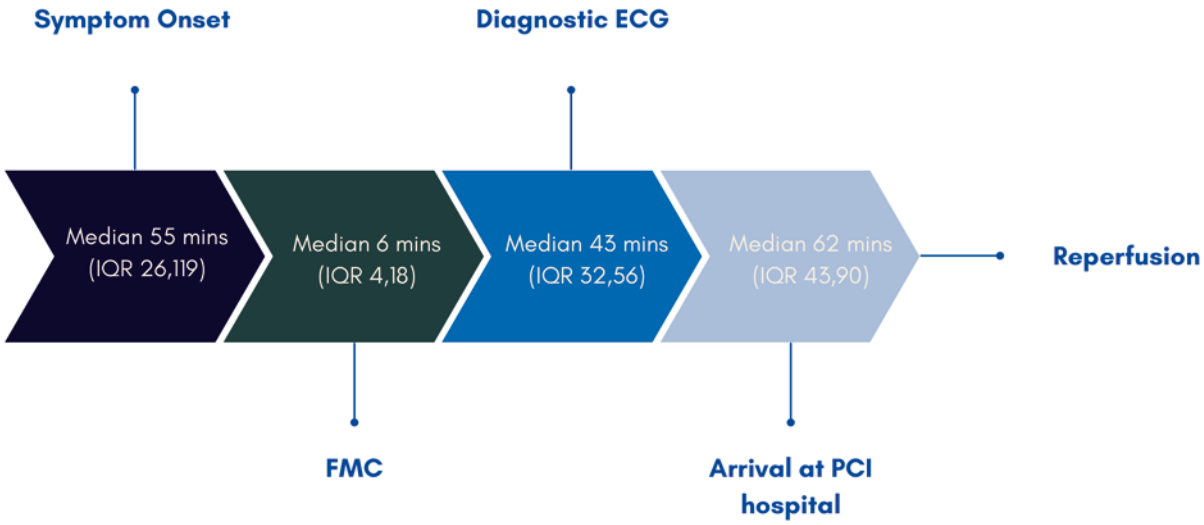
Primary PCI for STEMI presentations excluding all inter-hospital transfers and patients with STEMI onset whilst a current in-patient. Hospital 1 had NIL in-hours cases. Hospitals 3, 6 & 19 had NIL out-of-hours cases. In-hours: 8.00am - 6.00pm (Mon-Fri excluding public holidays). Out-of-hours: 6.00pm - 8.00am (Mon-Fri, public holidays and weekends).

Times from symptom onset to first medical contact, diagnostic ECG and reperfusion

The metric of system delay consists of the time from first medical contact (FMC) to diagnostic ECG, the time to transfer patients to a PCI-capable hospital after the diagnostic ECG and the time from hospital arrival to reperfusion (the door-to-balloon time). The median time from symptom onset to first medical contact (ambulance service, emergency department or GP) was 55 minutes (IQR: 26, 119).

The total ischaemic time represents the time from symptom onset to device use (reperfusion) and is presented in Figure 18. Shorter delays from first diagnostic ECG to hospital arrival and first medical contact (FMC) to reperfusion time were observed compared with previous years. While the time from symptom onset was longer among private patients, once these patients entered the system, remaining time delays were shorter than for public patients.

Figure 18: Median times from symptom onset to reperfusion



The effect of PHN and hospital sector on the various components of the total ischaemic time are shown in Table 13. The overall median FMC to diagnostic ECG time was 6 minutes (IQR: 4, 18). As with the door-to-balloon times in patients undergoing primary PCI, FMC to diagnostic ECG also improved when pre-hospital notification of the arriving STEMI patient was provided by ambulance services. The median time from FMC to diagnostic ECG with PHN was 5 minutes (IQR: 3, 14), eight minutes shorter than without PHN (13 minutes, IQR: 5, 34). The median time from FMC to reperfusion for the cohort was 109 minutes (IQR: 88, 143).

Table 13: Median times from symptom onset to reperfusion - public/private and PHN and No PHN

	All	Public	Private	PHN	No PHN
All Primary PCI*	(N=1,446)	(n=1,308)	(n=138)	(n=1,077)	(n=369)
Median Symptom onset to FMC- mins (IQR)	55 (26,119)	55 (26,117)	57 (29,137)	48 (24,100)	81 (37,174)
Median FMC to Diagnostic ECG- mins (IQR)	6 (4,18)	6 (3,18)	5 (4,14)	5 (3,14)	13 (5,34)
Median Diagnostic ECG to door- mins (IQR)	43 (32,56)	43 (32,56)	41 (25,58)	43 (33,56)	37 (23,53)
Median Diagnostic ECG to Balloon/Device time- mins (IQR)	96 (77,124)	97 (78,125)	85 (61,115)	100 (81,127)	87 (66,118)
Median FMC to Balloon/Device time - mins (IQR)	109 (88,143)	110 (89,144)	102 (73,133)	110 (89,140)	109 (82,158)

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

Radial access

The radial artery access rate in STEMI cases was 79.2% and similar to previous reporting periods. Higher rates were observed in the public sector (79.5%) compared to the private sector (76.3%) and there was variation among hospitals ranging from 55%-100%. The proportion of hospitals using radial access in ≥75% of their acute STEMI was 76%, an improvement compared to 2021 when the proportion was 73%.

Outcomes

Lesion and procedure success rates

The overall procedural success rate in 2022 was 92.4% with a range among hospitals from 87.2% to 100%. Procedural success was higher in male patients 92.8% compared with 91.1% for females. Older patients, those with prior CABG, renal dysfunction or reduced LV function had lower procedural success rates, as did out-of-hours cases and patients with cardiogenic shock and/or intubated OHCA (Table 14).

Table 14: Selected clinical characteristics of successful procedures

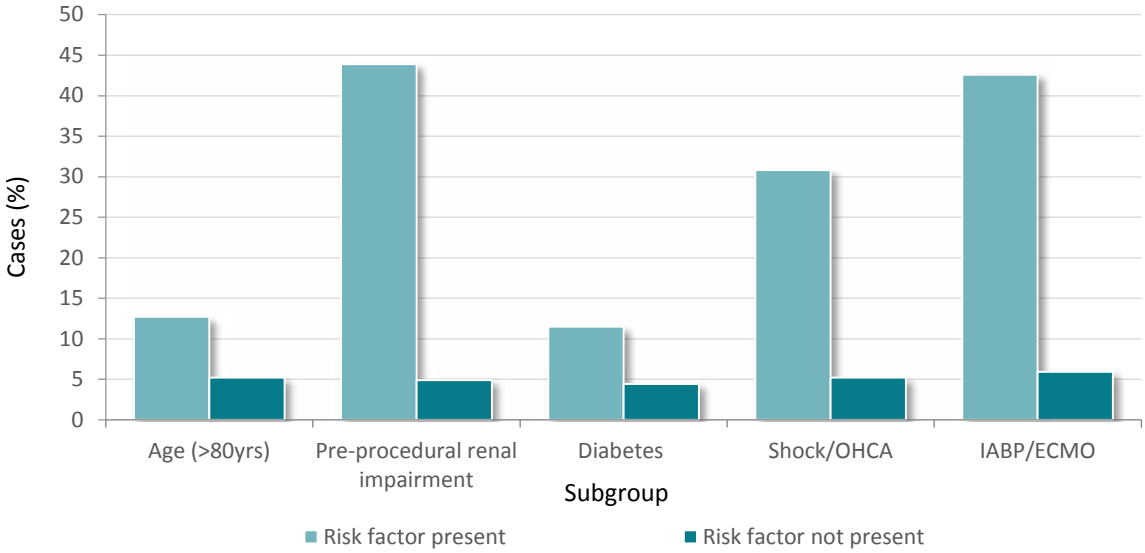
Clinical characteristics	Successful procedures* (N=10,767)
Age- years (Mean ± SD)	66.8 ±11.6
	(%)
Sex-female	91.1
Sex-male	92.8
Diabetes-Yes	91.3
Diabetes-No	92.8
Peripheral Vascular Disease-Yes	85.9
Peripheral Vascular Disease-No	92.6
Cerebrovascular Disease-Yes	87.6
Cerebrovascular Disease-No	92.6
Previous PCI-Yes	92.3
Previous PCI-No	92.5
Previous CABG-Yes	89.5
Previous CABG-No	92.6
Severe LVEF (<35%)-Yes	74.9
Severe LVEF (<35%)-No	93.0
Shock and/or intubated OHCA-Yes	51.1
Shock and/or intubated OHCA-No	93.7
In-hours	93.4
Out-of-hours	88.3
Public hospital	91.0
Private hospital	94.2
Chronic total occlusion-Yes	62.8
Chronic total occlusion-No	93.3
ACC/AHA B2/C lesion-Yes	90.6
ACC/AHA B2/C lesion-No	95.7

**Procedural success rate is defined as the successful treatment of all lesions and the absence of any major in-hospital complications.*

New renal impairment

Post-procedural renal function was recorded in 6,642 patients (57%). New renal impairment (NRI) occurred in 6.2% of cases. The rate of NRI post-PCI was highest in patients undergoing PCI for STEMI (9.2%), lower in NSTE-ACS (5.8%) and lowest in non-ACS patients (4.0%). Figure 19 presents rates of new renal impairment selected high-risk subgroups. As expected, the highest rate of new renal impairment was observed in patients with significant pre-procedural renal impairment. NRI was also higher among high-acuity patients including those with cardiogenic shock and/or intubated OHCA or those requiring mechanical haemodynamic support.

Figure 19: Rates of new renal impairment in selected high-risk subgroups

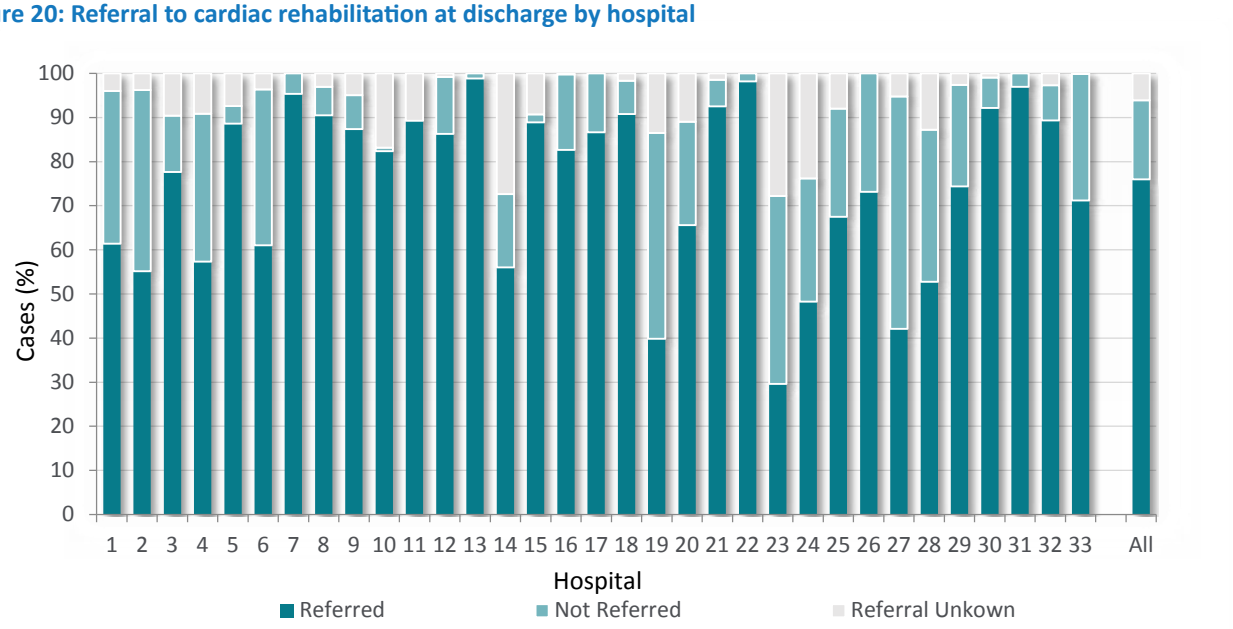


Data available for 6,642 cases.

