

Treatment pathways for people hospitalised for acute coronary syndrome

Web report | Last updated: 20 Mar 2024 | Topic: [Heart, stroke & vascular diseases](#)

About

Acute coronary syndrome (ACS) includes heart attacks and unstable angina. People who survive an ACS event are at higher risk of having another cardiovascular event in the future. This report uses linked health data to map what happened next for 35,800 people who survived an ACS hospitalisation and describes the health outcomes they experienced. Measures of interventional procedures and medication are used to describe a person's 'treatment pathway'.

Cat. no: CDK 23

Findings from this report:

- [1 in 9 people \(12%\) experienced the treatment pathway defined as most comprehensive following an ACS event](#)
 - [Of people with a STEMI diagnosis, those who had the most comprehensive treatment pathway had the best outcomes](#)
 - [People with a NSTEMI diagnosis had the most variation in treatment pathways](#)
 - [Half of people who survived an ACS hospitalisation had an interventional procedure within 40 days](#)
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Summary

This report provides a snapshot of almost 35,800 people (aged 25 to 84) who survived an acute coronary syndrome (ACS) hospitalisation, using linked health data with high coverage of the Australian population ([National Integrated Health Services Information \(NIHSI\)](#)). The project looks at interventional procedures and medication use to describe a person's 'treatment pathway' after an ACS hospitalisation. High-level characteristics and health outcomes are described for those who did and didn't follow specific treatment pathways. The results provide an insight into patient journeys in reference to existing clinical guidelines (Chew et al. 2016), however they cannot be used to estimate the benefit from treatment pathways for individuals (see [note on interpretation](#)).

What is acute coronary syndrome?

Acute coronary syndromes (ACS) include heart attacks and unstable angina. These conditions are sudden, severe and life-threatening events. A heart attack (or acute myocardial infarction) is a life-threatening event, commonly where a blocked blood vessel threatens to damage the heart muscle. Angina is a chronic condition in which intermittent episodes of chest pain can occur when the heart has a temporary deficiency in blood supply. Unstable angina can be dangerous due to the changing severity in transient coronary narrowing.

Results are presented separately for the different diagnosis subtypes of acute coronary syndrome:

- ST segment elevation myocardial infarction (STEMI) - 7,853 people (22% of the people included)
- Non-ST segment elevation myocardial infarction (NSTEMI) - 17,109 people (48%)
- Unstable angina - 10,453 (29%)

Note: 1% (369) of the people included had a diagnosis of unspecified myocardial infarction (MI), only limited results are presented for this group due to the small size.

Mapping treatment pathways

This project describes peoples' treatment pathways using 3 measurement points during or after their initial ACS hospitalisation (referred to as the 'index hospitalisation' in this report). These measurement points were:

1. Was an interventional procedure (percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG)) undertaken in the index hospitalisation or within 40 days of discharge?
2. Were all 4 classes of guideline recommended medications initiated (defined as being supplied) within 40 days of discharge from the index hospitalisation?
3. Were all 4 classes of guideline recommended medications taken persistently, (defined as continuation without a gap in medication supply of 60 days or more) from first supply after hospitalisation until one year after? The first supply could be at any time in the first year, and at least 2 supplies were required. Persistence was not measured for people who died within 1 year of discharge.

Together, each of these measurement points were used to describe a person's treatment pathway. For example, a treatment pathway may involve having an interventional procedure, being initiated to all 4 classes of medications but then not taking these persistently.

Note on interpretation

It is important to note that interventional procedures and patterns of medication use are only a component of secondary prevention. Many factors, including some not captured in the analysis, impact both treatment decisions and the risk of experiencing poor health outcomes, for example age, health behaviours, and comorbidities. This project does not identify causal relationships between treatment pathways and health outcomes, but instead provides a starting point for further research and improved understanding of the patient journey.

Key findings

Interventional procedures

During their index hospitalisation (or within the following 40 days) 50% of people who survived an ACS hospitalisation had an interventional procedure (percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG)).

- This varied by subtype; 84% of people with STEMI, 49% of people NSTEMI and 28% of people with unstable angina.
- People who did not have a procedure were more likely to be women, be aged 75-84, live in *Outer regional, Remote and Very remote* areas or have identified prior coronary heart disease (CHD), across all diagnosis types.
- Of those who survived a STEMI or NSTEMI hospitalisation, fewer people who had an interventional procedure experienced adverse health outcomes in the 3 years after leaving hospital (Major adverse cardiac event (MACE) results for STEMI: 15% for those who received an interventional procedure compared with 22% for those who did not, and for NSTEMI: 19% compared with 28%).

Post-hospital initiation to medication

Only 31% of people filled a prescription for all 4 classes of recommended medications (referred to as initiation in this report) within 40 days of surviving an ACS hospitalisation.

- This varied by subtype; 56% of people with STEMI, 30% of people with NSTEMI and 14% of people with unstable angina.
- People who did not initiate were more likely to be women, be aged 75-84 or have identified prior CHD.

Persistently taking medications

One year after surviving an ACS hospitalisation 22% of people were consistently taking all 4 classes of recommended medications (referred to in this report as persistence).

- This varied by subtype; 37% of people with STEMI, 21% of people with NSTEMI and 13% of people with unstable angina.
- People who did not persist were more likely to be women and be aged 75-84.

A combined 'treatment pathway' in the year after hospitalisation

The most comprehensive treatment pathway (including an interventional procedure, initiation to all 4 classes of recommended medications within 40 days and persisted taking them at one year) was most likely for men, the middle-aged or those who lived in *metro and inner regional* areas.

Of people with a STEMI diagnosis, 27% who survived 1 year had the most comprehensive treatment pathway and generally had better outcomes.

- Almost 1 in 5 people (19%) who experienced the most comprehensive treatment pathway had an emergency cardiovascular disease (CVD) hospital readmission compared to 29% who had the least comprehensive treatment pathway.
- After the first year, 2.4% who experienced the most comprehensive treatment pathway died during follow up compared to 11.6% who had the least comprehensive treatment pathway.
- The groups who followed these different pathways differed by age, sex, socioeconomic group and comorbidities which will have contributed to their prognosis.

References

Chew DP, Scott IA, Cullen L, French JK, Briffa TG, Tideman PA, Woodruffe S, Kerr A, Branagan M, Aylward PEG. (2016) '[National Heart Foundation of Australia & Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Management of Acute Coronary Syndromes 2016](#)', *Heart Lung and Circulation* 25:895-951.

Background

Acute coronary syndrome (ACS) is a term that is used to describe sudden and life-threatening conditions that result in reduced blood flow to the heart. This term includes acute myocardial infarction (or heart attacks) and unstable angina.

How common is acute coronary syndrome?

In 2020, there were an estimated 56,700 acute coronary events among people aged 25 and over - equivalent to around 155 events every day. Around 12% of these events (6,900 cases) were fatal (AIHW 2023). The age-standardised rate of acute coronary events fell by more than half (59%) between 2001 and 2020. The decline in rates of acute coronary events has been attributed to a number of factors, including improvements in medical and surgical treatment, and reductions in risk factor levels (AIHW 2023).

Heightened risk of secondary acute coronary syndrome events

People who have been admitted to hospital for ACS are at an increased risk of having another cardiovascular event in the future. Medication use, lifestyle changes such as quitting smoking, and cardiac rehabilitation can reduce the risk of subsequent events. Research from Western Australia reported nearly half of coronary heart disease events (which includes acute coronary syndromes) from 1995 to 2005 occurred in the 6% of the general population (aged 35 to 84) with a history of the disease (Briffa et al. 2011).

Effective secondary prevention is important to reduce national incidence of ACS events. The need for improvements in the transition from hospital care into the community, and support services for those people with heart disease after discharge, are key actions outlined in the National Strategic Action Plan for Heart Disease and Stroke (Department of Health 2020).

Medications for secondary prevention

The Australian Clinical Guidelines for the management of Acute Coronary Syndromes (Chew et al. 2016) recommend that people who survive an ACS event be prescribed a multidrug regime, which includes 4 classes of medicines - a statin, beta blocker, angiotensin-converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) and antithrombotic agents. Despite strong evidence that this substantially reduces the risk of future cardiovascular events, not all patients are prescribed these drugs and, among those who are, not all continue to take them over the long-term (Naderi et al. 2012; Packard and Hillman 2016; AIHW 2022). Some people may be unable to, or choose not to, follow the advice of their doctor. For others, the decision to not start or continue these medications may be done in consultation with a medical professional due to adverse side effects, contraindications, a new therapeutic approach, or other clinical reasons.

What does this project add?

This project provides real-world evidence on the treatment pathways utilised by those who survived an ACS hospitalisation, including interventional procedures and medication use in the year post-hospital discharge. In addition, it examines health outcomes, demographic and clinical characteristics among those who followed different treatment pathways. However, it is important to note that interventional procedures and patterns of medication use are only a component of secondary prevention. Many factors, including some not captured in the analysis, impact both treatment decisions and the risk of experiencing poor health outcomes. For example, poor prognosis due to age-related frailty or multimorbidity may drive the decision to not perform interventional procedures while also contributing to poorer health outcomes (Nedkoff et al. 2023).

