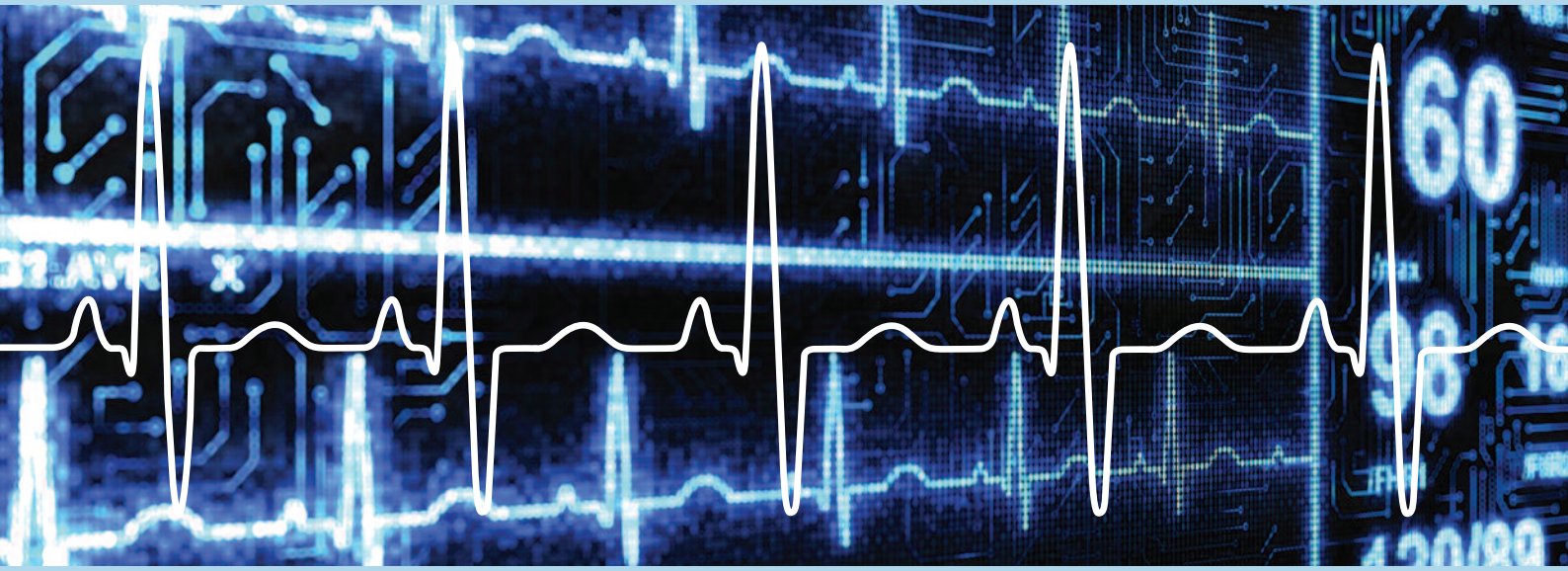
Victorian Cardiac Outcomes Registry

ANNUAL PUBLIC REPORT 2016



VCOR
VICTORIAN CARDIAC OUTCOMES REGISTRY

Improving cardiovascular outcomes Victoria-wide

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

Suggested citation:
A/Prof Jeffrey Lefkovits, Ms Angela Brennan, Dr Diem Dinh, Ms Rita Brien, Mrs Harriet Carruthers, Mrs Janine Doyle, Dr Dion Stub, Prof Andrea Driscoll and Prof Chris Reid on behalf of the VCOR. The Victorian Cardiac Outcomes Registry Annual Report 2016. Monash University, DEPM June 2017, Report No 4, 63 pages.

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Report No: 4,
June 2017

VICTORIA
State Government

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Acknowledgements

VCOR is funded by the Department of Health and Human Services (DHHS) Victoria with in-kind funding from Monash University. VCOR is operated by the Department of Epidemiology and Preventive Medicine (DEPM), Monash University, in association with the Victorian Cardiac Clinical Network, DHHS Victoria.

We gratefully acknowledge contributions made by the VCOR Steering Committee, the VCOR Clinical Quality Committee, the VCOR Data Research and Publications Committee, the VCOR Registry Custodian - Prof Chris Reid and the VCOR Clinical Director - A/Prof Jeff Lefkovits. We also acknowledge the VCOR Data and Project Management Committee staff at DEPM (Ms Angela Brennan, Dr Diem Dinh, Dr Nick Andrianopoulos, Dr Dion Stub, Prof Andrea Driscoll, Ms Rita Brien, Ms Harriet Carruthers, Mrs Janine Doyle, Mr Mark Tacey and Mrs Jill Edmonds).

In 2016 the Registry Custodian, Prof Chris Reid was supported by a National Health and Medical Research Council (NHMRC) Fellowship that provided salary support to contribute to initiatives such as the VCOR.

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

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

Foreword

As the inaugural Chief Executive of Safer Care Victoria, it is my great pleasure to introduce the Victorian Cardiac Outcomes Registry (VCOR) Annual Report for 2016 – the fourth such report from VCOR.

Our mission at Safer Care Victoria is "Outstanding health care for all Victorians. Always". Working with health services and health practitioners to deliver on that mission, and to show that, together, we are delivering on that mission, requires us to measure, analyse and report outcomes. Without meaningful data, delivered in a timely manner into the hands of those to whom the data matter most – clinicians and consumers – we cannot expect to even begin on the improvement journey. In the words of Galileo "Measure what can be measured, and make measurable what cannot be measured".

With the intent of informing and targeting improvement, clinical quality registries have become an important and effective tool in measuring, analysing and reporting health outcomes. The embedded clinical expertise in the design, running and reporting of registries is, in my view, the critical component of registry successes. The clinician voice ensures that the measures are relevant and meaningful and that the interpretation of the data is appropriately focussed on genuine opportunities for improvement. Let's be honest, nothing quite holds clinicians to account than other clinicians! In this way, clinical expertise has ensured that registries deliver on the expectations of the National Health and Hospitals Reform Commission (2009) that we have "systems in place to provide comparative clinical performance data back to health services and … clinicians".

VCOR and its Annual Reports are an exemplar of such clinical performance reporting. That all Victorian hospitals, public and private, that provide percutaneous coronary interventions now participate in VCOR is a measure of both the success of the registry and of the value that clinicians clearly place in the reported comparative data. In that regard, as you will read, the data include measures of process – time from arrival to first ECG or door-to-needle times, for example – and of outcomes, both clinical and patient reported. A standardized approach to outcome reporting, such as VCOR reporting, is an essential component of quality improvement and of ensuring the provision of safe and appropriate care. This is core business for Safer Care Victoria. I welcome the VCOR report and look forward to working with our Cardiac Clinical Network to applying its lessons.

The future of health outcome reporting will see increasing use of the patient voice, such as is evident in the standard sets developed by the International Consortium for Health Outcomes Measurement (ICHOM) and as presented in the VCOR report. This is important. At the end of the day – indeed at the beginning of the day – we are here to meet to needs of our consumers – patients, their families and carers. Asking them what is important is crucial to delivering on our mission. Safer Care Victoria looks forward to working with all of our clinical quality registries, our clinical networks, clinicians and health services, and of course consumers to provide outstanding health care. Always. VCOR is showing us the way in cardiac services.

On behalf of Safer Care Victoria, the Department of Health and Human Services, and indeed of all Victorians, I congratulate Associate Professor Lefkovits, the VCOR team and site leads, and all participating clinicians and hospitals on their commitment to improving cardiac services in our state. I commend the Annual Report to you and look forward to next year's report with even better outcomes.

Professor Euan Wallace AM

CEO, Safer Care Victoria

Executive Summary

In October 2016, the Victorian Department of Health and Human Services released a review of hospital safety and quality assurance in Victorian hospitals. The report, *Targeting Zero – Supporting the Victorian Hospital System to Eliminate Avoidable Harm and Strengthen Quality of Care[1]* was undertaken after the tragic events at Bacchus Marsh Hospital in 2013-2014 that resulted from avoidable and potentially avoidable deficiencies in care. Among the report's many crucial recommendations, was a strengthened role for clinical quality registries to facilitate the identification of any potential shortcomings in care. Also in 2016, the Victorian Department of Health and Human Services released its new cardiac services plan - *Design, service and infrastructure for Victoria's cardiac system[2]*. In this report, the utility of registries in ensuring safe and effective care was once again highlighted.

It is in this setting that the Victorian Cardiac Outcomes Registry (VCOR) has continued its mission to improve cardiac care across the state. The registry's core business is to measure and report on the quality and safety of patient care - within individual hospitals, comparatively with other hospitals, and aggregated at the state level. Safer Care Victoria now oversees its activities and provides funding through the Victorian Cardiac Clinical Network.

This Annual Report presents the activities of VCOR over 2016 in three separate areas of interest in cardiovascular care. These include percutaneous coronary intervention (PCI), the early treatment of acute myocardial infarction in rural and regional settings, and data relating to in-hospital management of heart failure. The first two directly relate to management of coronary artery disease, primarily in its acute form (heart attacks and angina). The third focuses on chronic heart disease (both coronary and non-coronary) that places a significant load on the individual and society in terms of disability, reduced quality of life, high healthcare resource consumption and costs.

In 2016, PCI data were captured on almost 10,000 cases across 13 public and 12 private hospitals. VCOR now has cumulative data on over 36,000 PCI cases, collected since its commencement in 2013. This year also marked the achievement of one of VCOR's main goals with unanimous engagement of all hospitals performing PCI in Victoria (public and private). While 5 private hospitals are yet to commence data contribution, it is envisaged that in 2017, VCOR will be able to report on all PCIs performed in the state.

The Report follows trends in patient demographics and emerging treatment patterns in PCI. Particular areas of interest are the increasing number of high-acuity patients with cardiogenic shock or out-of-hospital cardiac arrest and the continuing burden of emergency PCI for acute ST elevation myocardial infarction that is predominantly taken up by the public sector. The Report also reveals changing patterns of practice including widespread uptake of the radial artery for arterial access and near universal usage of drug-eluting stents. Overall outcomes remained similar to and often better than international benchmarks. When the comparison of hospital outcomes identified a performance outlier, the registry provided timely feedback to the affected health service, facilitating their own internal review of their processes and results.

In the second section of the Annual Report relating to early management of acute myocardial infarction in non-metropolitan settings, the number of contributing hospitals has grown to 9 in 2016, with plans to roll out the program to other hospitals across the state in the coming 1-2 years. The Report indicates that while these hospitals remain actively engaged in ongoing service improvement activities, there are still challenges to overcome. Treatment goals relating to timely and effective emergency treatment for acute ST elevation myocardial infarction were not fully met, and a number of sites struggled to maintain resources for reliable data collection and entry. An exciting innovation in 2016 was the establishment of data linkage with Ambulance Victoria for this patient group with synergistic data exchange benefitting both organisations.

The third section of this Report presents the results of the Heart Failure (HF)-Snapshot module. Unlike the other two modules, data for this module were collected in the form of a "snapshot", enrolling consecutive patients at participating health services for a limited period of time (1 month) in order to obtain a cross-sectional picture of heart failure-related treatment and outcomes. The number of hospitals participating in this module grew to 16 in 2016, with data collection activity undertaken in May-June 2016. There were mixed results with generally good compliance rates with guideline-recommended medical therapies and short-term mortality rates comparable to international rates, but relatively poor transitional care arrangements. Thirty-day readmission rates for heart failure were lower than for the previous year, but there is still room for further improvement.

The key findings from the various modules in 2016 are presented on the following pages.

Key Findings

PCI Registry

- A total of 25 out of 30 Victorian PCI hospitals contributed to the registry in 2016, representing approximately 100 interventional cardiologists. Data on 9,992 completed procedures involving 8,893 patients were collected. 62% of cases were managed in the public hospital system.
- The majority of patients undergoing PCI were male (77%). The mean age of patients was 66 years. Patients treated in private hospitals were six years older on average than public patients. Overall, approximately one in five patients were diabetic.
- Just over half the PCI cases in 2016 presented with an acute coronary syndrome (ACS). Their treatment was predominantly taken up by the public sector (77% public sector, 23% private). Treatment of ACS accounted for two-thirds of all PCI work done in the public sector and one-third of the private sector's caseload. PCI for acute STEMI (including pharmaco-invasive PCI and rescue PCI) took up 27% of the entire PCI workload in the public sector.
- For patients with stable (non-ACS) disease, 83% had a diagnosis of stable angina. A high-grade stenosis was noted in 92% and positive functional test in 42%. A total of 87% of non-ACS patients had at least 2 of these 3 PCI indicators.
- Treatment was predominantly single vessel PCI, with the majority of lesions (66%) between 11-30mm in length and the majority of patients (67%) receiving a single stent. Drug-eluting stent use increased from the previous year and was at 85% of cases. Functional assessment of coronary lesions by fractional flow reserve (FFR) was utilised in 2.5% of cases. Other adjunctive devices such as intravascular ultrasound and rotational atherectomy were performed in around 1% of cases. Bioresorbable vascular scaffolds (BVS) were implanted in very small numbers in 2016.
- For the first time, radial artery access was utilised more commonly than femoral access, at 55% of cases overall. Rates still varied quite widely among hospitals, with public hospitals generally having a higher uptake at 63% compared with private hospital radial access uptake at 43%. Lower rates were seen in females than males (48% vs 57%) and in the elderly (43% >80 years vs 57% <80 years).
- Emergency treatment for acute STEMI (primary PCI) accounted for 16% of the overall PCI workload among VCOR hospitals. The proportion of hospitals' STEMI workload that fell out-of-hours was 61%. The majority (86%) were treated in the public hospital system. Radial access was used in 60% of cases.
- 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) for acute STEMI PCI cases was 67 min, within the recommended threshold of ≤90 minutes. Overall, a door-to-balloon time ≤90 minutes was achieved in 72% of cases, close to the international benchmark target of 75% or more cases.
- The unadjusted in-hospital mortality rate overall was 1.8%. The rate was higher among patients presenting with STEMI (6.1%), and highest for patients with cardiogenic shock or out-of-hospital cardiac arrest requiring endotracheal intubation (37.3%). Excluding these 2 high-risk groups, the unadjusted in-hospital mortality rate for the rest of the cohort was just 0.4%.
- The signature key performance indicator of risk-adjusted 30-day mortality for the overall PCI cohort in 2016 was 2.8%. One hospital was identified as an outlier with a higher than expected risk-adjusted mortality rate and it received appropriate notification and an offer for guidance and assistance with subsequent quality assurance activities.
- Results of other outcome measures demonstrated an in-hospital major bleeding rate following PCI of 1.0%, being lower among radial access cases (0.5% radial vs 1.5% femoral) and highest in STEMI (2.1%). The 30-day unplanned cardiac readmission rate was 3.7% for the entire cohort with similar rates in the public and private sectors.

Key Findings continued ...

Management of Acute STEMI in Rural and Regional Centres

- The 2016 cohort comprised 148 patients with suspected STEMI, presenting to 9 rural or regional health services across Victoria. A total of 41 patients (28%) were ineligible for thrombolysis. Four were triaged to primary PCI and transferred to a PCI capable hospital. The remaining 103 patients, all received thrombolysis, either at the treating hospital (n=94) or via a pre-hospital thrombolysis protocol, administered by Ambulance Victoria (n=9).
- Only 57% of patients were transported by ambulance to hospital, while 36% were driven in by friends or family (self-presenters). Most (90%) patients were located within 50km of their treating hospital at symptom onset.
- The median time from pain onset to first medical or ambulance contact was 120 minutes. The median time taken for an ambulance to arrive was 12 minutes and the time to transfer to hospital was 52 minutes.
- The median time taken from hospital arrival to the recording of the first ECG was 10 minutes – compliant with guideline recommendations.
- The median door-to-needle time (time from patient arrival to time thrombolytic drug administered) was 39 minutes (IQR: 27, 69). None of the 9 participating hospitals managed to achieve a median door-to-needle time within the Australian guidelines recommendation of ≤30 minutes, and overall, only 32% of cases received timely thrombolysis within 30 minutes.
- The in-hospital mortality (before transfer) for the overall cohort was 6.1%. Mortality was higher among patients with cardiogenic shock (13 patients, 7 deaths (54%). There were 3 cases of major bleeding but no cases of stroke or intra-cerebral haemorrhage.
- Most thrombolytic-treated patients (95%) were subsequently transferred to a PCI capable hospital within 24 hours. The median time from referral request to the PCI capable hospital to the actual transfer from regional STEMI sites was 2.3 hours.
- Linkage with the VCOR PCI module determined that 85% of the entire cohort (both thrombolysis eligible and ineligible) were transferred to a PCI capable hospital. Of those, 68% had a subsequent PCI and 9% underwent CABG surgery.

Heart Failure Snapshot

- A total of 16 health services across the state participated in the 2016 Heart Failure Snapshot, with enrolment of 456 patients. The majority (58%) were male, and the median age was 76 years. Overall, 63% of patients had some form of left ventricular dysfunction, with 46% having predominantly systolic dysfunction and 14% predominantly diastolic dysfunction.
- The most common co-morbidities were atrial fibrillation (54%), diabetes (47%), anaemia (36%), history of angina (34%), chronic obstructive pulmonary disease (COPD) /asthma (31%), and moderate chronic kidney disease (31%).
- The majority of patients (85%) presented via the emergency department, with just under half (49%) admitted into a general medicine unit for management. Only 3 hospitals had a dedicated heart failure unit. Shortness of breath was the predominant reason for admission (88% of cases).
- For patients with heart failure with reduced ejection fraction, there were increases in the use of guideline-recommended medications at discharge.
- The median length of hospital stay was 6 days (IQR: 3, 9), with the majority of patients (72%) discharged to home.
- The unadjusted in-hospital mortality rate was 6%, rising to 10% at 30 days follow-up. Mortality rates for all hospitals were within control limits and there were no outliers in performance. Higher mortality rates were observed in patients with systolic dysfunction (9%), compared with patients with predominantly diastolic dysfunction (5%).
- At 30 days post discharge, the all-cause readmission rate was 21% which was lower than in the 2015 Heart Failure Snapshot (26%).

A/Prof Jeffrey Lefkovits
VCOR Clinical Director

Introduction

The Victorian Cardiac Outcomes Registry (VCOR) is a clinical quality registry, established in 2012 to monitor the performance of health services in Victoria in their delivery of a range of cardiac-based therapies. VCOR first reported on percutaneous coronary intervention (PCI), and has subsequently established modules for early management of acute ST elevation myocardial infarction in non-metropolitan areas and acute treatment of heart failure in the hospital setting. The registry encompasses hospitals in both the public and private sector and reports on the quality and effectiveness of cardiovascular health care in Victoria.

As VCOR enters its fifth year of operation, the broad aim of VCOR is still to provide meaningful information to clinicians, hospitals, health funders and consumers. The registry was developed to facilitate health services in their own continuous service development. The data from the registry allows hospitals to review and benchmark their own performance, ensuring patients receive the highest quality cardiac care possible. More broadly, the registry can also be utilised to assess overall compliance with national standards of cardiac care and evidence-based guidelines as well as 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.

Registry Governance and Structure

Governance

The governance of VCOR has been outlined in detail in previous Annual Reports[4]. VCOR conforms to the National Operating Principles for Clinical Quality Registries as set out by the Australian Commission on Safety and Quality in Health Care. In 2016, a review of the Governance Terms of Reference was undertaken and is awaiting ratification by the Steering Committee. A review of committee membership was also undertaken and ratified across all committees.

Steering Committee

The Steering Committee (SC) membership comprises representatives from each of the participating PCI sites, the Victorian Cardiac Clinical Network, the Department of Epidemiology & Preventive Medicine at Monash University and a consumer representative. Additionally, the SC expanded to include the Clinical Leads of the STEMI module and the Heart Failure Snapshot module as members in 2016.

Clinical Quality Committee

The Clinical Quality Committee (CQC) has a key role in meeting the overall aim and purpose of VCOR. Quarterly review of hospital key performance indicators (KPIs) and other data continued in 2016, with provision of numerous reports to sites across all modules. As in previous years, the CQC was active in identifying and assisting to manage with outlier performance, including providing feedback and review as requested. The robust processes related to the management, review, benchmarking and reporting of data in VCOR is underscored by the work of the CQC.

Data, Research and Publications Committee

The Data, Research and Publications Committee (DRP) reviews requests for analyses and access to group de-identified data for research projects. In 2016, the DRP reviewed several requests and approved two collaborative research projects that required group de-identified data. The DRP also oversaw several abstracts based on VCOR data that will be outlined further in the next section of this report.

Registry Activities

In 2016, the activities of VCOR as a clinical quality registry were directed to 3 specific areas in cardiovascular care. These were -:

1. Percutaneous coronary intervention
2. Early management of ST elevation myocardial infarction in rural and regional hospital settings
3. In-hospital management and outcomes of patients with acute decompensated heart failure

Each of these areas is dealt with in detail in subsequent sections of this report.