Referral to cardiac rehabilitation

The overall referral to cardiac rehabilitation rate was 76%, with 17.9% not referred and 6.1% with an unknown referral status. Referral rates were higher among patients treated in the public sector (77.5% public sector vs 74% private sector). There was marked variation among hospitals, with referral rates ranging from 30% to 99% (Figure 20).

Figure 20: Referral to cardiac rehabilitation at discharge by hospital



Compliance with guideline-recommended medications at discharge

Optimal medical therapy should accompany all PCI procedures and includes dual antiplatelet therapy (DAPT) and statins. The rates of prescription of DAPT, statin and other guideline-recommended medications by clinical presentation is presented in Table 15. As has been noted in previous years, the use of beta blockers and ACE inhibitors/angiotensin receptor blockers (ACE-I/ARB) is lowest among patients with non-ACS presentations.

Table 15: Rates of prescription of selected medications at discharge by clinical presentation

Clinical presentation	DAPT	Statin	BB	ACE-I/ARB
	%	%	%	%
STEMI	95.8	96.9	86.4	78.9
NSTE-ACS	95.4	95.3	73.1	72.4
Non-ACS	93.9	91.9	53.3	62.6

Among patients who require an oral anticoagulant (such as warfarin or a direct-acting oral anticoagulant), the additional use of a single anti-platelet agent (aspirin, clopidogrel or ticagrelor) is known as “double therapy”. When a second anti-platelet is added, this is known as “triple therapy” and its use attracts some controversy. Table 16 presents the 2022 rates of double and triple therapy at discharge and 30-days by a range of patient and clinical factors.

Triple therapy was utilised less commonly than double therapy in all age groups, across all clinical presentations and in both hospital sectors. Further, there was evidence of a shift from triple therapy to double therapy at 30-days across all these subgroups, consistent with guidelines that recommend that when triple therapy is used, it should only be continued for limited periods of time. Rates of triple therapy were lower in females compared with males and more common in patients with non-ACS presentations and those treated in the private sector.

Table 16: Rates of double and triple therapy at discharge and 30-days

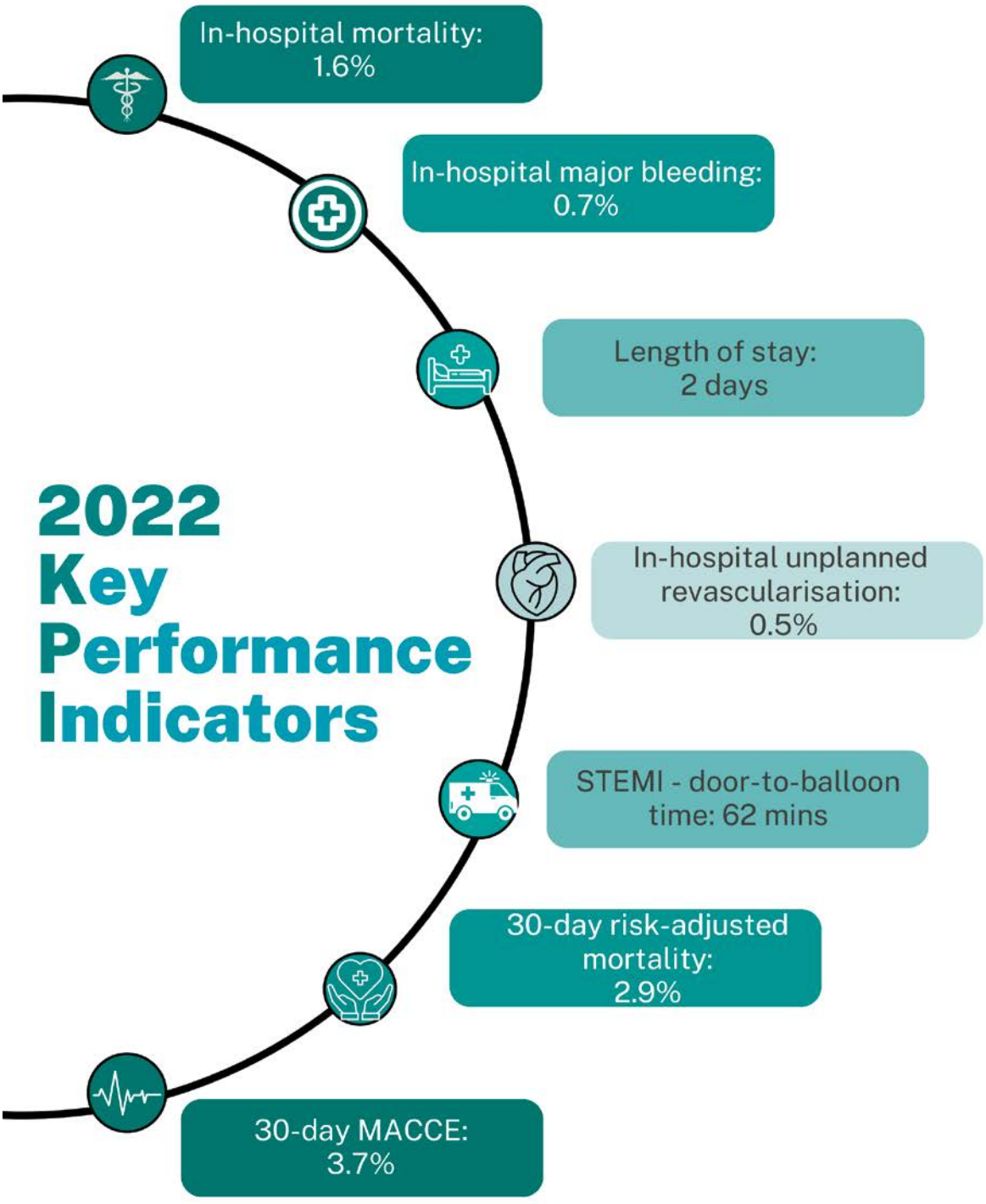
Characteristics	Discharge		30-Days	
	Double Therapy	Triple Therapy	Double Therapy	Triple Therapy
	%	%	%	%
Sex- male	10.8	7.7	11.7	5.3
Sex- female	10.9	7.2	11.4	5.1
Age <60 years	4.1	3.3	5.7	3.4
Age 60-69 years	8.2	6.2	9.2	4.7
Age 70-79 years	14.0	10.3	14.6	6.1
Age >79 years	21.5	12.8	21.4	8.1
STEMI	8.8	6.5	9.7	5.1
NSTE-ACS	10.4	7.6	11.2	5.4
Non-ACS	11.7	8.0	12.6	5.3
Public	9.6	7.5	10.9	5.2
Private	12.3	7.8	12.6	5.4

The proportion of STEMI patients discharged on at least four of the five evidence-based medications (aspirin, second antiplatelet agent, statin, beta blocker and ACE inhibitor/ARB) was 91.5%.

Key Performance Indicators

VCOR reports on the key performance indicators (KPIs) shown in Figure 21.

Figure 21: VCOR PCI Key Performance Indicators



All percentages reflect the 2022 rates for each outcome. Length of stay is median days. Door-to-balloon time is the median time in minutes.

In-hospital mortality

Trends in rates of in-hospital mortality from 2018 to 2022 among selected patient subgroups are presented in Table 17. The overall unadjusted rate of in-hospital mortality in 2022 was 1.6%. When high-acuity cases of cardiogenic shock and/or intubated OHCA were excluded, the overall rate declined to 0.4%. The in-hospital mortality rate for STEMI, excluding shock and/or intubated OHCA, was 1.5%.

Table 17: Trends in in-hospital mortality rates for selected clinical presentations: 2018 - 2022

Patient category	2018 (N=12,463)	2019 (N=12,355)	2020 (N=12,349)	2021 (N=12,478)	2022 (N=11,651)
	N (%)	N (%)	N (%)	N (%)	N (%)
All PCI patients	174 (1.4)	212 (1.7)	184 (1.5)	180 (1.4)	197 (1.6)
STEMI	119 (4.7)	148 (6.2)	140 (5.4)	118 (4.8)	135 (5.7)
Shock and/or intubated OHCA	116 (35.3)	138 (43.1)	116 (35.6)	113 (37.7)	127 (35.7)
NSTE-ACS	29 (0.8)	27 (0.8)	19 (0.5)	32 (0.9)	37 (1.2)
Non-ACS	26 (0.4)	37 (0.6)	25 (0.4)	30 (0.5)	25 (0.4)

In-hospital major bleeding

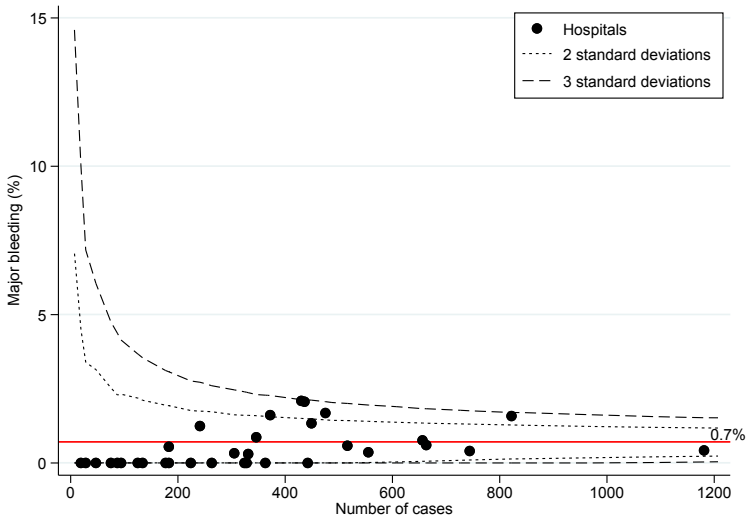
The rate of in-hospital major bleeding in 2022 was 0.7% (Table 18). There was a total of 22 cases requiring ECMO, with the bleeding rate in this high-risk group being 18%.

Table 18: In-hospital major bleeding rates for selected patient groups

Sub-group	N	Major bleeding rate
Clinical Presentation		N (%)
STEMI	2,378	41 (1.7)
NSTE-ACS	3,116	19 (0.6)
Non-ACS	6,146	26 (0.4)
Sex		N (%)
Male	8,990	48 (0.5)
Female	2,650	38 (1.4)
Arterial Access Route		N (%)
Radial access	8,864	29 (0.3)
Femoral access	2,743	57 (2.1)
Brachial access	33	0 (0)
Total	11,640	86 (0.7)

Major bleeding rates by hospital are presented in Figure 22. There were no outlier hospitals for major bleeding.

Figure 22: In-hospital major bleeding by hospital

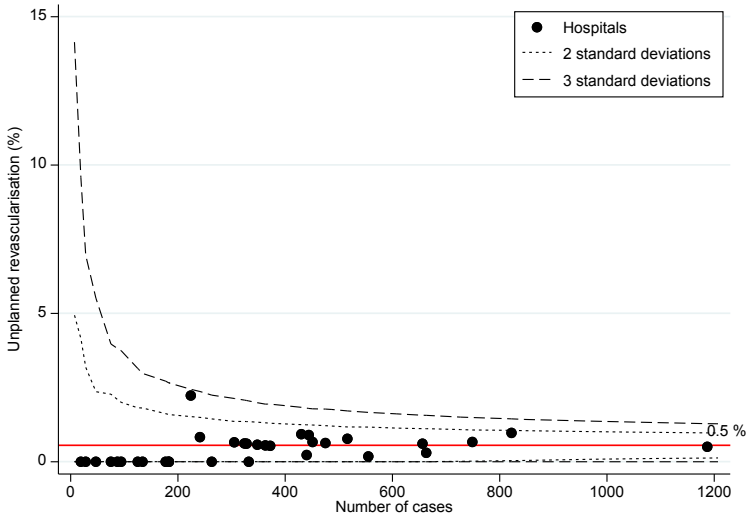


Excludes ECMO cases.

In-hospital unplanned revascularisation

A revascularisation procedure (PCI or CABG surgery) performed after the initial PCI is considered 'unplanned' if it was performed for recurrent ischaemia and was unexpected and not pre-arranged. The rate of in-hospital unplanned revascularisation was 0.5% and all participating hospitals were within control limits (Figure 23).

