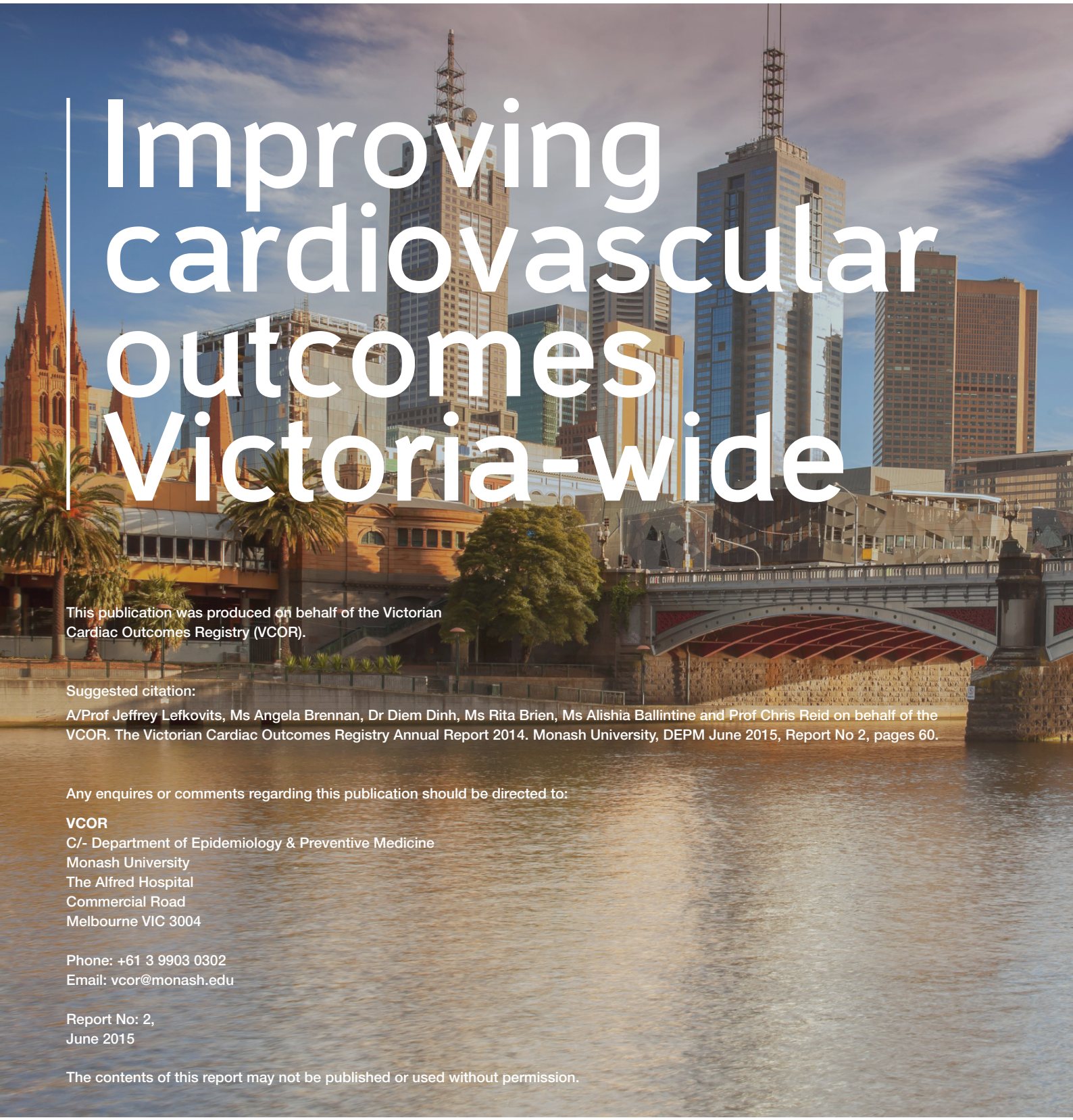
Victorian Cardiac Outcomes Registry

ANNUAL PUBLIC REPORT 2014

VCOR
VICTORIAN CARDIAC OUTCOMES REGISTRY



Improving cardiovascular outcomes Victoria-wide

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Acknowledgements

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

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

Executive Summary

Since its inception in 2012, the Victorian Cardiac Outcomes Registry (VCOR) has grown as a clinical quality registry, encompassing 27 public and private hospitals across the state of Victoria in 2014. Originally co-funded by the Department of Health in 2011 and a one-off grant from Medibank Private, the primary role for the registry is to monitor the performance of health services in Victoria – both public and private – in their delivery of high-quality cardiac-based therapies. The registry aims to identify trends in the quality of patient care over time, within individual hospitals, comparatively with other hospitals, and aggregated at the state level. The goal is to foster continuous improvement in patient care and outcomes across the entire Victorian health system.

The two current areas of focus for the registry are the performance of percutaneous coronary intervention (PCI) and the early treatment of myocardial infarction in rural and regional settings. Both relate to coronary artery disease - still a major cause of morbidity and mortality in our community. Its acute form (heart attacks and unstable angina) and chronic heart disease can both result in significant disability, poor quality of life and high health care costs. In Australia, death rates for cardiovascular disease have been gradually declining since the 1970s, with the relative contribution to overall mortality falling from 29% of all deaths in 1979 to 15% in 2010[1].Despite this, the number of people dying from coronary heart disease is still large, and it remains the single leading cause of death in Australia[2]. Effective treatment at all phases of the disease process is aimed at reducing symptoms of heart disease and positively influencing the risk of future heart attack, chronic disability from heart muscle damage and life expectancy.

Percutaneous coronary intervention has become one of the principal treatments for coronary disease in both its acute and chronic forms. Through the use of specialised balloon catheters and stents, the technique relieves blockages that form in the heart's coronary arteries. With well over 10,000 PCIs performed per year in Victoria alone, VCOR recognises that monitoring of performance and outcomes of PCI, as well as the identification of treatment gaps, are key priorities for health providers and health authorities alike. VCOR has additionally identified the early management of acute heart attack (acute myocardial infarction) as an area of special interest. PCI is an effective emergency treatment for acute heart attack; yet access to this highly specialised technique remains limited to metropolitan and large regional centres. For patients suffering heart attack beyond these regions, time-critical treatment is delivered in the form of an intravenous medication (thrombolytic therapy) that can dissolve the offending clot in the coronary artery. Prompt and effective management of acute myocardial infarction is clearly linked with better functional outcomes and improved short and long term survival.

VCOR began collecting data on patients undergoing PCI in 2013. In our first annual report, we reported on patients who underwent PCI in Victoria in 2013. However, this represented only a fraction of the total number of cases in Victoria, as 2013 was an incomplete year as many of the participating sites only commenced recruitment part way through the year. In this, our second report, the number of completed cases has increased to 8,214 with all 12 public hospitals and 9 of 17 private hospitals in Victoria in 2014 participating.

This report highlights significant findings on the performance of health services undertaking PCI in Victoria. We are pleased that for the first time, we are able to present risk-adjusted 30-day mortality outcomes. This type of analysis is a key function of clinical quality registries that allows differences in important patient characteristics to be taken into account before outcomes are compared. It is a fairer and more representative way of benchmarking the relative performances of hospitals against one other.

This report now also incorporates comparisons between public and private hospitals for various reported measures. The registry is now able to contrast and compare the two health sectors in relation to PCI with the intention that any important trends and lessons that may emerge help guide future service improvement and development in both health sectors.

Also for the first time, this report includes performance measures for six regional and rural centres in relation to their early management of acute myocardial infarction. The results underscore areas of strength and areas for improvement among the participating sites, as well as characterise the overall system and clinical milieu that these centres work in as they strive to deliver the best quality care possible in non-metropolitan settings.

Key Findings

Percutaneous Coronary Intervention Registry

- 70% of Victorian PCI hospitals participated in VCOR in 2014, representing approximately 100 interventional cardiologists. A total of 8214 completed cases were collected in 2014.
- The majority of patients undergoing PCI were male (77%). The mean age of patients was 66 years, although 22% were older than 75 years. Patients treated in private hospitals were 6 years older on average than those treated in public hospitals. Approximately one in 5 patients were diabetic. Almost one-third of patients had a history of previous PCI.
- Just over half of all PCI cases in 2014 were for treatment of an acute coronary syndrome (ACS). However, there was significant variation in the proportion of PCI performed in public versus private facilities, with the public sector bearing the greater proportion and overall number of patients treated for ACS.
- There was a trend towards an increased number of cases presenting with cardiogenic shock or cardiac arrest. These patients, at the most severe end of the clinical spectrum, were associated with much higher rates of in-hospital and 30-day mortality.
- The very elderly (>80 years) were a growing patient subgroup. The proportion of females in this cohort was higher (39% vs 21%); they were more likely to have had a prior history of stroke (8% vs 3%). A femoral access approach was more common than a radial artery approach in the elderly.
- Drug-eluting stent use remained at around the same level as 2013, at 75% of cases overall. There was significant variation among hospitals in their use of these stents, although generally high rates were seen in specific patient and lesion subsets where the risk of restenosis is high (diabetics, renal failure, chronic total occlusion, in-stent restenosis). Bioresorbable scaffolds were implanted in very small numbers in 2014.
- There was a continuing trend towards radial artery access at 37% of cases overall. This varied quite widely among hospitals, with a clear preference for femoral artery access in public hospitals (42% cases) compared with 30% of cases in private hospitals.
- Emergency treatment for acute STEMI accounted for 19% of the overall PCI workload, with variation among hospitals. There was a marked difference in STEMI rates in the public sector (30% of caseload) compared with the private sector (8% of caseload). The median time taken from patient arrival at the hospital to the first inflation of the balloon to re-open the artery (door-to-balloon time) was 68 min, which was well below the upper recommended threshold of <90 min. The goal of a door-to-balloon time <90mins was achieved in 70% of cases overall.
- The unadjusted in-hospital mortality rate overall was 2.0%. For patients presenting with STEMI, the rate was 7.4%. For patients with cardiogenic shock or out-of-hospital cardiac arrest requiring endotracheal intubation, the rate was 44%. For all other patients, the unadjusted in-hospital mortality rate was 0.3%.
- The risk-adjusted 30-day mortality rate for 2014 was 3.7%.
- The incidence of bleeding complications following PCI was low (0.8%) and especially low among radial access cases (0.4% radial vs 0.9% femoral).
- Overall length of stay was longer for the more acute conditions (STEMI and NSTEMI), but similar among public and private hospitals. Unplanned cardiac rehospitalisations at 30 days were more frequent among private patients than public patients.
- Benchmarking of hospitals demonstrated that all hospitals achieved rates within an acceptable range in relation to in-hospital and 30-day mortality. However, there were a small number of outlier hospitals in relation to rates of bleeding, major adverse cardiovascular events and target vessel failure at 30 days.

Key Findings continued...

Management of Acute STEMI in Rural and Regional Centres

- VCOR captured data on 64 patients from 6 regional and rural centres undergoing early treatment of STEMI in 2014. 73% were eligible for thrombolytic therapy and 100% of eligible patients received the medication, either at the treating hospital or prior to arrival.
- 37% of patients lived >25km from the treating hospital. The median time from pain onset to first medical contact was 72 minutes. The median time taken for an ambulance to arrive was 15 minutes.
- More than two-thirds of patients were transported by ambulance to hospital, while 19% were driven in by friend or family (self-presenters). Pre-hospital thrombolysis, given by trained ambulance officers in the field to patients who are located >30 minutes away from a hospital, was administered to 10% of cases, but this facility was not available at all regional locations.
- The median time taken to perform an ECG after patients' arrival was 8 minutes (IQR 3, 10). The median door-to-needle time (time from patient arrival to time thrombolytic drug administered) was 33 minutes (IQR 20, 59).
- While two-thirds of the hospitals were able to achieve door-to-needle times within 30 minutes in at least 50% of patients and >80% of cases received thrombolysis within 60 minutes, overall performance of the cohort did not quite reach the ideal targets of rapid delivery of thrombolysis within 30 minutes in at least 80% of patients.
- Nearly every patient treated with thrombolysis was subsequently transferred to a PCI capable hospital in under 24 hours, indicating high compliance with national guidelines for early treatment of STEMI.

Introduction

The Victorian Cardiac Outcomes Registry (VCOR) was established in 2012 to monitor and report on the quality and effectiveness of cardiovascular health care in Victoria.

The broad aim of this registry is to provide information to clinicians, hospitals, health funders and consumers that can be utilised to ensure patients receive the highest quality cardiac care possible. The data from our registry facilitates the benchmarking of hospitals' performance against one another - an effective tool for the identification of health services whose performance is below standard, or is exemplary to the point that it is a standout among its peers. Additionally, the registry can assist in assessing overall compliance with national standards of care and evidence-based guidelines and contribute to their continuing development and refinement.

The design and implementation of VCOR as a clinical quality registry is based around the Framework for Australian Clinical Quality Registries[3], developed by The Australian Commission for Safety and Quality in Health Care, in collaboration with the states and territories and expert registry groups. This framework was endorsed by the Australian Health Ministers' Advisory Council (AHMAC) in March 2014. Its application provides assurance to all key stakeholders that registry data and its supporting systems satisfy minimum security, technical and operating standards.

The Department of Epidemiology and Preventive Medicine, Monash University, conducted a pilot registry for cardiac procedures in 2009-10, which was a forerunner to VCOR. In late 2011, funding was obtained to set up a state-wide cardiac outcomes registry in Victoria and VCOR was established. Primary management of the registry is undertaken at the Department of Epidemiology & Preventive Medicine, Monash University, in association with the Victorian Cardiac Clinical Network, Department of Health and Human Services, Victoria.

Registry Governance

The governance model outlined in the inaugural VCOR Annual Report 2013 continues. All committees meet regularly as planned and engagement with all key stakeholders remains high.

Steering Committee

In 2014 the Steering Committee (SC) reviewed and approved the updating of the VCOR Terms of Reference. This update reflected a change in the membership such that all participating sites now have ex-officio membership on the Steering Committee. Additionally, the committee finally welcomed a consumer representative after a long engagement process.

Clinical Quality Committee

The purpose of the Clinical Quality Committee (CQC) is to review hospital key performance indicators (KPIs) on a quarterly basis. Health services are provided with individualised performance reports that identify their site while keeping all other sites anonymous. In 2014, a number of sites were identified as outliers in key performance measures around procedure-related major bleeding. The CQC provided feedback to the sites and offered assistance to facilitate the sites' own investigation of their results. All sites that were notified in this manner undertook their own in-house case reviews and provided feedback to the CQC of their findings and their action plans to address the concerns raised by their own internal reviews.

Data Access, Research and Publications Committee

The Data Access, Research and Publications Committee (DRP) reviews requests for access to group de-identified data. The Committee approved data access for 4 abstracts that were submitted to the Cardiac Society of Australia and New Zealand (CSANZ) 2015 Scientific Sessions. In accordance with VCOR policy, all data requests were first reviewed and approved by a Human Research Ethics Committee (HREC) prior to review by the DRP. All VCOR abstracts submitted were accepted for presentation in August 2015.

Registry Activities

In 2014, the focus of VCOR was primarily directed towards the collection, analysis and reporting of performance measures for PCI in Victoria, and as a second module, the early management of acute STEMI in rural and regional centres in Victoria. In addition to the day-to-day management of data and maintenance of the online data collection system, the registry undertook a number of other activities.

Regular meetings of the various stakeholders of the registry were held throughout the year. The Steering Committee, the Clinical Quality Committee and the Data Access, Research and Publications Committee all met separately on a quarterly timetable. Meetings with site data managers were conducted for discussion and feedback. These meetings were an opportunity for data managers to discuss processes and issues and receive updates about the registry.

A major ongoing activity for the registry has been its clinical audit program, designed to ensure the quality, integrity and accuracy of the data entered into the registry. A detailed report on the VCOR Clinical Audit is found later in this report.

In 2014, VCOR obtained funding from the Victorian Cardiac Clinical Network (VCCN) to develop a data collection system for patients admitted to hospital with heart failure. The initial pilot study was undertaken for a one-month period in 2014 by seven public hospitals. The study was successfully conducted and following revisions to the dataset, the Victorian Cardiac Clinical Network has since provided funding to expand and extend the data collection model of rolling one month snapshots of health services activities in relation to heart failure management in 2015.

The Victorian Cardiac Outcomes Registry also continues to publish a quarterly newsletter. This is widely distributed to all participating sites and publicly available on the VCOR public website.