In addition to the regular quarterly reports issued to all participating hospital sites, VCOR completed its first Special Report to Sites, focussing on an area of particular clinical interest. For this report, VCOR had identified that hospitals were struggling to consistently achieve accepted benchmarks for time to treatment in patients with acute ST elevation myocardial infarction. The report's intention was to highlight the issue, provide detailed and in-depth information on PCI hospital performance and provide tools to assist sites in improving their performance. The report was very well received and we look forward to monitoring this key process measure to see if the report positively influences performance. VCOR intends to continue this program of Special Reports into particular areas of interest to further assist hospitals in their continuous improvement programs.

As the day-to-day activities of data collection, analysis and reporting have become more streamlined and routine, VCOR has been able to increase its research activity related to safety and quality of care. With the support of Monash University's Centre of Cardiovascular Research and Education in Therapeutics (CCRET) and collaboration with internal and external researchers, a number projects are underway or are being planned. These include the refinement and validation of risk-adjustment models for mortality, new models for patient-reported outcome measures, epidemiological aspects of cardiac disease and health economics. A list of research publications for 2016 relating to VCOR is included at the end of this Report.

Another new and exciting area of activity that has opened up is the development of data linkages with other datasets and data collection bodies. Data linkage, as a strategy, combines information about people across different databases to obtain a bigger and more complete clinical picture than would be possible from one database alone. It can increase the value and use of existing data holdings at relatively low cost and has enormous potential for clinical research. In 2016, data linkages were undertaken across VCOR modules to provide a more comprehensive picture of the patient journey. Collaborations were also established with Ambulance Victoria (AV), the Department of Health and Human Services (DHHS) and the Australia and New Zealand Society for Cardiac and Thoracic Surgeons Database (ANZSCTS). These links will further define the patient journey across multiple service providers and episodes of care, and help to better understand longer-term patient outcomes.

Percutaneous Coronary Intervention (PCI)

Registry Module Activity

While this report primarily covers the 2016 calendar year, it also provides insights across the 4 years VCOR has been collecting data in selected areas of interest. PCI hospital participation is outlined in Table 1. In 2016, 25 PCI hospitals contributed data, including all 13 public hospitals and 12 of 17 private hospitals. The remaining five private hospitals were engaged in 2016 and will commence data collection in 2017, resulting in complete capture of all PCI data across Victoria.

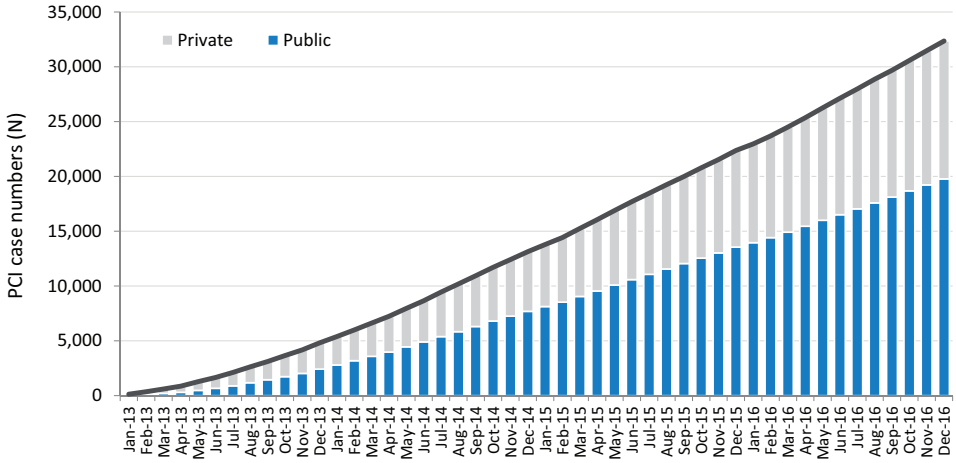
Table 1: Participation of Victorian PCI hospitals

Victorian PCI hospitals	Hospital type	2013	2014	2015	2016
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	●	●	●	●
Epworth Hospital Geelong	Private				●
Frankston Hospital	Public	●	●	●	●
Geelong Private Hospital	Private		●	●	●
Jessie McPherson Private Hospital	Private	●	●	●	●
Linacre Private Hospital	Private				○
Knox Private Hospital	Private	●	●	●	●
Melbourne Private Hospital	Private		●	●	●
MonashHeart, Monash Medical Centre	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 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 Hospital (Sunshine)	Public	N/A	N/A	●	●
Western Private Hospital	Private	●	●	●	●

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

A total of 9,992 cases were entered into VCOR in 2016, involving 8,893 patients, with 11% of patients undergoing more than one procedure. The number of cases treated in the public sector was 6,216 (62%) and 3,776 in private (38%). All cases included in this report had completed baseline and follow-up data available for reporting. The lost-to-follow-up (LTF) rate for 2016 was 1.5%, and the overall rate for the entire registry since its commencement is 1%. At the end of 2016, the VCOR registry had accumulated 32,353 cases, as shown in Figure 1.

Figure 1: Cumulative cases submitted by month from 2013-2016



Data Quality - Audit Activity

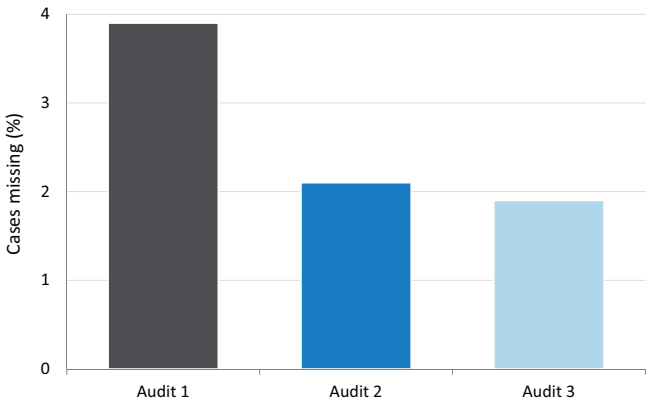
A key operational activity of a clinical quality registry is the performance of regular audits to ensure accuracy and completeness of data collection and entry into the registry[5]. This generally encompasses assessment of eligible cases to ensure all relevant cases are entered, as well as verification of source data. VCOR commenced auditing PCI cases in March 2014 and the process is ongoing. Case ascertainment audits (assessing that all eligible cases are entered into the registry) are undertaken on a yearly basis. Most sites have now undergone multiple audits since their entry into the registry. Figure 2 below illustrates progressive improvement in hospital performance with successive audits.

In instances where missing cases were identified, sites were subsequently able to retrieve and enter these cases into the registry. Only two sites had missing cases greater than 5% and these sites have subsequently instituted process changes to improve case entry compliance.

Data Quality assessment (review of source data to determine accuracy), are undertaken every 3 years whereby 5% of case records are randomly selected for comparison with the hospital medical record. Two additional brief audits were undertaken in 2016. The overall agreement rate between VCOR data and the hospital medical record is 97.5% from audits at 23 sites, indicating high quality data collection. This compares favourably with national and international registries [6, 7].

All sites are given a detailed, individualised report of their audit findings. VCOR recognises that registry data must be high quality and is committed to an ongoing, thorough and accurate audit program.

Figure 2: Overall rate of missing cases across each annual audit (2014-2016)



Patient Characteristics

For the 2016 cohort, the median age for males was 65 years (IQR: 57, 74) and for females 70 years (IQR: 61, 78). The distribution of cases by age is similar to previous years. As shown in Figure 3, the peak frequency of cases among men is in the seventh decade and for women, it is in the eighth decade. Table 2 compares selected patient demographic information from 2016 with previous years and indicates that the demographic profiles of the patients have remained similar across the four-year period.

Figure 3: Age and gender distribution of patients undergoing PCI

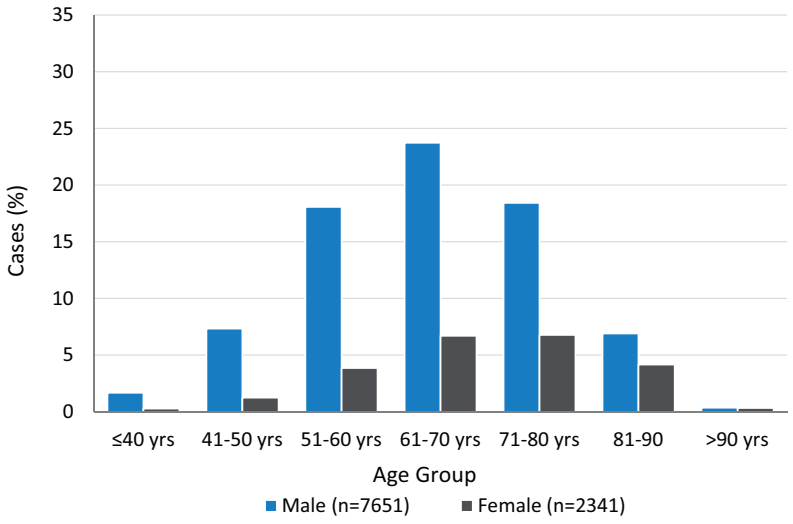


Table 2: Selected patient characteristics 2013-2016

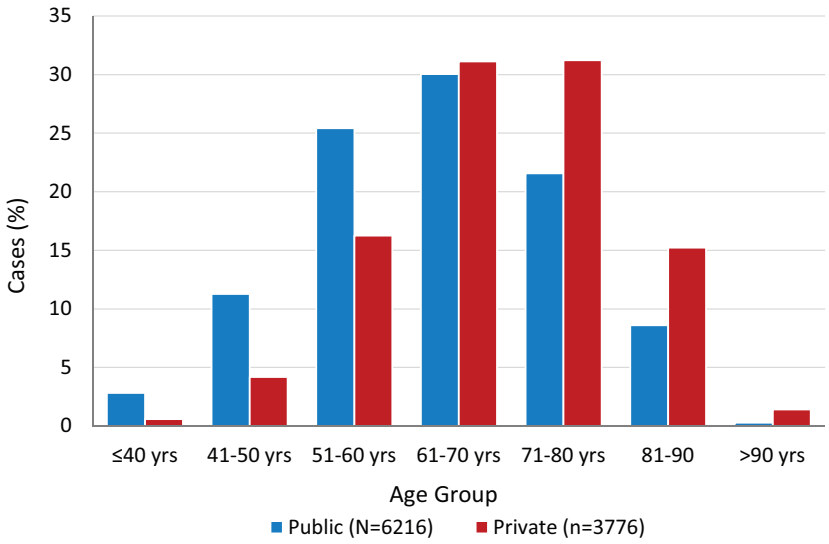
Patient characteristics	2013 (N=4809)	2014 (N=8327)	2015 (N=9225)	2016 (N=9992)
Age - years (Mean ±SD)	65.8 (±12.0)	65.3 (±11.9)	65.6 (±12.0)	66.0 (±12.0)
	%	%	%	%
Gender - female	22.9	23.1	23.0	23.4
Diabetes	22.4	21.6	23.0	21.7
PVD History	3.5	3.8	3.6	3.5
CVD History	3.8	3.7	4.0	3.3
Previous PCI	34.8	31.9	32.9	32.7
Previous CABG	8.9	8.4	7.6	7.6

Patient demographic factors by hospital sector are shown in Table 3. Patients treated in private hospitals tended to be older and were more likely to have had a previous PCI. The difference in age profiles between patients in the public and private sectors is illustrated in Figure 4. While elderly patients (>80 years) accounted for 11.8% of the overall PCI cohort, the proportion of elderly patients in the private sector was almost double the public rate (16.6% vs 8.9%). As in previous years, the elderly had higher rates of vascular comorbidities (peripheral vascular disease, cerebrovascular disease and previous bypass surgery), with an approximate doubling of these incidences compared with patients under 80 years (PVD: 6.8% vs 3.0%, CVD: 6.3% vs 2.9% and CABG: 12.7% vs 6.9%).

Table 3: Selected patient characteristics by hospital sector

Patient characteristics	Public (n=6216)	Private (n=3776)
Age - years (Mean ±SD)	63.8 (±12.1)	69.6 (±10.9)
	%	%
Gender - female	22.5	24.9
Diabetes	22.6	20.2
PVD History	3.3	3.8
CVD History	3.5	2.9
Previous PCI	26.7	42.6
Previous CABG	6.4	9.4

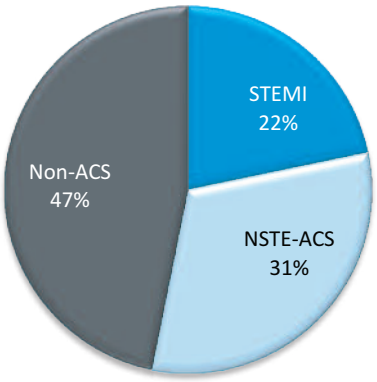
Figure 4: Age distribution for public and private patients



Clinical Presentation

Just over half the patients in the 2016 PCI cohort presented with an acute coronary syndrome (ACS). This includes the conditions of ST elevation myocardial infarction (STEMI), non-ST elevation myocardial infarction and unstable angina. The latter two are often grouped together as non-ST elevation ACS (NSTE-ACS). The percentages of patients with either an ACS or stable coronary disease across the VCOR cohort are shown in Figure 5.

Figure 5: Procedures by clinical presentation



While the proportion of ACS presentations has remained fairly constant over the previous 4 years, there are distinct differences among hospitals in regard to the burden of ACS in their overall case mix (Figure 6). These differences are highlighted when clinical presentation is categorised by hospital type. As shown in Figure 7, the public sector treats almost double the proportion of ACS patients compared with the private sector. This difference arises because the vast majority of PCIs for STEMI are managed in public hospitals in Victoria. This trend has been observed in previous years as well.

Figure 6: ACS and non-ACS cases by hospital

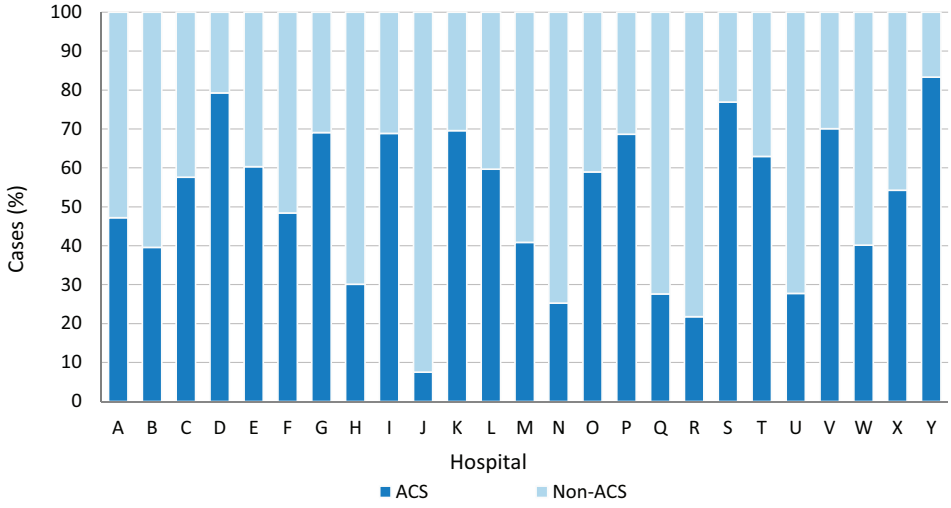
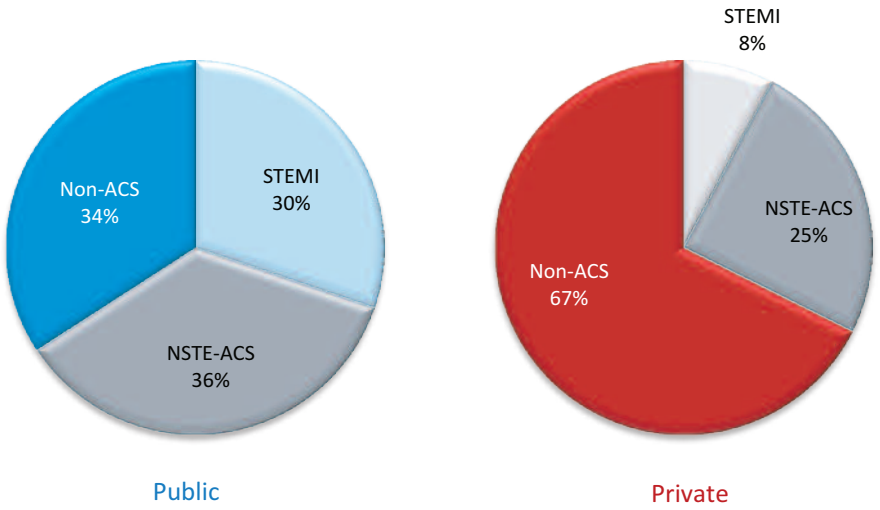


Figure 7: Procedures by clinical presentation for public and private hospitals



Indications for PCI

There is a growing body of evidence that suggests/supports monitoring reasons for performing PCI cases positively influences the overall quality of health care delivery. American peak cardiology organisations in particular, have developed guidelines for the appropriate use of PCI in both stable coronary disease [8] and acute coronary syndromes[9]. Yet, these appropriateness use criteria utilise comprehensive sets of criteria that are quite complex and their overall system has a number of other potential limitations to its implementation here in Victoria. As VCOR was designed around a utilitarian model focused on the practical assessment of procedural and patient outcomes, the registry has taken a simpler approach of providing a straightforward breakdown analysis of the indications for PCI to further understand and evaluate the reasons for performing PCI.

For ACS patients, revascularisation recommendations are generally based on the large body of evidence that supports an invasive revascularisation strategy. A diagnosis of ACS is therefore considered a primary indication for PCI in suitable patients with an identifiable culprit lesion, in accordance with Australian practice guidelines [10]. Table 4 outlines the proportions of various categories and sub-categories of ACS as the indication for PCI. Primary PCI for acute STEMI accounted for 28% of all ACS indications with the vast majority of these performed in the public sector. The largest ACS indication for PCI overall was NSTEMI (42%), with three-quarters of the caseload treated in public sector. The proportions of patients in the various sub-categories of ACS are similar to previous years.

Table 4: PCI Indication by ACS category and sub-category

	All sites (N=5703)	Public (n=4239)	Private (n=1464)
ACS category	N (%)	N (%)	N (%)
Primary PCI for acute STEMI	1603 (28.1)	1374 (32.4)	229 (15.6)
STEMI PCI 12-24 hours after symptom onset	230 (4.0)	203 (4.8)	27 (1.8)
Pharmaco-invasive PCI	228 (4.0)	200 (4.7)	28 (1.9)
Rescue PCI	99 (1.7)	91 (2.1)	8 (0.5)
PCI for OHCA/shock (non-MI)	31 (0.5)	28 (0.7)	3 (0.2)
PCI for NSTE-ACS	3512 (61.6)	2343 (55.3)	1169 (79.8)
NSTE-ACS sub-category	N (%)	N (%)	N (%)
NSTEMI	2394 (42.0)	1793 (42.3)	601 (41.1)
UAP	748 (13.1)	408 (9.6)	340 (23.2)
Recent ACS 7-30 days ago	370 (6.5)	142 (3.3)	228 (15.6)

When assessing appropriateness in stable (non-ACS) coronary disease, there is greater emphasis on the use of objective measures of ischaemia and stratification of patients into low, medium or high-risk groupings through lesion severity and presence of symptoms. Table 5 provides a breakdown of the reasons for PCI among non-ACS patients. About two-thirds of non-ACS patients were treated for stable angina, with a slightly smaller proportion in the private (63%) compared with the public (70%). A significant proportion (20%) of cases were attributed to the indication of "staged" PCI. This group of patients, with multi-vessel disease undergoing a second (and sometimes a third or fourth) PCI, was heterogeneous, with some patients with a recent ACS, others with an ACS more than 30 days ago, and others with no recent history of ACS. In these cases, it was more difficult to ascribe the usual indicators for PCI including angina symptoms, positive functional test and high-grade coronary stenosis (>70%).

Table 5: PCI Indications for non-ACS cases

	All sites (N=4289)	Public (n=1977)	Private (n=2312)
	N (%)	N (%)	N (%)
Stable angina	2845 (66.3)	1392 (70.4)	1453 (62.8)
No symptoms and no functional test	230 (5.4)	96 (4.9)	134 (5.8)
No symptoms and positive functional test	259 (6.0)	84 (4.2)	175 (7.6)
Staged PCI after ACS (<30 days after first procedure)	399 (9.3)	230 (11.6)	169 (7.3)
Staged PCI after ACS (>30 days after first procedure)	136 (3.2)	87 (4.4)	49 (2.1)
Staged PCI after original non-ACS indication	335 (7.8)	65 (3.3)	270 (11.7)
Miscellaneous*	85 (2.0)	23 (1.2)	62 (2.7)

**Miscellaneous group include arrhythmia, cardiomyopathy/heart failure, syncope, second attempt at lesion and others*

Cases were examined to determine how many of the three clinical, functional and anatomic indicators were present. Symptoms of angina or its equivalent were reported in 83% of non-ACS patients. A high-grade stenosis was noted in 92% and a positive functional test in 42%. A total of 87% of non-ACS patients had at least 2 of 3 indicators (Table 6).

