

VCOR

VICTORIAN CARDIAC OUTCOMES REGISTRY



ANNUAL PUBLIC REPORT 2023

Improving cardiovascular outcomes Victoria-wide

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

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VCOR 2023 Annual Report



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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 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

It is with great pleasure that I write this forward for the Annual Report of the Victorian Cardiac Outcomes Registry (VCOR) for 2023. I have the honour of leading the Victorian Heart Hospital, which opened for business in early 2023, as a new addition to the comprehensive care of patients with or at risk of a range of forms of cardiovascular disease across Victoria. Central to our mission is the ability to provide high volume and high quality care for patients.

In its 11th year, VCOR continues to go from strength to strength as the leading cardiovascular clinical quality registry in the country. VCOR is an essential tool that permits all hospitals and clinicians to review activity and a range of quality indicators. This has important implications for workforce and future service planning. As we have moved well into the post pandemic era, it is critical that we continue to provide high quality care to an increasing burden of patients with cardiovascular disease, while continuing to do more with limited resources. Clinical quality registries play a vital role in continuing to ensure that healthcare services are delivered in ways that provide the best outcomes for patients.

VCOR also provides an important resource for cardiovascular and health services researchers. Over the life course of VCOR a substantial number of high-quality scientific publications have been produced by researchers, who have accessed the registry data, to make important contributions to the scientific literature. With advances in registry delivery comes the ability to embed clinical trials within the real world. This will enable VCOR to provide increasing facets of information with the potential to further advance to provide quality health care.

I would like to congratulate the entire VCOR team, from hospitals to the central registry team. This is an extraordinary amount of work, which truly takes a village to produce consistently high-quality information every year. Most importantly, we should recognise the patients, whose information permits us to learn and grow. With these insights, we have the ability to provide better care for patients with heart disease.

Professor Stephen Nicholls

Director,
Victorian Heart Hospital



Introduction

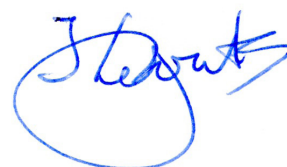
The Victorian Cardiac Outcomes Registry (VCOR), now in its eleventh year, has been witness to an ever-increasing focus on ensuring that contemporary healthcare delivery is of high quality, as safe as possible and equally accessible to all Australians. Since the Victorian Government's 2016 report, Targeting Zero – supporting the Victorian hospital system to eliminate avoidable harm and strengthen quality of care^[1], our state has provided strong support for clinical quality registries. In addition to this registry, the Department of Health actively sustains seven other clinical quality registries in clinical areas that include cardiothoracic surgery, intensive care and stroke among others. This ongoing commitment dovetails with the federal government's priorities, set out in the National Strategy for Clinical Quality Registries and Virtual Registries 2020–2030 and the federal funding of an additional 10 clinical quality registries^[2].

In this nurturing environment, VCOR continues its primary role of tracking the safety and performance of Victorian hospitals in relation to percutaneous coronary intervention (PCI) and cardiac implantable electronic devices (CIEDs). In 2023, 33 Victorian PCI hospitals and 15 CIED-implanting hospitals were actively contributing to VCOR, representing all the PCI activity and a substantial proportion of CIED implants across Victoria. As VCOR has matured as a clinical quality registry, the processes of performance benchmarking and quality assurance have been embedded into the day-to-day activities of many hospitals – both in the public and private sectors.

This report will demonstrate that PCI across Victoria is currently being performed at high standards of quality and safety, comparable to the best performing registries nationally and internationally. The report outlines demographic details of the Victorian PCI and CIED populations, characteristics of the types of activity being undertaken, how clinically appropriate these procedures are and provides measures of hospital and patient outcomes. Importantly, Victorians can be assured that the performance of the hospital they are treated at - anywhere in the state - is being measured and benchmarked against its peers. Through this report and the activities of VCOR in general, any variation in the quality of healthcare that may emerge can be quickly identified and addressed in a timely fashion at both the hospital level and via state government quality assurance bodies including Safer Care Victoria (SCV) and the Victorian Agency for Health Information (VAHI).

With the release of this report, VCOR gratefully acknowledges the support of the Department of Health Victoria. Our activities would not be possible without their unwavering commitment to ensuring access to, and the provision of safe and effective healthcare equally to every Victorian. I would also like to personally acknowledge and thank the VCOR Management Team at Monash University for their professionalism, work ethic and indefatigable effort in running the registry with all its manifold roles and functions.

VCOR hopes you find this report a useful and informative resource.



A/Prof Jeffrey Lefkovits
VCOR Clinical Director

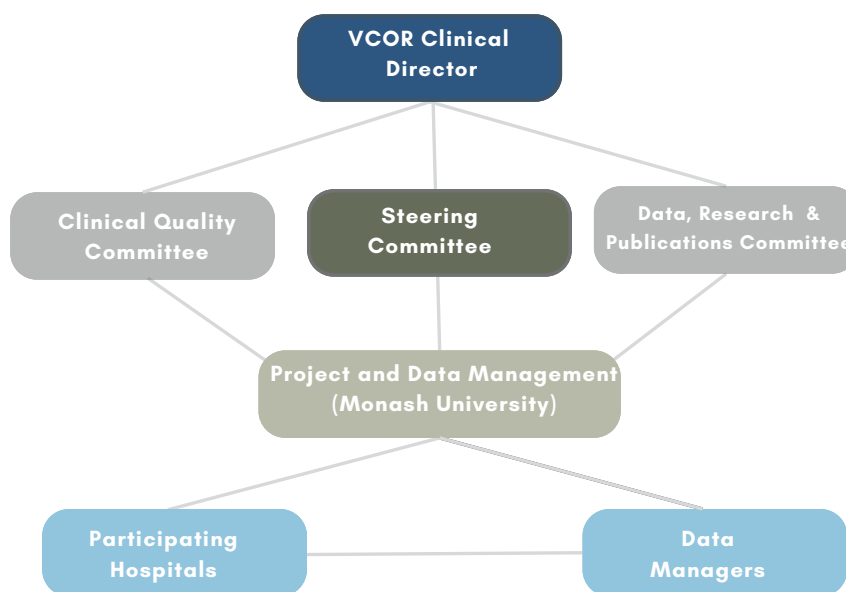
^[1] <https://www.health.vic.gov.au/publications/targeting-zero-the-review-of-hospital-safety-and-quality-assurance-in-victoria>

^[2] <https://www.health.gov.au/our-work/national-clinical-quality-registry-program>

Registry Governance and Structure

VCOR's governance structure and processes have been previously outlined. VCOR conforms to the principles set out in the Framework for Australian Clinical Quality Registries and the National Operating Principles for Clinical Quality Registries. VCOR also abides by all relevant standards related to security and protection of data of hospitals contributing to VCOR and its modules.

Figure 1: VCOR Governance Structure



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. Reports are provided to participating hospitals and the Victorian 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. The DRP comprises representatives from health services, Ambulance Victoria and the SPHPM.

Data Quality

In 2023, onsite case ascertainment audits were conducted at 32 out of 33 sites. The overall rate of missing cases was 1.5%. VCOR remains dedicated to ensuring data accuracy, a critical operational focus of clinical quality registries. This commitment is upheld through annual case ascertainment audits, quarterly reporting, routine data cleaning, and addressing data queries. Refer to Table 1 for a detailed list of hospitals contributing to VCOR and its modules.

Table 1: Hospitals contributing to VCOR

Victorian Hospitals	Hospital type	PCI Module	CIED Module
Albury Hospital	Public	•	
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	•	
Jessie McPherson Private Hospital	Private	•	•
Knox Private Hospital	Private	•	
Latrobe Regional Hospital	Public	•	
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	•	
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	•	
The Royal Melbourne Hospital	Public	•	•
Sunshine Hospital	Public	•	•
The University Hospital, Geelong	Public	•	•
Warringal Private Hospital	Private	•	
Western Private Hospital	Private	•	•

Key Findings PCI Module

Figure 2: PCI Key Findings



59% of all PCI cases were managed in the public system.

75%
of patients were male

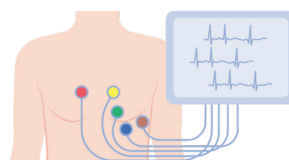


12,564 PCI cases were performed on 11,177 patients

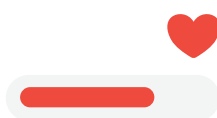


The median time taken from patient arrival at the hospital to the first balloon inflation door - to -balloon time (DBT) was 61 minutes

Primary PCI accounted for 15% of PCI caseload. The majority (90%) of primary PCI was undertaken in the public sector



56% of PCI cases in 2023 presented with an Acute Coronary Syndrome (ACS)



The unadjusted in-hospital mortality rate was 1.6%. The 30-day risk-adjusted mortality rate was 2.5%.

The median in-hospital major bleeding rate was 0.6% and was lower amongst radial access cases (0.3% radial vs femoral 1.8%).



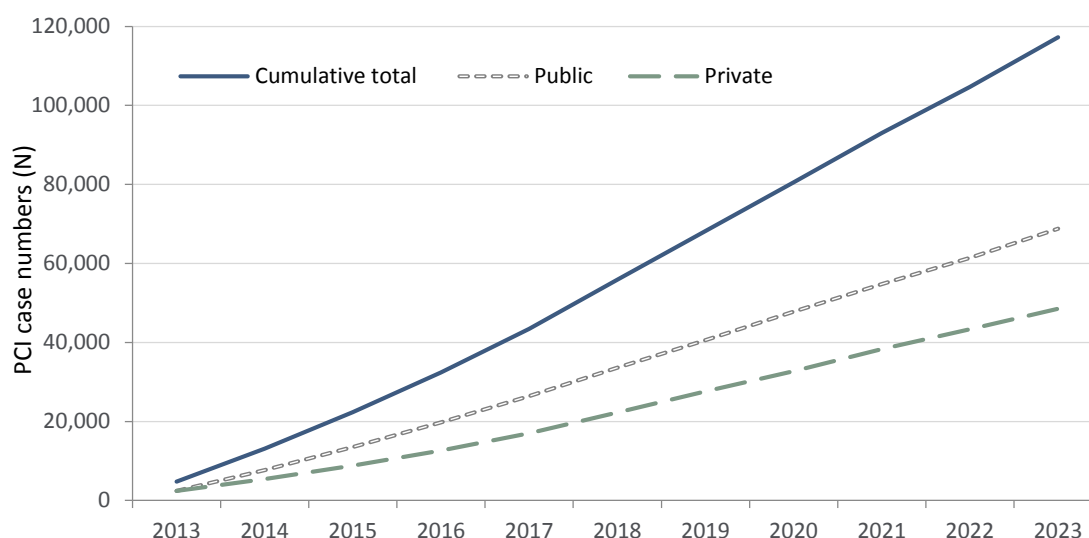
78.3 % of patients were referred to cardiac rehabilitation

Percutaneous Coronary Intervention (PCI)

Registry Module Activity

This report provides an overview of percutaneous coronary intervention (PCI) activities across Victoria throughout the 2023 calendar year, spanning from January 1st to December 31st. Over the past seven years, all 33 PCI-capable hospitals in Victoria, comprising 15 public and 18 private institutions, have consistently contributed data to VCOR. In 2023, a total of 12,564 PCI cases were recorded in the Victorian Cardiac Outcomes Registry (VCOR). As of December 31, 2023, the cumulative caseload in VCOR reached 117,280 cases. By hospital sector there were 68,769 public sector cases and 48,511 private sector cases. The cumulative recruitment rates by year and hospital sector are graphically depicted in Figure 3. The proportion of patients opting out of registry inclusion remained minimal, with opt-off rates at 0.18% for 2023 and 0.14% since the inception of the registry. The rate of patients lost to 30-day follow-up was 0.9%, consistent with historical data, with the overall rate of 1.0% since registry establishment.

Figure 3: Cumulative case numbers by year: 2013 - 2023



Patient Characteristics

Data were collected from 12,564 percutaneous coronary intervention (PCI) procedures, involving 11,177 individual patients. Among these patients, 1,387 underwent multiple procedures. The proportion of females undergoing PCI was similar to the previous years and represented 24.7% of the overall cohort. The median age for female PCI patients was 71 years (interquartile range [IQR]: 62-79). In contrast, male patients notably were younger, with a median age of 67 years (IQR: 59-75), illustrated in Figure 4.

Figure 4: Age and sex distribution of patients undergoing PCI

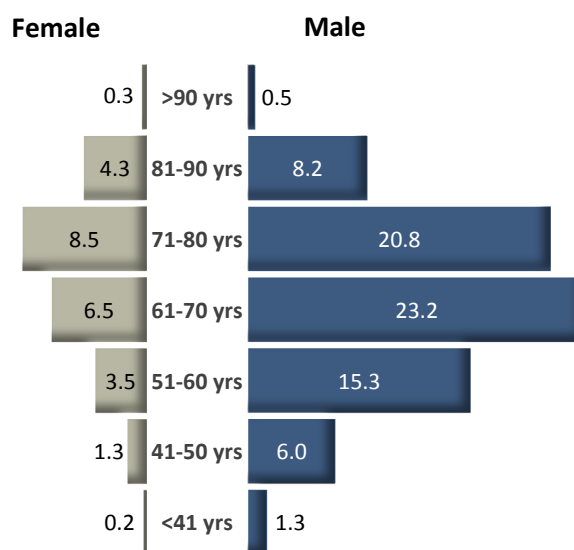


Table 2 presents selected demographic characteristics of patients from 2019 to 2023. Over this five-year time span, minor variations have been observed, with a gradual rise observed in the proportion of diabetic patients from 2021 to 2023.

Table 2: Comparison of selected patient characteristics: 2019 - 2023

Patient characteristics	2019 (N=12,355)	2020 (N=12,349)	2021 (N=12,478)	2022 (N=11,651)	2023 (N=12,564)
Age- years (Mean ±SD)	67.2 ±11.7	66.9 ±11.9	67.3 ±11.9	66.9 ±11.7	67.4 ±11.7
	%	%	%	%	%
Sex- female	24.5	24.5	25.2	22.8	24.7
Diabetes	23.2	23.8	23.6	24.1	25.2
Peripheral Vascular Disease	3.6	3.4	3.4	3.2	3.3
Cerebrovascular Disease	3.8	3.5	3.0	2.8	3.1
Previous PCI	33.1	33.6	32.7	31.3	32.3
Previous CABG	6.8	5.9	6.0	5.4	5.5

Patient characteristics stratified by hospital sector are shown in Table 3. The prevalence of severe obesity (defined as BMI ≥ 35 kg/m²) has demonstrated an upward trend in both sectors since the previous report, with notably higher rates observed among public sector patients. Concurrently, the incidence of chronic lung disease remained stable compared to the previous year within the public sector, but increased in the private sector, possibly reflective of the older demographic typically treated in private healthcare settings.

Table 3: Selected patient characteristics by hospital sector

Patient characteristics	Public (n=7,376)	Private (n=5,188)
Age- years (Mean $\pm$ SD)	64.7 $\pm$ 12.1	71.1 $\pm$ 10.1
	%	%
Sex- female	25.0	24.2
Diabetes	26.4	23.5
Peripheral Vascular Disease	2.8	3.9
Cerebrovascular Disease	3	3.1
Previous PCI	26.8	40.2
Previous CABG	4.4	7.0
Hypertension	62	72.8
Chronic Lung Disease	12.6	13.1
Body Mass Index (BMI) ≥ 35 kg/m ²	13.6	9.9

Case Presentation

Consistent with previous years, the majority of PCI procedures (82%) were conducted during standard working hours (8am to 6pm, Monday to Friday). Among the 18% of cases performed outside of these hours, a large proportion occurred in public sector hospitals (n=1,598, 70.5%). Notably, procedures performed during weekends and public holidays accounted for 47% of all out-of-hours cases, while the remainder occurred between 6pm and 8am on weekdays. As detailed in the PCI for STEMI section of this report, a substantial majority (81.3%) of out-of-hours PCIs were undertaken for the urgent management of STEMI patients.

Figure 5 illustrates the time intervals from hospital admission to PCI for cases of non-ST-elevation acute coronary syndrome (NSTEMI-ACS), categorised into four time frames. Compared to previous reports, there has been a notable increase in the proportion of patients receiving PCI within 24 hours of admission, 51% in 2023, marking an improvement from 49% in 2022 and 47% in 2021. Conversely, the percentage of patients experiencing delays exceeding 72 hours has seen a slight decrease compared to the preceding year.

Figure 5: Time delays from hospital admission to PCI for NSTEMI-ACS cases

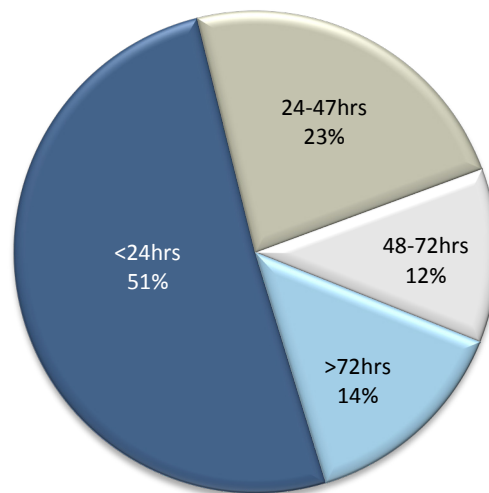


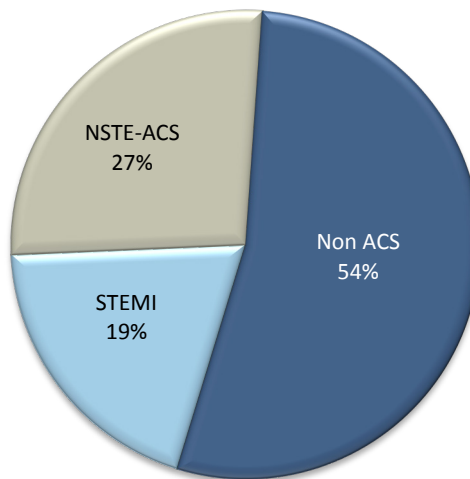
Table 4 presents the time delay to PCI for NSTEMI-ACS cases stratified by hospital sector. Both sectors have demonstrated an increase in the proportion of NSTEMI-ACS patients receiving treatment within 24 hours compared to previous reporting periods. Notably, the historical disparity observed in the private sector, where patients often experienced longer treatment delays has markedly diminished, now aligning more closely with the public sector.

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

	All sites (N=3,362)	Public (n=2,420)	Private (n=942)
	N (%)	N (%)	N (%)
<24hrs	1,708 (50.8)	1,253 (51.8)	455 (48.3)
24-47hrs	781 (23.2)	554 (22.9)	227 (24.1)
48-72hrs	394 (11.7)	272 (11.2)	122 (13.0)
>72hrs	479 (14.2)	341 (14.1)	138 (14.6)

PCI for non-ACS indications increased slightly compared to the previous report and accounted for 54% of procedures, see Figure 6.

Figure 6: Procedures by clinical presentation



Considerable variation was observed in the distribution of acute coronary syndrome (ACS) cases among PCI hospitals across Victoria, ranging from 0% to 80%. Several hospitals managed relatively few ACS cases, with one hospital reporting not treating any ACS cases. Conversely, a subset of hospitals handled a substantial ACS caseload, with five facilities having an ACS caseload ranging from 25%- 34%.

Indications for PCI

Table 5 presents the indications for PCI among patients with STEMI and NSTE-ACS, both overall and stratified by hospital sector. Consistent with prior reports, rescue PCI remains predominantly performed within the public sector.

