ANNUAL PUBLIC REPORT 2017

VICTORIAN CARDIAC OUTCOMES REGISTRY

VCOR
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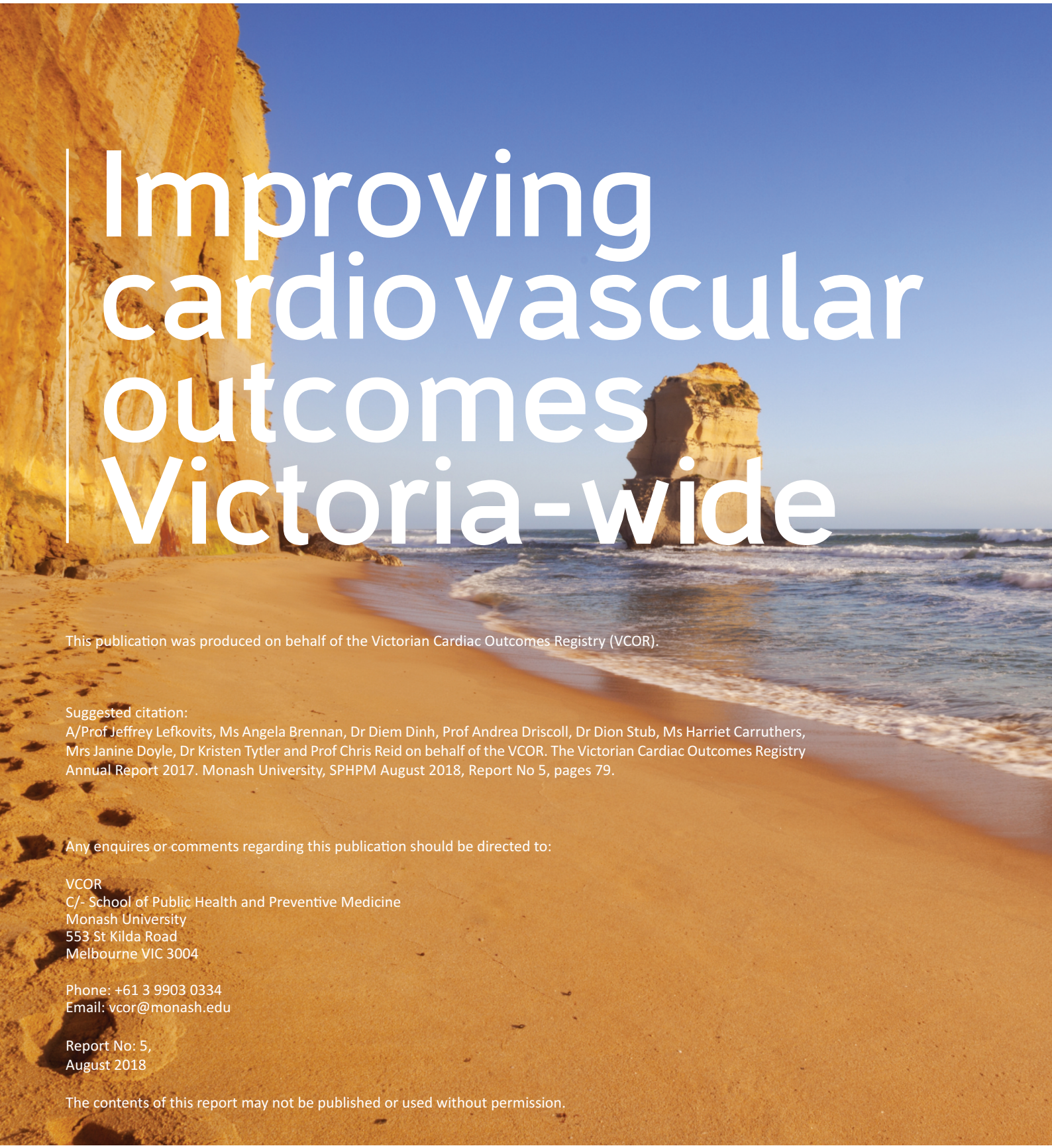

Improving cardiovascular outcomes Victoria-wide

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Contents

VCOR 2017 Annual Report

List of Figures

List of Tables

Acknowledgements

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

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Foreword

It is my pleasure to introduce the Victorian Cardiac Outcomes Registry (VCOR) Annual Report for 2017.

The Victorian Agency for Health Information (VAHI) strongly supports the role of Clinical Quality Registries (CQRs) in improving quality and safety, not only in the Victorian Health system but nationally.

Our mission at VAHI is to stimulate quality and safety improvements, increase transparency, accountability, and inform the community through monitoring and reporting on public and private health and well-being services. Ultimately, we aim to ensure that the community is better informed about health services, health services receive better information to serve their communities to provide better, safer care and that across our system - everyone has an accurate picture of where the concerns are and where we're getting it right.

The role of Clinical Quality Registries are increasingly being recognised as a critically important tool in improving the quality and safety of care. They are unique in being both a patient-centred and clinician-led approach to data collection, analysis and reporting - incorporating a peer based continuous quality improvement approach by optimising data utility to improve the appropriateness and effectiveness of healthcare.

Since its establishment six years ago, VCOR has successfully engaged all hospitals performing PCI in Victoria – across both the public and private sectors. It is clear that clinicians value the data the registry reports.

With increasing recognition of the important role of CQR's such as VCOR growing within the broader health system, opportunities for registries in examining outliers, linking registry data with broader datasets - providing even more powerful analytics, and the role of registries in Patient Reported Outcome Measures, I am excited for the potential future in registries such as VCOR.

So on behalf of The Victorian Agency for Health Information (VAHI) and the Department of Health and Human Services, I would like to congratulate Associate Professor Lefkovits and his team, as well as all of the participating clinicians and health services on VCOR.

I would like to commend the Annual Report to you, and look forward to seeing your continued outcomes in improving practice - and ultimately the lives of Victorians.

Dr Lance Emerson

CEO, Victorian Agency for Health Information

Executive Summary

The past 12 months have witnessed ongoing efforts to ensure Victorians receive high-quality and safe care. Following the release of two key reports in 2016 (1, 2), the Department of Health and Human Services established two separate but inter-related bodies to deal with all aspects of quality and safety across the healthcare system. The Victorian Agency for Health Information (VAHI) was created in 2017 to oversee the safety and quality of care by analysing and sharing information across Victoria's healthcare system. Safer Care Victoria, also started in 2017, was established in response to a serious governance failure in the Victorian healthcare system. Its priority areas include partnering with patients and their families, partnering with clinicians, providing leadership in governance, clinical improvement and innovation. Together, the two bodies utilise their relationships with health services, clinicians and consumers to drive improvements across the health system.

The Victorian Cardiac Outcomes Registry (VCOR), in its capacity as a clinical quality registry, is integrally involved with both VAHI and Safer Care Victoria. VCOR's continuing mission is to improve cardiac care across Victoria by measuring and reporting on the quality and safety of patient care at individual hospitals and comparatively with other hospitals.

For this fifth Annual Report, VCOR presents its activities in 3 areas of cardiovascular care. These include percutaneous coronary intervention (PCI), the management of ST elevation myocardial infarction (STEMI) in regional settings and in-hospital management of acute heart failure (HF). The first two directly relate to management of acute coronary artery disease. The third focuses on chronic heart disease (both coronary and non-coronary) that places a significant load on the individual and society in terms of disability and healthcare resource consumption.

In 2017, VCOR was engaged with all 30 hospitals (public and private) in Victoria that perform PCI. The Report included 10,792 cases across 13 public and 17 private hospitals. There were some continuing trends in practice, including the burden of emergency PCI for acute STEMI being predominantly managed in the public sector. Radial artery access was used with increasing frequency, providing improved safety and outcomes compared with femoral access and there was near-complete use of drug-eluting stents, with their superior long-term results. Overall hospital performance was very good in 2017, with either no or just one hospital outlier found when benchmarked for all key performance indicators.

In the second module on the management of acute STEMI, 10 regional hospitals actively participated in regular quality assurance activities. The Report found that there were shortfalls in achieving targets for timely emergency treatment of STEMI. VCOR responded with additional activities including education programs, regular stakeholder meetings and special reports to maintain the effort to improve services. Formal outlier management processes are to follow and VCOR will assist hospitals in their continuous improvement activities related to regional STEMI management.

The third section of this Report presents the results of the latest Heart Failure (HF)-Snapshot module. Unlike the other two modules which collected all cases at participating sites, this module undertook a "snapshot" of heart failure management, gathering information on consecutive patients over a 4-week period. The result is a cross-sectional picture of heart failure-related treatment and outcomes. Data were collected on 477 patients admitted with acute heart failure to 16 participating hospitals. There was good compliance overall with guideline-recommended medical therapies and all hospitals performed well on measures of mortality and readmission. However, there were some deficiencies in transitional care arrangements post-discharge - highlighting the need for timely referrals to outreach services such as heart failure programs and pharmacist medication reviews.

Also in 2017, VCOR commenced a fourth module centring on the appropriate use, safety and quality of care of cardiac implanted electronic devices (CIED). These include implantable cardioverter-defibrillators (ICD) and cardiac resynchronisation therapy (CRT) devices. The module commenced in a pilot phase, involving seven sites. Data are being collected and the dataset refined. Results and outcomes will be available in 2018.

The Victorian Cardiac Outcomes Registry has completed another busy year with its various projects, while fulfilling its primary purpose to monitor and report on the performance and outcomes of Victorian hospitals' cardiac services. The activities of VCOR may be diverse, but its aim remains sharply focussed on ensuring that Victoria's cardiac patients receive high-quality and safe care.

The key findings from the various modules in 2017 are presented on the following pages.

Key Findings

PCI Registry

- In 2017, VCOR grew to encompass all 30 public and private PCI hospitals in Victoria, involving around 120 interventional cardiologists. A total of 10,792 completed procedures were collected on 9,552 patients. 61.5% of cases were managed in the public system.

- The majority of patients undergoing PCI were male (76%). The mean age was 66 years overall, but on average, patients treated in private hospitals were six years older than public patients. Approximately one in five were diabetic and almost one-third had a previous PCI.

- Approximately 20% of cases were performed outside normal working hours in both the public and private hospital systems. Just over half of all STEMI cases were after-hours and 90% of those were in the public sector.

- Just over half the PCI cases presented with an acute coronary syndrome (ACS), with the majority (77%) treated in public hospitals. ACS cases accounted for two-thirds of the public sector's caseload and one-third of the private sector's. PCI for acute STEMI (including pharmaco-invasive PCI and rescue PCI) took up 26% of the PCI workload in the public sector.

- For patients with stable (non-ACS) disease, 65% had an indication of stable angina. The PCI indicator of a high-grade stenosis was noted in 91% and positive functional test in 49% of non-ACS cases. A total of 81% of non-ACS patients had at least 2 of these 3 PCI indicators.

- Particular lesion subsets including unprotected left main cases (1.5%), chronic total occlusions (3.5%) and in-stent restenosis (5.3%) were performed in similar numbers to previous years.

- The number of patients presenting with cardiogenic shock or out-of-hospital cardiac arrest was similar to previous years. High-volume public hospitals tended to have these high-acuity cases constitute a greater proportion of their overall caseload than lower-volume public centres. Private hospitals generally managed only small numbers of shock and cardiac arrest cases.

- Drug-eluting stent (DES) use continues to increase year-on-year and has reached 90% of all PCI cases. The gap in DES uptake between public and private sectors has narrowed (88% public vs 92% private). Concomitant functional assessment of coronary lesions by fractional flow reserve (FFR) occurred in 3.5% of cases. Other adjunctive devices such as intravascular ultrasound and rotational atherectomy were used infrequently.

- The preference for radial artery access has increased to 61% of cases. Rates varied among hospitals and were higher in public hospitals (68% public vs 50% private). Lower rates were seen in females than males (56% vs 63%) and in the elderly (49% >80 years vs 62% <80 years).

- Emergency treatment for acute STEMI (primary PCI) accounted for 13% of the overall PCI workload. The majority were treated in the public sector (92%). Radial access was used in 66% of cases. The median time taken from patient arrival at the hospital to the first inflation of the balloon (door-to-balloon time) was 63 minutes, within the recommended target of ≤90 mins. An overall door-to-balloon time of ≤90 mins was achieved in 77% of cases which was above the international benchmark target of 75% for the first time.

- The unadjusted in-hospital mortality rate was 1.8% overall. For acute STEMI the rate was 6.6% and highest for patients with cardiogenic shock or out-of-hospital cardiac arrest at 41.5%. Excluding these two high-risk groups, the unadjusted in-hospital mortality rate for the rest of the cohort was 0.3%.

- The signature key performance indicator of risk-adjusted 30-day mortality for the overall PCI cohort in 2017 was 2.9%. All but one hospital were within control limits. The one outlier hospital had a small volume of cases, potentially rendering its risk-adjustment process inaccurate. The affected site requires monitoring for a longer period to ensure the estimate of its mortality rate is accurate.

- The median in-hospital major bleeding rate was 0.7%, lower among radial access cases (0.5% radial vs 0.9% femoral) and highest in STEMI (1.7%). The median 30-day unplanned cardiac readmission rate was 3.6%, with similar rates in the public and private sectors. Rates of other major adverse outcomes were low and similar to previous years.

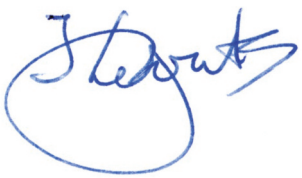
Key Findings continued ...

Management of Acute STEMI in Regional Centres

- The 2017 cohort comprised 287 patients with suspected STEMI, presenting to 10 regional health services across Victoria. A total of 88 patients (31%) were ineligible for thrombolysis. Forty-eight were triaged to primary PCI and transferred to a PCI capable hospital. The remaining 145 patients all received thrombolysis, either at the treating hospital (n=126) or prior to arrival via ambulance-initiated pre-hospital thrombolysis (n=19). Six patients were eligible, but did not receive thrombolysis.
- Only 55% of patients were transported by ambulance to hospital, while 35% were driven in by friends or family (self-presenters). Most patients (84%) were located within 50km of their treating hospital at symptom onset.
- The median time from pain onset to first medical or ambulance contact was 110 minutes. The median time taken for an ambulance to arrive was 16 minutes and the time to transfer to hospital was 54 minutes.
- The median time taken from hospital arrival to the recording of the first ECG was 10 minutes – compliant with guideline recommendations.
- The median door-to-needle time (time from patient arrival to administration of thrombolytic drug) was 48 minutes (IQR: 29, 113). Only one of 10 hospitals managed to achieve a median door-to-needle time within the Australian guidelines recommendation of ≤30 minutes, and overall, only 29% of cases received timely thrombolysis within 30 minutes.
- The in-hospital mortality (before transfer) for the overall cohort was 6%. Mortality was higher among patients with cardiogenic shock (32 patients, 11 deaths (34%)). There was 1 case of major bleeding but no cases of stroke or intra-cerebral haemorrhage.
- Nearly all patients treated with thrombolysis (94%) were subsequently transferred to a PCI-capable hospital within 24 hours. The median time from referral for transfer to actual transfer was 2.3 hours (IQR: 1.5, 4.5).
- Linkage with the VCOR PCI module determined that 82% of the entire cohort (both thrombolysis eligible and ineligible) were transferred to a PCI-capable hospital. Of those, 57% had a subsequent PCI and 6% underwent CABG surgery.

Heart Failure Snapshot

- A total of 16 health services across the state participated in the 2017 Heart Failure Snapshot, with enrolment of 477 patients. The majority (55%) were male, and the median age was 75 years. Overall, 72% of patients had predominant systolic dysfunction and 15% predominant diastolic dysfunction.
- The most common co-morbidities were atrial fibrillation (54%), diabetes (45%), anaemia (31%), history of angina (36%), chronic obstructive pulmonary disease/asthma (31%) and moderate chronic kidney disease (33%).
- The majority of patients (90%) presented to an emergency department, with just over half (52%) admitted into a general medicine unit for management. Only five hospitals had a dedicated heart failure unit. Infection was the most common reason for admission (21% of cases).
- For patients with heart failure with reduced ejection fraction, there were increases in the use of guideline-recommended medications at discharge compared with admission medications.
- The median length of stay in the acute hospital was 6 days (IQR: 3, 9), with the majority of patients (75%) discharged to home.
- The unadjusted in-hospital mortality rate was 4%, rising to 5% at 30 days follow-up. Mortality rates for all hospitals were within control limits and there were no outliers in performance. Higher mortality rates were observed in patients with systolic dysfunction (8%), compared with patients with predominantly diastolic dysfunction (5%).
- The all-cause readmission rates were 26% within 30 days and 50% at 90 days post discharge. This sobering finding that 1 in 2 patients treated in hospital for heart failure will end up back in hospital within 3 months underscores the urgent need for effective strategies both in hospital and in the ambulatory setting to improve the quality of care and reduce rehospitalisations.



A/Prof Jeffrey Lefkovits
VCOR Clinical Director

Introduction

Now in its sixth year of operation, the Victorian Cardiac Outcomes Registry (VCOR) is a clinical quality registry designed to monitor the quality (appropriateness and effectiveness) and safety of cardiac-related health care. It routinely collects, analyses and reports health-related information, allowing for benchmarking of hospitals' performance and outcomes. This measurement of variation is intended to drive quality improvement. It can also be utilised more broadly to assess overall compliance with national standards and evidence-based guidelines for the delivery of safe and effective cardiac care.

VCOR first reported on percutaneous coronary intervention (PCI) and subsequently established modules for management of acute ST elevation myocardial infarction in rural and regional areas and acute hospital treatment of heart failure. The registry encompasses hospitals in both the public and private sectors.

As a clinical quality registry, VCOR complies with the Australian Health Ministers' Advisory Councils Framework for Australian Clinical Quality Registries (3). It adheres to the relevant standards related to security and protection of data as well as to the technical and operating standards for Australian clinical quality registries.

Registry Governance and Structure

Governance

The governance of VCOR has been previously outlined in detail (4, 5). VCOR conforms to the National Operating Principles for Clinical Quality Registries as set out by the Australian Commission on Safety and Quality in Health Care (6).

Steering Committee

The Steering Committee membership comprises representatives from each of the participating PCI hospitals, the Victorian Cardiac Clinical Network, the Department of Epidemiology & Preventive Medicine at Monash University and the Clinical Leads of the STEMI module and the Heart Failure Snapshot module. In 2017 the Steering Committee ratified the updated VCOR Governance Terms of Reference. In addition, several updated VCOR policy documents and two newly developed policies were ratified.

Clinical Quality Committee

The Clinical Quality Committee (CQC) has responsibility for the oversight, analysis, interpretation and release of hospital performance data. Its role is central to VCOR's overall function as a clinical quality registry. Quarterly review of hospital key performance indicators (KPIs) and other data continued in 2017. As in previous years, regular reports were provided to participating sites in each of the three registry modules. The CQC was active in identifying outlier performance and assisting hospitals with the management of their outcomes, including providing feedback and review as requested.

Data, Research and Publications Committee

The role of the Data, Research and Publications Committee (DRP) is to review requests for access to and analysis of de-identified group data for research projects. In 2017, the DRP reviewed and approved numerous requests for data, including five collaborative projects. The DRP oversaw abstract development and publication based on VCOR data that will be outlined in the Publication and Presentation section of this report.

Percutaneous Coronary Intervention (PCI)

Registry Module Activity

This report covers PCI activity in Victoria for the 2017 calendar year from January 1 to December 31. Where relevant, trends in practice and outcomes for the previous 3 years are also presented. Table 1 lists the hospitals that have participated in the registry since its commencement. In 2017, all 30 PCI hospitals in Victoria contributed data - 13 public hospitals and 17 private hospitals. Among the private hospitals, 1 hospital both opened and commenced data submission in 2017 and a further 3 established hospitals that were engaged in 2016 commenced data submission in 2017.

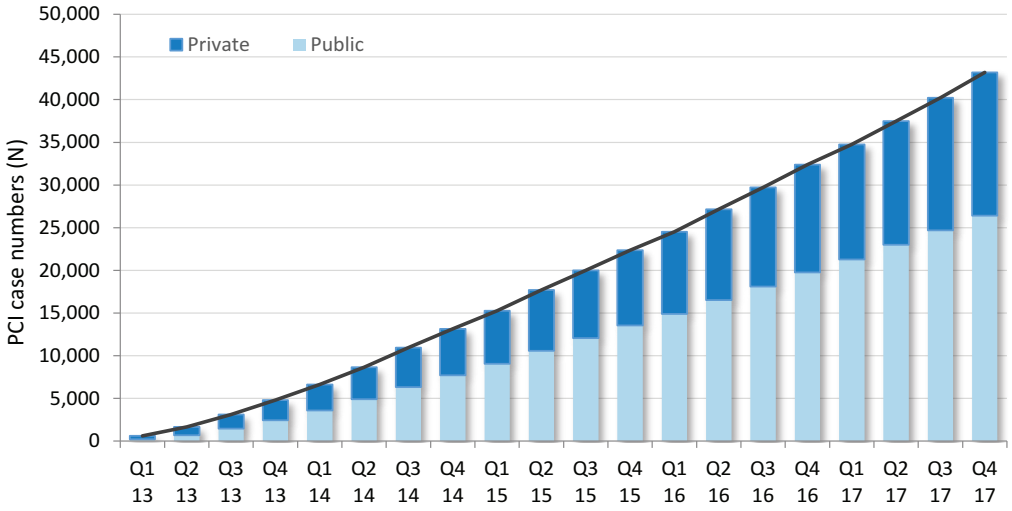
Table 1: Participation of Victorian PCI hospitals

Victorian PCI hospitals	Hospital type	2013	2014	2015	2016	2017
The 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	●	●	●	●	●
Geelong Private Hospital	Private		●	●	●	●
Holmesglen Private Hospital	Private				N/A	●
Jessie McPherson Private Hospital	Private	●	●	●	●	●
Knox Private Hospital	Private	●	●	●	●	●
Melbourne Private Hospital	Private		●	●	●	●
Monash Heart	Public	●	●	●	●	●
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 (Geelong)	Private			○	○	●
St Vincent's Hospital Melbourne	Public	●	●	●	●	●
St Vincent's Private Hospital	Private	●	●	●	●	●
The Royal Melbourne Hospital	Public	●	●	●	●	●
Sunshine Hospital	Public	N/A	N/A	●	●	●
The University Hospital, Geelong	Public	●	●	●	●	●
The Valley Private Hospital	Private				●	●
Warringal Private Hospital	Private				○	●
Western Private Hospital	Private	●	●	●	●	●

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

In total, 10,792 cases performed on 9,552 patients were entered into VCOR in 2017. Eleven percent of patients (n=1,240) underwent multiple procedures. The number of patients treated in the public sector was 6634 (61.5%) and 4158 in the private sector (38.5%). The lost-to-follow-up (LTF) rate in 2017 was 1.1%, and the overall LTF rate for the entire registry since its commencement was 1.3%. By the end of 2017, the VCOR registry had accumulated 43,189 cases as shown in Figure 1.

Figure 1: Cumulative cases submitted by quarter from 2013-2017

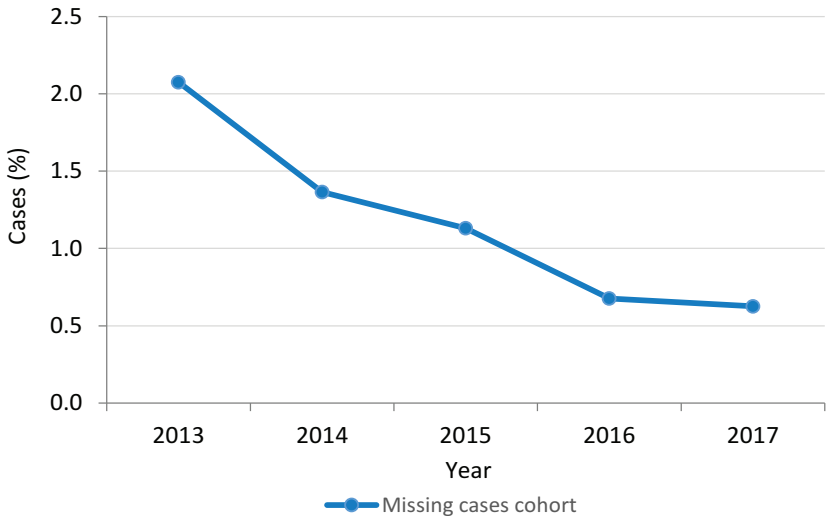


Data Quality - Audit Activity

VCOR is strongly committed to the accuracy, completeness and quality of its registry data. Ensuring data accuracy is a key operational activity of a clinical quality registry (7). VCOR's auditing activities include case ascertainment and data quality assessment audits, quarterly data completeness and data cleaning, as well as regular communications and training updates to all data managers.

Case ascertainment audits (assessing whether all eligible cases are actually entered into the registry) are conducted at all sites on a yearly basis. In general, site performance tends to improve with successive audits (Figure 2). VCOR also encourages sites to undertake regular self-audits to ensure all cases are being included in the registry. In instances where missing cases are identified, sites are able to retrieve these cases and subsequently enter them into the registry.

Figure 2: Overall rate of missing cases across each annual audit (2013-2017)



Data quality assessment (accuracy of data as determined by review of source data), is undertaken at all sites after the first year and then subsequently every 3 years. 5% of case records are randomly selected for comparison with the hospital medical record. The overall agreement rate between VCOR data and the hospital medical record was 98.4% from 34 completed audits, indicating high quality data collection. This rate compared favourably with national and international registries (8, 9).

