Chest pain epidemiology and care quality for Aboriginal and Torres Strait Islander peoples in Victoria, Australia: a population-based cohort study from 2015 to 2019

Luke P. Dawson,[a,b,c] Emily Nehme,[b,d] Luke J. Burchill,[c,e] Ziad Nehme,[b,d,f] Jessica O'Brien,[a] Jason Bloom,[a,g] Shelley Cox,[b,f] David Anderson,[d,h,f] Michael Stephenson,[b,d,f] Jeffrey Lefkovits,[b,c] Andrew J. Taylor,[a,i] David Kaye,[a,g] Karen Smith,[b,d,f] and Dion Stub[a,b,g,*]

[a]Department of Cardiology, The Alfred Hospital, Melbourne, Victoria, Australia
[b]School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia
[c]Department of Cardiology, The Royal Melbourne Hospital, Melbourne, Victoria, Australia
[d]Ambulance Victoria, Melbourne, Victoria, Australia
[e]Aboriginal Cardiovascular Health Equity Research Group, Department of Medicine, The University of Melbourne, Australia
[f]Department of Paramedicine, Monash University, Melbourne, Victoria, Australia
[g]The Baker Institute, Melbourne, Victoria, Australia
[h]Department of Intensive Care Medicine, The Alfred Hospital, Melbourne, Victoria, Australia
[i]Department of Medicine, Monash University, Melbourne, Victoria, Australia

Summary

Background This study examined chest pain epidemiology and care quality for Aboriginal and Torres Strait Islander ('Indigenous') patients presenting to hospital via emergency medical services (EMS) with chest pain.

Methods State-wide population-based cohort study of consecutive patients attended by ambulance for acute chest pain with individual linkage to emergency, hospital admission and mortality data in the state of Victoria, Australia from January 2015 to June 2019. Multivariable models were used to assess for differences in pre-hospital and hospital adherence to care quality, process measures and clinical outcomes.

Findings From 204,969 EMS attendances for chest pain, 3890 attendances (1.9%) identified as Aboriginal or Torres Strait Islander. Age-standardized incidence rates were higher overall for Indigenous people (3128 vs. 1147 per 100,000 person-years, incidence rate ratio 2.73, 95% CI 2.72–2.74), this difference being particularly striking for younger patients, women, and those residing in outer regional areas. In multivariable models, adherence to care quality and process measures was lower for attendances involving Indigenous people. In the pre-hospital setting, Indigenous people were less likely to be provided intravenous access or analgesia. In the hospital setting, Indigenous people were less likely to be seen by emergency clinicians within target time and less likely to transferred following myocardial infarction to a revascularization capable centre.

Interpretation Incidence of acute chest pain presentations is high among Indigenous people in Victoria, Australia. Opportunities to improve the quality of care for Indigenous Australians presenting with acute chest pain are identified.

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Keywords: Chest pain; Emergency medical services; Aboriginal and Torres Strait Islander peoples; Indigenous Australians; Disparities in care; Quality of care

Research in context

Evidence before this study
Ovid MEDLINE was searched on May 15, 2023, for papers published from inception until February 15, 2023, using the search terms "Indigenous Australians.mp", "health services, Indigenous" or "Aboriginal and Torres Strait Islander.mp" combined with the AND function using the search terms "chest pain", "myocardial infarction", "acute coronary syndromes", "suspected acute coronary syndromes", with no language restrictions. We also did a further search of references and relevant government reports. Several studies have assessed access to care and outcomes for myocardial infarction and acute coronary syndromes among Aboriginal and Torres Strait Islander ('Indigenous') Australians. However, few studies present data regarding Indigenous Australians presenting with chest pain especially in the state of Victoria. No studies were identified that specifically assessed chest pain presentations via ambulance in Victoria at a population-level.

Added value of this study
This study examines chest pain epidemiology and care quality for Indigenous Australians presenting to hospital via emergency medical services with chest pain over 4.5 years in Victoria. Among Indigenous Australians, chest pain incidence is high, especially for women, younger people, and in regional communities. EMS and hospital adherence to care quality and process measures was lower for attendances involving Indigenous peoples, suggesting there is substantial scope to improve care quality.