Percutaneous Coronary Intervention (PCI)

Site Engagement, Patient Recruitment and Case Numbers

The process of engagement of PCI sites in Victoria is ongoing in an effort to achieve the goal of collecting data from all Victorian PCI hospitals. As of July 2015, 26 PCI hospitals in Victoria were engaged for data collection and 23 were actively contributing data. For the period covered by this report from 1 January, 2014 to 31 December, 2014, there were 21 PCI hospitals contributing data (all 12 public hospitals and 9 of 17 private hospitals). A list of all eligible Victorian PCI hospitals in 2014 is shown in Table 1.

Figure 1: PCI Site engagement and participation in VCOR in 2014

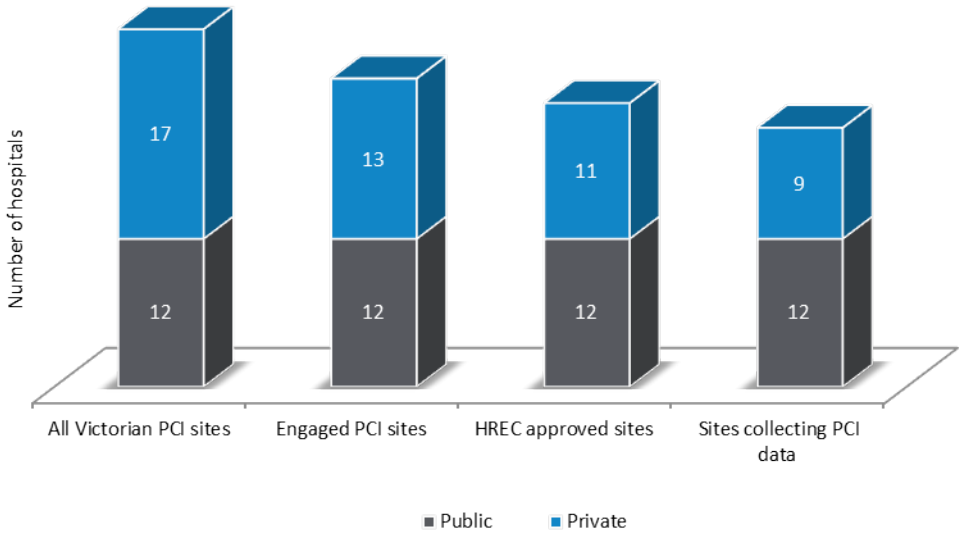


Table 1. Participation of Victorian PCI hospitals

Victorian PCI Sites	Hospital type	Sites collecting data in 2013	Sites collecting data in 2014
Alfred Hospital, The	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 Richmond	Private	•	•
Frankston Hospital	Public	•	•
Geelong Private Hospital	Private		•
Jessie McPherson Private	Private	•	•
Knox Private	Private	•	•
Linacre Private Hospital	Private		
Melbourne Private Hospital	Private		•
MonashHeart (Monash Medical Centre Clayton)	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 Avenue Hospital	Private		
The Northern Hospital	Public	•	•
The Royal Melbourne Hospital	Public	•	•
The University Hospital, Geelong	Public	•	•
The Valley Private Hospital	Private		
Warringal Private Hospital	Private		
Western Hospital (Footscray)	Public	•	•
Western Private Hospital	Private	•	•

A total of 8,214 completed cases were collected by VCOR in 2014. PCI case numbers steadily increased over the 2014 period (Figure 2), with an approximate 75% increment over 2013. This, in part, related to additional sites commencing recruitment in 2014, and the fact that several participating sites entered only a portion of their yearly caseload in 2013 after joining the registry part way through the year.

Figure 2: Total cases submitted by month in 2013 and 2014

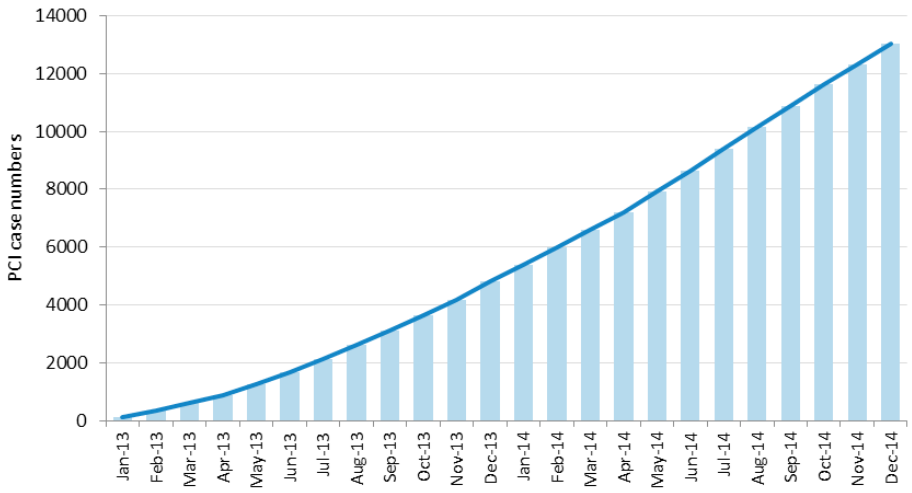
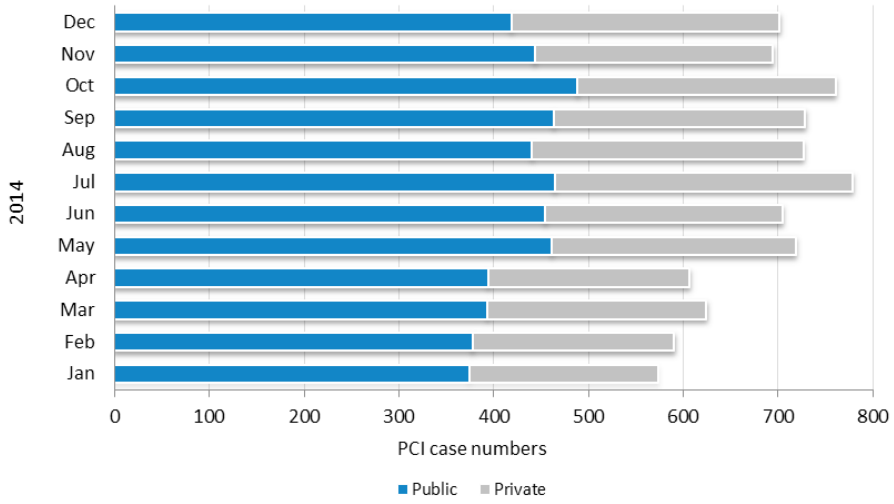


Figure 3 shows monthly case numbers for 2014 by hospital sector. The number of PCIs in the public sector is an accurate representation, as all public hospitals in Victoria now contribute to VCOR. Private hospital cases accounted for 37% the total caseload in the 2014 cohort, but not all private cases performed in Victoria were captured due to a number of private hospitals not yet contributing or not actually engaged with VCOR.

Figure 3: PCI cases for public and private hospitals in 2014



Data Completeness

Data completeness is reported for both baseline and follow-up data (Table 2). Following data entry into VCOR through the web portal, a case record is considered complete when all the fields are entered and relevant business rules ensuring data integrity have been met for both baseline and 30-day follow-up phases. Case records where baseline data have been entered, but 30-day follow-up data are still pending are considered incomplete and were not included in the analyses within this report.

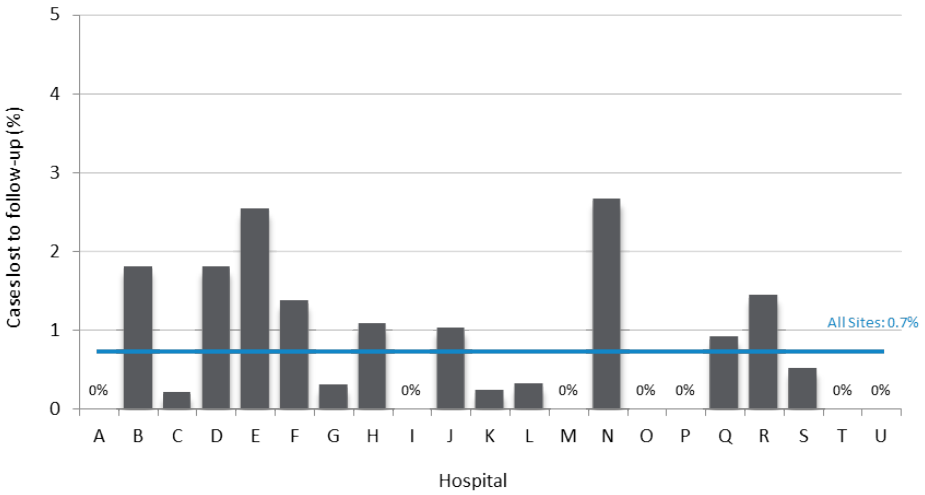
Sites are routinely informed of pending data deadlines and are regularly encouraged to complete baseline data entry and follow-up as comprehensively as possible. Sites are notified of the status of their data completeness on a regular basis. Of the total number of procedures entered in 2014, 99.5% cases were considered complete (n=8214). In comparison, the data completeness rate for 2013 was 95%.

Table 2. Data completeness by hospital

Hospital	% Baseline cases complete	% Follow-up cases complete	% All data (whole case) complete
A	100	100	100
B	100	96.5	96.5
C	100	99.6	99.6
D	100	100	100
E	97.9	100	97.9
F	100	99.7	97.7
G	99.8	99.7	99.7
H	100	100	100
I	100	99.7	99.8
J	98.3	100	98.3
K	100	99.8	99.8
L	100	100	100
M	100	100	100
N	100	99.1	99.1
O	97.7	97.9	97.7
P	100	100	100
Q	99.3	99.5	98.9
R	100	100	100
S	100	99.5	99.5
T	100	100	100
U	100	100	100
All sites	99.7%	99.7%	99.5%

Overall, more than 99% of patients were followed-up to 30 days after discharge. Figure 4 compares the rate of patients lost to follow-up by hospital. Patients also have the option to withdraw from having their data included in the registry. In 2014, the opt-out rate was 0.08% of patients, and the cumulative opt-out rate since commencement of the registry is 0.12%.

Figure 4: Rate of patients lost to follow-up by hospital in 2014



Data Quality – Audit Activities

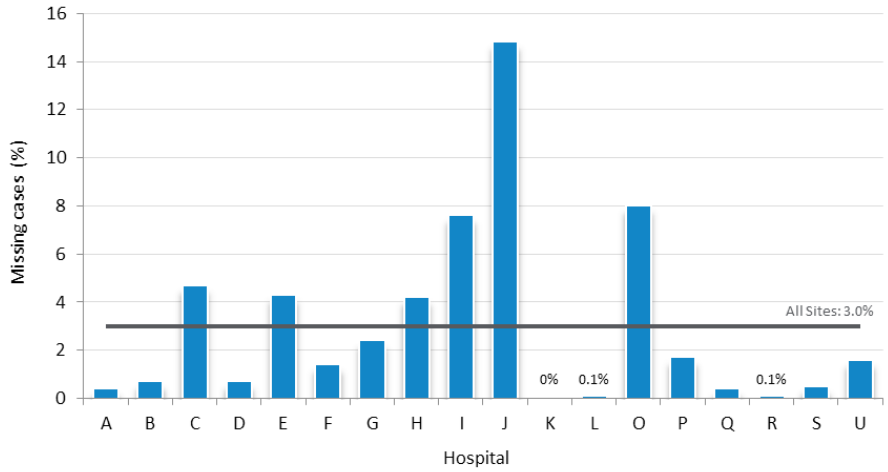
A key operational activity of a clinical quality registry is the performance of regular audits to ensure accuracy and completeness of data collection and entry into the registry[4]. This generally encompasses assessment of eligible cases to ensure all relevant cases are entered, as well as verification of source data.

The VCOR Audit Program involves visits to each participating centre, commencing approximately 1 year after commencing data collection. Initial audit activities include case ascertainment (assessing that all eligible cases are actually entered into the registry) and data quality assessment (accuracy of data as determined by review of source data). Following the initial audit, sites will be re-audited annually for case ascertainment and every 3 years for data quality assessment. If issues are identified with data quality, sites may be re-audited sooner. Sites are given a detailed, individualised report of their audit findings.

The audit process also provides the opportunity for data managers to query registry personnel about data-related issues and discuss any discrepancies. This has emerged as an additional and worthwhile benefit of the process, as data discrepancies have identified misinterpretation of registry definitions that have been subsequently clarified and resolved.

VCOR commenced auditing PCI cases in March 2014 and the process is ongoing. To date, 18 of the 23 sites currently collecting data have been audited, with the remainder scheduled following their first full year of operation. This report presents both aggregated results from all sites audited to date, and a comparison of audit outcomes by hospital. Figure 5 shows the results of the case ascertainment audits conducted to date. Pleasingly, the results indicated high compliance rates across all sites and identified no systematic omission of cases. The small proportions of missed cases were distributed randomly across the spectrum of acuity and involved all contributing clinicians. There were only 3 sites whose missing case rate was greater than 5% and all 3 sites have subsequently instituted process changes to improve case entry compliance. Where missing cases are identified, sites subsequently retrieve and enter these cases into the registry.

Figure 5: Missing cases by hospital in 2014



Sites M, N and T not due for audit until late 2015

With respect to data quality, 5% of case records were randomly selected for comparison with the hospital medical record. Hospital records are reviewed by a trained auditor with a cardiac clinical background, who is not aligned with the hospital being audited. The fields for audit encompass those used for risk-adjustment models and associated with outcome reporting. The overall agreement rate between VCOR data and the hospital medical record was 97%, indicating high quality data collection and compares favourably with national and international registries[5,6].

Some fields were commonly mismatched when case report forms were compared with hospital records. These included ejection fraction, last pre-procedural serum creatinine level, in-hospital bleeding and PCI indication. In order to address this, sites are now routinely monitored for data entry compliance with these fields. Whenever hospitals fall below a threshold, they are approached to review their compliance and retrospectively enter any available data. VCOR recognises that registry data must be high quality and is committed to an ongoing thorough and accurate audit program.

Patient Characteristics

The 8214 procedures included in this report were performed on 7338 individual patients. Approximately 11% of patients (n=876) underwent two or more PCI procedures in 2014. The majority of PCI patients were male (77%) and most procedures (78%) were performed on patients aged 51-80 years.

The median age for males was 65 years (IQR 57, 73) and for females was 70 years (IQR 62, 78). Table 3 compares selected patient demographic information in 2014 with the previous year. Overall, the demographic profile of the patient cohort was similar for 2013 and 2014. Age and gender distribution for the VCOR cohort are shown in Figures 6 and 7.

Table 3: Patient characteristics for 2013 and 2014

Patient characteristics	2013 cohort (N=4760)	2014 cohort (N=8214)
Age – years (Mean ±SD)	66.2 (±12.0)	65.7 (±11.9)
	%	%
Gender – female	22.9	23.1
Diabetes medication	22.3	21.6
Peripheral vascular disease history	3.5	3.8
Cerebrovascular disease History	3.8	3.7
Previous PCI	34.4	31.8
Previous CABG	8.9	8.3

The most notable differences in patient characteristics between the public and private sectors were that private patients presented with lower rates of diabetes, yet had considerably higher rates of previous coronary revascularisation procedures (PCI and CABG) (Table 4). Patients in the private sector were, on average, 6 years older than public hospital patients. Interestingly, the number of private patients exceeding 80 years was approximately double that of their public counterparts.

Table 4: Patient characteristics for public and private patients

Patient characteristics	Public (n=5180)	Private (n=3034)
Age – years (Mean ±SD)	63.5 (±12.0)	69.5 (±10.7)
	%	%
Gender – female	23.1	23.3
Diabetes medication	22.2	20.5
Peripheral vascular disease history	4.0	3.5
Cerebrovascular disease History	3.7	3.8
Previous PCI	26.0	41.8
Previous CABG	6.7	11.2

Figure 6 shows that women begin to make up an increasing proportion of the cohort in the older age groups and that the incidence for women peaks a decade later than it does for men.