Table 5: PCI indications by ACS category and hospital sector

PCI indications	All sites (N=6,358)	Public (n=4,982)	Private (n=1,376)
ACS Category	N (%)	N (%)	N (%)
Primary PCI*	1,880 (29.6)	1,695 (34.0)	185 (13.4)
STEMI PCI 12-24 hours after symptom onset	124 (2.0)	114 (2.3)	10 (0.7)
Pharmaco-invasive PCI	102 (1.6)	97 (1.9)	5 (0.4)
Rescue PCI	148 (2.3)	147 (3.0)	1 (0.1)
PCI For STEMI (1-7 Days no prior lysis)	133 (2.1)	121 (2.4)	12 (0.9)
PCI For STEMI (1-7 Days following lysis)	79 (1.2)	75 (1.5)	4 (0.3)
PCI for OHCA/shock (non-MI)	38 (0.6)	34 (0.7)	4 (0.3)
PCI for NSTE-ACS	3,854 (60.6)	2,699 (54.2)	1,155 (83.9)
NSTE-ACS sub-category	N (%)	N (%)	N (%)
NSTEMI	2,891 (75.0)	2,202 (81.6)	689 (59.7)
UAP	469 (12.2)	218 (8.1)	251 (21.7)
Recent ACS 8-30 days ago	494 (12.8)	279 (10.3)	215 (18.6)

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

Table 6 displays the indications for PCI in the non-acute coronary syndrome (non-ACS) patient cohort, presented both overall and by hospital sector. In both sectors, the primary indication for PCI in non-ACS cases is stable angina.

Table 6: Non-ACS PCI indications

PCI indications	All sites (N=6,206)	Public (n=2,394)	Private (n=3,812)
	N (%)	N (%)	N (%)
Stable angina	4,398 (70.9)	1,688 (70.5)	2,710 (71.1)
No symptoms and positive functional test	536 (8.6)	63 (2.6)	473 (12.4)
No symptoms and no functional test	192 (3.1)	73 (3.0)	119 (3.1)
Staged PCI after ACS (≤ 30 days after first procedure)	566 (9.1)	393 (16.4)	173 (4.5)
Staged PCI after ACS (> 30 days after first procedure)	194 (3.1)	123 (5.1)	71 (1.9)
Staged PCI after original non-ACS indication	320 (5.2)	54 (2.3)	266 (7.0)

For the past nine years, VCOR has conducted evaluations and reported on clinical factors observed in patients undergoing PCI for non-ACS indications, aimed at assessing procedural appropriateness (see Table 7). In the latest assessment, 53.5% of patients exhibited all three of the clinical factors that the registry utilises to support procedural appropriateness. This reflects a slight increase compared to the previous year. The proportion of patients presenting with at least two factors also rose, totaling 93.3% overall. Conversely, patients with only one or no clinical factors decreased to 6.7%. Consistent with the prior year, a minimal cohort (n=16) displayed no clinical factors to support the appropriateness of the PCI.

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

Symptoms	Positive functional test	High grade stenosis	Total
			N (%)
●	●	●	2,742 (53.5)
○	●	●	469 (9.2)
●	●	○	277 (5.4)
●	○	●	1,290 (25.2)
●	○	○	88 (1.7)
○	○	●	176 (3.4)
○	●	○	66 (1.3)
○	○	○	16 (0.3)
			5,124 (100)

In comparing hospital sectors (see Figure 7), the public sector demonstrated a notable increase in the proportion of cases with at least two clinical factors to support an appropriate PCI, rising to 95% from the previous year. In contrast, the private sector maintained a consistent proportion of 92% in this category. There was a decline observed in the number of patients with none or only one clinical factor in the public sector, whereas the figures remained relatively stable compared to the previous year in the private sector.

Figure 7: Key clinical factors in non-ACS patients by hospital sector

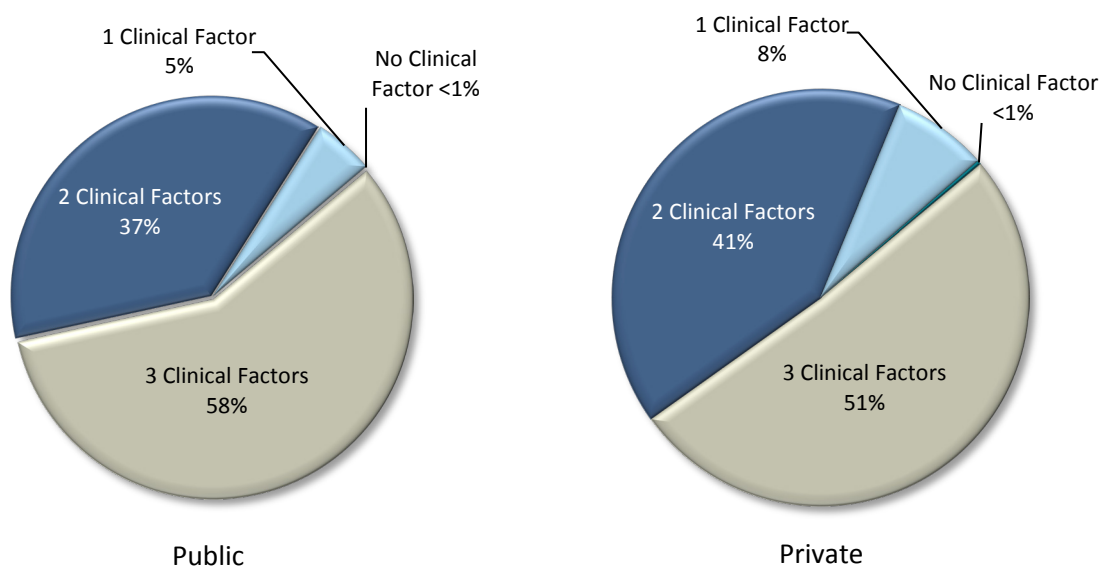
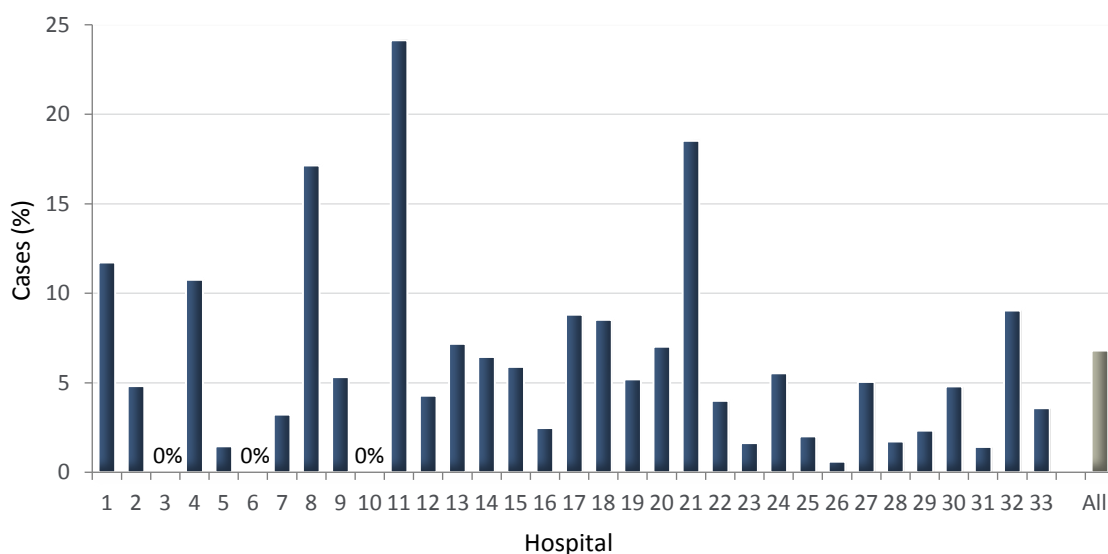


Figure 8 illustrates the distribution of non-ACS cases with either one or no clinical factors across different hospitals. Considerable variability was observed among hospitals, ranging from 0% to 24.1%. Overall, there were 346 cases where either none or just one clinical factor was present. Of these cases, the majority (74%) were treated in the private sector.

Figure 8: Proportion of non-ACS cases with 0-1 key clinical factor for PCI by hospital



Lesion and Clinical Subsets

The trends in PCI rates for selected lesion subsets over the past five years is shown in Figure 9. There was a slight decrease in cases involving unprotected left main coronary artery (ULM) stenting, whereas the number of procedures for chronic total occlusion (CTO) saw a slight increase. Rates of multivessel PCI also decreased over this period. Balloon angioplasty without stenting (POBA) increased to 5.6% in 2023 from 4.6% in 2022, while the use of POBA for treating in-stent restenosis rose to 44.7% in 2023 compared to 38.3% in 2022. Similarly, the utilisation of drug-coated balloons for in-stent restenosis treatment increased to 32.2% in 2023 from 27.7% in 2022.

Figure 9: Comparative trends in PCI for selected lesion subsets: 2019 - 2023

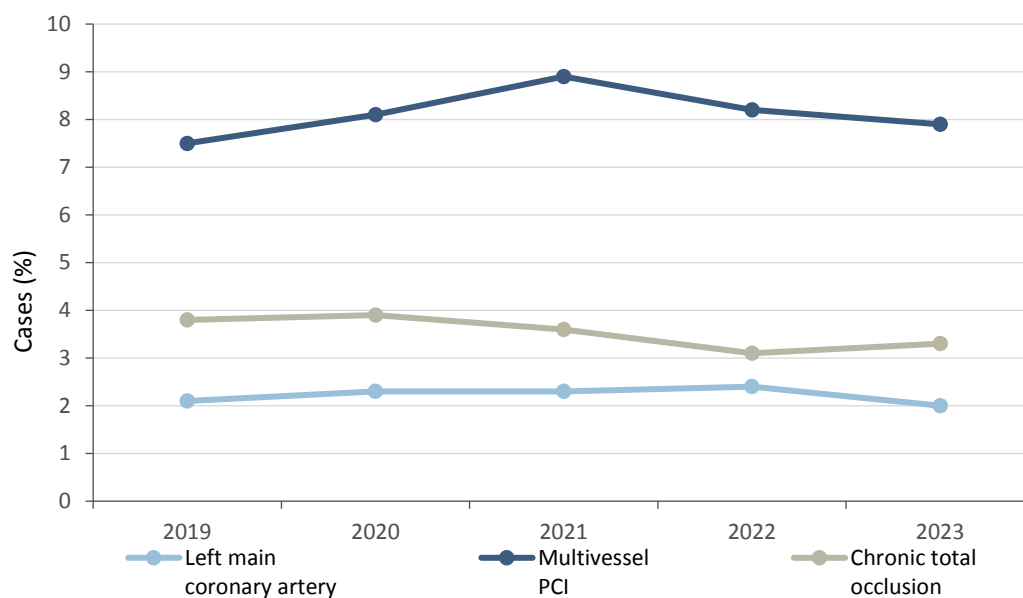


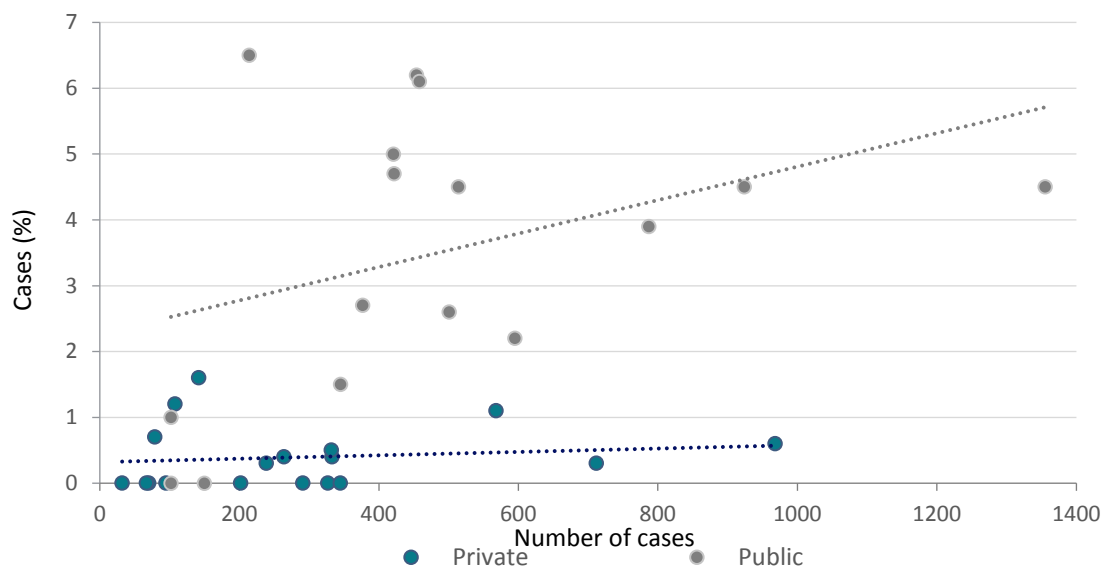
Table 8 presents the trends in the proportion of patients undergoing PCI who are medically compromised by cardiogenic shock and/or having experienced out-of-hospital cardiac arrest (OHCA) over the past five years. Overall, the rate of these high-acuity patients has been stable, with the majority (91.7%) treated within the public sector, constituting 3.5% of the total workload. In contrast, these cases represented only 0.5% of the overall workload in the private sector.

Table 8: Rates of cardiogenic shock and/or intubated OHCA: 2019- 2023

Presentation type	2019 (N=12,354)	2020 (N=12,347)	2021 (N=12,478)	2022 (N=11,651)	2023 (N=12,564)
	N (%)	N (%)	N (%)	N (%)	N (%)
Cardiogenic shock	269 (2.2)	273 (2.2)	246 (2.0)	305 (2.6)	277 (2.2)
Intubated OHCA	151 (1.2)	129 (1.0)	138 (1.1)	155 (1.3)	134 (1.1)
Shock and/or intubated OHCA	320 (2.6)	326 (2.6)	300 (2.4)	356 (3.1)	328 (2.6)

The correlation between hospital volume and hospital sector in the management of cardiogenic shock and/or intubated OHCA is illustrated in Figure 10. In 2023, fewer hospitals had an overall caseload exceeding 3% (n=9) compared to the previous year (n=14), with all such hospitals being in the public sector. Conversely, the majority of private sector hospitals did not manage any cases of cardiogenic shock and/or intubated OHCA during the period under review.

Figure 10: Cardiogenic shock and/or intubated OHCA cases by hospital volume and hospital sector



Coronary Device Use

Stents were deployed in 92.2% of PCIs, with drug-eluting stents used in 99.8% of cases where a stent was deployed. In the majority of instances (two-thirds), a single stent sufficed, mirroring past trends. The use of intravascular ultrasound (IVUS) nearly doubled compared to the previous year's report, whereas the utilisation of optical coherence tomography (OCT) remained low and unchanged from prior reports. IVUS and OCT use was more prevalent in the public hospital sector. There was a continued preference for use of rotational atherectomy and pressure wires in the private sector. Adjunctive imaging with IVUS or OCT was incorporated in 48.5% of left main coronary artery PCIs, indicating a 4.5% rise from the previous year. Detailed utilisation rates of adjunctive devices are depicted in Table 9. Other adjunctive devices such as intra-aortic balloon pump (IABP) and extracorporeal membrane oxygenation (ECMO) were infrequently used (0.2% collectively).

The use of coronary intravascular lithotripsy has demonstrated steady growth over the past three years, nearly doubling compared to the previous year (155 cases in 2023, up from 86 in 2022 and 47 in 2021). Conversely, the use of glycoprotein IIb/IIIa receptor inhibitors decreased to 5.3%, reflecting a 1.1% decline from the previous year, with predominant use noted in the STEMI patient cohort.

Table 9: Adjunctive device use by hospital sector

Adjunctive device type	All sites (N=12,564)	Public (n=7,376)	Private (n=5,188)
	N (%)	N (%)	N (%)
Intravascular ultrasound	770 (6.1)	482 (6.5)	288 (5.6)
Optical coherence tomography	352 (2.8)	276 (3.7)	76 (1.5)
Thrombus aspiration device	203 (1.6)	183 (2.5)	20 (0.4)
Rotational atherectomy	241 (1.9)	118 (1.6)	123 (2.4)
Pressure wire	766 (6.1)	277 (3.8)	489 (9.4)
IABP	25 (0.2)	20 (0.3)	5 (0.1)
ECMO	27 (0.2)	27 (0.4)	0 (0.0)

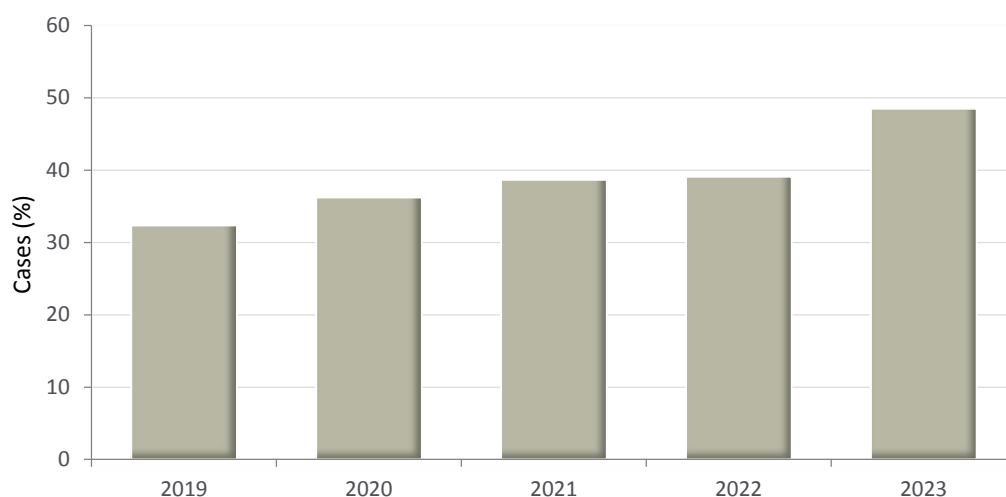
IVUS was utilised in 770 cases. Adjunctive coronary imaging is recognised as best practice particularly in cases where PCI is employed for treating an unprotected left main (ULM) coronary lesion, with its usage rate in this clinical scenario documented at 48.5% (see Table 10).

Table 10: IVUS use in unprotected left main

	2023	Public	Private
	N (%)	N (%)	N (%)
Intravascular ultrasound (IVUS)	96 (48.5)	60 (47.6)	36 (50.0)

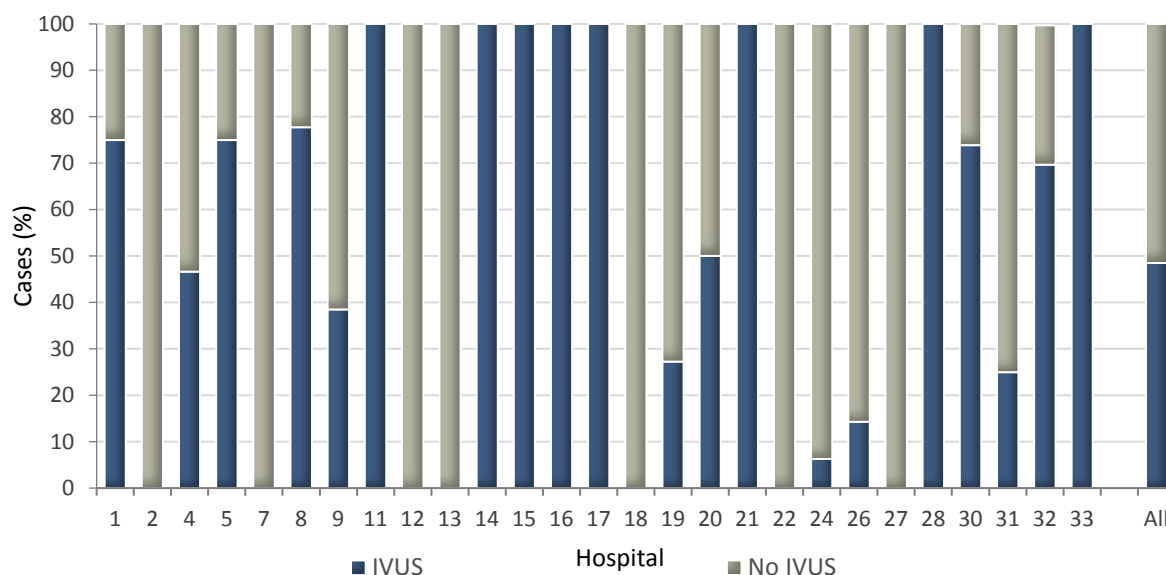
The use of IVUS in ULM PCI increased in 2023 and is shown in Figure 11. Overall, the rate of IVUS use in ULM PCI increased from 32% in 2019 to 48% in 2023.