The AIHW published a detailed analysis of the factors that are associated with patterns of medication use by coronary heart disease (CHD) and ACS patients discharged from hospital, in the report: Medication use for secondary prevention after coronary heart disease hospitalisations: patient pathways using linked data (AIHW, 2022). This 2022 report used multivariate logistic regression analysis to investigate the relationships between measures of medication used and factors including demographic and clinical characteristics, and use of community-based health care.

In comparison, this project presents descriptive unadjusted data to explore patient journeys. The cohort used for this project is slightly different and has a longer follow-up period due to the analysis being undertaken in a newer version of the National Integrated Health Services Information (NIHSI) data.

References

Australian Institute of Health and Welfare (2023) Heart, stroke and vascular disease: Australian facts, AIHW, Australian Government, accessed 16 February 2024.

AIHW (2022) Medication use for secondary prevention after coronary heart disease hospitalisations: Patient pathways using linked data, catalogue number CVD 98, AIHW, Australian Government, accessed 16 February 2024.

Briffa TG, Hobbs MS, Tonkin A, Sanfilippo FM, Hickling S, Ridout SC, Knuiman M. (2011) 'Population trends of recurrent coronary heart disease event rates remain high', *Circulation: Cardiovascular Quality and Outcomes*, 4:107-113.

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Nedkoff L, Briffa T, Murray K, Gaw J, Yates A, Sanfilippo FM, Nicholls SJ (2023) 'Risk of early recurrence and mortality in high-risk myocardial infarction patients: A population-based linked data study', *International Journal of Cardiology Cardiovascular Risk and Prevention* 17: 200185

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About the project

This project uses data from the National Integrated Health Services Information (NIHSI) (version 2.0) - a linked administrative data set held by the AIHW. The data sets used in this project were:

- admitted patient care data from the National Hospital Morbidity Database
- deaths data from the National Death Index
- prescription medications data from the Pharmaceutical Benefits Scheme (PBS) and the Repatriation Pharmaceutical Benefits Scheme (RPBS)
- data on use of Medicare-subsidised health services from the Medicare Benefits Schedule (MBS).

The NIHSI holds data from New South Wales, Victoria, Queensland, South Australia, Tasmania and the Australian Capital Territory from 2010-11 to 2019-20 for the above-mentioned datasets. In most states, the admitted patient care data are limited to only public hospitals. Additional information [about NIHSI](#) can be found on the AIHW website.

For a discussion of the limitations see [Limitations of the data](#).

Cohort

The cohort comprised 35,784 people, aged between 25 and 84, who had an acute coronary syndrome (ACS) hospitalisation with an acute care type between 1 July 2016 and 30 June 2017 and were alive at the point of discharge. See Table S1 in the [supplementary data tables](#) for details of cohort selection.

A diagnosis of acute coronary syndrome was defined in the admitted patient care data using the principal diagnosis field (International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM): I21.0-I21.4, I21.9, I20.0).

Acute care type indicates hospital care in which the intent is to perform surgery, diagnostic or therapeutic procedures in the treatment of illness or injury. It excludes rehabilitation or palliative care.

What is acute coronary syndrome?

Acute coronary syndrome (ACS) is a term used to describe a continuum of acute coronary artery diseases (including heart attacks and unstable angina). These conditions are sudden, severe and life-threatening events.

A heart attack (or acute myocardial infarction) is a life-threatening event commonly where a blocked blood vessel threatens to damage the heart muscle. Clinically, a heart attack is often categorised based on the pattern that appears on an electrocardiogram (ECG), a diagnostic tool that measures and records the heart's electrical activity.

- STEMI, or ST segment elevation myocardial infarction, is so named because the 'ST segment' on the ECG appears elevated. STEMI is a type of heart attack almost always caused by a complete blockage to a major coronary artery. This is the most easily diagnosed subtype of ACS.
- NSTEMI, or non-ST segment elevation myocardial infarction, is a type of heart attack in which an artery is frequently partially blocked. This severely reduces blood flow. Unlike STEMI, the 'ST segment' on the ECG is not elevated. There may or may not be other changes on the ECG. The diagnosis of a NSTEMI involves identification of elevated troponin levels through assays in a person with a clinical presentation consistent with a heart attack.
- Unspecified myocardial infarction is a clinical code within hospital data which does not specify the myocardial infarction diagnosis as either STEMI or NSTEMI.

Angina is a chronic condition in which intermittent episodes of chest pain can occur when the heart has a temporary deficiency in blood supply. Unstable angina can be dangerous due to the changing severity in transient coronary narrowing.

Reference period

Comorbidities, including prior hospitalisation for coronary heart disease (CHD), and use of in-scope cardiovascular disease (CVD) medicines were identified in the period 1 July 2010 (start of the data set) to the index hospitalisation in the 2016-17 financial year.

Demographic information, ACS subtype and interventional procedures were identified from the index hospitalisation record.

The follow-up period started on the day after discharge and ended at the end of the study period (3 years post-hospitalisation) or death - whichever occurred first. The first year of the follow-up period was used to examine treatment pathways in the cohort, including use of medications. Community-based health care, specifically visiting a cardiologist, was measure in the first year using MBS data. Health outcomes (emergency CVD readmissions and death) were measured for the 3 years.

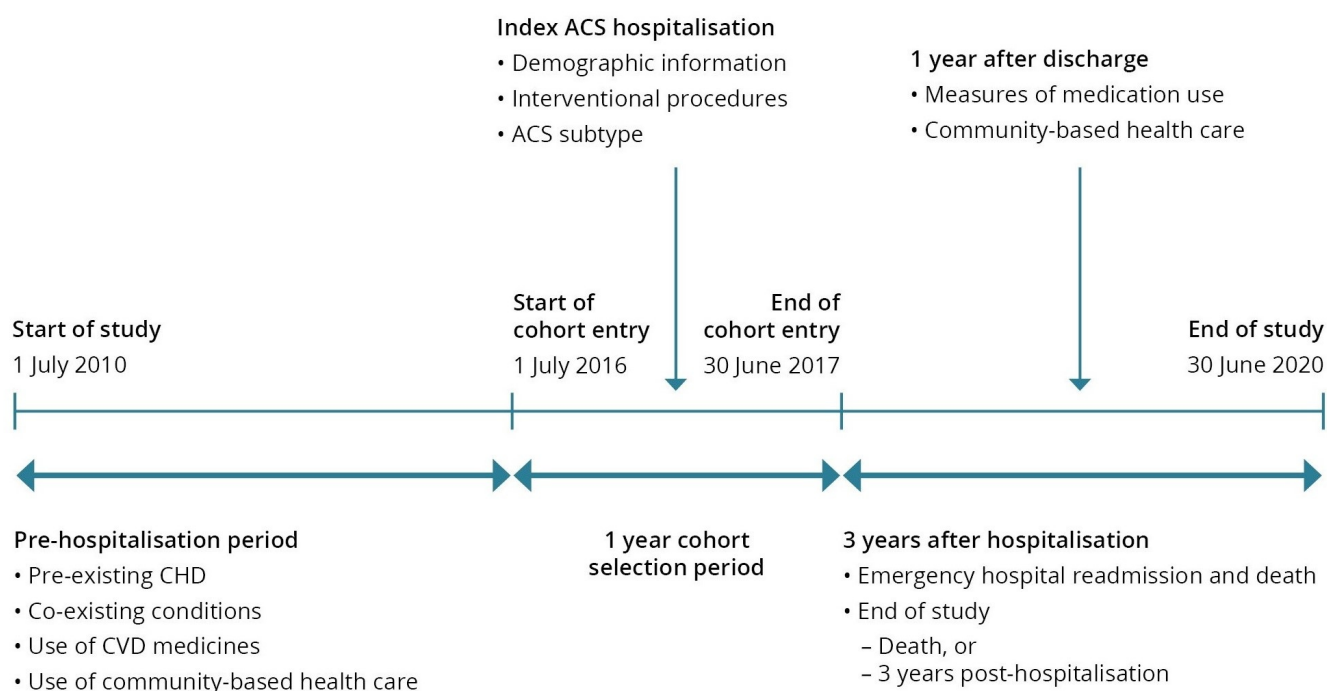
See the [supplementary data tables](#) for:

- the classification of acute coronary syndrome subtypes and comorbidities (Table S6)

- analysis variables and descriptions (Table S8).

See Figure 1 for an illustration of the reference period.

Figure 1: Reference period



Key variables

Medication use

Initiation: defined as the first PBS dispensing record for the relevant medication following hospital discharge. This project captures initiation to the 4 classes of guideline recommended medications within 40 days of discharge from the index hospitalisation.

The time point of 40 days post discharge was used to measure post-hospitalisation initiation (the filling of a medication prescription) to account for up to one month's supply a person may already have from before they went to hospital, plus up to 7 days of medication which may be supplied when leaving hospital in some Australian states.

Note: Aspirin was not included in this study, for details see [Limitations of the data](#).