Figure 6: Age and gender distribution of patients undergoing PCI

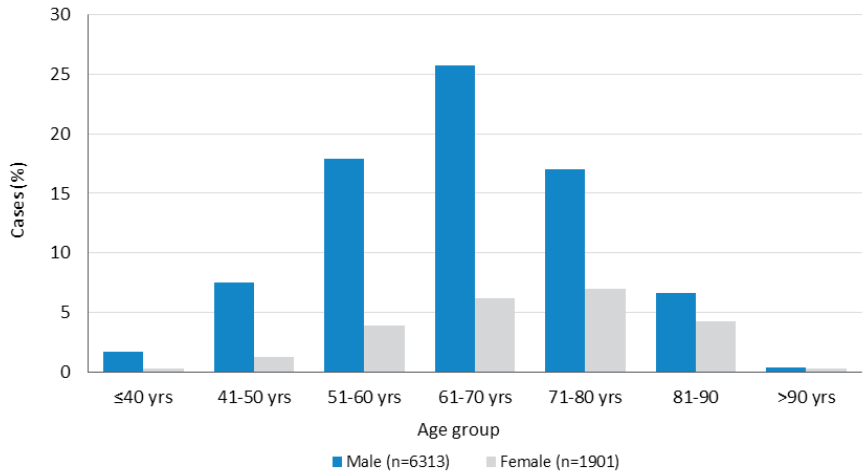
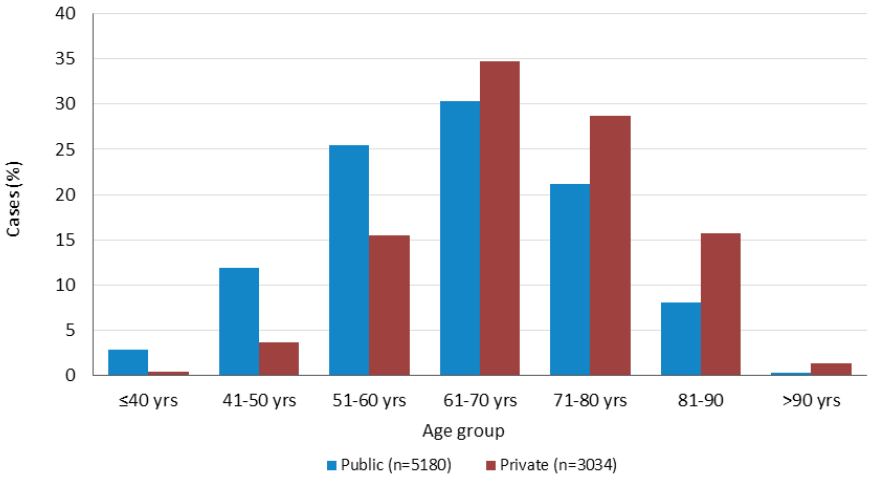


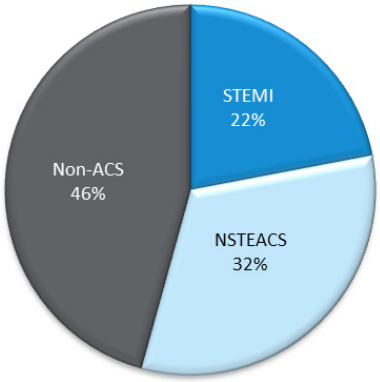
Figure 7: Age distribution for public and private patients



Clinical Presentation

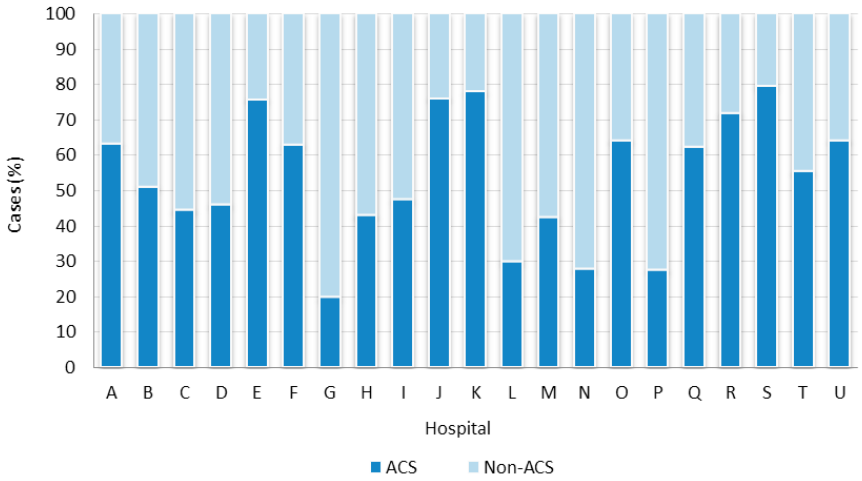
Patients presented in a number of ways for their PCI treatment. Patients with an acute coronary syndrome (ACS) were deemed as clinically unstable. This group includes the diagnoses of ST elevation myocardial infarction (STEMI), non-ST elevation myocardial infarction (NSTEMI) and unstable angina. Cases were considered 'non-ACS' when they presented without evidence of an acute coronary syndrome in the previous 7 days. Figure 8 shows the proportions of ACS subtypes across the cohort while Figure 9 shows ACS vs non-ACS breakdown by hospital.

Figure 8: Procedures by clinical presentation



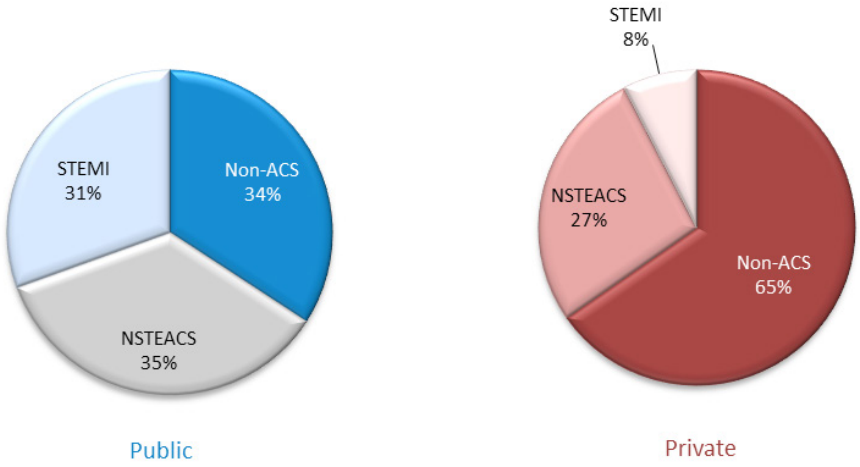
NSTEACS encompasses both NSTEMI and unstable angina

Figure 9: ACS and non-ACS cases by hospital



Overall, 54% of cases were patients presenting with an ACS within the last 7 days, although there was a marked difference in the mix of clinical presentations in public and private hospitals (Figure 10). The proportion of non-ACS cases in the private sector was almost double the proportion in the public sector.

Figure 10: Procedures by clinical presentation for public and private hospitals

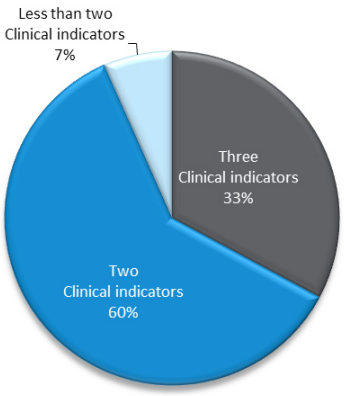


When considering clinical indications for the PCI procedures, the presence of an ACS itself was accepted as a primary indication, in line with Australian guidelines for the management of ACS[7] that recommend revascularisation wherever possible for patients presenting with an ACS. For non-ACS patients, the reason for the PCI procedure was further examined in terms of 3 clinical indicators for PCI:

1. angina symptoms (or equivalent)
2. positive functional test results
3. angiographic coronary stenosis greater than 70%

Most non-ACS cases (93%) had either 2 or 3 of these clinical PCI indicators (Figure 11).

Figure 11: Clinical indicators for PCI in non-ACS patients

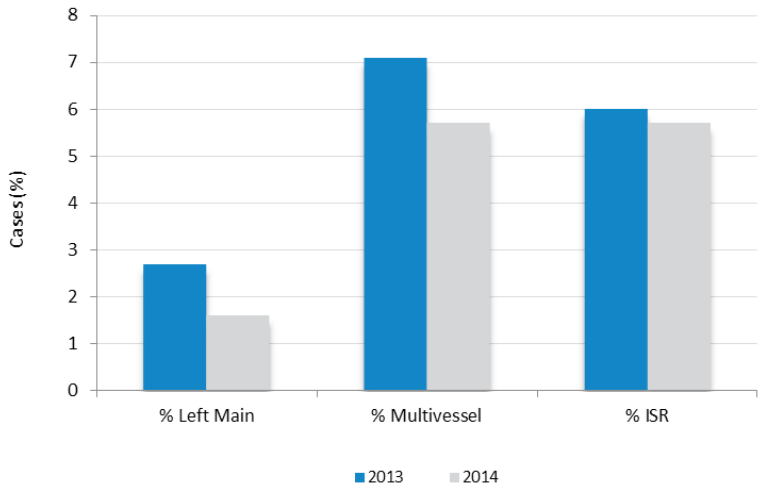


With respect to specific clinical and lesion subsets, there was a small increase in the proportion of patients with cardiogenic shock and intubated out-of-hospital cardiac arrest from 2013 to 2014 (Table 5). Left main coronary artery PCI remained an uncommon procedure in 2014 comprising only 1.6% of cases, as was multi-vessel PCI (5.7%) and PCI for in-stent restenosis, also at 5.7% (Figure 12).

Table 5: Patients presenting with cardiogenic shock or out-of-hospital cardiac arrest (OHCA) in 2013 and 2014

	Total	Cardiogenic shock	Intubated OHCA	Shock and/ or intubated OHCA
	N	N (%)	N (%)	N (%)
2013	4760	81 (1.7)	35 (0.7)	93 (2.0)
2014	8214	195 (2.4)	85 (1.0)	232 (2.8)

Figure 12: PCI lesion subsets



The overall trend of an ageing population in Australia was mirrored in the PCI cohort. In 2014, 22% of the patients undergoing PCI were older than 75 years and 12% were older than 80 years. The elderly cohort also had more vascular co-morbidities (peripheral vascular disease and cerebrovascular disease) as displayed in Table 6.

Table 6: Elderly patient (>80 years) characteristics

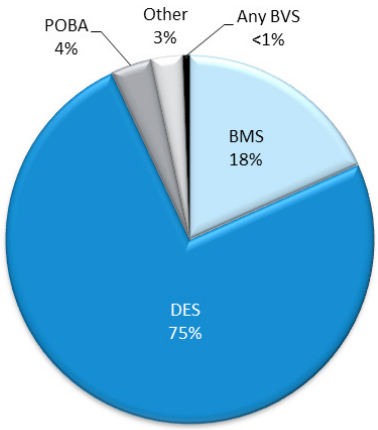
Patient characteristics	≤80 years (n=7267)	>80 years (n=947)
	%	%
Gender – female	21.1	39.1
Diabetes medication	21.9	18.9
Peripheral vascular disease history	3.3	7.7
Cerebrovascular disease history	3.2	7.8
Previous PCI	31.4	35.1
Previous CABG	7.5	14.5
STEMI	22.5	17.5
NSTEACS	32.3	33.1
Stable angina	30.3	32.4
Radial access	38.9	25.8
Femoral access	60.9	73.7
DES use	75.5	69.0

Care and Treatment of PCI Patients

The technique of PCI involves the use of balloon catheters and coronary stents to relieve areas of blockage and occlusion within coronary arteries. Figure 13 demonstrates that the overwhelming majority (94%) of PCI patients received stents, either as conventional bare metal stents or drug-eluting stents. A very small proportion of cases implanted the recently available new stent type - bioresorbable vascular scaffolds (BVS). This newly developed device acts as a scaffold inside the coronary artery to treat coronary narrowings but unlike metallic stents, is re-absorbed by the body over time (1-2 years). This has a number of potential advantages over conventional stents and is currently in its early phase of uptake into Australian practice. While only a small number of Victorian hospitals commenced implantation of these stents in 2014, VCOR is well positioned to monitor their uptake and outcomes across the state.

Approximately 4% of patients were treated with balloon angioplasty without stenting (POBA). This is usually as a consequence of the vessel size being too small or difficulty advancing a stent to the area of narrowing. The rate of balloon angioplasty alone was comparable with other international registries[8].

Figure 13: Device use across PCI cases



Drug Eluting Stents

Drug-eluting stents (DES) have been available in Victorian hospitals since 2003. While there was some controversy regarding their long-term safety early in their use, they have now clearly demonstrated superiority to bare metal stents in terms of restenosis risk. They also have proven to be safe with minimal increased risk of stent thrombosis compared with bare metal stents.

Drug-eluting stents are more expensive than bare metal stents and cost constraints in the public hospital system in particular have influenced the rate of DES implantation over the last 10 years. The rate of DES implantation remains an issue of interest for clinicians, hospital administrators and funders alike with the focus on how best to determine the balance between their superior clinical efficacy and higher cost.

In 2014, drug-eluting stents were used in 75% of cases in VCOR. However, as in previous years, there was marked variation of this rate across Victorian hospitals with rates ranging from 32% to 91% (Figure 14). When reviewing DES use across the public and private sector, differences become evident with 68% use of DES in public hospitals, compared with 87% DES use in private practice (Figure 15).

Figure 14: DES use by hospital

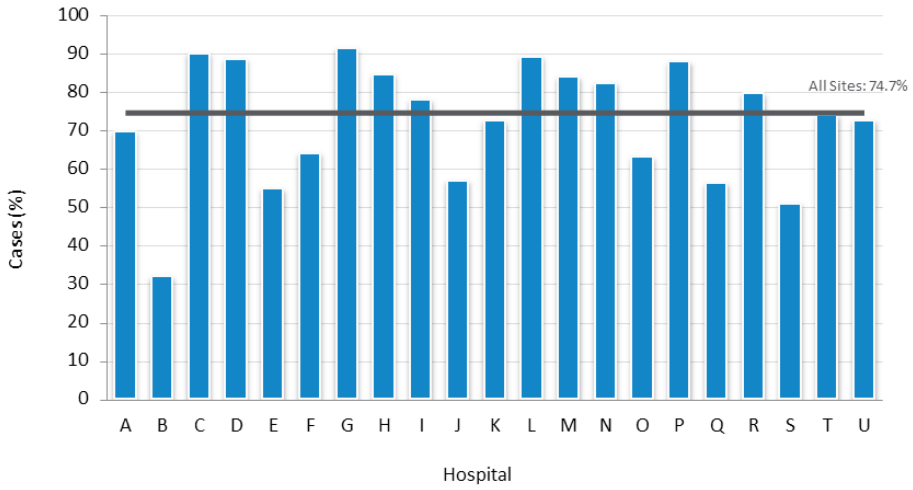
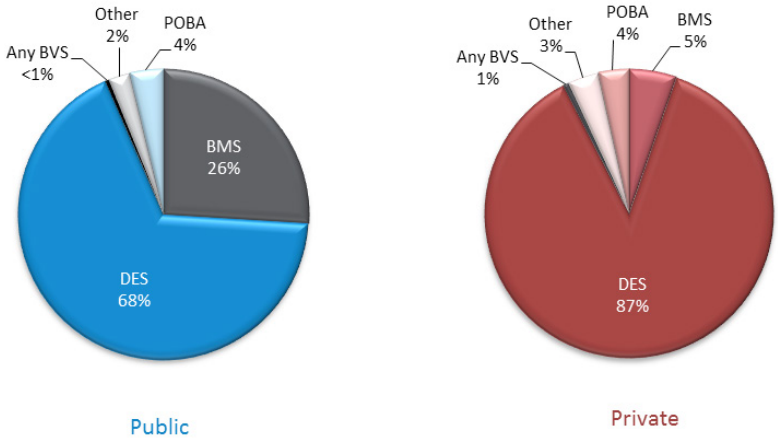


Figure 15: DES use for public and private hospitals



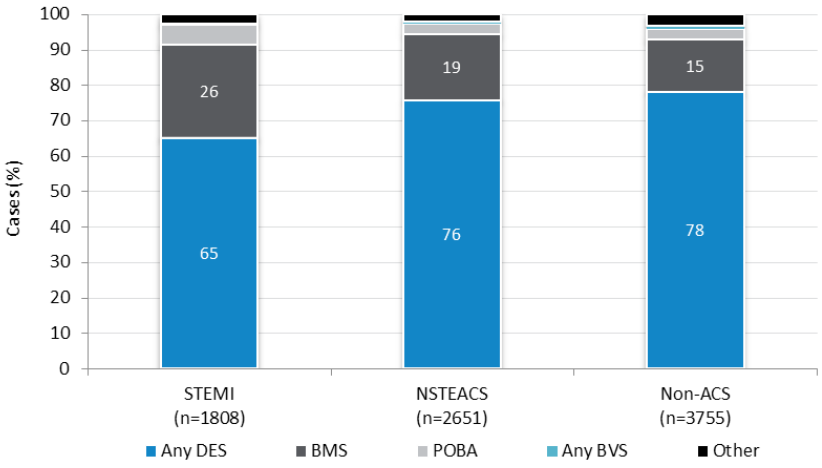
While the uptake of DES has generally been high among Victorian hospitals, there are identifiable patient subgroups that are likely to obtain greater benefit because of their increased risk of restenosis. These include diabetics and patients with renal failure. The incremental benefit of DES also extends to specific lesion subgroups such as chronic total occlusions (CTOs), complex lesions and in-stent restenosis. Table 7 and Figure 16 show DES use across different patient and lesion subgroups and the variation across different clinical presentations. As expected, diabetic patients and particular lesion subgroups at high risk of restenosis had higher rates of DES implantation. Interestingly, patients with renal failure (also at increased risk of restenosis) did not have noticeably higher DES rates than the overall cohort (77% vs 75% for entire cohort). This likely reflects the complexity of clinical issues that often accompany renal failure patients, including increased bleeding risk and potential difficulties with prolonged dual anti-platelet therapy in a dialysis population.