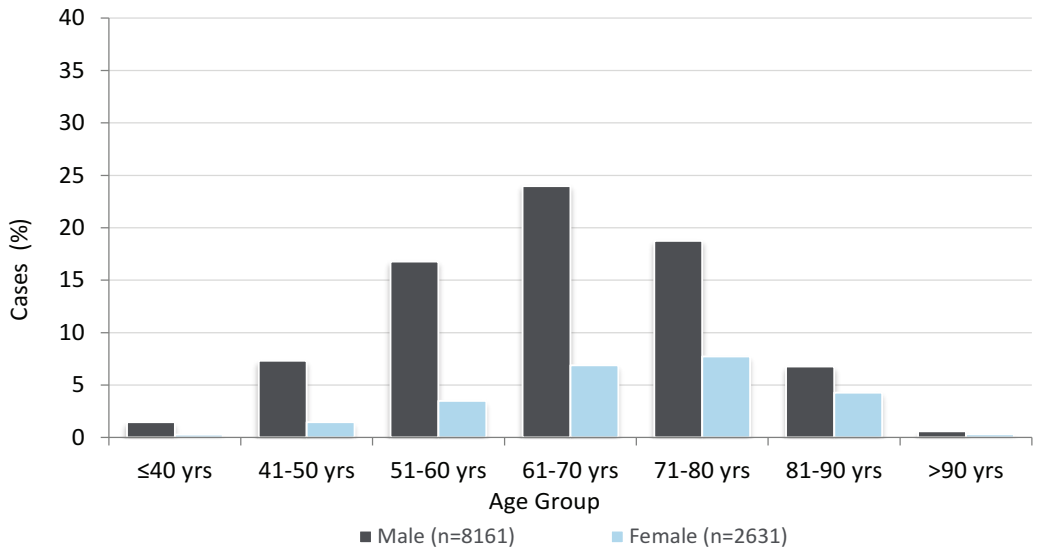
Data completeness and data cleaning are conducted on a quarterly basis. Any data queries that arise are forwarded on to the sites involved. They are then expected to address and amend their case records on the online system if necessary, prior to reporting deadlines.

VCOR undertakes onsite training and refresher sessions for all data managers and sends regular bulletins and updates, addressing common data entry issues including errors. Additionally, the registry runs an annual meeting for data managers that provides a forum to raise and discuss queries and problems related to data collection and submission.

Patient Characteristics

The median age for males in the 2017 cohort was 66 years (IQR: 57, 74) and for females, 71 years (IQR: 62, 78). The distribution of cases by age and gender was similar to previous years, although the number of females in the 71-80 year age group was higher than in 2016. The peak frequency of PCI procedures occurred in the seventh decade for men and the eighth decade for women (Figure 3).

Figure 3: Age and gender distribution of patients undergoing PCI



Selected patient demographic information for 2014-2017 is shown in Table 2. The demographic profiles of patients remained similar across the 4-year period.

Table 2: Comparison of selected patient characteristics: 2014-2017

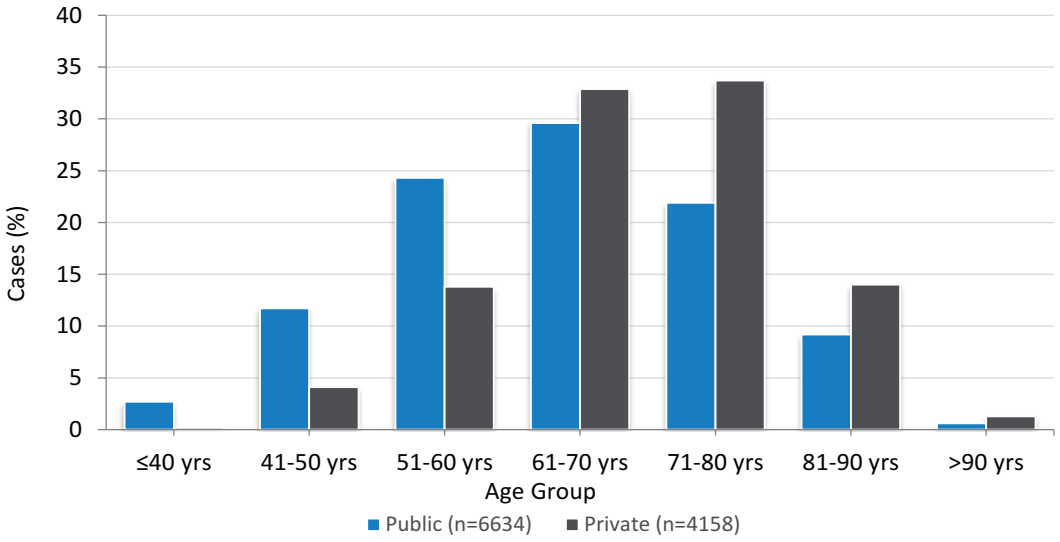
Patient characteristics	2014 (N=8329)	2015 (N=9926)	2016 (N=10030)	2017 (N=10792)
Age - years (Mean ±SD)	65.3 (±11.9)	65.6 (±12.0)	65.9 (±12.0)	66.4 (±11.9)
	%	%	%	%
Gender - female	23.1	23.0	23.4	24.4
Diabetes	21.6	23.0	21.6	21.7
PVD History	3.8	3.6	3.4	3.4
CVD History	3.7	4.0	3.3	3.9
Previous PCI	31.9	32.9	32.7	32.7
Previous CABG	8.4	7.6	7.6	7.3

Table 3: Selected patient characteristics by hospital sector

Patient characteristics	Public (n=6634)	Private (n=4158)
Age - years (Mean ±SD)	64.2 (±12.2)	70.0 (±10.4)
	%	%
Gender - female	24.0	25.0
Diabetes	22.5	20.5
PVD History	3.5	3.3
CVD History	4.3	3.3
Previous PCI	27.1	41.7
Previous CABG	6.5	8.6

Patients in the private sector tended to be older and more commonly had a previous PCI (Table 3). Elderly patients (>80 years) accounted for 11.9% of the PCI cohort in 2017 (Figure 4) and their overall proportion was higher in the private than in the public sector, similar to previous years.

Figure 4: Age distributions for public and private patients



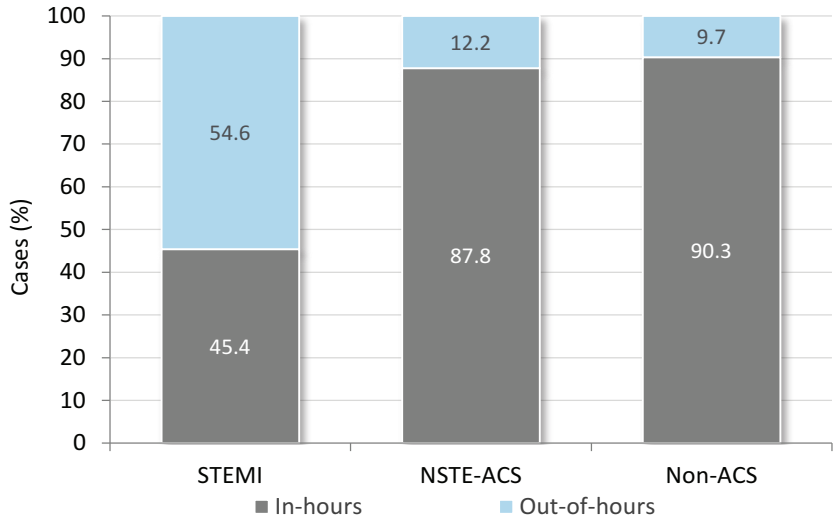
Resource utilisation

Performance of PCI, especially in acute or urgent situations, is often resource intensive and comprehensive information regarding the utilisation of hospital and human resources can assist hospital clinicians, administrators and funders with their financial planning and resource allocation activities.

In-hours vs out-of-hours cases

In 2017, approximately 20% of PCI cases were performed outside normal working hours. This proportion has remained stable for the 4-year period from 2014-2017. Work performed after-hours was mostly for urgent indications, with the majority of acute STEMI cases (55%) presenting outside normal working hours. In contrast, NSTEMI cases (12%) and non-ACS cases (10%) were much less frequently performed out-of-hours (Figure 5).

Figure 5: Proportion of cases in-hours and out-of-hours

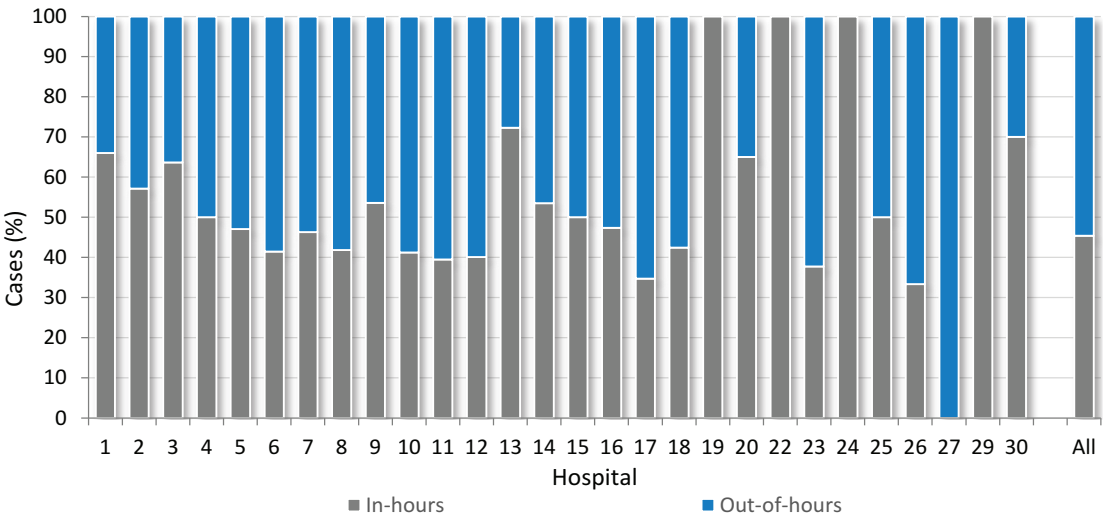


When comparing the public and private sectors, the proportion of cases performed out-of-hours was similar - 19.1% in public and 20.9% in private. Yet, the makeup of cases after-hours was quite different. For after-hours STEMI cases in particular, 90% presented to public hospitals and constituted 87% of the total after-hours workload in the public sector. In contrast, acute STEMI cases made up only 14% of the after-hours workload in the private sector.

The fact that most of the after-hours work in private hospitals was for NSTE-ACS or non-ACS indications reflects the casemix seen in the private sector. Additionally, many private hospitals operate catheterisation labs for extended hours during the week, so that part of their "normal" working hours includes times that are otherwise considered after-hours by conventional definitions. When weekend cases only were compared by hospital sector, the casemix profiles of public and private hospitals were more similar (97% ACS cases in public vs 83% ACS cases in private).

The proportions of STEMI cases treated in-hours and after-hours by hospital is shown in Figure 6, showing wide variation among hospitals. Several sites did the majority of their STEMI work out-of-hours.

Figure 6: STEMI cases in-hours and out-of-hours by hospital



Hospitals 4, 19, 22, 24, 26, 27 & 29 low STEMI numbers (n<5)

Timing of PCI for NSTE-ACS cases

Australian guidelines encourage early revascularisation for NSTE-ACS where appropriate, as there is no benefit delaying invasive treatment for an initial course of medical stabilisation. While there is not the same urgency as with STEMI cases, time to treatment of NSTE-ACS can still be viewed as a process measure of efficiency and resources management.

Figure 7 shows that almost half the cases of PCI for NSTE-ACS were managed expeditiously within 24 hours of hospital admission. The vast majority were treated within 72 hours, with only 16% undergoing PCI >72 hours after admission.

Figure 7: Time delays from hospital admission to PCI for NSTE-ACS cases

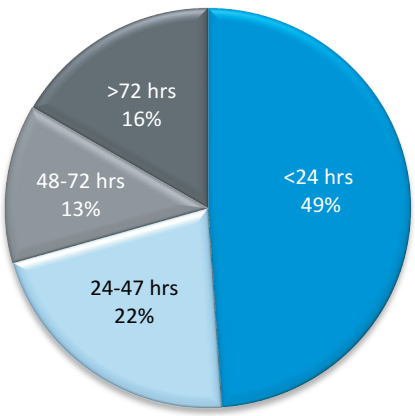
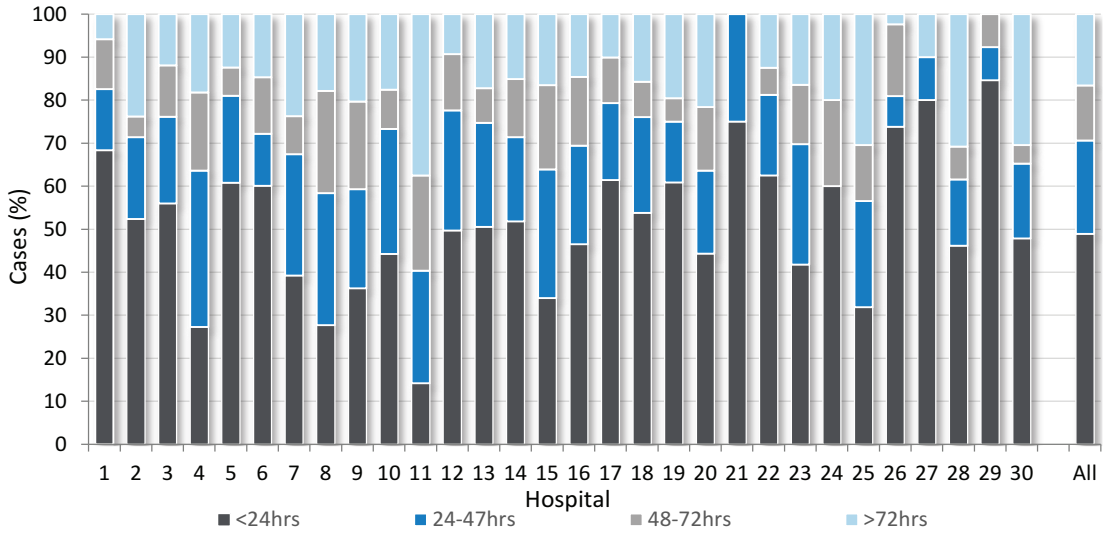


Figure 8: Time delays from hospital admission to PCI for NSTE-ACS cases by hospital



There was substantial variation in hospital performance when benchmarked against each other as shown in Figure 8. However, all but one hospital managed to treat at least 75% of their NSTE-ACS cases with PCI in under 72 hours. There was less variation in timing of PCI for non-ACS patients when the public and private sectors were compared, although private hospitals trended towards longer delays (Table 4).

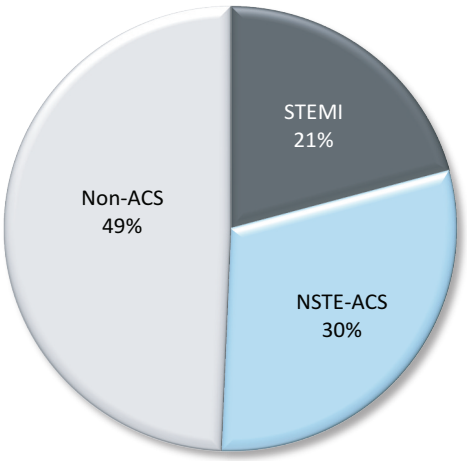
Table 4: Time delays from hospital admission to PCI for NSTE-ACS cases by hospital sector

	All sites (N=3223)	Public (n=2000)	Private (n=1223)
	N (%)	N (%)	N (%)
<24hrs	1577 (48.9)	1032 (51.6)	545 (44.6)
24-48hrs	700 (21.7)	427 (21.4)	273 (22.3)
48-72hrs	411 (12.8)	249 (12.4)	162 (13.2)
>72hrs	535 (16.6)	292 (14.6)	243 (19.9)

Clinical Presentation

In 2017, 51% of the PCI cohort presented with an acute coronary syndrome (ACS), comprising ST elevation myocardial infarction (STEMI) (21%), non-ST elevation myocardial infarction (NSTEMI) (23%) and unstable angina (7%). NSTEMI and unstable angina are generally considered together as non-ST elevation ACS (NSTE-ACS) as shown in Figure 9. The remainder (49%) had stable (non-ACS) coronary disease.

Figure 9: Procedures by clinical presentation



There were distinct differences among hospitals in the proportion of ACS cases contributing to their overall case mix, ranging from 4% to 80% (Figure 10). Further categorisation according to hospital sector showed that the public system was responsible for a much greater proportion of acute non-elective work compared with the private sector (Figure 11). In particular, the vast majority of PCI cases for STEMI (89%) were managed in public hospitals.

Figure 10: ACS and non-ACS cases by hospital

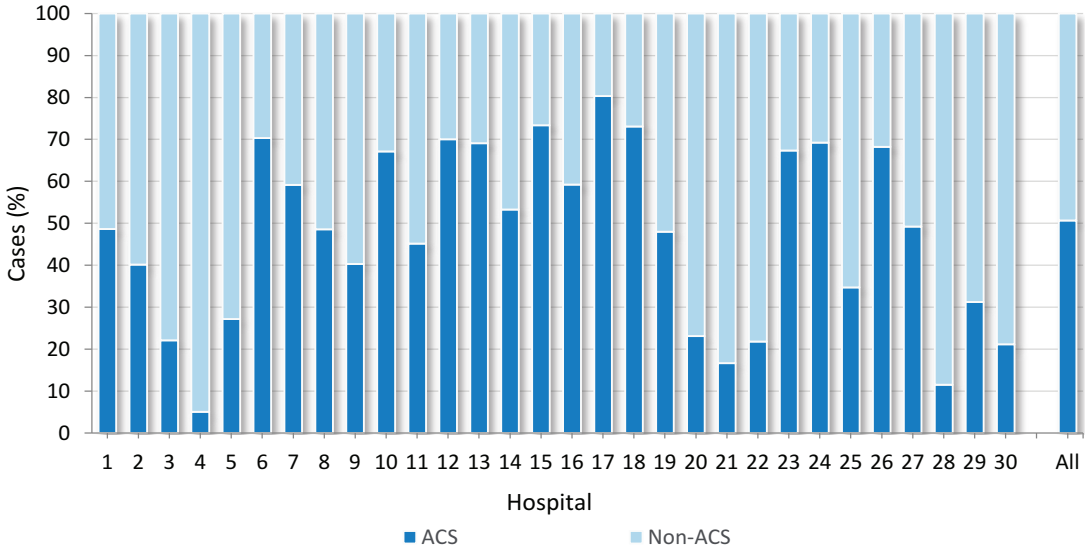
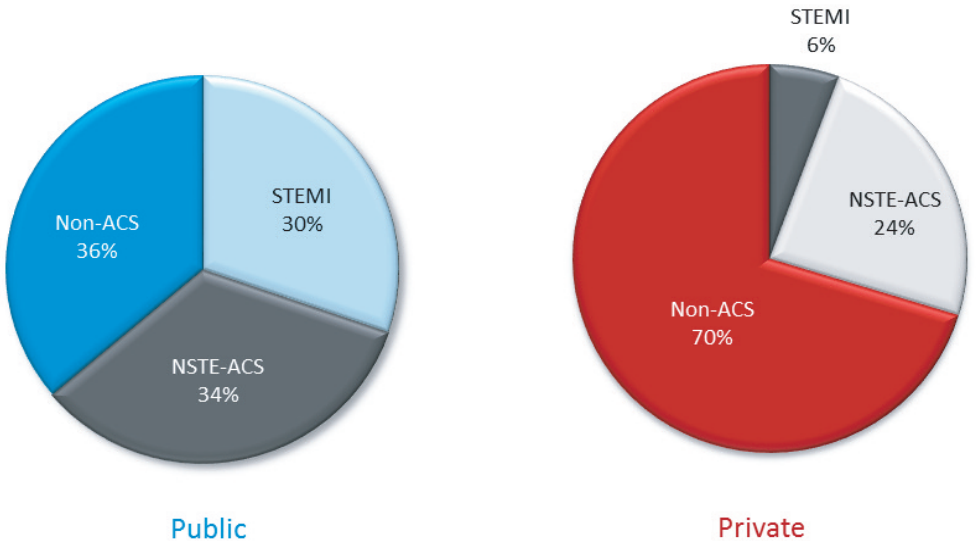


Figure 11: Procedures by clinical presentation for public and private hospitals



Indications for PCI

With the increasing focus on ensuring that therapies are used appropriately, the indication for PCI provides an important measure of how the procedure is being utilised. For ACS patients, recommendations for revascularisation are based on a large body of evidence that supports prompt treatment. A diagnosis of ACS is therefore considered a highly appropriate indication for PCI in suitable patients with an identifiable culprit lesion, in accordance with Australian practice guidelines (10).

Among the 2017 cohort, 51% of patients had the highly appropriate indication of ACS - mostly NSTEMI. The proportion of patients with unstable angina (12.3%) trended lower in 2017 compared with the preceding 2 years (14.1% in 2015 and 13.1% in 2016). Three-quarters of the NSTE-ACS caseload was managed in the public sector (Table 5).

Table 5: PCI Indications by ACS category

	All sites (N=5869)	Public (n=4373)	Private (n=1496)
ACS category	N (%)	N (%)	N (%)
Primary PCI for acute STEMI	1708 (29.1)	1527 (34.9)	181 (12.1)
STEMI PCI 12-24 hours after symptom onset	218 (3.7)	184 (4.2)	34 (2.3)
Pharmaco-invasive PCI	217 (3.7)	205 (4.7)	12 (0.8)
Rescue PCI	87 (1.5)	78 (1.8)	9 (0.6)
PCI for shock/OHCA (non-MI)	37 (0.6)	34 (0.8)	3 (0.2)
PCI for NSTE-ACS	3602 (61.4)	2345 (53.6)	1257 (84.0)
NSTE-ACS sub-category	N (%)	N (%)	N (%)
NSTEMI	2500 (42.6)	1885 (43.1)	615 (41.1)
Unstable angina	724 (12.3)	366 (7.7)	388 (25.9)
Recent ACS 7-30 days ago	378 (6.4)	124 (2.8)	254 (17.0)

When considering PCI for non-ACS indications, a number of additional factors come into play, including objective assessment of the burden of ischaemia and risk stratification of patients according to lesion severity and presence or absence of symptoms. Table 6 presents the reasons for PCI among non-ACS patients in the 2017 cohort. About two-thirds were treated for stable angina. A further 20% underwent PCI for prognostic indications, defined as the absence of symptoms (with or without demonstrable functional ischaemia). The indication of staged PCI refers to patients with multi-vessel disease undergoing a second (and sometimes a third or fourth) PCI and is subdivided according to the indication of the original procedure. Differences were seen among the public and private sectors, particularly with staged PCI, which was undertaken more commonly in the private sector.

Table 6: PCI Indications for non-ACS cases

	All sites (N=4923)	Public (n=2262)	Private (n=2661)
	N (%)	N (%)	N (%)
Stable angina	3210 (65.2)	1581 (69.9)	1629 (61.2)
No symptoms and no functional test	629 (12.8)	316 (14.0)	313 (11.8)
No symptoms and positive functional test	412 (8.4)	141 (6.2)	271 (10.2)
Staged PCI after ACS (<30 days after first procedure)	288 (5.9)	123 (5.4)	165 (6.2)
Staged PCI after ACS (>30 days after first procedure)	112 (2.3)	60 (2.7)	52 (2.0)
Staged PCI after original non-ACS indication	272 (5.5)	41 (1.8)	231 (8.7)

Non-ACS cases were further examined for the principal PCI indicators of symptom presence, positive functional test and high-grade coronary stenosis. Symptoms of angina or its equivalent were reported in 75% of non-ACS patients. A high-grade stenosis was noted in 91% and a positive functional test in 49%. A total of 81% of non-ACS patients had at least 2 of 3 indicators (Table 7).