Implications of all the available evidence
These findings suggests that improving chest pain care quality should be an urgent focus for health policy. Potential avenues for improvement including collection of Indigenous status by ambulance services, public reporting for health service care quality among Indigenous Australians, further improvements to primary prevention programs through Aboriginal community-controlled health services, and novel approaches to care that integrate cultural safety as an essential aspect of care quality.

Introduction

Improving health outcomes for Aboriginal and Torres Strait Islander people has been a focus for Australian health policy over the last four decades. Substantial progress has been made across many measures including reductions in overall and cardiovascular mortality.[1] However, differences in healthcare access and care quality remain, especially in cardiovascular readmission rates and in revascularisation access and outcomes.[1–4] Most research has been focussed at the disease level, assessing care quality and outcomes after a diagnosis has been made. This approach is clearly valuable in understanding diseases that might be over-represented, to focus primary and secondary prevention initiatives. But, to lead to a diagnosis, patients must first present with a symptom which requires appropriate investigation and management. Acute chest pain represents the most common cause of emergency department (EDs) presentations, accounting for one in ten of all attendances to emergency medical services (EMS) and represents a broad range of underlying diagnoses ranging from non-serious to life-threatening.[5] In this setting, reducing any differences in care quality for chest pain among population subgroups, including Aboriginal and Torres Strait Islanders, could represent a promising opportunity to improve health outcomes.

In this study, we examined chest pain epidemiology and care quality for Aboriginal and Torres Strait Islander ('Indigenous') patients presenting via emergency medical services (EMS) with chest pain in Victoria, Australia. Moreover, we specifically aimed to determine rates of EMS and hospital adherence to several predefined care quality and process measures that are either recommended by clinical or organisational guidelines or monitored by government as key performance measures.

Methods

This was a population-based observational cohort study of consecutive adult patients attended by EMS for acute chest pain between 1 January 2015 and 30 June 2019 in Victoria, Australia—a state of approximately 6.6 million people in the south-eastern part of the country of which 66,000 people (1.0%) identify as Aboriginal and/or Torres Strait Islander (8.1% of Australia's total Aboriginal and Torres Strait Islander population).[6] Differences in incidence rates, diagnoses, care quality, and outcomes were assessed according to Indigenous status.

In Australia, and especially Victoria, there are ongoing challenges with ethical oversight and conduct of Indigenous health research despite National Health and Medical Research Council guidelines.[7,8] The Victorian Aboriginal Research Accord Project, commenced by the Victorian Aboriginal Community Controlled Health Organisation (also known as VACCHO) in 2021, and expected to be finalised later this year, will provide a framework to assist research organization improve Aboriginal involvement in health research. For this project, in the absence of such an accord, members of the Victorian Aboriginal community and two Indigenous health researchers (LJB and JO'B) were engaged throughout the study, including one who served on the Victorian Aboriginal Research Accord steering committee and who is leading efforts to advance

Indigenous governance for Indigenous health research (LJB).[8]

Study population

Pre-hospital data entered into the EMS electronic patient care record by paramedics were linked to the Victorian Emergency Minimum Dataset (VEMD), the Victorian Admitted Episodes Dataset (VAED), and the Victorian Death Index (VDI) to determine pre- and in-hospital management, diagnoses and outcomes. Full details regarding the cohort and linkage processes have been published previously and are included in the Supplemental Material.[9] Previous audit analyses of the VEMD dataset had a 100% and 94% concordance rate with ED medical records for index myocardial infarction diagnosis and index acute coronary syndrome diagnosis, respectively.[10] Consecutive patients attended by EMS for chest pain were included if EMS recorded pain in the chest, or an EMS suspected diagnosis of ischaemic chest pain, ACS, acute myocardial infarction (MI), pleuritic pain, or angina. Exclusion criteria included traumatic chest pain, inter-hospital transfers, out-of-hospital cardiac arrest, and age <18 years. Ethics approval for the data linkage and this study was provided by the Monash University Human Research Ethics Committee (approval number 11681).