Table 7: DES use in different patient and lesion subgroups

	All PCI cases (N=8214)	All stented cases (n=7690)	DES use (n=6136)
Patient group	**N**	**N (%)**	**N (%)**
Diabetes medication	1772	1643 (92.7)	1414 (86.1)
Renal failure	147	127 (86.4)	98 (77.2)
Lesion subgroups	**N**	**N (%)**	**N (%)**
Chronic Total Occlusion	325	218 (67.1)	201 (92.2)
Complex lesion	4673	4256 (91.1)	3501 (82.3)
In-stent restenosis	471	351 (74.5)	334 (95.2)

Subgroups are not mutually exclusive
Stented cases = one or more lesions treated with a stent
DES use = one or more lesions treated with a DES or mixed stent strategy

Figure 16: Device use based on clinical presentation



DES group includes one or more lesions treated with a DES or mixed stent strategy
BVS group includes any BVS (drug eluting or not)
Other category = no stent used/no balloon deployed

Arterial Access

The worldwide trend towards greater use of the radial artery for arterial access in PCI was reflected in Victorian hospital practice, although significant variation in radial access rates exists among hospitals. Radial access has a number of potential advantages over the traditional femoral artery approach, including lower bleeding rates, greater patient comfort and improved outcomes – particularly in patients presenting with acute STEMI[9]. Given the change in vascular access is occurring to differing extents among various health services, it has been a priority of this registry to follow the trends closely and monitor any effects on outcomes.

For 2014, the overall rate of radial access for PCI was 37% (Figure 17), representing an almost 5% absolute rate increase compared with the previous year. Wide variation still exists among hospitals, however, with rates ranging from 1% to 70% (Figure 18). This variation is also apparent comparing hospital sectors. Radial access routes used in 42% of public cases compared with 30% in private hospitals (Figure 19). The reasons behind the lower uptake in private hospitals are not immediately obvious. In Victoria, a majority of the interventional cardiologists work in both sectors, rendering operator preference an unlikely factor. Nor is there any known policy for a preference for femoral access among private hospitals in Victoria. Other factors may play a part though such as differences in patient demographics and clinical presentation and this remains an area of great interest for ongoing monitoring and assessment.

As in the previous year, radial access rates were higher in male patients, although the rates rose in both males and females, with the gap between the sexes narrowing. Lower rates in women may in part be influenced by women's radial arteries being smaller and potentially more prone to radial artery spasm. However, as operator experience grows, worldwide trends have demonstrated that radial access is safe and effective in women, especially as females are at greater risk of vascular access related complications and bleeding[10].

Figure 17: Arterial access route for all PCI procedures

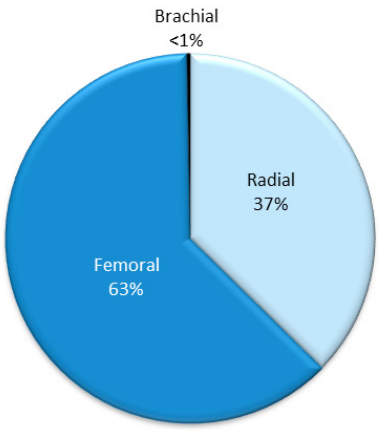


Figure 18: Arterial access route by hospital

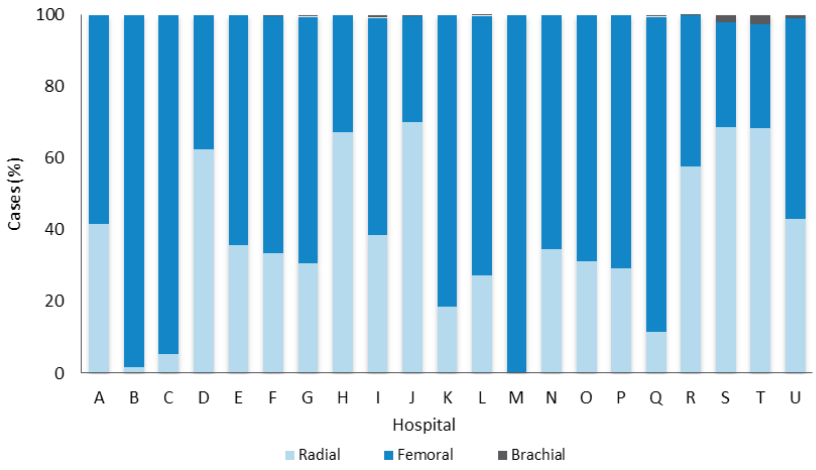


Figure 19: Arterial access route for public and private hospitals

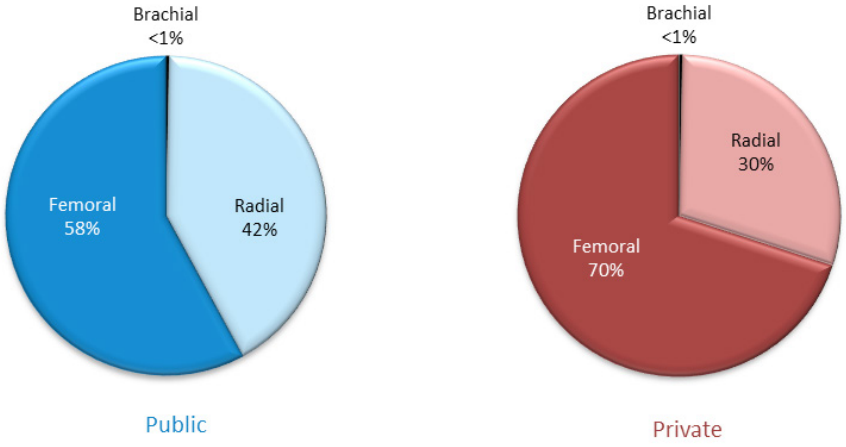


Table 8: Arterial access route by gender

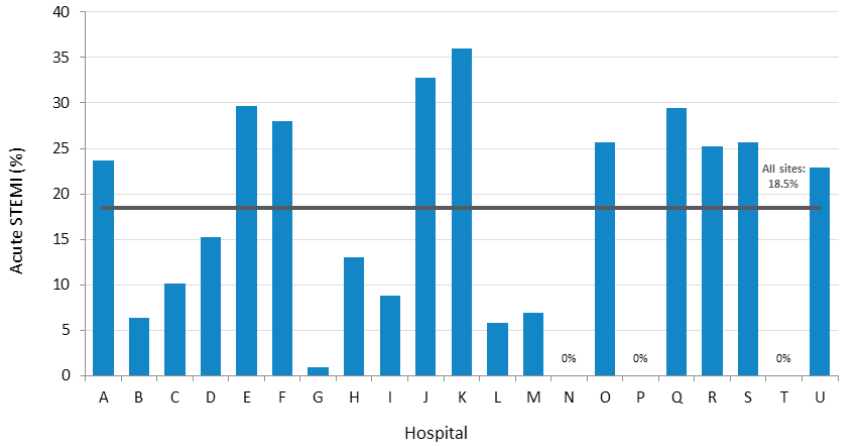
Access Route	All PCI cases	Male	Female
	N (%)	N (%)	N (%)
Radial access	3068 (37.4)	2437 (38.6)	631 (33.2)
Femoral access	5123 (62.4)	3855 (61.1)	1268 (66.7)
Brachial access	23 (0.3)	21 (0.3)	2 (0.1)

PCI for Acute STEMI

From its inception, one of the key roles of VCOR has been to monitor and report on patients presenting with acute ST elevation myocardial infarction (STEMI) who are treated with emergency PCI. This condition is associated with significant morbidity and mortality, and its diagnosis and management challenges hospitals systems and processes to deliver timely, efficient care in order to achieve the best patient outcomes.

Acute STEMI presentations are taking up a substantial proportion of the overall workload of many hospitals, although there is significant variation across hospitals (Figure 20). In 2014, 1518 patients presented directly to a PCI hospital with an acute STEMI and underwent PCI, representing 19% of the total caseload of the registry for the year. Overall, 57% of cases of acute STEMI were treated out-of-hours (between 6pm and 8am Monday to Friday and weekends).

Figure 20: Acute STEMI cases as a proportion of overall case numbers by hospital



Selected characteristics of patients undergoing PCI for STEMI are presented in Table 9. STEMI patients tended to be younger and had fewer traditional cardiac risk factors such as diabetes compared with other patients.

Table 9: Acute STEMI cohort patient characteristics

Patient characteristics	Acute STEMI patients (n=1518)	All other patients (n=6696)
Age - years (Mean ± SD)	62.1 (± 12.5)	66.5 (± 11.6)
	%	%
Gender (female)	20.6	23.7
Diabetes medication	15.4	23
PVD history	2.2	4.2
Cerebrovascular disease	2.6	4.0
Previous PCI	11.5	36.4
Previous CABG	2.6	9.6

The vast majority of acute STEMI patients (88%) were treated in the public sector. These cases accounted for approximately 26% of the public sector's caseload compared with just 6% of private hospitals' case volume. Patient characteristics were similar in the public and private sectors, apart from private patients being approximately 6 years older on average (Table 10).

Influences behind the uneven distribution of this high-intensity, higher-cost condition among the two health sectors are likely multifactorial. Yet, the burden falling predominantly on the public sector has occurred despite significant effort over the last 5-10 years by several private hospitals to develop dedicated around-the-clock services for the treatment of acute STEMI. Both public and private hospitals participate in the Ambulance Victoria program of pre-hospital notification of a suspected STEMI to the treating hospital to expedite emergency treatment and improve patient outcomes. It is an area that has been identified for further analysis as this trend, if it continues, is likely to inform future resource allocation and service improvement plans for both public and private sectors.

Table 10: Acute STEMI cohort patient characteristics for public and private hospitals

Patient characteristics	Public acute STEMI patients (n=1332)	Private acute STEMI patients (n=186)
Age - years (Mean ± SD)	61.4 ±12.4	67.0 ±12.3
Demographics	%	%
Gender – female	20.2	23.7
Diabetes medication	15.6	14.0
Peripheral vascular disease history	2.4	0.5
Cerebrovascular disease history	2.6	2.7
Previous PCI	10.9	15.6
Previous CABG	2.3	4.3
Inter-hospital transfer	21.3	23.1
Treatment	%	%
Primary PCI	89.5	89.2
Rescue PCI	7.3	8.6
Pharmaco-invasive therapy	3.2	2.2
Proportion 'out-of-hours' cases	57.4	53.2

Figures 21 and 22 show data pertaining to the three main PCI-based therapies for acute STEMI. The majority (90%) of STEMI patients were treated with primary PCI, where angioplasty and stenting are used as first line reperfusion therapy (re-opening the acutely occluded artery). In a further 3% of patients, PCI was performed as a rescue PCI procedure after failed thrombolysis. In this situation, patients had usually presented to non-PCI hospitals and received a clot-dissolving thrombolytic drug as initial reperfusion therapy. In cases where there are ongoing symptoms and signs of heart attack, urgent transfer to a PCI-capable hospital is arranged within 12 hours of symptom onset so that rescue PCI can be performed. The third treatment strategy, known as pharmaco-invasive therapy, is also applicable to patients who have received thrombolysis for acute STEMI, but differs from rescue PCI in that it is provided to patients who are clinically stable and do not have evidence of ongoing ischaemia. Patients are transferred in an expeditious fashion rather than as an emergency, and PCI is performed at some point 6-24 hours after symptom onset.

Figure 21: Acute STEMI cohort PCI treatment type

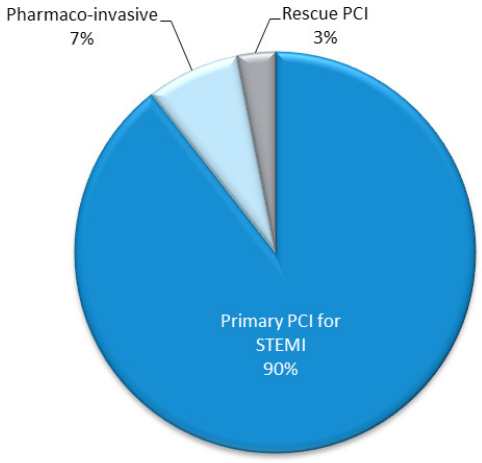
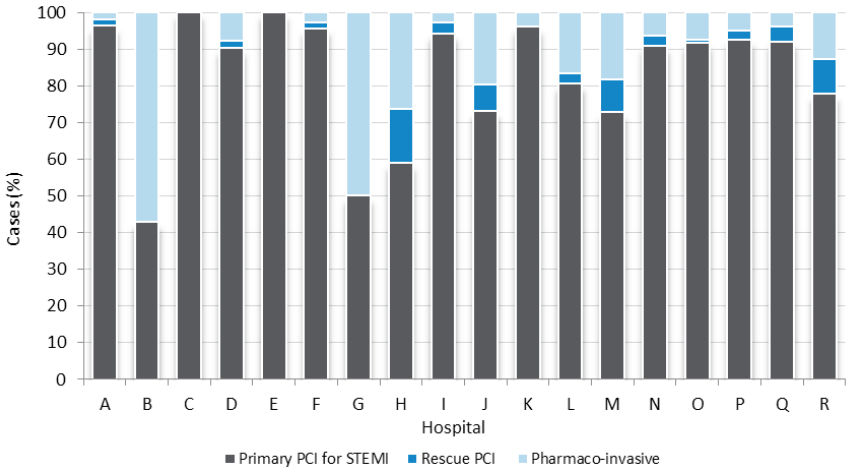


Figure 22: PCI treatment type for acute STEMI patients by hospital



Device use in the STEMI cohort is shown in Figures 23-25. The rate of drug-eluting stent implantation in acute STEMI was lower than in the overall cohort, particularly among patients treated in the public sector. This may in part be a residual effect of a trend away from DES in STEMI that occurred early on in the experience with DES.

That trend was driven by non-randomised data that suggested increased harm with DES in that particular setting. Those data have now largely been refuted, and the safety of DES is well established in the acute STEMI setting.