Figure 23: In-hospital unplanned revascularisation by hospital

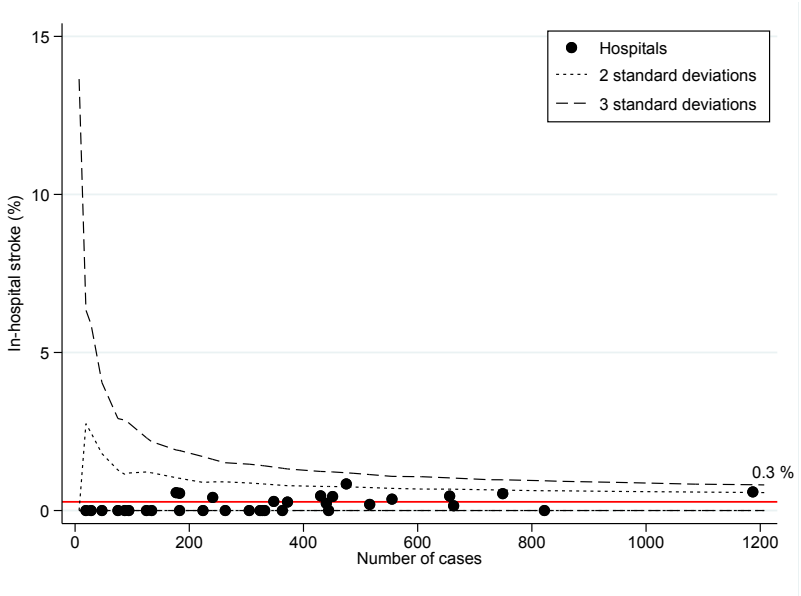


In total, 25 emergency CABG procedures were performed following PCI in 2022- similar to previous years. Patients undergoing emergency CABG were more likely to have presented with STEMI, have complex Type C lesions or CTO lesions. Sixteen percent of patients requiring emergency CABG had their index PCI at a hospital without onsite surgery and required urgent inter-hospital transfer. The overall mortality of patients requiring emergency CABG was 8%.

In-hospital stroke

The in-hospital stroke rate was 0.3% (range 0 - 0.8%), and unchanged from the previous year. There were 32 stroke events, three of which were haemorrhagic strokes. There were no outlier hospitals with respect to the incidence of in-hospital stroke.

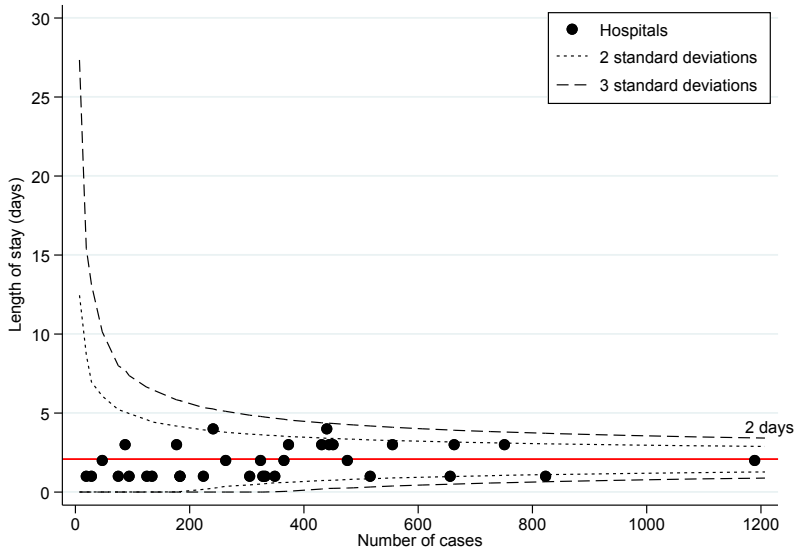
Figure 24: In-hospital stroke by hospital



Length of stay

The overall median length of stay remained consistent at two days, with all hospitals within control limits (Figure 25). However, the median length of stay varied by clinical presentation, ranging from one day for patients undergoing PCI for elective non-ACS indications up to four days for STEMI PCI cases. The overall proportion of same-day discharges in patients undergoing PCI for elective non-ACS cases was 3.5% (n=407), with the majority of these cases performed in the public sector.

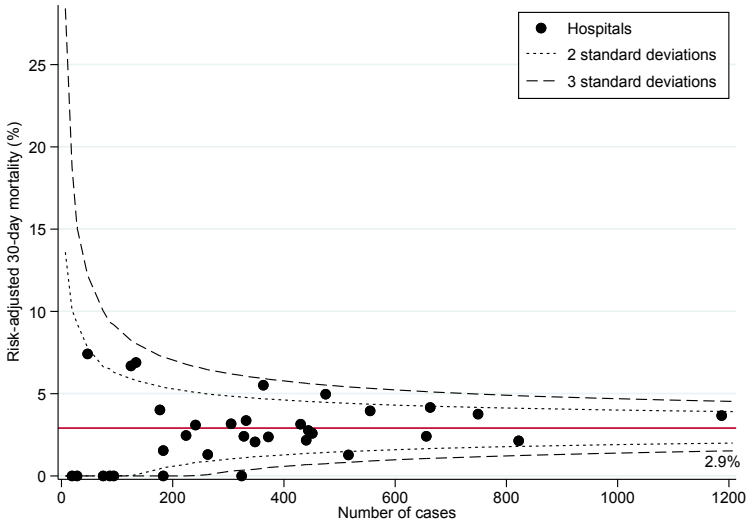
Figure 25: Median length of stay by hospital



Risk-adjusted mortality at 30-days

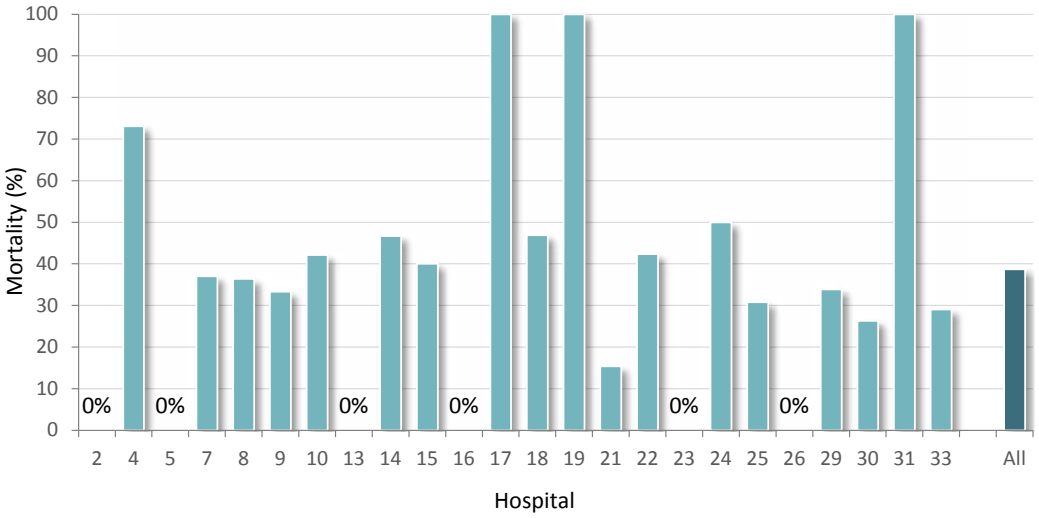
The 30-day risk-adjusted mortality rate was 2.9%. All participating hospitals were within control limits (Figure 26). No relationship between hospital volume and risk-adjusted mortality was evident.

Figure 26: Risk-adjusted mortality by hospital at 30-days



The 30-day mortality rates (unadjusted) for cardiogenic shock and/or intubated OHCA cases by hospital are shown in Figure 27. The mean mortality rate observed in this cohort was 38.7%. Overall, there were 354 cases with cardiogenic shock and/or intubated OHCA cases and a total of 137 deaths, with a number of hospitals not treating any cardiogenic shock and/or intubated OHCA cases. Furthermore, hospitals with high mortality rates tended to have very low numbers and their results should be viewed in this context.

Figure 27: Mortality rates for cardiogenic shock and/or intubated OHCA patients by hospital at 30-days



Hospital	2	4	5	7	8	9	10	13	14	15	16	17	18	19	21	22	23	24	25	26	29	30	31	33	ALL
Cases (N)	1	26	1	27	22	3	19	1	30	5	6	2	32	1	13	26	1	6	13	3	65	19	1	31	354

Major cardiac and cerebrovascular events at 30-days

The composite endpoint of Major Adverse Cardiac and Cerebrovascular Events (MACCE) combines the outcomes of death, new or recurrent myocardial infarction, stent thrombosis, target vessel revascularisation and stroke. The components of MACCE, for both the in-hospital and 30-day timepoints are shown in Table 19. The overall rate of 30-day MACCE was 3.7% and was higher in females compared to males (4.6% vs 3.4%) and across all MACCE components.

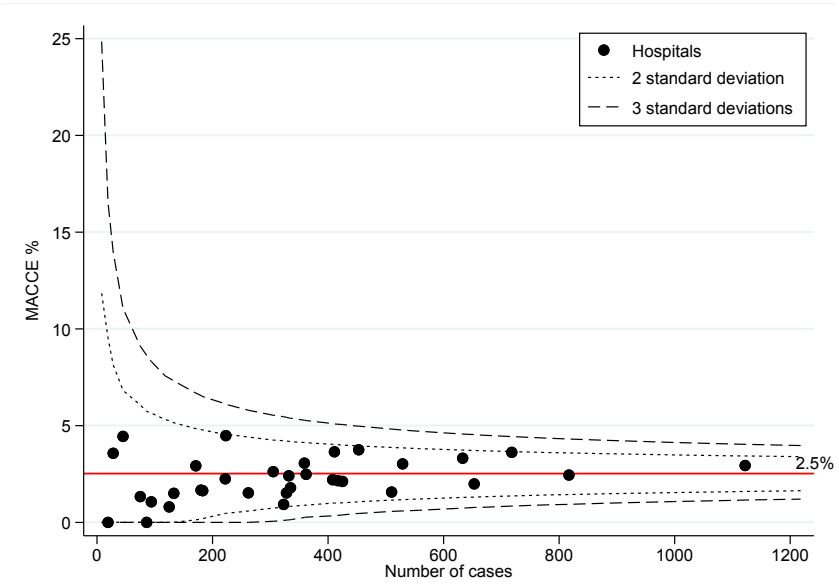
Table 19: Major adverse cardiac and cerebrovascular events at 30-days

MACCE component**	In-hospital events	30-day events*
	N (%)	N (%)
Mortality	191 (1.6)	244 (2.1)
Myocardial infarction	54 (0.5)	89 (0.8)
Stroke	32 (0.3)	49 (0.4)
Definite stent thrombosis	25 (0.2)	39 (0.3)
Probable stent thrombosis	3 (<0.1)	7 (0.1)
Target vessel revascularisation (TVR)†	64 (0.5)	117 (1.0)
MACCE	300 (2.6)	429 (3.7)

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

Figure 28 presents MACCE rates, excluding high-acuity cases of cardiogenic shock and/or intubated OHCA arrest. The overall rate was 2.5% and all hospitals were within control limits.

Figure 28: MACCE by hospital at 30-days

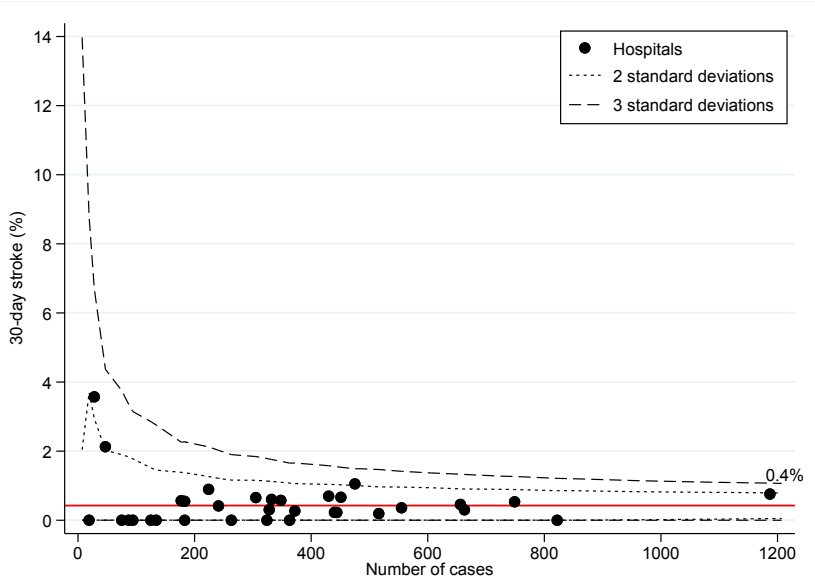


Excludes cardiogenic shock and/or intubated OHCA cases.