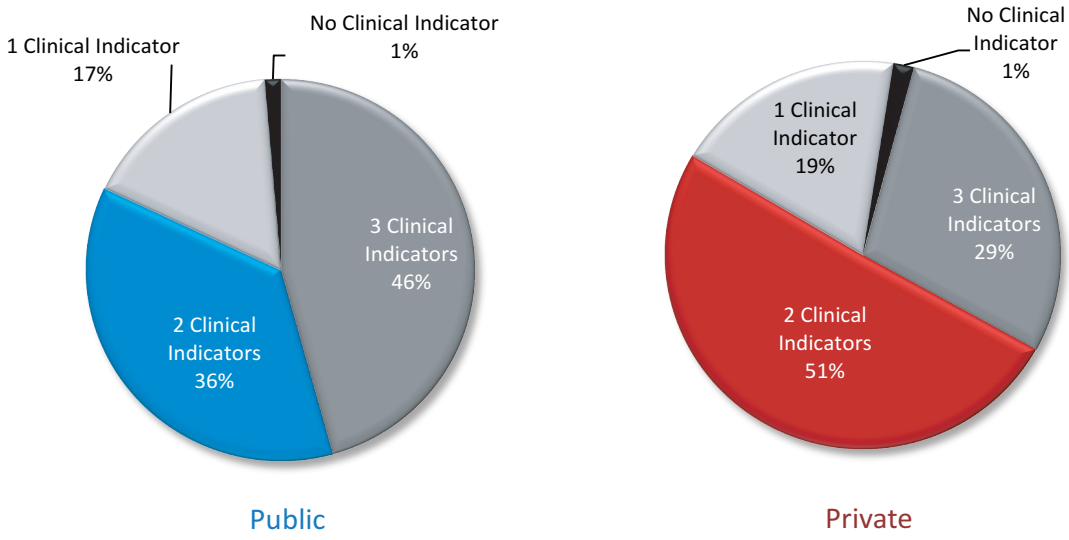
Table 7: Non-ACS patients: Indicators for PCI

Symptoms	Positive functional test	High grade stenosis	Total
			N (%)
●	●	●	1570 (36.9)
○	●	●	370 (8.7)
●	●	○	110 (2.6)
●	○	●	1377 (32.4)
●	○	○	153 (3.6)
○	○	●	557 (13.1)
○	●	○	50 (1.2)
○	○	○	64 (1.5)
			4251 (100)

Table Legend: ● = clinical indicator present; ○ = clinical indicator not present

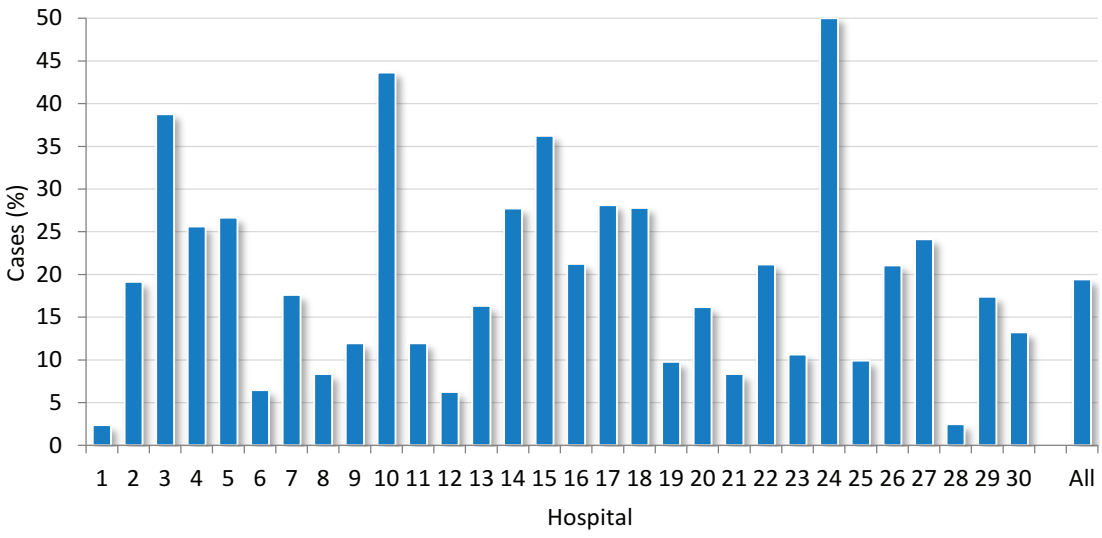
The pattern of PCI indicators varied according to hospital sector (Figure 12). A larger proportion of patients in the public sector had 3 PCI indicators present, whereas the majority of non-ACS patients treated in private had 2 indicators. However, both sectors had a similar proportion of non-ACS cases with at least 2 indicators (82% public, 80% private).

Figure 12: Indicators for PCI in non-ACS patients by hospital sector



In nearly 1 in 5 non-ACS cases, there was either just one or no indicator for PCI. Figure 13 demonstrates the variation seen among hospitals in relation to the proportion of non-ACS cases with 0 or 1 PCI indicator (range 2% – 50%). Hospitals that were above the overall cohort average of 19% were equally distributed across the public and private sectors.

Figure 13: Proportion of non-ACS cases with 0-1 indicators for PCI by hospital



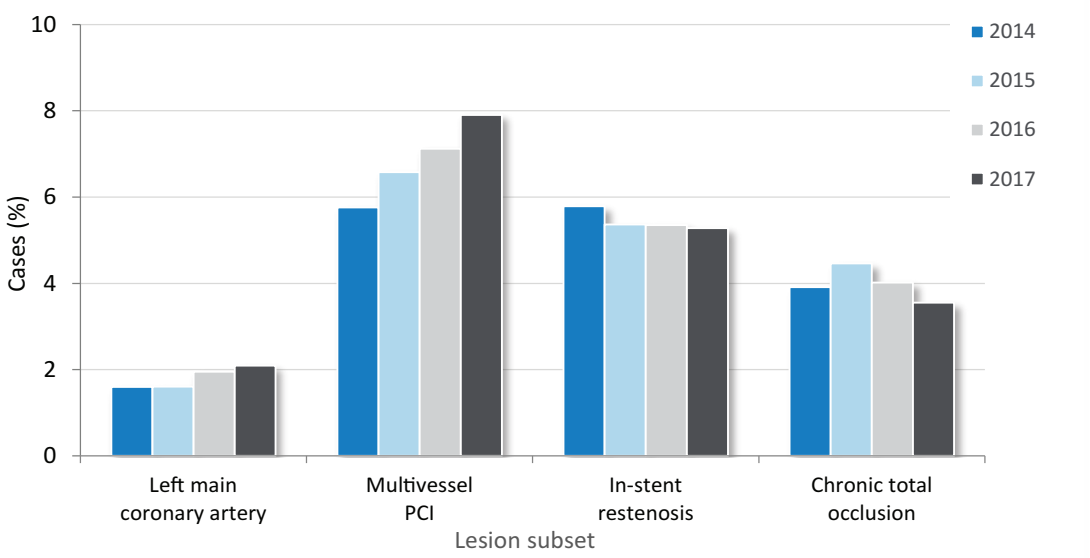
Hospital 24 low case numbers (n<5)

Clinical and Lesion Subsets

Comparative trends in procedural rates among selected coronary lesion subsets for the period 2014-2017 are shown in Figure 14. Treatment was overwhelmingly for native coronary disease, with bypass graft PCI representing a small fraction of cases that was trending downwards from 2.4% in 2014 to 1.8% in 2017.

In contrast, the number of cases performed for "unprotected" left main lesions (lesions without functioning bypass grafts to the left anterior descending and/or left circumflex arteries) was quite low, but had increased over time. This likely reflects the growing body of evidence supporting the safety and efficacy of left main PCI compared with CABG surgery. In 2014, 56% of left main cases were "unprotected" and this rose to 71% in 2017. The rate of intravascular ultrasound (IVUS) use with left main cases was 12.9% overall, and 16.6% in the subgroup of unprotected left main cases.

Figure 14: Comparative trends in PCI for selected lesion subsets: 2014-2017



PCI for multi-vessel disease increased over the past 4 years, whereas PCI for in-stent restenosis remained static at 5-6%. Approximately three-quarters of cases of in-stent restenosis were treated with a drug-eluting stent, and this proportion has also remained relatively static over the last 4 years. The use of drug-eluting balloons is mostly restricted to in-stent restenosis, and while their use was still very limited, there was an increase from just 32 cases in 2014 to 59 cases in 2017, representing 13% of in-stent restenosis cases for that year.

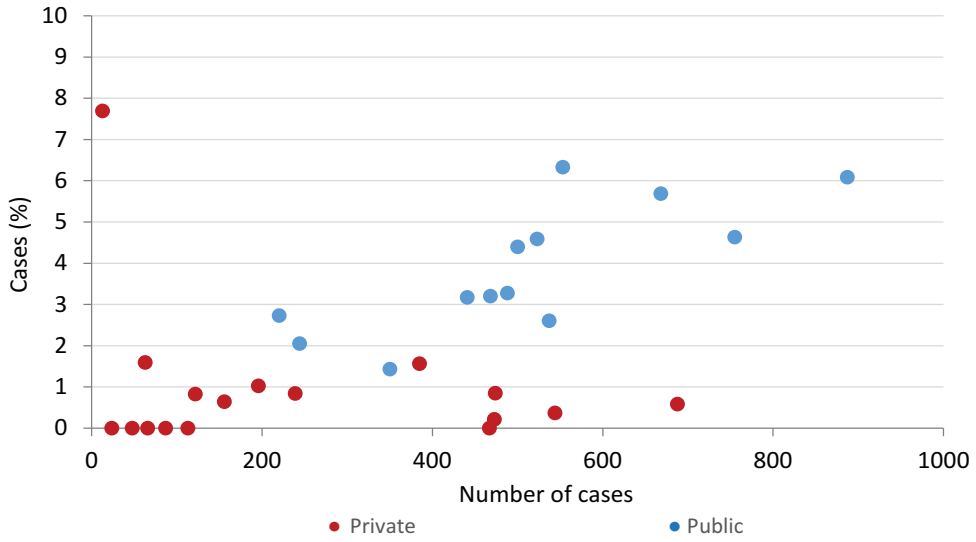
There was no increase in cases of chronic total occlusion, despite the availability of new and advanced techniques for treating this condition. This contrasted with international trends that have demonstrated considerably higher rates of PCI for CTO (11).

Table 8: Patients presenting with cardiogenic shock or out-of-hospital cardiac arrest (OHCA): 2014-2017

Presentation type	2014 (N=8329)	2015 (N=9228)	2016 (N=10030)	2017 (N=10792)
	N (%)	N (%)	N (%)	N (%)
Cardiogenic shock	198 (2.4)	223 (2.4)	278 (2.8)	256 (2.4)
Intubated OHCA	89 (1.1)	108 (1.2)	126 (1.3)	142 (1.3)
Shock and/or intubated OHCA	239 (2.9)	253 (2.7)	309 (3.1)	308 (2.9)

Patients presenting with cardiogenic shock, out-of-hospital cardiac arrest (OHCA) or both, represent a special group with a very high risk of death and other adverse outcomes (12, 13) and high consumption of hospital resources. Case numbers remained stable over the last 4 years (Table 8).

Figure 15: Shock and OHCA cases by hospital volume and hospital sector (public/private)

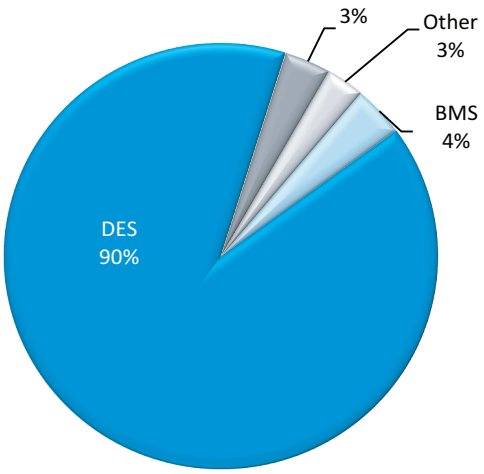


The majority of patients with cardiogenic shock and/or OHCA presented to public hospitals (92%). The treatment burden for this resource-intensive group accounted for 4.3% of public hospital work and 0.6% of the private sector caseload. Figure 15 illustrates the relationships between hospital volume, hospital sector (public/private) and proportion of shock/OHCA cases treated. For public hospitals, there was a positive association apparent between case numbers and the overall volume of the hospital's PCI program – shock/OHCA cases took up a greater proportion of the overall caseload in the busier hospitals. In contrast, for private hospitals, there was no apparent relationship between hospital volume and shock/OHCA case numbers. It is likely that this distribution pattern of cases is a reflection of the referral strategy of Ambulance Victoria for shocked and cardiac arrest patients.

Device Use

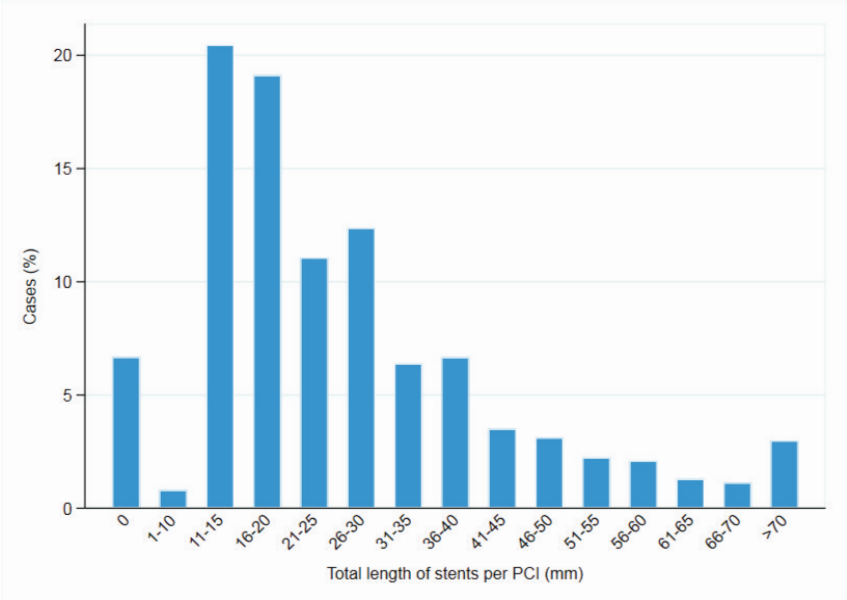
In 2017, at least one coronary stent was implanted in 93.7% and balloon angioplasty alone (POBA) was performed in 3% of cases. Bioresorbable vascular scaffolds (BVS), commercially available in Australia since 2013, were withdrawn from the market in May 2017 (14). Only 17 BVS devices were used in VCOR patients in 2017 and overall, BVS use in Victoria in the previous 4 years involved very small numbers. A breakdown of device use in 2017 is shown Figure 16.

Figure 16: Device use in PCI cases



The majority of patients (67%) received a single stent, with 20% of patients receiving two stents during PCI. Two percent of cases received ≥ 4 stents in a single case. The sum of the length of stents deployed was most commonly between 11-30mm (Figure 17) and multiple or overlapping stents totalling >50 mm in length were used in 8% of cases. There were no differences in the number or total length of stents among public and private hospitals.

Figure 17: Total length of stents used per PCI case (includes all lesions treated)



As in previous years, the adjunctive coronary imaging techniques of intravascular ultrasound (IVUS) and optical coherence tomography (OCT) were utilised infrequently, and mostly in the public sector. Thrombus aspiration (catheter-based extraction of blood clots that occlude the coronary artery) continued to be performed in low numbers, mainly in cases of acute STEMI (n=256). Its use is likely to remain limited, with the lack of clinical evidence demonstrating any benefit. Rotational atherectomy was also used in very small numbers, similar to 2016.

A total of 373 cases had adjunctive fractional flow reserve (FFR) assessed at the time of the PCI. The use of FFR to evaluate lesions of intermediate severity to guide PCI is supported by a strong evidence base (15). While the uptake of FFR appeared to be quite low, the number reported here does not include cases where FFR was performed but there was no subsequent PCI. It is therefore an underestimate of the total number of FFR cases actually performed across Victoria.

The use of specialised devices for patients with cardiogenic shock such as intra-aortic balloon pumps (IABP) and extracorporeal membrane oxygenation (ECMO) was very limited and no different to previous years. The vast majority of these devices were used in the public sector.

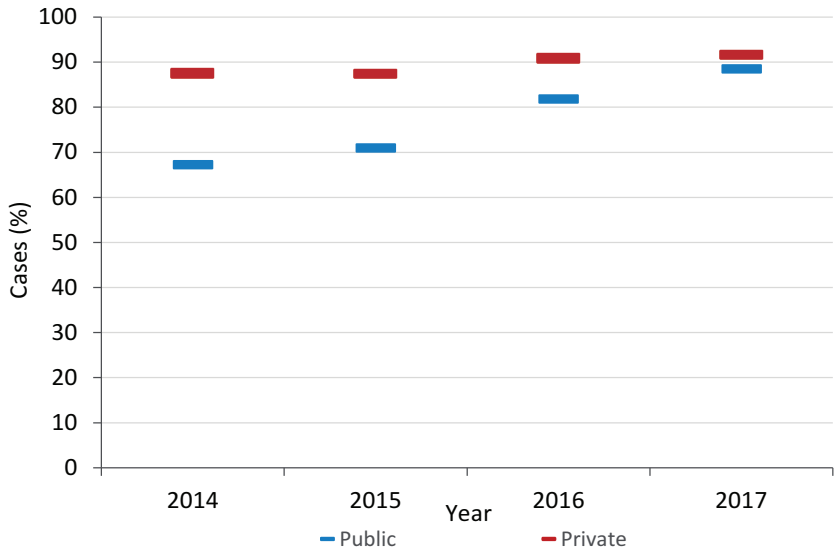
Table 9: Adjunctive device use

Adjunctive device type	All sites (N=10792)	Public (n=6634)	Private (n=4158)
	N (%)	N (%)	N (%)
Intravascular ultrasound	135 (1.3)	102 (1.5)	33 (0.8)
Optical coherence tomography	46 (0.4)	33 (0.6)	13 (0.3)
Thrombus aspiration device	291 (2.7)	257 (3.9)	34 (0.8)
Rotational atherectomy	137 (1.3)	75 (1.1)	62 (1.5)
Fractional flow reserve	373 (3.5)	194 (2.9)	179 (4.3)
IABP	67 (0.6)	59 (0.9)	8 (0.2)
ECMO	15 (0.1)	13 (0.2)	2 (<0.1)

Drug Eluting Stents

Selection of drug eluting stents (DES) rather than bare metal stents has continued to grow. In 2017, they were utilised in 90% of cases overall - an increase of 5% over the previous year. DES use in Victoria was higher in 2017 compared to other Australian state-based registries (16), but still not quite at the near 100% penetration seen in large European registries (17). Furthermore, there was still substantial variation among hospitals, ranging from 64-97% across the 30 hospitals in VCOR. Previously, this variation was strongly influenced by hospital sector, with fewer DES used in the public system due to cost restrictions and funding arrangements. However, in the last 2 years, the cost of DES has fallen and the gap between hospital sectors has substantially narrowed (88% public sector vs 92% private sector) (Figure 18).

Figure 18: Trends in DES usage by hospital sector: 2014 - 2017



Glycoprotein IIb/IIIa receptor inhibitor use

The glycoprotein (GP) IIb/IIIa receptor inhibitors are a potent class of anti-platelet medication, now predominantly used as second-line agents in high-risk PCI or when there is large intracoronary thrombus burden. Their use has been steadily declining due to a number of factors including a greater range of oral anti-platelets now available, the more widespread practice of oral anti-platelet pre-loading and improvements in angioplasty equipment. In 2017, GP IIb/IIIa receptor inhibitors were used in 901 cases (8.3%) – the lowest annual rate over the 4-year period from 2014-2017. The drugs' greatest use was still among patients with acute STEMI (n=652), 72% of total GP IIb/IIIa receptor inhibitor use and 29% of the acute STEMI cohort. They were prescribed to a lesser extent in NSTE-ACS (n=176), 20% of total GP IIb/IIIa receptor inhibitor use and 1.4% of the NSTE-ACS cohort and rarely in non-ACS cases (73 of 4923 cases).

Arterial Access

A significant change in PCI practice over the past 4 years has been the increased use of the radial artery for arterial access. In 2017, radial access was utilised in at least 50% of cases in both the public and private sectors for the first time in Victoria. Figure 19 demonstrates the growth of radial access and the concomitant decline in femoral access use over the previous 4 years.

Radial access has a number of potential advantages over femoral access, including lower bleeding rates, increased patient comfort and improved outcomes – especially in STEMI. While rates have increased, radial use in Victoria is still substantially lower than reported rates in international PCI registries (17, 18) and VCOR will continue to monitor this trend closely.

Figure 19: Trends in arterial access: 2014 - 2017

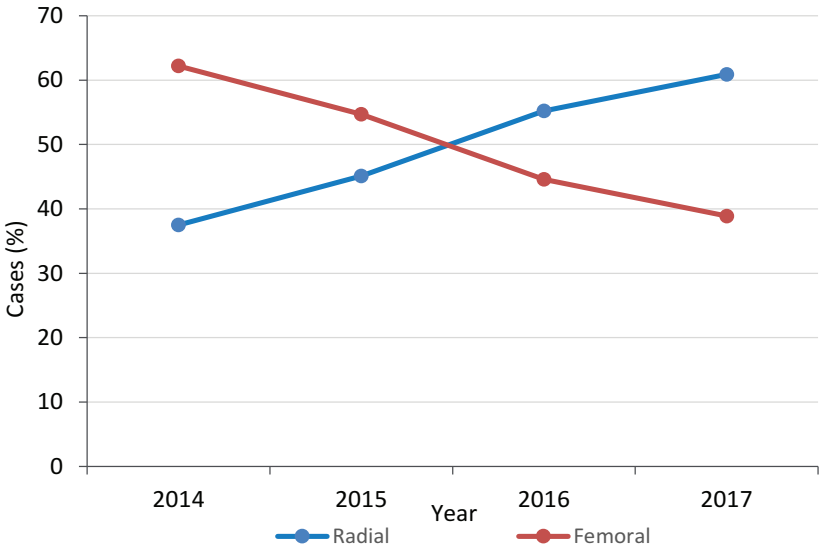


Figure 20 demonstrates the comparative uptake of radial access among individual hospitals. As in previous years, there was significant variation, with uptake ranging from 27-100%. The private sector still utilised femoral access more commonly than the public sector, although radial use continued to grow with the two approaches used evenly in private hospitals (Figure 21).

Figure 20: Arterial access route by hospital

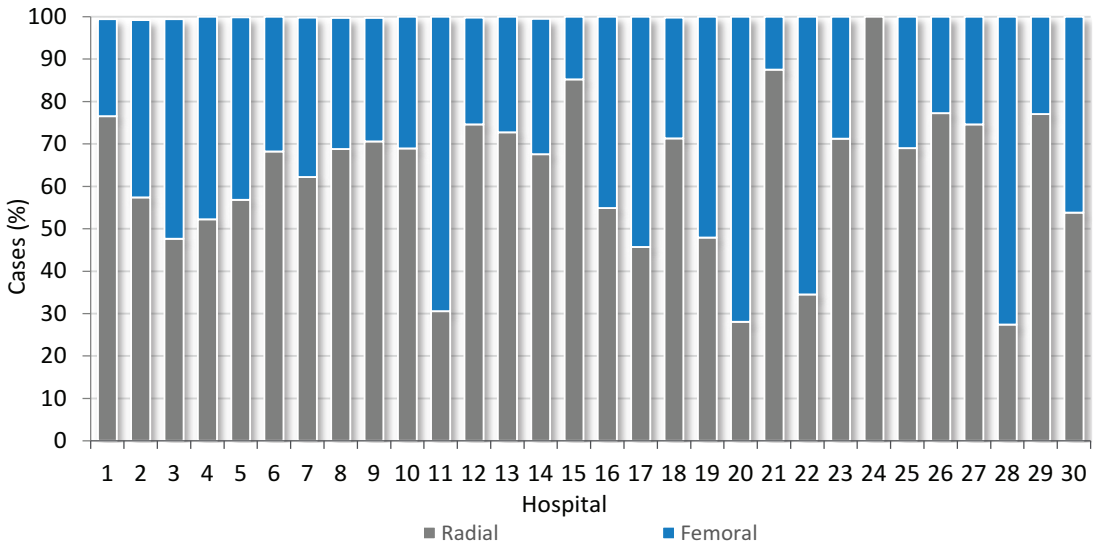


Figure 21: Arterial access route in public and private hospitals

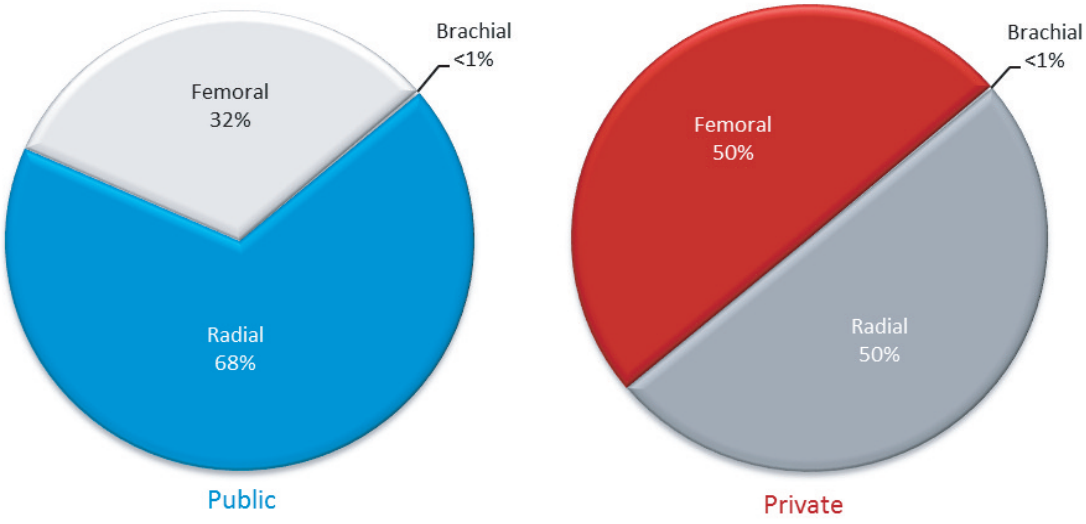
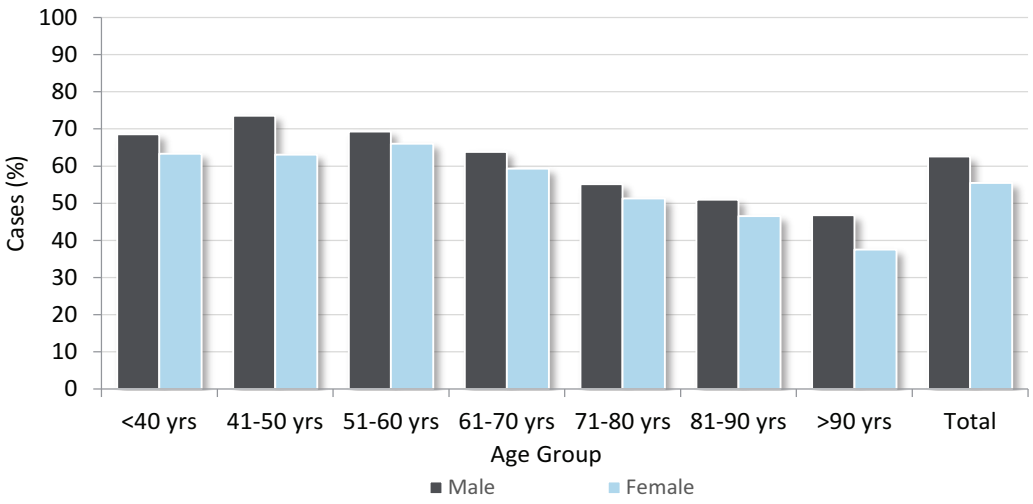


Figure 22 illustrates that radial access was selected more commonly in males across all age groups with an overall rate of 62.6% in males and 55.5% in females. Interestingly, the largest gap in radial access use between genders was among the 41-50 years age group. Rates of radial approach declined with increasing age, falling below the 50% benchmark for patients over 80 years (49% >80 years vs 62% <80 years).