Figure 23: Device use within the acute STEMI cohort

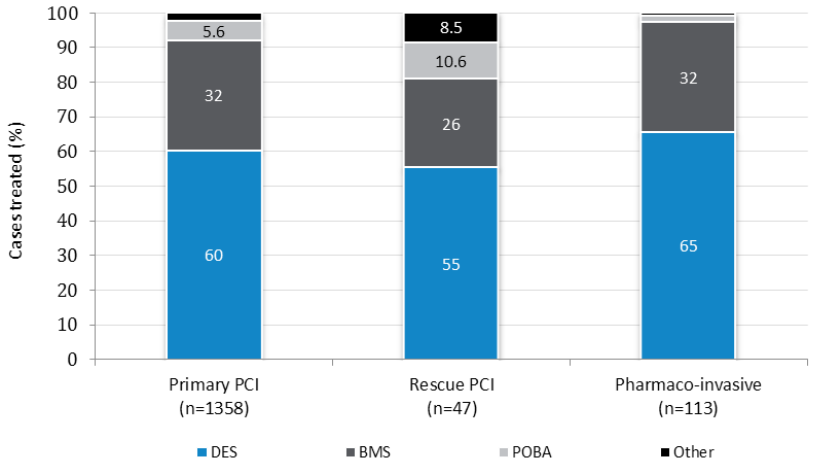


Figure 24: DES use for acute STEMI patients by hospital

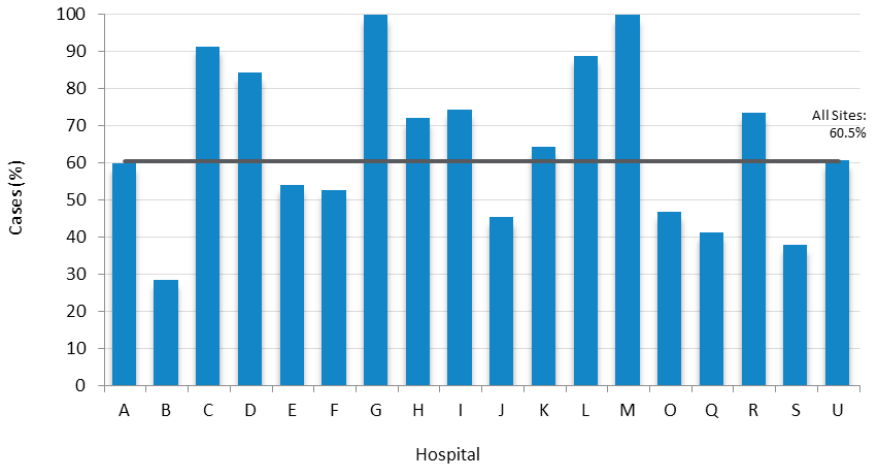
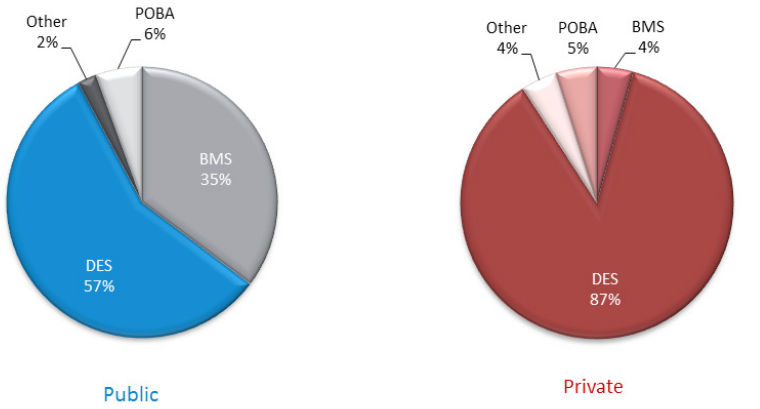
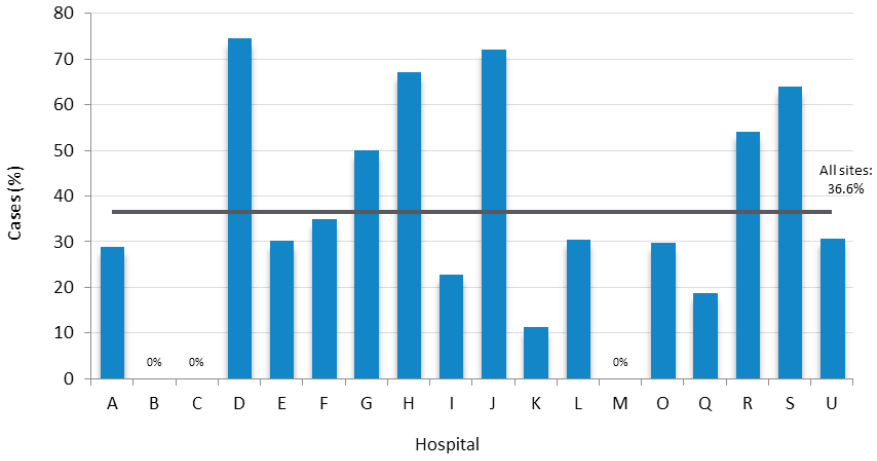


Figure 25: DES use for public and private acute STEMI patients



The rates of radial artery access across hospitals for acute STEMI PCI are compared in Figure 26. The benefits of the radial approach are arguably the greatest in this patient group, with lower bleeding rates and evidence of improved outcomes including lower mortality[11,12]. As a consequence, practice guidelines encourage operators to strongly consider the radial approach in acute STEMI, although it is acknowledged that significant experience with radial access is required before operators should consider utilising the technique in the time-critical and often high stress scenario of a STEMI PCI. Overall, the uptake of the radial approach for acute STEMI remains modest at 37%, although some hospitals clearly favour this approach in the majority of their STEMI cases.

Figure 26: Radial access rates for acute STEMI cohort



Sites N, P & T had no acute STEMI patients

For patients presenting with STEMI and undergoing primary PCI, the time taken from their arrival to the hospital until the insertion of a device to unblock the vessel (usually a balloon catheter or other device to extract clot) is known as the door-to-balloon time. This is a key performance measure that assesses the ability of hospital systems and processes to treat acute STEMI in a timely and efficient manner. It is generally accepted that the benchmark door-to-balloon time that hospitals should aim for is 90 minutes or less in at least 80% of cases[7].

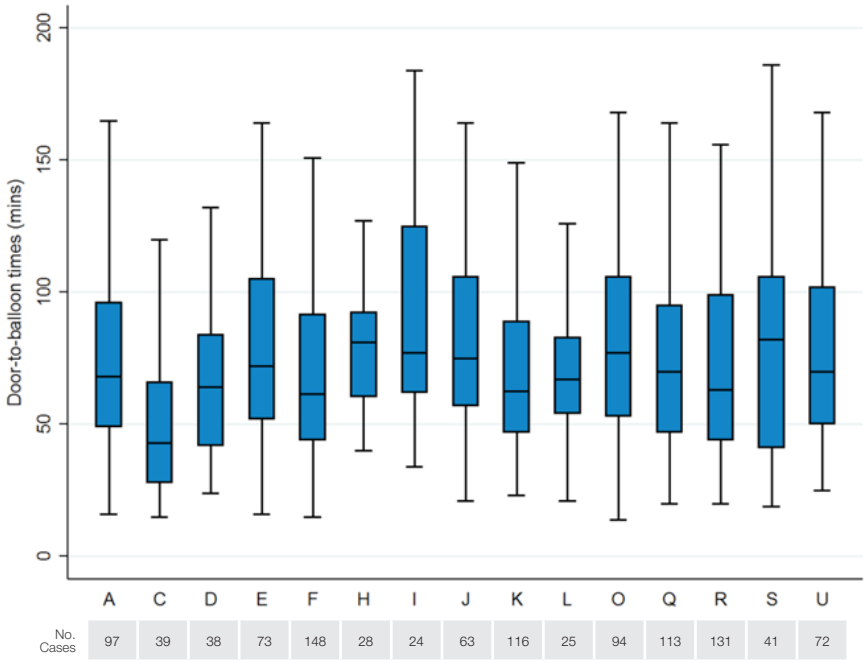
The door-to-balloon times for the primary PCI cohort are shown in Table 11, and compared among participating VCOR hospitals in Figures 27 and 28. These data demonstrate that in 2014, all Victorian hospitals had a median door-to-balloon time below the 90-minute national benchmark for timeliness in treating STEMI patients. Furthermore, the availability of pre-hospital notification of a STEMI case to the receiving hospital significantly impacted door-to-balloon times, with 84% of cases whose treating hospital was pre-notified about patients' impending arrival achieved a door-to-balloon time of less than 90 minutes compared with only 58% where there was no pre-hospital notification.

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

Door-to-Balloon Time	Primary PCI* (all)	Primary PCI (no pre-hospital notification)	Primary PCI (pre-hospital notification only)
	(N=1102)	(n=575)	(n=527)
Median - mins (IQR)	68 (47, 95)	81 (60, 115)	54 (39, 77)
Proportion of cases ≤90 mins	70.5%	58.3%	83.9%

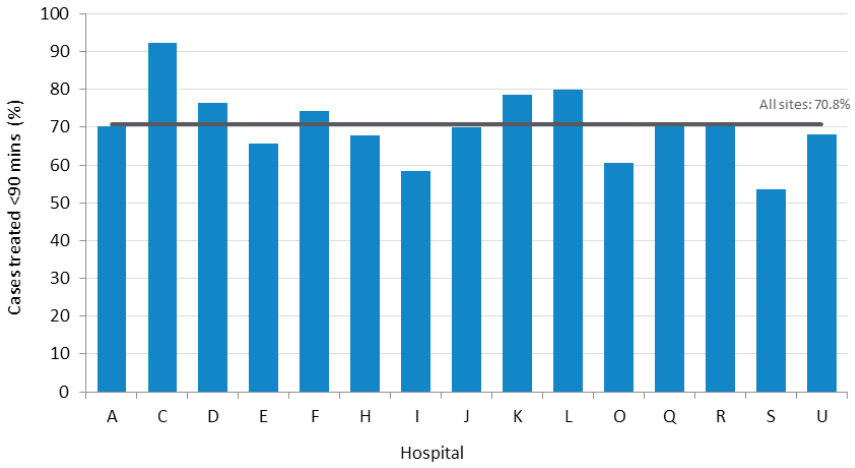
**Primary PCI for STEMI presentation excluding all inter-hospital transfer arrivals*

Figure 27: Door-to-balloon time for primary PCI cases by hospital



Sites B, G, M excluded <5 Primary PCI Cases. Sites N, P and T had no acute STEMI cases.

Figure 28: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes by hospital



Sites B, G, M excluded <5 Primary PCI Cases. Sites N, P and T had no acute STEMI cases.

Outcomes

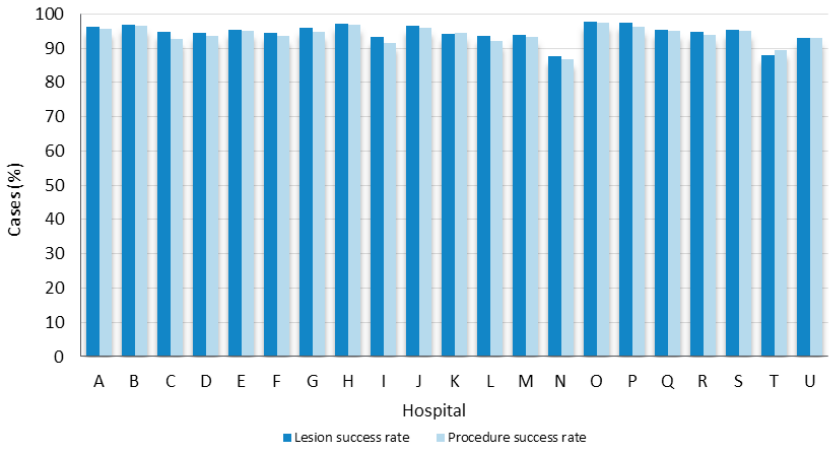
Lesion and Procedure Success Rates

Successful outcomes with PCI relate to re-opening narrowed or blocked coronary arteries with a coronary stent or balloon with a high chance of success, a low risk of complications and a strong likelihood of a durable long-term result. Historically, this procedure has been highly successful. Success can be further measured in terms of individual lesion success where the lesion is reduced to less than 10% residual stenosis following stenting, or less than 50% residual stenosis following balloon angioplasty alone.

Procedure success is defined as all attempted lesions successfully treated, without any significant in-hospital complications.

Overall, hospitals reported 95% of lesions attempted were successfully treated, while the overall procedure success rate for the cohort was 94%. Figure 29 displays lesion success and procedure success rates for each hospital.

Figure 29: Lesion and procedure success by hospital



Key Performance Indicators (KPIs)

Based on clinically relevant procedural outcomes, VCOR has adopted a number of key performance indicators (KPIs) to monitor and benchmark the performance of health services in their delivery of quality cardiac care.
The KPIs reported for the VCOR PCI module are:

- 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 target vessel failure
- 30-day major adverse cardiac and cerebrovascular event (MACCE)

For the first time, VCOR has included a risk-adjustment model for 30-day mortality. The process of risk adjustment is an essential component of reporting of patient outcomes in mature clinical quality registries[13]. As a statistical tool, risk adjustment allows data to be presented in a way that controls for variations in patient population and is a fair and more representative way of benchmarking hospitals' relative performance. The performance indicator of 30-day mortality was selected for risk-adjustment as a standard and comparable performance measure utilised by many other registries. It was possible to perform this analysis on the 2014 cohort because registry case numbers were now sufficient to apply a statistically significant and robust risk-adjustment model.

A risk-prediction scoring tool was developed using the Melbourne Interventional Group multi-centre percutaneous coronary intervention registry mortality risk-adjustment models[5]. This tool was then applied to the VCOR patient cohort to predict the expected probability of 30-day mortality. Observed and expected rates of death to 30 days were calculated and risk adjustment performed. The clinical characteristics used to construct the risk-adjustment model for 30-day mortality were:

- Age ≥80 years
- Acute coronary syndrome
- Glomerular filtration rate
- Left ventricular ejection fraction
- Cardiogenic shock
- Left anterior descending coronary artery disease

A. In-hospital Mortality

The overall unadjusted in-hospital mortality rate in 2014 was 2.0%. However, there was marked variation in this rate when analysed by clinical presentation. Table 12 demonstrates that the highest mortality (44%) was found in patients presenting with cardiogenic shock or out-of-hospital cardiac arrest requiring endotracheal intubation (OHCA). At the other end of the spectrum, patients presenting with low-risk clinical presentations had an in-hospital mortality rate of just 0.3%, a good indication of the overall safety of modern PCI. In 2014, the in-hospital mortality for patients presenting with STEMI was 7.4%, representing a 1.7% increase compared with 2013 results.

Table 12: Unadjusted in-hospital mortality rates

Patient category	Total	In-hospital mortality rate
	N	N (%)
All PCI patients	8209	166 (2.0)
All patients without STEMI* or shock/ intubated OHCA	6369	19 (0.3)
STEMI* patients	1806	134 (7.4)
Shock/intubated OHCA patients	231	102 (44.2)

**Any recent STEMI with symptom onset within the last 7 days*
5 cases excluded from all outcome analyses to avoid reporting double mortality

B. In-hospital Bleeding Events

In-hospital major bleeding is a well recognised performance measure linked with adverse short and long-term outcomes, including increased mortality[14]. Confusingly, there are many different classifications of major bleeding in the clinical arena and this makes comparisons across trials and registries difficult. VCOR has adopted standardised bleeding definitions for cardiovascular clinical trials as established by the international Bleeding Academic Research Consortium (BARC)[15]. Consistent with the BARC criteria, major bleeding was defined as including bleeding that requires blood transfusion, cardiac tamponade, intracranial haemorrhage and/or any fatal bleeding.

The overall in-hospital major bleeding rate in 2014 was 0.8% (Figure 30), similar to the 2013 rate of 0.7%. Figure 30 demonstrates individual rates of in-hospital major bleeding among hospitals by case volume. For this reporting period, one hospital was identified as an outlier with their rate of in-hospital major bleeding, and in line with VCOR policy, this information was fed back to the hospital concerned.

A subsequent internal review by that hospital identified specific high-risk patient characteristics unique to their patient population that predisposed selected cases to an increased bleeding risk. There were no systemic issues or gaps in care found and the hospital concerned has also now flagged bleeding as an outcome measure that will receive special focus in the coming year.

Highest bleeding rates were seen in patients presenting with STEMI (Table 13). Somewhat unexpectedly, the bleeding rates were similar among males and females (Table 14), as data from 2013 had previously shown a threefold increase in bleeding rates among women. There was a doubling of major bleeding with femoral access compared with radial access (0.9% vs 0.4%). However, case numbers were very low in both groups and it is uncertain whether this increase is actually clinically meaningful (Table 15).