Table 6: Non-ACS patients: Clinical Indicators for PCI

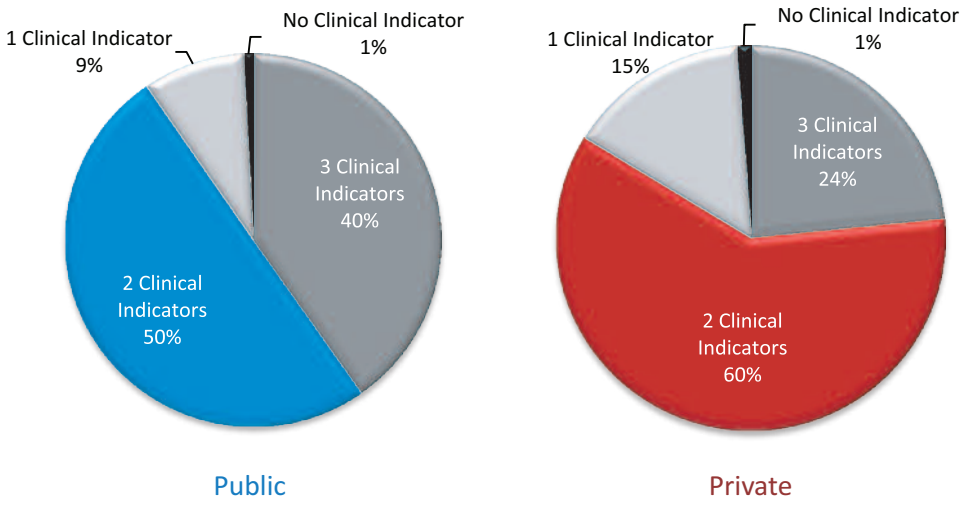
Symptoms	Positive functional test	High grade stenosis	Total
			N (%)
●	●	●	1069 (31.3)
○	●	●	257 (7.5)
●	●	○	84 (2.5)
●	○	●	1559 (45.6)
●	○	○	133 (3.9)
○	○	●	267 (7.8)
○	●	○	18 (0.5)
○	○	○	32 (0.9)
			3419 (100)

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

Excludes all staged PCI cases (n=870)

There was some variation in the pattern of PCI indicators when the public and private sectors were compared. Figure 8 demonstrates that there was a weighting towards 2 clinical indicators in the private (60% of non-ACS cases) compared with the public sector (50% of non-ACS cases).

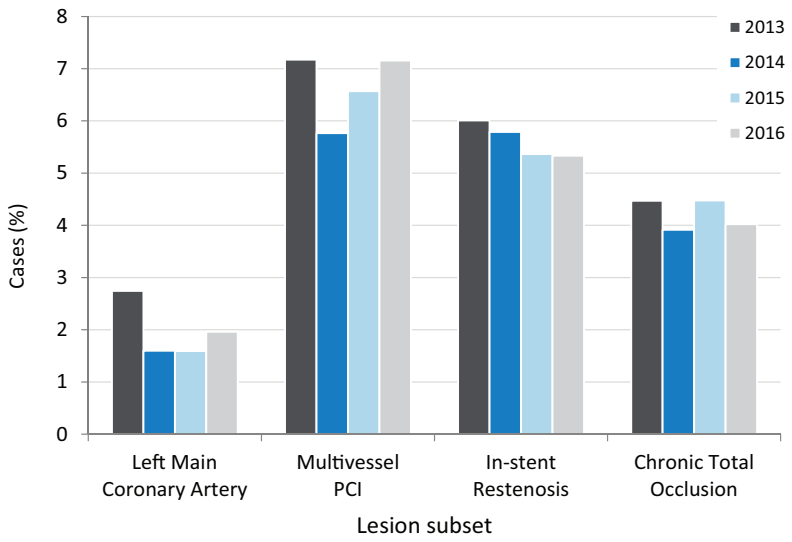
Figure 8: Clinical indicators for PCI in non-ACS patients for public and private hospitals



Clinical and Lesion Subsets

Trends in PCI management over time are reflected by the incidence and treatment of specific types of coronary lesions. In particular, there has been a very strong worldwide trend in the last decade to undertake PCI for lesions in the left main coronary artery, previously almost exclusively the domain of cardiac surgery[11]. Among the VCOR cohort, left main PCI still remains an infrequent procedure, accounting for only 2% of cases. PCI for other lesion subsets including multi-vessel disease (7.2%) and in-stent restenosis (5.3%) was also relatively uncommon, with rates similar to the last four years (Figure 9). Advanced techniques for treatment of chronic total occlusions is another area of burgeoning development, but case numbers have not really increased yet, accounting for just 4% of the overall workload. However, this is expected to grow in the coming years and VCOR will be focussing on this area through the monitoring of uptake, performance and outcomes with these highly specialised PCI techniques.

Figure 9: Comparative trends in incidence over time for selected PCI lesion subsets



Another trend in PCI management has been an increasing interest in high-risk PCI for cardiogenic shock. In 2016, the proportion of cases presenting with cardiogenic shock or out-of-hospital cardiac arrest was 3.1% and has not substantially increased in the last four years (Table 7).

Table 7: Patients presenting with cardiogenic shock or out-of-hospital cardiac arrest (OHCA): 2013-2016

Presentation type	2013 (N=4809)	2014 (N=8327)	2015 (N=9225)	2016 (N=9992)
	N (%)	N (%)	N (%)	N (%)
Cardiogenic shock	82 (1.7)	198 (2.4)	223 (2.4)	278 (2.8)
Intubated OHCA	36 (0.7)	89 (1.1)	108 (1.2)	126 (1.3)
Shock and/or intubated OHCA	95 (2.0)	239 (2.9)	253 (2.7)	309 (3.1)

Device Use

VCOR has also followed patterns of device use in PCI that can evolve over time. In 2016, at least one coronary stent was implanted in 94% of cases, slightly more than the previous year (92%). Balloon angioplasty alone (POBA) was performed in a very small number of cases, as was drug-eluting balloon angioplasty to treat in-stent restenosis. Despite the availability of the bioresorbable vascular scaffold (BVS) in the Australian market since 2013, the uptake of this new stent technology has been small. In 2016, just 72 patients (1%) across 15 hospitals received a BVS, similar to the previous year. A breakdown of device use in 2016 is shown Figure 10.

The total number of stents used and total stent length per patient are shown in Figures 11 and 12. The majority of patients (67%) received a single stent and in the majority of cases (66%), the total length of stents that were deployed was between 11-30mm. Multiple or overlapping stents totalling >50 mm in length were used in 8% of cases (Figure 12), equally distributed across the public and private sectors.

Figure 10: Device use among PCI cases

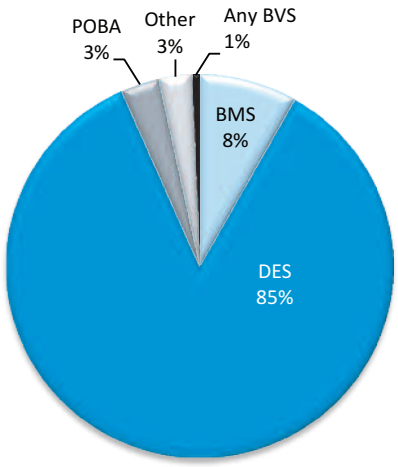


Figure 11: Number of stents used per PCI case (includes all lesions treated)

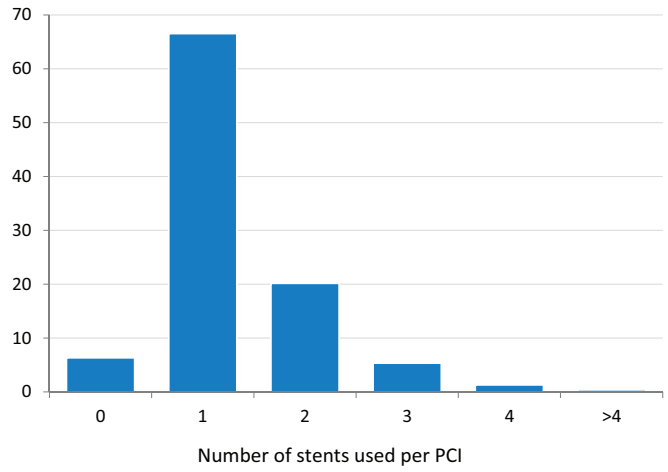
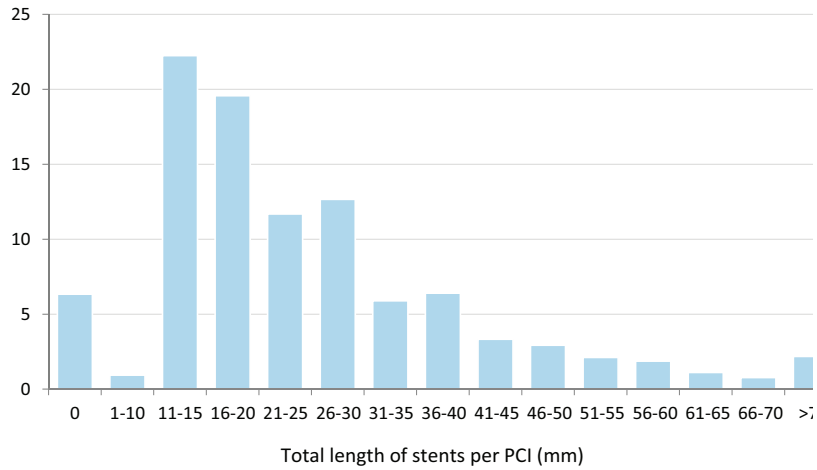


Figure 12: Total length of stents used per PCI case (includes all lesions treated)



The use of various adjunctive devices in PCI was generally limited (Table 8). Devices that assist the visualisation of the coronary anatomy such as intravascular ultrasound (IVUS) and optical coherence tomography (OCT) were employed infrequently, but were more commonly used in the public sector. On the other hand, fractional flow reserve (FFR) - an evidence-based technique used to determine whether coronary lesions should be treated - was applied equally across the public and private systems. Rotational atherectomy - a mature adjunctive treatment particularly useful for heavily calcified lesions - was used sparingly in 2016, as in previous years.

Recent data have discounted the effectiveness of routine thrombus aspiration (catheter-based extraction of blood clots that occlude the coronary artery) in the setting of acute STEMI[12]. In 2016, thrombus aspiration occurred in 3.5% of cases – mostly in STEMI cases (n=289), but also in a small number of other cases including NSTE-ACS (n=45) and non-ACS (n=12). This technique was utilised mostly in the public sector. VCOR also tracked the use of intra-aortic balloon pump (IABP) and extracorporeal membrane oxygenation (ECMO) devices that support the circulation in patients with cardiogenic shock. The rate of use of these devices was low and they were almost exclusively deployed in the public hospital system.

Table 8: Adjunctive device use

Adjunctive device type	All sites (N=9992)	Public (n=6216)	Private (n=3776)
	N (%)	N (%)	N (%)
Intravascular ultrasound	118 (1.2)	92 (1.5)	26 (0.7)
Optical coherence tomography	60 (0.6)	51 (0.8)	9 (0.2)
Thrombus aspiration device	346 (3.5)	298 (4.8)	48 (1.3)
Rotational atherectomy	101 (1.0)	59 (0.9)	42 (1.1)
Fractional flow reserve	254 (2.5)	158 (2.5)	96 (2.5)
IABP	71 (0.7)	64 (1.0)	7 (0.2)
ECMO	12 (0.1)	10 (0.2)	2 (<0.1)

Drug Eluting Stents

Drug-eluting stents (DES) are now the predominant stent type used in all hospitals across Victoria (Figure 13). They have demonstrated superiority to bare metal stents in relation to the risk of stent re-narrowing (restenosis), and previous concerns about their safety have largely been dispelled, especially with the second-generation drug-eluting stents now commonly used. The registry has documented continuing growth in their use from around 75% in the previous three years up to 85% in 2016. Nevertheless, there is still significant variation in DES use among hospitals, ranging from 59% to 96% as shown in Figure 13. The use of DES has been greater in the private sector, although the gap is narrowing (Figure 14).

Figure 13: DES use by hospital

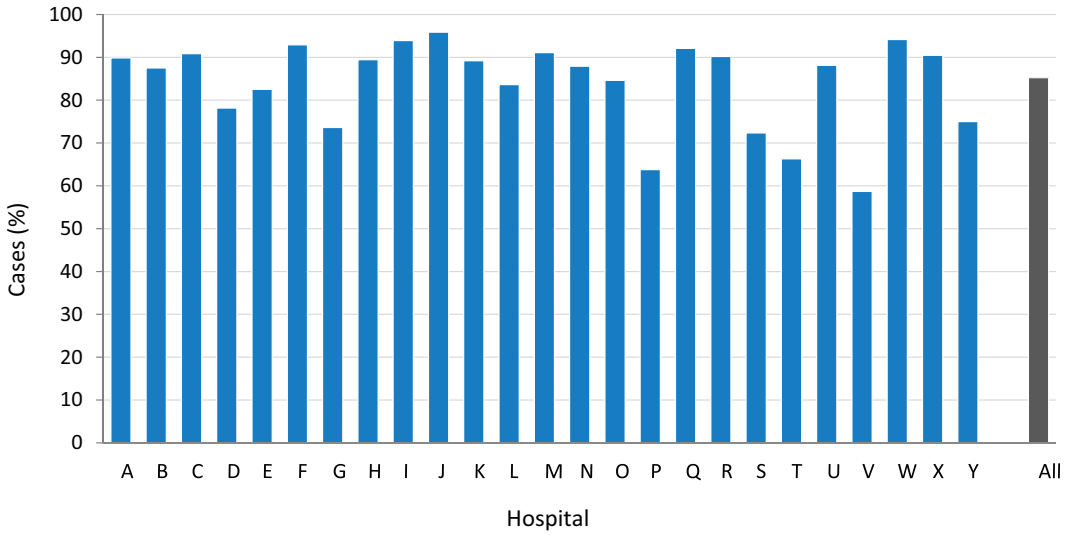
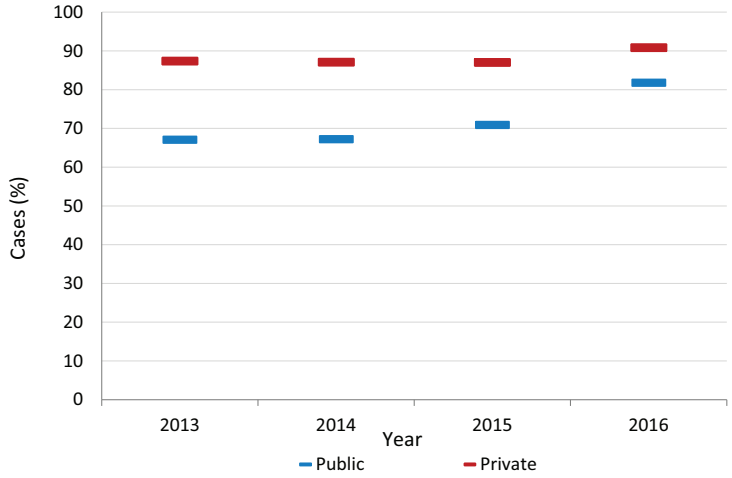
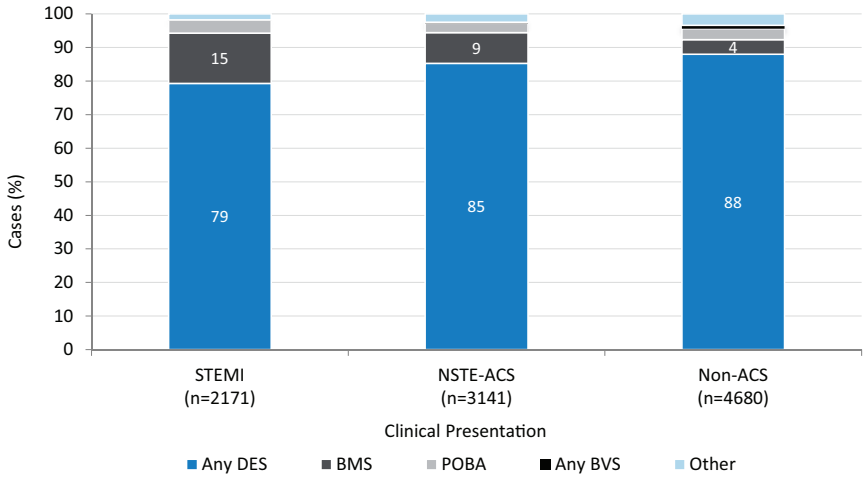


Figure 14: Trends in DES usage by hospital sector: 2013-2016



The use of DES in acute STEMI (79%) still remains lower than in other acute coronary syndromes (85%) and in non-ACS stable disease (88%) (Figure 15). However, the rate in acute STEMI has increased compared with the previous year (64% in 2015). Smaller increases in DES use were observed in the NSTE-ACS cohort (78% in 2015) and the non-ACS cohort (82% in 2015).

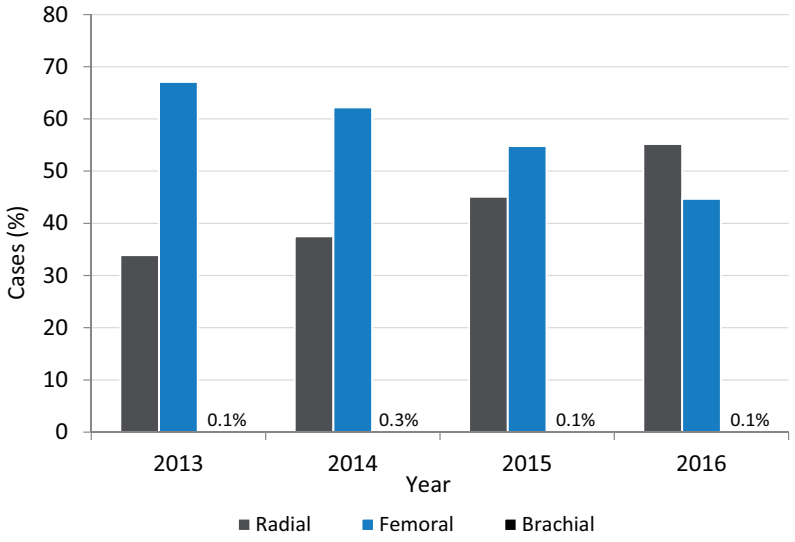
Figure 15: Device use by clinical presentation



Arterial Access

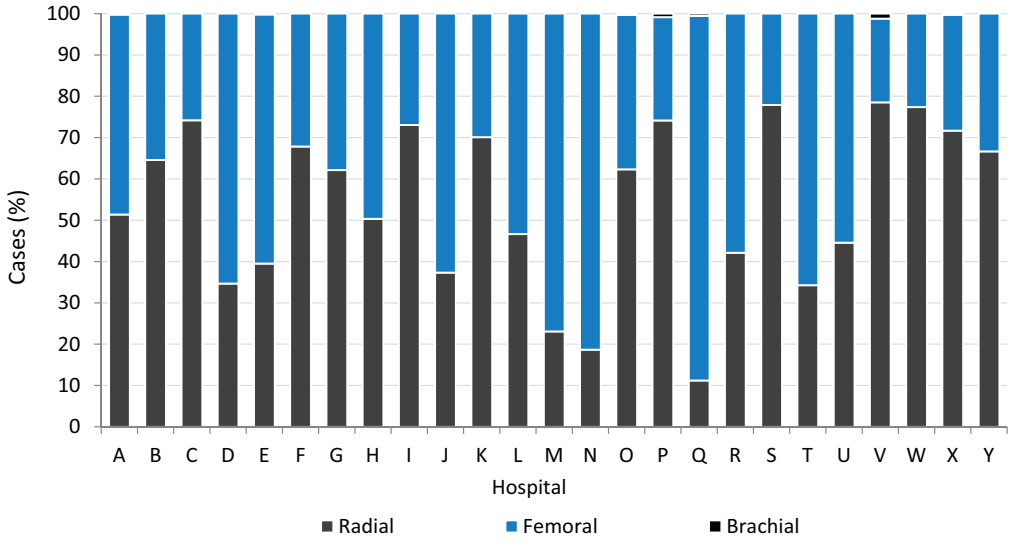
The use of the radial artery for arterial access continued to grow in VCOR hospitals in 2016. Previous VCOR reports demonstrated that patterns of practice in arterial access have been changing. In 2016, for the first time, radial access was more commonly used than the femoral route (55% radial vs 45% femoral, Figure 16). This represented an absolute 10% increase over the previous year, and is reflective of the worldwide trend towards a predominance of radial access for PCI.