Persistence: the continuation of prescribed treatments for the recommended period. In this project, a person was classified as being no longer persistent (discontinued) when there was a gap in medication supply of 60 days or more for any of the 4 medication classes. As with initiation, persistence to all 4 medication classes was reported to capture alignment to Guideline recommendations. Time spent in public hospitals was excluded from this measure as the supply of medications in this setting would not be captured in the PBS data. Persistence was measured for each medication class from the first supply until one year post hospitalisation. The first supply could be at any time in the first year (unlike initiation in which a 40-day window was used), and at least 2 supplies were required. Persistence was not measured for people who died within 1 year of discharge.

For more information about how these measures are derived see [Medication use for secondary prevention after coronary heart disease hospitalisations: patient pathways using linked data - technical report](#).

For capture of ATC codes for medication classes see Table S7 in the [supplementary data tables](#).

Interventional CVD procedures

Intervention procedures measured:

Coronary artery bypass grafting (CABG): surgical procedure using blood vessel grafts to bypass blockages in the coronary arteries and restore adequate blood flow to the heart muscle.

Percutaneous coronary intervention (PCI): restore blood flow to blocked coronary arteries. There are 2 types: coronary angioplasty without stent, and coronary stenting.

For consistency, this same period (40 days) used for initiation was applied to capture intervention procedures that occurred soon after the index hospitalisation.

Capture of interventions that occurred during the 40 days after index hospitalisation will be an underestimate, due to no availability of private hospital data for some states.

Comorbidities

Comorbidity information was obtained for the following conditions in the admitted patient care data only: Pre-existing CHD, Congestive heart failure, Chronic obstructive pulmonary disease, Kidney failure, Peripheral vascular disease, Cancer, Diabetes, Hypertension, and Cerebrovascular disease. Therefore, it is likely an underestimate of comorbidities in the cohort.

Health outcomes

CVD readmission: emergency readmission to hospital with an urgent care type and principal diagnosis of CVD (ICD-10-AM: I00-I99).

Major adverse cardiac events (MACE): emergency hospital readmission (principal diagnosis) or death (underlying cause) due to ACS, stroke, or heart failure (ICD-10 and ICD-10-AM: I20.0 I21, I50, I60-I64).

CVD death: death with an underlying cause of CVD (ICD-10: I00-I99).

All cause death: Death from any cause.

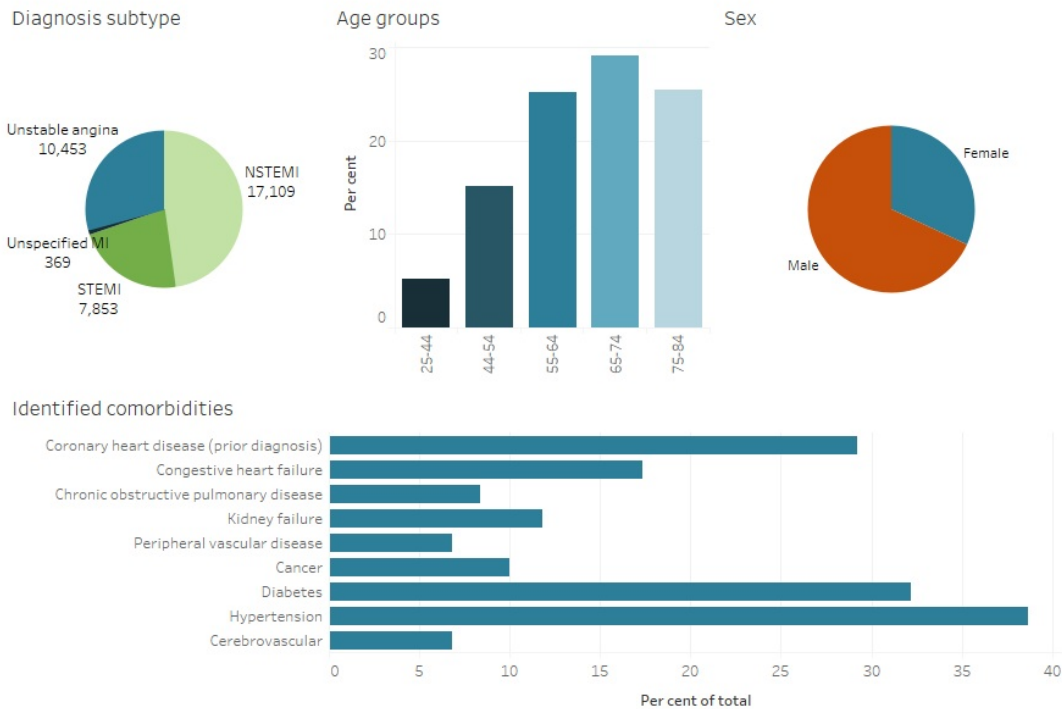
For variable descriptions see Table S8 in the [supplementary data tables](#).

About the people in this project

This project included 35,784 people, aged between 25 and 84, who had an acute coronary syndrome (ACS) hospitalisation.

Figure 2: Distribution of diagnosis subtype, age group, sex, comorbidities and adverse health outcomes of the ACS cohort

Figures show that in this cohort the most common diagnosis subtype is NSTEMI, age group is 65-74 and comorbidity is hypertension.



Adverse health outcomes in 3-year follow up period

Category group	ACS	NSTEMI	STEMI	Unspecified MI	Unstable angina
All cause death	12.04	15.95	8.07	21.95	8.28
CVD death	4.85	6.52	3.40	9.21	3.04
Emergency CVD readmission	29.96	31.89	23.24	28.73	31.90
MACE event	21.34	23.64	16.12	19.51	21.57

Notes on outcome categories: There is overlap in these outcome categories. CVD deaths are a subset of all death. MACE events combine emergency readmissions and death due to ACS, stroke, or heart failure. These readmissions and deaths are also included in the broader categories of CVD emergency readmissions and CVD deaths, respectively.

Source: AIHW NIHSI 2010-11 to 2019-20, analysis of NIHSI

1 in 4 people were aged 75-84 years

Around 2 in 3 people in the ACS cohort were men and most people lived in *Major cities* (61%). Fourteen percent lived in *Outer regional*, *Remote* or *Very remote* areas. Four percent (n=1,359) of the cohort were Aboriginal and Torres Strait Islander (First Nations) people.

Results for pathways are presented by all demographic factors, where possible, in the [supplementary data tables](#).

1 in 2 people had a diagnosis of NSTEMI

Almost half (48%, n=17,109) of the cohort had a diagnosis of NSTEMI, 29% (n=10,453) were diagnosed with unstable angina and 22% (n=7,853) had a diagnosis of STEMI. Only 1% (n=369) of the cohort had unspecified myocardial infarction (MI).

Almost 1 in 3 had pre-existing CHD

Thirty percent of the cohort had a hospitalisation for CHD in the prior 6 years and 2 in 3 people had used one of the 4 in-scope classes of medicines in the 3 months prior to their hospital admission.

Of the selected comorbidities measured, the most common were hypertension (39%) and diabetes (32%). Seventeen percent had a history of congestive heart failure, and 12% had a diagnosis of renal failure. It is important to note that comorbidity information was obtained from the admitted patient care data only. Therefore, it is likely an underestimate of comorbidities in the cohort.

For details see [About this project: Key variables](#).

12% died during the 3-year follow-up period, and 40% of these deaths were due to CVD causes

One percent of the cohort died within the first 40 days of the follow-up period and five percent of the cohort died during the first-year of the follow-up period. Thirty percent of the cohort had an emergency CVD readmission in the 3-year follow up period. One in 5 (21%) experienced a major adverse cardiac event (MACE) during the 3-year follow up period. A MACE included emergency hospital readmission (or death due to ACS, stroke, or heart failure).

Differences by diagnosis type

Those diagnosed with STEMI were younger and more likely to be men

People with a STEMI diagnosis were younger (29% were 25-54 years), more likely male (76%), and were less likely to have identified comorbidities when compared with the rest of the cohort (18% were 25-54 years, 67% men). For example, around 1 in 3 people with unstable angina, unspecified MI and NSTEMI had a diagnosis of diabetes, compared with 1 in 4 (24%) of people with a STEMI diagnosis. Further, 1 in 4 people with STEMI also had a diagnosis of hypertension, compared with around 43% in the rest of the cohort.

A higher proportion of people with STEMI (62%) visited a cardiologist in the year post hospitalisation when compared to other subtypes. Fifty-six percent of people with unstable angina or NSTEMI, and 47% of people with unspecified MI visited a cardiologist in the year post hospitalisation.

Around 1 in 2 people with unstable angina had a history of CHD

Those with a diagnosis of unstable angina tended to be older and had a greater proportion with a prior CHD diagnosis (46%) when compared with other subgroups (NSTEMI: 27% and STEMI: 11%).

Four in 5 people with unstable angina had been dispensed an in-scope CVD medicine in the 3 months prior to the index hospital admission. In comparison, around 2 in 3 people with NSTEMI and unspecified MI, and 45% of people with STEMI, had been dispensed in-scope medicines in this period.

Approximately 1 in 6 people (16%) with NSTEMI died in the 3-year follow-up period

Eight percent of those with STEMI and unstable angina, and 22% of those with unspecified MI, died during the 3-year follow up period. Deaths due to CVD (underlying cause) ranged between 3.4% among those with STEMI and 9.2% among those with unspecified MI.