Study definitions

Indigenous status was recorded in the VEMD or VAED datasets on admission to ED or hospital, and therefore patients that did not have a VEMD or VAED record (due to either not attending hospital or no record linkage) were excluded from the study. Victoria has a smaller Indigenous population compared to other Australian states and for this reason we elected to use the more inclusive 'ever-identified' approach to avoid potential risks of under-identification, especially in metropolitan regions.[11,12] Therefore if the two databases (VEMD and VAED) were discordant, the dataset recording Indigenous status was considered to be correct. National guidelines require health services to ask the mandatory question "Are you of Aboriginal or Torres Strait Islander origin?" on admission to ED or hospital. Socioeconomic status was determined using the Index of Relative Socioeconomic Disadvantage (IRSD), which ranks each residential postcode based on household income, unemployment rate, home and motor vehicle ownership, educational level, and non-English speaking background.[13] Conventionally, IRSD percentile ranking data are categorised into quintiles, and the same approach was used in this study. Geographic remoteness was determined by the EMS event postcode using the Accessibility and Remoteness Index of Australia (ARIA), which uses five categories (Metropolitan, Inner regional, Outer regional, Remote, and Very remote) according to relative access to services. Due to low numbers of events in 'Remote' and 'Very remote' locations these categories were combined with 'Outer regional'. Hospitals were classified according to revascularisation capabilities as (1) non-revascularisation centres if neither percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) revascularisation facilities were available, (2) PCI only centres, and (3) PCI and CABG centres. Discharge diagnoses were defined according to International Classification of Diseases 10 (ICD-10-AM) coding as the hospital discharge primary diagnosis if discharged from hospital, or the emergency department (ED) primary diagnosis if discharged from the emergency department.

Outcomes and care process and quality measures

Outcomes reported included rates of mortality and EMS reattendance for chest pain, with each reported at 30-days and long-term (median follow-up 2.3 years). The term 'adherence' in this study refers to EMS and hospital network adherence to the following care and process measures rather than individual or patient-level adherence. Pre-hospital care processes and quality measures examined included rates of 12-lead electrocardiograms (ECG), analgesia or nitrate administration for patients with a pain score >2 out of 10, intravenous cannulation, and aspirin administration, each of which are in line with Ambulance Victoria clinical care guidelines. Hospital care processes and quality measures included rates of ED clinician review within target time-period, ambulance off-load within 40 min, ED length of stay less than 4 h, and angiography (for catheterization capable centres) or transfer (for non-catheterization capable centres) for patients diagnosed with MI. The first three hospital care measures focus on timely access to care and are monitored and assessed monthly by the Victorian Department of Health.[14] The fourth measure was selected with the goal of assessing care quality for MI according to existing management guidelines.[15]

Statistical analysis

Age-standardized incidence rates of total chest pain case presentations per 100,000 person-years according to Indigenous status were calculated using 2016 age-specific population estimates available from the Australian Bureau of Statistics (ABS) by 5-year age brackets with confidence intervals calculated assuming a Poisson distribution and the same age and ethnicity distribution for linked and unlinked episodes. Age- and sex-specific incidence rates were calculated according to ten-year age brackets. Incidence rates according to Indigenous status were compared using incidence rate ratios (IRRs) and 95% confidence intervals (CIs).

Missing data for presenting characteristics (Supplementary Table S1) and for care processes (analgesia if pain score >2/10, off-load time <40 min, ED review time, ED length of stay <4 h) were managed with multiple imputation using chained equations assuming missingness at random. All other variables with complete data (including survival and readmission data)

were also included as predictor variables in the imputation process. Ten datasets were imputed using all variables included in the multivariable models and Rubin's rules were used to pool results.[16] To assess for differences in care processes and quality according to Indigenous status, we calculated adjusted risk differences using multilevel mixed-effects logistic regression models with inclusion of receiving hospital as a random effect to account for clustering. Fixed effects included in the model were age, sex, comorbidities, clinical status at EMS arrival (systolic blood pressure, heart rate, respiratory rate, oxygen saturations, low Glasgow-coma score [defined as less than 15], and fever [defined as temperature $\geq$38 °C]), initial pain score out of ten, socioeconomic status quintile, event location, private hospital status, and hospital revascularisation capabilities. Intraclass correlation coefficients (ICCs) were presented to assess the proportion of variance in care or outcomes that occurs at the hospital-level. Differences in care measures were assessed in the full cohort and in the subgroup of patients with a final diagnosis of MI to account for potential differences in presentations. We also assessed whether the total number of care measures adhered to for each patient, as an ordinal variable, was different according to Indigenous status, overall and in several subgroups including sex, age category, and event location with unadjusted P-values presented according to a chi-square test.