Figure 30: In-hospital major bleeding rates

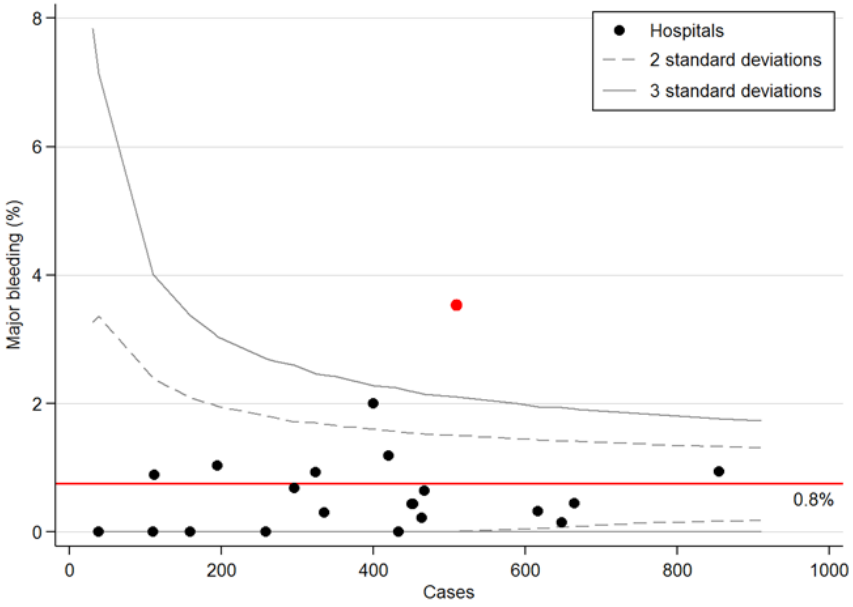


Table 13: In-hospital major bleeding rates by clinical presentation

Clinical presentation	Total	Major bleeding rate
	N	N (%)
STEMI	1796	35 (1.9)
NSTEACS	2662	10 (0.4)
Non-ACS	3751	17 (0.5)
Total	**8209**	**62 (0.8)**

Table 14: In-hospital major bleeding rates by gender

Gender	Total	Major bleeding rate
	N	N (%)
Male	6309	45 (0.7)
Female	1900	17 (0.9)
Total	**8209**	**62 (0.8)**

Table 15: In-hospital major bleeding rates by arterial access route

Arterial access route	Total	Major bleeding rate
	N	N (%)
Radial access	3067	11 (0.4)
Femoral access	5119	48 (0.9)
Brachial access	23	3 (13.0)
Total	**8209**	**62 (0.8)**

C. Length of Stay

Length of stay is generally considered a useful process measure reflecting the efficiency of hospitals in managing particular procedures or operations. It is influenced by a complex set of factors surrounding the management of the patient, including clinical presentation, complexity of the procedure and patient factors. For most elective PCI cases, length of stay is expected to be one day, whereas PCI in patients with acute coronary syndromes is typically associated with multi-day hospital stay, usually related to the underlying condition rather than the actual procedure.

Figure 31 shows the median length of stay (in days) by clinical presentation. As in 2013, length of stay varied by clinical presentation. The median length of stay was longest for patients presenting with STEMI, decreasing as the severity of the presentation decreased. A shorter median length of stay was observed among patients treated in private hospitals (Figure 32).

Figure 31: Length of stay by clinical presentation

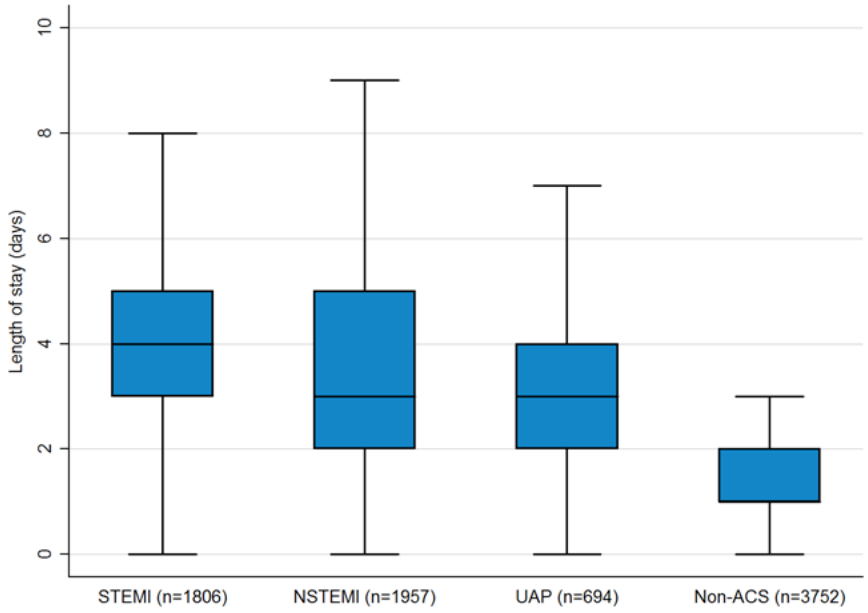
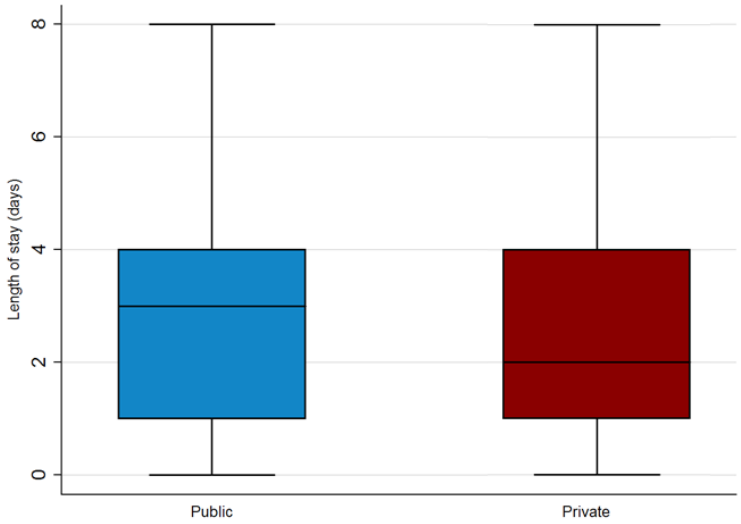


Figure 32: Length of stay for public and private hospitals

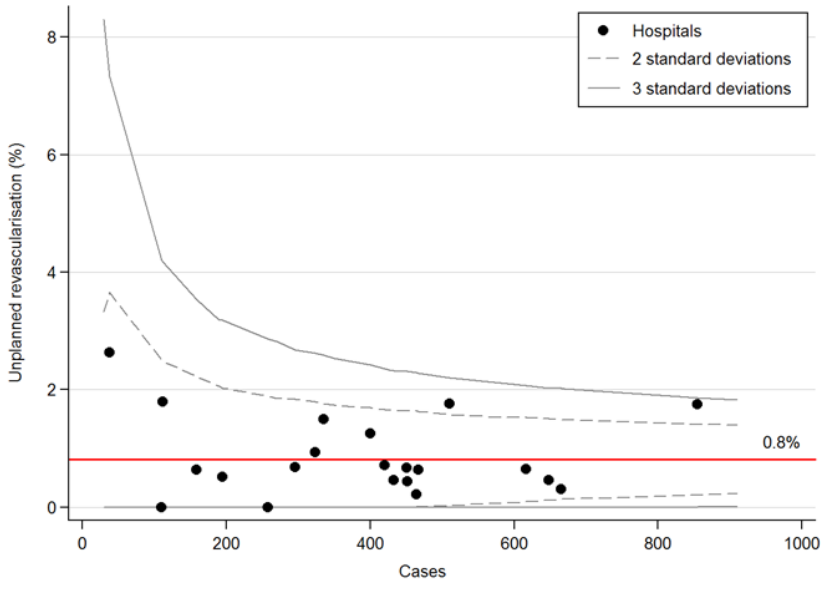


D. In-hospital Unplanned Revascularisation

In-hospital unplanned revascularisation refers to any unexpected revascularisation procedure (either PCI or CABG surgery) the patient undergoes following the index PCI, but within the same admission. Typically, this occurs as a result of the complication of acute or subacute stent thrombosis, often presenting as an evolving acute myocardial infarction. The metric of unplanned in-hospital revascularisation also includes unplanned procedures on coronary vessels other than the one initially treated with PCI.

The overall rate of in-hospital unplanned revascularisation was 0.8%. Figure 33 demonstrates that all hospitals had rates of unplanned revascularisation within control limits.

Figure 33: In-hospital unplanned revascularisation rates



E. Risk-adjusted 30-Day Mortality

The overall risk-adjusted 30-day mortality for the 2014 cohort was 3.7% (Figure 34). As seen in other international PCI registries, 30-day mortality rates are strongly influenced by clinical presentation[16,17]. Although risk adjustment modelling takes this into account, the mortality rates for cases of cardiogenic shock and out-of-hospital cardiac arrest were so much higher than other PCI patient subgroups that it is justifiable to analyse the various subgroups separately. Figure 35 demonstrates lower overall mortality rates when cases of cardiogenic shock and out-of-hospital cardiac arrest were excluded. There is considerable spread in 30-day mortality rates for these two high risk groups among hospitals (Figure 36), but case numbers are generally low and therefore direct comparison of proportions can be potentially misleading. All hospitals participating in VCOR in 2014 had adjusted 30-day mortality rates within acceptable control limits.

Figure 34: Risk-adjusted 30-day mortality rates

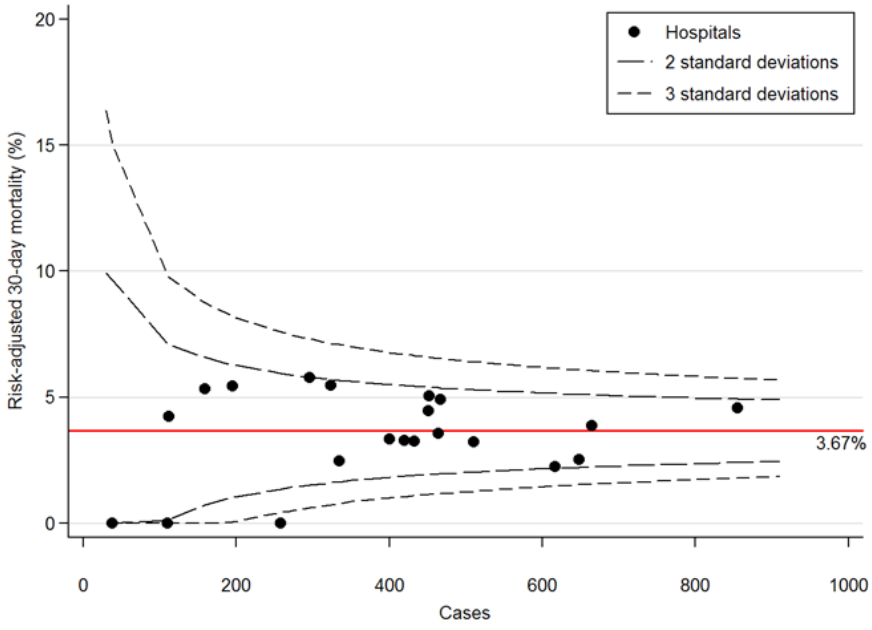


Figure 35: Unadjusted 30-day mortality rates excluding cardiogenic shock and intubated OHCA patients

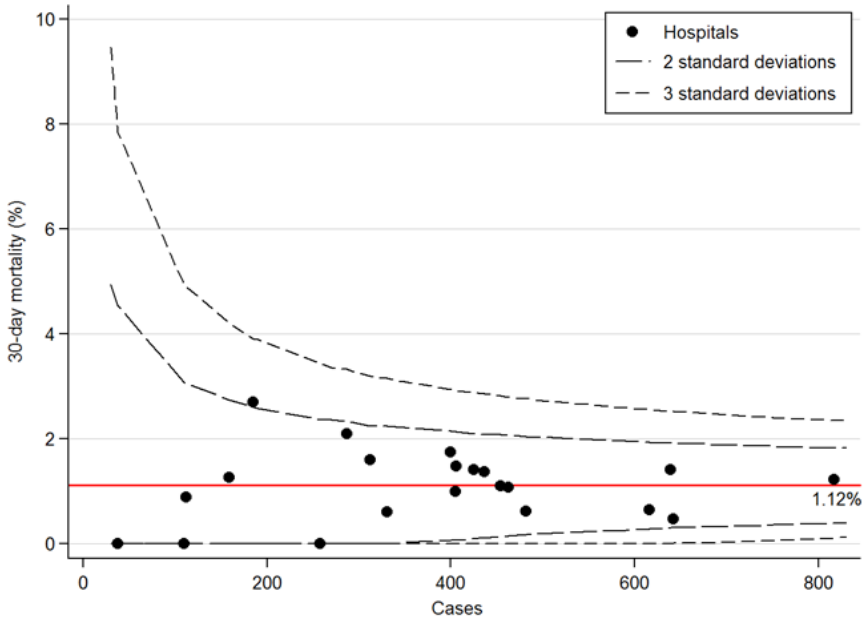
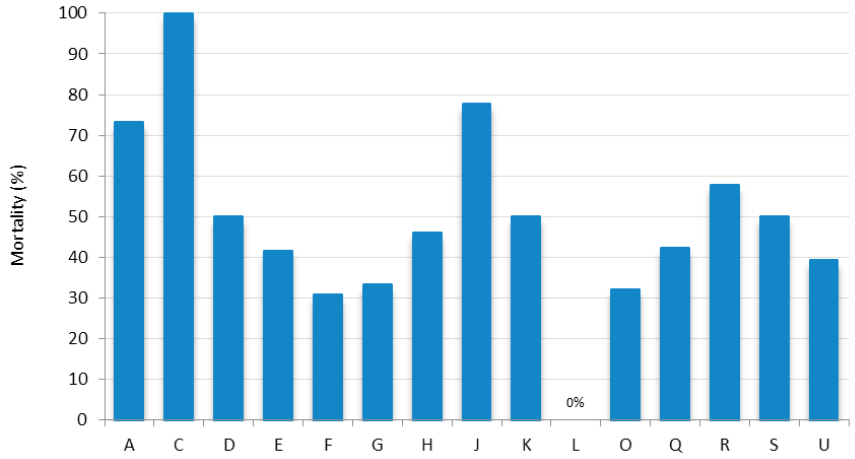


Figure 36: 30-day mortality rates for cardiogenic shock and intubated OHCA patients by site

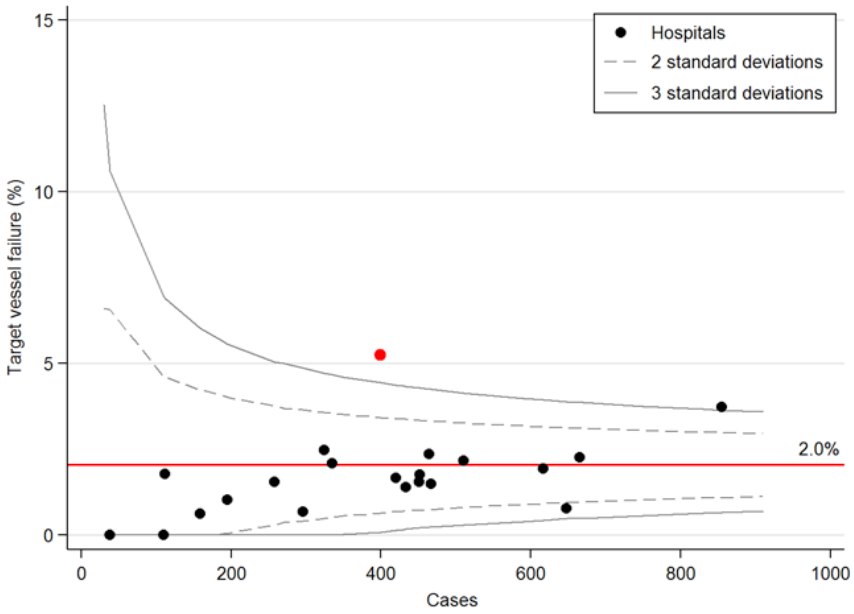


Sites B, I, M, N, P & T had no shock or intubated OHCA patients
Site C & L experienced low numbers (n=1 shock/intubated OHCA patient)

F. 30-Day Target Vessel Failure

Target vessel failure at 30 days is a measure of the number of cases subsequently found to have restenosis or re-occlusion of the artery initially treated with PCI. It includes all cases that undergo target vessel revascularisation within the 30-day period - either by repeat PCI or coronary artery bypass surgery (CABG). The overall rate of 30-day target vessel failure in 2014 was 2.0%, similar to 2013 results (Figure 37). One hospital was an outlier in 2014, with a higher rate of 30-day target vessel failure than other hospitals. That hospital subsequently undertook an internal review of those cases and determined that further clarification around the definitions of data elements was required at that site. The hospital did not identify any systemic practice issues or gaps in quality of care in relation to the observed incidence of target vessel failure.