Figure 22: Radial artery access by gender and age group



PCI for Acute STEMI

PCI, when used as the primary reperfusion strategy for patients with acute STEMI (primary PCI), is an area of special interest for performance assessment and benchmarking. As a time-critical treatment, it requires very high standards of efficiency to achieve the best outcomes for patients and health services are expected to comply with state and national performance targets. Yet, hospitals often face limitations to their ability to provide around-the-clock emergency service.

In 2017, 1,957 patients underwent PCI within 24 hours of the onset of an acute STEMI. Of these, 1706 patients underwent primary PCI – defined as presenting from the community within 12 hours of symptom onset and not receiving prior thrombolytic therapy. Other sub-categories of patients undergoing PCI within 24 hours of STEMI onset are shown in Table 10.

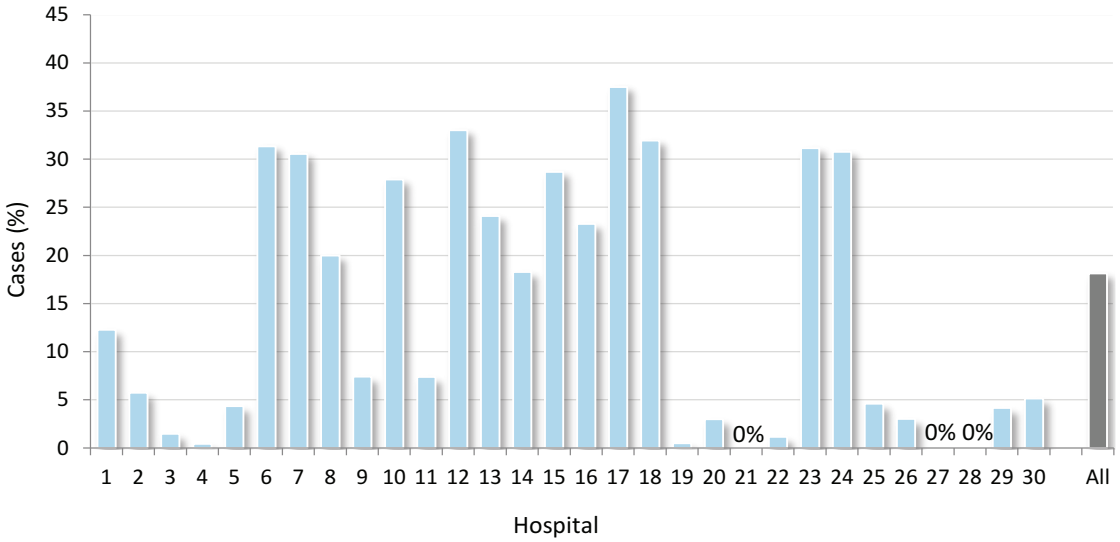
Table 10: Sub-categories of patients undergoing PCI for STEMI within 24 hours

PCI for acute STEMI sub-categories	All sites (N=1957)	Public (n=1755)	Private (n=202)
	N (%)	N (%)	N (%)
Primary PCI* (<12 hrs, no lytic)	1706 (87.2)	1525 (86.9)	181 (89.6)
Rescue PCI (<24 hrs, previous lytic, unstable)	87 (4.4)	78 (4.4)	9 (4.5)
Pharmaco-invasive PCI (<24 hrs, previous lytic, stable)	164 (8.4)	152 (8.7)	12 (5.9)

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

PCI for acute STEMI represented 18% of the total 2017 PCI caseload. Patients were predominantly treated in the public sector (90% of all STEMI cases), accounting for 26% of the public hospital workload compared with 5% in the private sector. The proportions of cases treated for acute STEMI across hospitals is shown in Figure 23. A number of private hospitals did not offer acute PCI services in 2017.

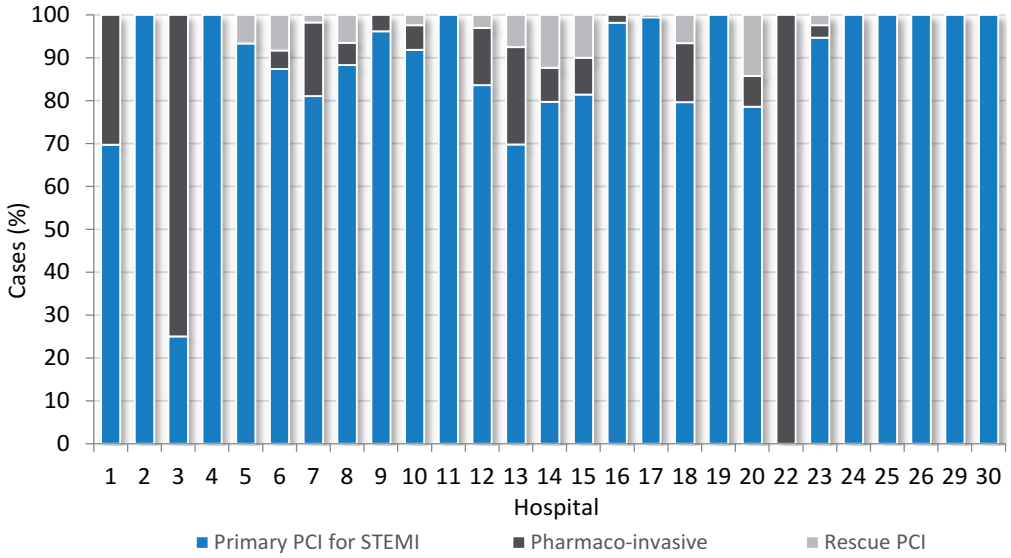
Figure 23 Acute STEMI cases as a proportion of overall case numbers by hospital



Hospitals 4, 19, 22, 24, 26 & 29 had low Acute STEMI numbers (n=<5). Hospitals 21, 27 & 28 had Nil Acute STEMI cases.

Figure 24 shows the relative proportions of acute STEMI PCI sub-categories among hospitals. Although the predominant subgroup in nearly all hospitals was primary PCI, there was notable variation in the amount of work dedicated to rescue PCI and pharmaco-invasive PCI across hospitals.

Figure 24: PCI treatment type for acute STEMI patients by hospital



Hospitals 4, 19, 22, 24, 26 & 29 had low Acute STEMI numbers (n=<5). Hospitals 21, 27 & 28 had Nil Acute STEMI cases.

Compared with the rest of the cohort, acute STEMI patients were younger (62.5 ± 12.8 years vs 67.3 ± 11.5 years), and had fewer traditional cardiac risk factors such as diabetes (14.4% vs 23.4%), and peripheral vascular disease (1.1% vs 3.9%). The acute STEMI cohort also had fewer previous revascularisation procedures including previous PCI (11.4% vs 37.4%) and coronary artery bypass grafting (2.1% vs 8.4%). Patients with acute STEMI in the private sector were older (66.8 ± 12.1 private sector vs 62 ± 12.8 public sector), but had similar gender and risk profiles.

Primary PCI for Acute STEMI

Door-to-balloon times

For patients presenting from the community to a PCI-capable hospital with an acute STEMI within 12 hours of symptom onset, the door-to-balloon time (DBT) is a measure of the time taken from arrival to hospital until the time of insertion of a device to unblock the vessel (typically a balloon catheter). It reflects the efficiency of hospitals' systems and processes to provide time-critical treatment and has become a standard key performance indicator (KPI) for hospital assessment and benchmarking. For 2017, VCOR continued to use the traditional benchmark target of DBT ≤90 minutes, even though a 2016 update of the national guidelines set an ideal DBT target of ≤60 minutes (10, 19). The older benchmark was kept for this report as it was considered that more time was needed for the new benchmark target to be acknowledged and integrated into routine delivery of care.

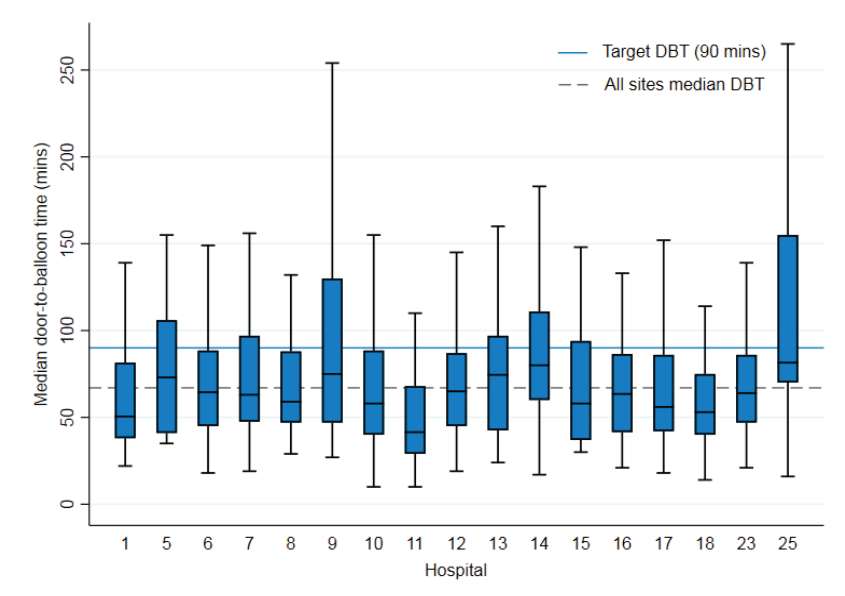
The median door-to-balloon time for 2017 was 63 minutes (IQR: 4, 89) (Table 11) – an improvement over the previous 3 years (20). For the first time since the registry's commencement in 2013, all hospitals achieved a median door-to-balloon time within the recommended ≤90 minutes benchmark (Figure 25).

Table 11: Door-to-balloon times: 2014-2017

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

**Excludes inter-hospital transfers and in-patient STEMIs*

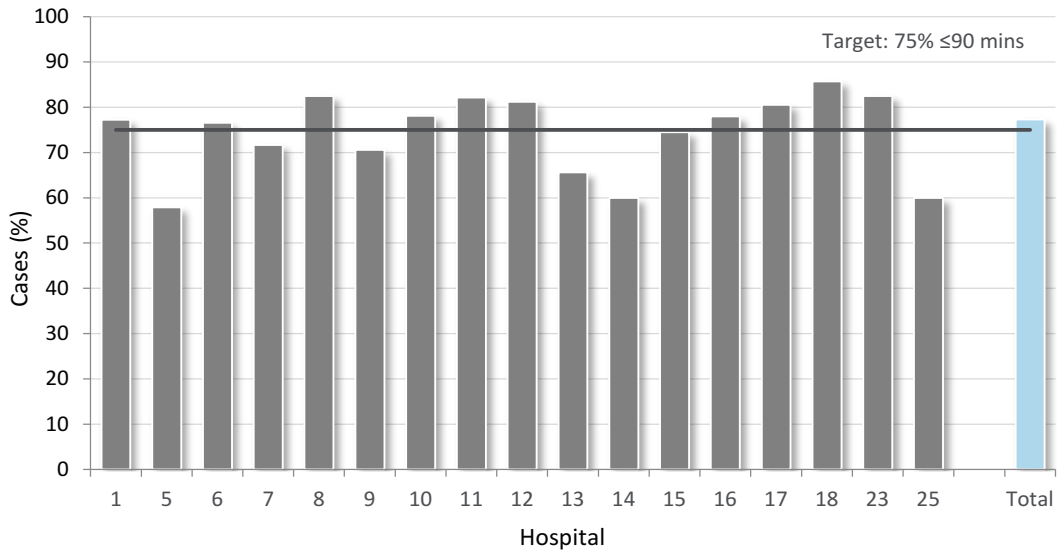
Figure 25: Door-to-balloon time for primary PCI cases by hospital



Hospitals 2,3,4,19,20,21,22,24,26,27,28,29 & 30 not included (Primary PCI cases n<5)

Although widely accepted, the use of a median value for a hospital's door-to-balloon time tends to over-estimate actual performance. The related compliance benchmark of ≥75% cases achieving a DBT≤90mins is this registry's preferred measure of performance. The DBT compliance for the overall cohort was 77%, surpassing the international benchmark target of ≥75% of cases (21). While there was variation among hospitals (range 58% to 88%), the number of hospitals that achieved the benchmark was higher in 2017 than in the previous 3 years and the gap between the best and worst performing hospitals has narrowed (Figure 26).

Figure 26: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes by hospital



Hospitals 2,3,4,19,20,21,22,24,26,27,28,29 & 30 not included (Primary PCI cases n<5)

Notification to hospitals of the imminent ambulance arrival of an acute STEMI patient is referred to as pre-hospital notification (PHN). This practice allows hospitals to activate the cardiac catheterisation laboratory team and set up rapid transfer from hospital entrance to catheter laboratory to minimise delays to the commencement of the PCI. Table 12 demonstrates the positive impact of PHN on door-to-balloon times with lower median DBT and higher proportion of cases achieving the compliance benchmark of ≥75% cases with DBT≤90mins.

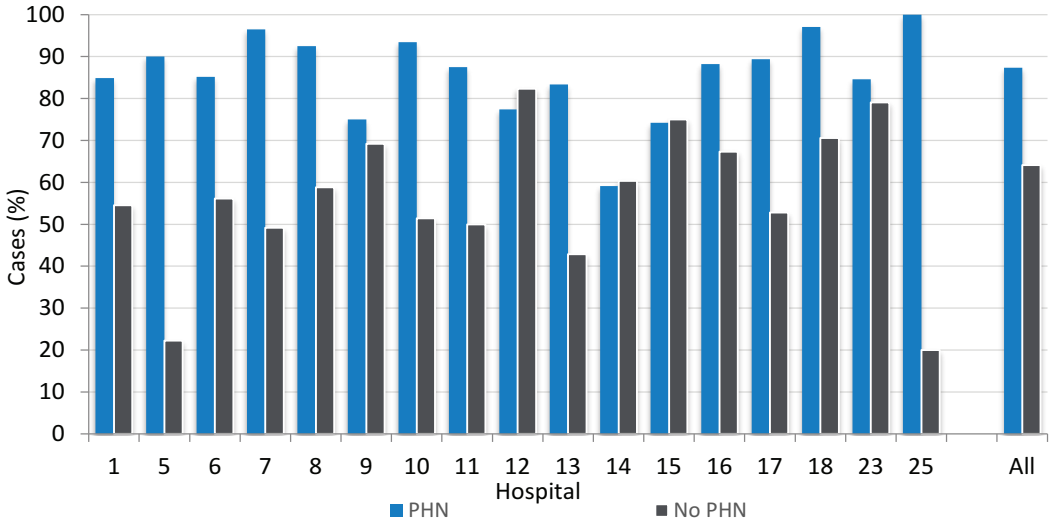
Table 12: Door-to-balloon time for primary PCI cases

Door-to-balloon Time	Primary PCI* (all cases)	Primary PCI* (PHN only†)	Primary PCI* (no-PHN†)
	(N=1423)	(n=807)	(n=616)
Median – mins (IQR)	63 (44, 89)	53 (40, 74)	78 (55, 106)
Proportion of cases ≤90 mins (%)	77.3	87.4	64.1

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

All hospitals offering primary PCI services participated in PHN with Ambulance Victoria, although there was variation in the proportions of cases with PHN across hospitals (range 23% - 86%) with an average of 57% for the overall cohort. All but two hospitals were able to reach the target of ≥75% cases with DBT≤90mins with pre-hospital notification (Figure 27).

Figure 27: Percentage of primary PCI cases with door-to-balloon time ≤90 minutes – pre-hospital notification (PHN) vs no pre-hospital notification

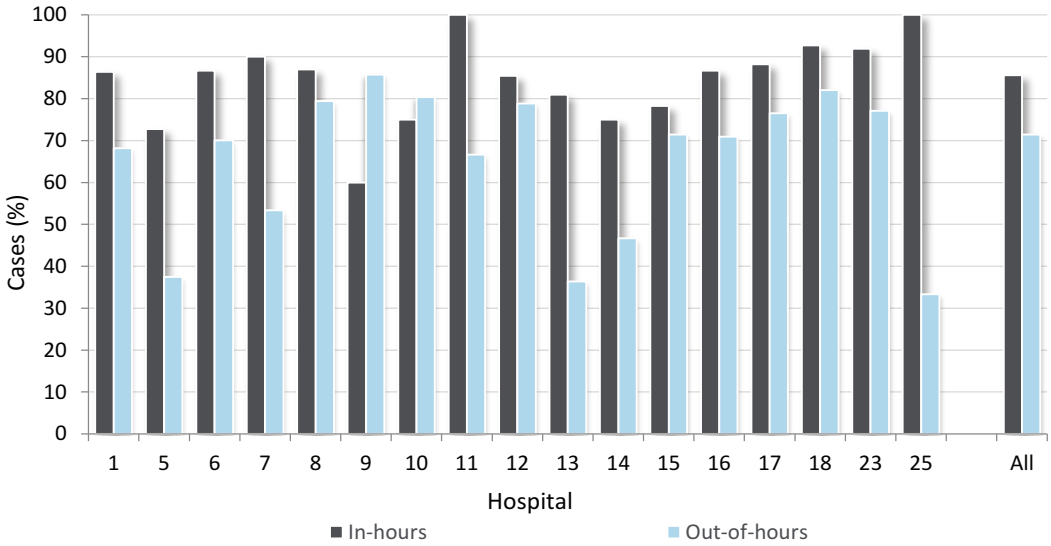


Hospitals 2,3,4,19,20,21,22,24,26,27,28,29 & 30 not included (Primary PCI cases n<5)

In-hours versus out-of-hours presentation

Cases that are performed outside normal working hours add additional pressures to the systems and processes required to deliver timely treatment for acute STEMI. In 2017, the proportion of STEMI cases treated out-of-hours was 59%, with the variation among hospitals ranging from 34-70%. As in previous reports, most hospitals had longer delays to the commencement of the procedure after-hours (Figure 28). Yet, the gaps in performance between in-hours and after-hours cases was smaller overall in 2017 than in previous years. Seven of the 17 sites achieved the DBT compliance benchmark of ≥75% cases out-of-hours.

Figure 28: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes – in-hours vs out-of-hours presentation



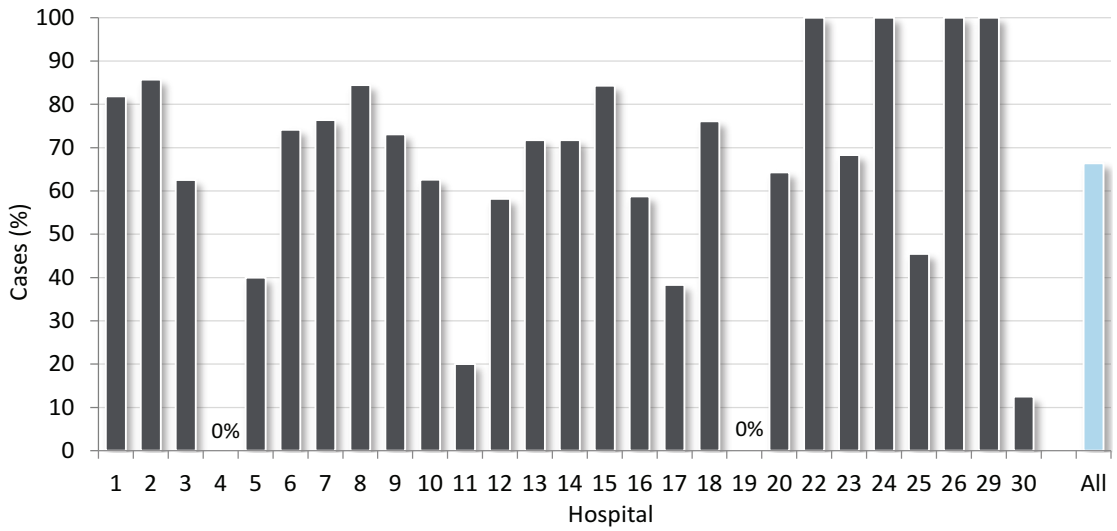
Hospitals 2,3,4,19,20,21,22,24,26,27,28,29 & 30 not included (Primary PCI cases n<5)

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

Radial access for Acute STEMI

Radial artery access is emerging as a performance indicator in primary PCI because of the strong evidence base for improved outcomes with its use (22). The proportion of cases utilising the radial approach has been increasing over the past 4 years. In 2017, the rate was 66% - the highest seen so far and a 6% absolute increase from the previous year. While there was still some variation in radial use across hospitals, it is notable that 4 sites used the radial approach in 100% of their STEMI cases (Figure 29).

Figure 29: Radial access rates in acute STEMI cohort by hospital



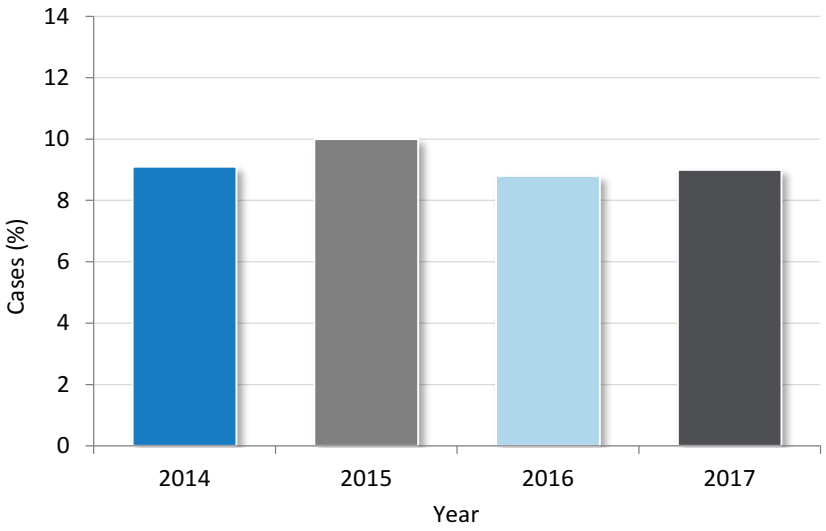
Low rate of acute STEMI cases for hospitals 4, 19, 22, 24, 26, 29 (n<5), 2, 3 and 30 (n<10).

Outcomes

Lesion and Procedure Success Rates

Successful treatment of a coronary lesion is defined as a residual stenosis (the degree of narrowing at the end of the procedure) of less than 10% following stenting or less than 50% following balloon angioplasty alone. Procedural success requires both the successful treatment of all lesions and the absence of any major in-hospital complications such as stent thrombosis, stroke or myocardial infarction. In 2017, the mean lesion success rate was 95% (range across hospitals 84%-100%) and the mean procedural success rate was 91% (range across hospitals 79%-97%). Rates of lesion and procedural success and failure (Figure 30) have been very stable over the period from 2014-2017.

Figure 30: Unsuccessful PCI procedure rates: 2014-2017



Trends in patient and lesion factors associated with an unsuccessful procedure were analysed for the first time. Table 13 demonstrates differences in clinical and lesion features among successful and failed PCI cases. Unsuccessful procedures were more commonly associated with diabetes, previous stroke, poor renal function, poor left ventricular function and cardiogenic shock, but not age or gender. Chronic total occlusion (CTO) lesions were nearly 8 times more commonly associated with failed procedures.

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

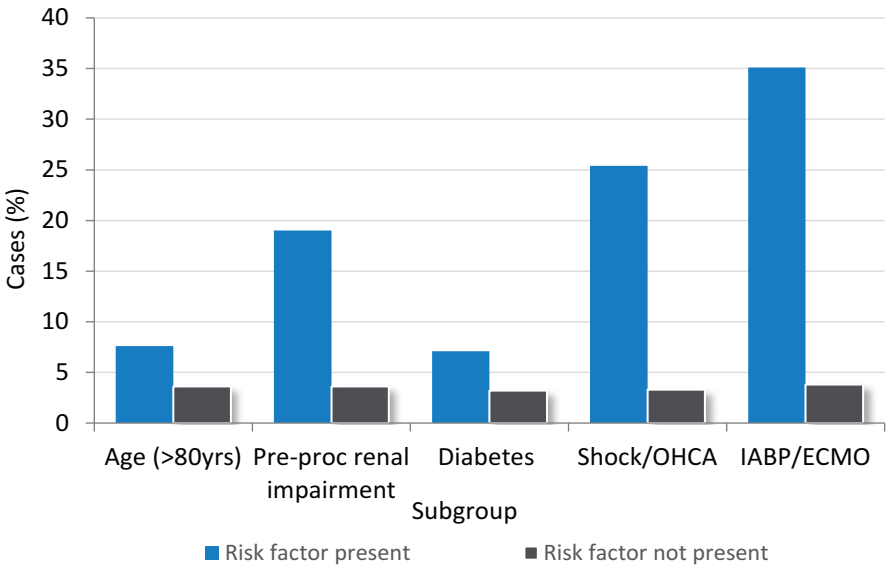
Patient characteristics	Successful procedure (n=9825)	Unsuccessful procedure (n=967)
Age – years (Mean ±SD)	66.3 (±11.8)	67.8 (±12.7)
	N (%)	N (%)
Gender - female	2389 (24.3)	242 (25.0)
Diabetes	2104 (21.4)	241 (24.9)
PVD history	333 (3.4)	34 (3.5)
CBVD history	368 (3.7)	56 (5.8)
Previous PCI	3233 (32.9)	298 (30.8)
Previous CABG	707 (7.2)	80 (8.3)
eGFR<45/Renal replacement therapy	779 (7.9)	148 (15.3)
Normal LVEF (>50%)	5987 (68.2)	430 (51.1)
Mild LVEF (45-50%)	1598 (18.2)	164 (19.5)
Moderate LVEF (35-44%)	846 (9.6)	117 (13.9)
Severe LVEF (≤35%)	347 (4.0)	131 (15.6)
Shock/OHCA	145 (1.5)	163 (16.9)
Out-of-hours case	1865 (19.0)	273 (28.2)
Public hospital	5372 (54.7)	594 (61.4)
Chronic total occlusion	221 (2.2)	162 (16.8)
ACC/AHA B2/C lesion	5804 (59.1)	764 (79.0)

New Renal Impairment

Angiographic contrast agents used during PCI may cause acute impairment of renal function, especially in patients with pre-existing kidney disease, diabetes, hypertension or advanced age. Its incidence is an important outcome measure for PCI, as there are methods to minimise contrast-induced nephropathy when the risk is appropriately identified and managed.