Figure 16: Trends in arterial access: 2013-2016



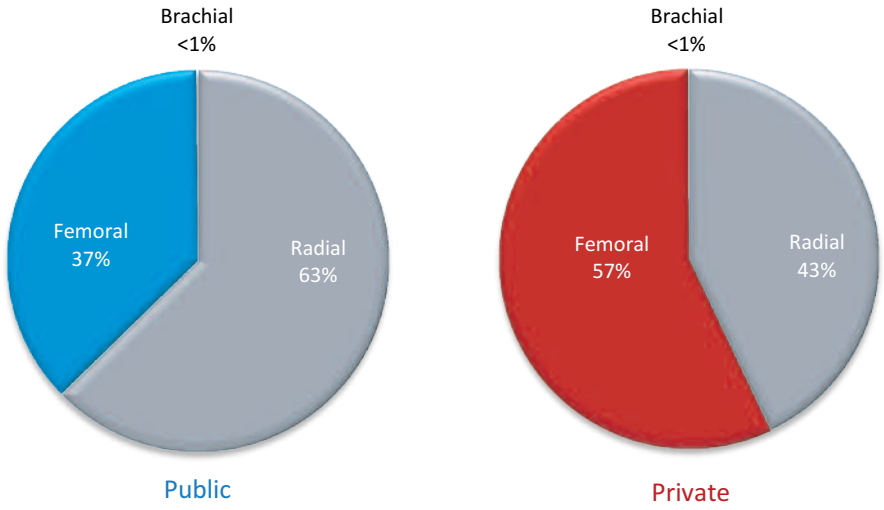
Despite the overall increase in radial artery utilisation, rates of radial access varied widely among health services, ranging from 11% to 78% (Figure 17). In particular, the use of the radial artery was lower among private hospital patients (Figure 18). Yet, with the overall increase in radial artery use, both the public and private increased by similar percentages (21% and 22% relative increases) over the previous year.

Figure 17: Arterial access route by hospital



Females tended to have the radial artery used less often than males (48% vs 57%), but the overall percentage in females had increased over the previous year (40% in 2015). In the elderly, lower rates of radial access were seen (43% >80 years vs 57% <80 years).

Figure 18: Arterial access route in public and private hospitals

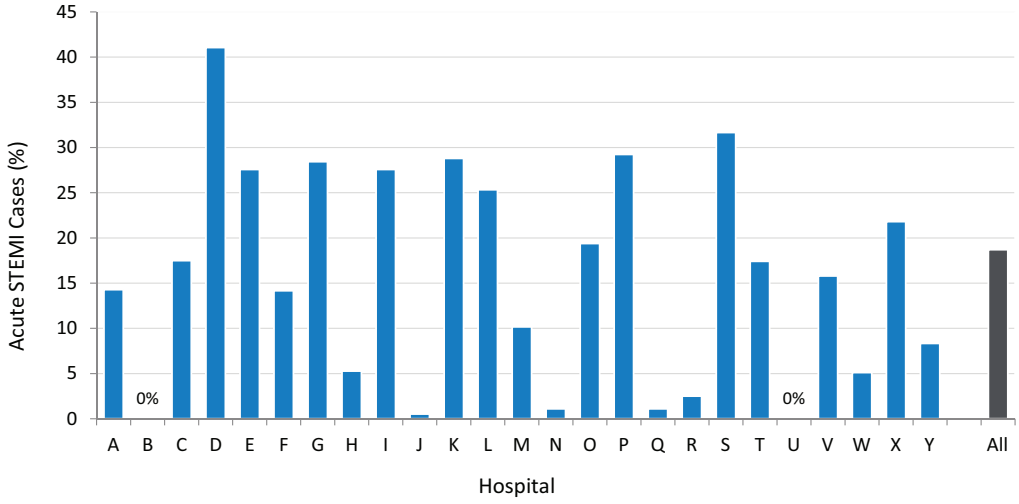


PCI for Acute STEMI

More than any other indication for PCI, acute STEMI places significant demands on the systems of care to treat patients in an effective, time critical manner. Hospitals often have to juggle limited resources to provide around-the-clock emergency service. Yet, they are mandated to comply with state and national performance standards in the delivery of timely and efficient emergency treatment. Accordingly, PCI for acute STEMI represents a special case for analysis and performance assessment by a clinical quality registry.

In 2016, 1,603 patients presented directly to a PCI hospital with an acute STEMI and underwent PCI as the primary reperfusion treatment for their heart attack. This represents 16% of the total caseload across the registry for the year. Cases were predominantly treated in the public hospital sector (86% of all STEMI cases), and they accounted for 26% of the public hospital workload. In contrast, PCI of STEMI accounted for 7% of the workload in the private sector. These percentages are similar to previous years. A breakdown of the proportion of cases treated for acute STEMI across hospitals is shown in Figure 19. A number of hospitals do not offer acute PCI services and therefore have zero cases.

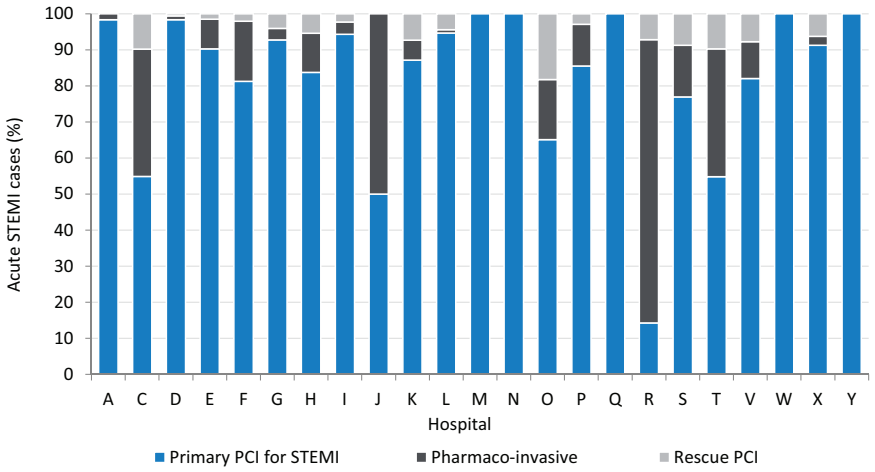
Figure 19: Acute STEMI cases as a proportion of overall case numbers by hospital



Compared with the rest of the cohort, acute STEMI patients were younger (62.5 ± 12.6 years vs 66.8 ± 11.7 years), had fewer traditional cardiac risk factors such as diabetes (15.6% vs 23.1%), peripheral vascular disease (2.2% vs 3.7%) and cerebrovascular disease (2.7% vs 3.4%). The acute STEMI cohort also had fewer previous revascularisation procedures including previous PCI (11.9% vs 37.4%) and coronary artery bypass grafting (1.7% vs 8.9%). Privately treated patients were an older group than public sector patients and had a greater proportion of women (26% private vs 20% public).

Figure 20 shows the proportions of PCI treatment type for acute STEMI by hospital. The proportion of acute STEMI cases treated with a pharmaco-invasive approach for the entire cohort rose to 8.9%, almost 3% higher than the previous year. This strategy mainly applies to patients who initially present to a non-PCI hospital and undergo emergency reperfusion therapy with a clot-dissolving thrombolytic drug. They are then transferred urgently to a PCI hospital to undergo adjunctive PCI where suitable within 4-24 hours of the heart attack. The growth in this combination approach likely reflects recent Australian guidelines that encourage non-PCI hospitals to transfer their STEMI patients early, rather than continue to manage them in hospitals without on-site angiography facilities[13]. There has also been a significant change in transfer policy by Ambulance Victoria to facilitate early and rapid transport of STEMI patients.

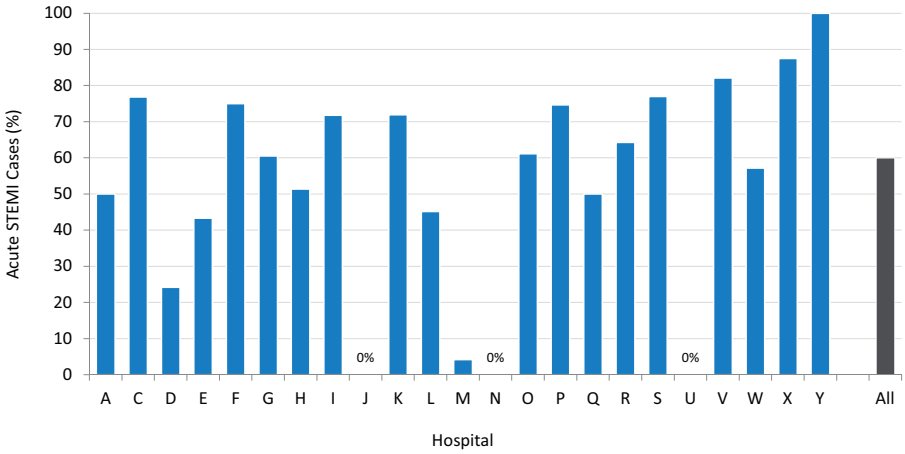
Figure 20: PCI treatment type for acute STEMI patients by hospital



Low rates of acute STEMI cases for hospitals J, N, Q, Y (n<5), R and W (n<15)

The proportion of acute STEMI cases treated via radial arterial access increased by 13% since 2015, to 60% of STEMI cases in 2016. Given the strong evidence base for better outcomes when radial access is utilised in acute STEMI[14], the growth in radial artery usage in this patient cohort is appropriate. However, there is still some notable variation in radial use in the STEMI cohort across hospitals (Figure 21).

Figure 21: Radial access rates in acute STEMI cohort



Low rates of acute STEMI cases for hospitals J, N, Q, Y (n<5), R and W (n<15)

Door-to-balloon Times for PCI for Acute STEMI (Primary PCI)

The time taken from a STEMI patient's arrival at the hospital till the insertion of a device to unblock the vessel (typically a balloon catheter) is known as the door-to-balloon time (DBT). It is a key performance indicator and provides an aggregate measure of how well hospitals' systems and processes for managing time-critical STEMIs are working. When benchmarking hospitals, VCOR has adopted the national benchmark standard of a DBT ≤90 minutes[13], similar to other international guidelines[15]. This analysis is limited to STEMI cases presenting to a PCI capable hospital, and excludes STEMI patients transferred from outside hospitals and those who developed a STEMI while an in-patient.

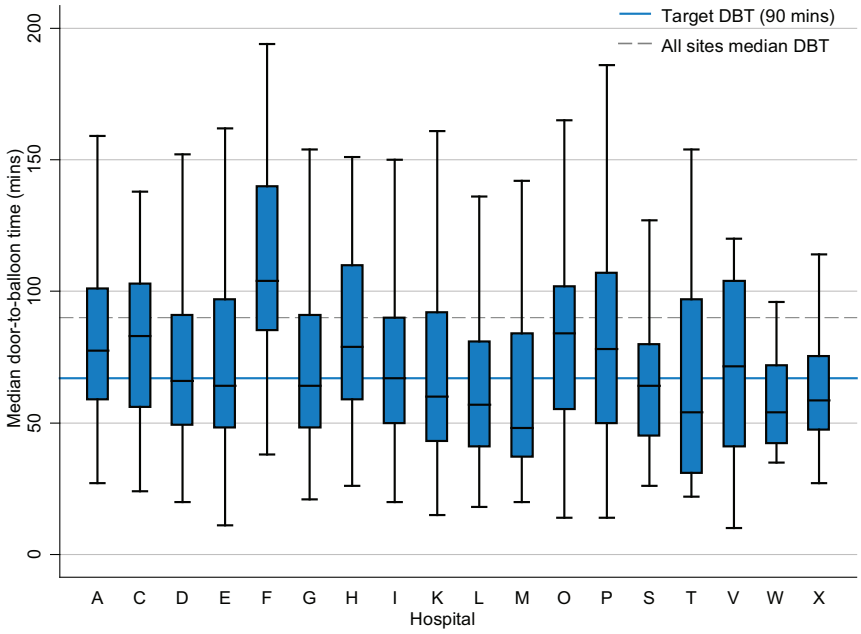
The median door-to-balloon time for the overall primary PCI cohort was 67 minutes (IQR: 47, 96) (Table 9). The range for median door-to-balloon-times was 48-104 minutes, with all but one hospital achieving a median door-to-balloon time within the recommended ≤90 minutes benchmark (Figure 22).

Table 9: Door-to-balloon-time for primary PCI cases

Door-to-balloon Time	Primary PCI* (all cases)	Primary PCI* (PHN only†)	Primary PCI* (no-PHN†)
	(N=1303)	(n=717)	(n=586)
Median – mins (IQR)	67 (47, 96)	55 (40, 76)	87 (61, 114)
Proportion of cases ≤90 mins (%)	71.9%	86.3%	54.3%

**Primary PCI for STEMI presentations excluding all inter-hospital transfer arrivals*
†Pre-hospital notification (PHN)

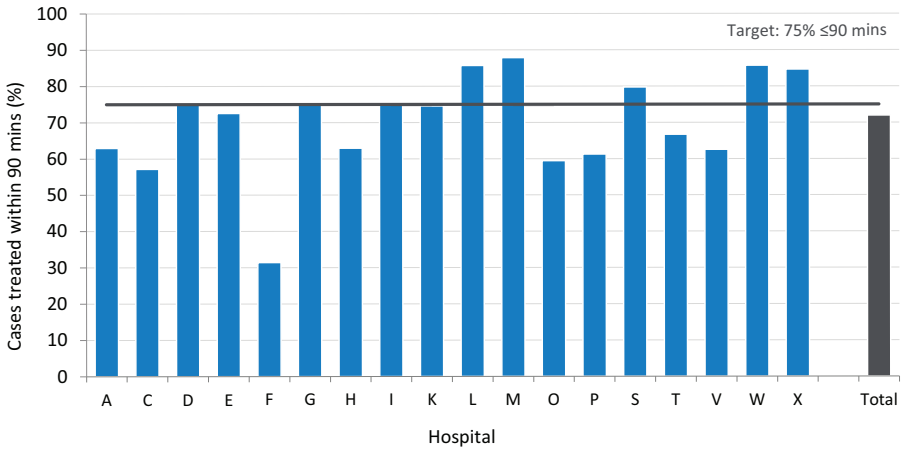
Figure 22: Door-to-balloon time for primary PCI cases by hospital



Hospitals B, J, N, Q, R, U, Y not included (Primary PCI cases n<5)
Hospital W low numbers (n<10)

The median door-to-balloon (DBT) time, while useful as a benchmark measure, tends to over-estimate the performance of health services. Arguably, the compliance benchmark of ≥75% cases achieving DBT within 90 minutes is the preferred measure of performance in this context. The DBT compliance for the overall cohort was 72%, close to the international benchmark target of ≥75% of cases. However, there was a significant spread among hospitals ranging from 31% to 88% (Figure 23). While only 9 hospitals accomplished the compliance benchmark of ≥75% of cases, this was an improvement over 2015, when only 4 hospitals achieved the benchmark level.

Figure 23: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes by hospital



Hospitals B, J, N, Q, R, U, Y not included (Primary PCI cases n<5)
Hospital W low numbers (n<10)

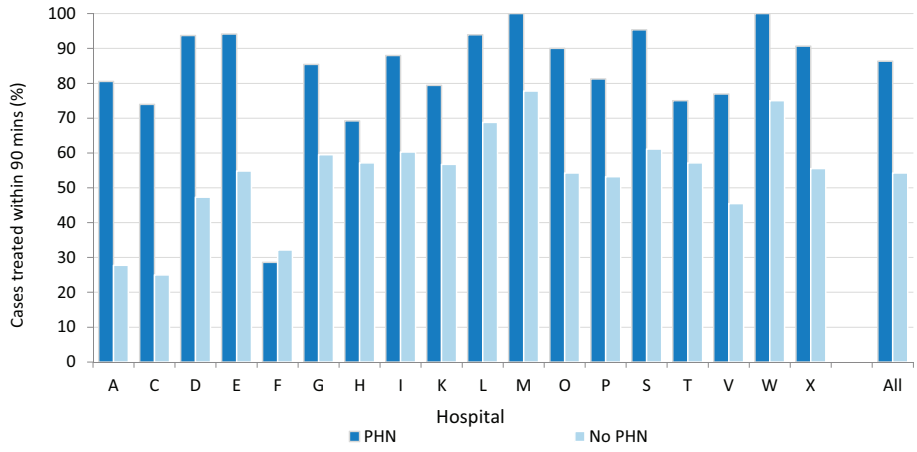
Factors Influencing Door-to-Balloon Time Compliance

Pre-hospital notification

Notification by ambulance to hospitals of an acute STEMI patient's imminent arrival is referred to as pre-hospital notification (PHN). This allows hospitals to prepare for the arrival of a STEMI patient, activate the cardiac catheterisation laboratory team and set up rapid transfer from hospital entrance to catheter laboratory to minimise delays to the commencement of the PCI.

Figure 24 compares the proportion of primary PCI cases achieving DBT within 90 minutes for patients triaged with and without pre-hospital notification for each hospital. Compliance rates for DBT≥90 mins were higher in patients triaged with pre-hospital notification, with 86% achieving a door-to-balloon time of less than 90 minutes. In contrast, only 54% achieved DBT within 90 minutes without pre-hospital notification. There was significant variation in the number of cases with PHN across hospitals (range 15% - 83%) with an average of 55% for the overall cohort.

Figure 24: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes - pre-hospital notification (PHN) vs no pre-hospital notification

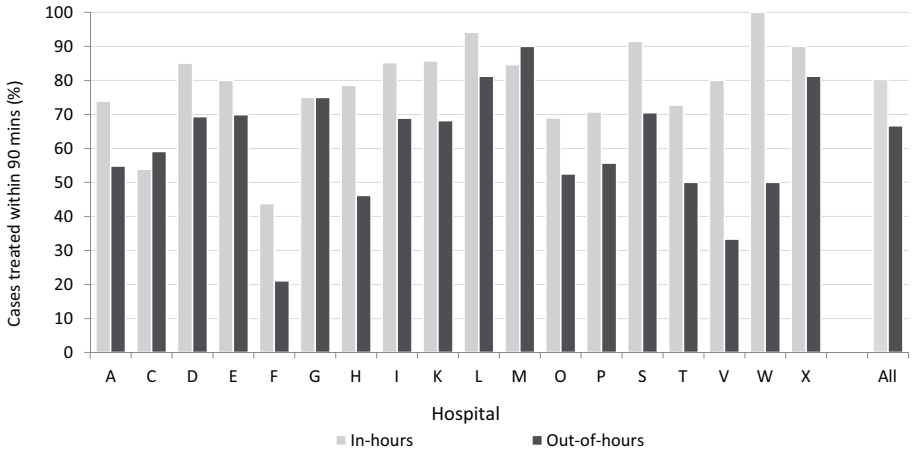


Hospitals B, J, N, Q, R, U, Y not included (Primary PCI cases n<5)
Hospital W low numbers (n<10)

In-hours versus out-of-hours presentation

The proportion of STEMI cases treated out-of-hours and therefore necessitating staff call-backs was 61% for the overall cohort. As in previous reports, cases performed outside normal working hours demonstrate longer delays till commencement of the procedure (Figure 25). This was predominantly due to increases in the time taken to transfer patients to the cardiac catheter laboratory. The proportion of hospitals' STEMI workload that fell out-of-hours ranged from 21%-90%.

Figure 25: Proportion of primary PCI cases with door-to-balloon time ≤90 minutes - in-hours vs out-of-hours presentation



Hospitals B, J, N, Q, R, U, Y not included (Primary PCI cases n<5)

Hospital W low numbers (n<10)

In-hours: 8:00am – 6:00pm (Mon – Fri). Out-of-hours: 6:00pm – 8:00am (Mon – Fri and weekends).

Outcomes

Lesion and Procedure Success Rates

In general, a PCI is considered successful if the narrowed or blocked coronary arteries are re-opened with a coronary stent or balloon and the patient remains free of complications. Lesion success is defined as a reduction of the narrowing to less than a 10% residual stenosis following stenting, or less than 50% following balloon angioplasty alone. Procedure success is defined as all attempted lesions successfully treated, without any significant in-hospital complications. As in previous years, the lesion success rate was high at 95% and the overall procedure success rate was 91% (range for hospitals 83%-99%).

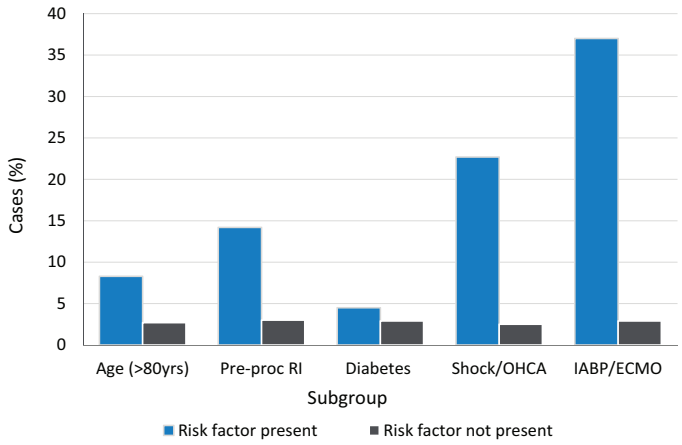
New Renal Impairment

The use of angiographic contrast agents during PCI can lead to acute impairment of renal function, especially in patients with pre-existing kidney disease, diabetes, hypertension or advanced age. Steps can be taken to minimise the risk of contrast-induced nephropathy and its incidence is an important outcome measure of any PCI service.