Stroke at 30-days

The stroke rate at 30-days was 0.4% and all hospitals were within control limits (Figure 29). In the period between hospital discharge and 30-days there were four additional haemorrhagic strokes, eight additional ischaemic strokes and a further eight strokes where the type was not recorded.

Figure 29: Stroke by hospital at 30-days



Rehospitalisation at 30-days

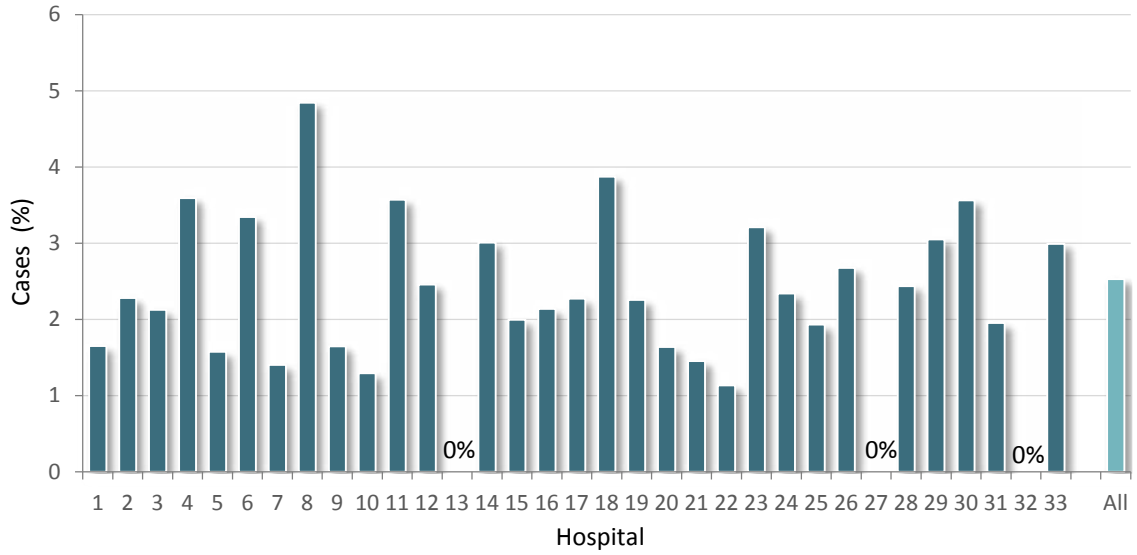
The rates of rehospitalisation within 30-days of discharge following PCI and by hospital sector is shown in Table 20. The overall rate of 30-day rehospitalisation appears to have gradually declined over the past few years (13.3% in 2019, 12.0% in 2020, 10.8% in 2021 and 9.6% in 2022).

Table 20: Rehospitalisation by hospital sector

	All patients (N=11,341)	Public (n=6,379)	Private (n=4,962)
	N (%)	N (%)	N (%)
Rehospitalisations	1,091 (9.6)	514 (8.1)	577 (11.6)
Non-cardiac rehospitalisations	334 (3.0)	202 (3.2)	132 (2.6)
Cardiac rehospitalisations	757 (6.7)	312 (4.9)	445 (9.0)
Unplanned cardiac rehospitalisations	287 (2.5)	180 (2.8)	107 (2.2)
Planned cardiac rehospitalisations	470 (4.1)	132 (2.1)	338 (6.8)

Unplanned cardiac rehospitalisation within 30-days is a measure of hospital performance and the rate by hospital is shown in Figure 30. The average was 2.5% with a range of 0% to 4.8%. The rate of unplanned cardiac readmissions declined by 0.4% compared with 2021.

Figure 30: Unplanned cardiac rehospitalisation by hospital at 30-days



Quality of life

The EQ-5D Quality of Life (QoL) tool is collected at the 30-day follow-up. Patients are 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. In 2022, responses were completed in 77% of cases, with a number of hospitals unable to conduct the questionnaire because of resource capacity constraints. Compared to the previous year, the domain of reporting a mobility problem decreased in all groups except non-metropolitan patients, while the domain of moderate/extreme anxiety/depression decreased across all groups. The EQ-5D QoL domains by socio-economic status (SES) and patient location (non-metro and metro) are presented in Table 21.

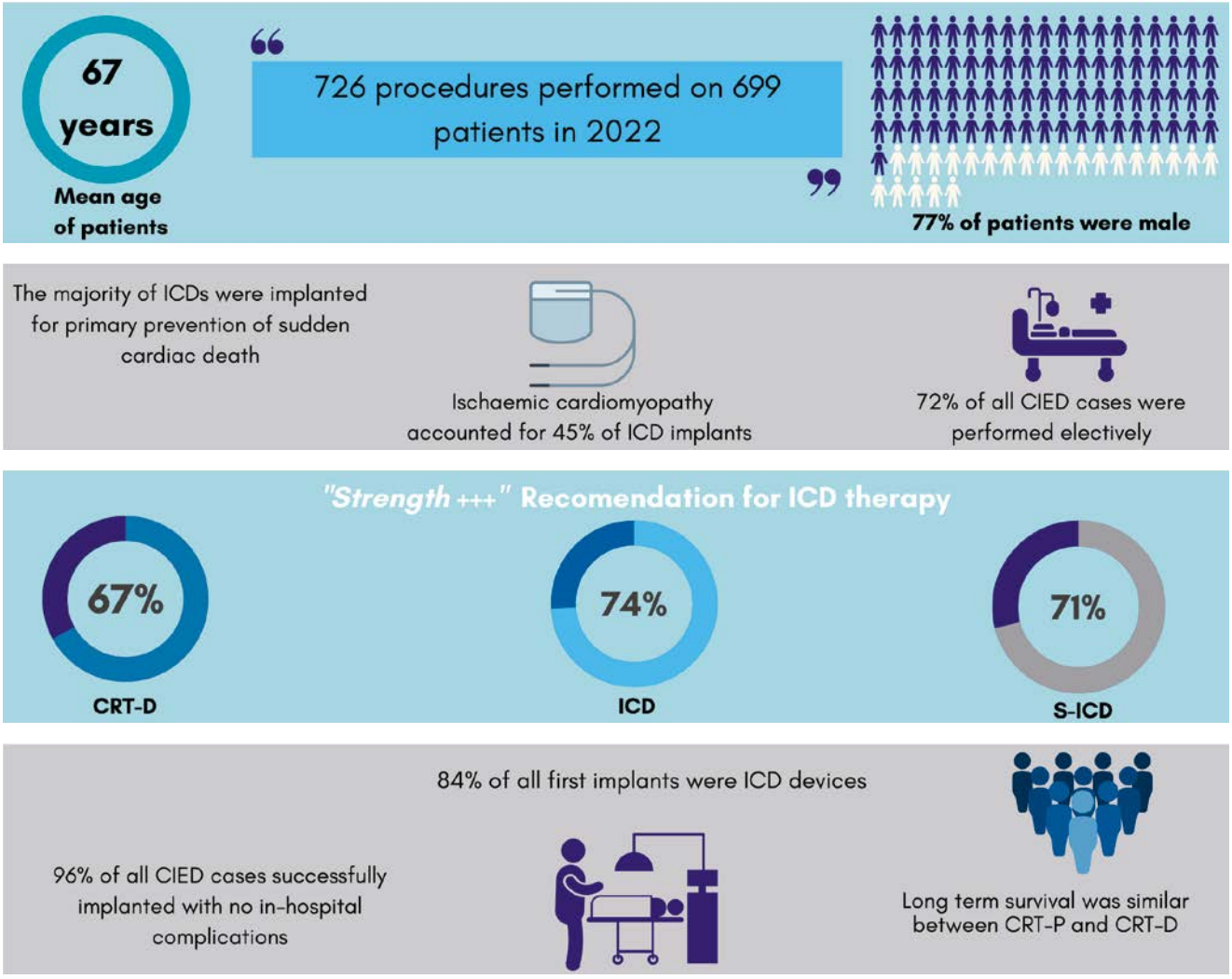
Table 21: Patients reported experience by socio-economic status and in non-metro/metro areas

Quality of Life components	Low SES (n=1,997)	High SES (n=8,661)	Non-metro (n=2,627)	Metro (n=5,940)	All (N=8,054)
	%	%	%	%	%
Some problem with mobility	9.8	7.3	11.0	6.8	7.9
Some problem with personal care	4.2	3.2	5.0	2.9	3.5
Some problem with usual activity	11.7	9.9	9.0	13.9	10.4
Moderate/extreme pain/discomfort	11.5	8.6	11.6	8.1	9.1
Moderate/extreme anxiety/depression	8.5	8.1	9.7	7.1	8.3
Assessment of own health status (score 0-100)	79.5	77.7	79.6	77.4	78.2

Cardiac Implantable Electronic Devices (CIED)

Key Findings CIED Module

Figure 31: CIED Key Findings



Background

Commencing in 2018, VCOR has been collecting data on cardiac implantable electronic devices (CIEDs). There are currently 14 hospitals contributing to this module, 10 in the public sector and four in the private sector (Table 22). This module focuses on two device therapies – implantable cardiac defibrillators (ICD) and cardiac resynchronisation therapy (CRT).

Table 22: Participating Victorian CIED hospitals

Victorian CIED hospitals	Hospital type	2018	2019	2020	2021	2022
Alfred Hospital	Public	●				
Austin Hospital	Public	●	●	●	●	●
Ballarat Base Hospital	Public		●	●	●	●
Bendigo Hospital	Public		●	●	●	●
Box Hill Hospital	Public		●	●	●	●
Cabrini Hospital Malvern	Public		●	●	●	●
Footscray Hospital	Private	●	●	●	●	●
Frankston Hospital	Private		●	●	●	●
Jessie McPherson Private Hospital	Private		●	●	●	●
Monash Heart	Private	●	●	●	●	●
Mulgrave Private Hospital	Public	●	●	●	●	●
The Royal Melbourne Hospital	Public	●	●	●	●	●
Sunshine Hospital	Private		●	●	●	●
The University Hospital Geelong	Private					●
Western Private Hospital	Private			●	●	●

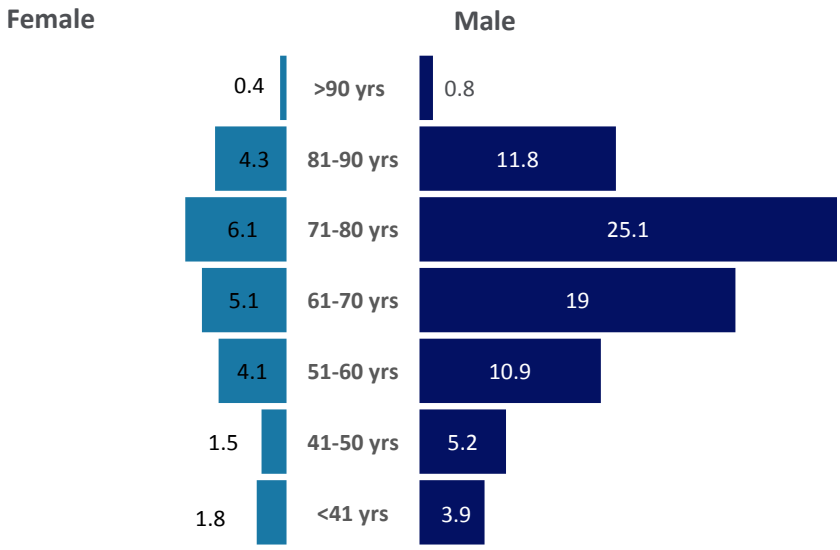
Table Legend: • A contributing data.