For 2017, the overall rate of new renal impairment (NRI), defined as a serum creatinine rise >44.2 µmol/L or 25% above pre-procedural value within 5 days of PCI procedure, was 4.1%. However, the risk of NRI was higher among particular high-risk groups as shown in Figure 31. New renal impairment was highest among cases of cardiogenic shock and out-of-hospital cardiac arrest – especially those that required mechanical support.

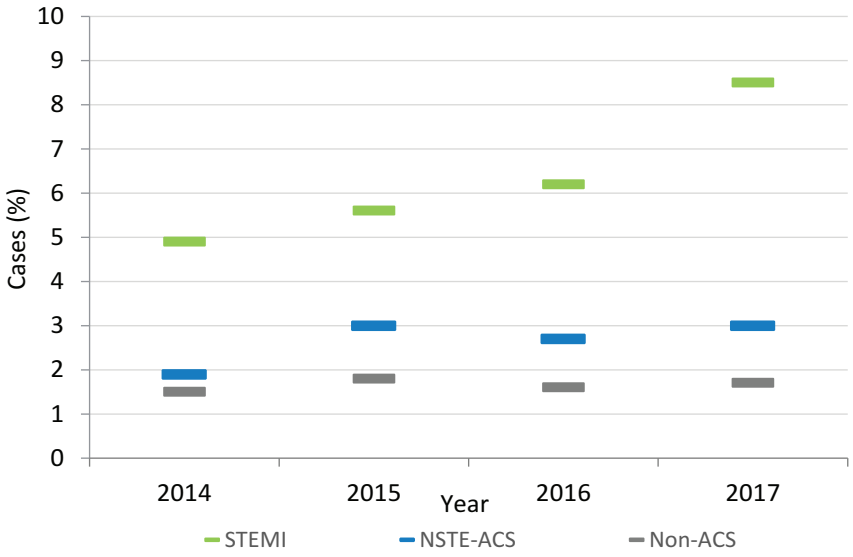
Figure 31: Rate of new renal impairment in selected high-risk sub-groups



Data available for 7564 cases

The incidence of new renal impairment for the period 2014-2017 by clinical presentation is shown in Figure 32. Acute STEMI had the highest rates of NRI, which trended higher over the 4-year period. NRI rates for NSTE-ACS and non-ACS cases were more stable. Admittedly, there is a probable bias towards detecting NRI in higher-risk cases, as these patients are more likely to have renal function measured post-procedure. Nevertheless, the incidence of NRI in acute STEMI over time may represent a clinically significant trend, and the registry will continue to follow this.

Figure 32: Trends in rates of new renal impairment for period 2014-2017 by clinical presentation



Referral to Cardiac Rehabilitation

National guidelines recommend routine referral to cardiac rehabilitation and/or secondary prevention programs following admission with acute coronary syndrome (19). Yet, referral rates are often low (23). In 2017, the overall rate for referral to cardiac rehabilitation among VCOR hospitals following a PCI was 72%. Rates varied by clinical presentation (Table 14) and were higher among ACS cases at 81% and lower in the private sector compared to the public sector (65% vs 77%).

Table 14: Referral rates to cardiac rehabilitation by clinical presentation

Clinical presentation	Cases with data available	Rehabilitation referral rate
	N	N (%)
STEMI	2102	1758 (83.6)
NSTE-ACS	3109	2442 (76.6)
Non-ACS	5299	3470 (65.5)
All cases	10591	7670 (72.4)

Compliance with Guideline-Recommended Discharge Medications

Several classes of medication are recommended for treatment of coronary disease, with dual anti-platelet therapy (DAPT) and statins indicated for virtually all patients undergoing PCI with stent insertion. Compliance is never complete though because of contra-indications or other reasons such as allergy or drug intolerance. For the 2017 cohort, prescription of dual anti-platelet therapy and statins was generally high at 93%, although there was an apparent difference in statin use by hospital sector (Table 15).

Table 15: Discharge prescription rates of dual antiplatelet therapy and statins

	All sites	Public	Private
	N (%)	N (%)	N (%)
Dual antiplatelet therapy	10076 (94.1)	6227 (94.6)	3849 (93.2)
Statins	9771 (93.0)	6116 (95.3)	3655 (89.3)

Table 16 outlines the rates of prescription of the various drug classes for coronary disease by clinical presentation. As expected, the greatest compliance rates were seen among the high acuity condition of STEMI. Considering the five main evidence-based drugs used after an ACS presentation (aspirin, additional anti-platelet, statin, beta blocker (BB) and ACE inhibitor (ACE-I)/angiotensin receptor blocker (ARB)), the proportion of patients discharged on at least 4 of these 5 medications was 83%.

Table 16: Discharge prescription rates by clinical presentation

	DAPT	Statins	BB	ACE-I/ARB
	%	%	%	%
STEMI	97.0	90.0	90.0	84.0
NSTE-ACS	94.0	96.0	73.0	75.0
Non-ACS	91.0	95.0	58.0	65.0

Key Performance Indicators

VCOR reports clinically relevant procedural outcomes in terms of the following key performance indicators (KPIs):

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

In order to report risk-adjusted outcomes, VCOR developed a risk-adjustment model for 30-day all-cause mortality (24). We also explored in a sub-group model whether the extreme high-risk conditions of cardiogenic shock and out-of-hospital cardiac arrest should be excluded to optimise predictive accuracy. Our modelling technique resulted in high predictive accuracy that was comparable with the best performing risk-adjustment models worldwide. However, in contrast to some other risk-adjustment models for cardiac registries, our model was robust enough not to require the exclusion of extreme high-risk cases to maintain its high predictive accuracy. The clinical characteristics used to construct the VCOR risk-adjustment model for 30-day mortality were:

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

In-hospital Mortality

The overall unadjusted in-hospital mortality rate for 2017 was 1.8%. For patients without high-risk presentations of STEMI, shock or out-of-hospital cardiac arrest, the in-hospital mortality rate was low at 0.3% (Table 17). Mortality remained low for uncomplicated STEMI (1.9%) and high among patients with shock or out-of-hospital cardiac arrest – 37% without associated STEMI and 42% associated with STEMI.

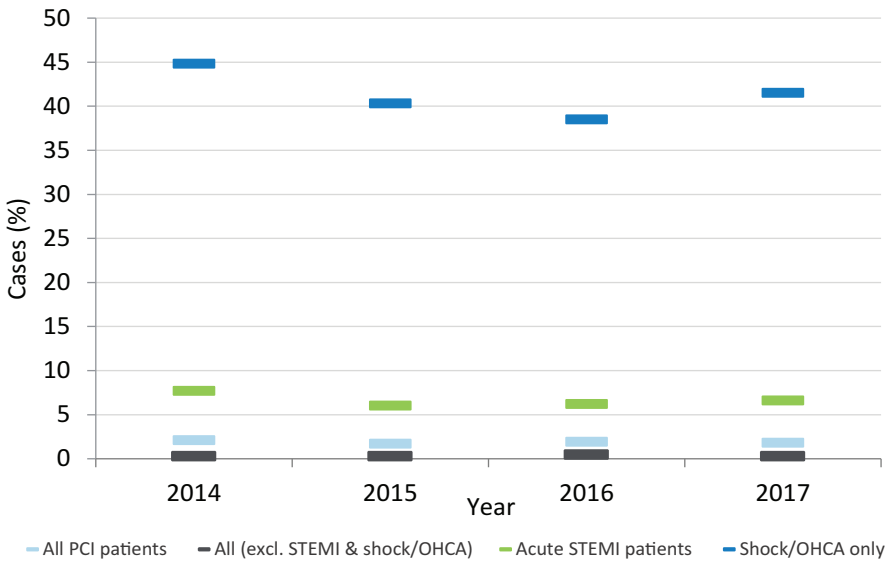
Table 17: Unadjusted in-hospital mortality rates for selected patient groups

Clinical presentation	Total	In-hospital mortality rate
	N	N (%)
All PCI patients*	10776	190 (1.8)
Patients without STEMI or shock/intubated OHCA	8471	29 (0.3)
Acute STEMI patients	1953	128 (6.6)
Shock/intubated OHCA patients	301	125 (41.5)

**Cases with multiple procedures were excluded to avoid mortality being counted more than once (n=16)*

Figure 33 illustrates trends in in-hospital mortality rates over the period from 2014-2017. Overall rates have remained relatively consistent for the 4-year period.

Figure 33: Comparative in-hospital mortality trends for different clinical presentation groups (2014 – 2017)



In-hospital major bleeding

The definition of major bleeding was based on the international Bleeding Academic Research Consortium (BARC) standardised bleeding definitions for cardiovascular clinical trials (25), which have been shown to predict adverse outcomes, including prolonged hospital stay, increased risk of ischaemic events and higher mortality (26). BARC bleeding categories 3 and 5 were used to determine major bleeding.

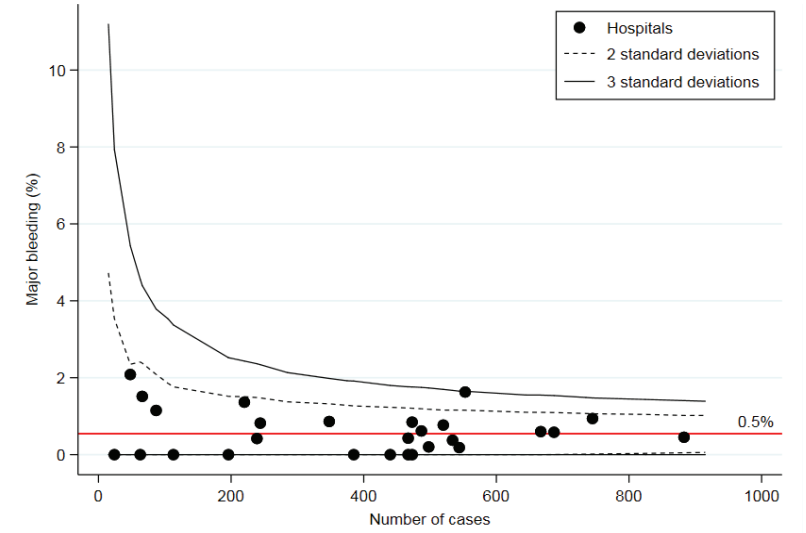
The overall in-hospital major bleeding rate in 2017 was 0.7%. Patients treated with ECMO had high rates of bleeding (9 of 15 patients, 60%). STEMI patients had a near 3-fold increase in bleeding compared with NSTE-ACS cases. Major bleeding was also more common among females than males and femoral rather than radial access cases (Table 18).

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

Sub-group	N	Major bleeding rate
Clinical Presentation		N (%)
STEMI	2240	39 (1.7)
NSTE-ACS	3218	18 (0.6)
Non-ACS	5318	14 (0.3)
Gender		N (%)
Male	8151	46 (0.6)
Female	2625	25 (1.0)
Arterial Access Route		N (%)
Radial access	6569	30 (0.5)
Femoral access	4190	39 (0.9)
Brachial access	17	2 (11.8)
Total	10776	71 (0.7)

A comparison of in-hospital major bleeding rates among participating hospitals is shown in Figure 34. There was no relationship apparent between major bleeding rates and hospital case volume.

Figure 34: Rates of in-hospital major bleeding



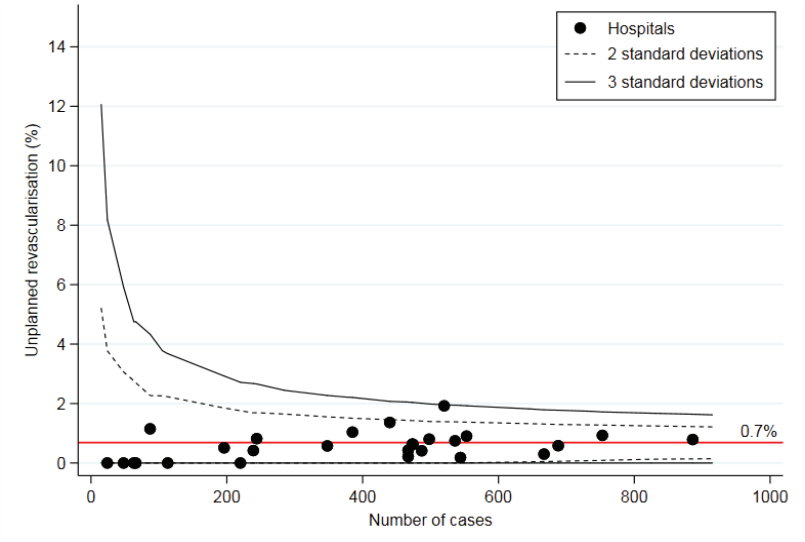
Hospitals excluded due to low PCI Ns: Site 2, 24 and 30

Excludes ECMO cases (n=15)

In-hospital unplanned revascularisation

In-hospital unplanned revascularisation refers to any unexpected revascularisation procedure (either PCI or CABG surgery) following the index PCI, and within the same admission. The measure includes any unplanned additional procedure to the coronary lesion initially treated or any other coronary lesion not otherwise planned for treatment. For 2017, the overall rate of in-hospital unplanned revascularisation was 0.7%. Figure 35 demonstrates that all participating hospitals had rates of unplanned revascularisation within control limits.

Figure 35: Rates of in-hospital unplanned revascularisation by hospital



Hospitals excluded due to low PCI Ns: Site 2, 24 and 30

A total of 42 patients underwent emergency CABG surgery. Selected clinical features and outcomes associated with emergency surgery are shown in Table 19. Nearly half the cases were in patients undergoing urgent PCI for STEMI. Approximately one-quarter of cases requiring emergency bailout with surgery occurred in hospitals without on-site surgical backup. Adverse outcomes were common in this patient group, with higher rates of in-hospital mortality and major bleeding compared with the overall patient cohort.

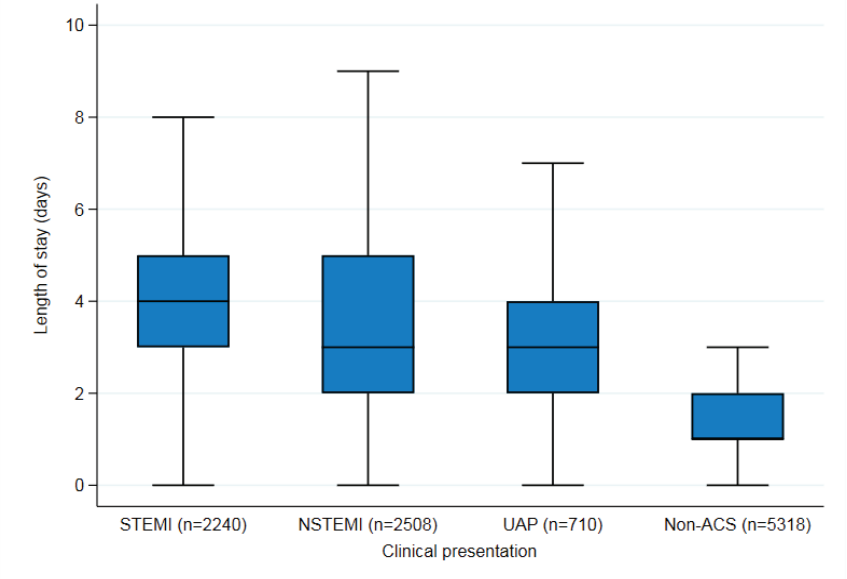
Table 19: Selected clinical features and outcomes associated with emergency CABG surgery

Presentation	Emergency CABG (N=42)
	N (%)
STEMI	19 (45.2)
Shock/OHCA	4 (9.5)
ACC/AHA B2/C lesion	20 (47.6)
Chronic total occlusion	3 (7.1)
Unprotected left main PCI	2 (4.8)
PCI performed in hospitals without on-site surgery	11 (26.2)
In-hospital outcomes	N (%)
Mortality	4 (9.5)
New MI	3 (7.1)
Major bleeding	7 (16.7)
Stroke	0 (0.0)

Length of Stay

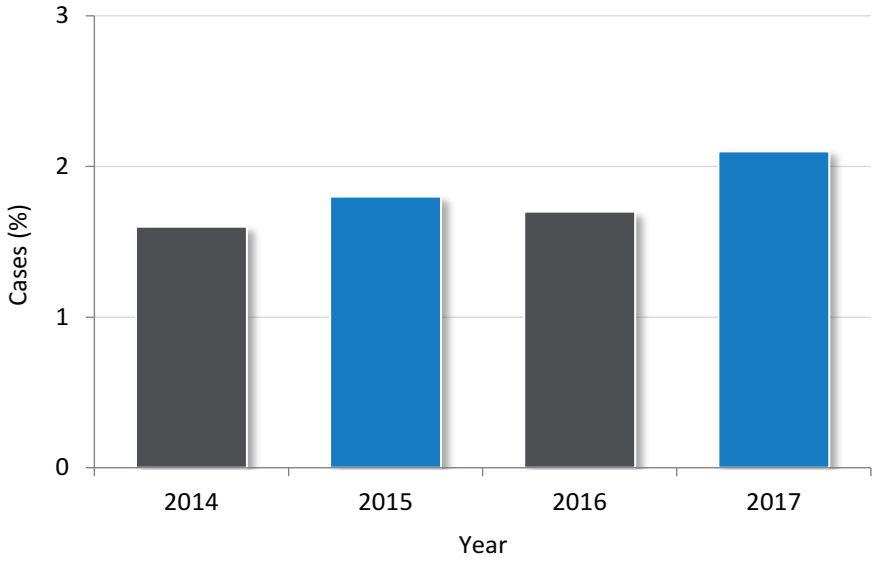
As expected, length of hospital stay was longer among cases of acute coronary syndrome, as they typically have multi-day hospital stays related to the overall management of the underlying condition. Most elective PCI cases had a length of stay of one day (Figure 36). Median length of stay was shorter among patients treated in private hospitals (3 days public vs 2 days private), likely reflecting the greater proportion of non-ACS cases treated in the private sector.

Figure 36: Length of stay by clinical presentation



The practice of discharging elective, non-emergency patients on the same day as their PCI, rather than keeping them overnight for an extended period of observation has been adopted in many European and American centres. It has a number of potential advantages including improved patient satisfaction, increased bed availability and a reduction in hospital costs. Technological improvements and the more widespread use of radial artery access has facilitated this trend, which has been found safe and efficient (27). Historically, same day discharge has been uncommon among VCOR hospitals and Figure 37 shows the actual number of cases by year for the period 2014-2017. In 2017, 174 of 230 same day discharges (76%) were from the public sector.

Figure 37: Number of cases with same-day discharge by year



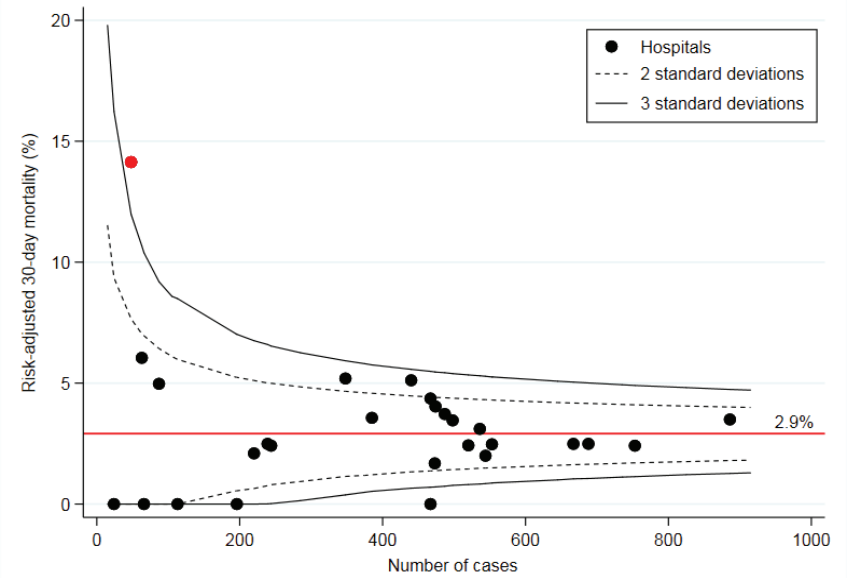
30-day mortality

The 30-day risk-adjusted mortality rate is a key outcome measure used to assess the quality and safety of hospital care. It reflects how the actual (observed) outcomes for a hospital compare with outcomes that are expected for that hospital and facilitates meaningful comparisons among hospitals by adjusting for differences in casemix, clinical and demographic factors.

The overall risk-adjusted 30-day mortality for the cohort was 2.9%. Figure 38 illustrates the comparative rates for participating hospitals. In 2017, all but one hospital had adjusted 30-day mortality rates within control limits. The one hospital that was an outlier had a low volume of cases (1 death out of 48 cases).

It is well-recognised that risk adjustment models have lower accuracy at the extremes of risk and for low-volume centres, the risk-adjusted rate may not be indicative of the true quality of their performance (28). The high mortality in the one outlier hospital was therefore interpreted with caution, with the understanding that the site will require a longer period of monitoring to establish a potentially more accurate estimate of its mortality rate. In the meantime, registry management of the outlier hospital included appropriate notification of their outlier status and an offer of assistance with the hospital's subsequent quality assurance activities.

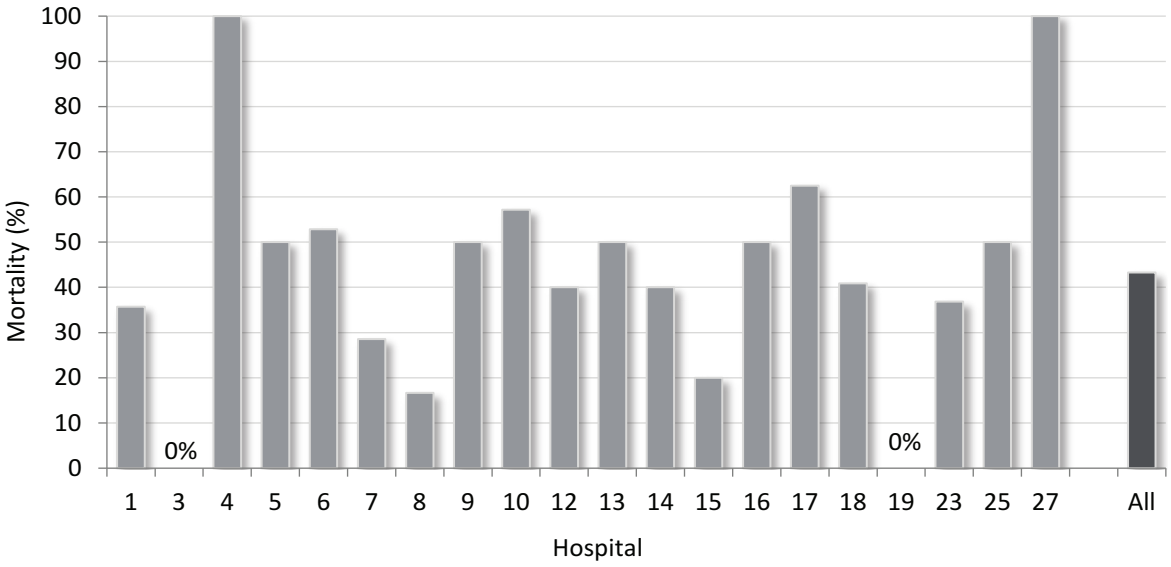
Figure 38: Risk-adjusted 30-day mortality



Hospitals excluded due to low PCI Ns: Site 2, 24 and 30

Although risk adjustment is designed to account for the influence of high-mortality conditions such as cardiogenic shock and out-of-hospital cardiac arrest, Figure 39 separately compared unadjusted 30-day mortality rates for this combined patient group to gauge the extent of variation across hospitals for these especially high-risk conditions. The majority of hospitals had mortality rates within the range of 25-50%, with the 2 hospitals with 100% mortality having just one patient each in their cohort.

Figure 39: 30-day mortality rates for cardiogenic shock and intubated OHCA patients by hospital

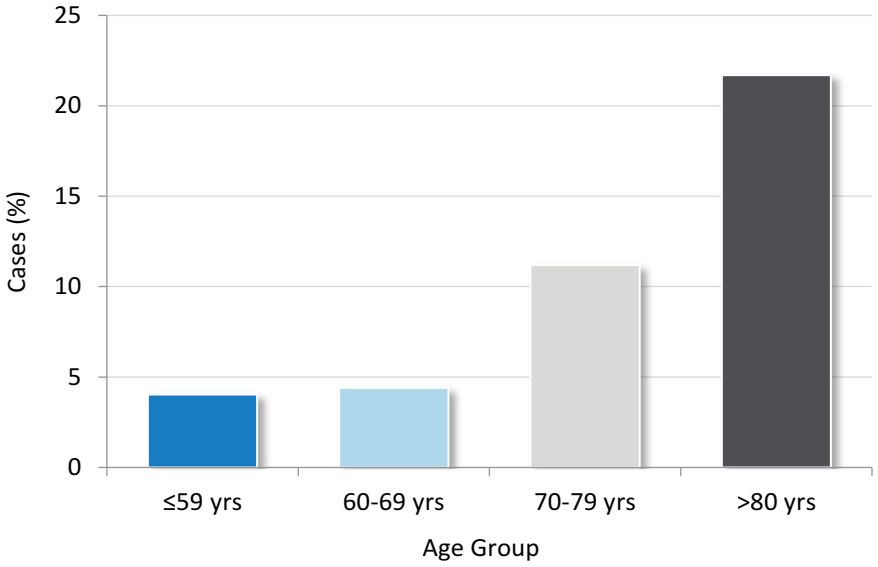


1	3	4	5	6	7	8	9	10	12	13	14	15	16	17	18	19	23	25	27	ALL
14	2	1	4	53	35	6	4	14	20	6	35	5	14	16	22	2	38	2	1	298

Hospitals 2, 11, 20, 21, 22, 24, 25, 26, 28, 29, 30 had no shock or intubated OHCA cases.