Figure 37: 30-day target vessel failure rates



G. 30-Day Major Adverse 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. Figure 38 shows MACCE rates at 30 days among participating VCOR hospitals. The overall MACCE rate of 4.7% was similar to 2013 (4.6%). One hospital had outcomes that were outside control limits. An internal review by that site has commenced as a result of these findings.

Figure 38: 30-day MACCE rates

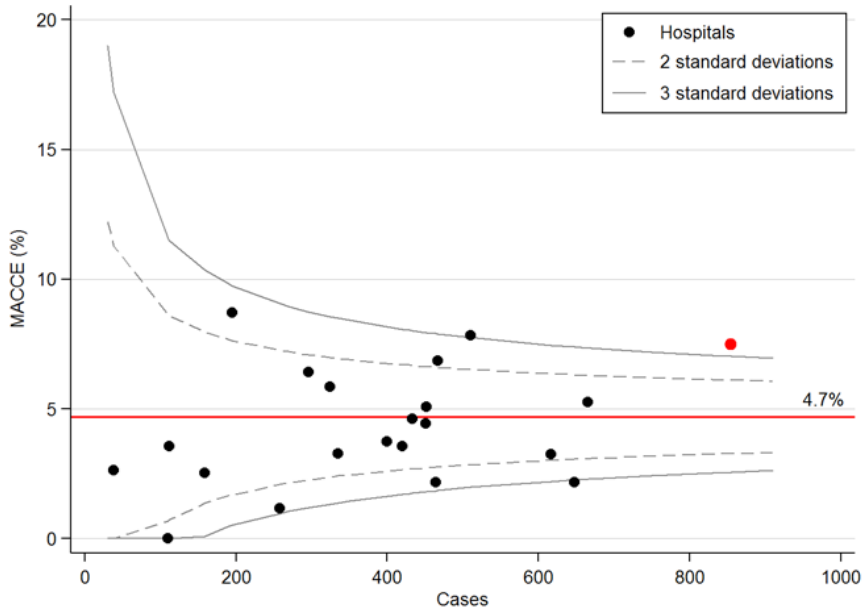


Table 16: 30-day MACCE rates by component

MACCE component	In-hospital events	30-day events*
	N (%)	N (%)
Total mortality	166 (2.0)	196 (2.4)
Myocardial Infarction	88 (1.1)	111 (1.4)
Stroke	26 (0.3)	34 (0.4)
Definite stent thrombosis	14 (0.2)	30 (0.4)
Probable stent thrombosis	6 (0.1)	7 (0.1)
Target vessel revascularisation (TVR)†‡	91 (1.1)	156 (1.9)
MACCE	**292 (3.6)**	**386 (4.7)**

**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

Other Outcomes

30-Day Stent Thrombosis Rates

A standardised definition of stent thrombosis, proposed by the Academic Research Consortium (ARC)[18] was utilised in VCOR. The definition categorises stent thrombosis according to the level of documentation supporting the diagnosis and the timing of the event. For this registry, which currently reports outcomes to 30 days only, stent thrombosis was categorised as definite or a confirmed 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 definite 30-day stent thrombosis rate in 2014 was 0.4%. The probable stent thrombosis rate at 30 days was 0.1%. There were no major differences in stent thrombosis rates among hospitals overall, or when the public private sectors were compared.

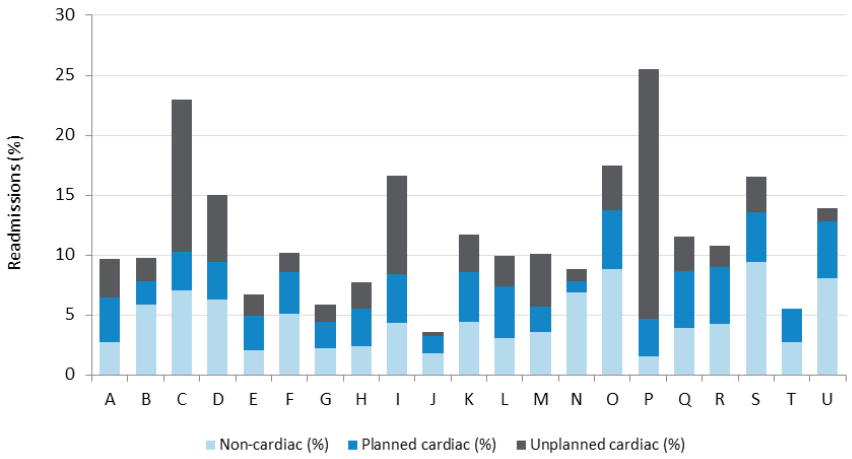
30-Day Rehospitalisation Rates

The overall rate of rehospitalisation within 30 days of PCI was 12%. This included 5.8% who were rehospitalised more than once during that period. Nearly two-thirds of recorded readmissions were for cardiac causes, and of these, half were unplanned cardiac readmissions. Table 17 divides readmission rate into various sub-categories, based on the total number of PCI cases. The rate of unplanned cardiac rehospitalisation is of particular interest in relation to assessment of quality of care, with clinicians, hospitals and funders all highly motivated to minimise unplanned readmissions as much as practicable. Figure 39 demonstrates significant variation among hospitals in unplanned cardiac readmission rates.

Table 17: 30-day rehospitalisation rates

Rehospitalisation type	All patients
	%
Total readmissions (any)	11.8
Non-cardiac readmissions	4.5
Cardiac readmissions	7.3
Unplanned cardiac readmissions	3.7
Planned cardiac readmissions	3.6

Figure 39: 30-day rehospitalisation rates by hospital



The 30-day rehospitalisation rates for public and private hospitals are shown in Table 18. In the public sector, 11% of patients were readmitted within 30 days from discharge. Of these, 4.1% were readmitted more than once during the 30 days. In contrast, the rate of 30-day rehospitalisation was higher among private patients, with 14% readmitted within 30 days, although fewer private patients were readmitted more than once during the 30 days (1.7%).

Rates for all cardiac readmissions and unplanned cardiac readmissions were also higher in the private sector. These findings are noteworthy and raise as yet unanswered questions regarding the various factors that may have had an influence on these results. Better understanding of these findings can potentially inform approaches to service improvement and more efficient delivery of care in both the public and private sectors and is an area that had been flagged for further study and analysis.

Table 18: 30-day rehospitalisation rates for public and private hospitals

Rehospitalisation type	Public (n=5180)	Private (n=3034)
	%	%
Total readmission rates (any)	10.8	13.7
Cardiac readmissions	6.1	9.6
Unplanned cardiac readmissions	2.2	6.4
Planned cardiac readmissions	3.9	3.2

Quality of Life Metrics

At 30-day follow-up, patients were asked to rate their perceived quality of life in a series of questions based on a standardised measure, the EQ-5D[19]. Patients reported on 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 Figures 40-44. Overall, the majority of patients reported "no problem" in these areas.

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. The mean score across the 2014 cohort was 77.1±16.3. Fifty percent of patients reported their own health status in a range of 70 – 90.

Figure 40: Quality of life (mobility)

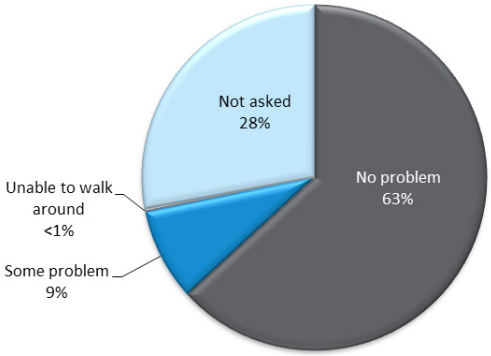


Figure 41: Quality of life (personal care)

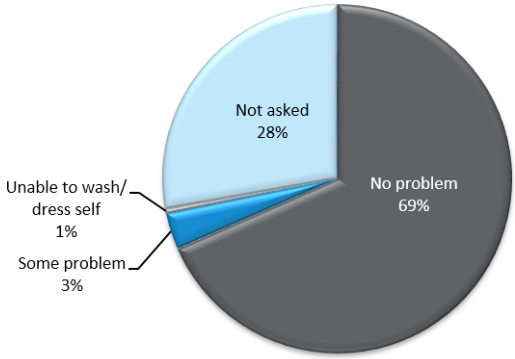


Figure 42: Quality of life (usual activities)

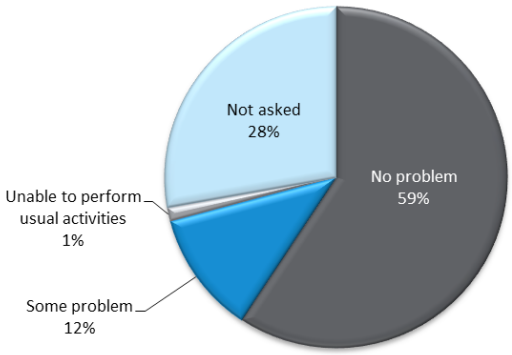


Figure 43: Quality of life (pain/discomfort)

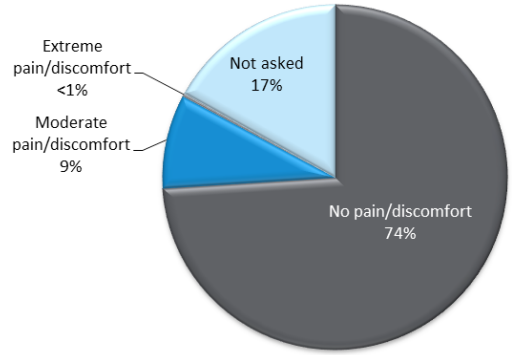
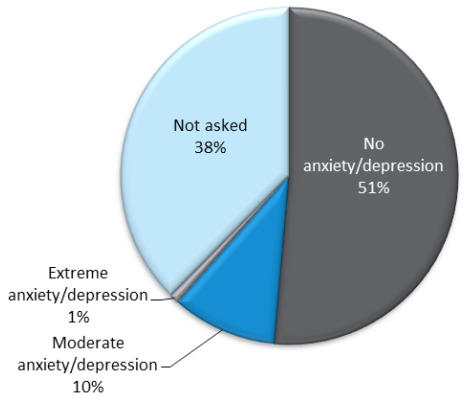


Figure 44: Quality of life (anxiety/depression)



Management of acute ST-elevation myocardial infarction (STEMI) in regional Victoria (early STEMI management)

Background

In 2014, the scope of the Victorian Cardiac Outcomes Registry was extended beyond PCI, with a separate module developed, focusing on the early management of STEMI in non-metropolitan hospital settings.

From its outset, one of the principal aims of VCOR, as set by the Department of Health and Human Services Victoria, was to undertake quality assurance activities in cardiac care outside the setting of PCI, encompassing healthcare activities in rural and regional areas. A growing body of evidence indicates patients presenting with acute coronary syndromes away from large metropolitan centres face significant additional challenges related to timely access to treatment, quality and appropriateness of treatment. Between 1997 and 2007, rates of death from myocardial infarction declined; yet there was significant variation in those rates according to region[20].

With these considerations in mind, VCOR developed its second module of activity pertaining to the early management of acute ST elevation myocardial infarction. This condition was chosen because it has a strong evidence base for effective treatment, well-developed standards of care and measurable process and outcome performance indicators. The VCOR Early STEMI Management module was designed to focus particularly on the delivery of timely and effective reperfusion therapy, and the eventual disposition of these patients initially treated in hospitals without PCI facilities. These two areas of attention are well recognised as having significant influence on patient outcomes.

Module Design

The STEMI Early Management module was modelled on the VCOR PCI module with a standard set of essential and epidemiologically sound variables collected. These data elements comply with standardised data definitions and include identifying information, clinical details, process and outcome measures. Co-morbidity data are collected to allow for statistical adjustments based on individual risk factors that may affect clinical outcomes. The data elements collected include details on reperfusion therapy, in-hospital clinical events, complications and clinical outcomes.

There is also a special focus on inter-hospital transfers, as Victorian rural and regional health services typically identify delays in timely inter-hospital transfer to metropolitan hospitals as the single biggest obstacle to efficient and cost-effective treatment of STEMI. The registry module is particularly interested in characterising key impediments to the system of transfer including difficulty in finding beds in the receiving hospitals and imprecisely defined roles and responsibilities of individual health professionals with respect to patient retrieval.

Site Selection

In 2013, the following 4 sites within the Hume and Gippsland regions were recruited to commence and pilot the Early STEMI Management module:

- Goulburn Valley Health (Shepparton)
- Latrobe Regional Hospital (Traralgon)
- Northeast Health Wangaratta
- West Gippsland Healthcare Group (Warragul)

After the initial pilot phase of the project was designed, two further sites across Victoria joined the project:

- Central Gippsland Health Service (Sale)
- Bairnsdale Regional Health Service

The module is designed to enrol all patients with suspected STEMI either presenting to the index hospital or current in-patients, irrespective of whether they are deemed suitable for thrombolysis.

Patient Characteristics

The number of patients presenting with suspected STEMI to participating regional hospitals in 2014 was 64. Of those, 17 (27%) had contra-indications to thrombolysis. These included late presentation (n=3, 5%), significant comorbidities (n=2, 3%), uncertain diagnosis (n=4, 6%) or resolution of ECG changes (n=6, 9%).

Of the remaining 47 patients, all received thrombolytic therapy, either prior to arrival or at the treating hospital. Ambulance Victoria, with the support of the Cardiac Clinical Network, Department of Health and Human Services, Victoria, introduced a program of pre-hospital thrombolysis in 2014. The program has been rolling out in a sequential fashion across regional Victoria, and 10% of cases in the 2014 regional STEMI cohort were treated in the pre-hospital phase. Of the patients who were suitable for thrombolysis, and did not receive it in the pre-hospital phase, 73% received thrombolysis at their index treating hospital.

The median age of the 2014 regional STEMI cohort was 59 years (IQR 51, 72) for males and for females 57 years (IQR 51, 69). Table 19 shows selected characteristics of the patients.

Table 19: Regional STEMI patient characteristics

Patient characteristics	Total (N=64)
Age - mean (SD)	61 years (±14.0)
Presenting Heart Rate - mean (SD)	79.4 (±21.3)
	%
Gender – female	31.3
Pre-hospital thrombolysis (ambulance presentation only)	9.1
Site of infarction - anterior	34.4
Site of infarction - inferior	48.4
Site of infarction - posterior	6.3
Site of infarction - other	10.9
LBBB	3.1

The majority of regional STEMI patients arrived by ambulance (69%). A further 19% self-presented to the hospital emergency department and 8% of patients arrived from another treating hospital (inter-hospital transfer). The distance travelled to the emergency department did not exceed 50kms for any patient, with 63% travelling 25kms or less.

Time Intervals to Treatment

For all patients except those with in-hospital STEMI, the median time from pain onset to first medical contact (patient delay) was 72 minutes (IQR 27, 237). The median time from first medical contact to hospital arrival (pre-hospital delay) was 50 minutes (IQR 38, 68). For those patients who travelled less than 25kms to hospital, the median pre-hospital delay was 43 minutes (IQR 37, 56) and for those travelling between 26 and 50kms, the median time was 64 minutes (IQR 40, 93). Time intervals related to ambulance calls are noted in Table 20.