The overall rate of new renal impairment, defined as a serum creatinine rise >44.2 µmol/L or 25% above pre-procedural value within 5 days of PCI procedure was 3.3%. An analysis of new renal impairment rates for selected high-risk subgroups is shown in Figure 26. For each of the high-risk subgroups, the rate of new renal impairment was between 1.5-10 times higher than its comparator.

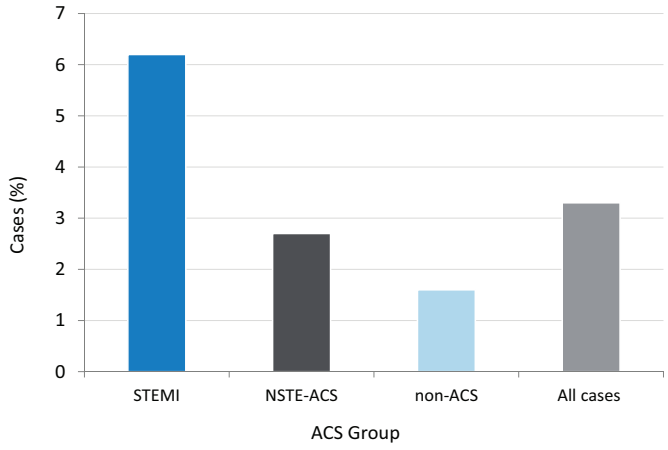
New renal impairment (RI) also varied according to clinical presentation. The highest incidence of new renal impairment was in STEMI cases (6.2%), which often involve patients with the greatest acuity and periods of hypotension (low blood pressure) that exacerbate the risk of renal impairment (Figure 27).

Figure 26: Rate of new renal impairment in selected high-risk subgroups



Data available for 7165 cases

Figure 27: New renal impairment rates by clinical presentation



Data available for 7165 cases

Referrals to Cardiac Rehabilitation

National guidelines and clinical care standards strongly endorse referral of patients with coronary disease to an appropriate cardiac rehabilitation or other secondary prevention program. Yet, less than 50% of patients with an ACS were referred to cardiac rehabilitation on a recent national survey and compliance with secondary prevention measures was poor[16]. VCOR has therefore monitored the rate of referrals after PCI to assist hospitals in their discharge planning and secondary prevention strategies.

In 2016, the overall rate for referral to cardiac rehabilitation after an admission for PCI among VCOR hospitals was 76.3%. Table 10 demonstrates that referral rates varied according to clinical presentation – highest for patients with STEMI and lowest in stable non-ACS presentations. Referral rates also varied by hospital sector – 84% public sector vs 64% private sector. There are likely several factors affecting these referral rates and is an area that will require further attention and analysis.

Table 10: Referral rates to cardiac rehabilitation by clinical presentation

Clinical Presentation	Cases with data available	Rehabilitation referral rate
	N	N (%)
STEMI	2034	1740 (85.5)
NSTE-ACS	3112	2457 (78.9)
Non-ACS	4654	3283 (70.5)
All cases	9800	7480 (76.3)

Compliance with Guideline-Recommended Discharge Medications

Dual anti-platelet therapy and statins are recommended therapies for all patients undergoing PCI and stent insertion unless there are specific contraindications. Compliance with these medications was high, with 94% of patients discharged on dual anti-platelet therapy and a statin. For patients presenting with an ACS that have additional drug requirements, Table 11 and 12 outlines the rates of prescription of these guideline-recommended medications after PCI. The highest use was in STEMI patients. When considering the 5 main evidence-based drugs recommended after a PCI associated with an ACS (aspirin, additional anti-platelet, statin, beta blocker and ACE inhibitor/ARB), the proportion of patients discharged on at least 4 out of 5 medications was 83%.

Table 11: Discharge Prescription Rates of Beta Blockers (BB) by clinical presentation

Clinical Presentation	Cases with data available	BB rate
	N	N (%)
STEMI	2014	1776 (88.2)
NSTE-ACS	3067	2301 (75.0)
Non-ACS	4570	2731 (59.8)
All cases	9651	6808 (70.5)

Table 12: Discharge Prescription Rates of ACE Inhibitor/Angiotensin Receptor Blockers (ARB) by clinical presentation

Clinical Presentation	Cases with data available	ACEI/ARB rate
	N	N (%)
STEMI	2009	1690 (84.1)
NSTE-ACS	3080	2242 (72.8)
Non-ACS	4569	2985 (65.3)
All cases	9658	6917 (71.6)

Key Performance Indicators

VCOR reports on a number of key performance indicators (KPIs) based on clinically relevant procedural outcomes. 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 major adverse cardiac and cerebrovascular event (MACCE)

For 30-day risk adjusted mortality rates a risk-prediction scoring tool, based on the Melbourne Interventional Group[17] multicentre PCI registry mortality risk-adjustment model was developed and has been used by VCOR since 2014. The clinical characteristics used to construct the VCOR risk-adjustment model were:

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

In-hospital Mortality

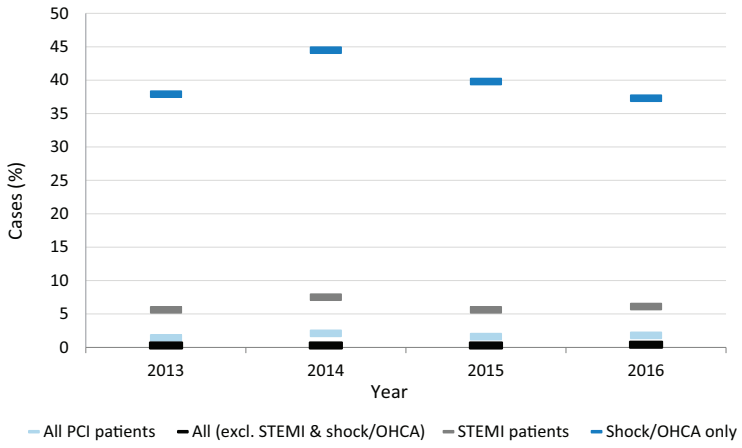
The unadjusted in-hospital mortality rate for 2016 was 1.8%. Table 13 demonstrates that the highest mortality was found in patients presenting with cardiogenic shock or out-of-hospital cardiac arrest requiring endotracheal intubation (OHCA). When high-risk patients were excluded, in-hospital mortality rates were very low at 0.4%. Figure 28 demonstrates the trend in in-hospital mortality rates over the previous 4 years. Low-risk PCI has consistently had very low mortality rates, while in-hospital mortality for patients with shock or out-of-hospital cardiac arrest have been trending down over the last 3 years.

Table 13: Unadjusted in-hospital mortality rates for selected patient groups

Patient category	Total	In-hospital mortality rate
	N	N (%)
All PCI patients*	9977	183 (1.8)
All patients without STEMI or shock/intubated OHCA	7762	34 (0.4)
STEMI patients	2166	132 (6.1)
Shock/intubated OHCA patients	303	113 (37.3)

**Cases with multiple procedures were excluded to avoid mortality being counted more than once (n=15)*

Figure 28: Comparative in-hospital mortality trends for different clinical presentation groups (2013-2016)



STEMI includes any STEMI patient with ACS onset within the last 7 days

In-hospital Bleeding

As an outcome measure, In-hospital major bleeding predicts adverse short and long-term outcomes, including prolonged hospital stay, increased risk of ischaemic events and higher mortality[10]. Utilising the international Bleeding Academic Research Consortium (BARC) standardised bleeding definitions for cardiovascular clinical trials[18], VCOR reports on major bleeding events (identified by BARC categories 3 and 5) to include bleeding that requires blood transfusion, cardiac tamponade, intracranial haemorrhage and/or any fatal bleeding.

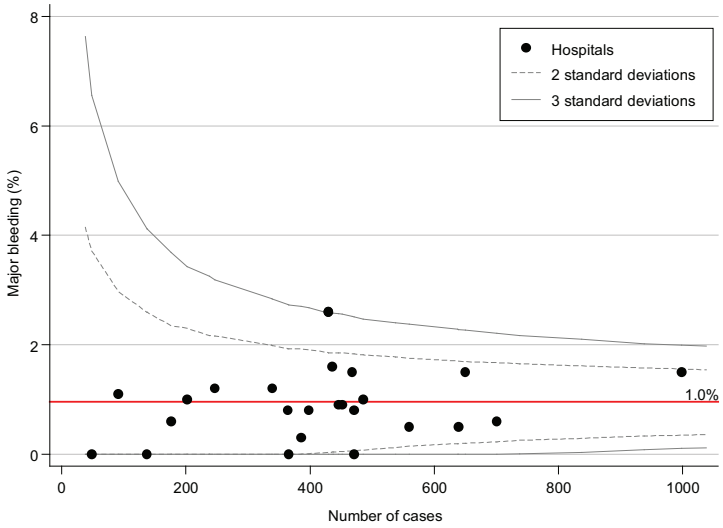
The overall in-hospital major bleeding rate in 2016 was 1.0% (Table 14). High-risk groups for major bleeding included patients treated with ECMO (bleeding in 6 out of 11 ECMO patients, 55%), STEMI patients and females. Femoral arterial access was associated with a threefold increase in major bleeding compared with radial access (1.5% vs 0.5%). A comparison of in-hospital major bleeding rates among participating hospitals is shown in Figure 29.

Table 14: In-hospital major bleeding rates by sub-group

Sub-group	N	Major Bleeding Rate
Clinical Presentation		N (%)
STEMI	2160	46 (2.1)
NSTE-ACS	3138	30 (1.0)
Non-ACS	4668	19 (0.4)
Gender		N (%)
Male	7633	56 (0.7)
Female	2333	69 (1.7)
Arterial Access Route		N (%)
Radial access	5508	30 (0.5)
Femoral access	4444	65 (1.5)
Brachial access	14	0 (0.0)
Total	9966	95 (1.0)

Excludes ECMO cases (n=11) and cases with multiple procedures to avoid mortality being counted more than once (n=15)

Figure 29: Rates of in-hospital major bleeding

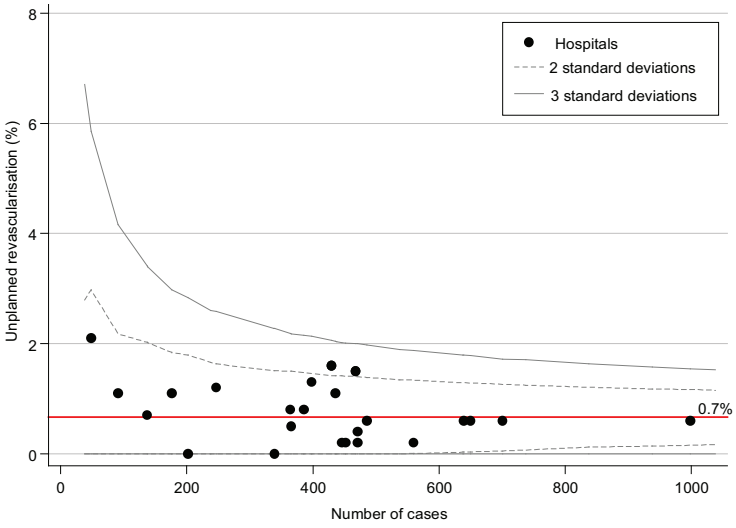


Excludes ECMO cases (n=11)
Site Y excluded due to low numbers (n<15)

In-hospital unplanned revascularisation

In-hospital unplanned revascularisation refers to any unexpected revascularisation procedure (either PCI or CABG surgery) following the index PCI, and within the same admission. The measure includes unplanned procedures on coronary vessels other than the one initially treated with PCI. For 2016, the overall rate of in-hospital unplanned revascularisation was 0.7%. Figure 30 demonstrates that all participating hospitals had rates of unplanned revascularisation within control limits.

Figure 30: Rates of in-hospital unplanned revascularisation

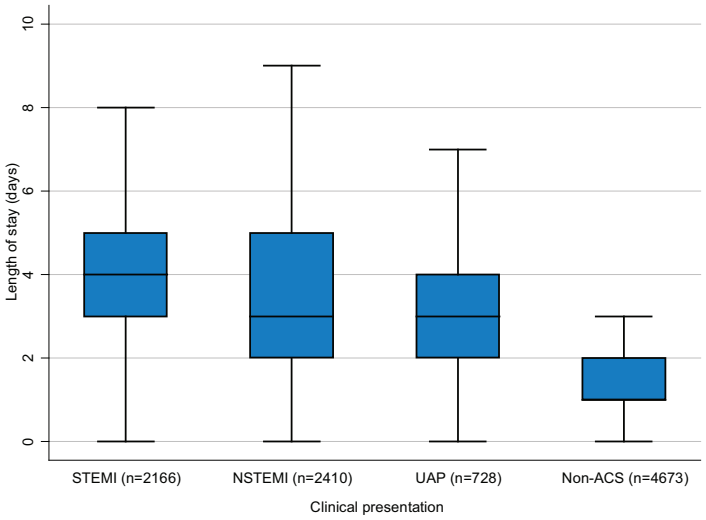


Site Y excluded due to low numbers (n<15)

Length of Stay

For most elective PCI cases, length of stay is expected to be one day, whereas patients undergoing PCI for an acute coronary syndrome typically have multi-day hospital stays, usually related to the overall management of the underlying condition. Figure 31 shows the median length of stay (in days) was greatest for patients presenting with STEMI, decreasing as the acuity of the presentation decreased. A shorter median length of stay was observed among patients treated in private hospitals (3 days public vs 2 days private), likely reflecting the greater proportion of non-ACS cases treated in the private sector.

Figure 31: Length of stay by clinical presentation

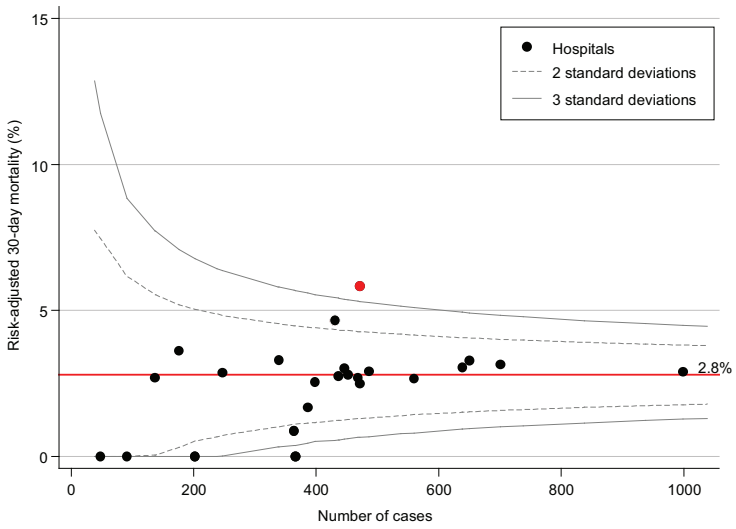


30-day risk-adjusted mortality

The 30-day risk adjusted mortality rate is one of the principal outcome measures used to assess the quality and safety of hospital care and is a crucial component for valid and meaningful comparisons of hospital performance. Despite well-recognised limits to the precision of risk-adjustment models, the technique of risk-adjustment helps level the playing field for inter-institutional comparisons. The metric essentially reflects how the actual (observed) outcomes for a hospital compare with outcomes that are expected for that hospital.

While the overall risk-adjusted 30-day mortality for the cohort was 2.8%, the real strength of the measure is in the comparison of the hospitals' outcomes. Figure 32 demonstrates that all but one hospital had adjusted 30-day mortality rates within control limits. One hospital demonstrated special-cause variation as an outlier, with observed performance significantly different to its expected performance. In response VCOR followed its policy for management of outliers with appropriate notification to the hospital along with the offer of guidance and assistance with the hospital's subsequent quality assurance activities.

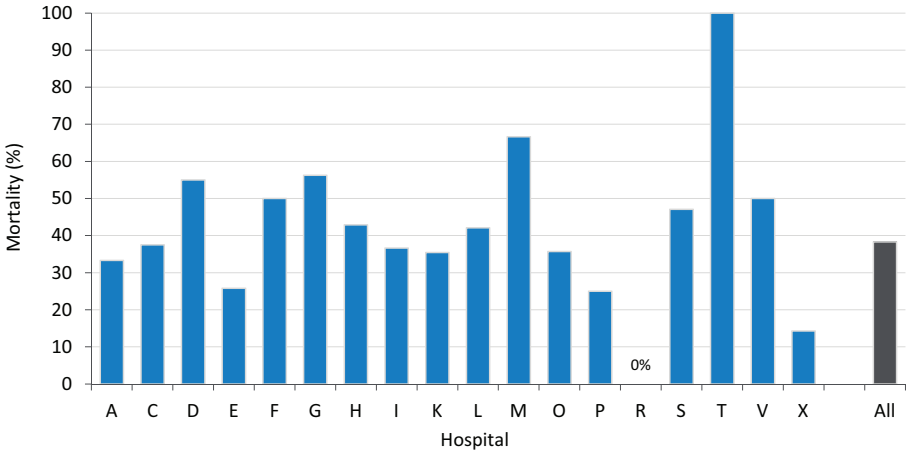
Figure 32: Risk-adjusted 30-day mortality



Site Y excluded due to low numbers (n<15)

The current risk-adjustment model utilised by VCOR incorporates cardiogenic shock as one of the included clinical characteristics of the model. Yet, cardiogenic shock is generally associated with mortality rates much higher than other clinical presentations, and arguably is a special case that should be analysed separately to the rest of the cohort. Figure 33 demonstrates the 30-day mortality rate for patients with cardiogenic shock or out-of-hospital cardiac arrest. As expected, all hospitals demonstrated much higher mortality rates in this patient subgroup compared with an overall unadjusted 30-day mortality rate of 1.1% for patients without shock and out-of-hospital arrest. Some hospitals had very low numbers of cases and therefore comparisons of mortality rates across hospitals should be interpreted with caution.

Figure 33: 30-day mortality rates for cardiogenic shock and intubated OHCA patients by site



Hospital	A	C	D	E	F	G	H	I	K	L	M	O	P	R	S	T	V	X	All
N	3	16	20	31	8	16	7	30	79	19	3	28	12	2	17	1	4	7	303

Hospitals B, J, N, Q, U, W, Y had no shock or intubated OHCA cases

30-day Major Cardiac and Cerebrovascular Events (MACCE)

The composite endpoint of major adverse cardiac and/or cerebrovascular events (MACCE) includes all cases of death, new or recurrent myocardial infarction or stent thrombosis, target vessel revascularisation or stroke. The overall MACCE rate was 4.4% (Table 15). When the high acuity cases with cardiogenic shock or out-of-hospital cardiac arrest were excluded (n=303 cases), the 30-day MACCE rate dropped to 3.1%.

Table 15: 30-day MACCE rates

MACCE Component	In-hospital events	30-day events*
	N (%)	N (%)
Total mortality	183 (1.8)	218 (2.2)
Myocardial infarction	63 (0.6)	101 (1.0)
Stroke	34 (0.3)	50 (0.5)
Definite stent thrombosis	16 (0.2)	39 (0.4)
Probable stent thrombosis	9 (0.1)	15 (0.2)
Target vessel revacularisation (TVR) ǂ	67 (0.7)	126 (1.3)

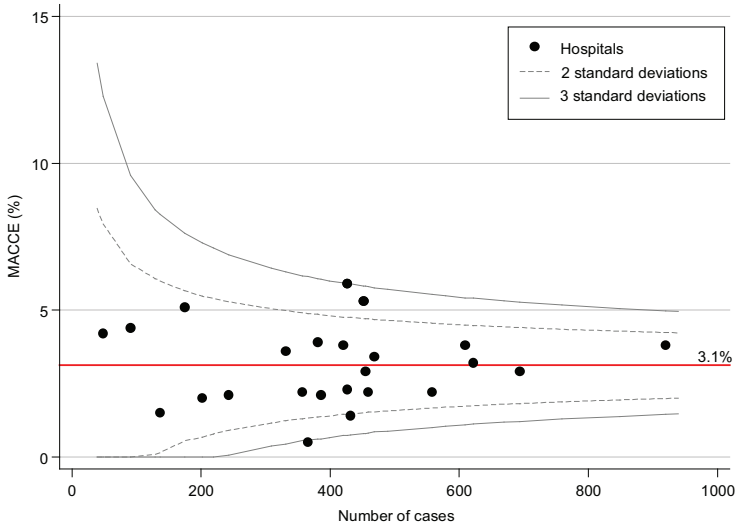
Categories are not mutually exclusive

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

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

A comparison of hospitals' performance in relation to MACCE is shown in Figure 34 and demonstrates only common-cause variation among all the hospitals and no performance outliers.