Emergency CVD readmissions were lowest among those with STEMI (23%) and highest among those with NSTEMI and unstable angina (32%).

1 in 6 people with unspecified MI lived in *Outer regional, Remote and Very remote areas*

Unspecified MI was the smallest subgroup. More than 2 in 3 (68%) were over 65 years and 5.2% identified as being of Aboriginal and/or Torres Strait Islander origin. The unspecified MI subtype had a higher proportion of people with congestive heart failure (27%) when compared with those with NSTEMI (22%), STEMI and unstable angina (13% in both).

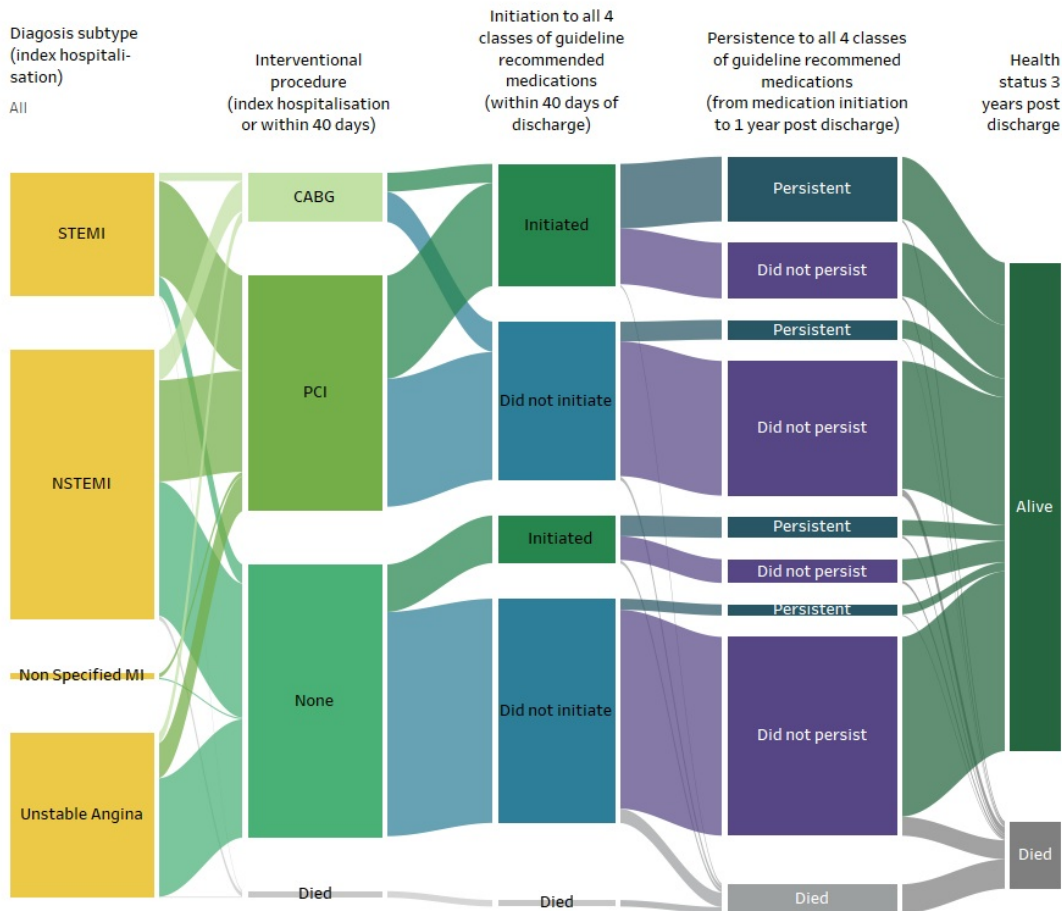
See S3 in the supplementary data tables for demographic, clinical characteristics in the cohort, by ACS subtype.

Explore the treatment pathways

Treatment pathways of almost 35,800 people who survived an acute coronary syndrome (ACS) event are illustrated in Figure 3.

Figure 3: Treatment pathways and outcomes, by ACS subtype

The Sankey shows the proportion of people who followed different treatment pathways illustrated with the 3 measurement points and survival at 3 years.



Source: AIHW NIHSI 2016-17 to 2019-20, analysis of NIHSI

Peoples' treatment pathways are described using 3 measurement points during or after their initial acute coronary syndrome hospitalisations (referred to as the "index hospitalisation" in this report). These measurement points were:

1. Was an **interventional procedure** (percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG)) undertaken in the index hospitalisations or within 40 days of discharge? Interventional procedures were not measured for people who died within 40 days of discharge.
2. Were all 4 classes of guideline recommended medications **initiated** (defined as being supplied) within 40 days of discharge from the index hospitalisation? Initiation was not measured for people who died within 40 days of discharge.
3. Were all 4 classes of guideline recommended medications taken **persistently**, (defined as continuation without a gap in medication supply of 60 days or more) from first supply after hospitalisation until one year after? The first supply could be at any time in the first year, and at least 2 supplies were required. Persistence was not measured for people who died within 1 year of discharge.

Together, each of these measurement points were used to describe a person's treatment pathway. For example, a treatment pathway may involve having an interventional procedure, being initiated to all 4 classes of medications but then not taking these persistently.

Outcomes reported include death within 40 days, 1 year and 3 years post index hospitalisation, emergency cardiovascular disease (CVD) hospital readmission, major adverse cardiac event (MACE), and CVD-specific death.

For details about the definitions used see [About this project: Key variables](#).

Common treatment pathways

The most common pathway (taken by 36% of the ACS cohort) was that no interventional procedures were undertaken, they were not initiated to the guideline recommended medications, and at 1 year were alive but not persistent. Only 1 in 9 people (12%) received the most comprehensive treatment pathway (having an interventional procedure and medication initiation within 40 days, and at one year were alive and persistence to all 4 classes guideline recommended medications), however these varied considerably by diagnosis subtype.

Initiation to all 4 classes of guideline recommended medications was higher for people who had a procedure across all diagnosis groups in the cohort. (See *Medication use for secondary prevention after coronary heart disease hospitalisations* (AIHW, 2022) for detailed analysis of factors associated with medication initiation and persistence).

Variation in treatment pathways by diagnosis subtype

For people with ST segment elevation myocardial infarction (STEMI) (22% of the cohort), the 3 most common treatment pathways all involved an interventional procedure. The most comprehensive treatment pathway of an interventional procedure, initiation and persistence to all 4 classes of guideline recommended medications was taken by 27% of people with a STEMI diagnosis.

The two most common treatment pathways for people with a diagnosis of NSTEMI were either a procedure or no procedure followed by no initiation and no persistence to all 4 classes of guideline recommended medications.

People with unstable angina had the least variation in treatment pathways: 60% followed the pathway of no interventional procedures undertaken, not initiated to the guideline recommended medications, and not persistent.

The people who followed treatment pathways

People who did not have a procedure were more likely to be women, be aged 75-84, live in *Outer regional, Remote and Very remote areas* and have identified prior coronary heart disease (CHD), compared to those who had a procedure. This was consistent across all diagnosis groups.

The group who experienced the most comprehensive treatment pathway (an interventional procedure, initiation and persistence to all 4 classes of guideline recommended medications) and were alive at one year, compared to the group who had the least comprehensive treatment pathway (no interventional procedure, and no initiation or persistence) and also alive at one year, had:

- a higher proportion of men and people aged 45 to 65 years
- a higher proportion of people who lived in *Major cities* and areas of less socioeconomic disadvantage (in the STEMI cohort)
- a lower proportion of people with identified prior CHD and other comorbidities (in the STEMI and NSTEMI cohorts).

The outcomes experienced during and after treatment pathways

In the 3 years following the index hospitalisation, 21% of the cohort experienced a MACE, an outcome which involved an emergency readmission to hospital and/or death due to ACS, stroke, or heart failure. Thirty percent of the cohort had an emergency readmission due to cardiovascular disease (CVD) more broadly, and of the 12% of the total cohort who died in this period, 40% of these deaths were due to CVD (death with an underlying cause of CVD (ICD-10: I chapter)).

The groups who had interventional procedures generally experienced less adverse health outcomes, although there was less variation in health outcomes among those who did and did not undergo procedures for those with a diagnosis of unstable angina compared to other ACS subtypes.

For those with a STEMI diagnosis and alive at 1 year:

- adverse health outcomes were lowest among those who had the most comprehensive treatment pathways (an interventional procedure, initiation and persistence to all 4 classes of guideline recommended medications) (MACE: 12%).
- emergency readmissions and MACE were highest among those who did not undergo a procedure, and initiated medications at 40 days but were non-persistent at 1 year post discharge (32% and 25% for CVD readmissions and MACE respectively).

Explore the treatment pathways

ST-segment elevation myocardial infarction (STEMI) is a type of heart attack almost always caused by a complete blockage to a major coronary artery. This is the most easily diagnosed subtype of acute coronary syndrome (ACS) and accounted for 22% of the cohort.