There was a clear relationship between age and 30-day mortality for patients presenting with acute STEMI, with a doubling of the rate among patients in their ninth decade compared with the previous decade (Figure 40).

Figure 40: 30-day mortality for acute STEMI by age group



30-day major cardiac cerebrovascular events (MACCE)

The composite endpoint of major adverse cardiac and/or cerebrovascular events (MACCE) includes all cases of death, new or recurrent myocardial infarction or stent thrombosis, target vessel revascularisation or stroke. The overall MACCE rate was 4.4% (Table 20). The rate dropped to 3.2% when the high-risk conditions of cardiogenic shock or out-of-hospital cardiac arrest were excluded (n=298 cases).

Table 20: Major adverse cardiac and cerebrovascular event rates

MACCE component	In-hospital events	30-day events*
	N (%)	N (%)
Total mortality	190 (1.8)	235 (2.2)
Myocardial infarction	68 (0.6)	110 (1.0)
Stroke	24 (0.2)	40 (0.4)
Definite stent thrombosis	27 (0.3)	54 (0.5)
Probable stent thrombosis	8 (0.1)	8 (0.1)
Target vessel revascularisation (TVR)†	74 (0.7)	139 (1.3)

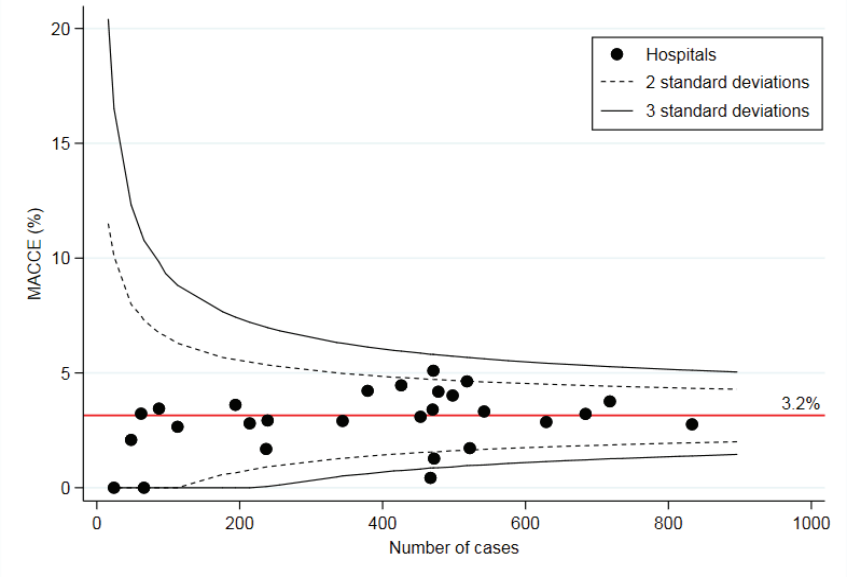
**30-day events reported include in-hospital events.*

Categories are not mutually exclusive.

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

A comparison of hospitals' performance with MACCE found that all sites were within control limits and there were no outliers related to this important composite safety outcome measure.

Figure 41: 30-day MACCE



Hospitals excluded due to low PCI Ns: Site 2, 24 and 30

Excludes all shock/OCHA cases (n= 298)

30-day stent thrombosis

Stent thrombosis was reported as a "definite" event (symptoms suggestive of an acute coronary syndrome and angiographic or pathologic confirmation of stent thrombosis) or a "probable" event (unexplained death within 30 days or target vessel myocardial infarction without angiographic confirmation of stent thrombosis). The 30-day definite stent thrombosis rate was 0.5% as shown in Table 20. There were no major differences in stent thrombosis rates among participating sites or when public and private sectors were compared.

30-day rehospitalisation

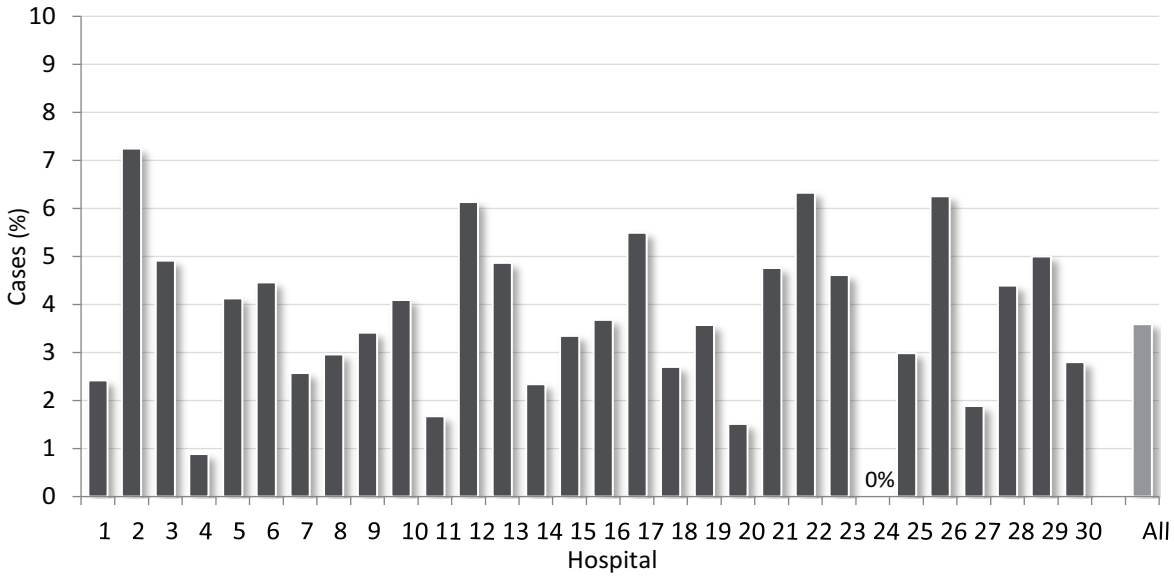
The 30-day rehospitalisation rate was 13.7% overall and essentially unchanged from the previous year. Re-admission for a cardiac indication accounted for 69% of cases, and approximately one-third were unplanned (Table 21).

Table 21: Rehospitalisation rates

Rehospitalisation Type	All Patients (N=8830)	Public Patients (n=5461)	Private Patients (n=3369)
	N (%)	N (%)	N (%)
Total readmissions	1209 (13.7)	588 (17.5)	621 (11.4)
Non-cardiac readmissions	373 (4.2)	224 (4.1)	149 (4.4)
Cardiac readmissions	836 (9.5)	397 (7.3)	439 (13.0)
Unplanned cardiac readmissions	317 (3.6)	209 (3.8)	108 (3.2)
Planned cardiac readmissions	519 (5.9)	188 (3.4)	311 (9.2)

Unplanned readmission rates have become a key indicator of hospital performance and quality of care. Comparative rates of unplanned readmissions are shown in Figure 42. Rates of unplanned cardiac readmission were similar among public and private hospitals.

Figure 42: 30-day unplanned cardiac rehospitalisation rates by hospital

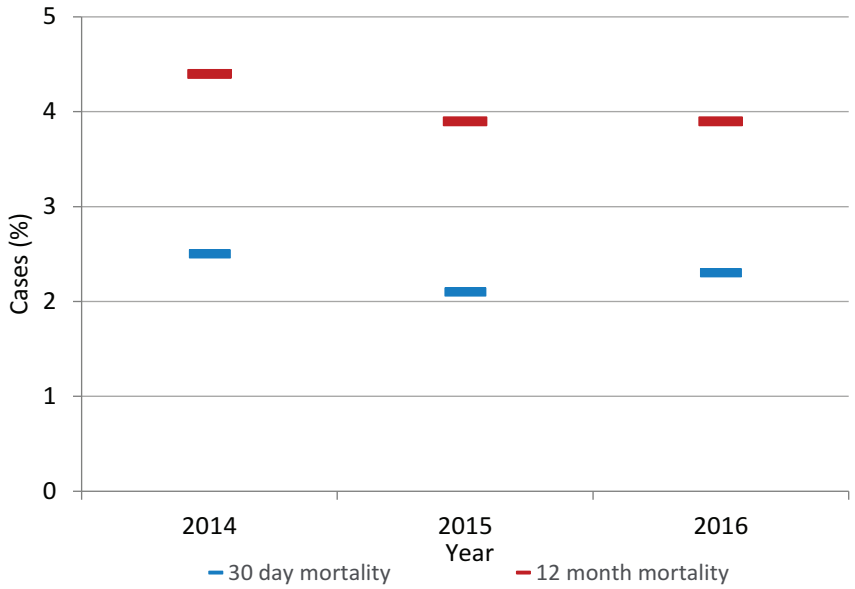


Site 24 – Low case numbers (n<5)

12-month mortality trends

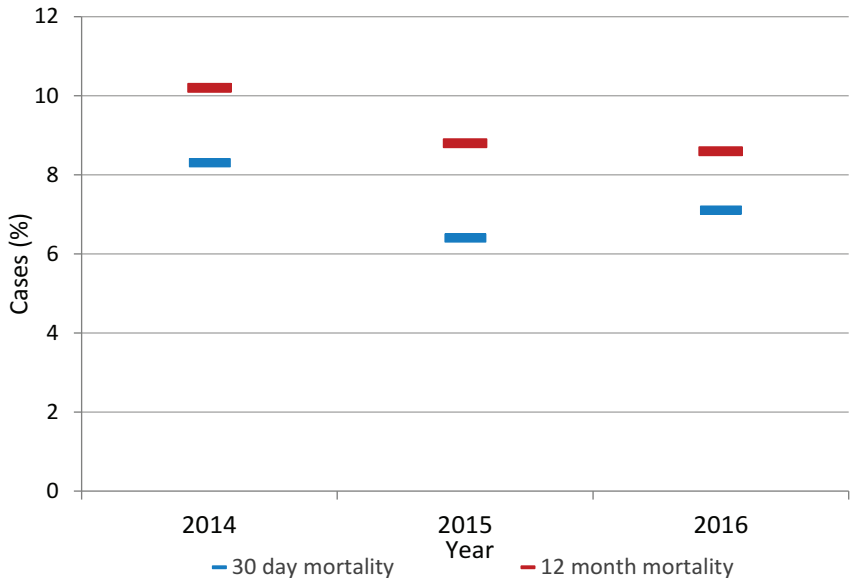
Mortality rates at 12 months were obtained through linkage with the National Death Index (NDI) - a catalogue of death records obtained from the Registries of Births, Deaths and Marriage in each state and territory. Data were available for the period 2014-2016 (Figure 43).

Figure 43: Comparison of 30-day and 12-month mortality rates 2014-2016 – All PCI cases



The trend towards lower 12-month death rates over the 3-year period appeared to be predominantly related to reductions in STEMI mortality (Figure 44).

Figure 44: Comparison of 30-day and 12-month mortality rates 2014-2016 – STEMI Cases



Quality of Life

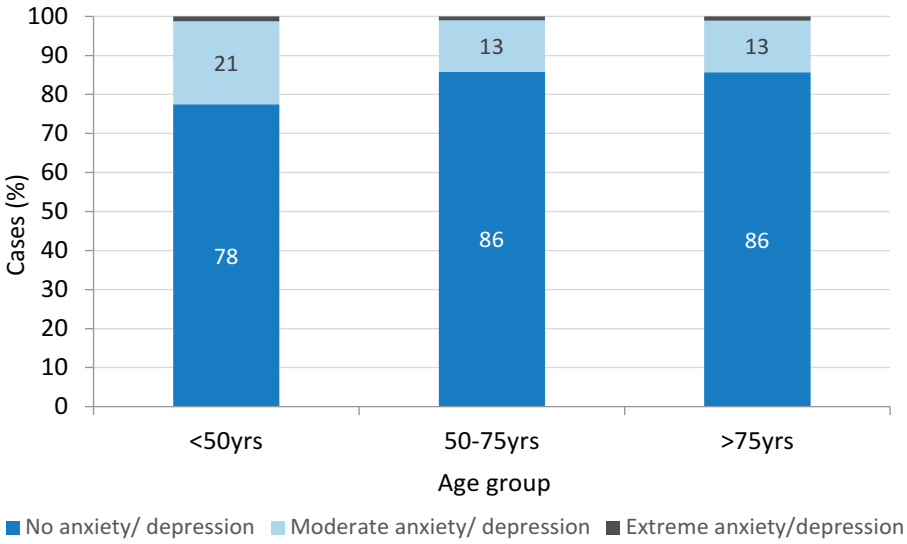
Patients were requested to rate their perceived quality of life at 30-day follow-up in a series of questions based on a standardised measure, the EQ-5D (29). Patients assessed their mobility, ability to perform usual domestic and personal care tasks, level of pain or discomfort and whether they experienced any anxiety or depression. The results are shown in Table 22.

Table 22: Quality of life metrics

PCI Cohort	No problem	Some problems	Not asked
(N=10405)	N (%)	N (%)	N (%)
Mobility	6316 (60.7)	839 (8.0)	3250 (31.2)
Personal care	6771 (65.1)	384 (3.7)	3250 (31.2)
Usual activities	6069 (58.3)	1085 (10.5)	3251 (31.2)
Pain/discomfort	6826 (60.4)	854 (8.2)	3265 (31.4)
Anxiety/depression	5729 (50.7)	932 (9.0)	4194 (40.3)

Patients were also asked to rate their own health status on a scale from 1-100, with 100 being the best a patient could remember ever feeling. Of the 63% of patients who responded, the median rating score for their own health status was 80 out of 100 (IQR: 70, 90). While responses tended to be similar among age groups divided into <50 years, 50-75 years and >75 years, younger patients were more likely to report depression and/or anxiety that was in the moderate or severe range (Figure 45). Patients' initial clinical presentation (ACS vs non-ACS) did not appear to influence subsequent quality of life ratings.

Figure 45: EQ-5D responses to anxiety/depression by age group



Management of Acute ST-Elevation Myocardial Infarction (STEMI) in Regional Victoria

Background

VCOR maintains a strong commitment to ensuring that all Victorians, regardless of their location have access to robust systems of care for cardiac emergencies. It is well recognised that patients presenting with acute coronary syndromes (ACS), away from large metropolitan centres, face significant additional challenges related to timely access to treatment. The VCOR STEMI Management module continues to monitor and report on the treatment of STEMI patients in non-metropolitan hospital settings. Through linkages with Ambulance Victoria and the VCOR PCI dataset, the STEMI module can track the complete treatment pathway of patients experiencing STEMI in regional Victoria. This includes aspects of pre-hospital care, initial emergency department management and timeliness to coronary angiography and revascularisation when clinically appropriate. VCOR developed this module for management of acute STEMI in regional Victoria because of the strong evidence base for the benefits of timely treatment, well-developed standards of care and measurable process and outcome indicators. The module was designed to focus particularly on the delivery of timely and effective reperfusion therapy and the ultimate disposition of these patients.

Registry Module Activity

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

The STEMI module has significantly expanded since its commencement in 2013. From the initial four sites in the Hume and Gippsland regions recruited to pilot the module, the project now includes 10 regional health centres providing care to STEMI patients. (Table 23). This has led to 80-100% increases in STEMI module numbers year-on-year, to provide a comprehensive assessment of process and outcomes for patients in regional Victoria experiencing STEMI. The registry promotes regular engagement with its regional stakeholders through published bulletins and biannual data summaries. VCOR has continued its regular visits to regional centres for direct engagement with local teams, incorporating the VCOR data into practice improvement for STEMI patients.

Table 23: Participation of regional Victorian hospitals in STEMI module

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

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

Data Linkage with VCOR STEMI Module

Data linkages across VCOR modules with key collaborators including Ambulance Victoria and the Victorian Admitted Episodes Dataset (VAED) continued in 2017. These important data linkages have enabled the monitoring of the entire journey of the regional STEMI patient, through presentation at the index hospital, choice and timing of reperfusion therapy, patient transfer and subsequent cardiac interventions.

Patient Characteristics

In 2017, 287 patients presented with suspected STEMI to the 10 participating regional hospitals. Of these, 88 (31%) were ineligible for thrombolysis for reasons that included late presentation (n=24), significant comorbidities (n=12), initially uncertain diagnosis (n=25) or contra-indication to thrombolysis (n=18). Forty-eight (17%) patients underwent emergency primary PCI. This was an increase in primary PCI cases over previous years and was largely driven by the expansion of PCI services at one large regional centre. The remaining 145 patients all received appropriate thrombolytic therapy, either in the emergency department (n=126) or through the pre-hospital thrombolysis scheme administered by Ambulance Victoria (n=19) since 2014. Six patients were eligible, but did not receive thrombolysis.

The mean age for the 2017 regional STEMI cohort was 67 years (range 23-96 years). Table 24 compares selected patient characteristics over the 3-year period from 2015-2017. The mean age has remained largely unchanged for the last 3 years, as has been the gender distribution, with a predominance of males.

Table 24: Regional STEMI patient characteristics 2015-2017

Patient characteristic	2015 (N=138)	2016 (N=148)	2017 (N=287)
Age – years (mean ±SD)	66 ±12	66 ±14	67 ±15
Presenting heart rate - BPM (mean ±SD)	79.1 ±24.8	81.5 ±22.4	83 ±25.0
	%	%	%
Gender – female	34.1	33.1	35.9
Pre-hospital thrombolysis*	10.1	6.1	6.6
Site of infarction – anterior	40.6	33.8	40.0
Site of infarction – inferior	51.4	48.5	46.0
Site of infarction -posterior	2.2	6.8	3.0
Site of infarction – other	5.1	10.9	11.0

**Ambulance presentation only*

Of the 287 patients, 159 were brought in by ambulance, and 101 patients self-presented to an emergency department. Five percent of STEMIs were current in-patients at regional centres and approximately 4% of patients arrived from another treating hospital (inter-hospital transfer). Most patients (84%) travelled ≤50km to reach the treating hospital, whereas 8% had to travel more than 75kms for treatment.

Time Delays to Transfer

For all patients except those with an in-hospital STEMI, the median time from pain onset to first medical contact (patient delay) was 110 minutes (IQR: 42, 316). The median time from first medical contact to hospital arrival (pre-hospital delay) was 58 minutes (IQR: 43, 109). Time intervals related to ambulance calls for the last 3 years are noted in Table 25. Overall, time intervals were similar, with some minor year-to-year variation.

Table 25: Time intervals related to ambulance call, arrival and transfer 2015-2017

Ambulance Times	2015 (N=99)	2016 (N=83)	2017 (N=148)
	Mins (IQR)	Mins (IQR)	Mins (IQR)
Time from symptom onset to ambulance call	74 (23, 240)	90 (21, 263)	81 (27, 301)
Time from call receipt to ambulance arrival	21 (12, 30)	14 (10, 24)	16 (11, 30)
Time from ambulance arrival to hospital arrival	55 (39, 77)	50 (36, 71)	54 (38, 75)

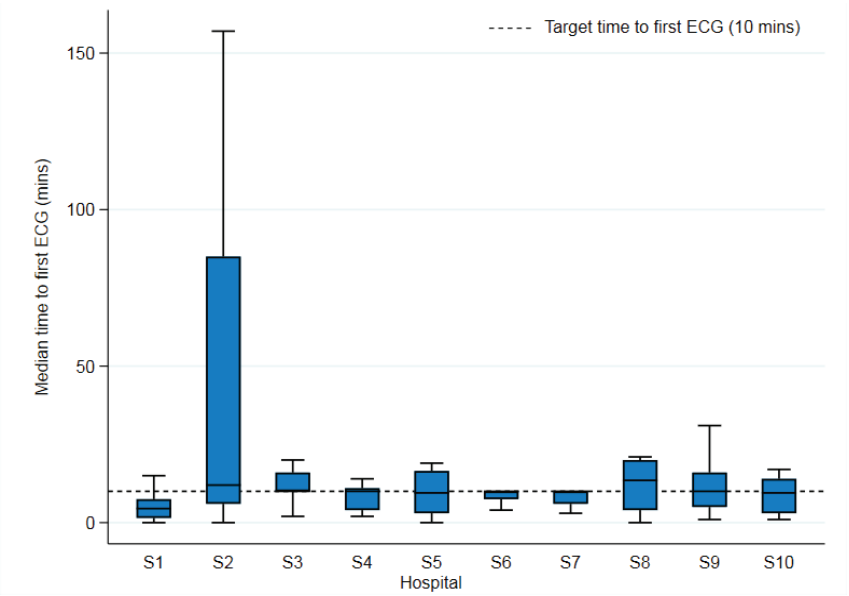
In-hospital Process Times

(time from arrival to first ECG and door-to-needle time)

It is well-recognised that delays to reperfusion are correlated with higher rates of mortality and morbidity (30). The timely delivery of reperfusion therapy is a key performance outcome in the VCOR STEMI module and is evaluated by a number of specific process measures. These include the time to first ECG and the time taken from hospital presentation to administration of the thrombolytic drug - known as the door-to-needle time.

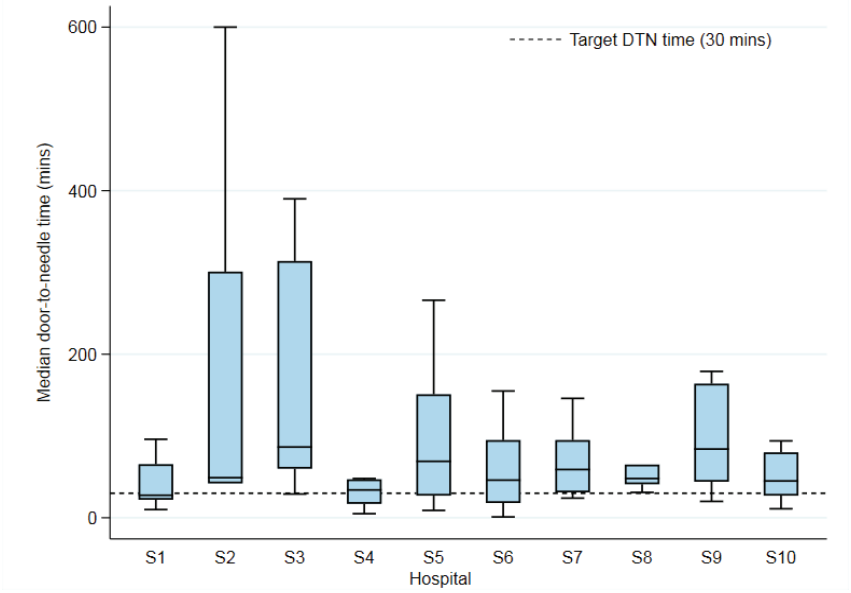
For all sites in 2017, the median time from arrival to first ECG was at the recommended benchmark of 10 minutes (Figure 46).

Figure 46: Time from arrival to first ECG time by hospital (regional STEMI patients)



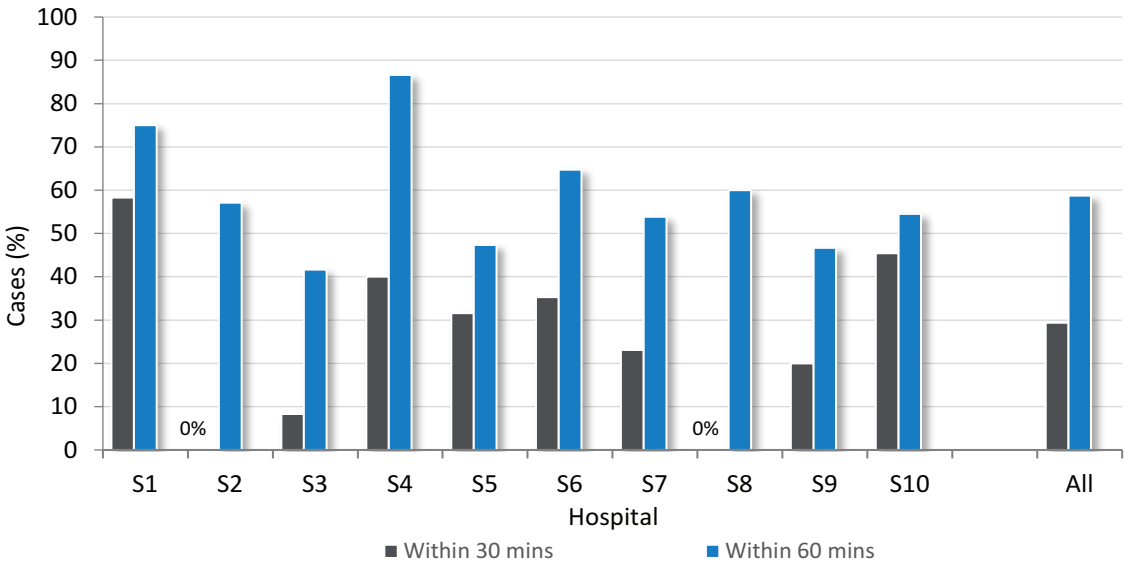
The ideal door-to-needle time recommended by Australian National Heart Foundation/Cardiac Society of Australia and New Zealand is less than 30 minutes (10). This is a challenging target, with many centres in Australia, Europe, Canada and Americas reporting real-life median door-to-needle times up to 40-60 minutes (31-33). The median door-to-needle time for VCOR regional STEMI sites was 48 minutes (IQR: 29, 113). The target median door-to-needle time ≤30mins was not achieved by any site in 2017 (Figure 47).