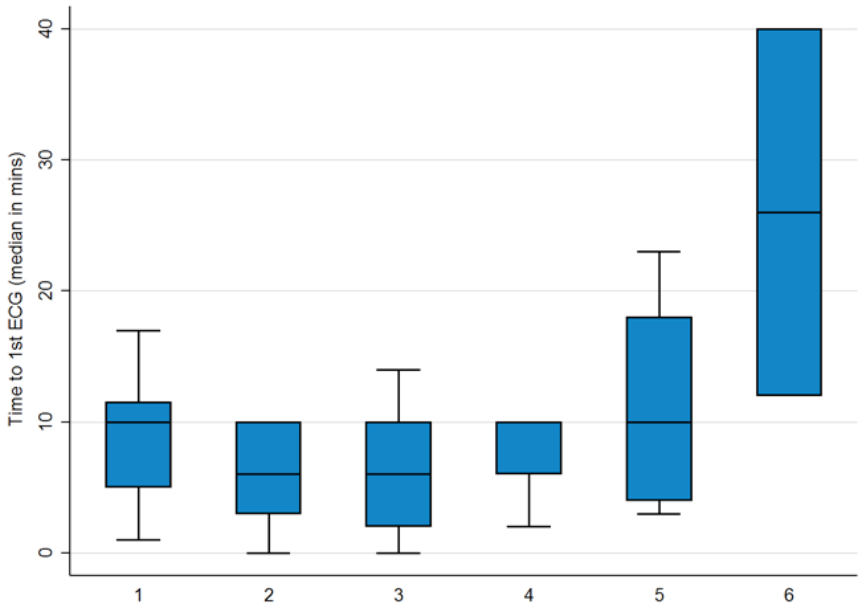
Table 20: Regional STEMI ambulance times

Ambulance times	Median time (N=44)
	Mins (IQR)
Time from symptom onset to ambulance call	42 minutes (13, 130)
Time from call receipt to ambulance arrival	15 minutes (10, 20)
Time from ambulance arrival to hospital arrival	47 minutes (37, 64)

In-hospital Process Times (Arrival to ECG time, Door-to-Needle Time and Overall System Delay)

Efficient delivery of timely reperfusion therapy is a key performance outcome and can be evaluated by process measures that reflect the rapidity of diagnosis and treatment of acute STEMI. These include the time taken to perform the first ECG after hospital arrival and the time taken from hospital presentation to administration of thrombolytic drug, known as the door-to-needle time. Figure 45 shows the median times taken to perform the first ECG upon hospital arrival for the 6 participating hospitals. All but one hospital had a median time less than 10 minutes. The last hospital (site 6) entered only 2 patients in the 2014 cohort and its results may therefore not be representative.

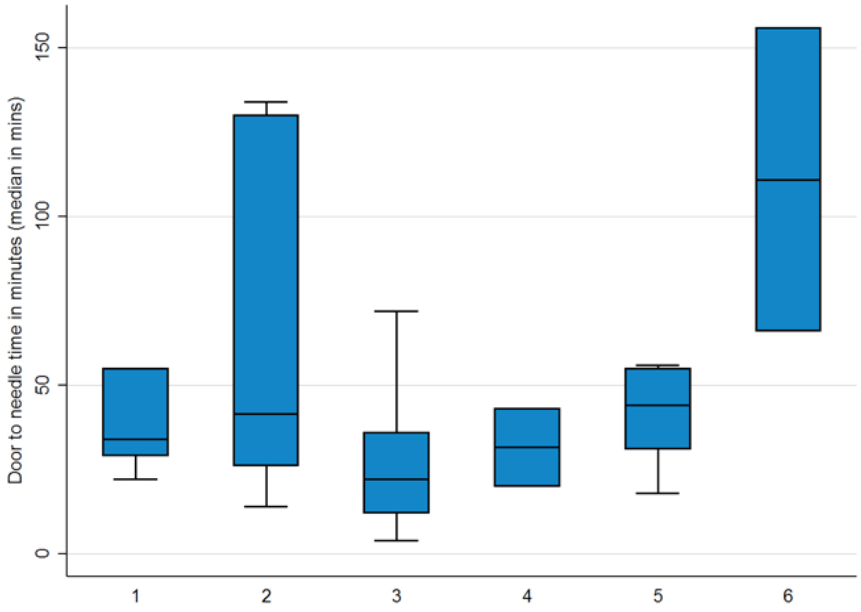
Figure 45: Time from arrival to first ECG time by hospital (regional STEMI patients)



The Australian National Heart Foundation/Cardiac Society of Australia and New Zealand Guidelines recommend an ideal target door-to-needle time of 30 minutes or less[7].

The median door-to-needle time for all VCOR regional STEMI sites was 33 minutes (IQR 20, 59). Median door-to-needle times for the six participating hospitals are shown in Figure 46.

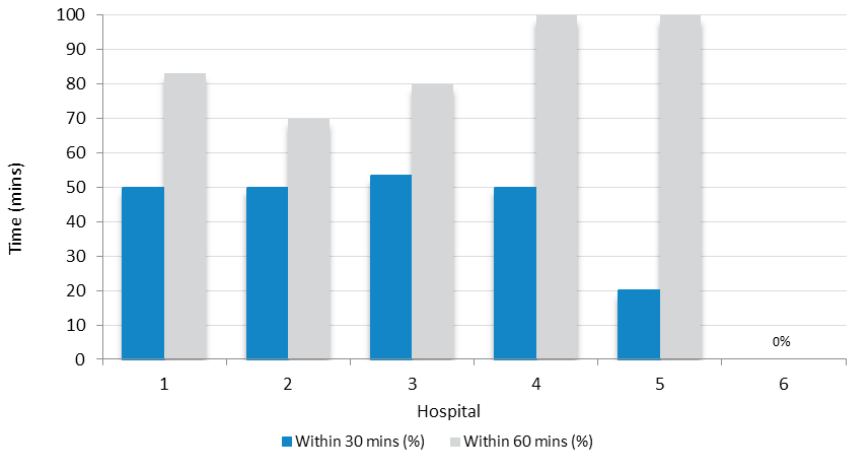
Figure 46: Door-to-needle times by hospital (regional STEMI patients)



When analysed according to the proportion of cases treated within guideline recommendations, participating VCOR sites achieved door-to-needle times of 30 minutes or less in 45% of cases, and times less than 60 minutes in 78% of cases (Figure 47). All but one site were able to deliver thrombolysis within 60 minutes in at least 70% of cases. The last site (Site 6) only treated two STEMI patients in 2014, which is not a large enough sample to be able to benchmark with other sites.

These results suggest that the need to achieve guideline-recommended door-to-needle times in a majority of cases has been only partially met and underscores the critical importance of benchmarking and performance assessment activities for all sites involved in acute management of STEMI.

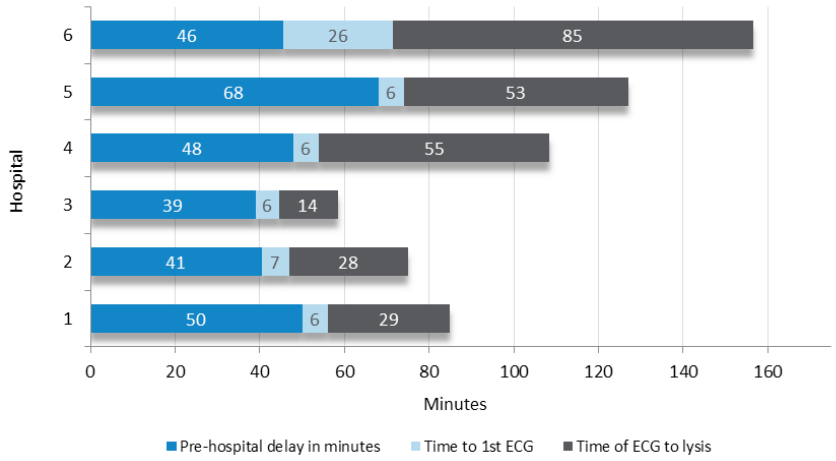
Figure 47: Proportion achieving door-to-needle times within 30 and 60 mins



While the use of the metric of door-to-needle time is well established in performance measurement and quality assurance activities, there is an increasingly widespread trend to measure time delays from first medical contact to thrombolytic drug administration instead. This measure will be the same for patients self-presenting to hospital, but will differ for those patients who are first assessed by ambulance paramedics. With the strong evidence base of the benefits of pre-hospital thrombolysis, any delay to effective treatment can be minimised if ambulance officers are trained and capable of administering thrombolysis to STEMI patients that are located more than 30 minutes from a treating hospital.

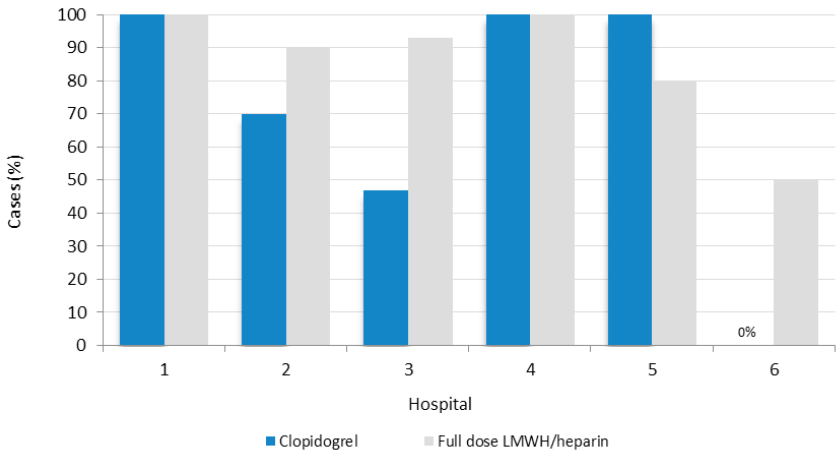
Data from the 2014 cohort of regional STEMI cases indicate that the metric of first medical contact–to-needle time was 51.5 minutes longer on average than the door-to-balloon time overall (Figure 48). Thus, compliance with the guideline of achieving thrombolysis in less than 30 minutes was even lower among participating sites when first medical contact was used as the starting time to measure system delay. These data provide strong support for the need to continue development and enhancement of efficient pre-hospital thrombolysis programs right across the state of Victoria.

Figure 48: Overall system delay times by hospital (regional STEMI patients)



With respect to adjunctive treatments following thrombolysis, the Australian National Heart Foundation/Cardiac Society of Australia and New Zealand Guidelines provide strong recommendations for antithrombotic therapy (unfractionated heparin or low molecular weight heparin), and anti-platelet therapy with clopidogrel following thrombolysis[21,22]. Figure 49 shows that most hospitals treat more than 80% of patients with antithrombotic therapy. Compliance rates of concomitant anti-platelet therapy with clopidogrel are lower and range from 47% to 100%.

Figure 49: Treatment and outcomes: adjunctive therapies by hospital (regional STEMI patients)



In-hospital Outcomes and Transfer Rates

In-hospital outcomes for regional STEMI patents in the 2014 cohort are shown in Table 21. The mean unadjusted in-hospital mortality rate for the 6 participating hospitals was 7.8%, comparable to other registries of STEMI from around the world[21,23,24]. Cardiogenic shock occurred in 12.5% of patients overall, and its in-hospital mortality rate was 62%. There were no major bleeding episodes and no cases of intra-cerebral haemorrhage among thrombolysis treated patients. However, it is important to note that as it was outside the scope of this registry module to track outcomes beyond the admission to the index regional hospital.

Accordingly, the outcomes in Table 21 reflect events at the index hospital only and not for the total admission episode that would also include outcomes at the transfer hospital.

Most patients (95%) were transferred to a PCI capable hospital within 24 hours of thrombolytic therapy. Only two patients (2 cases from site 6) were transferred outside this period (both took 31 hours). The median time from referral request to the actual transfer from VCOR regional STEMI sites to metropolitan PCI hospitals was 2.3 hours (IQR 1.4, 6.2) (Figure 50).

Figure 50: Patient transfer times to metro VCOR hospital (regional STEMI patients)

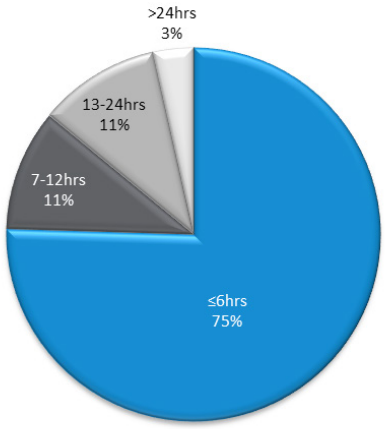


Table 21: In-hospital outcomes for regional STEMI patients

In-hospital outcomes	Site 1 (n=12)	Site 2 (n=14)	Site 3 (n=21)	Site 4 (n=6)	Site 5 (n=7)	Site 6 (n=4)	All sites (n=64)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Death	1 (8.3)	1 (7.1)	3 (14.3)	0 (0)	0 (0)	0 (0)	5 (7.8)
Cardiogenic shock	1 (8.3)	1 (7.1)	1 (7.1)	0 (0)	0 (0)	0 (0)	8 (12.5)
Myocardial re-infarction	2 (16.7)	2 (14.3)	3 (14.3)	0 (0)	0 (0)	1 (25.0)	8 (12.5)
Major bleeding	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Stroke	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Future Directions

The Victorian Cardiac Outcomes Registry has established a successful collaborative model of quality assurance data collection and reporting among the state's cardiology community – spanning both the public and private sectors. The continued output of high quality health information aimed at improving the care and outcomes of patients with cardiovascular conditions is the primary and overriding goal of this registry and our future efforts will continue to be directed in this way.

Our plans incorporate a number of different strategies.

We aim to improve the quality of the data that are collected, acknowledging that data accuracy is the cornerstone of a clinical quality registry. We will build upon our current clinical auditing activities, extend our ongoing support for data managers and continue our regular audit of hospital medical records for case ascertainment and case report form accuracy. We plan to work closely with colleagues in participating hospitals and extend systems of regular feedback on data completeness of key data fields.

The move to reporting risk adjusted 30-day mortality outcomes has been an important achievement for VCOR. However, the process did reveal some issues collecting particular data elements important in the risk adjustment process, including left ventricular ejection fraction and renal function. We plan to place particular focus on the collection of these important data elements, providing regular monthly feedback to sites on their collection compliance and offer ongoing support to sites to assist in this process.

We intend to continue our site engagement activities to help achieve our goal of universal participation of all PCI hospitals in Victoria. We also aim to engage other stakeholders and interested parties in the area of quality assurance in PCI. VCOR has already reached out to a number of state-based organisations in Australia who are currently involved in PCI quality activities. Our state-wide registry is assisting the trans-Tasman effort for a combined Australia and New Zealand registry of PCI, being coordinated by the Australian Cardiac Outcomes Registry (ACOR) under the auspices of the Cardiac Society of Australia and New Zealand (CSANZ).

Our activities beyond PCI are set to continue. Our registry module for early management of STEMI in rural and regional settings was successfully launched in 2014. We plan to expand this module to incorporate a greater number of non-metropolitan hospitals across the state. Our processes for engagement and ongoing feedback to these hospitals will be further tailored to their needs in order to provide the best value for their quality activity. Our heart failure module pilot phase will continue, with several sites now engaged in a rolling "snapshot" model of data collection for limited periods, repeated yearly to provide active and dynamic measures of activity and outcomes in acute decompensated heart failure. We are also working with CSANZ and ACOR to assist in their activities related to the setting up and running of a national registry for high-risk implantable cardiac devices including pacemakers, implantable defibrillators and prosthetic cardiac valves.

With all our registry-based activities – current and future - the focus of the Victorian Cardiac Outcomes Registry remains strongly patient oriented. As VCOR builds on its early achievements, we look forward to a healthcare environment that ensures patients receive cardiac care of the highest quality, with the best healthcare outcomes possible, irrespective of their location, insurance status or healthcare provider.

Glossary

ACS	Acute Coronary Syndrome
BARC	British Academic Research Consortium
BMS	Bare Metal Stent
BVS	Bioresorbable Vascular Scaffold
CABG	Coronary Artery Bypass Graft
CSANZ	Cardiac Society of Australia and New Zealand
CTO	Chronic Total Occlusion
DEPM	Department of Epidemiology & Preventive Medicine
DES	Drug Eluting Stent
IQR	Inter Quartile Range
KPI	Key Performance Indicator
MACCE	Major Adverse Cardiac & Cerebrovascular Event
NHMRC	National Health & Medical Research Council
NSTEACS	Non-ST Elevation Acute Coronary Syndrome
NSTEMI	Non-ST Elevation Myocardial Infarction
OHCA	Out of Hospital Cardiac Arrest
PCI	Percutaneous Coronary Intervention
POBA	Plain Old Balloon Angioplasty
STEMI	ST-Elevation Myocardial Infarction
TVR	Target Vessel Revascularisation
UAP	Unstable Angina Pectoris
VCOR	Victorian Cardiac Outcomes Registry

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Table 21: VCOR funding to date

Organisation	Funding by year				
	2011	2012	2013	2014	2015
Medibank Private	$100,000	$400,000	$400,000	$300,000	
Department of Health	$200,000	$200,000	$205,000	$350,000	$256,000
Department of Health - Victorian Cardiac Clinical Network (VCCN)				$159,466	$204,202
Sub Total	**$300,000**	**$600,000**	**$605,000**	**$809,466**	**$460,202**
Total Funding Received					**$2,774,668**

Correct at 1 July 2015

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