Patients and procedures

In 2022, 726 CIED procedures were performed in 699 patients. The average age of patients was 67+14 years and 77% of patients were male (Figure 32). The majority of all procedures (72%) were performed electively. First implants accounted for over half (54.5%) of all cases; 39.1% of cases were for generator replacement; the remaining cases included new leads (1.7%) and system explant or revision (4.7%).

Device implants were most frequent in the 71–80-year age group for both males and females. The majority of cases were performed in patients over 50 years, with patients under 50 years representing just 12.4% of the overall cohort.

Figure 32: Age and sex distribution of patients undergoing CIED implantation



Device types

The four types of CIED devices that are monitored by VCOR are shown in Figure 33.

Figure 33: CIED Device Types

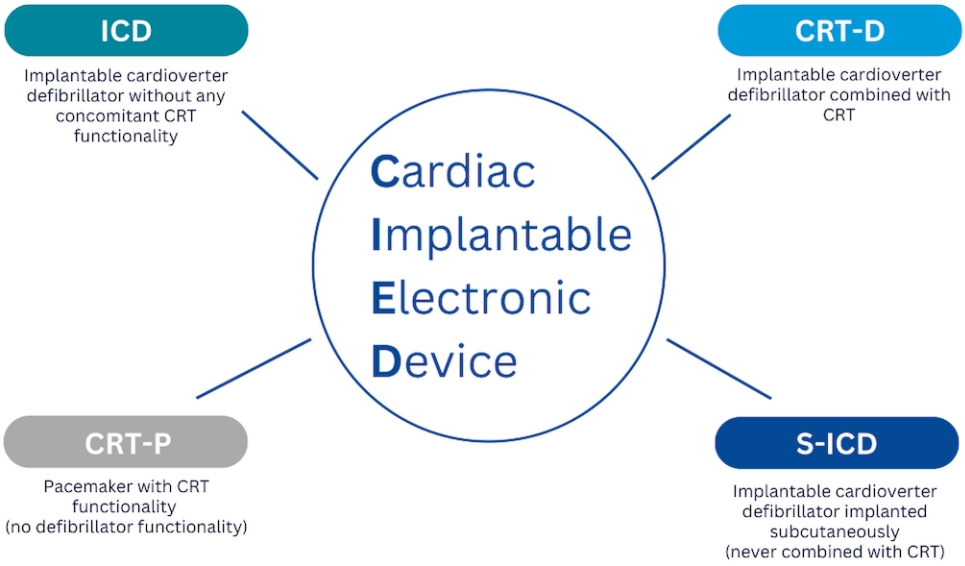
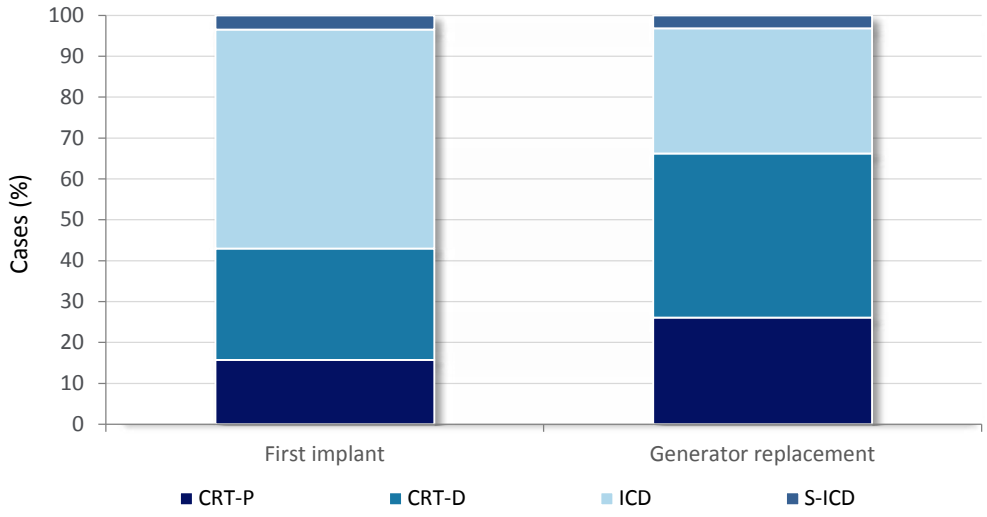


Figure 34 presents the proportions of device types implanted. The majority of the first implants (84%) and generator replacements (74%) were ICD type devices (ICD, S-ICD and CRT-D). With respect to the implantation site, most devices utilising CRT (CRT-D or CRT-P) were implanted in the left pre-pectoral region (91.3%). The remainder were implanted in either the left sub-pectoral region (2.8%) or in the right pre-pectoral region (5.0%). The majority (87%) of ICDs were implanted in the left pre-pectoral region.

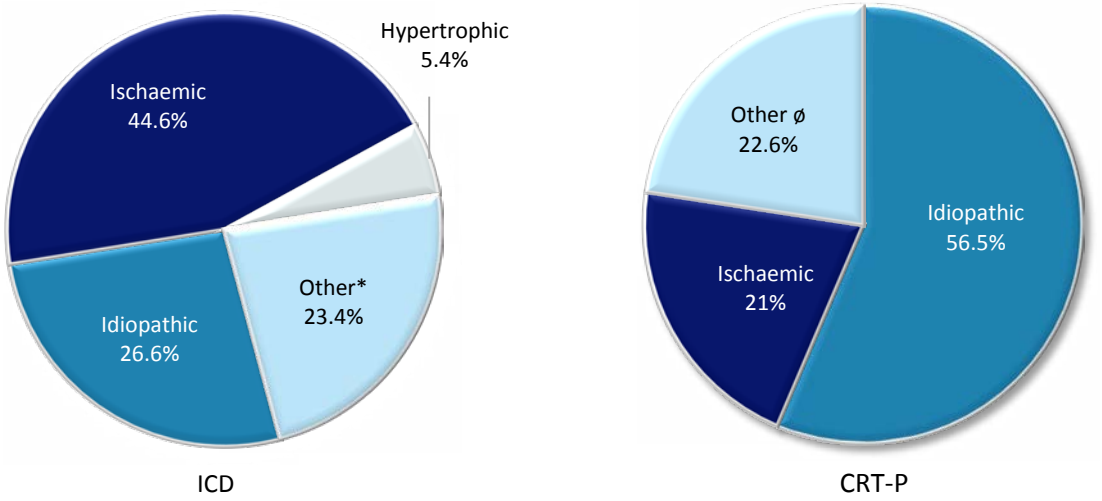
Figure 34: Device type – first implant and generator replacement



Cardiomyopathy aetiology

The aetiology of the underlying cardiomyopathy for patients undergoing first ICD or CRT-P is shown in Figure 35. Patients with ischaemic cardiomyopathy accounted for 45% of ICD implants, whereas for CRT-P devices, the most common underlying aetiology was idiopathic or unknown (57%). Ischaemic heart disease was the underlying cause in 21% of patients treated with CRT-P devices.

Figure 35: Aetiology in patients undergoing first CIED implant

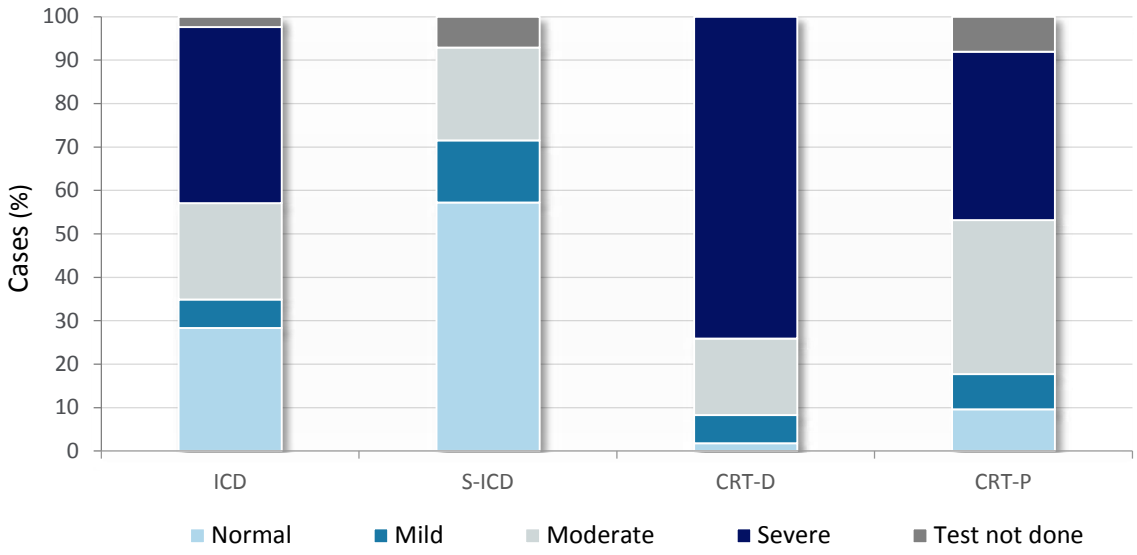


** Includes familial/congenital & idiopathic ventricular fibrillation.*
Ø Includes valvular, familial/congenital & structurally normal heart.

Left ventricular function

The presence of significant left ventricular (LV) dysfunction is an important determinant of CIED therapy type. Figure 36 shows the distribution of LV impairment severity among patients treated with a CIED device (first implants only). Among patients receiving a CRT device, underlying moderate or severe LV dysfunction was present in 92% of CRT-D cases and 74% of CRT-P cases. For patients treated with ICD, 60% had underlying moderate or severe LV dysfunction.

Figure 36: Left ventricular function by CIED type (first implants only)



Indications for CIED therapy

ICDs

The majority (55%) of ICDs (ICD, CRT-D and S-ICD) were implanted for primary prevention of sudden cardiac death. Ischaemic cardiomyopathy was the underlying condition in 47% of these cases. For the indication of secondary prevention of sudden cardiac death (previous cardiac arrest or VT/VF), just under half (48%) were for prior ventricular tachycardia and 45% were for prior ventricular fibrillation.

Cardiac resynchronisation therapy

Criteria used to determine the appropriateness of CRT use, as recommended by national and international guidelines, include a QRS width ≥120 milliseconds, the presence of severe left ventricular dysfunction and New York Heart Association (NYHA) Class II or greater symptoms. Table 23 shows that 81% of CRT-D cases had a QRS width ≥120 msec, 74% had presence of severe left ventricular dysfunction and NYHA class II or greater was evident in 94% of cases. Compliance with these appropriateness criteria was lower among patients undergoing CRT-P procedures.

Table 23: Inclusion criteria for CRT by device type

	CRT-D (N=108)	CRT-P (N=62)
	N (%)	N (%)
QRS width≥120 msec	87 (81)	44 (71)
Severe left ventricular dysfunction (LVEF<35%)	80 (74)	24 (39)
NYHA Class II or greater	102 (94)	59 (95)

Assessing the strength of recommendation for CIED therapy

VCOR has established a series of clinical algorithms, based on national and international guidelines, to evaluate the strength of the recommendation for implantation of a CIED. This form of analysis is provided to hospitals and clinicians as a quality assurance tool and is not intended as an adjudication of whether a particular device was appropriate or not for a particular patient. VCOR acknowledges that there is a great deal of complexity and individualisation in the decision-making process regarding implantation of CIEDs which cannot be fully represented in a series of clinical algorithms and that a decision regarding appropriateness requires specific evaluation of all patient and clinical factors which is beyond the scope of our algorithms.

Figure 37 shows the proportions of strength of recommendation (+, ++ or +++) for ICD implantation (ICD, CRT-D and S-ICD) among the cohort of ICDs (n=314). A *strength +++* recommendation was present in 72% of cases of implantable defibrillator therapy.