Figure 34: 30-day MACCE



Excludes all shock/OHCA cases (n=303)

Site Y excluded due to low numbers (n<15)

30-day stent thrombosis

Stent thrombosis was reported as a "definite" event (symptoms suggestive of an acute coronary syndrome and angiographic or pathologic confirmation of stent thrombosis) or a "probable" event (unexplained death within 30 days or target vessel myocardial infarction without angiographic confirmation of stent thrombosis). In 2016, the definite 30-day stent thrombosis rate was 0.4% (Table 15). There were no major differences in stent thrombosis rates among hospitals overall or when the public private sectors were compared.

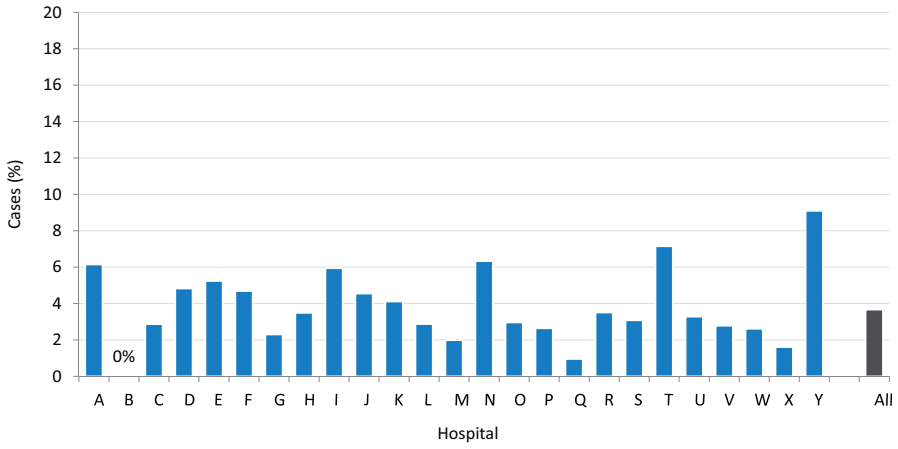
30-day rehospitalisation

At 30 days following PCI the overall rate of rehospitalisation was 13.7%, similar to the previous year. Readmission for cardiac causes occurred in 70% of cases, but only approximately one-third were unplanned (3.7% for the entire cohort, Table 16). The rate of unplanned readmission is being increasingly used as a metric of the performance or quality of hospital care or treatment and a comparison of this rate among participating hospitals is shown in Figure 35. Rates of unplanned cardiac readmission were similar among public and private hospitals.

Table 16: Rehospitalisation rates

Rehospitalisation Type	All Patients (N=8308)	Public Patients (n=5205)	Private Patients (n=3103)
	N (%)	N (%)	N (%)
Total readmissions	1141 (13.7)	632 (12.1)	509 (16.4)
Non-cardiac readmissions	338 (4.0)	231 (4.4)	107 (3.4)
Cardiac readmissions	803 (9.7)	401 (7.7)	402 (13.0)
Unplanned cardiac readmissions	305 (3.7)	203 (3.9)	102 (3.3)
Planned cardiac readmissions	498 (6.0)	198 (3.8)	300 (9.7)

Figure 35: 30-day unplanned cardiac rehospitalisation by hospital



Quality of Life Metrics

Patients were requested to rate their perceived quality of life at 30-day follow-up in a series of questions based on a standardised measure, the EQ-5D[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 Table 17.

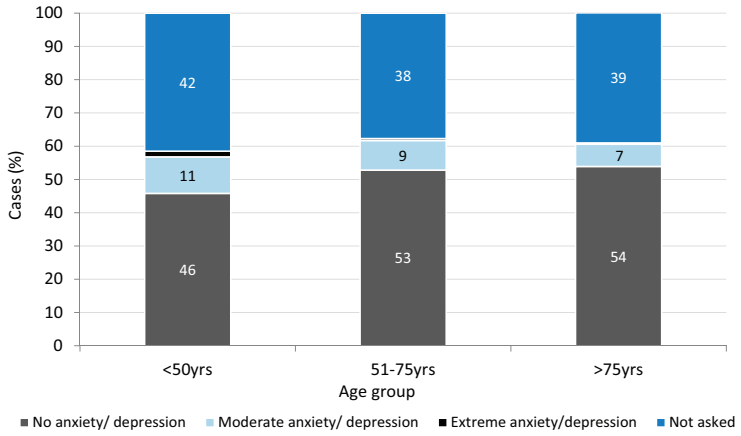
Patients were also asked to rate their own health status on a scale from 1-100, with 100 being the best a patient could remember ever feeling. Of the 44% of patients who responded, the median rating score for their own health status was 80 out of 100 (IQR 70, 90).

Table 17: Quality of life metrics for 2016 PCI cohort

PCI Cohort	No problem	Some problems	Not asked
(N=9992)	N (%)	N (%)	N (%)
Mobility	5971 (62.2)	753 (7.8)	2881 (30.0)
Personal care	6397 (66.6)	331 (3.4)	2877 (30.0)
Usual activities	5671 (59.0)	1053 (11.0)	2881 (30.0)
Pain/discomfort	5886 (61.3)	819 (8.5)	2900 (30.2)
Anxiety/depression	5021 (52.3)	896 (9.3)	3688 (38.4)

Patterns of responses to the EQ-5D were quite similar when patients were divided into age groups of <50 years, 50-75 years and >75 years. Interestingly, there was a higher rating of "moderate or extreme anxiety/depression" among the youngest patients (12.7%) compared with 50-75 year (9.6%) and >75 year groups (7.1%) (Figure 36).

Figure 36: EQ-5D responses to anxiety/depression by age group



The quality of life responses were also analysed according to clinical presentation as it would be expected that the patients who presented with the highest acuity disease may have different responses to those patients who had stable disease. Overall, more complete response rates were noted for patients with non-ACS presentations (82% for non-ACS vs 61% for ACS). However, there were no major differences in each of the 5 quality of life categories assessed according to clinical presentation.

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

Background

A major challenge in Australian health care is ensuring patients in non-metropolitan regions with time critical illnesses have rapid availability of emergency specialist care. It is well recognized that patients who present with acute coronary syndrome in rural and regional areas face additional challenges related to timely treatment and definitive cardiology care[20]. The VCOR Early STEMI Management module was designed to monitor and report on the treatment of STEMI patients in non-metropolitan hospital settings, including aspects of pre-hospital care, initial emergency department management and timeliness to revascularisation and coronary angiography. VCOR developed this module because of the strong evidence base for effective treatment, well-developed standards of care and measurable process and outcome performance indicators.

Registry Module Activity

The Early STEMI Management module enrolls all patients with suspected STEMI who either present to the Emergency Department (ED) or are in-patients at the index rural or regional hospital, irrespective of whether they are deemed suitable for thrombolysis. The registry was modelled on the VCOR PCI module with a standard set of essential and epidemiologically sound variables collected. Data elements included details on reperfusion therapy, in-hospital clinical events, complications and clinical outcomes. Special focus was also given to data 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 commenced activities in 2013, with four sites in the Hume and Gippsland regions recruited to pilot the module. The number of hospitals actively contributing to the registry has now expanded to nine, with the continued rollout of the module to other major regional centres across Victoria in the last 18 months (Table 18). The registry promotes regular engagement with its regional stakeholders through published bulletins and biannual data summaries. VCOR has also been visiting its regional stakeholders for direct engagement with local teams and incorporating the VCOR data into practice improvement for STEMI patients.

Data Linkage

For the first time in 2016, key data linkages and collaborations were established to provide a more comprehensive picture of the patient journey and outcomes in STEMI. The Early STEMI Management module was linked with the VCOR PCI module, tracking outcomes of non- metropolitan patients after transfer from their index hospital. Further data linkage was performed with the Ambulance Victoria (AV) pre-hospital database, providing important pre-hospital details and interventions.

Table 18: Participation of regional Victorian hospitals in Early STEMI Management module

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

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

Patient Characteristics

In 2016, a total of 148 patients presented with suspected STEMI at participating hospitals. Data were collected from nine regional hospitals. Of the 148 patients, 41 (28%) were ineligible for thrombolysis. These included late presentation (n=15), significant comorbidities (n=4), uncertain diagnosis (n=5) or contra-indication to thrombolysis (n=17). Four patients were transferred for emergency primary PCI. The remaining 103 patients, all received appropriate thrombolytic therapy, either in the hospital ED (n=94) or through the pre-hospital thrombolysis scheme administered by Ambulance Victoria (n=9). This program has been rolling out in a sequential fashion across regional Victoria since 2014.

The average age for the 2016 regional STEMI cohort was 66 years, ranging from 31 to 95 years. Table 19 shows selected characteristics of the patients.

Table 19: Regional STEMI patient characteristics (2013-2016)

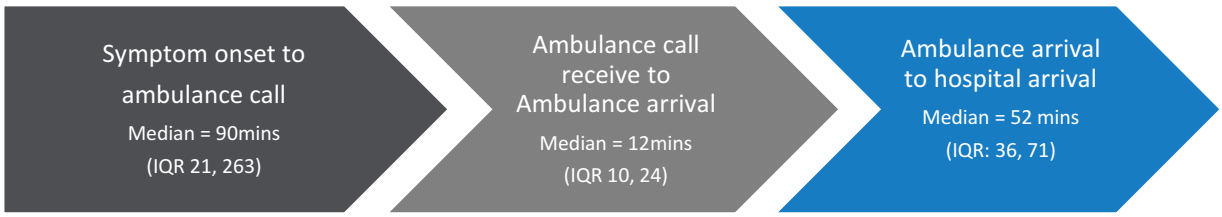
Patient characteristic	2014 (N=64)	2015 (N=138)	2016 (N=148)
Age – years (mean ±SD)	61 ±14	66 ±12	66 ±13.7
Presenting heart rate - BPM (mean ±SD)	79.4 ±21.3	79.1 ±24.8	81.5 ±22.4
	%	%	%
Gender – female	31.3	34.1	33.1
Pre-hospital thrombolysis (ambulance presentation only)	9.1	10.1	10.7
Site of infarction – anterior	34.4	40.6	33.8
Site of infarction – inferior	48.4	51.4	48.6
Site of infarction -posterior	6.3	2.2	6.8
Site of infarction –lateral	-	-	6.8
Site of infarction –intermediate	-	-	0.7
Site of infarction – other	10.9	5.1	3.4

Of the 148 patients, 84 (57%) were brought in by ambulance, and 54 (36%) of patients self-presented to ED. Four percent of STEMIs were current in-patients at regional centres, and approximately 3% of patients arrived from another treating hospital (inter-hospital transfer). While most patients (90%) were located within 50km of the treating hospital, almost 6% of patients travelled more than 75kms for treatment.

Time Delays to Transfer

For all patients except those with in-hospital STEMI, the median time from pain onset to first medical contact (patient delay) was 120 minutes (IQR: 37, 268). The median time from first medical contact to hospital arrival (pre-hospital delay) was 66 minutes (IQR: 37, 85). For patients who travelled less than 25kms to hospital, the median pre-hospital delay was shorter at 53 minutes (IQR: 33, 75), for those travelling between 26 and 50kms, the median time was 90 minutes (IQR: 79, 103). Patients travelling more than 50kms, the median time was 106 minutes (IQR: 73, 196). Time intervals related to ambulance calls are noted in Figure 37.

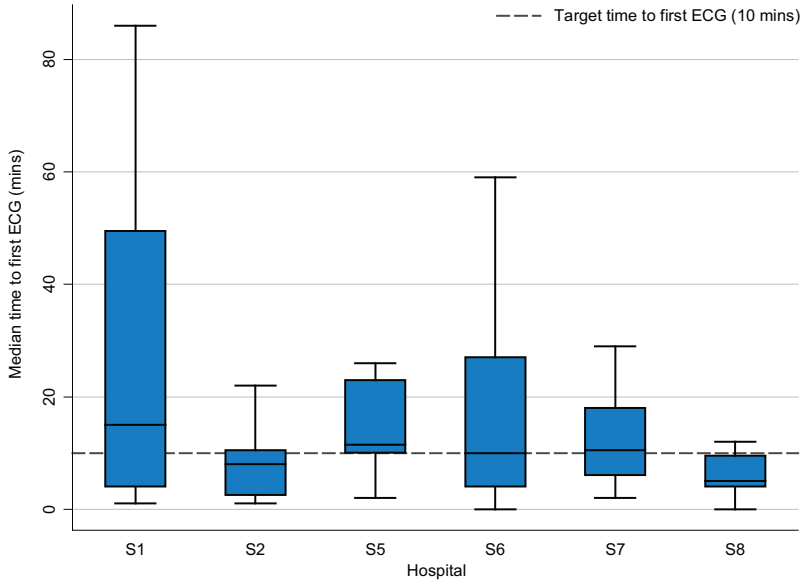
Figure 37: Ambulance time intervals for regional STEMI patients



In-hospital Process Times (Arrival to ECG time and Door-to-Needle Time)

The efficient and timely delivery of reperfusion therapy is a key performance outcome and can be evaluated with a number of specific process measures. These include the time to first ECG and the time taken from hospital presentation to administration of thrombolytic drug, known as the door-to-needle time. Across all sites in the 2016 cohort, the median time to first ECG was at the recommended benchmark of 10 minutes (Figures 38).

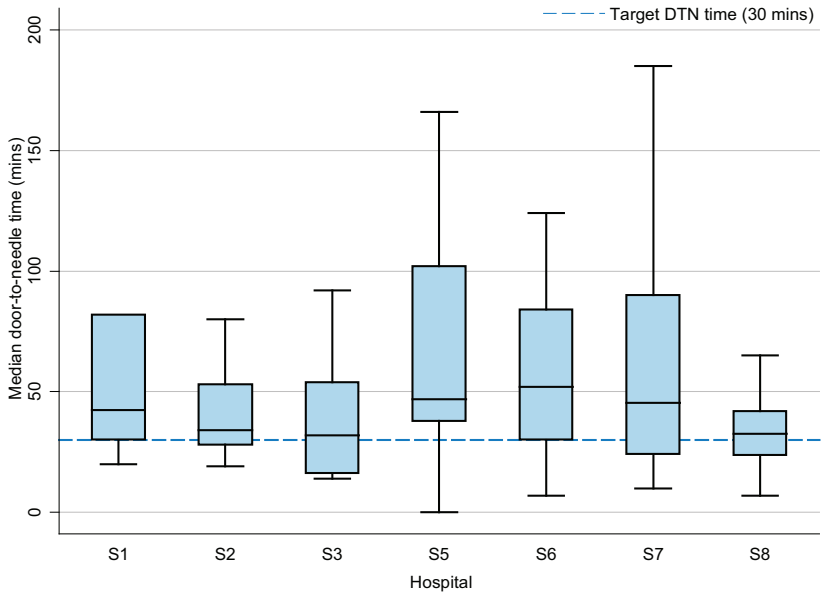
Figure 38: Time from arrival to first ECG time for regional STEMI patients by hospital



Hospitals S3, S4 and S9 not included due to low case numbers (n<5)

The overall median door-to-needle time for VCOR regional STEMI sites was 39 minutes (IQR: 27, 69). The ideal target door-to-needle time (DTN), recommended by Australian National Heart Foundation/Cardiac Society of Australia and New Zealand Guidelines is less than 30 minutes[13]. This ideal median target of 30 minutes was not achieved by any of the sites in 2016 (Figure 39).

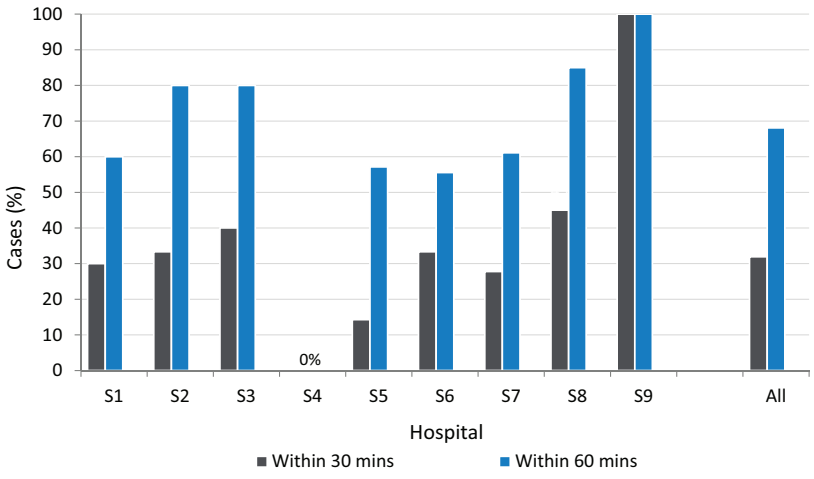
Figure 39: Door-to-needle times for regional STEMI patients by hospital



Hospitals S4 and S9 not included due to low case numbers (n<5)

When hospital performance was analysed by compliance rates for door-to-needle times ≤30 minutes, 32% cases were managed within this benchmark rate. The proportion of compliant cases rose to 68% when a door-to-needle time delay of ≤60 minutes was applied (Figure 40).

Figure 40: Proportion achieving door-to-needle times within 30 and 60 minutes (regional STEMI patients)



Hospitals S4 and S9 had low case numbers (n<5)

As with door-to balloon times in patients undergoing PCI, door-to-needle times (DTN) with thrombolysis also improved when pre-hospital notification of the arriving STEMI patient was received from ambulance services. The median door-to-needle time with pre-hospital notification was 24 minutes (IQR: 16, 56) among the 18 patients who were triaged in the field. 10 of the 18 cases with pre-hospital notification achieved a median door-to-needle time within 30 minutes. Table 20 shows DTN for all cases thrombolysed at the index hospital, including self-presenters and ambulance arrivals with and without pre-hospital notification.

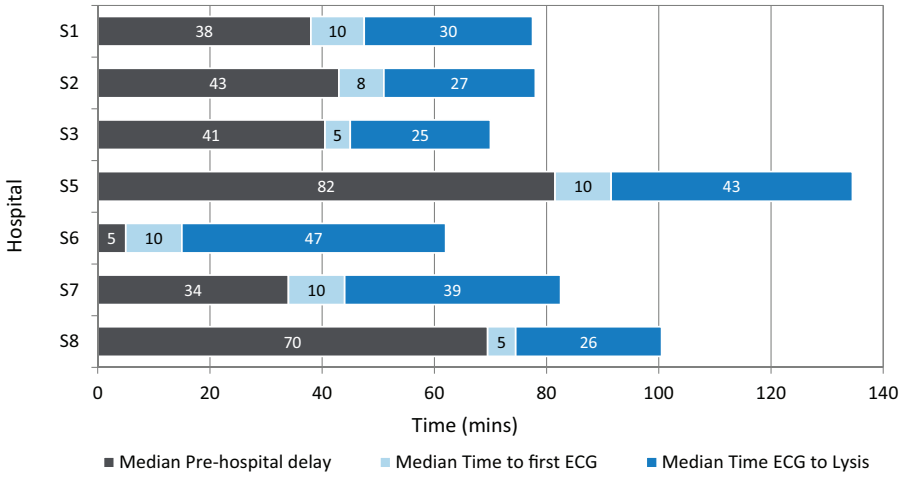
Table 20: Door-to-needle times for pre-hospital notification (PHN) and no PHN (regional STEMI patients)

Hospital	Total cases	Median door-to-needle time (all cases)	Median door-to-needle time (with PHN)	Median door-to-needle time (no PHN)
	N	Mins (IQR)	Mins (IQR)	Mins (IQR)
S1	10	43 (29, 308)	-	43 (31, 754)
S2	15	34 (28, 53)	-	34 (31, 61)
S3	5	32 (15, 73)	-	54 (32, 92)
S4	2	-	-	-
S5	14	47 (37, 109)	39 (19, 59)	61 (38, 148)
S6	9	52 (30, 104)	-	52 (30, 104)
S7	18	46 (23, 90)	-	48 (35, 90)
S8	20	33 (23, 43)	28 (12, 70)	35 (23, 43)
S9	1	-	-	-
All sites	94	39 (27, 69)	24 (16, 56)	41 (30, 70)

Hospitals S1, S2, S3, S4, S6, S7, S9 had low numbers (n<3)

A comparison of the system delay (comprising pre-hospital delay plus door-to-needle time) for the participating hospitals is shown in Figure 41. The median system delay for the entire cohort was 64 minutes, substantially longer than the median door-to-needle time of 39 minutes. This measure is arguably a better performance metric than the door-to-needle time, as it emphasises the urgency of commencing treatment the moment the patient comes into contact with the medical system. International guidelines are now recommending ideal time delays from first medical contact to thrombolysis of <30 minutes[21], underscoring the importance of continued development of pre-hospital thrombolysis programs to shorten first medical contact to reperfusion.