Figure 11: IVUS use in unprotected left main 2019 - 2023



The use of IVUS in ULM varied by hospital (0%- 100%) as shown in Figure 12. Several hospitals treated few numbers of patients with a left main coronary lesion (IVUS in ULM case range: 1 to 33).

Figure 12: Rate of IVUS use in unprotected left main by hospital



Hospital	1	2	4	5	7	8	9	11	12	13	14	15	16	17	18	19	20	21	22	24	26	27	28	30	31	32	33	ALL
Cases (N)	4	3	15	8	1	9	13	1	3	5	2	1	4	2	1	11	4	1	1	16	7	6	1	23	16	33	7	198

Hospitals 3, 6, 10, 23, 25, 29 had no ULM cases.

Arterial access

The overall utilisation rate of radial artery vascular access reached 79%, marking a continued increase from the previous year. Since 2018, there has been a gradual rise in the adoption of radial artery access where it was 66%. As consistently observed, public sector hospitals exhibited a higher preference for radial artery access (81.5%) compared to private sector hospitals (75.4%). Furthermore, radial artery access remains more prevalent in male patients (80.5%) than in female patients (74.5%).

In STEMI cases, the use of radial artery access increased to an overall rate of 84.4%, a 5% increase compared to the previous year. Public sector hospitals reported higher rates of 84.7% compared to 81.6% in the private sector. There was notable variability among hospitals, with rates ranging from 72% to 90%. The proportion of hospitals utilising radial access in 75% or more of their acute STEMI cases was 84.2%, compared to 73% in 2021.

PCI for STEMI

In 2023, a total of 2,466 patients underwent PCI for ST-elevation myocardial infarction (STEMI). The public sector treated the majority of these cases, accounting for 91% overall. Primary PCI was the predominant treatment approach, representing 76.2% of STEMI PCI cases, an increase from the prior year. Detailed subcategories of PCI for STEMI are shown in Table 11. The distribution of STEMI PCI caseload varied widely among hospitals, ranging from 0% to 49.5%. Overall, nearly half (49.8%) of PCI procedures for STEMI were performed during out-of-hours periods.

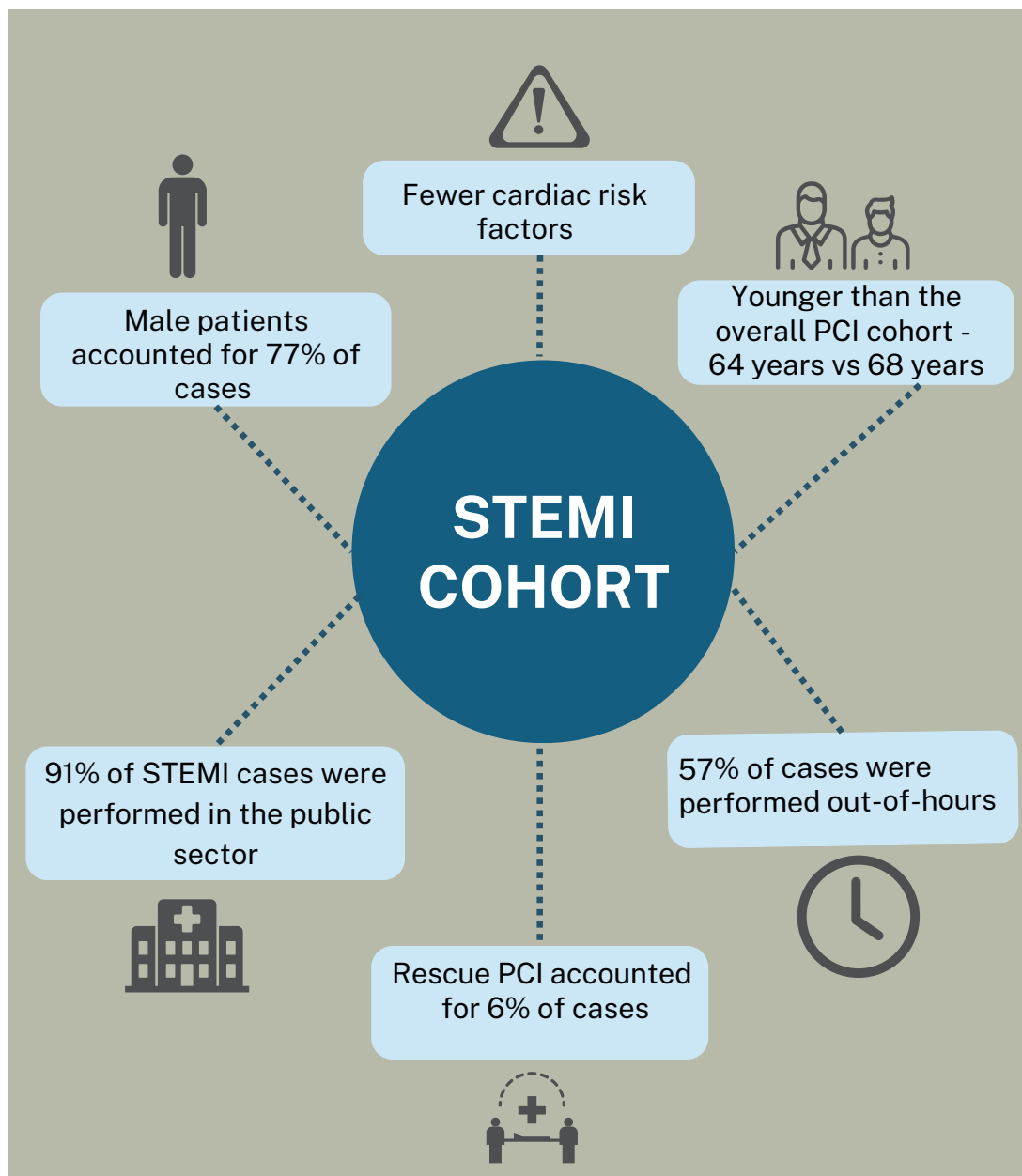
Table 11: Subcategories of patients undergoing PCI for STEMI

PCI for STEMI categories	All sites (N=2,466)	Public (n=2,249)	Private (n=217)
	N (%)	N (%)	N (%)
Primary PCI (<12 hrs, no thrombolysis)	1,880 (76.2)	1,695 (75.4)	185 (85.3)
PCI for STEMI 12-24 hours (no thrombolysis)	124 (5.0)	114 (5.1)	10 (4.6)
Pharmaco-invasive PCI (<24 hrs, previous thrombolysis, stable)	102 (4.1)	97 (4.3)	5 (2.3)
Rescue PCI (<24 hrs, previous thrombolysis, unstable)	148 (6.0)	147 (6.5)	1 (0.5)
PCI for STEMI 1-7 days following lysis	133 (5.4)	121 (5.4)	12 (5.5)
PCI for STEMI 1-7 days no prior lysis	79 (3.2)	75 (3.3)	4 (1.8)

Compared to the rest of the PCI cohort, patients presenting with STEMI were younger, with a mean age of 63.8 ± 12.8 years versus 68.2 ± 11.3 years in non STEMI cases. They also exhibited lower prevalence of certain cardiac risk factors such as diabetes (19.5% vs 24.1%) and peripheral vascular disease (1.7% vs 3.2%). Rates of prior revascularisation procedures were notably lower among STEMI patients compared to the overall cohort, with prior PCI at 13.3% versus 31.3% and prior coronary artery bypass grafting at 1.7% versus 5.4%, consistent with previous reports.

The demographic profile of STEMI patients differed between the public and private sectors. Private sector STEMI patients were on average six years older (63.3 ± 12.7 years in public vs 69.1 ± 12.5 years in private) and exhibited higher rates of prior stroke (1.7% in public vs 4.1% in private). Additionally, as previously observed, patients treated in private hospitals had higher rates of prior PCI (12.6% in public vs 20.7% in private), peripheral vascular disease (1.6% in public vs 2.3% in private), and prior coronary artery bypass grafting procedures (1.4% in public vs 5.5% in private). Figure 13 outlines key characteristics related to STEMI patients and their management.

Figure 13: STEMI patient characteristics



Time Delays to Treatment

The key performance measure of door-to-balloon time (DBT) serves as a benchmark for assessing hospital performance in managing patients with STEMI. Previous reports during the COVID-19 pandemic highlighted an increase in DBT and a reduction in the proportion of cases achieving DBT ≤ 90 minutes and ≤ 60 minutes. Encouragingly, there was an improvement observed in 2023, with an increased proportion of cases treated within ≤ 60 minutes and ≤ 90 minutes, alongside a decline in the median DBT compared to the previous year. However, neither of these metrics has yet returned to pre-pandemic levels (see Table 12).

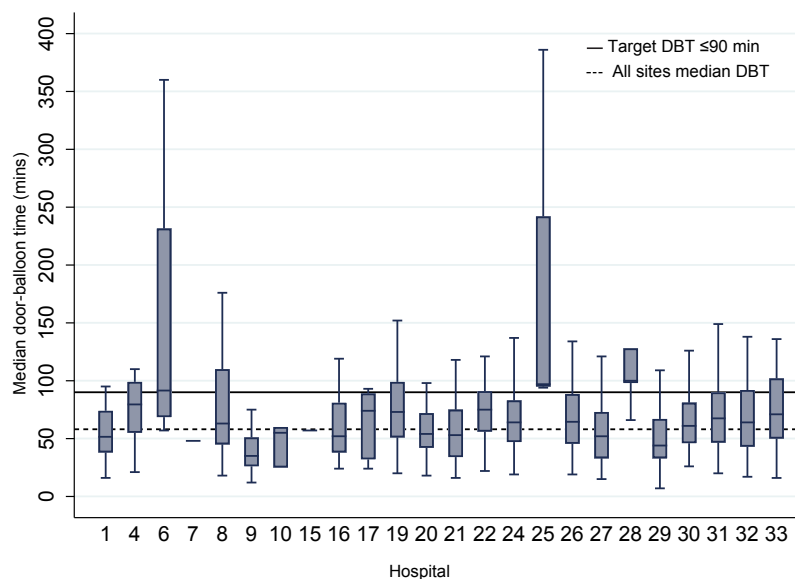
Table 12: Door-to-balloon times for primary PCI cases: 2019 - 2023

Door-to-balloon time	2019	2020	2021	2022	2023
	(N=1,495)	(N=1,623)	(N=1,565)	(N=1,469)	(N=1,532)
Median – mins (IQR)	58 (40, 84)	62 (43, 91)	61 (43, 92)	62 (43, 90)	61 (42, 84)
Proportion of cases ≤ 90 mins (%)	80.8	74.7	74.4	75.2	79.1
Proportion of cases ≤ 60 mins (%)	54.0	48.4	49.3	47.6	49.3

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. The median across all hospitals was 61 minutes, with 9 hospitals achieving a median below this.

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

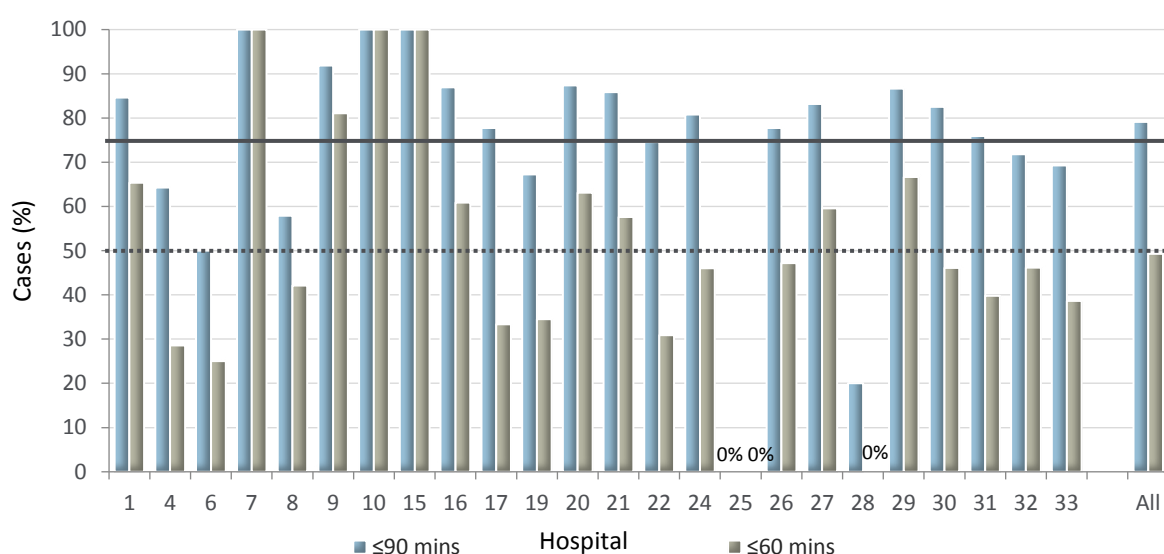


Primary PCI for STEMI presentations excluding all inter-hospital transfers and patients with STEMI onset whilst a current in-patient.

Figure 15 compares hospital compliance with two key door-to-balloon time (DBT) metrics among hospitals treating primary PCI patients. In the latest assessment, 3 hospitals achieved a DBT ≤ 60 minutes in 100% of their cases. Four hospitals achieved a DBT ≤ 60 minutes in 75% of their cases. When the compliance threshold is lowered to 50% of all primary PCI cases, 10 out of 24 hospitals met this criterion.

Notably, one low-volume hospital did not meet the ≤ 90 -minute DBT metric for any of their patients, and a second only managed it in 20% of their cases. These findings support focusing on procedural volume as a key factor in ensuring timely and guideline-recommended management of primary PCI cases.

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 6, 7, 10, 15, 25 & 28 had low primary PCI cases ≤ 5 . Hospitals 2, 3, 5, 11, 12, 13, 14, 18, 23 had no primary PCI cases.

Pre-hospital notification (PHN)

Pre-hospital notification (PHN) occurred in 74.9% of primary PCI cases, reflecting a small increase compared to the previous year. Consistent with prior findings, PHN was associated with a notable reduction in median door-to-balloon time (DBT) and an increase in the proportion of cases treated within ≤ 90 minutes (see Table 13).

Table 13: Door-to-balloon times for Primary PCI cases by pre-hospital notification status

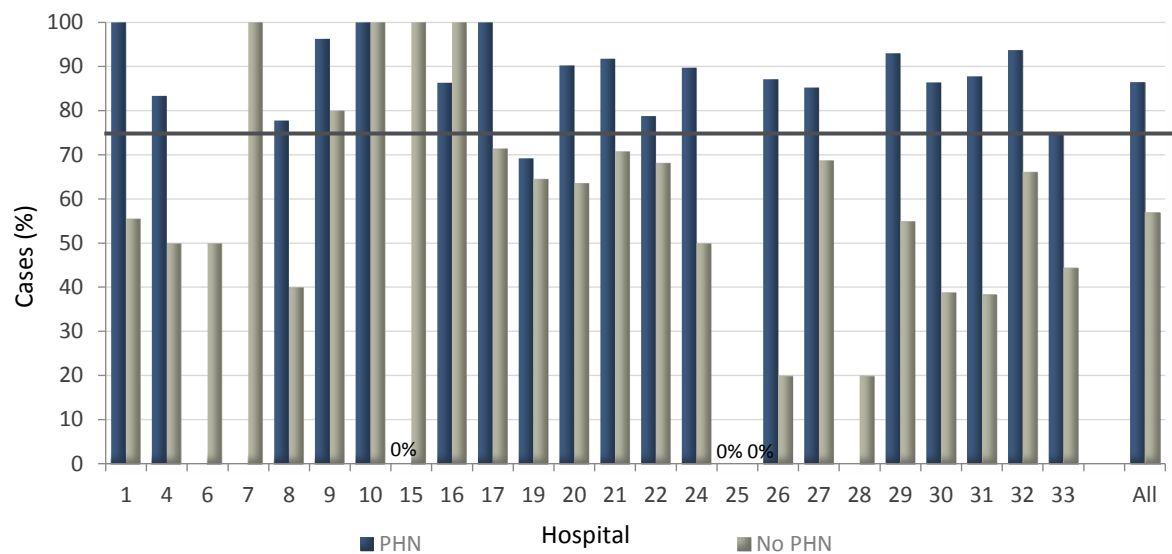
Door-to-balloon time	Primary PCI*	Primary PCI* (PHN only†)	Primary PCI* (no-PHN†)
	(N=1,532)	(n=1,148)	(n=384)
Median – mins (IQR)	61 (42, 84)	54 (39, 75)	83 (61, 109)
Proportion of cases ≤ 90 mins (%)	79.1	86.5	57.0

*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 illustrates the impact of PHN on compliance with achieving a door-to-balloon time (DBT) of ≤ 90 minutes across hospitals. The beneficial effect of PHN on DBT is evident. Only two hospitals did not meet the target of treating more than 75% of cases within a DBT ≤ 90 minutes, indicating improvement compared to the previous year.

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



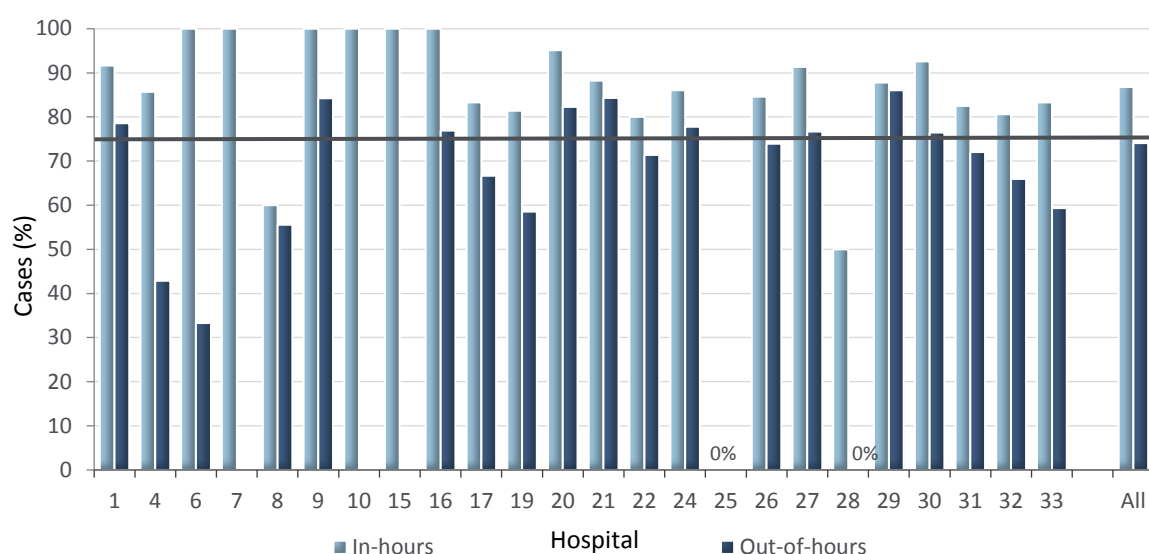
Primary PCI for STEMI presentations excluding all inter-hospital transfers and patients with STEMI onset whilst a current in-patient. Hospitals 6, 7 and 28 had no PHN cases. Hospitals 6, 7, 10, 15, 25 & 28 had low primary PCI cases ≤ 5 . Hospitals 2, 3, 5, 11, 12, 13, 14, 18, 23 had no primary PCI cases.



In-hours versus out-of-hours presentation

The distribution of primary PCI cases performed in-hours versus out-of-hours procedures is illustrated in Figure 17. The rate of primary PCI undertaken out-of-hours showed a slight decrease compared to the previous year (60.5% in 2023 vs 62.3% in 2022). The proportion of out-of-hours cases varied widely among hospitals, ranging from 0% to 86.1%. In-hours procedures demonstrated higher compliance with achieving a door-to-balloon time of ≤ 90 minutes, with 86.8% of cases meeting this target. In contrast, out-of-hours procedures had a lower compliance rate, with 74.1% of primary PCI cases achieving a door-to-balloon time of ≤ 90 minutes.