Figure 37: Strength of recommendation for ICD therapy

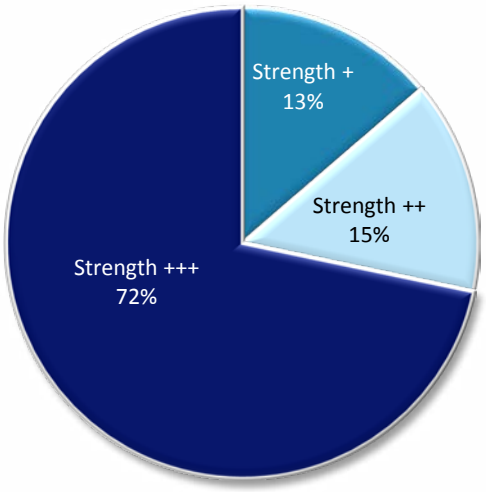


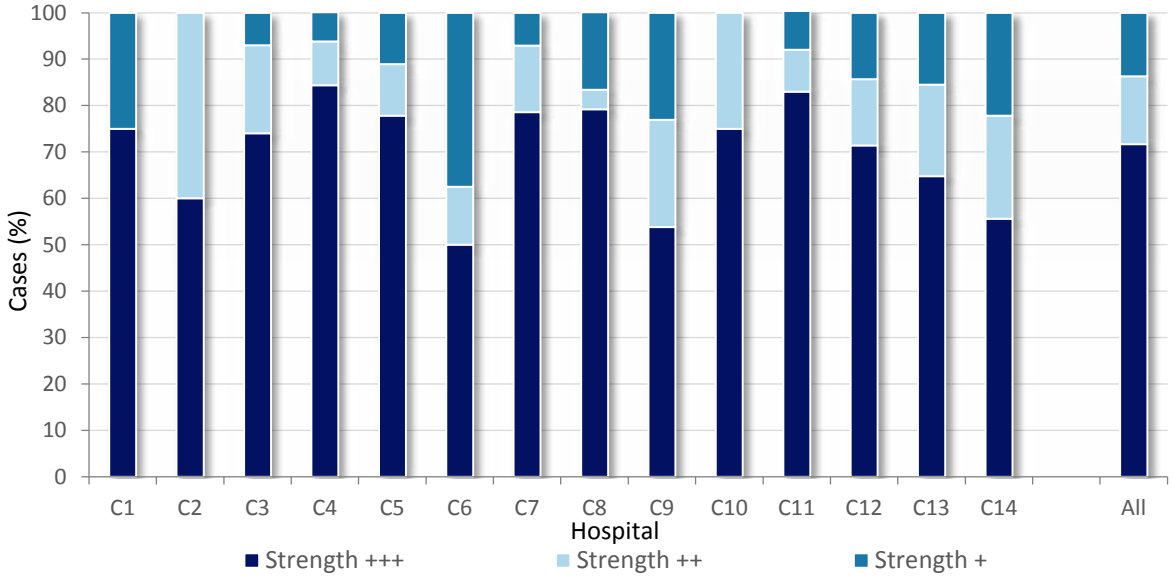
Table 24 outlines the strength of reccomendation by ICD device type. All three ICD device types had a majority of cases with *strength +++* recommendation.

Table 24: Strength of recommendation for ICD therapy by form of therapy

Strength of recommendation	CRT-D (N=101)	ICD (N=199)	S-ICD (N=14)
	N (%)	N (%)	N (%)
Strength +++	68 (67)	147 (74)	10 (71)
Strength ++	9 (9)	35 (18)	2 (14)
Strength +	24 (24)	17 (9)	2 (14)

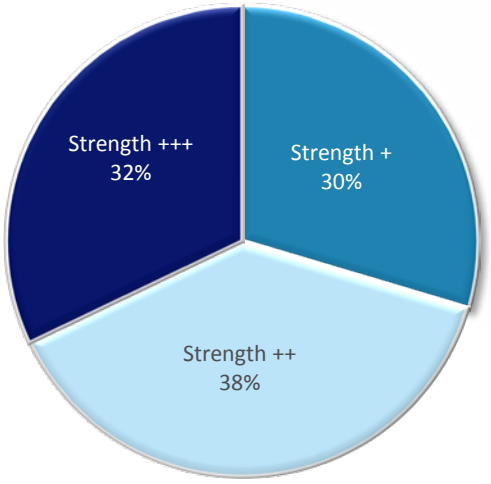
Figure 38 benchmarks hospitals in relation to the strength of recommendation for defibrillator therapy (ICD, CRT-D or S-ICD). In all hospitals, a *strength +++* recommendation was present in at least 50% of cases (range 50%- 84%).

Figure 38: Strength of recommendation for ICD therapy by hospital



Among patients with CRT devices (n=162), the strength of the recommendation for that therapy demonstrated a different distribution to ICD therapy. As shown in Figure 39, a *strength +++* recommendation was present in just under one third of cases.

Figure 39: Strength of recommendation for CRT therapy



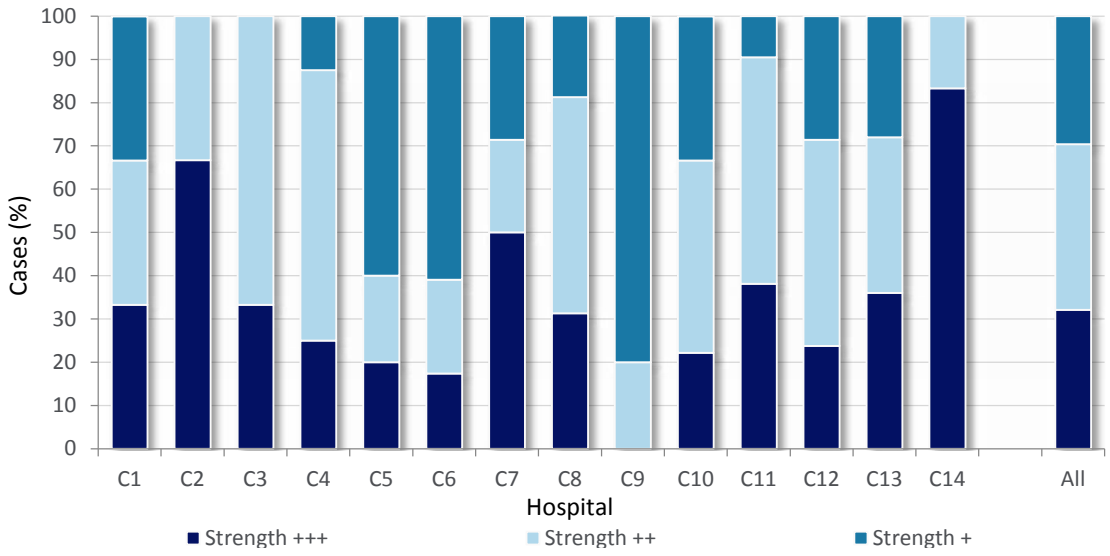
When CRT-P and CRT-D therapies were compared, a greater proportion of cases had lower strength recommendations with CRT-P (Table 25). This likely reflects that the patients being considered for CRT-D and CRT-P are quite disparate in their clinical presentations and requirements.

Table 25: Strength of recommendation for CRT by device type

Strength of recommendation	CRT-D (N=106)	CRT-P (N=56)
	N(%)	N(%)
Strength +++	38 (36)	14 (25)
Strength ++	39 (37)	23 (41)
Strength +	29 (27)	19 (34)

Figure 40 presents a benchmarking analysis of hospitals with respect to the strength of recommendation for CRT. Overall, there was a *strength +++* or strength ++ recommendation present in over 70% of cases. However, there were a number of hospitals where a *strength +* recommendation was present in >50% of their CRT cases. It should be noted that several hospitals had very low case numbers suggesting that strength of recommendation for CRT at these hospitals should be interpreted with caution.

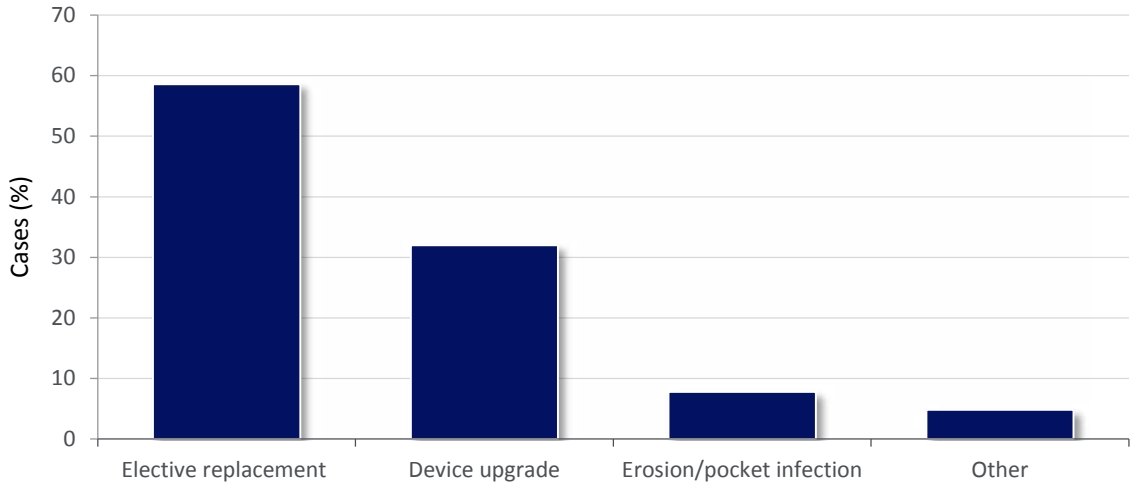
Figure 40: Strength of recommendation for CRT by hospital



Replacements and revisions

CIED generator replacements were most commonly undertaken for end-of-life elective replacements (59%) as shown in Figure 41. A further 32% of replacements were for device upgrade, while erosion/pocket infection accounted for 8% of generator replacements.

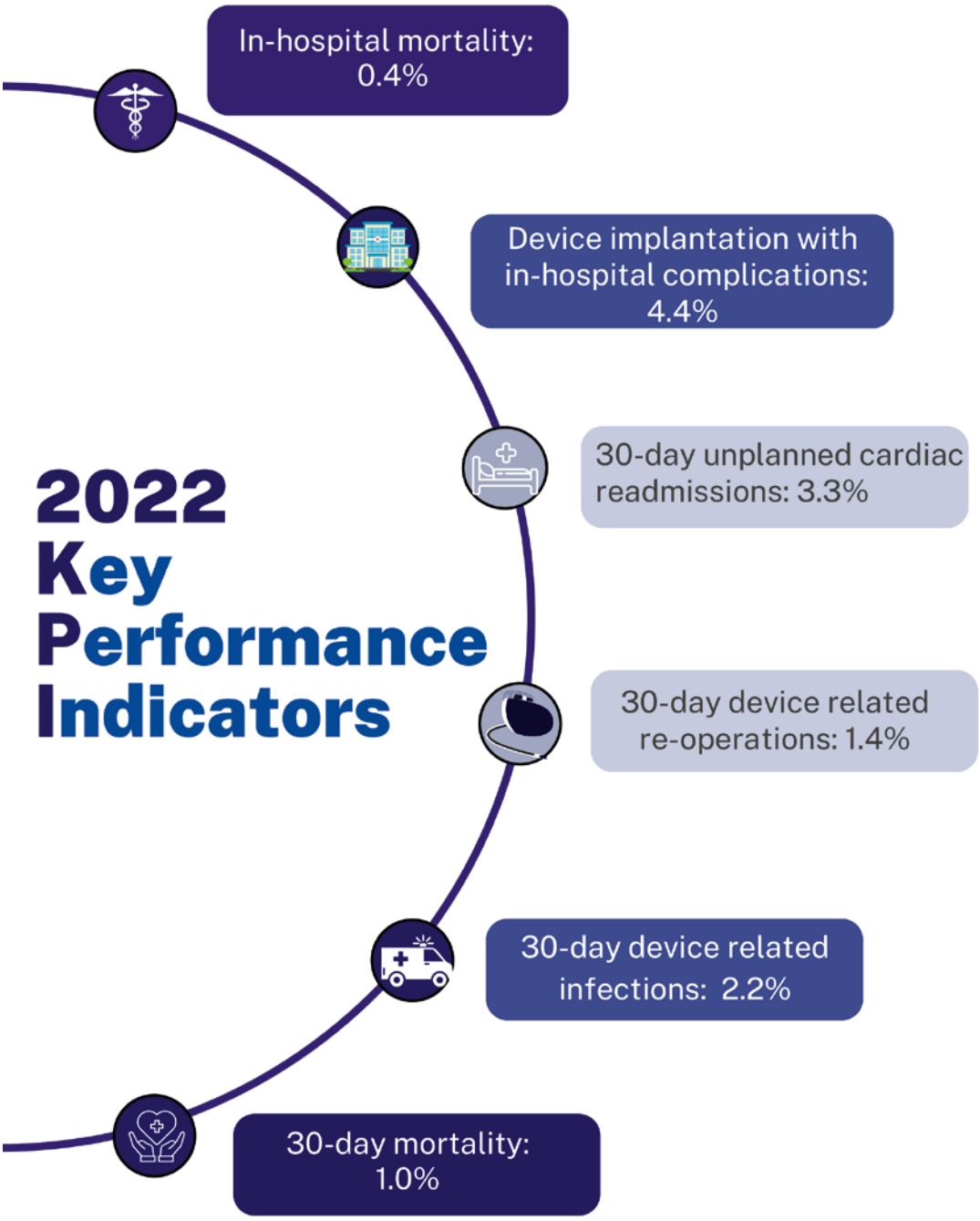
Figure 41: Indications for generator replacement, explant or revision



Outcome measures

The key performance indicators (KPIs) used to monitor and benchmark hospital performance in relation to CIED therapy are shown in figure 42.