Figure 41: Overall system delay times (regional STEMI patients)

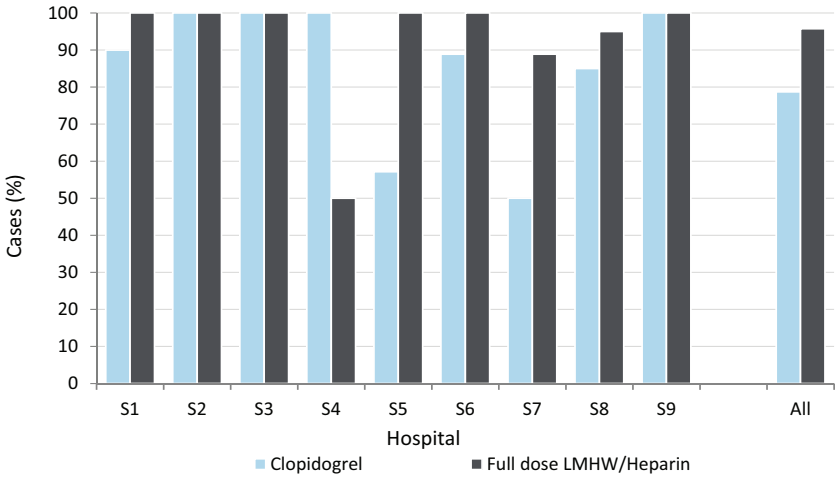


Hospitals S4 and S9 excluded due to low case numbers (n<5)

Adjunctive Therapies

Australian guidelines provide strong recommendations for antithrombotic therapy (unfractionated heparin or low molecular weight heparin), and anti-platelet therapy with clopidogrel following thrombolysis[13]. Figure 42 shows very high rates of both antithrombotic therapy (96%) and clopidogrel use (78%) among patients.

Figure 42: Treatment and outcomes: adjunctive therapies (regional STEMI patients)



Hospitals S4 and S9 had low case numbers (n<5)

In-hospital Outcomes and Transfer Rates

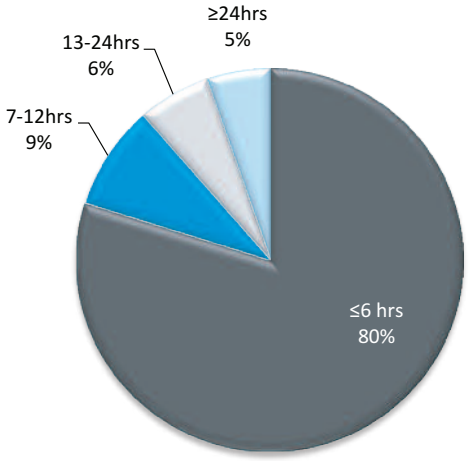
The mean unadjusted in-hospital mortality rate for the nine participating hospitals was 6.1%, comparable to other international registries of STEMI [22, 23] (Table 21). Cardiogenic shock (CS) occurred in 8.8% of patients, and was associated with an in-hospital mortality rate of 54% (7 deaths in 13 patients with CS). Major bleeding occurred in three cases (2%) but there were no cases of stroke among treated patients during their stay at the index hospital.

Table 21: In-hospital outcomes for regional STEMI patients

Hospital	Total cases	Mortality	Cardiogenic Shock	Myocardial re-infarction	Major bleeding	Stroke
	N	%	%	%	%	%
S1	19	5.3	10.5	0.0	0.0	0.0
S2	18	0.0	5.6	0.0	0.0	0.0
S3	6	0.0	0.0	0.0	0.0	0.0
S4	4	0.0	0.0	0.0	0.0	0.0
S5	38	15.8	18.4	2.6	2.6	0.0
S6	13	0.0	7.7	7.7	0.0	0.0
S7	21	0.0	4.8	0.0	4.8	0.0
S8	20	5.0	5.0	5.0	0.0	0.0
S9	9	11.0	0.0	11.0	11.0	0.0
All sites	148	6.1	8.8	2.7	2.0	0.0

Importantly, most patients (95%) were transferred to a PCI capable hospital within 24 hours of thrombolytic therapy. 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, 4.2) (Figure 43).

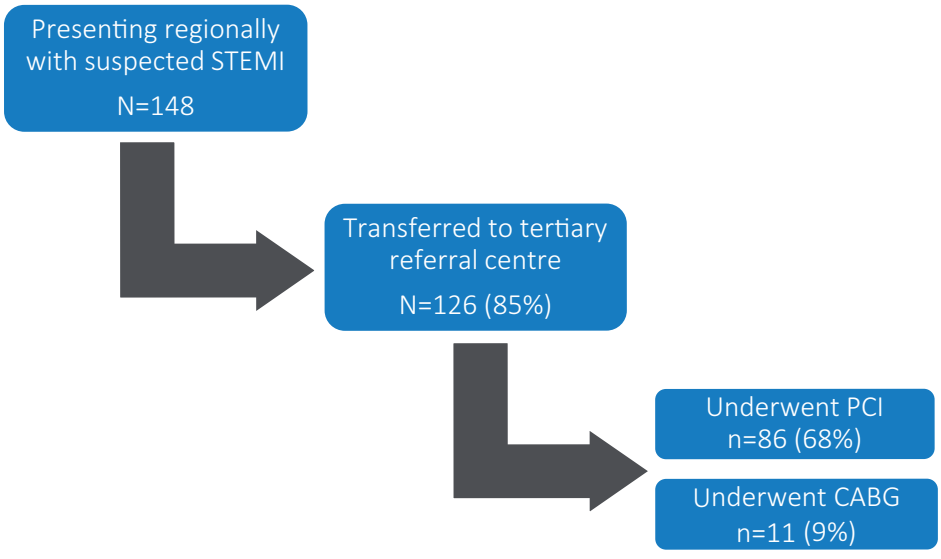
Figure 43: Patient transfer times to metro VCOR hospital (regional STEMI patients)



Revascularisation Rates

For the first time in 2016, VCOR was able to link patient data across its modules. Therefore providing crucial follow-up and clinical outcome data to regional STEMI patients who underwent subsequent PCI. Probabilistic matching indicated that of the 148 regional patients treated for STEMI, 126 patients were transferred to a PCI centre (85%). Of these patients, 68% had PCI and 9% underwent CABG (Figure 44).

Figure 44: Regional STEMI module inter-hospital transfer and revascularisation rates

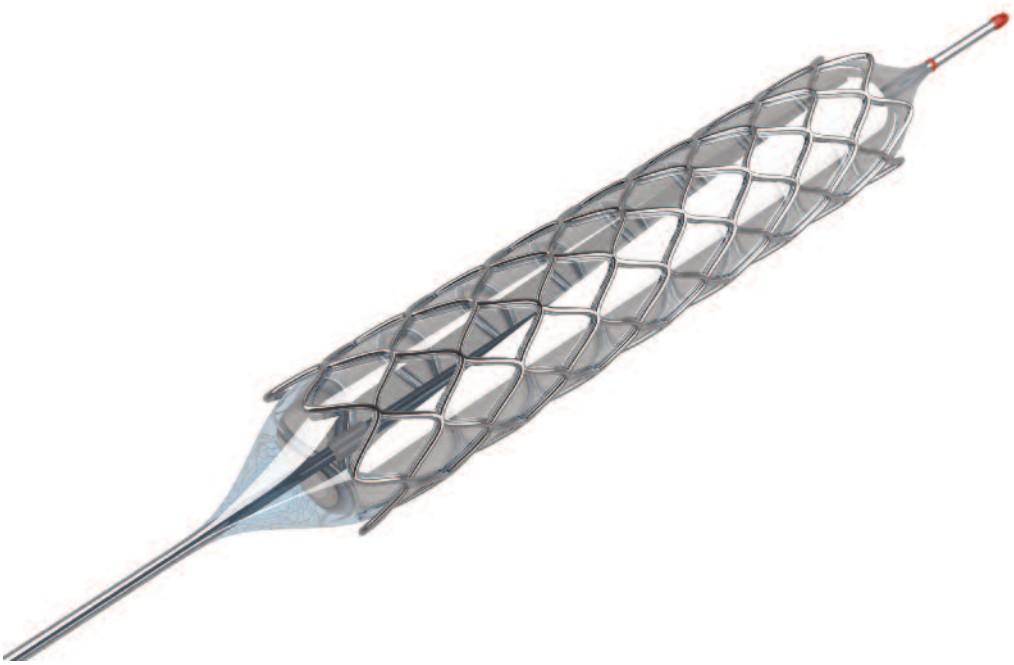


Further analysis of the 86 patients who underwent subsequent PCI included the 4 patients who were transferred urgently for primary PCI. These 4 patients had no in-hospital complications, with three patients discharged to home and one to inpatient rehabilitation. Twenty patients were transferred for a rescue PCI, in which thrombolysis had not achieved reperfusion of the occluded artery. For these patients, urgent transfer and rescue PCI are indicated. The median time from thrombolysis to PCI was 5 hours (IQR: 4, 6) for this group. The in-patient mortality rate for the rescue PCI cohort was 10%.

The remaining patients were transferred in a stable state and underwent pharmaco-invasive PCI (PCI within 24 hours of successful thrombolysis). The median time from thrombolysis to PCI was 22 hours (IQR: 9, 34). There were no deaths in this group (Table 22).

Table 22: Outcomes for regional STEMI patients by reperfusion strategy

Outcomes	Primary PCI Cohort (N=4)	Pharmaco-invasive PCI Cohort (N=62)	Rescue PCI Cohort (N=20)
Median time from thrombolysis to PCI – hrs (IQR)	n/a	22 hrs (9, 34)	5 hrs (4, 6)
	(%)	(%)	(%)
Lesion successfully treated	100	98.8	95.5
In-hospital mortality	0.0	0.0	10.0
In-hospital unplanned revascularisation	0.0	0.0	0.0
In-hospital major bleeding	0.0	4.8	0.0
30-day mortality	0.0	1.6	10.0
30-day unplanned revascularisation	0.0	1.6	0.0
30-day MACCE	0.0	4.8	10.0



Heart Failure (HF) Snapshot

Background

Heart failure (HF) represents a major public health problem associated with high mortality, frequent hospitalisation and major utilisation of health care costs [24]. Thus, optimal utilisation of resources to impact the public burden of heart failure is a significant health system priority. This requires a clear understanding of the epidemiology of the condition, the scope of currently available management strategies and demographic characteristics that predict rehospitalisation. Although considerable data exist from international sources, there are only limited data on the epidemiology and public burden of heart failure in Victoria.

In 2014, VCOR received funding to commence a pilot project related to heart failure patients in Victoria. The overall aim was to improve the safety and quality of care provided to these patients. The design involved the periodic collection and analysis of key clinical information from individual healthcare encounters to facilitate benchmarking of performance and improvement in the quality of health care services. The pilot project, entitled HF-Snapshot, enrolled consecutive patients at participating health services for a limited period of time (one month), in order to obtain a "snapshot" of heart failure-related treatment and outcomes. The pilot phase was successfully completed in 2014 and resulted in the development of a functional minimum dataset for a heart failure clinical quality registry.

Registry Module Activity

In 2016, work proceeded on all aspects of the project, including the updating of all data elements. The number of participating sites increased to 16 hospitals. Data collection activities for 2016 were completed by year's end. Overall, there was strong engagement and interest shown by hospitals in the HF-Snapshot project.

All patients admitted to hospital with acute decompensated heart failure over a one month period during June-July 2016 were enrolled into the 2016 snapshot (Table 23) and followed-up at 30 days post-discharge.

Table 23: Participation of hospitals in HF-Snapshot (2014-2016)

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

Table Legend: ● = contributing data

Patient Characteristics

The 16 participating hospitals enrolled 456 patients admitted to hospital with acute decompensated heart failure. The majority of the patients were male (58%) with a median age of 76 years. The most common co-morbidities were atrial fibrillation (54%), diabetes (47%), anaemia (36%), history of angina (34%), chronic obstructive pulmonary disease (COPD) /asthma (31%), and moderate chronic kidney disease (31%) (Table 24).

Table 24: HF-Snapshot patient characteristics (2015-2016)

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

For patients admitted to hospital with acute decompensated heart failure, 61% had experienced a previous hospitalisation for heart failure. Ischaemic cardiomyopathy was present in 37% of these patients and of these, 31% had a history of prior CABG and/or PCI. Hypertensive heart failure occurred in 22% of patients.

Clinical Presentation

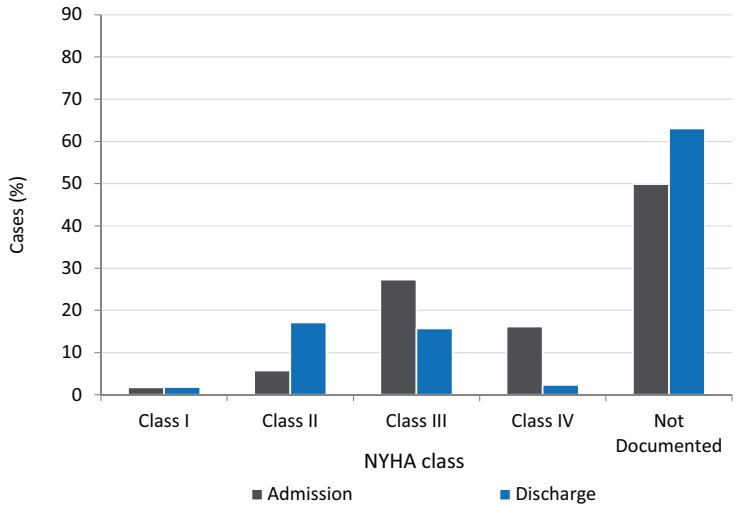
Nearly all the patients (85%) were admitted to hospital through the Emergency Department. Overall, 49% were admitted under General Medicine and 38% under Cardiology (Table 25). Three hospitals had a dedicated heart failure unit. Yet even in those hospitals, the majority of heart failure patients were admitted under General Medicine. Medication non-adherence was considered the precipitant for admission in 8% of patients, similar to 2015 (7%). In contrast, fewer patients were admitted with fluid overload as a precipitant in 2016 (33% in 2016 vs 48% in 2015). Other precipitants for admission are shown in Table 25.

Table 25: HF-Snapshot clinical presentation (2015-2016)

Clinical presentation	2015 cohort (N=289)	2016 cohort (N=456)
	%	%
Admission location – Emergency Department	90.3	84.6
Admitting speciality	%	%
Heart failure unit	8.0	6.4
Cardiology	29.8	37.5
General medicine	52.2	49.3
Gerontology	3.1	2.4
Precipitant for admission	%	%
Ischemia	10.0	9.9
Medication-non-compliance	7.3	8.3
Medication-precipitating drugs	1.4	1.8
Shortness of breath	57.8	88.2
Rhythm disturbance	14.9	9.9
Infection	20.8	18.2
Fluid overload	48.4	32.7

On admission, 41% of patients were in sinus rhythm and 42% were in atrial fibrillation. At discharge, the proportion of patients in sinus rhythm had increased to 48%. There was also an improvement in patients' functional status (as assessed by the New York Heart Association (NYHA) class) by the time of discharge (Figure 45). The greatest improvement in functional class was in the sickest patient group on presentation (NYHA Class IV). A reasonable proportion of patients did not have their functional class adequately documented at admission and or discharge.

Figure 45: New York Heart Association (NYHA) class rates on admission and discharge during HF-Snapshot



Overall, 63% of patients had left ventricular dysfunction. Of these, 46% of patients were diagnosed with predominantly systolic dysfunction (heart failure with reduced ejection fraction, HFrEF) and 14% had predominantly diastolic dysfunction (heart failure with preserved ejection fraction, HFpEF) on echocardiography.

During their hospital admission, 84% of patients were prescribed intravenous frusemide and 87% were prescribed oral diuretics. Medications prescribed on admission and discharge for the entire heart failure cohort are listed in Table 26. These rates do not take into account the type of heart failure the patient had (HFrEF vs HFpEF) nor the contraindications associated with prescribing these medications such as ACE inhibitors (ACEIs), beta-adrenergic blockers, angiotensin receptor blockers (ARBs), ivabradine and/or aldosterone antagonists in heart failure with reduced ejection fraction (HFrEF).

Table 26: Medications prescribed at admission and discharge for all patients during HF-Snapshot

Medications	At admission (N=456)	At discharge (N=429)*
	%	%
AACE Inhibitor	35.1	42
Beta Blocker	60.7	71.8
ARB	19.1	20.5
Ivabradine	2.9	3.3
Calcium channel antagonist	19.3	16.6
Digitalis	15.4	16.6
Nitrate	14.7	16.1
Other vasodilator	5.5	5.8
Antiarrhythmic	8.8	7.9
Lipid lowering agent	53.9	58.5
Anticlotting agents	%	%
Antiplatelet	45	50.8
Anticoagulant	38.4	43.1
Diuretic Agents	%	%
Aldosterone antagonist	21.1	34.3
Loop diuretic	70.6	93.7
Thiazide diuretic	6.4	9.1

**In-hospital mortality cases not included (n=27)*

When adjusting for contraindications and only including patients diagnosed with HFrEF, the prescribing of beta-adrenergic blockers, ACEI/ARBs and aldosterone antagonists all increased from time of admission to time of discharge (Figures 46 and 47).

Figure 46: Prescribing of beta-adrenergic blockers in HFrEF cohort with heart rate >60 BPM on admission and discharge during HF-Snapshot

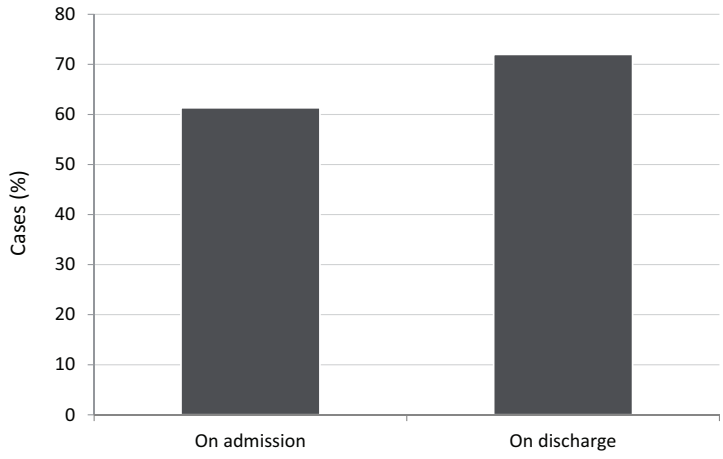
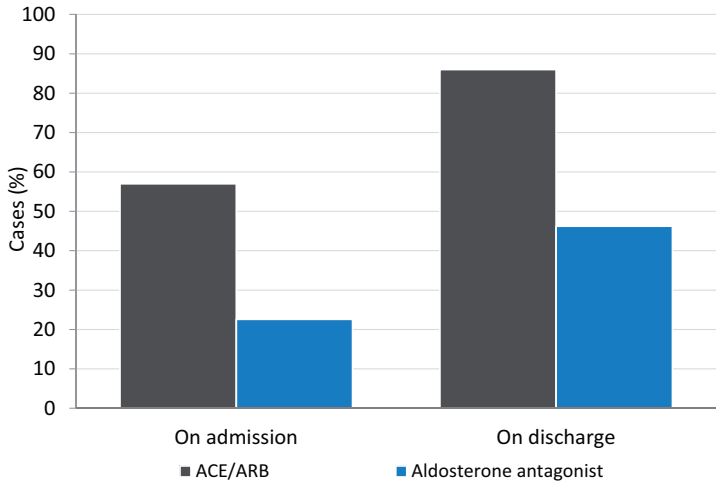


Figure 47: Prescribing of ACEI/ARB in HFrEF with eGFR >60 on admission and discharge during HF-Snapshot



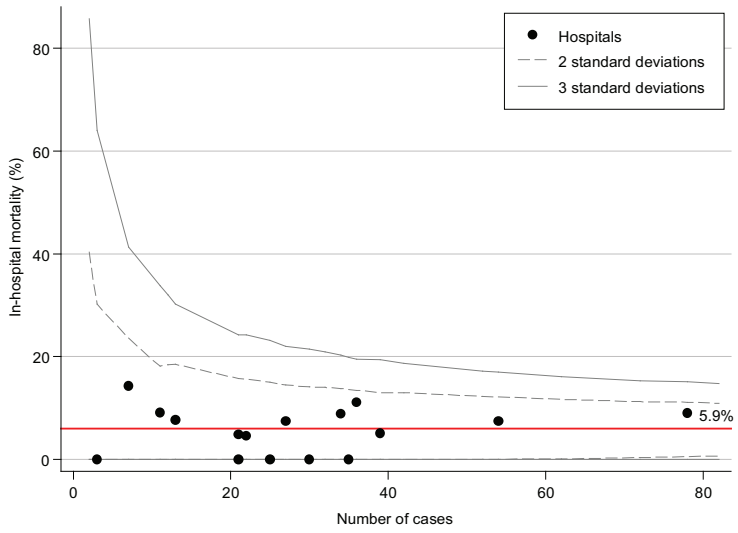
Median length of hospital stay was 6 days (IQR: 3, 9). Overall, 72% were discharged to home and a further 7.5% transferred to rehabilitation unit or hospital (Table 27).