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.
Hospitals 7, 10, 15 & 25 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).*

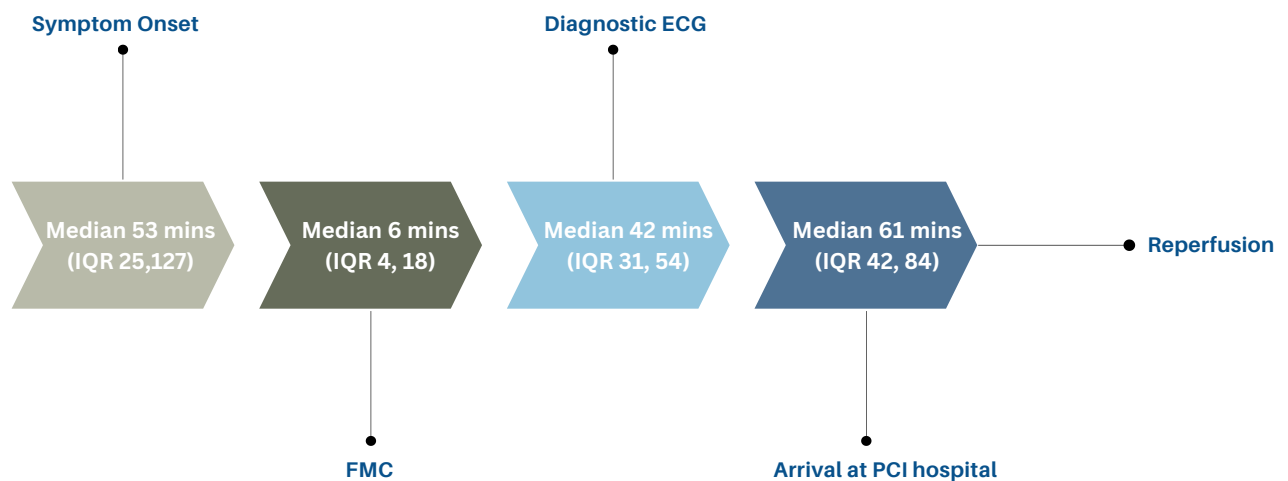
Times from symptom onset to first medical contact, diagnostic ECG and reperfusion

The median time from symptom onset to first medical contact (FMC)- typically ambulance service, emergency department or general practitioner- was 53 minutes (IQR: 25, 127). This time interval represents the “patient delay”- the time taken for the patient to recognise and act upon their symptoms and is dependent on factors that include the patient’s level of health literacy and the effectiveness of public health education programs and campaigns.

In contrast to this patient-related treatment delay, “system delay” reflects the performance of the health system and its associated processes in treating STEMI patients as efficiently and effectively as possible. The metric of system delay encompasses several critical time intervals: time from FMC to diagnostic ECG, the time to transfer patients to a PCI-capable hospital after the diagnostic ECG, and the door-to-balloon time (time from hospital arrival to reperfusion).

Total ischaemic time, depicting the duration from symptom onset to device use (i.e. patient delay plus system delay), is illustrated in Figure 18. The interval from first diagnostic ECG to hospital arrival and from FMC to reperfusion demonstrated a slight decrease in 2023. As noted previously, private patients experienced longer delays from symptom onset to FMC; however, once within the system, subsequent delays were shorter compared to public patients. Overall, median times across the symptom onset to reperfusion journey for STEMI patients decreased in 2023.

Figure 18: Median times from symptom onset to reperfusion



Median time from symptom onset to FMC (patient delay) was observed to be higher in private hospitals, where a smaller proportion of STEMI patients were managed. Table 14 details the various components of total ischaemic time, both overall and by hospital sector.

Table 14: Median times from symptom onset to reperfusion - public/private and PHN and No PHN

	All	Public	Private	PHN	No PHN
All Primary PCI*	(N=1,513)	(n=1,381)	(n=132)	(n=1,135)	(n=378)
Median Symptom onset to FMC- mins (IQR)	53 (25,127)	51 (25,125)	60 (36,139)	46 (24,104)	80 (36,168)
Median FMC to Diagnostic ECG- mins (IQR)	6 (4,17)	6 (4,17)	7 (4,15)	5 (3,14)	11 (5,28)
Median Diagnostic ECG to door- mins (IQR)	42 (31,54)	42 (31,54)	38 (26,52)	42 (32,54)	38 (26,50)
Median Diagnostic ECG to Balloon/Device time- mins (IQR)	95 (75,120)	96 (76,121)	81 (64,105)	96 (78,122)	87 (68,113)
Median FMC to Balloon/Device time- mins (IQR)	105 (85,135)	106 (86,136)	91 (73,122)	106 (87,134)	104 (79,137)

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

Outcomes

Lesion and procedure success rates

In PCI, procedural success is defined as the successful treatment of all lesions without major in-hospital complications and serves as a critical metric indicating the effectiveness of treatment and patient outcomes. In 2023, the overall procedural success rate was 92.1%, with some disparity observed between public and private hospitals, with rates of 90% and 94%, respectively. Within individual institutions, procedural success rates ranged from 86.3% to 96.9%. Gender-based analysis revealed a marginal difference in procedural success rates, with male patients achieving a slightly higher rate of 92.3% compared to 91.5% among females. This represents a narrowing of the gender gap from previous assessments.

Identified risk factors associated with procedural failure included procedures performed outside regular hours, patients with severely reduced left ventricular function, and lesions of increased complexity such as chronic total occlusions. Additionally, patients presenting with cardiogenic shock or those requiring intubation following out-of-hospital cardiac arrest were at higher risk for unsuccessful procedures (see Table 15).

In terms of lesion-specific outcomes, success was defined by residual stenosis post-intervention of less than 10% following stenting and less than 50% following balloon angioplasty. The overall mean lesion success rate was 95%, although the metric varied among hospitals, ranging from 90.0% to 98.1%.

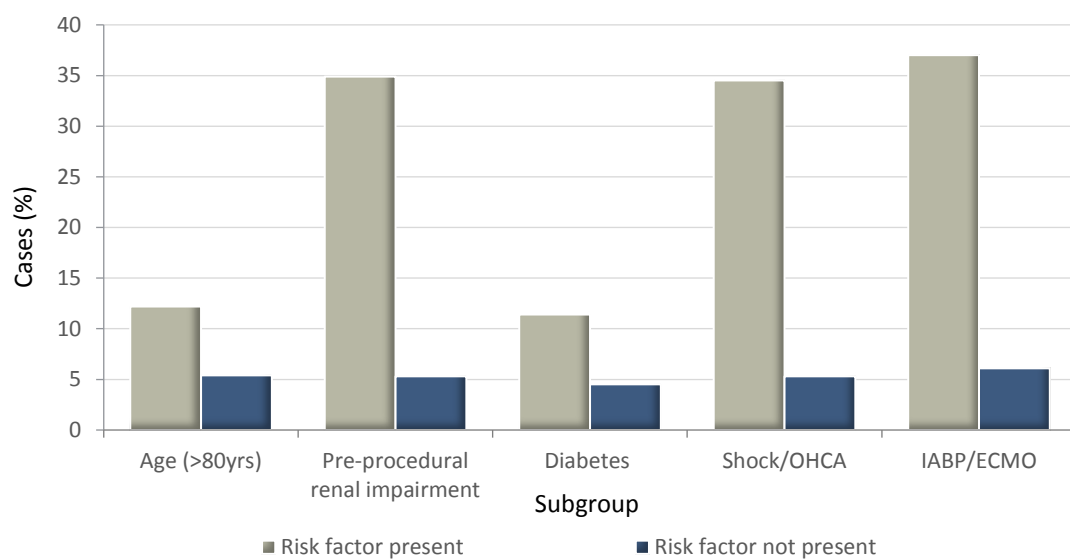
Table 15: Comparison of clinical features among successful PCI cases

Clinical characteristics	Characteristic present	Characteristic NOT present
	Procedure success (%)	Procedure success (%)
Cerebrovascular Disease	88.6	92.2
Chronic total occlusion	62.9	93.1
Severe LVEF (<35%)	79.1	95
Shock and/or intubated OHCA	48.8	93.3
ACC/AHA B2/C lesion	90.5	94.6
Out-of-hours	87.3	93.2

New renal impairment

Post-procedural renal function was recorded in 7,496 patients (59.7%), with new renal impairment (NRI) occurring in 6.3% of cases. NRI was higher in patients undergoing PCI for STEMI (9.9%) compared to those with NSTEMI-ACS (6.4%) and was notably lower in the non-ACS cohort (3.8%). Figure 19 illustrates NRI rates in high-risk subgroups, highlighting the highest occurrence in patients needing mechanical hemodynamic support and those with significant pre-procedural renal impairment, though at lower rates than previously reported. An increase in NRI from the previous report was observed in patients with high-acuity conditions such as cardiogenic shock and/or intubated OHCA (34.5% in 2023 versus 31% in 2022).

Figure 19: New renal impairment in selected high-risk subgroups



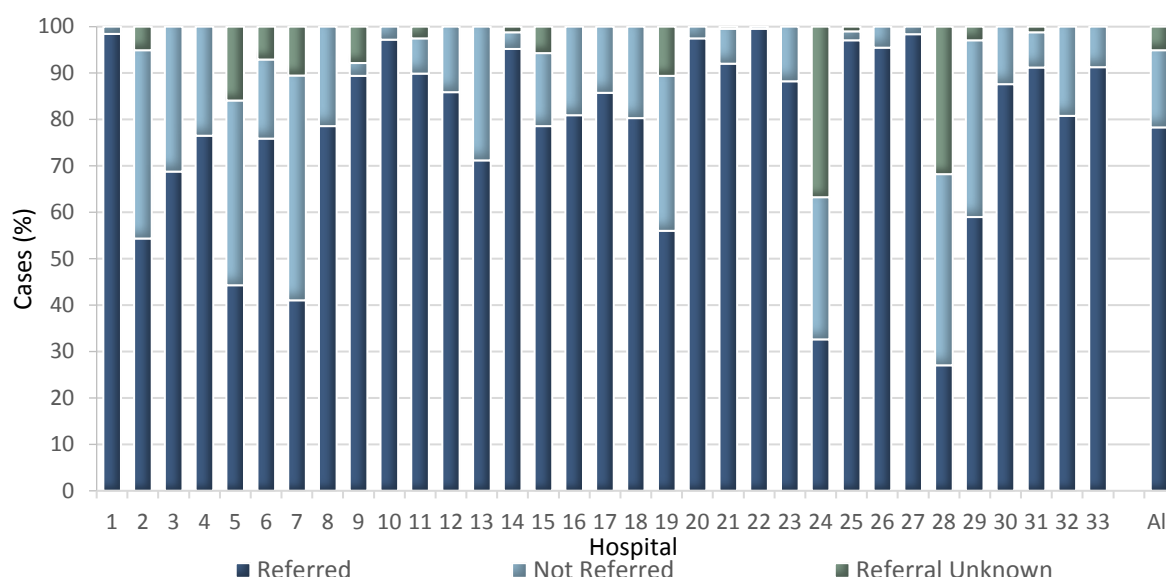
Data available for 7,496 cases.



Referral to cardiac rehabilitation

The overall referral rate to cardiac rehabilitation (CR) was 78.3%. A further 16.6% were not referred, and 5.1% had an “unknown” referral status. This marks a modest improvement from our previous report. Referral rates varied with treatment setting, with a higher rate observed in the private sector (79.3%) compared to the public sector (77.6%). Notably, private sector hospitals demonstrated a 5% increase in referral rates (74% in 2022). Hospital-specific analysis revealed substantial variability, with referral rates spanning from 27% to 99% (Figure 20). Among the non-ACS patient cohort, 75.8% were referred to CR. Rates of referral were higher in patients undergoing PCI for NSTEMI-ACS (80.5%) and STEMI (82.4%). These findings underscore the variability in CR referral practices across different hospital settings and patient populations, indicating opportunities for targeted interventions to improve referral rates.

Figure 20: Referral to cardiac rehabilitation at discharge by hospital



Compliance with guideline-recommended medications at discharge

The recommended medical regimen following PCI includes dual antiplatelet therapy (DAPT) and statins. DAPT, statins, and other guideline-recommended medications at discharge, categorised by clinical presentation is presented in Table 16. These rates have remained stable over several reporting periods. Consistent with prior data, the utilisation of beta blockers and ACE inhibitors/angiotensin receptor blockers (ACE-I/ARB) is lowest among patients with non-ACS presentations.

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

Clinical Presentation	DAPT	Statin	BB	ACE-I/ARB
	%	%	%	%
STEMI	95.5	97.5	85.2	81.8
NSTEMI-ACS	95.7	95.1	72.3	70.5
Non-ACS	93.7	91.6	53.2	63.5

A subset of patients requires both an oral anticoagulant (such as warfarin or a direct-acting oral anticoagulant) along with a single antiplatelet agent (like aspirin, clopidogrel or ticagrelor). When only one antiplatelet agent is administered, this combination is termed “double therapy”. Treatment with two antiplatelet agents is considered “triple therapy”, and remains a topic of debate due to the associated risk of excess bleeding.

Table 17 outlines the rates of double and triple therapy at discharge and 30 days post-procedure across various patient and clinical factors. Notably, the rate of double therapy at discharge increased compared to the previous year, rising to 12.1% in 2023 from 10.8% in 2022. Triple therapy was less frequently utilised across all age groups and clinical presentations compared to double therapy. Triple therapy rates were lower among females compared to males, more prevalent among patients with non-acute coronary syndromes (non-ACS) and those receiving treatment in private healthcare settings. While the rate of triple therapy at discharge showed an increase from 7.6% in 2022 to 8.7% in 2023, the decline in triple therapy usage at 30 days across all subgroups, aligns with current clinical guidelines.

Table 17: Rates of double and triple therapy at discharge and 30-days

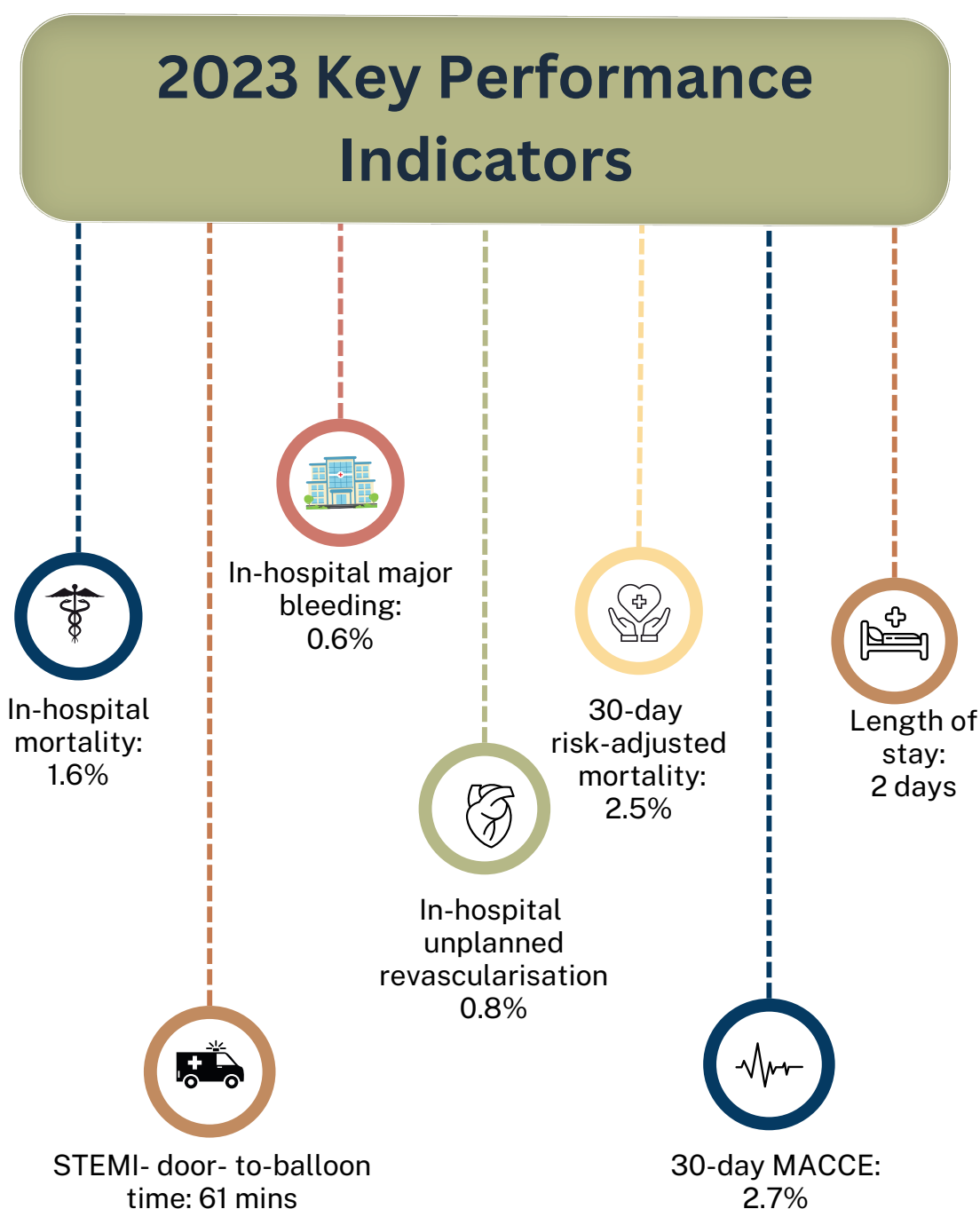
Characteristics	Discharge		30-Day	
	Double Therapy	Triple Therapy	Double Therapy	Triple Therapy
	%	%	%	%
Sex- male	12.2	8.9	12.1	5.4
Sex- female	11.8	8.2	11.9	4.8
Age <60 years	5.1	4	5.7	3
Age 60-69 years	8.4	6.4	8.8	4.2
Age 70-79 years	16.2	11.9	15.4	6.5
Age >79 years	22.9	14.5	22.2	8.8
STEMI	10.2	7.5	10.5	5.3
NSTE-ACS	10.4	7.7	10.5	4.5
Non-ACS	13.7	9.6	13.4	5.7
Public	10.7	8.4	11.1	5.0
Private	14.1	9.1	13.5	5.8

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 92.2%, a slight increase compared to the previous year.

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 2023 rate for each outcome. Length of stay is median days. Door-to-balloon time is the median time in minutes.

In-hospital mortality

Table 18 outlines the trends in in-hospital mortality rates over the past five years across various patient subgroups. In 2023, the unadjusted overall rate of in-hospital mortality was 1.6%. Excluding high-acuity cases involving cardiogenic shock and/or intubated out-of-hospital cardiac arrest (OHCA), the overall mortality rate decreased to 0.7%. Within the STEMI cohort, the in-hospital mortality rate was 5.4%. However, when cases involving shock and/or intubated OHCA were excluded, the mortality rate for STEMI was 0.4%.