Figure 42: CIED Key Performance Indicators



All percentages reflect the 2022 rates for each outcome.

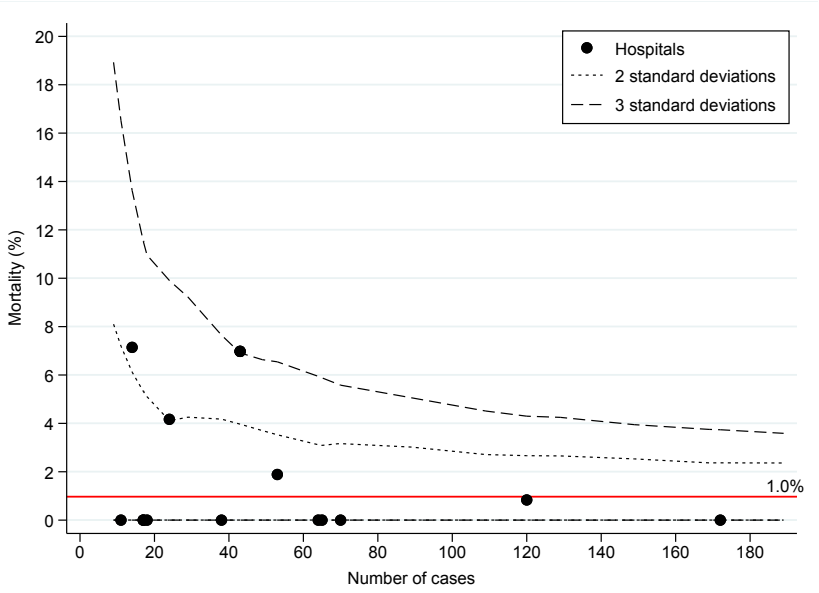
In-hospital mortality

In 2022, there were three in-hospital deaths, one of which was a cardiac death that was not device-related. The other two deaths were not device or cardiac related.

Mortality at 30-days

The overall 30-day mortality rate was 1.0 % with four additional deaths recorded after discharge and within 30-days of device implantation. Two of these deaths were from non-cardiac causes and two were from unknown causes. All hospitals were within control limits for this outcome measure (Figure 43).

Figure 43: CIED Mortality at 30-days



Successful device implantation without in-hospital complications

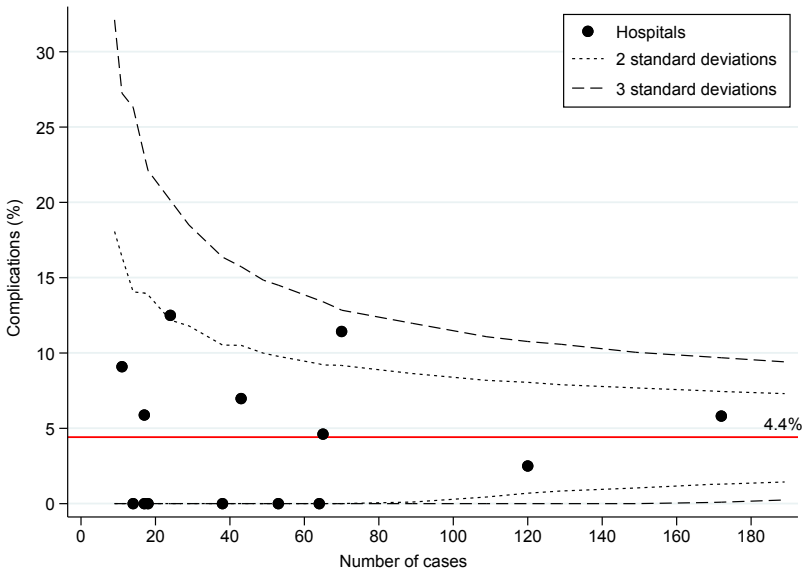
Overall, 95.6% of CIED cases were successfully implanted without any in-hospital complications. Complications that did occur included failure to position leads, severe hypotension, wound haematoma, lead dislodgement, pain requiring intervention, pericardial effusion and cardiac arrest (Table 26).

Table 26: In-hospital complications by hospital and device type

Hospital	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	Total
	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N (%)
CRT-P, n (%)	0	0	0	0	0	0	0	1	0	0	1	2	0	0	4 (2.9)
CRT-D, n (%)	0	1	0	2	0	0	0	4	2	0	0	1	4	1	15 (6.8)
ICD, n (%)	0	0	0	1	0	0	0	3	1	3	2	0	5	0	12 (4.0)

There were no outliers for in-hospital complications as shown in Figure 44.

Figure 44: In-hospital rates of CIED related complications



Unplanned cardiac readmissions, device-related reoperations and infections at 30-days

The 30-day unplanned cardiac admission rate was 3.3%. The 30-day device-related reoperation rate was 1.4%. There were no outliers for any of these outcomes (Figures 45 and 46).

Figure 45: CIED related unplanned cardiac readmissions at 30-days

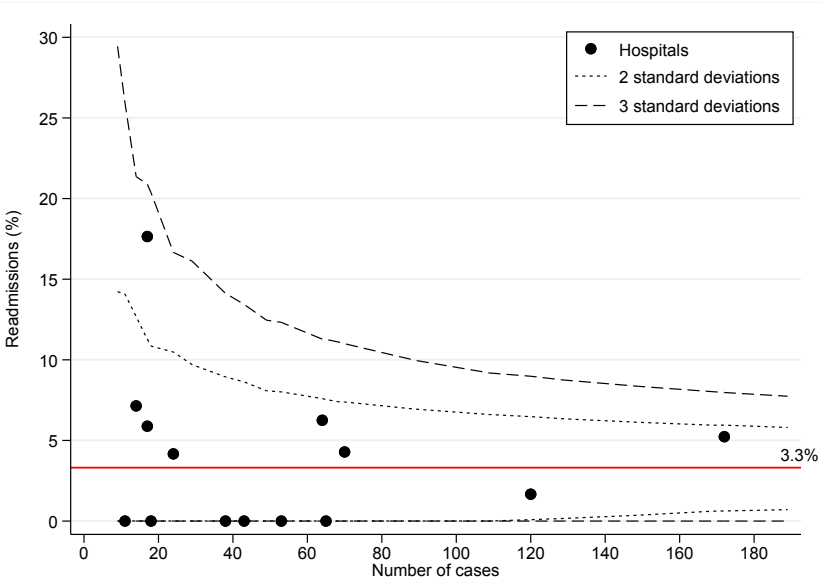
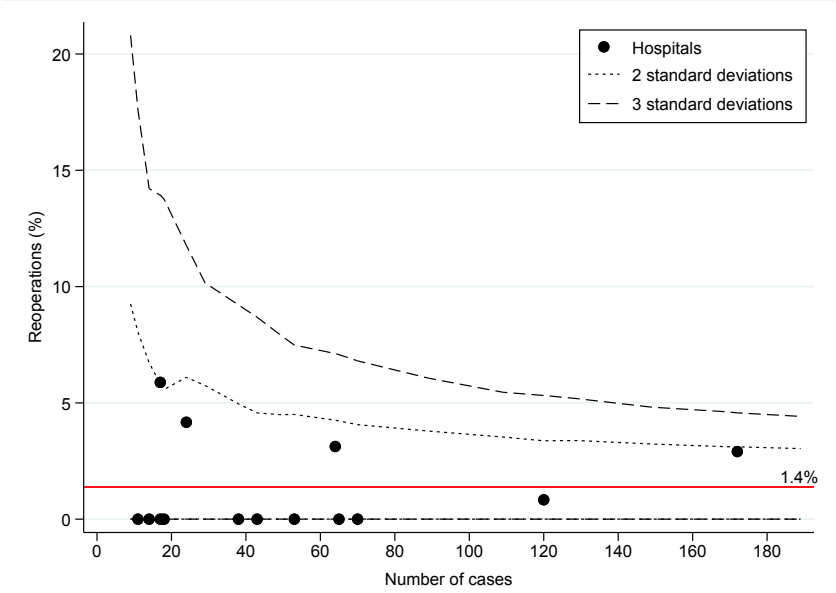
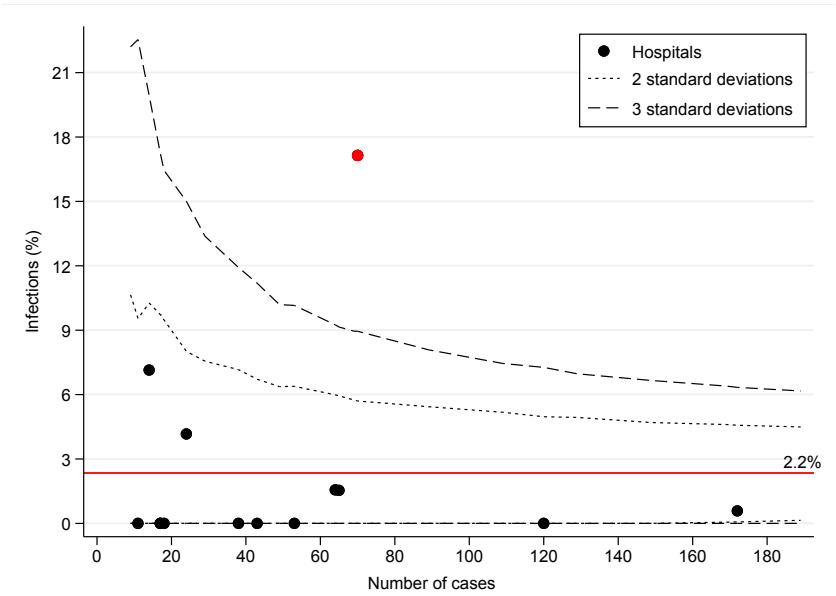


Figure 46: CIED device-related reoperations at 30-days



The 30-day device-related infection rate was 2.2%. One hospital was identified as an outlier, with a device-related infection rate of 15.7% (Figure 47). While the definition of 30-day device-related infections includes superficial wound infections, pocket infections or wound dehiscence, all 11 cases of infection in the outlier hospital were for the least serious finding of superficial wound infection.