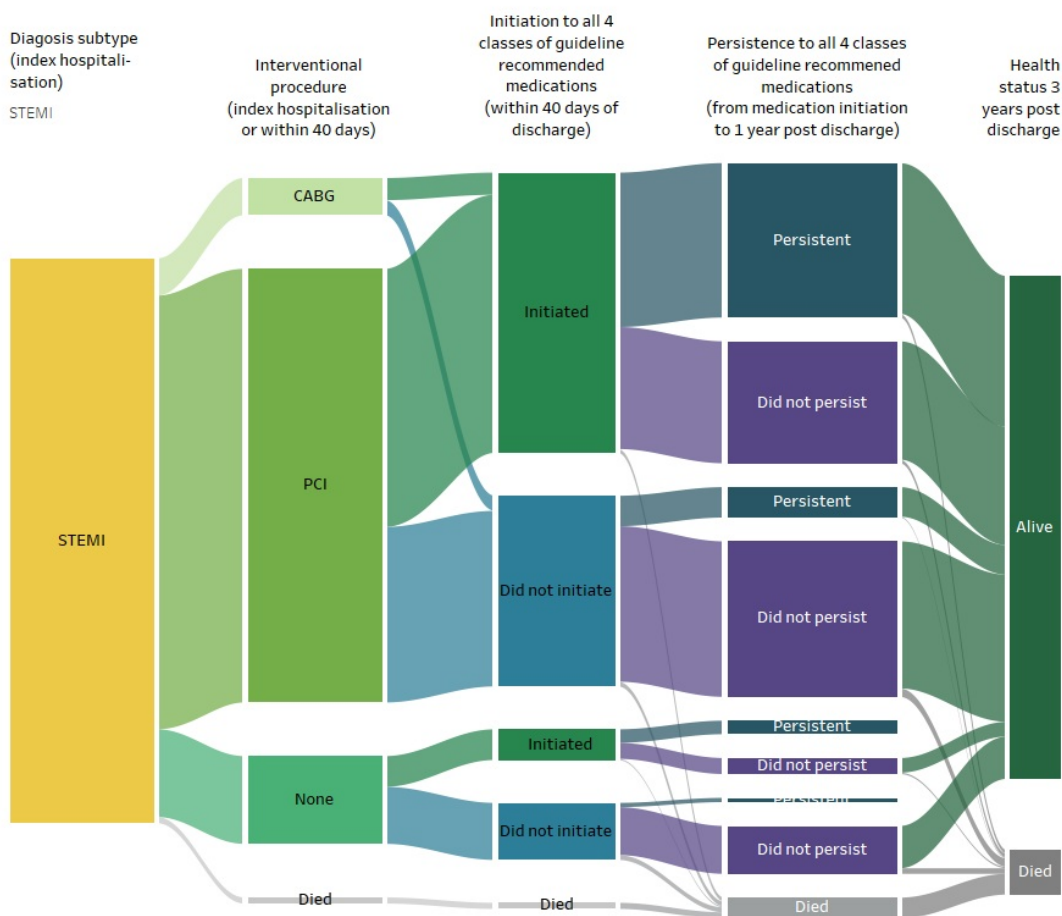
- Individuals with STEMI had the highest rate of interventional procedure (84%) of the diagnosis groups.
- Those who had no procedure were more often women, had a history of coronary heart disease (CHD), and lived in *Outer regional, Remote* and *Very remote areas* compared to those who underwent an interventional procedure (PCI or CABG).
- STEMI was the only diagnosis group for which the most comprehensive treatment pathway (an interventional procedure, initiation and persistence to all 4 classes of guideline recommended medications) was one of the most common, taken by 27%. For those with a STEMI diagnosis, adverse health outcomes were lowest among those who took this treatment pathway.
 - CVD emergency readmissions were 19% compared with 24% for the other treatment pathways combined. Major cardiac events (MACE) 12% compared to 17%.
 - This group had a lower proportion people aged 75 to 84 years, lower prior CHD and comorbidities identified compared to the other treatment pathways combined.

Explore the treatment pathways for the people with this diagnosis in Figure 4 and information about the people who followed these pathways in Figure 5.

A summary of these treatment pathways and the people who followed them is below.

Figure 4: Treatment pathways and outcomes, among those with STEMI

This Sankey shows the proportion of people who followed different treatment pathways illustrated with the 3 measurement points and survival at 3 years.

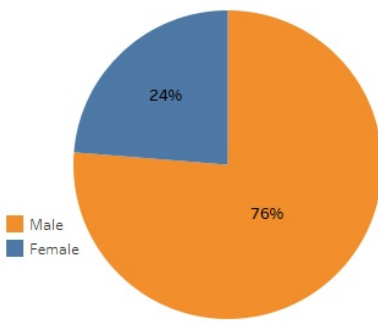


Source: AIHW NIHSI 2016-17 to 2019-20, analysis of NIHSI

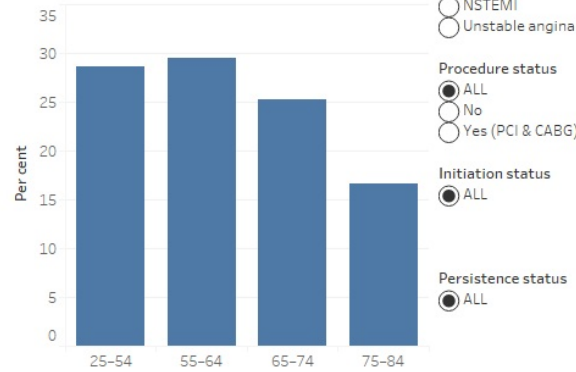
Figure 5: Age group, sex, identified comorbidities, and health outcomes among those with STEMI, by treatment pathway group

Figures show that among those with STEMI, the most common age group is 55-64 and comorbidity is hypertension.

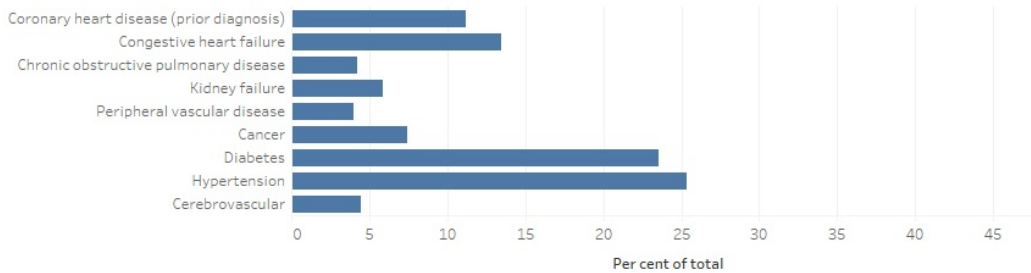
Sex



Age groups



Identified comorbidities



Outcomes in 3-year follow up period

All cause death	8.07%
CVD death	3.40%
Emergency CVD readmission	23.24%
MACE event	16.12%

Notes

Outcome categories: There is overlap in these outcome categories. CVD deaths are a subset of all death. MACE events combine emergency readmissions and death due to ACS, stroke, or heart failure. These readmissions and deaths are also included in the broader categories of CVD emergency readmissions and CVD deaths, respectively.

Exclusions: When procedure status or initiation status are selected, people who died in the first 40 days are excluded. When persistence status is selected, people who died in the first year are excluded.

Source: AIHW NIHSI 2010-11 to 2019-20, analysis of NIHSI

People's treatment pathways after a STEMI hospitalisation

People's treatment pathways are described using 3 measurement points during or after their initial ACS hospitalisations (referred to as the index hospitalisation).

Note that differences in health outcomes experienced by people following different treatment pathways should not be interpreted as causal. Many factors, impact both treatment decisions and the risk of experiencing poor health outcomes.

Measurement point 1: Interventional procedures

During their index hospitalisation (or within 40 day), 84% of people with STEMI had an interventional procedure. Around 4 in 5 people (78%) with STEMI underwent a PCI. Of these individuals, around 1 in 5 (22%) were women, and 11% lived in *Outer regional*, *Remote* and *Very remote* areas. One in 10 had a prior CHD diagnosis. Twenty-two percent had an emergency CVD readmission in the follow up period, and 5% died.

Seven percent of people with STEMI underwent a CABG procedure at the index hospitalisation or in the 40 days post discharge. Of these individuals, 18% were women, 15% lived in *Outer regional*, *Remote* and *Very remote* areas, and 10% had a history of CHD. Twenty two percent had an emergency CVD readmission during the follow up period, and 6.6% died.

Among those with STEMI who did not undergo a procedure (16%), 1 in 3 were women, and 18% lived in *Outer regional*, *Remote* and *Very remote* areas. History of CHD was more common among those who had no procedure (30%) when compared to those who underwent PCI or CABG. Thirty-one percent had an emergency CVD readmission, and 16% died in the follow-up period.

Measurement point 2: Medication initiation

Initiation to all guideline-indicated medications was higher among those who underwent a procedure in people with STEMI. Of people with STEMI, 35% of those who did not undergo a procedure, and 60% of those who underwent a PCI and/or a CABG procedure, initiated guideline indicated medications within 40 days. A slightly higher proportion of men initiated the 4 medicine classes compared with women (57% and 51% respectively).