Figure 47: Door-to-needle times for regional STEMI patients by hospital



Hospitals' performance was also assessed by their compliance rates in achieving door-to-needle times ≤30mins. For the overall cohort, just 29% of cases were treated within a 30-minute timeframe, with a range among hospitals from 0% to 58%. At 60 minutes, 59% of cases had received thrombolysis (range 42%-87%). A comparison of hospital performance in achieving door-to-needle times ≤30mins is shown in Figure 48.

Figure 48: Proportion achieving door-to-needle times within 30 and 60 minutes



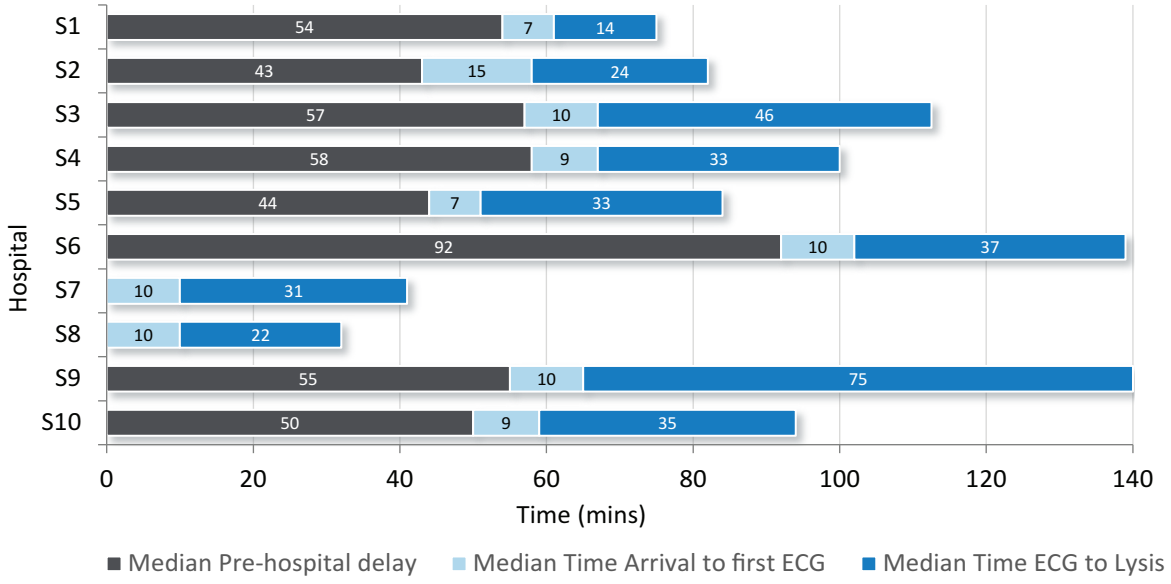
As with door-to-balloon times in patients undergoing PCI, door-to-needle times with thrombolysis also improved when pre-hospital notification of the arriving STEMI patient was received from ambulance services. The median door-to-needle time with pre-hospital notification was 24 minutes (IQR: 11, 45) among the 18 patients who were triaged in the field. Twelve of the 18 cases with pre-hospital notification achieved a door-to-needle time within 30 minutes (Table 26).

Table 26: Door-to-needle times with or without pre-hospital notification (PHN)

Hospital	Total cases	Median door-to-needle time (all cases)	Median door-to-needle time (with PHN)	Median door-to-needle time (no PHN)
N	Mins (IQR)	Mins (IQR)	Mins (IQR)	
S1	12	69 (27, 151)	28 (21, 140)	85 (36, 197)
S2	7	30 (26, 78)	-	38 (27, 86)
S3	12	27 (21, 77)	-	28 (21, 90)
S4	15	84 (44, 164)	34 (21, 49)	110 (60, 179)
S5	19	86 (60, 352)	-	86 (60, 352)
S6	17	61 (32, 114)	-	61 (32, 114)
S7	13	49 (42, 301)	-	49 (42, 301)
S8	5	34 (17, 47)	17 (5, 17)	37 (24, 47)
S9	15	43 (17, 100)	-	53 (18, 105)
S10	11	48 (36, 154)	-	48 (36, 154)
All sites	126	48 (28, 113)	24 (11, 45)	59 (21, 125)

A comparison of the system delay (comprising pre-hospital delay plus time to first ECG/lysis) for the participating hospitals is shown in Figure 49. The median system delay for the entire cohort was 71 minutes, substantially longer than the median door-to-needle time of 48 minutes. This measure is arguably a better performance metric than the door-to-needle time, as it emphasises the urgency of commencing treatment the moment the patient comes into contact with the medical system. International guidelines are now recommending ideal time delays from first medical contact to thrombolysis of <30mins (34), underscoring the importance of continued development of pre-hospital thrombolysis programs to shorten the time from first medical contact to reperfusion.

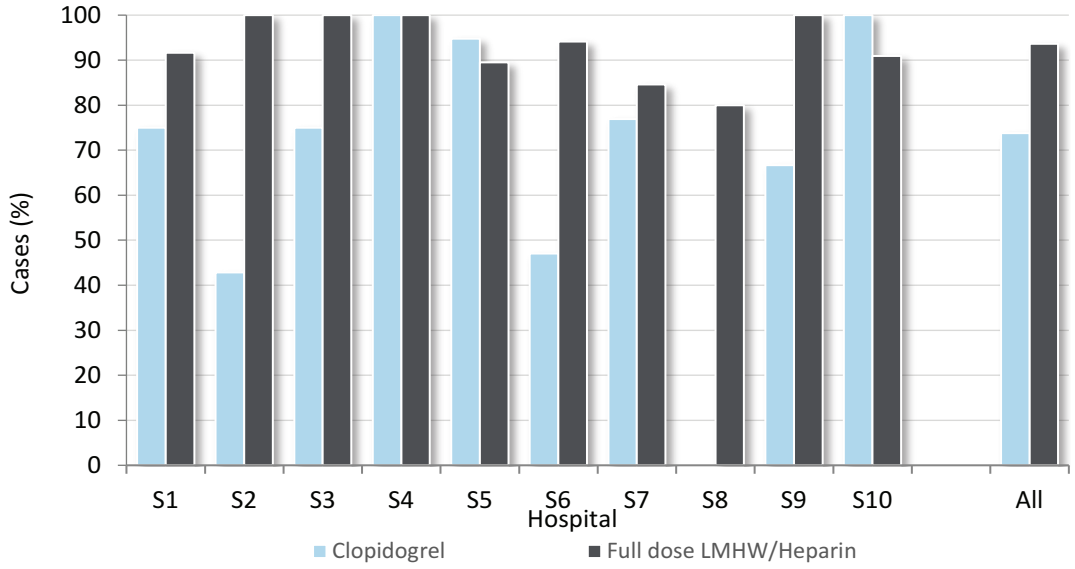
Figure 49: Overall system delay times



Adjunctive Therapies

National guidelines provide strong recommendations for adjunctive antithrombotic (unfractionated heparin or low molecular weight heparin) and antiplatelet agents in patients with STEMI following thrombolysis (19). Traditionally, the second antiplatelet agent added to aspirin following thrombolysis has been clopidogrel. Figure 50 shows high usage rates of both antithrombotic therapy (94%) and clopidogrel (74%). The use of newer antiplatelet agents was quite low. However, based on emerging evidence (34), it is anticipated that their use will increase in this setting.

Figure 50: Treatment and outcomes: adjunctive therapies



In-hospital Outcomes and Transfer Rates

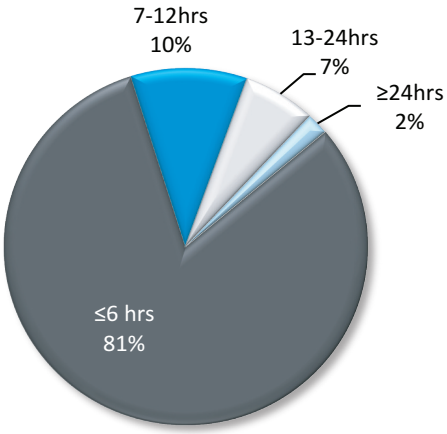
The incidence of in-hospital major adverse cardiac events remained low in 2017. The mean unadjusted in-hospital mortality rate for the ten participating hospitals was 6% - comparable to international registries of STEMI (35, 36) and has remained around this level for the past 4 years. The highest mortality was seen in the subgroup of patients with cardiogenic shock (34%). Complications of STEMI therapy remained rare in 2017. Major bleeding occurred in only 1 patient (0.3%) and there were no cases of acute stroke. A comparison of the rates of major adverse cardiac events by hospital is shown in Table 27.

Table 27: In-hospital major adverse cardiac and cerebrovascular event rates 2017

Hospital	Total cases	Mortality	Cardiogenic Shock	Myocardial re-infarction	Major bleeding	Stroke
	N	%	%	%	%	%
S1	15	0.0	27.0	7.0	0.0	0.0
S2	16	6.0	13.0	0.0	0.0	0.0
S3	52	4.0	19.0	0.0	2.0	0.0
S4	16	0.0	6.0	19.0	0.0	0.0
S5	44	16.0	18.0	2.0	0.0	0.0
S6	88	3.0	3.0	0.0	0.0	0.0
S7	17	12.0	12.0	6.0	0.0	0.0
S8	6	0.0	0.0	0.0	0.0	0.0
S9	18	0.0	6.0	0.0	0.0	0.0
S10	15	13.0	7.0	13.0	0.0	0.0
All sites	287	6.0	11.0	3.0	0.3	0.0

In 2017, 94% of patients were transferred to a PCI-capable hospital within 24 hours of thrombolytic therapy. The median time from referral request to the actual transfer to a metropolitan PCI-capable hospital was 2.3 hours (IQR: 1.5, 4.5) (Figure 51). This high rate of timely transfer is an indicator that the system of coordinated care for acute STEMI in rural and regional Victoria is robust and working well.

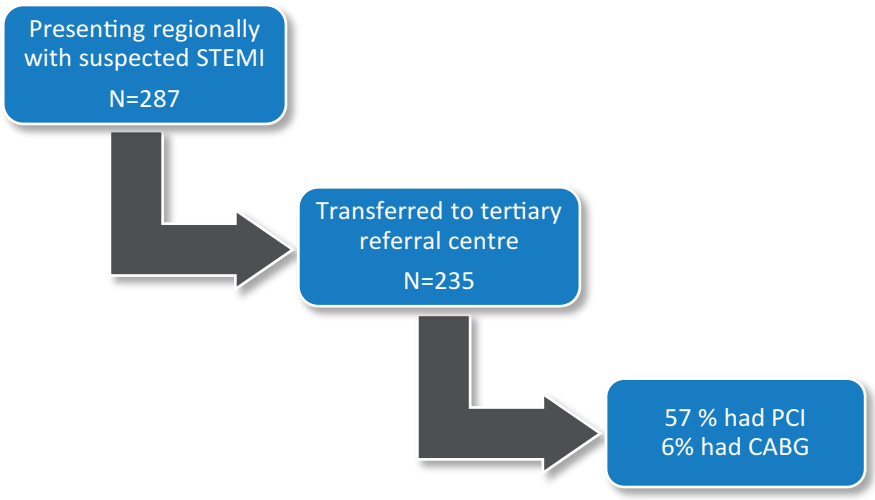
Figure 51: Patient transfer times from regional centre to metropolitan hospital



Revascularisation Rates

Data linkage with the VCOR PCI module provided additional information regarding follow-up and outcomes for patients enrolled in the STEMI module. Probabilistic matching determined that of the 287 regional patients treated for STEMI, 235 patients were transferred to a tertiary hospital. Of those, 57% subsequently underwent PCI and 6% were treated with CABG (Figure 52).

Figure 52: Regional STEMI module inter-hospital transfer and revascularisation rates

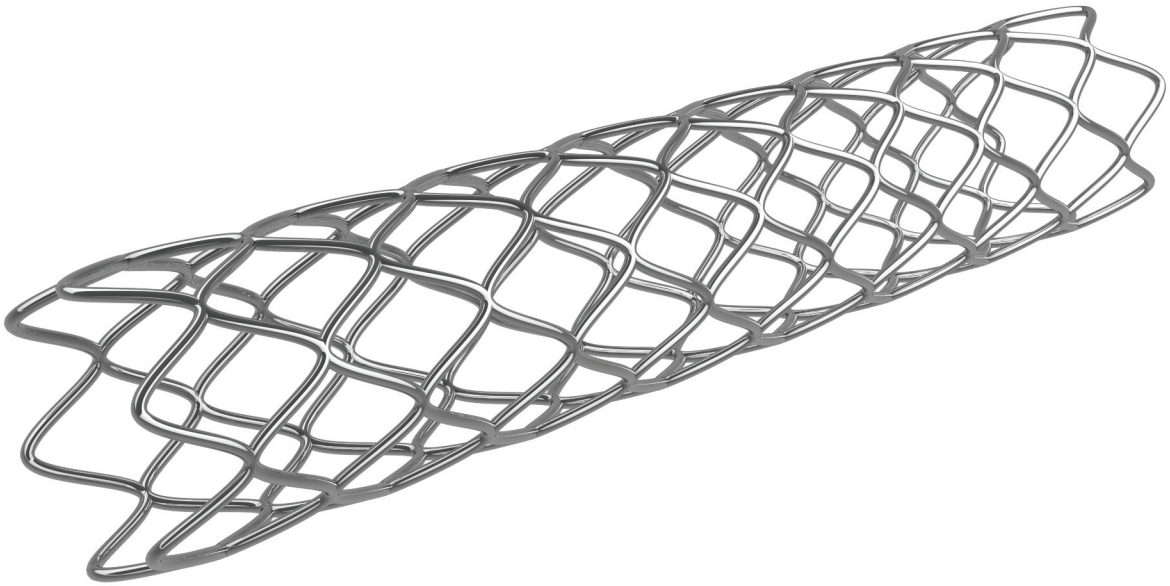


Among the total of 135 patients in the STEMI module who underwent PCI, 31 patients underwent primary PCI. A further 11 patients were transferred for rescue PCI, with evidence of ongoing ischaemia or failed reperfusion after receiving thrombolysis. These patients generally require urgent transfer and the median time from thrombolysis to rescue PCI was 5 hours (IQR: 3, 6).

Table 28 compares the outcomes of various patient subgroups from the 2017 STEMI module who underwent PCI. Interestingly, there were no in-hospital deaths seen among the rescue PCI cases – a group that would normally be expected to be at high risk for adverse events. However, at 30 days, the mortality rate for rescue PCI was the highest at 9.1%. This was due to just one death and reflects the need for caution in interpreting results when case numbers are low. As expected, major bleeding rates were highest in subgroups that had received thrombolysis prior to PCI.

Table 28: Outcomes for regional STEMI patients by reperfusion strategy

Outcomes	Primary PCI (N=31)	Rescue PCI (N=11)	PCI ≤24hrs of lysis (N=50)	PCI >24hrs of lysis (N=19)
Median time from thrombolysis to PCI – hrs (IQR)	N/A	5 hrs (3, 6)	17 hrs (7,23)	35 hrs (28, 60)
	%	%	%	%
Lesion successfully treated	100	100	93.0	95.0
In-hospital mortality	6.5	0.0	2.0	5.3
In-hospital unplanned revascularisation	0.0	0.0	0.0	0.0
In-hospital major bleeding	0.0	9.1	2.0	5.3
30-day mortality	6.5	9.1	2.0	5.3
30-day unplanned revascularisation	0.0	9.1	2.0	0.0
30-day MACCE	6.5	18.2	6.0	5.3



Heart Failure Snapshot

Background

Heart failure (HF) represents a major public health issue, associated with high mortality, frequent hospitalisations and significant utilisation of health care resources. Almost 70% of the health care costs associated with heart failure are attributable to acute hospital care, with more than 41,000 people hospitalised with heart failure annually in Australia (37). The prognosis of people with heart failure is poor and worse than most common forms of cancer (38).

In order to improve outcomes in HF patients we need to have a clear understanding of the epidemiology of the condition, the burden on the health care system - including hospitalisations and community services, demographic characteristics that may predict rehospitalisation and the scope of currently available management strategies. Although considerable data exist from international sources, there are only limited data available on the epidemiology and burden of heart failure in Victoria. International benchmarks for patients admitted to hospital with acute heart failure indicate there is a 10% in-hospital mortality rate, 30% mortality rate within one year (39, 40), and 20-25% of patients will be readmitted within one month (41, 42).

In 2014, VCOR undertook its first HF-Snapshot and since this time four HF-Snapshots have been completed. Briefly, HF-Snapshot encompasses the enrolment of consecutive HF patients at participating health services over a one month period in order to obtain a "snapshot" of HF related admissions and outcomes. For this latest snapshot, data elements were updated, a greater number of sites were recruited and there was a longer period of follow-up (90 days).

Registry Module Activity

In 2017, 16 hospitals participated in the HF-Snapshot extending for a 4-week period from May to June. A listing of the participating hospitals in each of the 4 snapshots from 2014-2017 is shown in Table 29.

Table 29: Participation of hospitals in HF-Snapshot 2014-2017

Hospital	Hospital type	2014	2015	2016	2017
The Alfred Hospital	Public	●	●	●	●
Austin Hospital	Public	●	●	●	●
Bairnsdale Regional Health Service	Public	○	●	●	●
Bendigo Hospital	Public	●	●	●	●
Box Hill Hospital	Public		●	●	●
Central Gippsland Health Service (Sale)	Public	○	●	●	●
Dandenong (Monash Health)	Public	○	○	●	●
Epworth Hospital Richmond	Private	○	○	●	●
Footscray Hospital	Public	●	●	●	●
Frankston Hospital	Public	●	○	●	●
Latrobe Regional Health (Traralgon)	Public	○	●	○	
MonashHeart (Monash Medical Centre Clayton)	Public	●	●	●	●
The Northern Hospital	Public	○	●	●	●
The Royal Melbourne Hospital	Public	○	●	●	●
St Vincent's Hospital Melbourne	Public	●	●	●	●
Sunshine Hospital	Public	○	○	●	●
University Hospital, Geelong	Public	●	●	●	●

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

Patient Characteristics

The 2017 HF-Snapshot enrolled 477 patients admitted to hospital with acute heart failure. The majority were male (55%). The mean age was 75±14 years and 81% had previous hospitalisations for heart failure. Patient co-morbidities in the 3 most recent HF-Snapshots are compared in Table 30, with some year-to-year differences in demographic profiles noted. These varying patterns in concomitant co-morbidities underscore the complexity that is often encountered when managing patients with heart failure.

Table 30: HF-Snapshot patient characteristics 2015-2017

Patient characteristics	2015 (N=289)	2016 (N=456)	2017 (N=477)
Age – years (Mean ±SD)	77 + 13	76 ± 14	75 ± 14
	%	%	%
Gender – female	42.9	41.9	45.3
Treated diabetes	39.1	46.5	45.1
Cardiovascular Medical History	%	%	%
Cerebrovascular disease	15.6	19.7	19.5
History of angina	41.2	33.8	36.3
History of MI	28.7	30.0	30.5
History of heart failure	65.7	78.9	77.8
Arrhythmia	54.3	54.3	54.5
History of PCI or CABG	30.1	31.1	30.3
CIED therapy	22.1	23.0	21.4
Non-Cardiovascular Medical History	%	%	%
COPD/Asthma	34.9	30.7	30.6
Obstructive sleep apnoea	15.3	11.8	16.1
Anaemia	24.2	35.7	30.9
Iron deficiency	12.5	25.9	19.8
Depression	16.3	18.9	21.4
Liver disease -Mild	4.9	2.6	4.4
Liver disease -Moderate/severe	3.1	2.2	2.7
Chronic Kidney disease -Mild	13.8	20.0	17.9
Chronic Kidney disease -Moderate	31.5	31.4	33.2
Chronic Kidney disease -Severe/dialysis	13.5	14.3	13.7
Dementia	8.7	6.8	9.4

Clinical Presentation

Nearly all the patients in 2017 (89.9%) were admitted to hospital after presenting to the emergency department. The majority of cases were admitted to a General Medicine unit, with just 32% managed by a Cardiology specialty unit. Five hospitals had a dedicated sub-specialty heart failure unit. The most common precipitant for hospital admission was Infection (20.8%), while other causes such as myocardial ischaemia or medication-related issues were less common (Table 31).

Table 31: HF-Snapshot clinical presentation 2017

Clinical presentation	2017 (N=477)
	%
Admission location – Emergency Department	89.9
Admitting speciality	%
Heart failure unit	9.4
Cardiology	32.1
General medicine	51.6
Gerontology	2.5
Precipitant for admission	%
Ischaemia	10.1
Medication-non-adherence	9.6
Medication-precipitating drugs	1.5
Rhythm disturbance	13.2
Infection	20.8

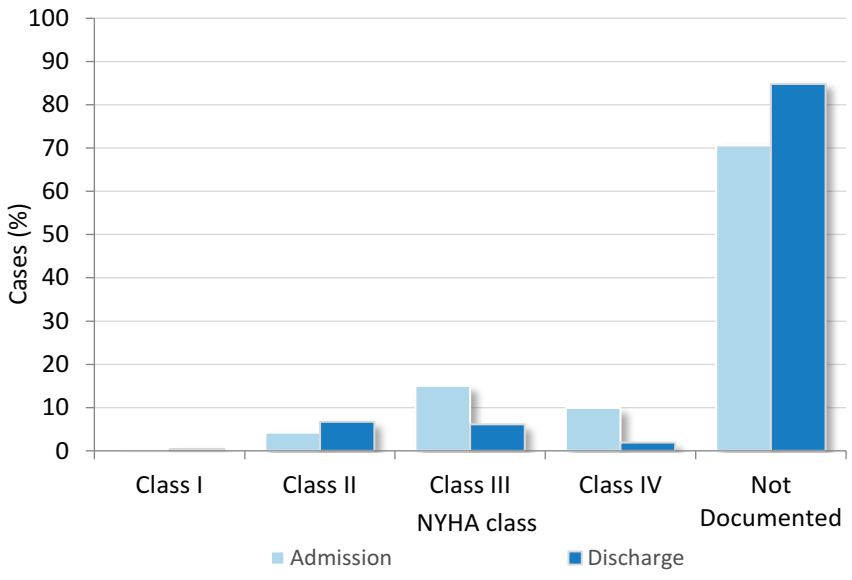
On admission, the proportion of patients in sinus rhythm was the same as those in atrial fibrillation (AF) at 41% for both. The proportions shifted by the time of discharge, with patients in sinus rhythm increasing to 46% and a corresponding decrease in AF cases to 36%. The mean heart rate in beats per minutes (BPM), was lower at discharge at 73.8±12 compared to 85.5±22.8 at admission.

Overall, 72% of the cohort were diagnosed with left ventricular systolic dysfunction, while 15% had predominantly diastolic dysfunction on echocardiography.

Functional status

Functional status on admission and discharge, as assessed by the New York Heart Association (NYHA) classification, is shown Figure 53. For those cases where NYHA class was documented, there was an observable improvement in patients' functional status at discharge, with the proportion of NYHA Class IV patients falling from 9.9% on admission to 1.9% at discharge. There was a similar fall in NYHA Class III patients and a concomitant rise in Class II cases.

Figure 53: New York Heart Association (NYHA) class rates at admission and discharge 2017



Drug therapies

A total of 88% of patients were prescribed intravenous frusemide, 61% received oxygen therapy, 16% had ventilatory support with continuous or bilevel positive airway pressure (CPAP/BiPAP) and 2% required mechanical ventilation. The mean number of medications prescribed at discharge was 10.4±4.2. Medications prescribed at admission and discharge for the overall cohort are listed in Table 32. These rates do not take into account the type of heart failure, or individual patient contra-indications associated with either prescribing or taking these medications and should be interpreted accordingly.

Table 32: Medications prescribed at admission and discharge 2017

Medications	Admission (N=477)	Discharge (N=459)*
	%	%
ACE Inhibitor	33.1	36.2
Beta Blocker	63.6	70.6
Ivabradine	3.2	3.7
ARB	17.7	15.5
Calcium channel antagonist	22.7	18.7
Digitalis	15.6	15.7
Nitrate	12.6	15.7
Other vasodilator	5.7	5.2
Antiarrhythmic	8.8	10.2
Lipid lowering agent	55.7	57.3
Anticlotting agents	%	%
Antiplatelet	48.1	50.5
Anticoagulant	46.4	51.2
Diuretic Agents	%	%
Aldosterone antagonist	27.1	38.1
Loop diuretic	75.6	94.3
Thiazide diuretic	10.7	12.6

**In-hospital mortality cases not included (n=18)*

The unadjusted prescription rates for key therapeutic medications showed no differences between admission and discharge. However, additional analyses among patients with heart failure with reduced ejection fraction (HFrEF) and adjusted for contraindications showed that use of beta-blockers, ACE inhibitors (ACEI)/angiotensin receptor blockers (ARB) and aldosterone antagonists all increased from admission to discharge (Figures 54 and 55).