Table 18: Trends in in-hospital mortality rates for selected clinical presentations: 2019 - 2023

Patient category	2019 (N=12,355)	2020 (N=12,349)	2021 (N=12,478)	2022 (N=11,651)	2023 (N=12,564)
	N (%)	N (%)	N (%)	N (%)	N (%)
All PCI patients	212 (1.7)	184 (1.5)	180 (1.4)	197 (1.6)	203 (1.6)
STEMI	148 (6.2)	140 (5.4)	118 (4.8)	135 (5.7)	133 (5.4)
Shock and/or intubated OHCA	138 (43.1)	116 (35.6)	113 (37.7)	127 (35.7)	119 (36.3)
NSTE-ACS	27 (0.8)	19 (0.5)	32 (0.9)	37 (1.2)	33 (1.0)
Non-ACS	37 (0.6)	25 (0.4)	30 (0.5)	25 (0.4)	37 (0.5)

In-hospital major bleeding

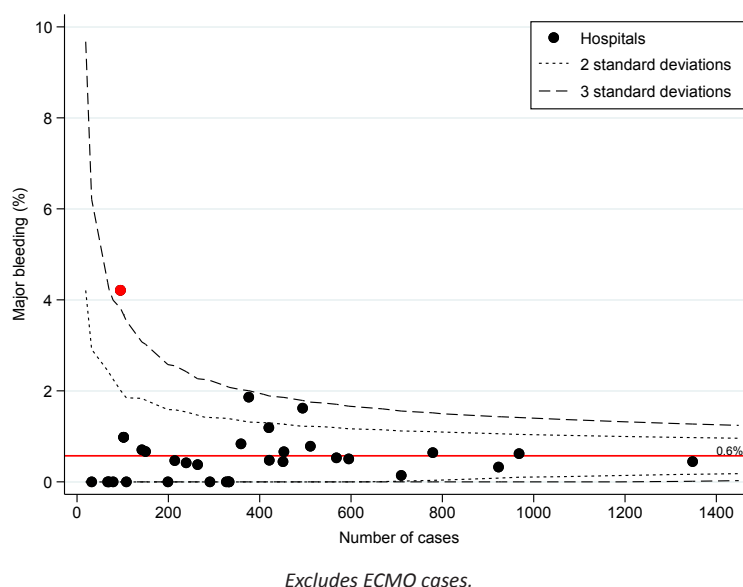
In-hospital major bleeding across a range of presentations is shown Table 19. The highest rate of in-hospital major bleeding (20%) was observed in the cohort of patients requiring ECMO (n=25).

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

Sub-group	N	Major bleeding rate
Clinical Presentation		N (%)
STEMI	2465	31 (1.3)
NSTE-ACS	3358	17 (0.5)
Non-ACS	6724	29 (0.4)
Sex		N (%)
Male	9450	50 (0.5)
Female	3097	27 (0.9)
Arterial Access Route		N (%)
Radial access	9917	31 (0.3)
Femoral access	2592	46 (1.8)
Brachial access	38	0 (0)
Total	12,547	86 (0.7)

Unadjusted major bleeding rates by hospital are presented in Figure 22. The rate range among hospitals was 0-4.2%. One low-volume hospital was identified with an in-hospital major bleeding rate greater than 3 standard deviations beyond the mean.

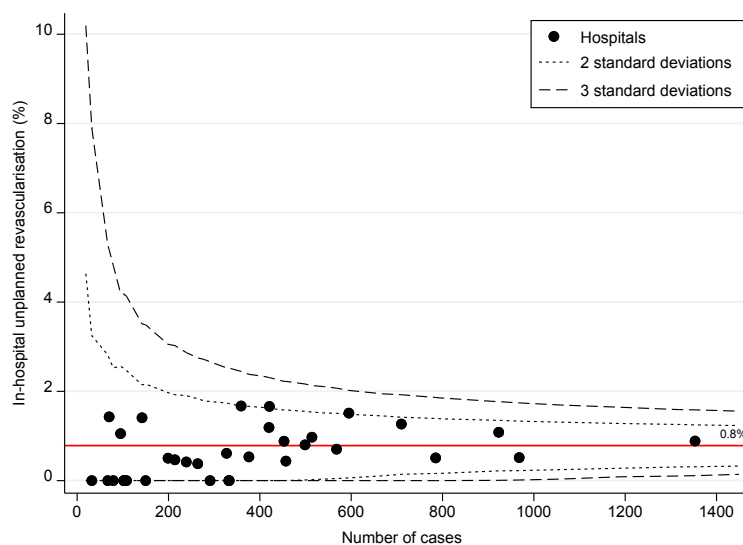
Figure 22: In-hospital major bleeding by hospital



In-hospital unplanned revascularisation

An unplanned revascularisation procedure, whether PCI or CABG surgery, refers to a procedure performed subsequent to the initial PCI that was unexpected and not pre-arranged and typically due to recurrent ischaemia. In 2023, the overall rate of unplanned revascularisation was 0.8%, showing a slight increase from the previous year. All participating hospitals remained within control limits, as shown in Figure 23.

Figure 23: In-hospital unplanned revascularisation by hospital



In total, there were 32 unplanned CABG procedures performed following the index PCI, with approximately one-third of these cases occurring among the non-ACS, NSTEMI-ACS, and STEMI patient cohorts (see Table 20). Among patients requiring unplanned cardiac surgery, 40.1% of cases (n=13) underwent their initial PCI in hospitals without cardiac surgical facilities and required inter-hospital transfer.

Table 20: In-hospital CABG by clinical presentation

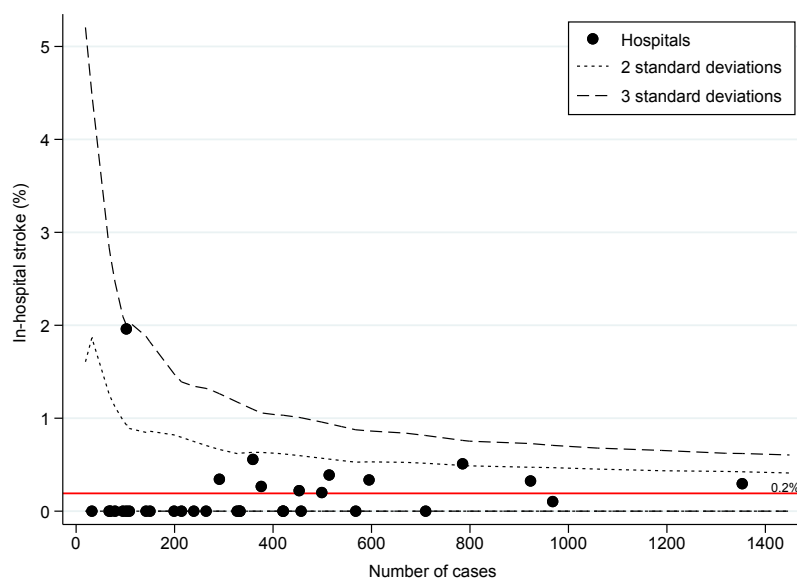
In-hospital CABG	All patients (N=12,564)	Planned CABG (n=46)	Unplanned CABG (n=32)
	N	N (%)	N (%)
Non-ACS	6,773	14 (0.2)	11 (0.2)
NSTEMI-ACS	3,362	10 (0.3)	11 (0.3)
STEMI	2,466	22 (0.9)	10 (0.4)

Forty-six patients underwent planned CABG following PCI, with the largest subgroup having presented with STEMI (n=22). Among these patients, 45.6% (n=21) required inter-hospital transfer. The in-hospital mortality rate for patients undergoing planned CABG was 2.2%, in contrast to patients requiring emergency CABG who had a near-tripling of the mortality rate to 6.3%.

In-hospital stroke

The in-hospital stroke rate was 0.2% (range 0- 2.0%). There were no outlier hospitals with respect to the incidence of in-hospital stroke (Figure 24).

Figure 24: In-hospital stroke by hospital

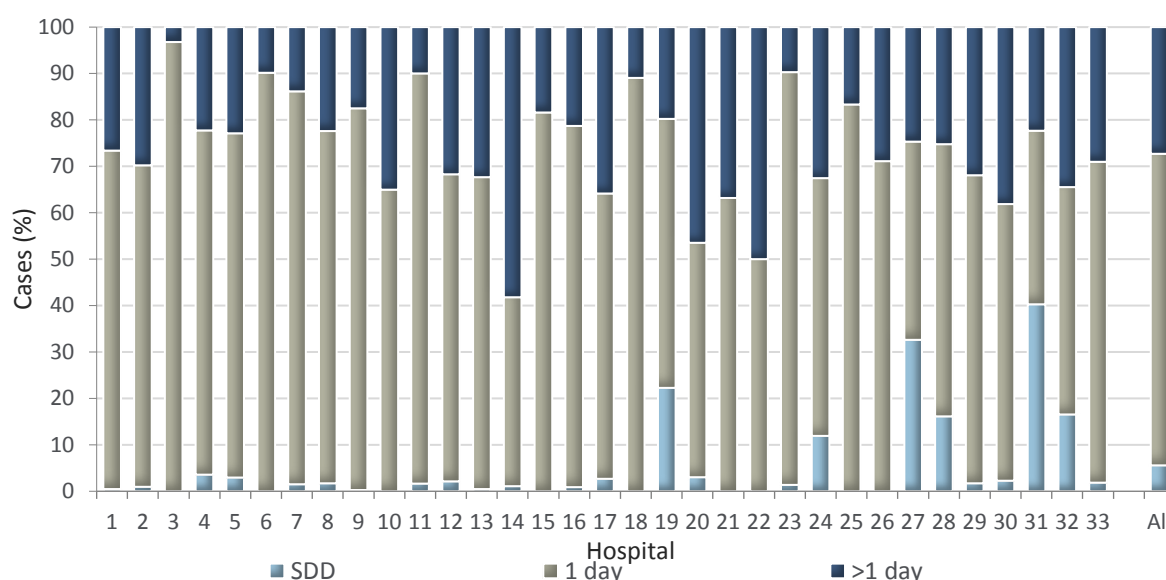


Length of stay

The overall median length of stay was 2 days, however this varied according to clinical presentation. Length of stay ranged from 1 day for patients undergoing PCI for elective non-ACS indications, 3 days for NSTEMI-ACS patients and 4 days for STEMI PCI patients.

The discharge of patients directly home on the same day as elective PCI (same day discharge-SDD) is increasingly recognised as a safe, convenient and potentially cost saving practice in appropriately selected cases. Figure 25 illustrates the distribution of discharge rates to home by hospital sector. Overall, 5.6% of elective PCI patients were discharged directly to home on the same day, with a notable disparity between public hospitals (12%) and private hospitals (1.4%). Transfers to another healthcare facility on the day of PCI were uncommon, occurring in less than 1% of elective cases. Among all elective PCI patients, 67% were discharged to home after a one-day hospital stay, while 27.5% required a hospital stay of more than two days. These findings highlight the variability in discharge practices and lengths of stay following elective PCI, in part, reflecting both patient-specific considerations and institutional protocols.

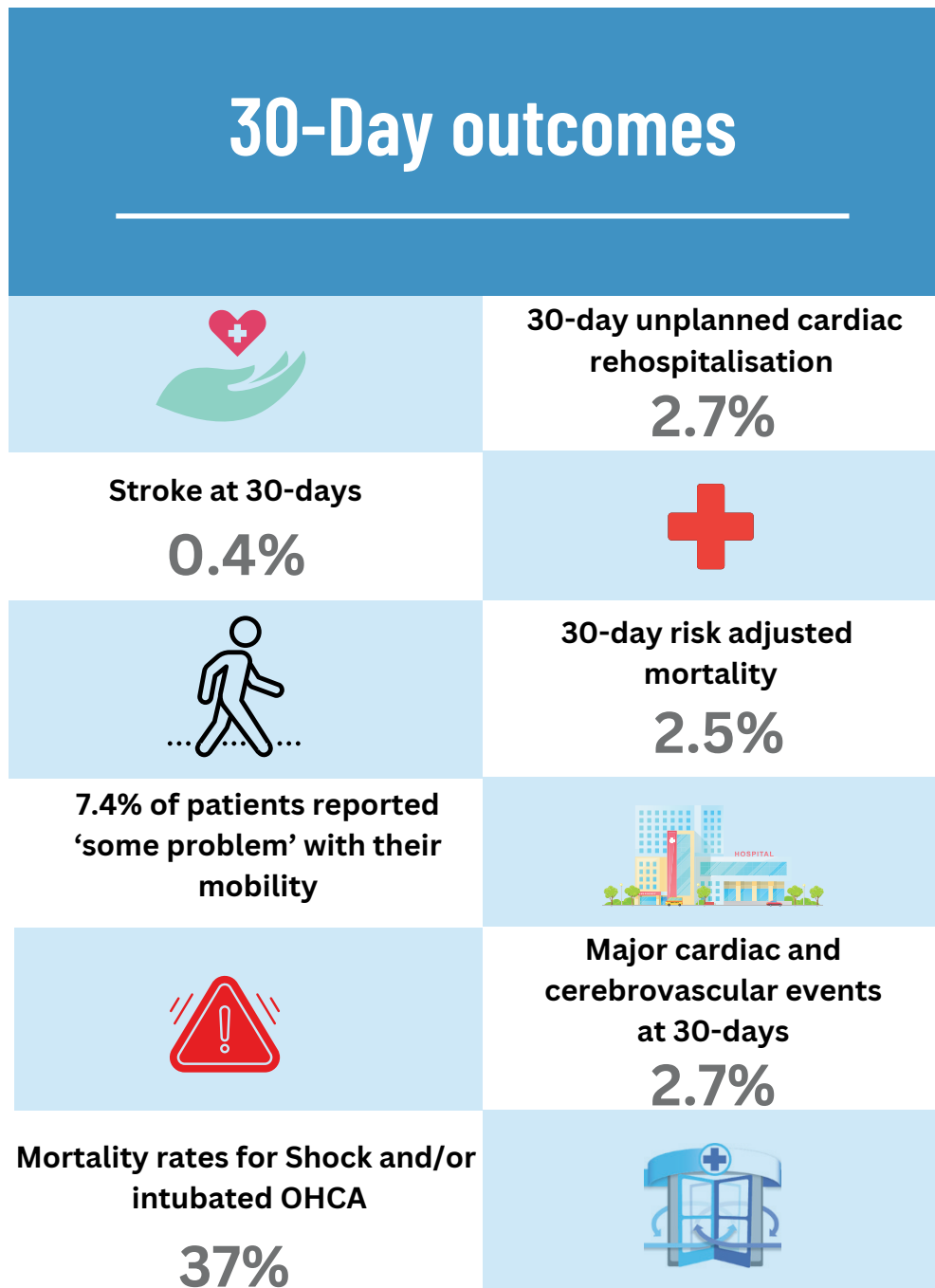
Figure 25: Rate of discharge directly to home for elective patients by hospital sector



30-Day Outcomes

An overview of 30-day outcomes is shown in Figure 26.

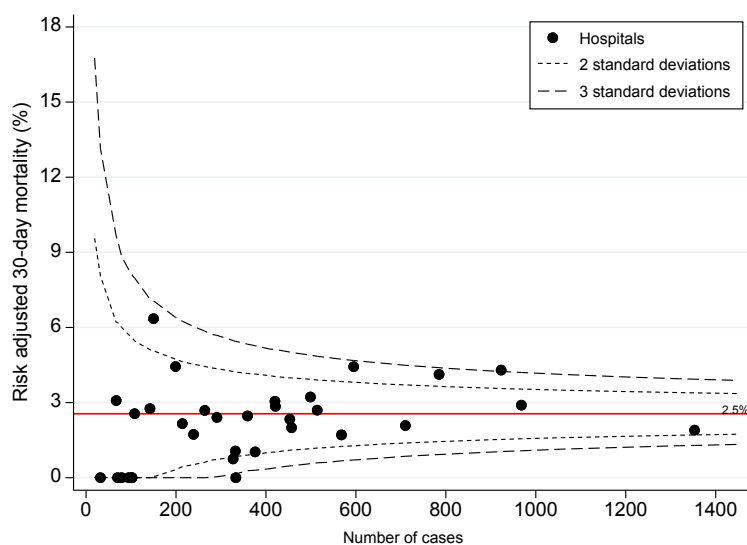
Figure 26: 30-day outcomes



Risk-adjusted mortality at 30-days

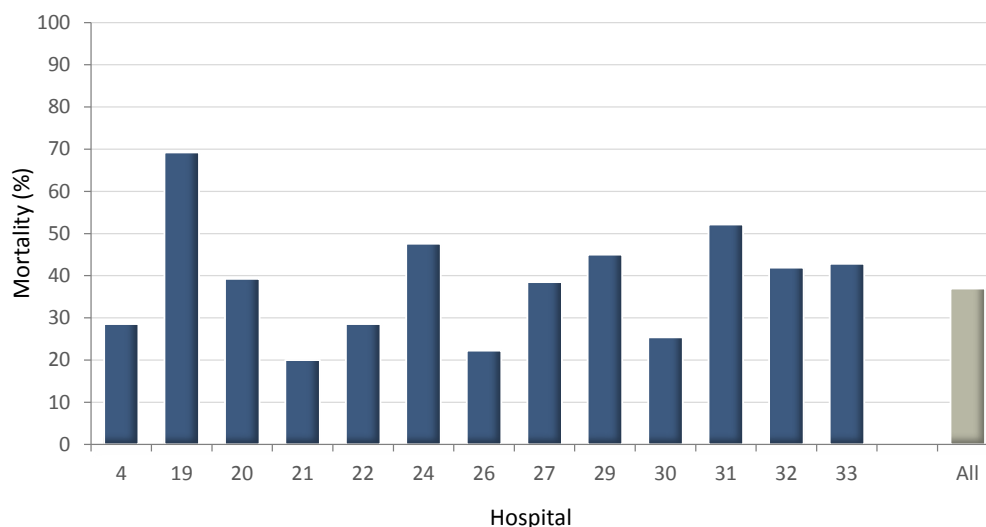
The 30-day risk-adjusted mortality rate was 2.5%. All participating hospitals were within control limits (Figure 27). No relationship between hospital volume and risk-adjusted mortality was apparent.

Figure 27: Risk-adjusted mortality by hospital at 30-days



The unadjusted rate of 30-day mortality in patients with cardiogenic shock and/or intubated OHCA by hospital is shown in Figure 28. There were 322 cases, with a mean mortality rate of 37%- lower than in the previous year (38.7% in 2022). Eleven hospitals did not treat any cardiogenic shock and/or intubated OHCA cases and a further 9 hospitals treated ≤ 2 cases. No relationship between hospital volume and mortality with these high-acuity cases was observed.

Figure 28: Mortality rates for cardiogenic shock and/or intubated OHCA patients by hospital at 30-days



*Hospitals 1,2,3, 9, 11, 13, 14, 15, 17, 23 & 28 had NIL cases with cardiogenic shock and/or intubated OHCA.
Hospitals 5, 6, 7, 8, 10, 12, 16, 18 & 25 had ≤ 2 cases with cardiogenic shock and/or intubated OHCA and were excluded.*

Major cardiac and cerebrovascular events at 30-days

The composite endpoint of major adverse cardiac and cerebrovascular events (MACCE) incorporates the outcomes of death, new or recurrent myocardial infarction, stent thrombosis, target vessel revascularisation and stroke. Table 21 displays the rates of MACCE observed both in-hospital and at 30 days, alongside the individual rates of each contributing component. Overall, the 30-day MACCE rate remained stable at 3.7%, consistent with the previous year's findings.

Table 21: Major adverse cardiac and cerebrovascular events at 30-days

MACCE component**	In-hospital events	30-day events*
	N (%)	N (%)
Mortality	194 (1.5)	242 (1.9)
Myocardial infarction	55 (0.4)	78 (0.6)
Stroke	24 (0.2)	51 (0.4)
Definite stent thrombosis	24 (0.2)	31 (0.2)
Probable stent thrombosis	9 (0.1)	15 (0.1)
Target vessel revascularisation (TVR)†	98 (0.8)	151 (1.2)
MACCE	324 (2.6)	465 (3.7)

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

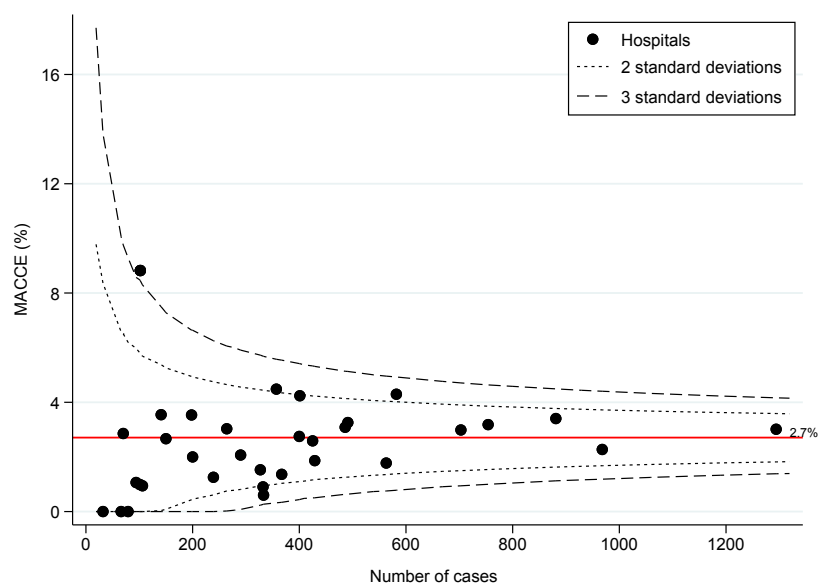
**Cases with multiple procedures were excluded to avoid mortality being counted more than once (n=18).