Table 27: Discharge destination during HF-Snapshot

Discharge Destination	2015 cohort N=289	2016 cohort N=456
	%	%
Home	73.4	72.1
Hospital In The Home	2.1	2.2
Rehabilitation Unit / Hospital	8.7	7.5
Nursing Home / Aged Care Facility	6.2	6.8
Local or Referring Hospital	2.8	2.9
Palliative Care	2.1	0.4
Tertiary Referral Centre	0.0	2.2
In-hospital Mortality	4.8	5.9

The overall unadjusted in-hospital mortality for the 2016 cohort was 6%. Figure 48 demonstrates comparative rates of in-hospital mortality among hospitals. There were no performance outliers for in-hospital mortality and no apparent relationship between mortality and hospital volume.

Figure 48: In-hospital all-cause mortality during HF-Snapshot

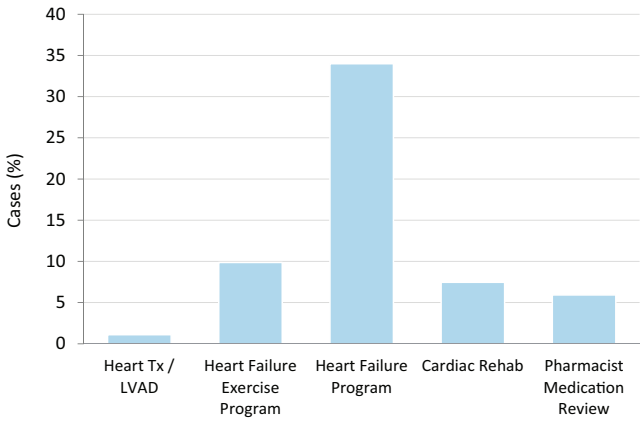


Transitional Care after Discharge

For the entire cohort, 63% of patients had an outpatient appointment scheduled at discharge, and by 2 weeks, 27% had been seen. Referrals were either to a public sector outpatient clinic or to a private cardiologist/clinic. For public sector outpatients, 49% of patients were seen within 30 days of discharge. For patients followed up privately, 25% were reviewed within 14 days and 39% were seen within 30 days of discharge.

Referrals to a heart failure program were low at 34% (Figure 49). Only 6% of patients had a pharmacist medication review arranged post-discharge and 10% were referred to a heart failure exercise program (Figure 49). While these rates appear below ideal levels, there may be an under-estimation of "appropriate" referral rates. The HF-Snapshot was unable to identify those patients who were ineligible or unsuitable for referral to a heart failure program, pharmacist medication review or exercise program, as different sites had varying inclusion and exclusion criteria. These results were similar among hospitals and have been fed back to the participating sites. Deficiencies in transitional care arrangements post-discharge identified in this report highlight the need for improvements in processes relating to timely referrals and outpatient appointments.

Figure 49: Discharge planning during HF-Snapshot



Outcome measures

The unadjusted 30-day mortality rate was 9.9% for the overall cohort (Figure 50). This was similar to 2015 (9.3%), and comparable to international 30-day mortality rates[25]. The 30-day mortality rate was higher in patients diagnosed with HFrEF (8.9%) compared with HFpEF (4.8%). All hospitals were within control limits for 30-day mortality (Figure 51).

Figure 50: Overall outcome measures during HF-Snapshot 2016

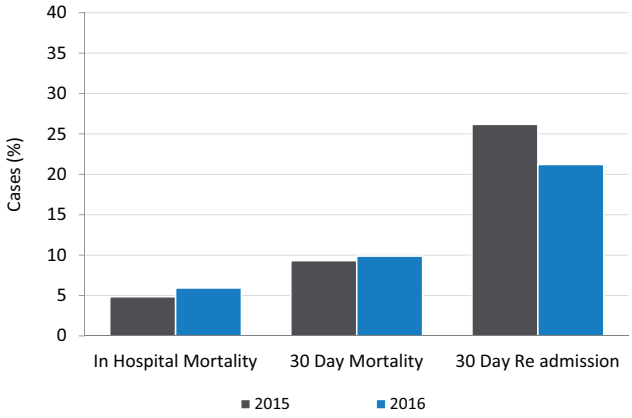
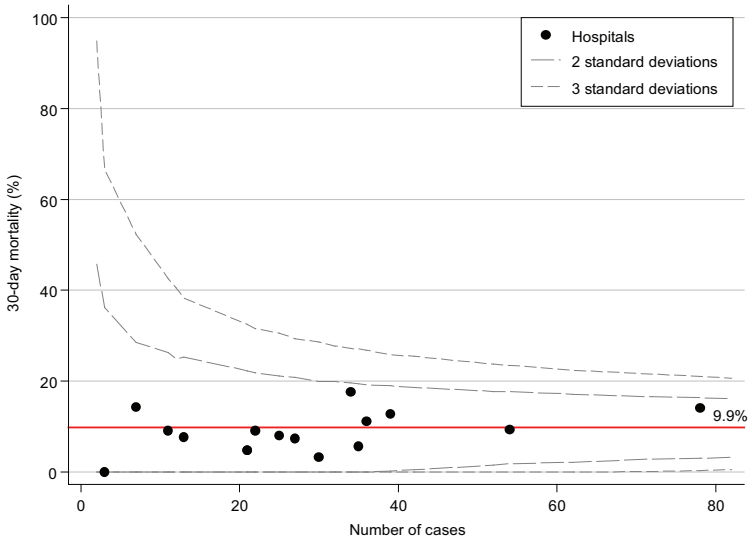
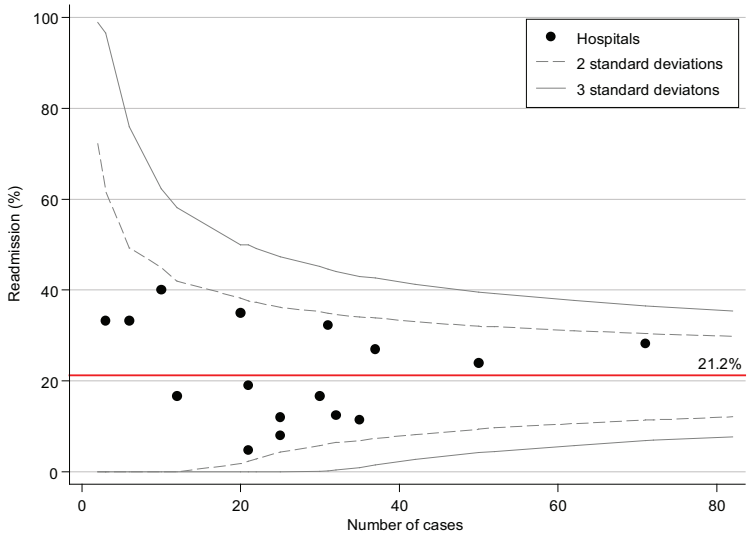


Figure 51: Unadjusted 30-day mortality during HF-Snapshot 2016



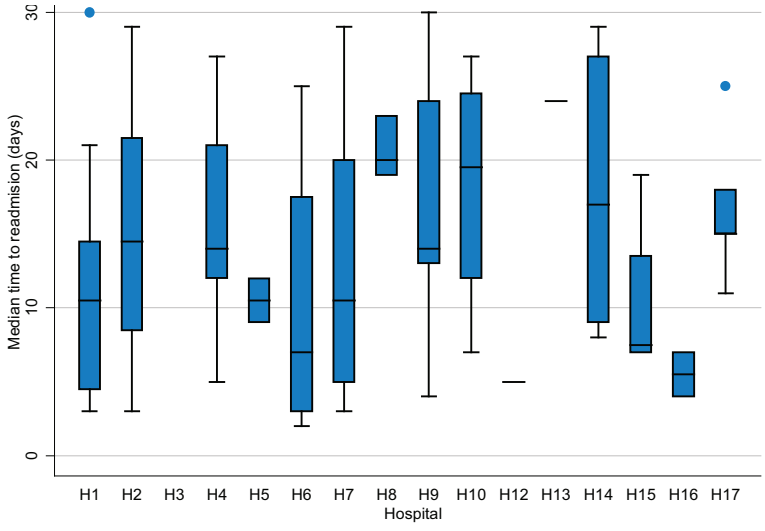
At 30 days post-discharge, the all-cause readmission rate was 21% (Figure 52) - lower than in 2015 (26%) and comparative international rates of 25% [25] (Figure 50). One potential factor in this improved readmission rate was a separate program, undertaken during this time, aimed at targeting readmissions for heart failure. The Victorian Cardiac Clinical Network funded individual projects in 7 health services involved in HF-Snapshot to implement models of care aimed at reducing heart failure readmissions. All the projects demonstrated an improvement in short-term patient outcomes and this likely positively influenced 30-day readmission rates.

Figure 52: 30-day all-cause hospital readmission during HF-Snapshot 2016



For those patients readmitted to hospital, the median time to readmission was 14 days (IQR: 7, 22) (Figure 53). Of the patients readmitted, 40% were readmitted within 10 days of discharge.

Figure 53: Time to readmission by hospital for HF-Snapshot 2016



HF-Snapshot future work

In 2017, another snapshot will be conducted from mid-May to June with planned 3-month follow-up across 16 hospitals. The follow-up period has been extended to provide a comprehensive perspective of inpatient and transitional care in a cohort of patients hospitalised with acute decompensated heart failure and known for its high burden of disease. It is hoped that there will be further improvements in readmissions, mortality and pharmacotherapy compared with 2016 results.

Future Directions

In many respects, the future directions of VCOR will be strongly influenced by the culture of increased vigilance of hospital performance and the strengthening of safety and quality for patients that has emerged at a state level in Victoria in 2016. This is on a background of the recent report, *Targeting Zero: Supporting the Victorian hospital system* that proffered a comprehensive set of recommendations to ensure delivery of safe and continuously improving care by our hospital system. It complements the blueprint for the redesign, service and infrastructure for Victoria's cardiac system, released by the Department of Health and Human Services that sets out the framework for these service improvements. Safer Care Victoria, together with the Cardiac Clinical Network, the Victorian Agency for Health Information and the Department of Health and Human Services will help implement these changes.

VCOR is looking forward to a busy and productive year ahead, as a principal tool for data collection, performance monitoring and benchmarking, and as an enabler of the identification of potential shortcomings in care.

From a workflow standpoint, VCOR has been focussing on a comprehensive revision of all the data elements throughout 2016, and version 2.0 of our PCI database will be released in 2017. Our robust auditing activities will continue to ensure the highest quality data are collected. VCOR will continue to expand its modules of early STEMI management and acute heart failure management with engagement of further sites and ongoing support for health services.

The 2017 year will also see an exciting addition to VCOR with the impending commencement of a fourth module to monitor the safety and quality of implantation of cardiac implantable electronic devices (CIED). In an initial pilot phase to commence in July 2017, five health services will participate in a registry module that both tracks contact details of the patient and device and clinical quality data to assess performance and outcomes of the patients and their devices as well as the health services that manage them.

VCOR will continue to develop linkages with large administrative datasets, organisations and other registries to enhance the quality and breadth of its data, while at the same time work collaboratively to the mutual benefit of all participants. The registry has also established links with researchers both within its network and with a number of external academic institutions in areas that include quality of life metrics, patient-related outcomes, epidemiological aspects of cardiac disease and health economics.

The activities of VCOR may be diverse, but its aim remains sharply focussed on ensuring that Victorian patients with cardiac conditions receive the highest quality care and the best outcomes possible irrespective of their location, insurance status or healthcare provider. Through the strong and ongoing support of Victoria's cardiovascular clinicians in the medical, nursing and allied health spheres and committed involvement of other key stakeholders including funders, health providers, hospital executives and patient advocates, VCOR looks ahead to a productive future in the coming years.

Glossary

ACEI	Angiotensin-Converting-Enzyme Inhibitors
ACS	Acute Coronary Syndrome
ANZSCTS	Australian and New Zealand Society of Cardiac and Thoracic Surgeons
ARB	Angiotensin Receptor Blockers
ARC	Academic Research Consortium
BARC	British Academic Research Consortium
BB	Beta-adrenergic Blockers
BMS	Bare Metal Stent
BPM	Beats Per Minute
BVS	Bio-resorbable 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
DTB	Door-to-balloon
DTN	Door-to-needle Time
ECG	Electrocardiograph
ECMO	Extracorporeal Membrane Oxygenation
ED	Emergency Department
eGFR	Estimated Glomerular Filtration Rate
HF	Heart Failure
HFpEF	Heart Failure with Preserved Ejection Fraction
HFrEF	Heart Failure with Reduced Ejection Fraction
IABP	Intra-aortic Balloon Pump
IQR	Inter Quartile Range
KPI	Key Performance Indicator
LMHW	Low Molecular Heparin Weight
MACCE	Major Adverse Cardiac & Cerebrovascular Event
NHMRC	National Health & Medical Research Council
NSTE-ACS	Non-ST Elevation Acute Coronary Syndrome
NSTEMI	Non-ST Elevation Myocardial Infarction
NYHA	New York Heart Association
OHCA	Out of Hospital Cardiac Arrest
PCI	Percutaneous Coronary Intervention
POBA	Plain Old Balloon Angioplasty
RI	Renal Impairment
SD	Standard Deviation
STEMI	ST-Elevation Myocardial Infarction
TVR	Target Vessel Revascularisation
UAP	Unstable Angina Pectoris
VCOR	Victorian Cardiac Outcomes Registry

Publications and presentations in 2016

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VCOR Custodian

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Professor Richard Harper
Ms Angela Brennan
Professor John McNeil

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A/Prof Jeffrey Lefkovits

Heart Failure Clinical Lead

Prof Andrea Driscoll

Early STEMI Management Clinical Lead

Dr Dion Stub

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Dr Stephen Duffy	Alfred Hospital, The
Dr David Clark	Austin Hospital, The
Prof Ernesto Oqueli	Ballarat Base Hospital
Dr Voltaire Nadurata	Bendigo Hospital
Dr Jennifer Cooke	Box Hill Hospital
A/Prof Jeffrey Lefkovits	Cabrini Hospital Malvern
A/Prof Ron Dick	Epworth Hospital Richmond
A/Prof Ron Dick	Epworth Hospital Eastern
A/Prof Ron Dick	Epworth Eastern, Geelong
Dr Geoff Toogood	Frankston Hospital
A/Prof Nicholas Cox	Footscray Hospital
A/Prof John Amerena	Geelong Private Hospital
Dr James Sapontis / Dr Robert Gooley	Jessie McPherson Private Hospital
Dr Michael Leung	Linacre Private Hospital
Dr Michael Rowe	Knox Private Hospital
A/Prof William van Gaal	Northern Hospital, The
Dr James Sapontis / Dr Robert Gooley	MonashHeart (Monash Medical Centre Clayton)
Dr Roderic Warren	Melbourne Private Hospital
Dr Olivier van den Brink	Peninsula Private Hospital
A/Prof Leeanne Grigg	Royal Melbourne Hospital, The
Dr Chris Hengel	St John of God (Ballarat)
Dr Nimalan Nadarajah	St John of God (Bendigo)
Dr Martin Sebastian	St John of God (Geelong)
A/Prof Jack Gutman	St Vincent's Private Hospital
A/Prof Andrew MacIsaac	St Vincent's Hospital Melbourne
A/Prof Nicholas Cox	Sunshine Hospital
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Dr Jodie-Ann Senior	Valley Private Hospital, The
Dr Mark Horrigan	Warringal Private Hospital
Dr Deepak Haikerwal	Western Private Hospital

VCOR Site Leads (Early STEMI Management Hospitals)

Dr Franz Eversheim	Albury Wodonga Health (Albury Campus)
Dr Franz Eversheim	Albury Wodonga Health (Wodonga Campus)
Dr Voltaire Nadurata	Bendigo Hospital
Dr Howard Conner	Central Gippsland Health Service (Sale)
Dr Tunde Ibrahim	Goulburn Valley Health (Shepparton)
Dr Alistair Wright & Dr Tony Chan	Latrobe Regional Health (Traralgon)
Dr Mark Wadsworth	Mildura Base Hospital
Dr Robert Krones	Northeast Health (Wangaratta)
Dr Brett Forge	West Gippsland Healthcare group (Warragul)
Dr Sanath Weerakkody	Wimmera Base Hospital (Horsham)

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Prof David Kaye	Alfred Hospital, The
Prof Andrea Driscoll & Prof David Hare	Austin Hospital, The
Dr Justin Mariani & Ms Debbie Gash	Bairnsdale Regional Health Service
Dr Voltaire Nadurata	Bendigo Hospital
Dr Jennifer Cooke	Box Hill Hospital
Dr Howard Conner	Central Gippsland Health Service (Sale)
Dr Siobhan Lockwood & Prof James Cameron	Dandenong Hospital (Monash Health)
Dr Hendrik Zimmet	Epworth Hospital Richmond
Dr Chris Neil	Footscray Hospital
Dr Geoff Toogood & Dr Phillip Carrillo	Frankston Hospital
Dr Gautam Vaddadi	Northern Hospital, The
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A/Prof James Wong	Royal Melbourne Hospital, The
A/Prof David Prior	St Vincent's Hospital Melbourne
Dr Chris Neil	Sunshine Hospital
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Funding

Funding was originally sought and obtained in 2011 from Medibank Private and the Department of Health and Human Services Victoria. Additional funding from the Victorian Cardiac Clinical Network was provided in 2014, 2015 and 2016 to support ongoing operations of the PCI, Early Management of Acute STEMI (Regional Victoria) and Heart Failure data collection modules (Table 28). Considerable in-kind support from Monash University has also been provided throughout the years.

Table 28: VCOR Funding 2011 – 2016

Funding Body	2011	2012	2013	2014	2015	2016
	$	$	$	$	$	$
Medibank Private	$100,000	$400,000	$400,000	$300,000	-	-
Department of Health & Human Services	$200,000	$200,000	$205,000	$509,466	$460,202	$834,815
Sub total	$300,000	$600,000	$605,000	$809,466	$460,202	$834,815
Total received						$3,609,483

Correct at 1 June 2017

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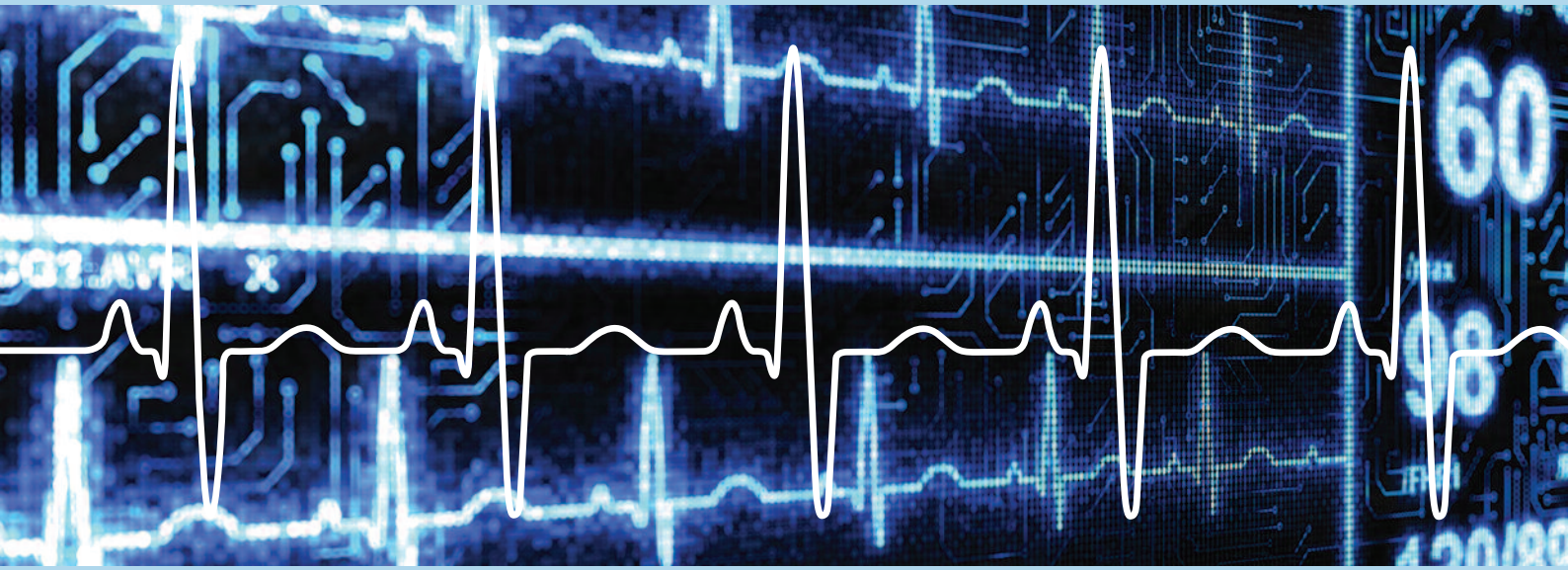
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