For clinical outcomes, we used a multilevel parametric time to first event model based on the Weibull distribution.[17] Long-term outcomes (mortality and re-attendance) used a censorship date of 30 September 2019, representing the final date of data linkage. Results are reported as hazard ratios (HR) and 95% CIs, and the models included the same variables for random and fixed effects as in the previously described analysis using the multiply-imputed dataset. Several sensitivity analyses were performed. To account for potential differences in presentations, outcomes were assessed in the same manner within diagnostic subgroups. To further understand any outcome differences we undertook several sensitivity analyses without adjustment, adjusted for age alone, and stratifying according to 10-year age brackets given different age distributions between Indigenous and non-Indigenous cases.

Statistical analysis was performed using StataMP version 17.0 (College Station, Texas, USA).

Role of the funding source
The funder of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

Results
A total of 242,989 unique chest pain episodes attended by EMS during the study period met inclusion criteria (Supplementary Figure S1). Of these, 38,025 cases (15.5%) were transported to hospital but were not able to be linked to index ED or hospital admission records and were excluded, leaving 204,964 cases in the primary analysis. The linked cohort had higher rates of regional presentation, but higher rates of presentation to a private hospital, higher socioeconomic status, and lower rates of all comorbidities (Supplementary Table S2).

Of the included cohort, 3890 cases (1.9%) identified as Indigenous, of which 3510 (90.2%) had Aboriginal heritage alone, 75 (1.9%) Torres Strait Islander heritage alone, and 305 (7.8%) had Aboriginal and Torres Strait Islander heritage, while 1170 (0.6%) were unable to be asked and 166 (0.1%) declined to answer. For cases with both VEMD and VAED records, agreement in classification of Indigenous heritage between the two datasets was 99.9% (Cohen's kappa 0.975) (Supplementary Table S3).

Age-standardized incidence rates for chest pain were higher among cases reporting Indigenous heritage in comparison to cases not reporting Indigenous heritage (3128 total chest pain case presentations vs. 1147 total chest pain case presentations per 100,000 person-years, incidence rate ratio [IRR] 2.73, 95% confidence interval [CI] 2.72–2.74) (Fig. 1). The difference was more pronounced in outer regional areas (IRR 3.39, 95% CI 3.32–3.47) compared to major cities and inner regional areas (IRRs 2.30 and 2.26, respectively). Differences in chest pain incidence were more marked in women than men (IRR 2.96, 95% CI 2.95–2.98 vs. IRR 2.42, 95% CI 2.41–2.43) and among younger age groups. Incidence rates according to Indigenous status by local government area are shown in Supplementary Figure S1.

Clinical characteristics and diagnoses
Indigenous Australians presenting with chest pain were younger (mean age 49.5 years vs. 62.7 years), more commonly women, and more commonly of lower socioeconomic status (Table 1). Event location was more often regional, and presentation more likely to a public hospital without revascularisation capabilities. Among Indigenous Australians, rates of diabetes mellitus, chronic kidney disease, prior coronary disease, and chronic airways disease were higher, while rates of hypertension, hyperlipidaemia, peripheral vascular disease were lower. Tachycardia and higher pain scores were more common among Indigenous Australians presenting with chest pain, while other observations were largely comparable.