†TVR refers to any 'unplanned' PCI or CABG revascularisation of the target vessel.

Categories are not mutually exclusive.

In-hospital MACCE rates (excluding high-acuity cases of cardiogenic shock and/or intubated OHCA) by hospital are shown in Figure 29. The rate overall was 2.7% and all hospitals were within control limits.

Figure 29: MACCE by hospital at 30-days

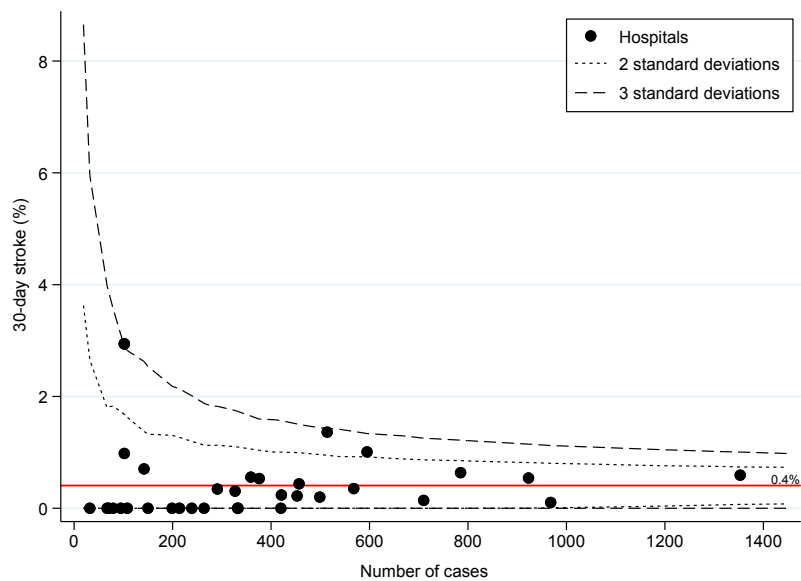


Excludes cardiogenic shock and/or intubated OHCA cases.

Stroke at 30-days

The rate of 30-day stroke was 0.4% and all hospitals were within control limits (Figure 30). In the period between hospital discharge and 30 days there were 29 additional strokes- 3 haemorrhagic strokes, 21 ischaemic strokes and a further 5 where the type of stroke was not recorded.

Figure 30: Stroke by hospital at 30-days



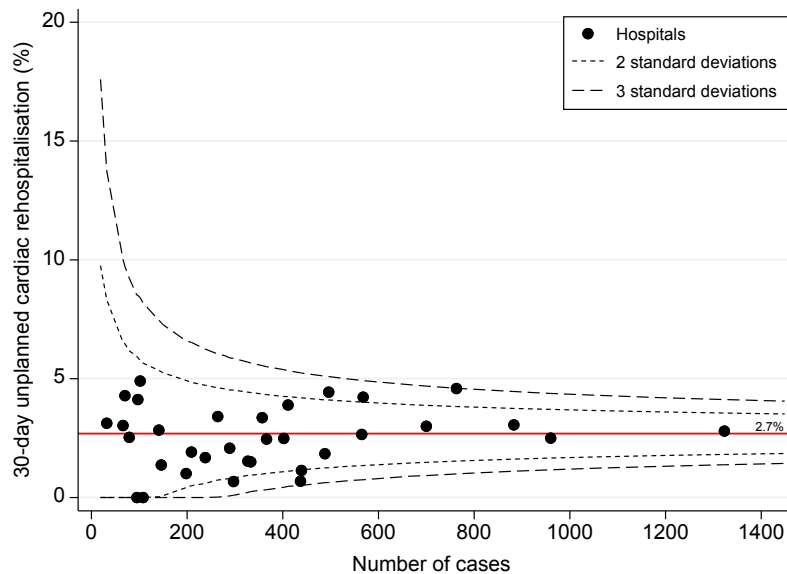
Rehospitalisation at 30-days

Rehospitalisation within 30 days of discharge occurred in 9.8% of patients overall (Table 22), and more commonly occurred in the private sector. The majority of rehospitalisations were cardiac-related. Of those admissions, 329 cases (27.5%) were unplanned (Figure 31). There were no outlier hospitals for 30-day unplanned cardiac rehospitalisation.

Table 22: Rehospitalisation by hospital sector

	All patients (N=12,249)	Public (n=7,130)	Private (n=5,119)
	N (%)	N (%)	N (%)
Rehospitalisations	1,195 (9.8)	622 (8.7)	573 (11.2)
Non-cardiac rehospitalisations	361 (2.9)	236 (3.3)	125 (2.4)
Cardiac rehospitalisations	834 (6.8)	386 (5.4)	448 (8.8)
Unplanned cardiac rehospitalisations	329 (2.7)	212 (2.9)	117 (2.3)
Planned cardiac rehospitalisations	505 (4.1)	174 (2.5)	331 (6.5)

Figure 31: Unplanned 30-day cardiac rehospitalisation by hospital



Quality of life

The EQ-5D Quality of Life (QoL) tool is collected by hospitals at the 30-day follow-up. The components of QoL measurement tool include mobility, personal care tasks, level of pain or discomfort and anxiety or depression. Responses were collected in 77.9% of cases across hospitals. The EQ-5D QoL domains by socio-economic status (SES) and patient location (metropolitan vs non-metropolitan) are presented in Table 23. Trends towards lower scores among specific QoL components were evident among patients with lower socio-economic status and who were non-metropolitan residents. However, when patients assessed their own overall health status post PCI, these socio-economic and location differences were less apparent.

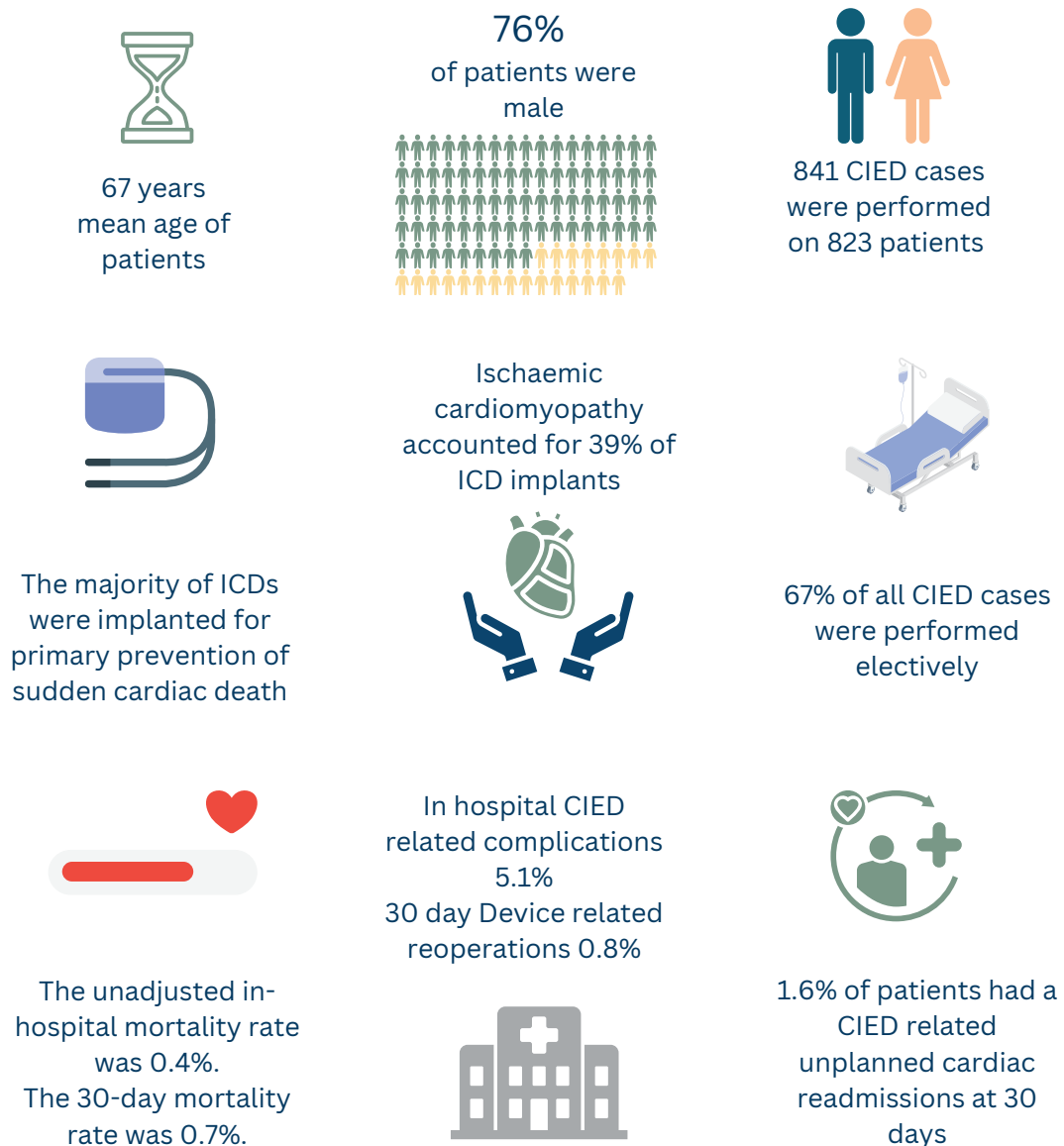
Table 23: Patients reported experience by socio-economic status and in non-metro/metro areas

Quality of Life components	Low SES (n=2,136)	High SES (n=7,335)	Non-metro (n=2,869)	Metro (n=6,518)	All (N=9,471)
	%	%	%	%	%
Some problem with mobility	10.1	6.7	9.3	6.7	7.4
Some problem with personal care	4.4	3.1	4.3	3	3.4
Some problem with usual activity	11.9	9.2	12.1	8.9	9.8
Moderate/extreme pain/discomfort	10.3	8.7	9.5	9.1	9.1
Moderate/extreme anxiety/depression	8.8	7.7	8.9	7.7	8.0
Assessment of own health status (score 0-100)	75.1	75.2	76.5	74.5	75.1

Cardiac Implantable Electronic Devices (CIED)

Key Findings CIED Module

Figure 32: CIED Key Findings



Registry Module Activity

VCOR commenced data collection on cardiac implantable electronic devices (CIED) in 2018, focusing on two types of therapies: implantable cardiac defibrillators (ICD) and cardiac synchronisation therapy (CRT). Presently, VCOR's CIED module involves 11 public hospitals and 4 private hospitals. As of December 31, 2023, the cumulative number of CIED cases collected in VCOR was 4,036.

A breakdown of the demographic profiles and device utilisation by cardiac condition for the entire cumulative CIED cohort is shown in Figures 33-35. Women and patients ≤ 70 years who received CIED therapy were more likely to have a non-ischaemic condition. Similarly, the majority of patients receiving an CRT-P or S-ICD had a non-ischaemic cause.

Figure 33: Demographics of patients undergoing CIED implantation 2018 - 2023

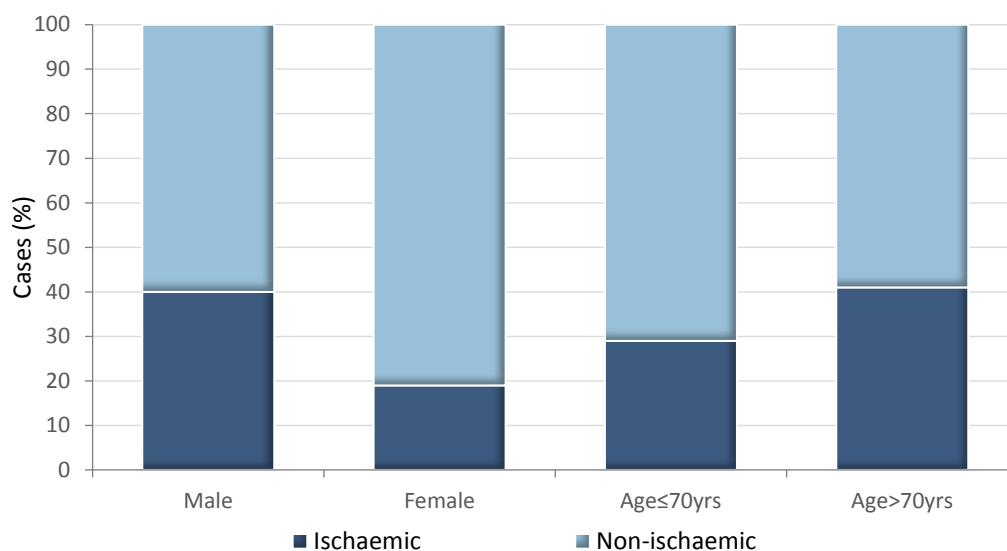


Figure 34: Device utilisation by condition 2018 - 2023

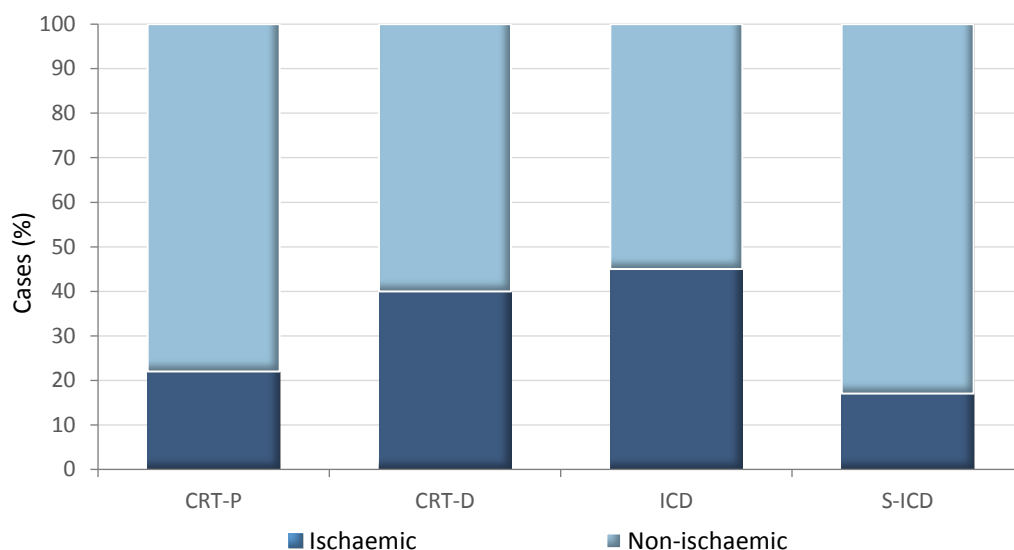
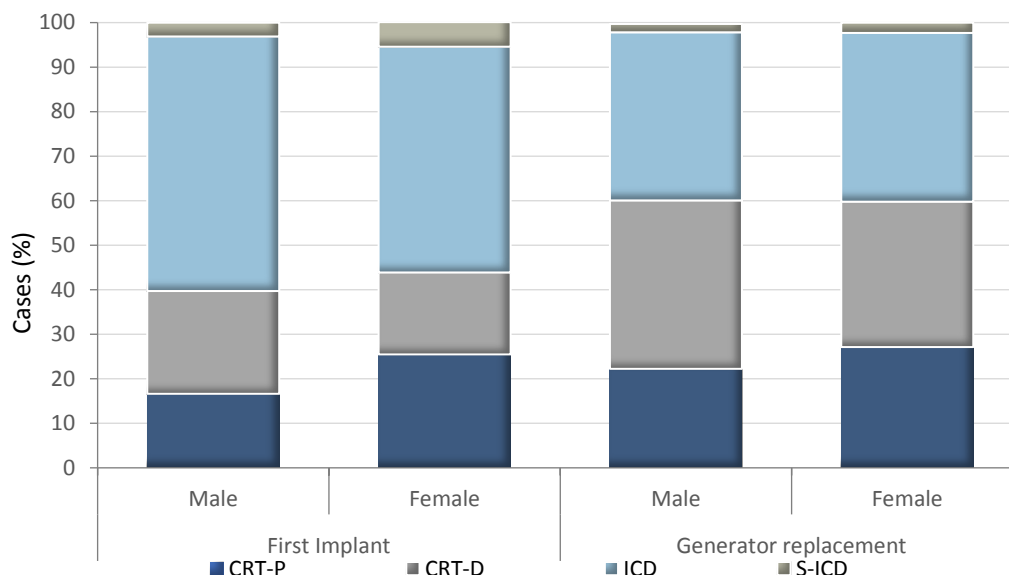


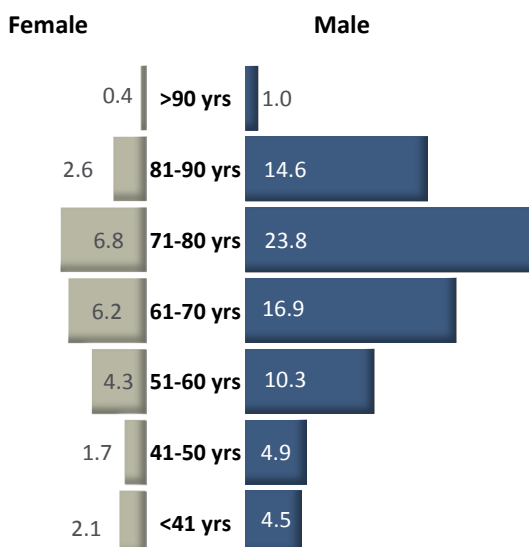
Figure 35: First implants vs Generator Replacement 2018 - 2023



Patients and procedures

In 2023, the CIED module gathered data on 841 procedures conducted in 823 patients. Among these patients, males accounted for 76% with an average age of 67 ± 14 years (see Figure 36). Women were on average almost four years younger than men (64 ± 14 vs 68 ± 14). First implants constituted more than half (54.5%) of all CIED cases, with the majority (67.1%) performed electively. Generator replacements comprised 40.3% of cases, while system explants and revisions accounted for 3.4%, and new lead insertions made up 1.9% of the total procedures.