Emergency CVD readmissions and all cause death was highest among those who did not undergo a procedure or initiate medicines within 40 days (30% and 19% respectively), and lowest among those who underwent a procedure and initiated all classes of guideline Indicated medications (22% and 4% respectively).

Measurement point 3: Persistence to medication

Note, persistence measures are only estimated for those who were alive at one year. All comparisons below exclude people who died in the first year after index hospitalisation.

For individuals with STEMI who were alive at one year, emergency CVD readmissions, a MACE, and all-cause death were lowest among those who underwent an interventional procedure, initiated 4 classes of medicines in 40 days and were persistent at 1 year (CVD readmissions: 18% MACE: 12% All cause death: 2.4%).

Emergency readmissions and MACE were highest among those who did not undergo a procedure, initiated medications at 40 days but were non-persistent at 1 year post discharge (32% and 25% for CVD readmissions and MACE respectively).

The rate of death (after the first year) from any cause was highest among those who did not undergo a procedure, initiate guideline recommended medications or persist at 1 year (19%). This group were older than other STEMI treatment subgroups, which would be a likely influence on both treatment decisions and the higher rate of death in this group. Age has been shown to be an independent predictor of adverse health outcomes in high-risk MI patients. (Nedkoff 2023)

See Figure 5 for comparisons of age group, sex, comorbidities and health outcomes among treatment groups.

Explore the treatment pathways

Non-ST segment elevation myocardial infarction (NSTEMI) is a type of heart attack in which an artery is frequently partially blocked. This severely reduces blood flow. Almost half (48%) of the acute coronary syndrome (ACS) cohort had a diagnosis of NSTEMI.

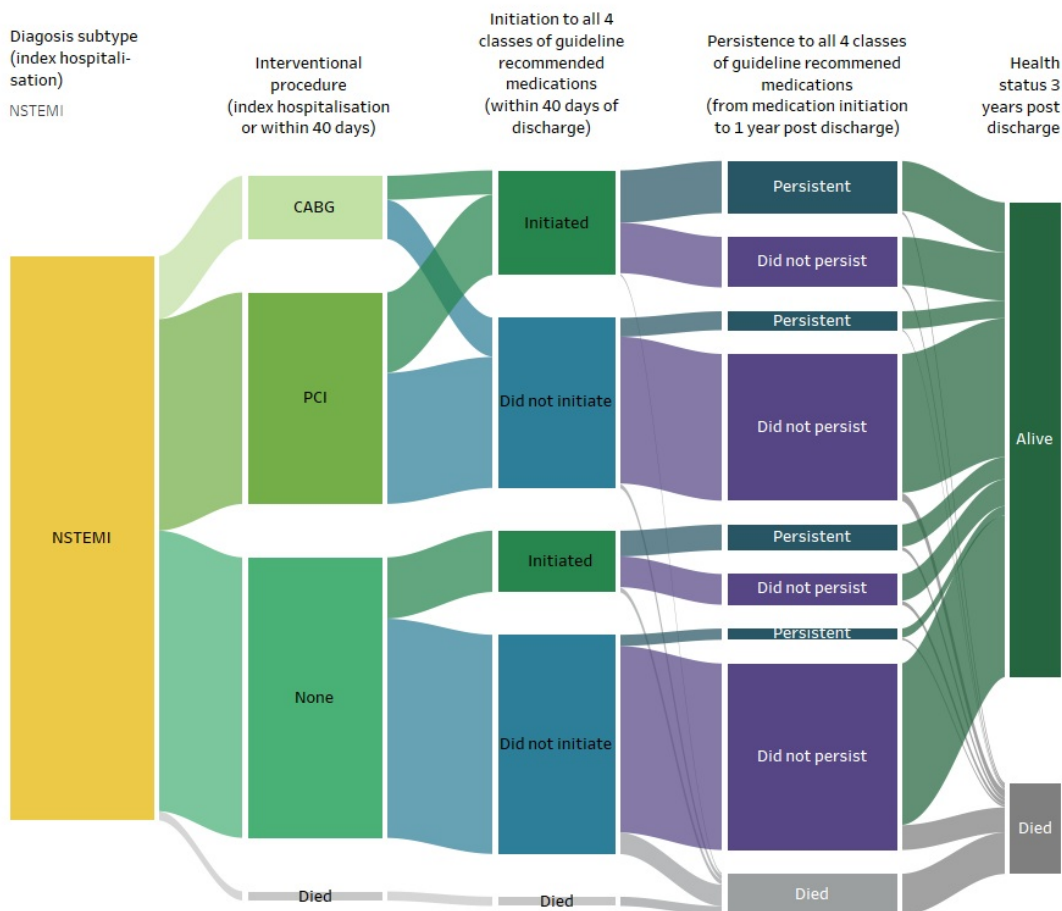
- Almost half the people with NSTEMI had an interventional procedure. Compared to people who did not have an interventional procedure, these people:
 - were younger, had a lower rate of prior CHD, more likely to be men
 - were more likely to initiate the recommended medication regimen
 - had better health outcomes.
- People with NSTEMI had the most variation in treatment pathways. The 3 most common treatment pathways captured the experience of 68% of people with NSTEMI, (compared to 76% for people with STEMI and 82% for people with unstable angina).
- The treatment pathways with the lowest proportion of people who experienced adverse health outcomes were those who had a procedure and either, did not initiate or persist with 4 classes of medications or those who initiated within 40 days and were still taking all 4 classes at 1 year post discharge.

Explore the treatment pathways for the people with this diagnosis in Figure 6 and information about the people who followed these pathways in Figure 7.

A summary of these treatment pathways and the people who followed them is below.

Figure 6: Treatment pathways and outcomes, among those with NSTEMI

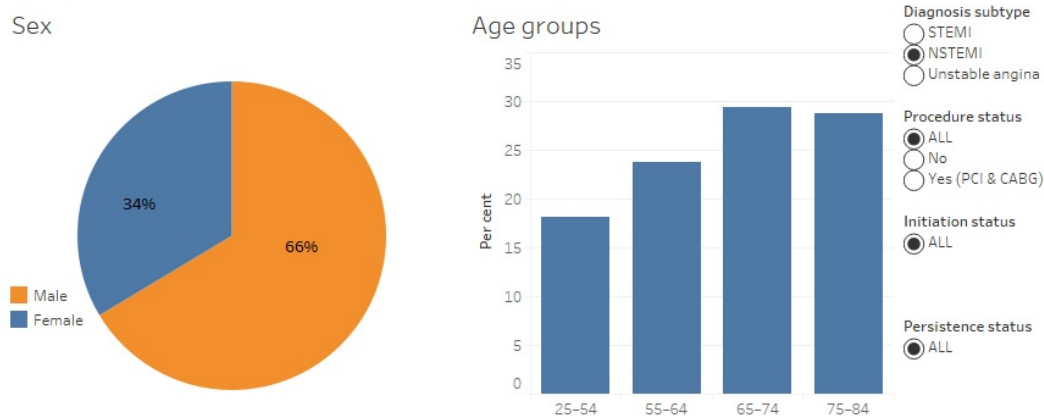
The Sankey shows the proportion of people who followed different treatment pathways illustrated with the 3 measurement points and survival at 3 years.



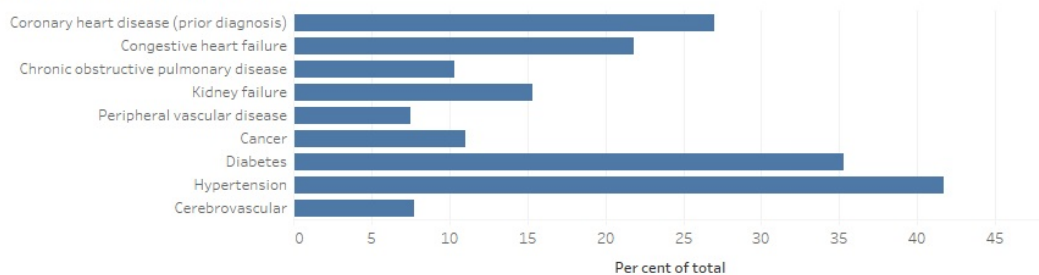
Source: AIHW NIHSI 2016-17 to 2019-20, analysis of NIHSI

Figure 7: Age group, sex, comorbidities, and health outcomes among those with NSTEMI, by treatment subgroup

Figures show that among those with NSTEMI, the most common age group is 65-74 and comorbidity is hypertension.



Identified comorbidities



Outcomes in 3-year follow up period

All cause death	15.95%
CVD death	6.52%
Emergency CVD readmission	31.89%
MACE event	23.64%

Notes
 Outcome categories: There is overlap in these outcome categories. CVD deaths are a subset of all death. MACE events combine emergency readmissions and death due to ACS, stroke, or heart failure. These readmissions and deaths are also included in the broader categories of CVD emergency readmissions and CVD deaths, respectively.
 Exclusions: When procedure status or initiation status are selected, people who died in the first 40 days are excluded. When persistence status is selected, people who died in the first year are excluded.