Age- and sex-specific discharge diagnoses according to Indigenous status are shown in Table 2. The proportion of chest pain presentations diagnosed with myocardial infarction across all age groups was higher for Indigenous women, but lower for Indigenous men compared to non-Indigenous groups. Respiratory and other medical diagnoses were more common for cases with Indigenous heritage across all ages, while
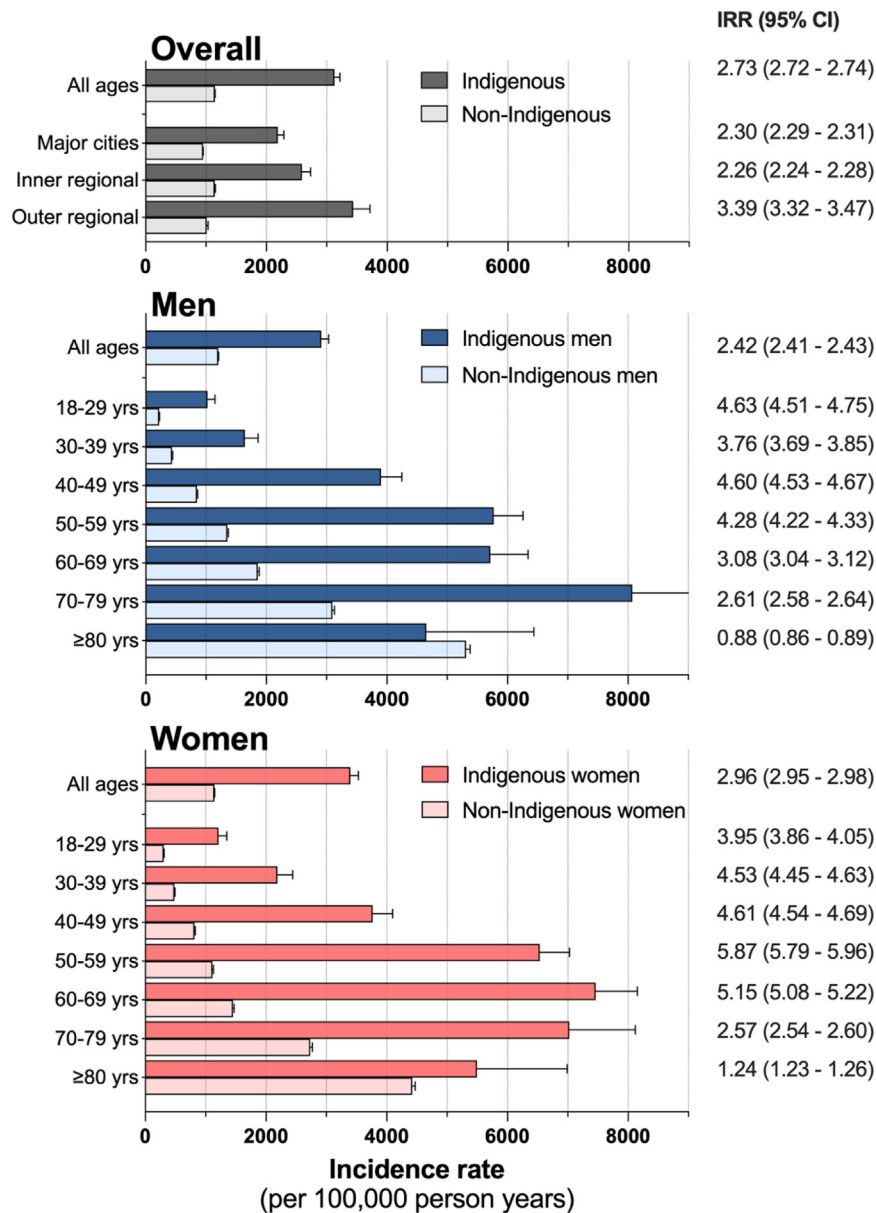
Fig. 1: Age-standardized, age- and sex-specific incidence rates, and incidence rate ratios (IRR) among Indigenous Australians in Victoria, Australia. Overall incidence and incidence by remoteness (top panel) presented as age-standardized incidence rate per 100,000 person-years at risk, while age- and sex-specific incidence rates (bottom panels) are not age-adjusted.

arrhythmia and other cardiovascular conditions were less frequent. Non-specific chest pain was less commonly the final diagnosis for cases with Indigenous heritage outside of the older cohort (age ≥65 years).

Care quality and process measures
Pre-hospital and hospital care quality and process measures overall, and for patients with a final diagnosis of MI, are shown in Table 3, Fig. 2, and Supplementary Figure S3. Among pre-hospital care measures, rates of

EMS adherence to all four measures were lower for Indigenous patients in unadjusted analysis. In adjusted analysis, rates of pre-hospital intravenous cannulation (adjusted risk difference −8.0 percentage points, 95% confidence interval [CI] −9.4 to −6.5) and analgesia administration if pain score greater than 2 out of 10 (adjusted risk difference −2.1 percentage points, 95% CI −3.3 to −0.9) were lower for Indigenous cases.