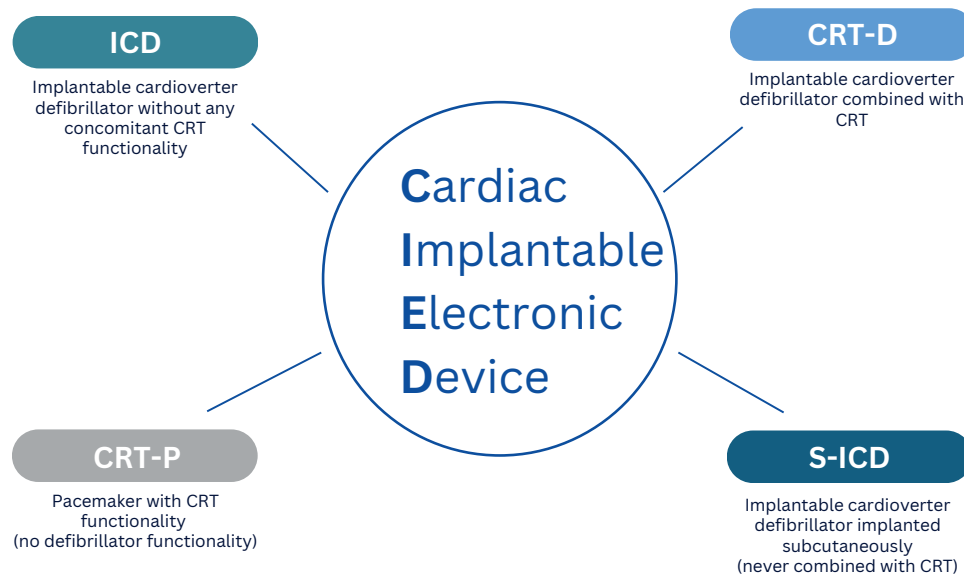
Figure 36: Age and sex distribution of patients undergoing CIED implantation



Device types

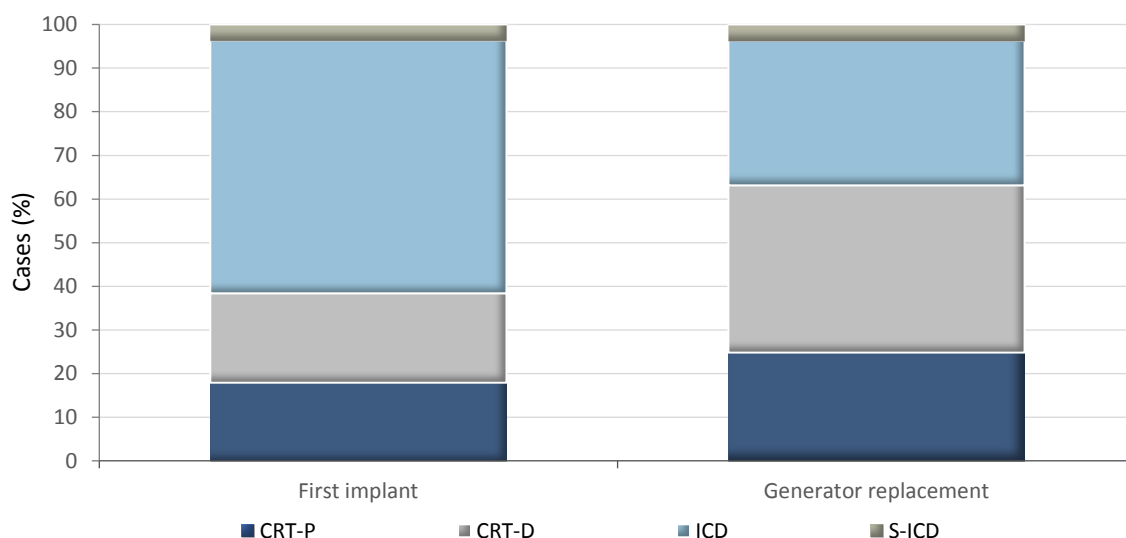
The four types of CIED devices that are monitored by VCOR are shown in figure 37.

Figure 37: CIED Device Types



The majority of first implants and generator replacements (82% & 75% respectively) were ICD type devices (ICD, S-ICD or CRT-D) as shown in Figure 38. Most CIEDs were implanted in the left pre-pectoral region (CRT 88.7% and ICD 85.5%). The remainder were implanted in either the left sub-pectoral region (CRT 5.1%, ICD 1.7%) or in the right pre-pectoral region (CRT 4.6%, ICD 3.9%).

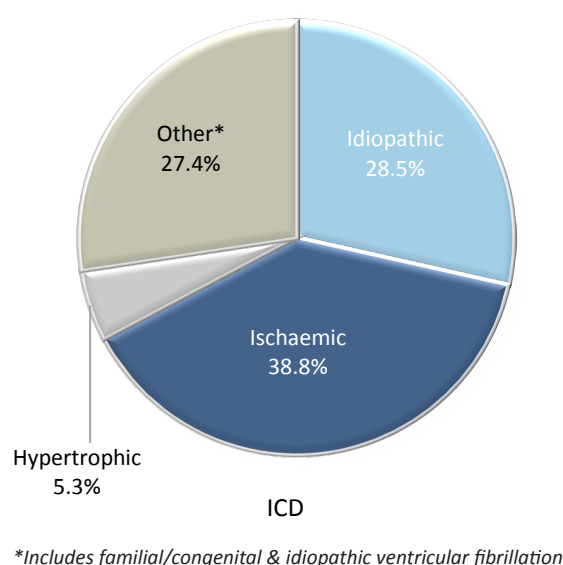
Figure 38: Device type - first implant and generator replacement



Cardiomyopathy aetiology

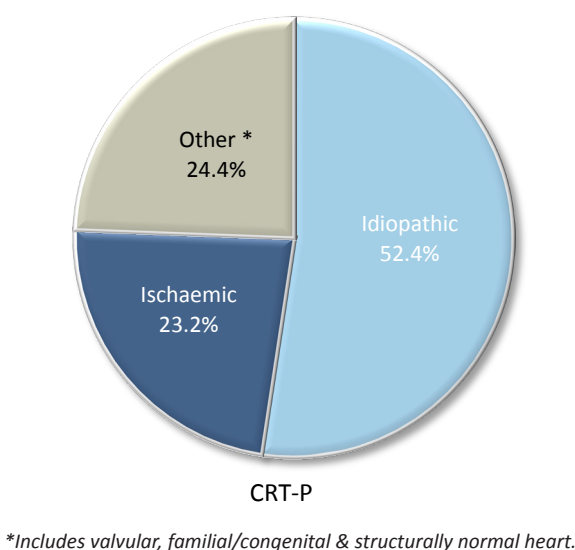
The aetiology of underlying cardiomyopathy among patients receiving their initial CIED implant are illustrated in Figures 39 and 40. Among those receiving an ICD device, 38.8% had ischaemic cardiomyopathy, while 28.5% had an idiopathic aetiology. Another 27.4% had cardiomyopathy due to other causes (refer to figure footnote). A smaller proportion, 5.3%, of patients undergoing their first CIED implant had hypertrophic cardiomyopathy.

Figure 39: Aetiology in patients undergoing first CIED implant - ICD



In the CRT-P group, idiopathic cardiomyopathy was the most prevalent underlying aetiology, accounting for 52.4%. Ischaemic heart disease contributed to 23.2% of cases, while other causes were present in over one-quarter of patients (refer to figure footnote).

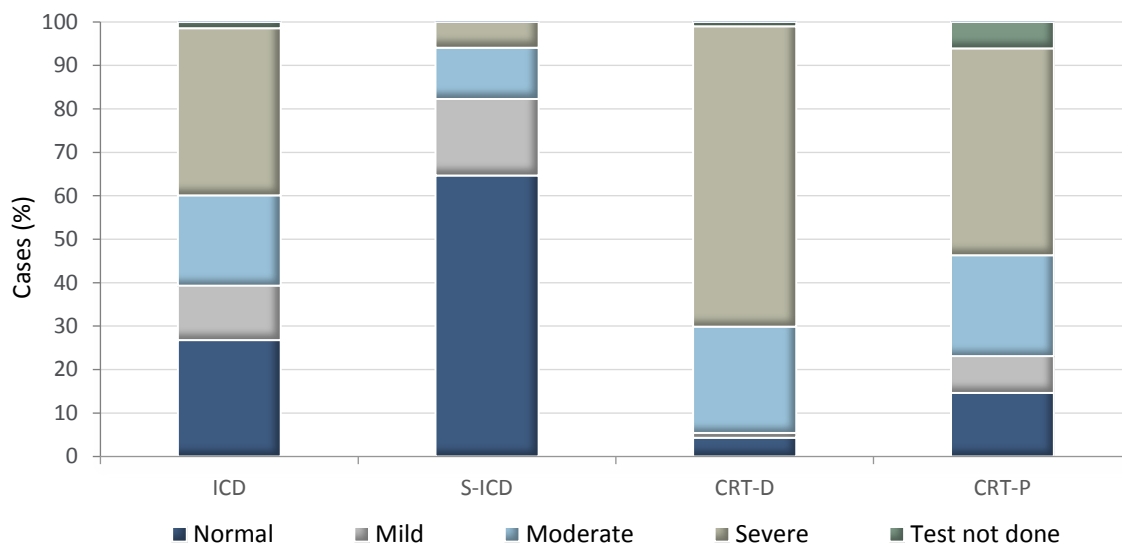
Figure 40: Aetiology in patients undergoing first CIED implant - CRT-P



Left ventricular function

Figure 41 illustrates the distribution of degree of left ventricular impairment among patients undergoing CIED therapy. Patients receiving CRT-D therapy had the highest proportion of cases with severe LV dysfunction while those who were triaged to S-ICD mostly had normal or mildly reduced LV function.

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



Indications for CIED therapy

ICDs

ICD devices are typically implanted to prevent sudden cardiac death, either as primary or secondary prevention measures. In 2023, slightly more than half (51%) of all ICD implants were for primary prevention, with 38% of these cases attributed to ischaemic cardiomyopathy. Regarding secondary prevention, the majority (93%) of ICD implants were performed in patients with a history of prior ventricular tachycardia (49%) or ventricular fibrillation (44%). Secondary prevention ICD implants also included patients with previous cardiac arrest (4%) or syncope (3%).

Cardiac resynchronisation therapy

The guidelines for cardiac resynchronization therapy (CRT), both national and international, stipulate specific inclusion criteria for its use, including a QRS width ≥ 120 milliseconds, severe left ventricular dysfunction and New York Heart Association (NYHA) Class II or greater symptoms. Table 24 displays the distribution of these criteria among CRT-D and CRT-P cases. Overall, adherence to these criteria was observed to be lower among patients undergoing CRT-P procedures compared to CRT-D.

Table 24: Inclusion criteria for CRT by device type

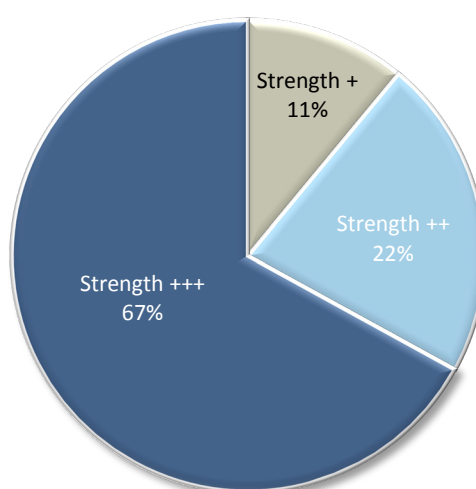
	CRT-D (N=94)	CRT-P (N=82)
	N (%)	N (%)
QRS width ≥ 120 msec	84 (89)	58 (71)
Severe left ventricular dysfunction (LVEF $<35\%$)	65 (70)	39 (48)
NYHA Class II or greater	78 (85)	74 (92)

Assessing the strength of recommendation for CIED therapy

VCOR has developed a set of evidence-based clinical algorithms aligned with national and international guidelines to assess the recommendation strength for implanting a cardiac implantable electronic device (CIED). It is important to clarify that these algorithms do not serve as definitive judgement on whether a specific device was appropriate for a particular patient. Rather, they are intended to be used more generally as a tool to assist hospitals and clinicians in their quality assurance activities. The actual determination of the appropriateness of a CIED for a particular patient requires a comprehensive evaluation of all relevant factors, a process that extends beyond the scope of VCOR's algorithms.

Figure 42 illustrates the strength of recommendation for ICD implantation, categorised as +, ++, or +++. Among cases involving implantable defibrillator therapy (including ICD, CRT-D, and S-ICD devices, n=365), either a strength +++ or strength ++ recommendation was present in 89% of instances.

Figure 42: Strength of recommendation for ICD therapy



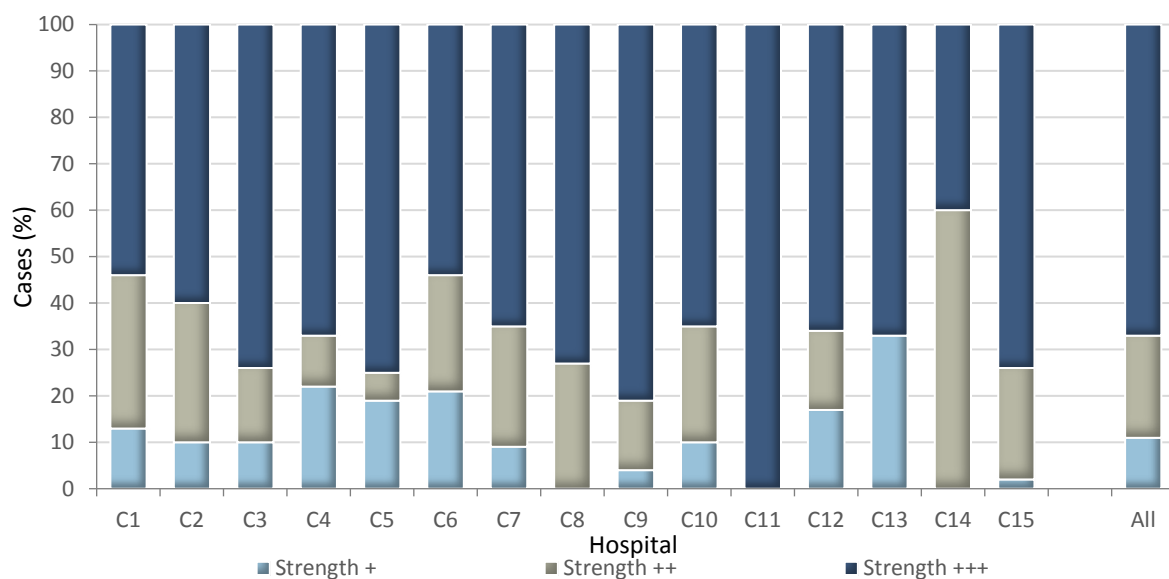
Further analysis of the strength of recommendation by ICD device type is detailed in Table 25. Approximately two-thirds of ICD and CRT-D devices received a strength +++ recommendation, whereas just over half of S-ICD devices had a strength +++ recommendation for use.

Table 25: Strength of recommendation for ICD therapy by form of therapy

Strength of Indication	CRT-D (N=90)	ICD (N=258)	S-ICD (N=17)
	N (%)	N (%)	N (%)
Strength +++	60 (67)	175 (68)	9 (53)
Strength ++	10 (11)	64 (25)	7 (41)
Strength +	20 (22)	19 (7)	1 (6)

Figure 43 benchmarks hospitals in relation to the strength of recommendation for defibrillator therapy. All but one hospital had a strength +++ recommendation of use in at least 50% of cases (range 40%- 100%).

Figure 43: Strength of recommendation for ICD therapy by hospital



Among patients who received a CRT device (n=168), a strength +++ or strength ++ recommendation was present in 71% cases as shown in Figure 44.

Figure 44: Strength of recommendation for CRT therapy

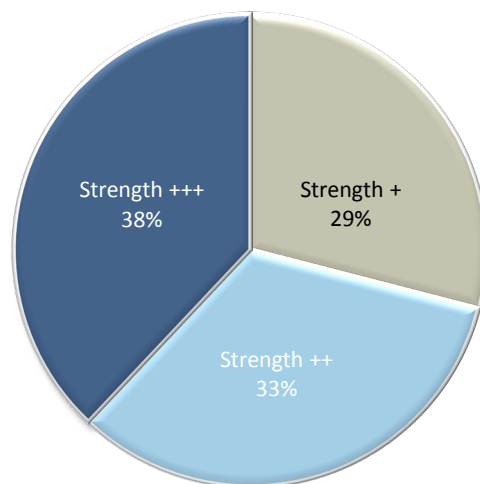


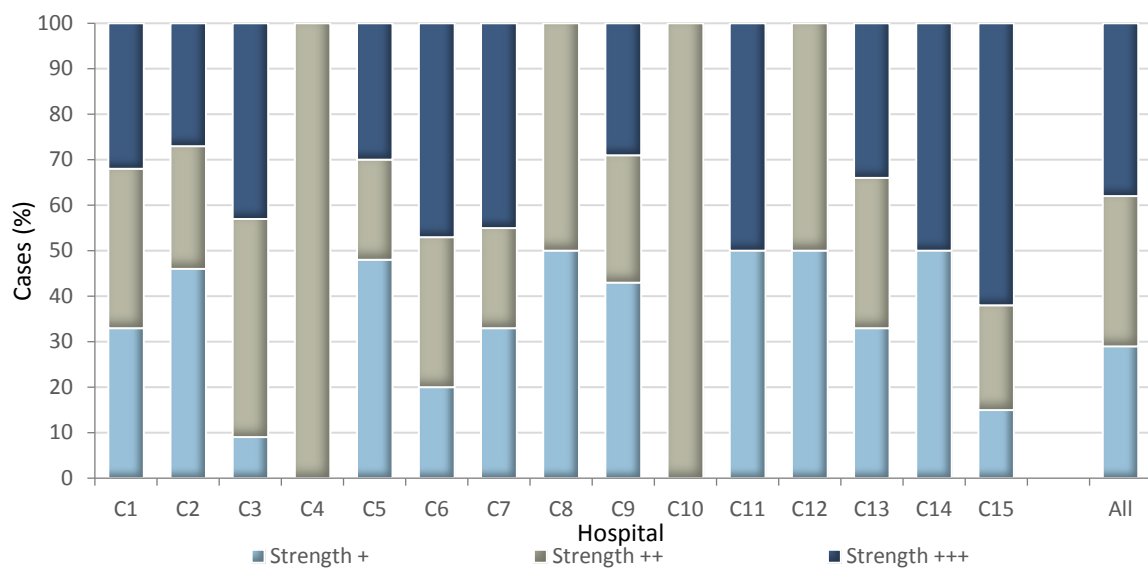
Table 26 compares the proportion of CRT-P cases with a strength +++ recommendation for use against CRT-D. The disparity likely arises from clinical differences among the two patient groups. Overall, the proportion of devices in the CRT group receiving a strength + recommendation was notably higher compared to ICD devices.

Table 26: Strength of recommendation for CRT by device type

Strength of Indication	CRT-D (N=91)	CRT-P (N=77)
	N(%)	N(%)
Strength +++	31 (34)	32 (42)
Strength ++	36 (40)	20 (26)
Strength +	24 (26)	25 (32)

Figure 45 depicts hospitals' benchmarking concerning the strength of recommendation for CRT implantation. The proportion of strength +++ or strength ++ recommendations varied significantly among hospitals. Notably, some hospitals had a strength + recommendation in more than 50% of their CRT cases. However, it is crucial to note that several hospitals had very low case numbers, which suggests that the strength of recommendation for CRT device implantation at these institutions should be interpreted cautiously.

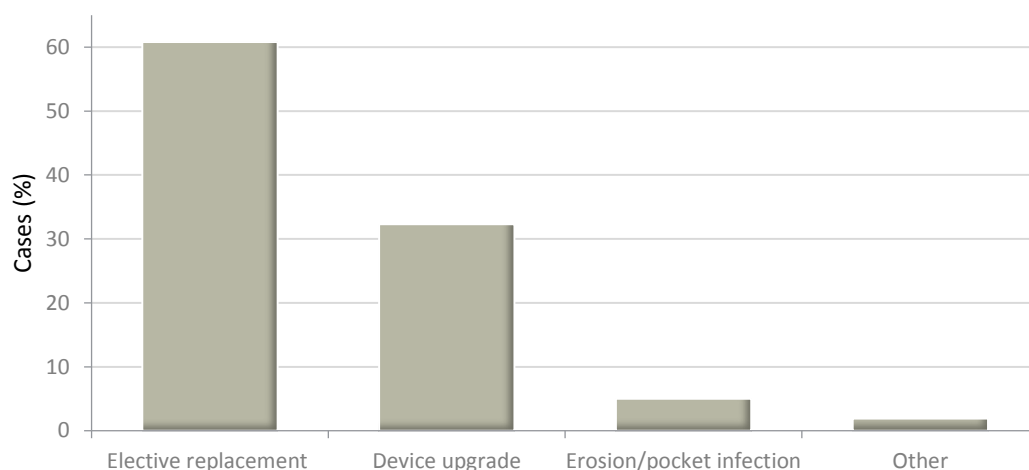
Figure 45: Strength of recommendation for CRT by hospital



Replacements and revisions

The indications for CIED generator replacement, explant or revision is shown in Figure 46. Almost two thirds (61%) were for end-of-life elective replacements. The remainder of replacements were for device upgrade (32%) while erosion/pocket infection and other reasons accounted for 5% of generator replacements.