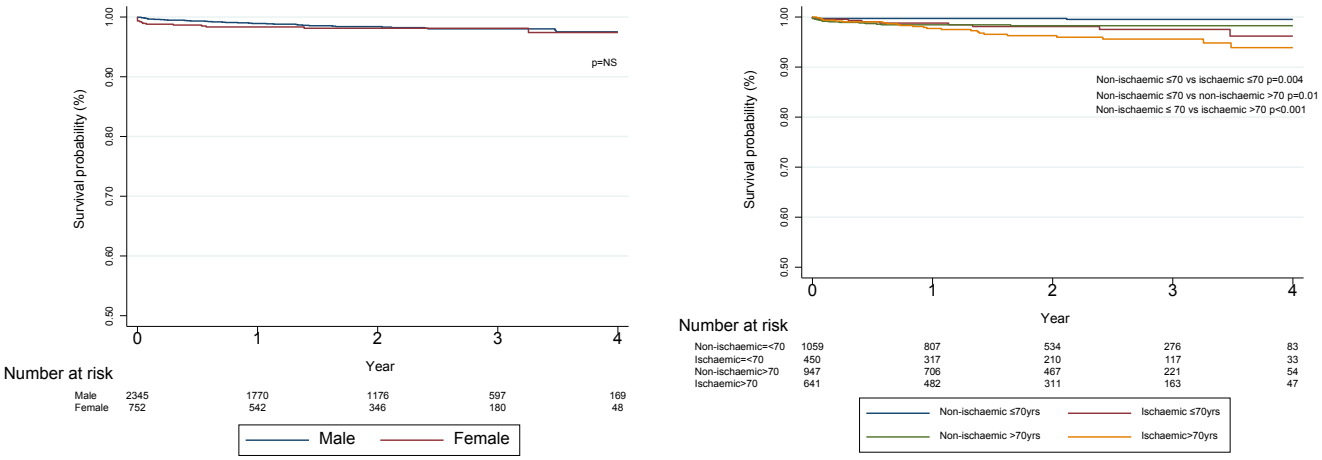
Figure 47: CIED device-related infections at 30-days



Long-term mortality

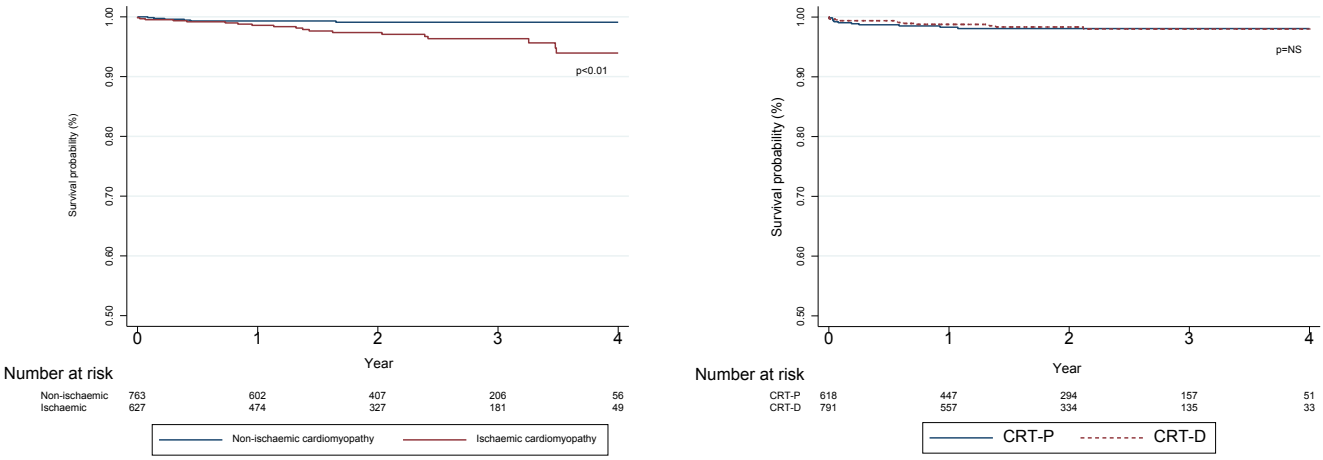
Linkage to the National Death Index (NDI) was undertaken to determine long-term survival after CIED implantation for the period between 2018-2022. Figure 48 compares long-term survival by sex and by age stratified by aetiology. At four years post device implantation, the overall mortality rate was 1.7%. Long-term outcomes were similar between males and females (1.6% vs 1.9%, p=0.60). Long-term survival among patients with non-ischaemic conditions and ≤70 years was better compared to the other three groups, with the lowest survival rate observed in patients >70 years with ischaemic cardiomyopathy (non-ischaemic ≤70 years 0.4%; ischaemic ≤70 years 2.0%; non-ischaemic >70 years 1.6%; ischaemic >70 years: 3.6%, p<0.001) (Figure 48).

Figure 48: Kaplan-Meier survival curves by sex and age



For ICD cases, long-term survival for patients with ischaemic cardiomyopathy was lower than patients with non-ischaemic cardiomyopathy (97% vs 99.2%, p<0.01). Long-term survival was similar between CRT-P and CRT-D (98.2% vs 98.5%, p=0.70) (Figure 49).

Figure 49: Kaplan-Meier survival curves by ICD clinical conditions and CRT types



Summary

The VCOR CIED module continues to track the performance and outcomes of ICD and CRT device therapy. Just over half of the cases were for first implants. A total of 84% of these first implants had ICD functionality and 43% had CRT (either with or without concomitant ICD therapy). Among the ICD cases, ischaemic cardiomyopathy was the underlying cardiac condition in 45%, whereas for patients requiring CRT, over half the cases had a non-ischaemic cause. Assessment of the strength of recommendation for device therapy demonstrated that among ICD cases, the overwhelming majority had a *strength +++* recommendation for device use and this finding was mostly consistent across participating hospitals. In contrast, CRT device therapy - and particularly CRT-P - showed a different pattern, with a *strength +++* recommendation present in less than half of the cases. In-hospital and 30-day outcomes were generally acceptable, although benchmarking analysis did identify one hospital with an increased rate of superficial wound infections. VCOR believes that this information provides valuable feedback to participating sites to assist them in their ongoing quality assurance activities. We will continue to try to engage additional hospitals into this module in the coming year.

Future Directions

Now in its 10th year, VCOR has established itself as a mature clinical quality registry, providing risk-adjusted data on performance and outcomes for virtually all PCI cases performed in Victoria. However, there are still many challenges ahead.

Perhaps the greatest challenge VCOR faces is being able to transition away from its current but long-term unsustainable model of manual data collection. While this approach of data acquisition that is reliant on a data manager collecting patient information one case at a time provides the highest quality information at a patient level, it is very labour intensive and expensive. Hospitals constantly face capacity constraints that limit the extent of their involvement in registries - as seen with VCOR's CIED module in particular, where it has been very difficult to recruit additional hospitals because sites have difficulty accessing the resources for data collection. Some states are addressing this challenge by committing to 'data lakes' that store, process and analyse large amounts of health-related data. They plan to utilise electronic medical record (EMR) data for their registry activities and clinically integrate those data back into patient records and clinical dashboards. Artificial intelligence is likely to play an important role in this area in the future, with one approach focusing on a portal to receive data from multiple EMR sources to populate a registry. This has potential applicability in Victoria, and VCOR, through its affiliation with Monash University, is well placed to participate in this future area of research and development.

VCOR continues to liaise closely with the Department of Health and Human Services Victoria, assisting them in their ongoing work on the design, services and infrastructure of Victoria's cardiac system. There is a current focus on trying to reduce low value care that provides little or no benefit and may even lead to patient harm and to provide care that is appropriate. VCOR already assesses appropriateness of PCI and CIED implantation in its two modules, and is looking for further ways in which this type of information can be integrated into clinicians' practices to ensure high-quality standards of care. There is also opportunity to further develop policies and processes in dealing with outlier hospitals. Instances of serious and significant outlier events are now referred to Safer Care Victoria and VCOR is well-positioned to assist Safer Care Victoria in ensuring hospitals are well managed in terms of their outcomes and quality assurance activities.

Central to a well-functioning clinical quality registry is the ability to provide risk-adjusted outcomes. VCOR developed and validated its own risk adjustment model for 30-day mortality which it is still using. However, as demographics trends evolve, risk adjustment models need review and revision and VCOR plans to undertake this work in the next 12-24 months.

An exciting future opportunity for VCOR centres around linkages with other datasets. The registry has formed a relationship with the Centre for Victoria Data Linkage (CVDL)- now joined with the Victorian Agency for Health Information (VAHI), Department of Health and Human Services Victoria. VCOR has potential access to the CVDL's Victorian Linkage Map that provides population-wide linkable data to support evidence-based research. VCOR also enjoys a strong working relationship with Ambulance Victoria, with regular comprehensive two-way data linkage and exchange that has enhanced both organisations' data analysis, research and quality assurance activities. Future potential linkages are envisaged with the Australian and New Zealand Society of Cardiac and Thoracic Surgeons (ANZSCTS) Cardiac Surgery Database and the Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient Database. The National Cardiac Registry (NCR) has commenced state-based reports that benchmark an individual state or territory's outcomes with a national dataset. Although this process is still in an early phase because of incomplete national datasets, Victoria is currently contributing the largest number of cases and is looking forward to utilising national comparative datasets in its ongoing quality assurance activities.

Future growth is planned in relation to recruitment of additional hospitals in Tasmania, expansion of our CIED module and the development of new modules including the monitoring of radiofrequency ablation for atrial fibrillation. VCOR is also actively fostering relationships with external researchers and organisations to promote high-quality translational research. VCOR has membership on the Health Leadership Research Forum - an initiative of the Australian Cardiovascular Alliance (ACvA) - designed to embed research and evidence into health systems and comprising the Commonwealth Government, state and territory health executives and clinical and analytical experts.

We can look back on 10 years of activity with some satisfaction and observe how the functions and activities of a clinical quality registry have become embedded into routine daily practice of PCI in Victoria. However, it is the road ahead that requires our main attention. This 2022 Annual Report has highlighted the progress made in PCI quality assurance and the broader contributions of VCOR to cardiology research and epidemiology. Yet, there is an overarching imperative for continuous quality improvement to achieve measurable gains in efficiency, performance and outcomes in the delivery of safe and high-value care to all Victorians in a fair and equitable manner. This is what VCOR is focussed on as it faces the challenges ahead.

Glossary

ACC/AHA	American College of Cardiology and the American Heart Association
ACEI	Angiotensin Converting Enzyme Inhibitors
ACS	Acute Coronary Syndrome
ARB	Angiotensin Receptor Blockers
ARIA	Accessibility and Remoteness Index of Australia
BARC	Bleeding Academic Research Consortium
BB	Beta adrenergic Blockers
BMI	Body Mass Index
CABG	Coronary Artery Bypass Graft
CIED	Cardiac Implantable Electronic Devices
CRT	Cardiac Resynchronisation Therapy
CSANZ	Cardiac Society of Australia and New Zealand
CTO	Chronic Total Occlusion
DAPT	Dual Antiplatelet Therapy
DBT	Door-to-balloon time
DEPM	Department of Epidemiology & Preventive Medicine
ECG	Electrocardiograph
ECMO	Extracorporeal Membrane Oxygenation
FFR	Fractional Flow Reserve
IABP	Intra-Aortic Balloon Pump
ICD	Implantable Cardiac Defibrillator
IHD	Ischaemic Heart Disease
IQR	Inter Quartile Range
IVUS	Intravascular Ultrasound
KPI	Key Performance Indicator
LOS	Length of stay
LTF	Lost to follow-up
LVEF	Left Ventricular Ejection Fraction
MACCE	Major Adverse Cardiac and Cerebrovascular Event
MACE	Major Adverse Cardiac Event
MI	Myocardial Infarction
NCR	National Cardiac Registry
NDI	National Death Index
NHMRC	National Health & Medical Research Council
NRI	New Renal Impairment
NSTE-ACS	Non-ST elevation acute coronary syndrome
NSTEMI	Non-ST Elevation Myocardial Infarction
NYHA	New York Heart Association
OCT	Optical Coherence Tomography
OHCA	Out of Hospital Cardiac Arrest
PCI	Percutaneous Coronary Intervention
PHN	Pre-hospital notification
POBA	Plain Old Balloon Angioplasty
PVD	Peripheral Vascular Disease
SCV	Safer Care Victoria
SBT	Symptom onset to balloon time
SDT	Symptom onset to door time
SD	Standard Deviation
STEMI	ST-elevation myocardial infarction
TVR	Target Vessel Revascularisation
UAP	Unstable Angina Pectoris
VCOR	Victorian Cardiac Outcomes Registry

Publications and presentations in 2022

Publications

Al-Mukhtar O, Vogrin S, Lampugnani ER, Noaman S, Dinh DT, Brennan AL, Reid C, Lefkovits J, Cox N, Stub D, Chan W. Temporal Changes in Pollen Concentration Predict Short-Term Clinical Outcomes in Acute Coronary Syndromes. *J Am Heart Assoc.* 2022 Apr 5;11(7):e023036. doi: 10.1161/JAHA.121.023036. Epub 2022 Mar 15. PMID: 35289185.

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Presentations 2022

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A/Prof Andrew MacIsaac	St Vincent's Hospital, Melbourne
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