Among hospital care and process measures, rates of ED clinician review within target time was lower among

Variable	Indigenous	Non-indigenous
N	3890	201,074
Aboriginal	3510 (90.3%)	–
Torres Strait Islander	75 (1.9%)	–
Both Aboriginal & Torres Strait Islander	305 (7.8%)	–
Age, mean (SD)	49.5 (15.2)	62.7 (18.2)
<50 years	1803 (46.4%)	49,227 (24.5%)
50–64 years	1472 (37.8%)	50,641 (25.2%)
≥65 years	615 (15.8%)	101,206 (50.3%)
Sex		
Women	2119 (54.5%)	100,401 (49.9%)
Men	1770 (45.5%)	100,625 (50.1%)
Event location		
Metropolitan	1870 (49.1%)	148,849 (74.5%)
Inner regional	1312 (34.4%)	42,441 (21.3%)
Outer regional	629 (16.5%)	8405 (4.2%)
Socioeconomic status		
Quintile 1 (lowest)	1784 (51.2%)	48,915 (26.9%)
Quintile 2	704 (20.2%)	39,298 (21.6%)
Quintile 3	615 (17.6%)	36,271 (20.0%)
Quintile 4	266 (7.6%)	33,345 (18.5%)
Quintile 5	119 (3.4%)	23,707 (13.0%)
Hospital type		
Public	3754 (96.5%)	190,795 (94.9%)
Private	136 (3.5%)	10,279 (5.1%)
Hospital capability		
PCI and CABG	1126 (28.9%)	79,013 (39.3%)
PCI only	995 (25.6%)	61,330 (30.6%)
No revascularisation	1769 (45.5%)	60,731 (30.3%)
Past history		
Hypertension	1208 (32.1%)	86,933 (45.2%)
Hyperlipidaemia	898 (23.8%)	62,772 (32.6%)
Diabetes mellitus	1033 (27.4%)	40,222 (20.9%)
Chronic kidney disease	157 (4.2%)	6229 (3.2%)
Prior coronary disease	1454 (38.6%)	67,498 (35.1%)
Prior stroke	254 (6.7%)	13,058 (6.7%)
PVD	29 (0.8%)	2312 (1.2%)
COPD	520 (13.8%)	17,725 (9.2%)
Clinical status		
Tachycardia	882 (23.1%)	34,434 (17.3%)
Hypotension	104 (2.7%)	3836 (1.9%)
Hypoxia	157 (4.1%)	10,052 (5.1%)
Tachypnoea	203 (5.2%)	11,118 (5.5%)
Febrile (≥38 °C)	171 (4.9%)	8136 (4.5%)
Low GCS (<15)	217 (5.6%)	9747 (4.9%)
Pain scores (out of ten)		
0–3	481 (13.2%)	37,697 (19.5%)
4–7	1382 (37.8%)	86,124 (44.5%)
8–10	1793 (49.0%)	69,777 (36.0%)

Percentages are reported as a proportion of total patients with available data for that variable. Rates of missing data are presented in Supplementary Table S1 and were less than 5% for all variables except temperature (9.2% missing) and SES (9.6% missing). CI, confidence interval; SD, standard deviation; PVD, peripheral vascular disease; COPD, chronic obstructive pulmonary disease; BP, blood pressure; O2, oxygen saturations; C, celsius; GCS, Glasgow coma scale; SES, socioeconomic status.

***Table 1*: Cohort characteristics.**

Indigenous Australians, while rates of ambulance off-load within 40 min were higher. In adjusted analysis, rates of ED clinician review (adjusted risk difference −2.4 percentage points, 95% CI −3.8 to −1.0) were lower for Indigenous patients. Disposition from emergency was more commonly discharge home rather than admission among Indigenous cases, with rates of self-discharge also being higher (Supplementary Table S4).