Source: AIHW NIHSI 2010-11 to 2019-20, analysis of NIHSI

People's treatment pathways after a NSTEMI hospitalisation

People's treatment pathways are described using 3 measurement points during or after their initial ACS hospitalisations (referred to as the index hospitalisation).

Note that differences in health outcomes experienced by people following different treatment pathways should not be interpreted as causal. Many factors, impact both treatment decisions and the risk of experiencing poor health outcomes.

Measurement point 1: Interventional procedure

Of those with NSTEMI, 11% underwent a CABG procedure, and 38% underwent a PCI at the index stay or within 40 days of discharge. Those who did not undergo a procedure tended to be older, with a greater proportion of people aged 65 and over (no procedure: 64% CABG: 57%, PCI: 50%), have higher rates of prior CHD (no procedure: 34% CABG: 17%, PCI: 21%), and more be likely women (no procedure: 42% CABG: 21%, PCI: 26%).

Thirty seven percent of people who did not have a procedure had an emergency CVD readmission, 28% had a MACE and 22% died within 3 years. In comparison, among those who underwent a CABG procedure, 25% had an emergency readmission, 16% had a MACE and 7% died. Among those who underwent a PCI, 27% had an emergency CVD readmission, 19% had a MACE and 8% died within 3 years.

Measurement point 2: Medication initiation

Thirty percent of people with NSTEMI initiated all 4 guideline indicated medication classes within 40 days of hospital discharge. The proportion was higher among those who underwent a procedure (38%) compared to those who did not (22%).

Among those who did not undergo a procedure, a higher proportion of people who initiated 4 classes of medicines at 40 days had an emergency CVD readmission (41% and MACE (34%) compared with people who did not initiate (36% and 26% for emergency readmissions and MACE respectively). This may reflect higher risk profiles driving both medication decisions and health outcomes.

Among those who did undergo a procedure, there was little difference in the outcomes among those who did and did not initiate all 4 medication classes at 40 days (see Figure 7).

Measurement point 3: Persistence to medication

Note, persistence measures are only estimated for those who were alive at one year. All comparisons below exclude people who died in the first year after index hospitalisation.

Among people with NSTEMI alive at 1 year post hospital discharge, 21% continued to take all 4 guideline indicated medication classes. Those who did not undergo a procedure or initiate the 4 drug classes within 40 days post discharge, but had medications supplied later and were then persistent at 1 year, had worse health outcomes when compared to other NSTEMI treatment subgroups. One in 2 had an emergency CVD readmission, 2 in 5 had a MACE and 17% died in the follow up period. In some cases, the later initiation of medication may have been in response to the readmission event.

The subgroups with the lowest proportion of people who experienced adverse health outcomes were those who had a procedure but did not initiate or persist with 4 classes of medications (readmissions: 25% MACE: 17% death: 5.4%) and those who had a procedure, initiated within 40 days and were still taking all 4 classes at 1 year post discharge (readmissions: 26% MACE: 18% death: 4.5%).

See Figure 7 for comparisons of age group, sex, comorbidities and health outcomes among treatment groups.

Explore the treatment pathways

Angina is a chronic condition in which intermittent episodes of chest pain can occur when the heart has a temporary deficiency in blood supply. Unstable angina can be dangerous due to the changing severity in transient coronary narrowing. Of the acute coronary syndrome (ACS) cohort, 29% had a diagnosis of unstable angina.

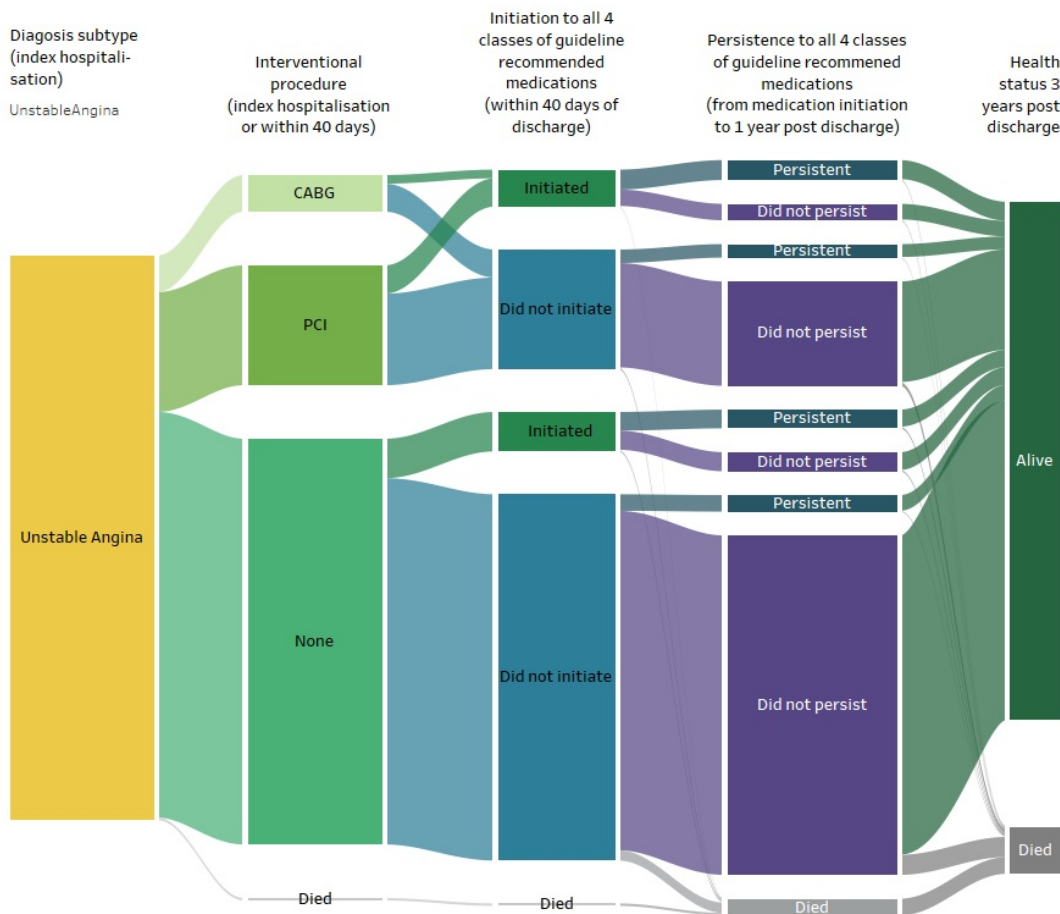
- People with unstable angina were the most likely to not have followed any of the 3 treatment pathway measurement points, which was the least comprehensive treatment pathway.
- The rate of emergency CVD readmissions among people with unstable angina was the highest compared to the other diagnosis groups.
- People with unstable angina had the least variation in treatment pathways, 60% followed the same pathway of no interventional procedures undertaken, not initiated to the guideline recommended medications, and not persistent.
- Compared to other ACS subtypes, there was less variation in health outcomes among those who did and did not undergo procedures.

Explore the treatment pathways for the people with this diagnosis in Figure 8 and information about the people who followed these pathways in Figure 9.

A summary of these pathways and the people who followed them is below.

Figure 8: Treatment pathways and outcomes, among those with unstable angina

The Sankey shows the proportion of people who followed different treatment pathways illustrated with the 3 measurement points and survival at 3 years.

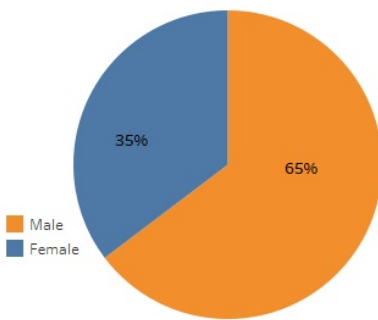


Source: AIHW NIHSI 2016-17 to 2019-20, analysis of NIHSI

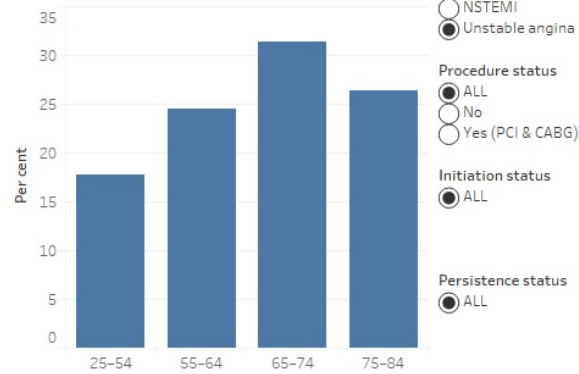
Figure 9: Age group, sex, comorbidities, and health outcomes among those with unstable angina, by treatment subgroup

Figures show that among those with unstable angina, the most common age group is 55-64 and comorbidity is a prior diagnosis of coronary heart disease.