Figure 54: Prescription rates for beta-blockers in HFrEF cohort with heart rate >60 BPM at admission and discharge 2017

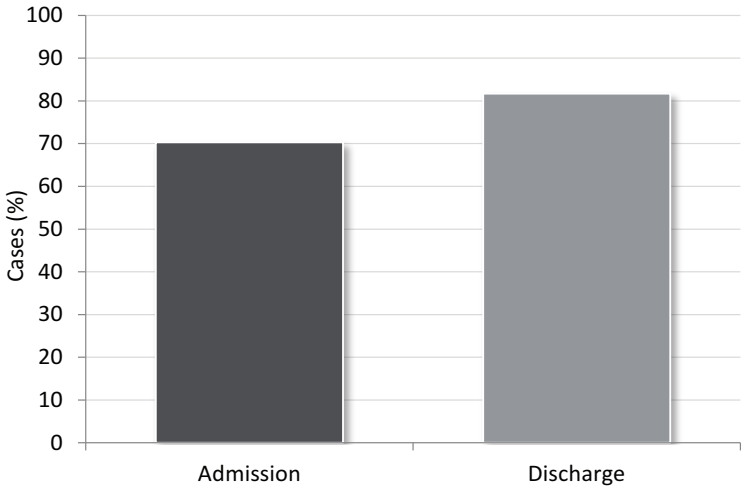
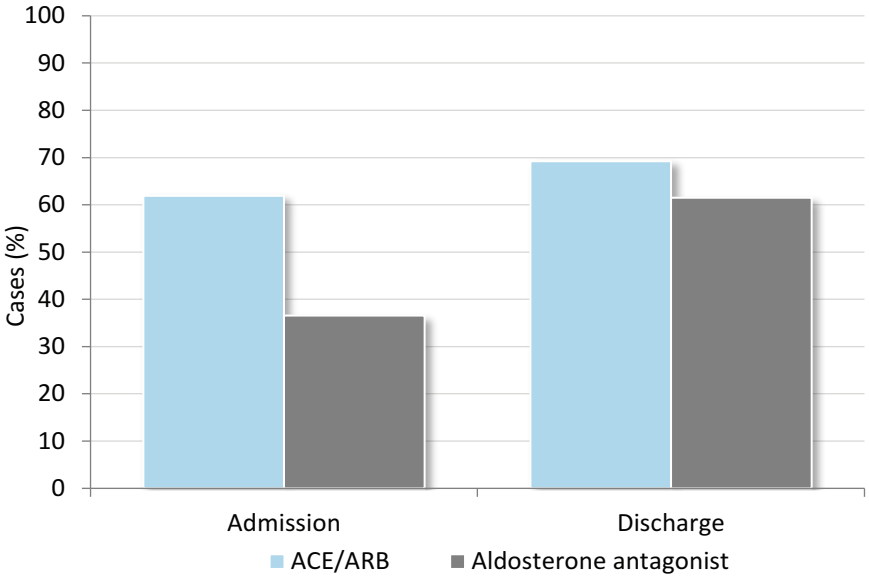


Figure 55: Prescription rates for ACEI/ARB and aldosterone antagonists in HFrEF with eGFR >60ml/min at admission and discharge 2017



Length of stay

The median length of hospital stay was 6 days (IQR: 3, 9), with 75% of the cohort discharged to home. In 2017, a slightly higher proportion of patients were discharged to an aged care facility (7.5% in 2017 vs 6.8% in 2016 vs 6.2% in 2015). Only 2 patients were referred to palliative care, suggesting that this may still be an under-utilised resource for a condition associated with a poor prognosis and multiple readmissions (Table 33).

Table 33: Discharge destination during HF-Snapshot 2017

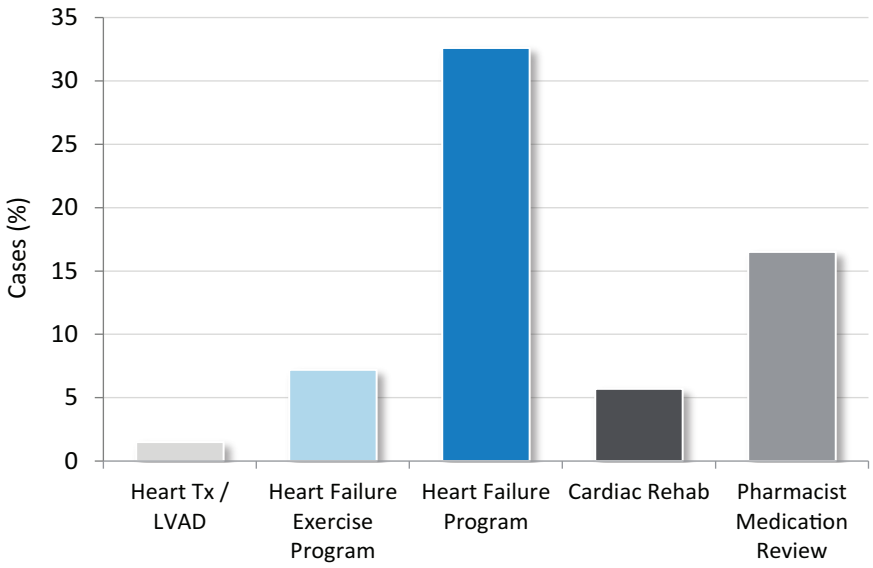
Discharge Destination	2017 (N=477)
	%
Home	75.3
Hospital in the Home	2.9
Rehabilitation Unit / Hospital	7.3
Aged Care Facility	7.5
Local or Referring Hospital	1.5
Palliative Care	0.4
Tertiary Referral Centre	1.0
In-hospital Mortality	4.0

Transitional care after discharge

Transitional care post-discharge for patients with acute heart failure plays a vital role in preventing hospital readmissions. The first month post-discharge is the most vulnerable period for these patients and is when they are at the highest risk of readmission. At discharge, 58.7% of patients had an outpatient appointment scheduled. Of the patients referred to an outpatient clinic, 19.7% were seen within 14 days, 43.5% of patients within 30 days of discharge and 73.8% within 90 days. Follow-up rates were similar for patients referred to private follow-up (usually by the treating cardiologist), with 20% seen within 14 days of discharge, 48.8% within 30 days and 71.2% within 90 days. One-third of patients were referred to a heart failure program post-discharge (Figure 56). However, this may be an underestimate of eligible referrals, as patients who were not suitable for a heart failure program could not be identified and excluded from this analysis.

As identified in this report, deficiencies in transitional care arrangements post-discharge highlight the need for improvements in processes relating to timely referrals, especially to outreach services such as heart failure programs and pharmacist medication reviews. These services have been shown to reduce readmissions and there is potential for significant reductions in rehospitalisation rates when they are fully utilised.

Figure 56: Post-discharge care plans 2017



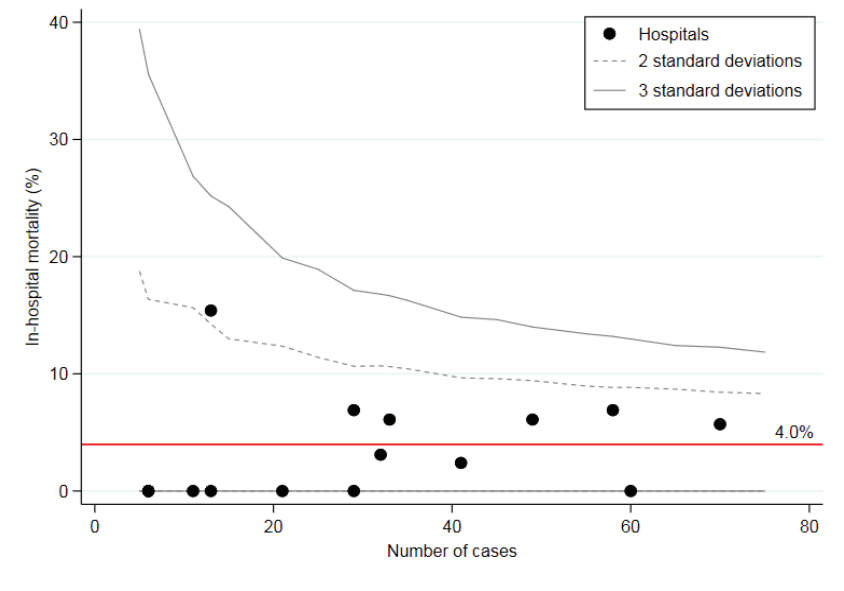
Outcome Measures

The principal outcome measures for HF-Snapshot were in-hospital mortality, 30-day and 90-day mortality and 30-day and 90-day readmission rates.

In-hospital outcomes

The overall unadjusted in-hospital mortality for 2017 was 4%, which is similar to international reports (43). Figure 57 demonstrates comparative in-hospital mortality rates among hospitals. All hospitals were within control limits. There was no particular relationship between hospital case volume and in-hospital mortality.

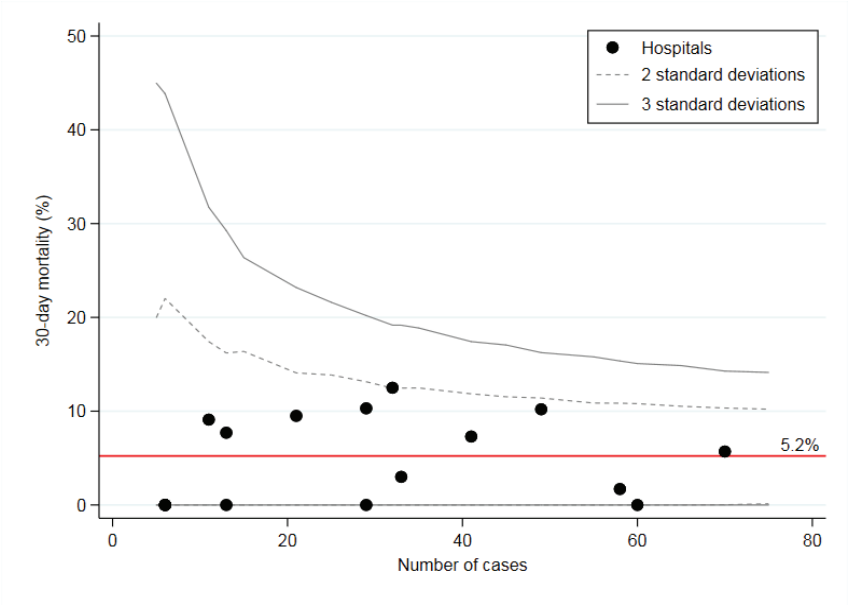
Figure 57: In-hospital all-cause mortality 2017



30-day outcomes

The unadjusted overall 30-day mortality rate was 5.2%. All hospitals were within control limits (Figure 58). This rate was lower than published international benchmarks (39, 40). Thirty-day mortality was higher among patients with HFrEF (8.2%) compared to those with heart failure with preserved ejection fraction (HFpEF) (4.7%).

Figure 58: Unadjusted 30-day mortality 2017



The overall readmission rate at 30 days was 26.2% (Figure 59). This rate was higher than in 2016 (21%) but still comparable to published international rates of approximately 25% (41, 42, 44) (Figure 60).

Figure 59: 30-day hospital readmission rates 2017

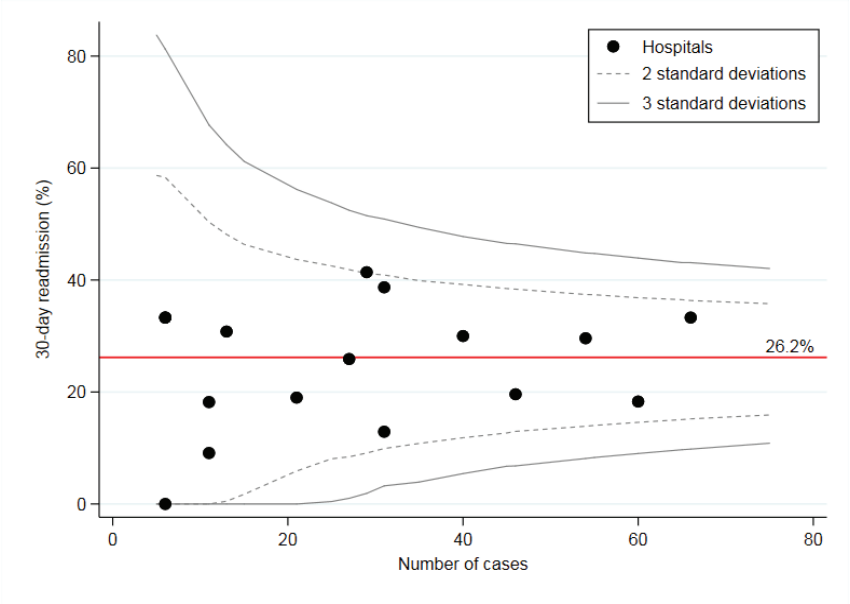
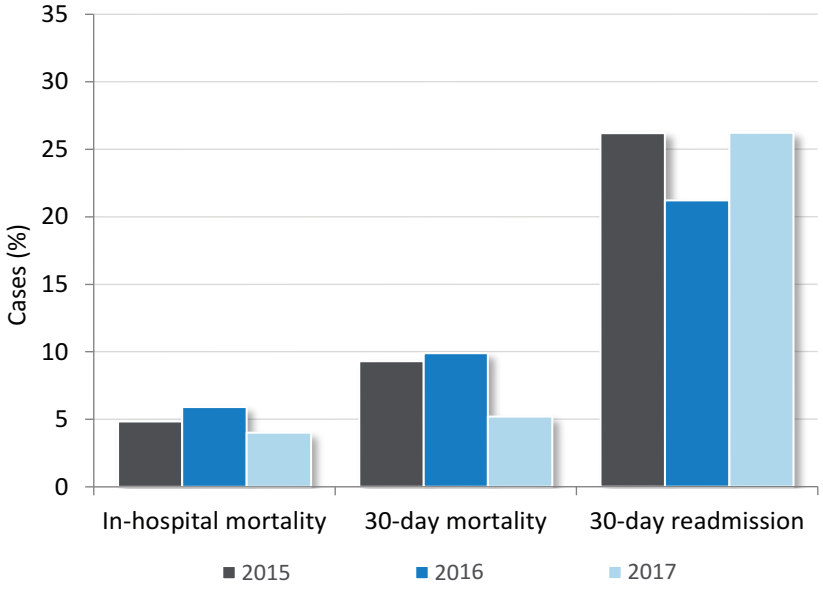


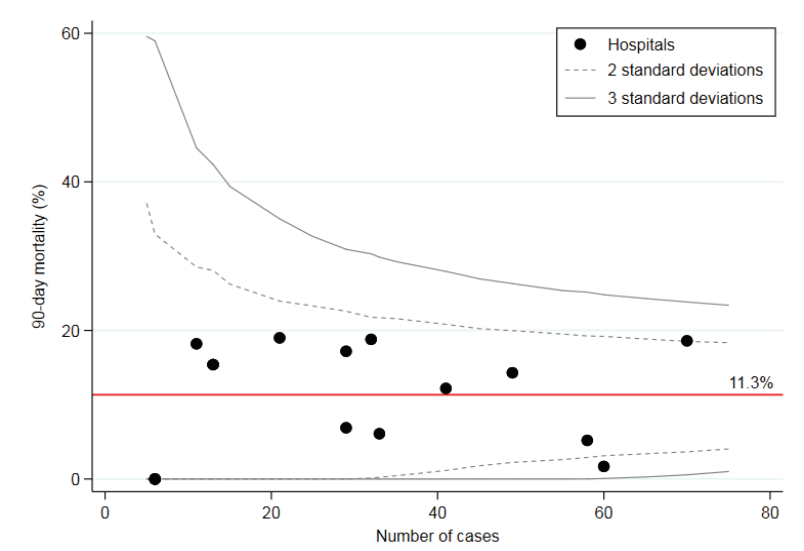
Figure 60: Comparison of selected outcome measures 2015-2017



90-day outcomes

The unadjusted 90-day mortality rate was 11.3%. All hospitals were within control limits (Figure 61). The 90-day mortality rate was higher among patients with HFpEF than HFrEF (16.3% HFpEF vs 15.5% HFrEF).

Figure 61: Unadjusted 90-day mortality 2017



Just on half the patient cohort for 2017 (49.8%) were re-admitted within 90 days of discharge (Figure 62). The median time to readmission was 29 days (IQR: 11, 56) (Figure 63).

Readmission for heart failure has been singled out by clinicians, health bureaucracies and funders as one of the key adverse outcomes for attention, as it is perceived as an indicator of poor quality care and excessive consumption of healthcare resources. The 2017 report was the first HF-Snapshot to report on 90-day readmission rates. With the sobering finding that 1 in 2 patients treated for heart failure in hospital end up being readmitted for heart failure within 3 months, there is a clear and urgent need to develop strategies to improve outcomes including better targeted in-hospital care, effective transitional care programs and comprehensive models for ambulatory care and chronic disease management.

Figure 62: 90-day hospital readmission rates 2017

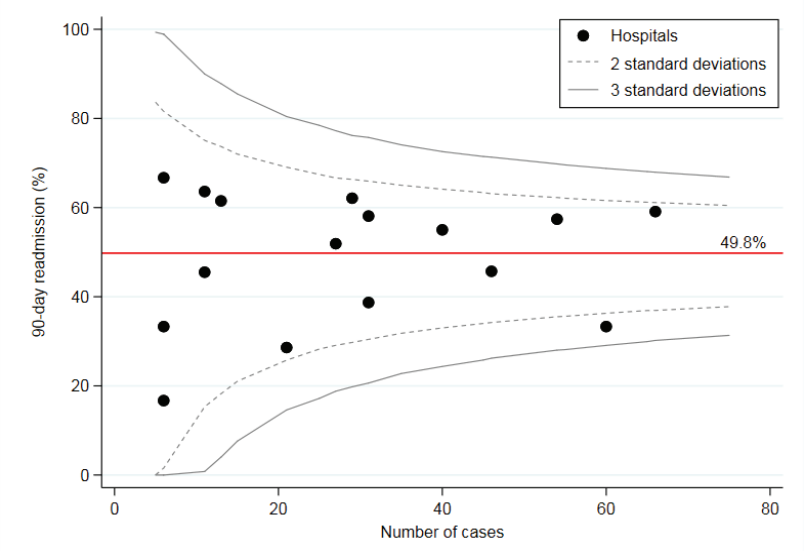
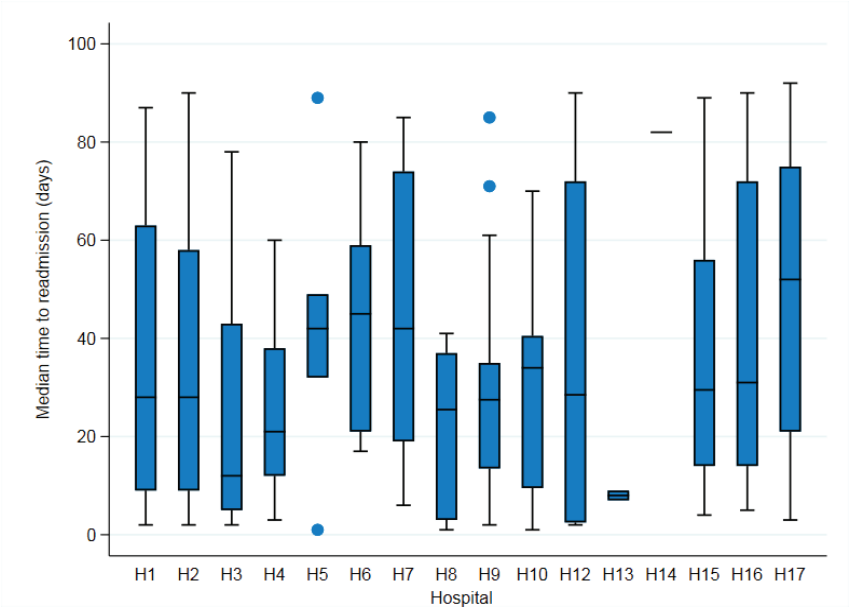


Figure 63: Time to readmission by hospital 2017



Quality improvement initiatives

Nearly 50% of the hospitals involved in HF-Snapshot reported quality improvement activities that were undertaken utilising the HF-Snapshot data. One hospital implemented the *Australian National Heart Foundation (NHF) Heart Failure Toolkit* and used these data to identify areas for improvement in processes of care and patient outcomes. Three hospitals delivered presentations to their clinical staff that utilised the HF-Snapshot data to outline the burden of HF and identify areas for local hospital improvement. Finally, two hospitals used the HF-Snapshot data to provide a local business case to fund additional heart failure specialist staff.

Future Directions

VCOR is looking forward to continuing its primary role of monitoring and reporting on the performance and outcomes of hospitals vis-á-vis their delivery of cardiac care. VCOR welcomes the opportunity to work under the aegis of Department of Health and Human Services and the bodies it has set up to ensure the safety and quality of care - including the Victorian Agency for Health Information, Safer Care Victoria and the Cardiac Clinical Network. These agencies are purpose-designed to ensure that variations in care are minimised and Victorian patients receive high-quality and safe care. It is within this framework of ongoing quality improvement that VCOR hopes to continue making a meaningful and worthwhile contribution.

In a busy year ahead, VCOR plans to implement the results of a comprehensive revision of all its data elements, with the release of version 2.0 of the database. Robust auditing activities will continue and potentially expand if sufficient resources can be procured. The registry will also maintain a strong focus on supporting sites in their data collection activities – sharing experiences across sites in both formal and informal settings.

A fourth registry module that monitors the safety, quality and appropriateness of implantation of cardiac implantable electronic devices commenced its pilot phase in 2017. This module will be expanded in 2018, with refinement and modification of the dataset based on the pilot phase results and a further rollout to additional hospitals in the public and private sectors.

Prompted by the withdrawal of the Abbott Vascular bioresorbable vascular scaffold in early 2017, VCOR will undertake a survey of long-term outcomes of bioresorbable vascular scaffold use among Victorian hospitals between 2013 and 2017. The results should be available in the form of a special report in late 2018.

Collaborations with researchers are underway in a number of areas including quality-of-life measures, patient reported outcomes and experiences, epidemiological aspects of cardiac disease and health economics. New areas of research and new research partners will be sought and engaged. Activities pertaining to linkage with administrative datasets and other registries will also continue.

Underlying all this activity is the principal aim of ensuring that cardiac patients receive high-quality, appropriate and safe care - irrespective of their location, insurance status or healthcare provider. VCOR is steadfast in its commitment to improving the quality of cardiovascular care and looks ahead to partnering with cardiovascular clinicians, hospitals, funders and health bureaucracies to provide the best health outcomes for all Victorians.

Glossary

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

Publications and Presentations in 2017

Biswas S, Dinh DT, Brennan AL, Tacey M, Andrianopoulos N, Brien R, Duffy S, Harper R, Nadurata V, van Gaal W, Grigg L, Cox N, Clark D, Reid CM, Lefkovits J, Stub D. Patient and hospital factors predicting prolonged door-to-balloon time in STEMI patients undergoing primary PCI. Paper presented at: 65th Annual Scientific Meeting of the Cardiac Society of Australia and New Zealand; Perth; 2017 August 10 – 13. *Heart, Lung and Circulation* 2017; 26; S222.

Biswas S, Dinh DT, Brennan AL, Tacey M, Andrianopoulos N, Brien R, Gutman J, Macisaac A, Hiew C, Rowe M, Dick R, Amerena J, Nadarajah N, Liew D, Stub D, Lefkovits J, Reid C. Incidence and predictors of 30-day unplanned cardiac readmission following Percutaneous Coronary Intervention: insights from the Victorian Cardiac Outcomes Registry. Poster presented at: 65th Annual Scientific Meeting of the Cardiac Society of Australia and New Zealand; Perth; 2017 August 10 – 13. *Heart, Lung & Circulation* 2017; 26; S81-2.

Biswas S, Dinh DT, Brennan AL, Tacey M, Andrianopoulos N, Brien R, Haikerwal D, Toogood G, Oqueli E, Cooke J, Warren R, Sapontis J, Wilson A, Hengel C, Reid CM, Stub D, Lefkovits J. Characteristics and outcomes of failed Percutaneous Coronary Intervention in a contemporary Australian cohort. Paper presented at: 65th Annual Scientific Meeting of the Cardiac Society of Australia and New Zealand; Perth; 2017 August 10 – 13. *Heart, Lung and Circulation* 2017; 26; S203.

Dinh DT, Reid CM, Brennan AL, Stub D, Lefkovits J. Guiding high quality PCI outcomes in Victoria: the Victorian Cardiac Outcomes Registry (VCOR). Paper presented at: 15th World Congress on Public Health; Melbourne; 2017 April 3 - 7.

Cox N, Brennan AL, Dinh DT, Brien R, Cowie K, Stub D, Reid CM, Lefkovits J. Implementing sustainable data collection for a cardiac outcomes registry in an Australian public hospital. *Heart, Lung and Circulation.* 2018; 27 (4), 464-8; online published-ahead-of-print 12 March 2017.

Noaman S, Vogrin S, Goh CY, Cheng Y, Brennan AL, Andrianopoulos N, Dinh DT, Lefkovits J, Reid CM, Walton A, Stub D, Cox N, Chan W. Comparison of short-term clinical outcomes of proximal versus non-proximal culprit lesion in patients treated with primary percutaneous coronary intervention for ST-elevation myocardial infarction. Poster presented at: *European Society of Cardiology*; Barcelona; 2017 August 26-30. *European Heart Journal* 2017; 38 (S1), 1199 - 200.

Stub D, Lefkovits J, Brennan AL, Dinh DT, Brien R, Duffy SJ, Cox N, Nadurata V, Clark D, Andrianopoulos N, Harper R, McNeil J, Reid CM. The establishment of the Victorian Cardiac Outcomes Registry (VCOR): monitoring and optimising outcomes for cardiac patients in Victoria. *Heart, Lung and Circulation.* 2018; 27 (4), 451-63; online published-ahead-of-print 12 October 2017.

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Table 34: VCOR Funding 2011 – 2017

Funding Body	2011	2012	2013	2014	2015	2016	2017
	$	$	$	$	$	$	$
Medibank Private	$100,000	$400,000	$400,000	$300,000	-	-	-
Department of Health & Human Services	$200,000	$200,000	$205,000	$509,466	$460,202	$834,815	$616,900
Sub total	$300,000	$600,000	$605,000	$809,466	$460,202	$834,815	$616,900
Total							$4,226,383

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