For patients with a final diagnosis of MI, most of the care differences identified for the overall cohort were not present, although this portion of the analysis was limited by smaller sample size. Rates of transfer for myocardial infarction from centres without cardiac catheterisation facilities were lower (adjusted risk difference −20.4 percentage points, 95% CI −30.1 to −10.8).

In ordinal analysis (Fig. 2), number of performance measures adhered to by health services was lower for Indigenous patients overall, and for both pre-hospital and hospital measures separately. These findings were consistent across subgroups, including in all age, sex, and event location subgroups except for older cases ≥65 years (Supplementary Figure S3). Age-group specific adherence rates and risk differences for each care quality and process measure were comparable to the primary analysis, but more marked differences were observed among younger age groups (Supplementary Table S5).

Clinical outcomes

Thirty-day and long-term outcomes according to Indigenous status are shown in Fig. 3. Unadjusted 30-day and long-term mortality were lower among Indigenous cases in the setting of being a younger population (Supplementary Table S6), while unadjusted 30-day and long-term representation rates with chest pain were higher. In multivariable analysis, 30-day mortality was comparable between Indigenous and non-Indigenous cases (adjusted hazard ratio [aHR] 0.99, 95% CI 0.72–1.36). However, risk of 30-day EMS reattendance for chest pain (aHR 1.65, 95% CI 1.54–1.77), long-term EMS reattendance for chest pain (aHR 1.61, 95% CI 1.54–1.69), and long-term mortality (aHR 1.36, 95% CI 1.22–1.50) were higher for Indigenous people.

Sensitivity analyses assessing unadjusted mortality rates according to age-group demonstrated higher 30-day mortality rates among Indigenous Australians aged <50 years (but comparable 30-day mortality rates ≥50 years), and higher long-term mortality rates among Indigenous Australians aged 18–39 years, and 50–69 years (but not other age groups). In sensitivity analyses assessing outcomes among diagnostic subgroups, long-term mortality rates were higher when chest pain was related to respiratory, other medical, and non-specific pain causes (but not cardiovascular causes) (Supplementary Table S7), while 30-day and long-term re-attendance rates were higher across most diagnostic subgroups (Supplementary Table S8).

Diagnosis	Women		Men	
	Indigenous	Non-indigenous	Indigenous	Non-indigenous
N	2119	100,401	1770	100,625
Less than 50 years, N	950	25,764	852	23,414
STEMI	9 (1.0%)	146 (0.6%)	13 (1.5%)	691 (3.0%)
NSTEACS	20 (2.1%)	322 (1.3%)	26 (3.1%)	826 (3.5%)
Heart failure	1 (0.1%)	82 (0.3%)	17 (2.0%)	105 (0.5%)
Arrhythmia	19 (2.0%)	907 (3.5%)	15 (1.8%)	718 (3.1%)
Other cardiovascular	34 (3.4%)	871 (3.4%)	23 (2.7%)	1247 (5.3%)
Respiratory	115 (12.1%)	2198 (8.5%)	55 (6.5%)	1431 (6.1%)
Other medical	280 (29.5%)	7121 (27.6%)	260 (30.5%)	5375 (23.0%)
Non-specific pain	472 (49.7%)	14,147 (54.9%)	443 (52.0%)	13,021 (55.6%)
50–64 years, N	859	23,059	613	27,567
STEMI	13 (1.5%)	466 (2.0%)	22 (3.6%)	1788 (6.5%)
NSTEACS	52 (6.1%)	1272 (5.5%)	60 (9.8%)	3065 (11.1%)
Heart failure	11 (1.3%)	261 (1.1%)	6 (1.0%)	319 (1.2%)
Arrhythmia	20 (2.3%)	924 (4.0%)	17 (2.8%)	1064 (3.9%)
Other cardiovascular	27 (3.1%)	1144 (5.0%)	37 (6.0%)	2028 (7.4%)
Respiratory	102 (11.9%)	1945 (8.4%)	63 (10.3%)	1660 (6.0%)
Other medical	186 (21.7%)	3901 (16.9%)	101 (16.5%)	3955 (14.4%)
Non-specific pain	448 (52.2%)	13,146 (57.0%)	397 (50.1%)	13,688 (49.7%)
65 years or older, N	310	51,548	305	49,644
STEMI	8 (2.6%)	1275 (2.5%)	7 (2.3%)	2232 (4.5%)
NSTEACS	35 (11.3%)	5130 (10.0%)	35 (11.5%)	7369 (14.8%)
Heart failure	7 (2.3%)	2574 (5.0%)	8 (2.6%)	1967 (4.0%)
Arrhythmia	15 (4.8%)	3328 (6.5%)	8 (2.6%)	2250 (4.5%)
Other cardiovascular	22 (7.1%)	3969 (7.7%)	28 (9.2%)	4485 (9.0%)
Respiratory	42 (13.6%)	5042 (9.8%)	40 (13.1%)	5226 (10.5%)
Other medical	42 (13.6%)	7626 (14.8%)	44 (14.4%)	6786 (13.7%)
Non-specific pain	139 (44.8%)	22,604 (43.1%)	135 (44.3%)	19,329 (38.9%)