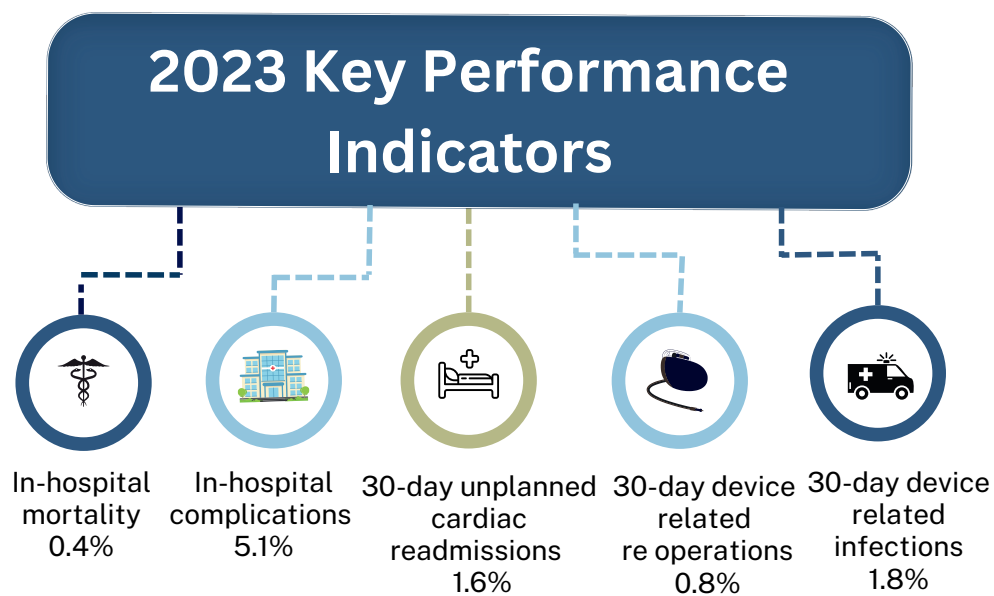
Figure 46: Indications for generator replacement, explant or revision



Outcome measures

The key performance indicators (KPIs) used to monitor and benchmark hospital performance in relation to CIED therapy are shown in Figure 47.

Figure 47: CIED Key Performance Indicators



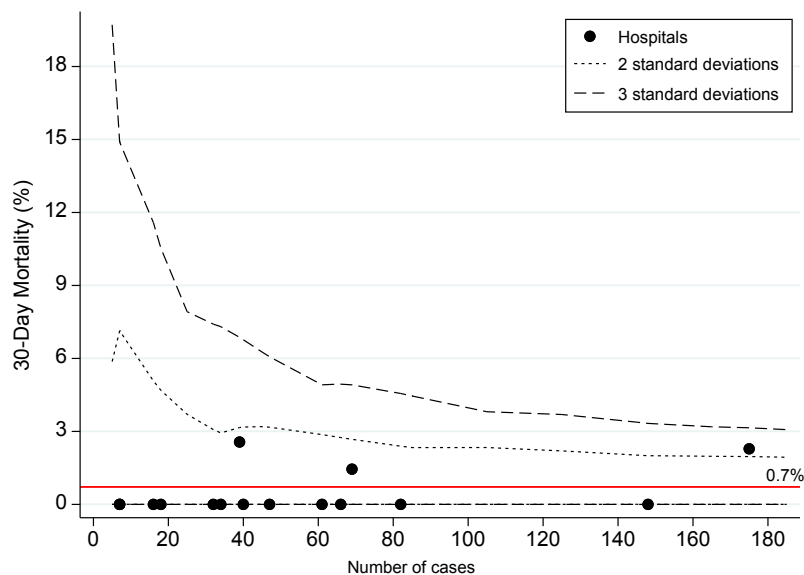
In-hospital mortality

There were 3 in-hospital deaths recorded in 2023. Only one of these was a cardiac death, but unrelated to the actual device.

30-day mortality

The overall 30-day mortality rate following device implantation was 0.7%. There were an additional 3 deaths occurring after hospital discharge but within 30 days of the procedure. Among these, one death was attributed to cardiac causes unrelated to the device, while the causes of death in the remaining two cases were undetermined. Figure 48 illustrates that all hospitals were within control limits for this outcome measure.

Figure 48: CIED Mortality at 30-days



Successful device implantation without in-hospital complications

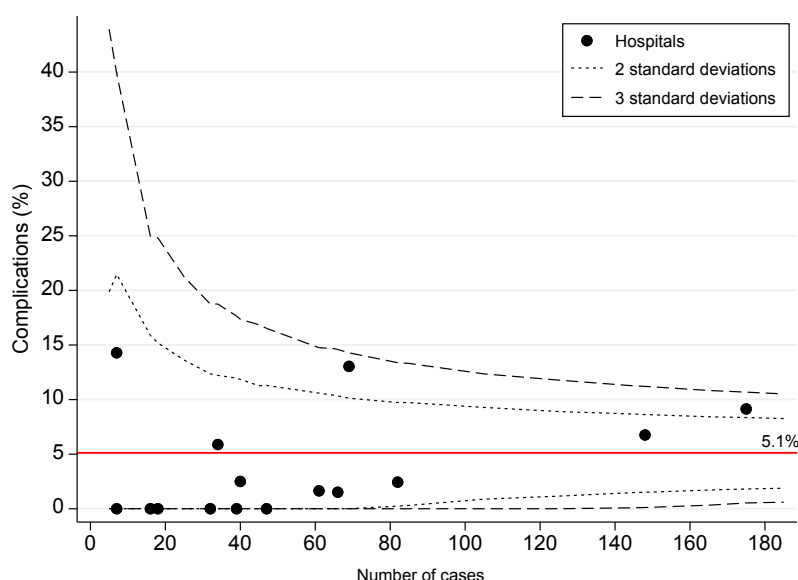
Table 27 outlines the in-hospital complications by hospital and device type. Complications included severe hypotension, wound hematoma, pain requiring intervention, phrenic nerve pacing, cardiac arrest, cardiac perforation, failure to position leads and pericardial effusion. In 2023, 94.9% of all CIED cases were successfully implanted without any in-hospital complications.

Table 27: In-hospital complications by hospital and device type

Hospital	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	Total
	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N (%)
CRT-P	3	0	4	0	2	0	0	0	0	0	0	0	0	0	0	9 (5.4)
CRT-D	6	0	1	0	2	0	0	0	1	0	0	1	1	0	1	13 (5.8)
ICD	2	0	3	0	5	1	0	0	0	0	0	1	0	0	1	13 (3.4)

Hospitals were benchmarked by frequency of complications as shown in Figure 49. There were no outliers for this outcome measure.

Figure 49: 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 1.6%. The 30-day device-related reoperation rate was 0.8%. There were no outliers for any of these outcome measures (Figures 50 and 51).

Figure 50: CIED related unplanned cardiac readmissions at 30-days

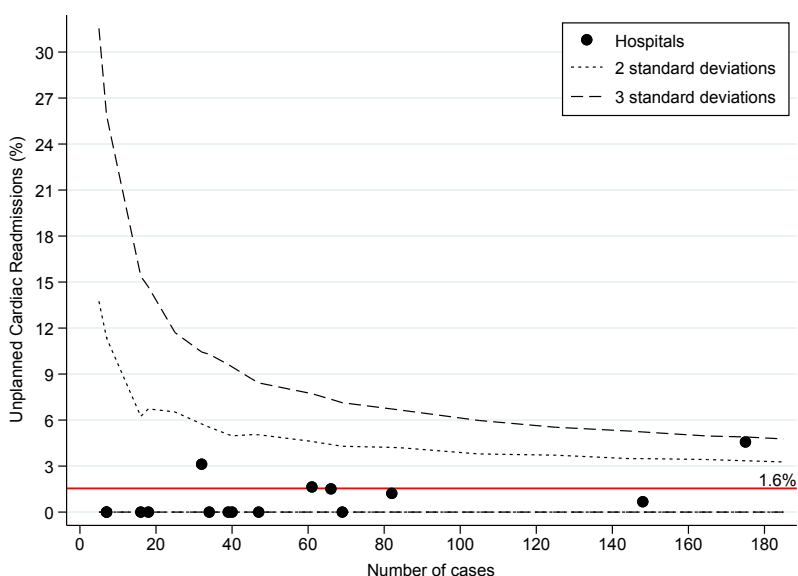
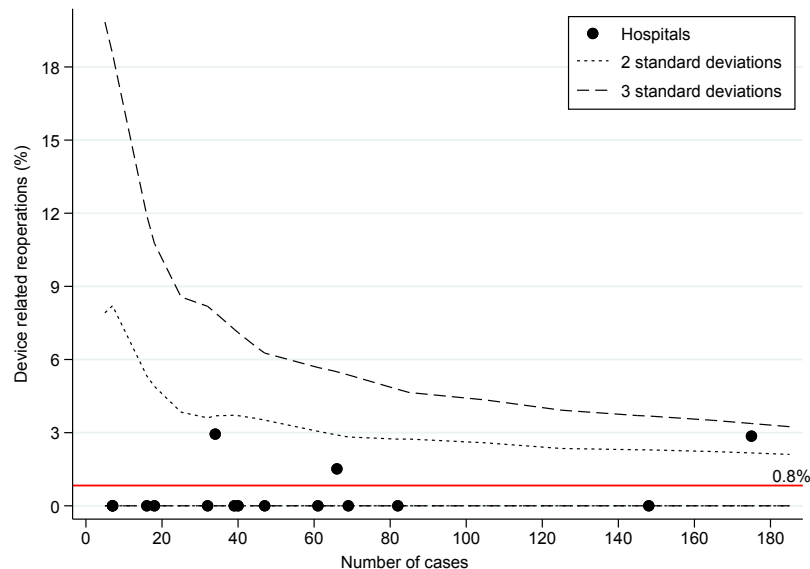
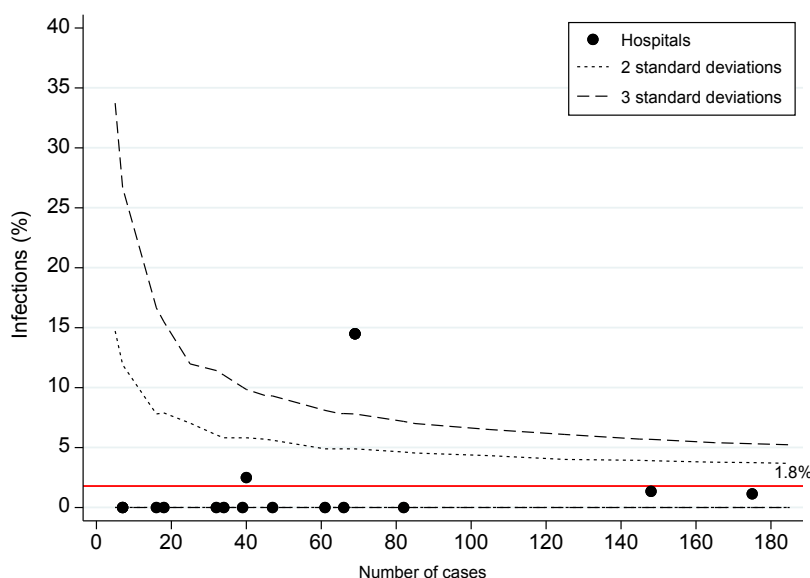


Figure 51: CIED device-related reoperations at 30-days



The 30-day device-related infection rate was 1.8% and included superficial wound infections, pocket infections and wound dehiscences. One hospital was identified as an outlier, with a device-related infection rate of 14% (Figure 52), however all 10 cases were for the least serious finding of superficial wound infection.

Figure 52: CIED device-related infections at 30-days



Summary

In 2023, 841 CIED cases were entered into the register, with just over half undergoing initial device implants. Of those implants, 50% included ICD therapy and 46% provided CRT, either alone or in combination with an ICD. As in past years, the underlying aetiology among ICD cases (ICD, CRT-D and S-ICD) and CRT-P was more commonly non-ischaemic. Most ICD procedures across participating hospitals were performed with a strong or medium strength clinical recommendation, suggesting consistency in clinical decision-making in this clinical context. In contrast, CRT device therapy was more variable, with a greater proportion of cases having a lower strength clinical recommendation. In-hospital and 30-day outcomes were good, with no performance outliers in any of the metrics among the 15 participating hospital sites. Efforts to broaden participation in this module will continue in the upcoming year.



The Future: Innovating for enhanced healthcare outcomes

Looking to the future, clinical quality registries like VCOR are at the threshold of significant transformation, with the increasing availability of technological advancements and strategic collaborations aimed at improving healthcare outcomes nationwide.

Technological integration and data management

The longer-term viability of Australian cardiac registries hinges on the integration of advanced technologies to streamline data collection and analysis. Moving away from traditional manual methods, registries are hoping to utilise electronic medical record (EMR) integration and “data lakes” — comprehensive repositories that store and process large volumes of health-related data. This shift will not only enhance the efficiency of data acquisition but also enable real-time insights and decision-making for clinicians and policymakers. VCOR recognises that artificial intelligence (AI) is set to potentially revolutionise this process by automating data processing and identifying patterns. Portals can be developed to aggregate data from multiple EMR sources into the registry to improve data accuracy and empower clinicians with tools such as integrated clinical dashboards that support evidence-based practice. VCOR, through its relationship with Monash University, is well-positioned to take advantage of these technological innovations as they are developed and refined.

National integration and collaborative initiatives

As part of its forward-looking strategy, VCOR is also actively contributing to national benchmarking efforts through its participation in the National Cardiac Registry (NCR). The future of cardiac registries in Australia can only be enhanced by collaboration among healthcare providers, government agencies, and research institutions. NCR is currently consolidating a comprehensive national dataset that will facilitate benchmarking, comparative analysis and the dissemination of best practices. These efforts enable contributing registries, hospitals and clinicians to identify regional variations in cardiac care outcomes, implement targeted interventions, and ensure equitable access to high-quality care across the country. There is also the opportunity to forge partnerships with international organisations and participate in global research initiatives, Australian registries like VCOR can contribute valuable insights, validate findings, and adopt best practices that elevate standards of cardiac care worldwide.

Enhancing quality assurance and patient-centred care

Quality assurance remains a cornerstone of VCOR’s mission, with a focus on assessing the appropriateness of procedures and reducing variations in care delivery. By integrating quality metrics into routine clinical practice and leveraging real-world data, VCOR will hopefully empower healthcare providers to provide care that prioritises patient safety and enhances long-term health outcomes. VCOR is also actively seeking collaborations with quality assurance bodies to foster programs and initiatives that support hospitals and clinicians in delivering high-quality care. The registry has already engaged with Safer Care Victoria to assist in their 100,000 Lives Program aimed at reducing harm and improving health outcomes through partnerships with health services and other groups in both small and large-scale quality improvement projects.

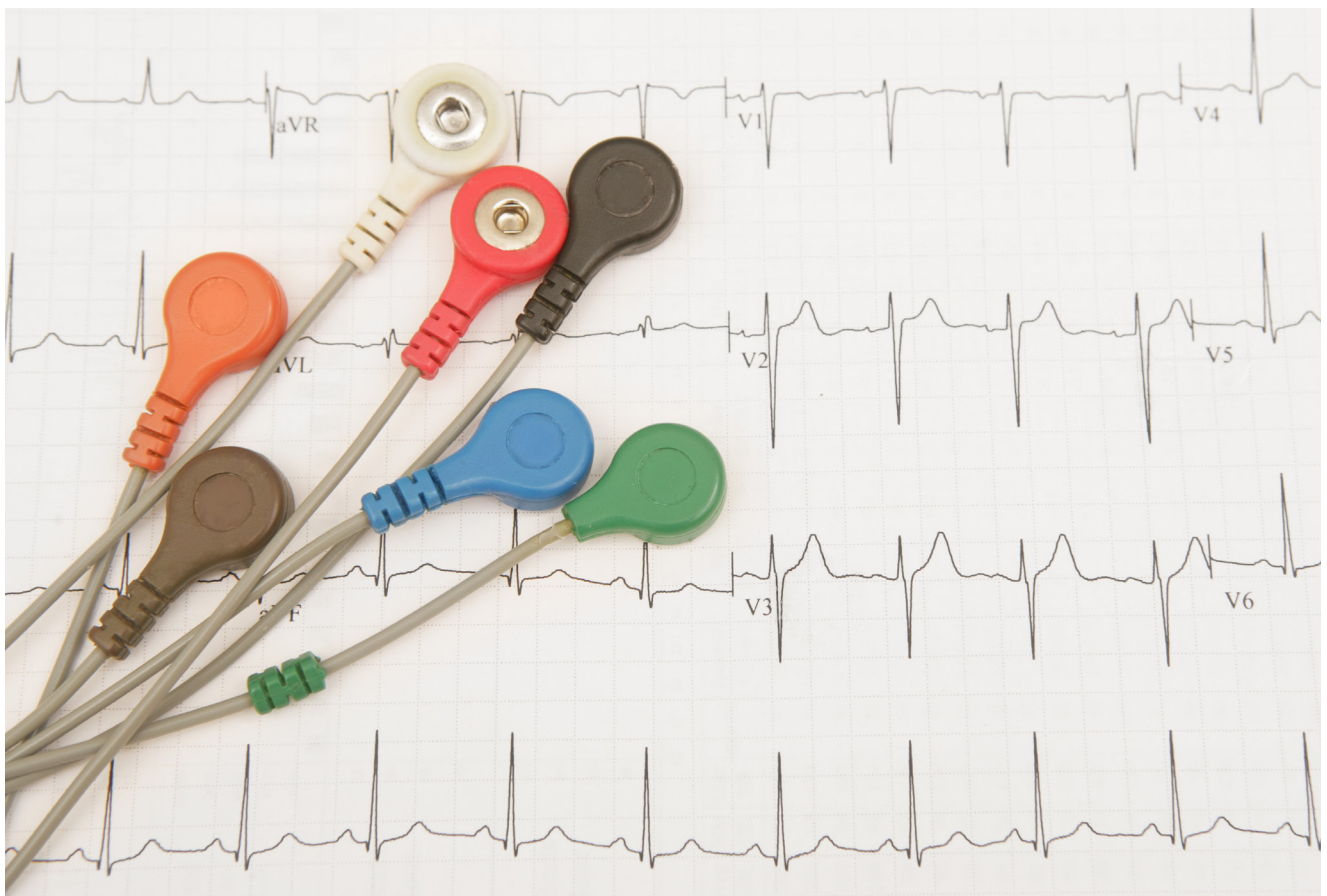
Advancing risk adjustment and data linkages

VCOR continues to refine its risk adjustment models to ensure accurate outcome assessments and is excited to introduce a risk adjustment for in-hospital major bleeding in 2024. Major bleeding is recognised as an important prognostic marker in PCI, and accurate determination of the incidence of these events together with benchmarking of hospitals on this important outcome measure will assist clinicians and other stakeholders in identifying performance issues more accurately and promoting continuous quality improvement.

Moreover, VCOR's strategic partnerships with entities like the Centre for Victoria Data Linkage (CVDL) and Ambulance Victoria underscore its commitment to leveraging comprehensive data linkages for evidence-based research and quality improvement initiatives. As an example, in the coming year, Monash University will be working with the Department of Health, Victoria to develop linkages with the Victorian Integrated Non-Admitted Health (VINAH) dataset with respect to cardiac rehabilitation. The collaboration will hopefully provide more comprehensive data beyond a simple measure of referral rates for cardiac rehabilitation to include rates of attendance and program completion and the identification of factors that may promote or inhibit the uptake of cardiac rehabilitation by patients. Future linkages with national databases such as ANZSCTS (cardio-thoracic surgery) and ANZICS (intensive care) are also planned to further enhance VCOR's ability to benchmark and drive continuous improvement in cardiac care outcomes.

Conclusions

In conclusion, while VCOR faces challenges in transitioning from manual data collection to more automated and integrated systems, its proactive approach to embracing technology and collaboration heralds a promising future. By leveraging AI, enhancing data linkages, refining risk adjustment models, and strengthening national and international collaborations, VCOR is poised to sustain its leadership in cardiac care quality improvement. As healthcare landscapes evolve, VCOR remains committed to innovation and poised to drive continuous improvement in cardiac care quality and patient outcomes in the years to come.



Glossary

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

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