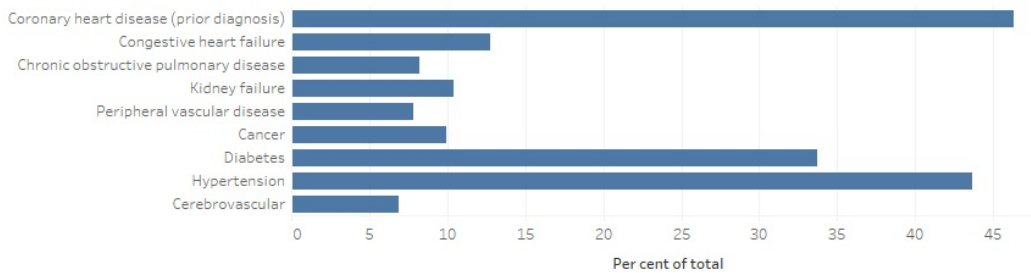
Sex



Age groups



Identified comorbidities



Outcomes in 3-year follow up period

All cause death	8.28%
CVD death	3.04%
Emergency CVD readmission	31.90%
MACE event	21.57%

Notes

Outcome categories: There is overlap in these outcome categories. CVD deaths are a subset of all death. MACE events combine emergency readmissions and death due to ACS, stroke, or heart failure. These readmissions and deaths are also included in the broader categories of CVD emergency readmissions and CVD deaths, respectively.

Exclusions: When procedure status or initiation status are selected, people who died in the first 40 days are excluded. When persistence status is selected, people who died in the first year are excluded.

Source: AIHW NIHSI 2010-11 to 2019-20, analysis of NIHSI

People's treatment pathways after an unstable angina hospitalisation

Peoples' treatment pathways are described using 3 measurement points during or after their initial ACS hospitalisations (referred to as the index hospitalisation).

Note that differences in health outcomes experienced by people following different treatment pathways should not be interpreted as causal. Many factors, impact both treatment decisions and the risk of experiencing poor health outcomes.

Measurement point 1: Interventional procedure

Twenty eight percent of people with unstable angina had a procedure during the index stay or in the 40 days following hospital discharge. Noting, procedures undertaken after the index stay will be underestimated due to limited availability of private hospital data in the analysis. One in 14 people with unstable angina had a CABG procedure and 1 in 5 underwent a PCI procedure. Among those who underwent a CABG or PCI procedure, 17% and 23% were women, respectively. Forty one percent of those who did not have a procedure were women.

A slightly higher proportion of those who did not have a procedure were aged 25-54 years (19%) when compared to those who underwent CABG (11%) or PCI (16%).

When compared to other ACS subtypes, there was less variation in health outcomes among those who did and did not undergo procedures.

Measurement point 2: Medication initiation

Fourteen percent of those with unstable angina initiated all 4 classes of medicines at 40 days. Initiation to guideline indicated medications was higher among those who underwent a procedure (24%) compared with those who didn't (10%).

Seventy one percent of those who did not undergo a procedure but initiated all 4 classes of medications had a prior CHD diagnosis compared with 45% in those who did not initiate medications. The proportion with a prior CHD hospitalisation was substantially lower among those who underwent a procedure (did not initiate: 43%, did initiate: 48%)

Those who underwent a procedure but did not initiate all guideline-indicated medications had the lowest proportion of people who experienced poor health outcomes (CVD readmission: 29%, MACE: 19%, all cause death: 5.2%). In contrast, those who did not have a procedure, but initiated 4 drug classes within 40 days, had the highest proportion of poor health outcomes when compared to other treatment subgroups (CVD readmission: 46%, MACE: 36%, all cause death: 12%). This group had a substantially higher proportion of people with identified comorbidities when compared to other treatment subgroups, which is likely to have impacted both treatment decisions and risk of experiencing adverse health outcomes.

Measurement point 3: Persistence to medication

Note, persistence measures are only estimated for those who were alive at 1 year. All comparisons below exclude people who died in the first year after index hospitalisation.

Of people with unstable angina, 61% did not have a procedure and did not initiate or persist with guideline indicated medicines.

Those with unstable angina who had a procedure but did not initiate or persist with guideline indicated medications at 1 year post hospitalisation had the lowest rate of adverse health outcomes (CVD readmission: 28%, MACE: 17%, all cause death: 3.7%). When compared to other treatment subgroups, this group had a lower proportion of women (20%), First Nations people (1.7%), and had a greater proportion of people living in higher socioeconomic areas (see supplementary table S5b).

In contrast, those who had no procedure, did not initiate medications at 40 days, but were classified as persistent at 1 year had the highest proportion of people with an emergency CVD readmission (58%) or MACE (46%). This group had a high proportion of people with prior CHD (74%) and other identified comorbidities (for example, diabetes: 50% and hypertension: 65%).

The subgroup with the highest rate of death was those who did not have a procedure but initiated and persisted with medications (8.7%). Two in 3 people in this subgroup were aged 65-74 years, and a high proportion of people had identified comorbidities when compared with other subgroups. For example, 3 in 4 had a prior CHD diagnosis, 1 in 4 had congestive heart failure, and 1 in 2 had diabetes.

See Figure 9 for comparisons of age group, sex, comorbidities and health outcomes among treatment groups.

Interpretation

What does this project tell us?

This project describes some of the common treatment pathways people take following an acute coronary syndrome (ACS) hospitalisation. Linked administrative data enables effective secondary use of data to explore patient's real-world journeys through the health system. It provides evidence on how many people appear to align with existing clinical guidelines and identifies high level characteristics of those who do and don't take specific treatment pathways.

Monitoring patient's real world 'treatment pathways' is important to understanding guideline implementation, particularly as guidelines change and evolve over time. The 2022 Australian Institute of Health and Welfare (AIHW) publication [*Medication use for secondary prevention after coronary heart disease hospitalisations: patient pathways using linked data*](#) (AIHW, 2022) provides further detail about variation in the use of medication recommended by guidelines (Chew et al. 2016) and highlights subpopulations that would benefit from additional ongoing support after their transition from hospital to the community.

While this project describes the health outcomes experienced by those in different treatment subgroups, interventional procedures and medication use are only some of the factors that impact health outcomes. For example, older people with multiple comorbidities may not undergo interventional procedures due to a high risk and may also be more likely to experience poor health outcomes. Further, as this data are collected for administrative purposes, with research being its secondary use, many of the factors that impact both treatment decisions and health outcomes are not captured. For example, there is limited information about clinical factors (such as blood pressure and blood lipid levels), adverse reactions or unacceptable side effects due to in-scope medications, and psychosocial factors. This project cannot identify causal relationships between treatment pathways and health outcomes, but instead provides a starting point for further research and improved understanding of the patient journey.

Limitations of the data

The NIHSI (version 2.0) includes data from 6 of the 8 jurisdictions of Australia and therefore results may not be generalisable to Western Australia and the Northern Territory. Further, private hospital data were available only for Victoria (to June 2017), Queensland and the Australian Capital Territory. As a result, readmissions and the capture of interventional procedures undertaken within 40 days of index hospitalisation will be underestimated. The inclusion of only emergency readmissions may somewhat mitigate the impact on the readmission outcome measure.

The reason for discontinuing a medication is not captured in the administrative data. For example, it may be due to a patient's choosing, or may be done in consultation with a medical professional due to adverse side effects or a new therapeutic approach. In addition, an assumption of the analysis is that PBS dispensing records accurately represent medication use. However, it is possible that a person may be dispensed a medicine but does not take the full course or fails to take it as prescribed by their health professional.

Medications supplied in public hospitals are not available in this data. Time spent admitted to public hospitals was excluded from the measurement of persistence as the supply of medications in this setting would not be captured in the PBS data. The use of 40 days post index hospitalisation to measure initiation was selected to account for up to one month's supply from before the hospitalisations and supplies from the hospital which are not captured in the PBS for all jurisdictions.

PBS data do not include any information about the intended dosage; as a result, this information was estimated for the cohort. Incorrect dosage assumptions may impact persistence estimates.

Aspirin, an antiplatelet agent, was excluded from the analysis as it is available over the counter and is therefore not comprehensively captured in the PBS data set. While the guidelines recommend dual antiplatelet therapy (aspirin and another antiplatelet), those who only took aspirin will be classified as not initiating and persisting to all 4 guideline indicated medication classes.

Comorbidity information is obtained from the admitted patient care data, from hospitalisations prior to the index and the index hospitalisation, and relies on valid and accurate coded data. The identification of comorbidities is likely to be an underestimate of disease burden in the population. Further, multimorbidity, which is an indicator of more complex health conditions and treatment needs is not captured.

In this analysis, Indigenous status was derived from the admitted patient care data recorded at the index hospitalisation only. This may be an underestimate of the First Nations population in the cohort.

References

Australian Institute of Health and Welfare (AIHW) (2022) [*Medication use for secondary prevention after coronary heart disease hospitalisations: patient pathways using linked data*](#), catalogue number CVD 98, AIHW, Australian Government.

Chew DP, Scott IA, Cullen L, French JK, Briffa TG, Tideman PA, Woodruffe S, Kerr A, Branagan M, Aylward PEG. (2016) '[*National Heart Foundation of Australia & Cardiac Society of Australia and New Zealand: Australian Clinical Guidelines for the Management of Acute Coronary Syndromes 2016*](#)', *Heart Lung and Circulation* 25:895-951.





Data