STEMI, ST elevation myocardial infarction; NSTEACS, non-ST elevation acute coronary syndrome.

Table 2: **Age- and sex-specific diagnosis rates among Indigenous Australians.**

Discussion

In this population-based cohort study, we assessed epidemiology, care quality, process measures, and outcomes for acute chest pain presentations among Indigenous Australians in Victoria, Australia. The major findings can be summarized as follows: (1) age-standardized incidence of EMS attendances for acute chest pain among the Indigenous population is high, especially among younger people, women, and in outer regional areas; (2) ambulance/institutional adherence to pre-hospital and hospital care quality and process measures, in addition to overall number of measures adhered to, was lower for Indigenous cases of undifferentiated chest pain, but care differences were less marked among cases with a discharge diagnosis of myocardial infarction; (3) rates of EMS reattendance for chest pain and long-term mortality were higher among Indigenous Australians following discharge from hospital, while rates of short-term mortality were similar. The differences in EMS and hospital adherence to care process and quality measures demonstrate that there is

substantial scope to improve care quality for Indigenous patients presenting with acute chest pain in Victoria, which should be a focus for health policy.

Improving health outcomes has been a focus for Australian health policy for several decades. The 'Closing the Gap' framework, adopted in 2008, aims to rapidly improve Indigenous life-expectancy with a target of no difference in life-expectancy by 2031. Some progress has been made, with cardiovascular mortality approximately halved, and improved access to angiography and specialists.[1] Much of the previous research regarding Indigenous health has been focussed on differences in outcomes between Indigenous and non-Indigenous Australians.[18–22] Although it is important to understand where differences in outcomes may be present, a sole focus on outcomes can contribute to a deficit discourse in Indigenous healthcare research, which does not necessarily result in improved health outcomes.[23,24] Therefore, one of the primary aims of the current study was to assess whether differences in care processes and quality were present, in turn highlighting

Measure	Indigenous n/N (%)	Non-indigenous n/N (%)	Risk difference (95% CI)	P	Adjusted risk difference[a] (95% CI)	P	ICC
Chest pain care							
Aspirin administered	1443/3890 (37.1)	83,009/201,074 (41.3)	–4.3 (–5.9 to –2.7)	<0.001	–0.8 (–2.3 to 0.8)	0.314	0.021
12-lead ECG	2162/3890 (55.6)	114,910/201,074 (57.2)	–1.6 (–3.1 to 0.0)	0.050	–0.3 (–1.6 to 0.9)	0.622	0.313
Analgesia if pain >2/10	2280/2677 (85.2)	108,711/123,675 (87.9)	–3.4 (–4.5 to –2.3)	<0.001	–1.9 (–3.0 to –0.7)	0.001	0.032
IV cannula inserted	1895/3890 (48.7)	113,793/201,074 (56.6)	–7.8 (–9.3 to –6.2)	<0.001	–7.1 (–8.5 to –5.7)	<0.001	0.063
Reviewed in target time	2650/3660 (72.4)	139,031/182,214 (76.3)	–4.0 (–5.3 to –2.7)	<0.001	–2.4 (–3.7 to –1.1)	<0.001	0.063
Off-load <40 min	3143/3746 (83.9)	160,516/194,447 (82.6)	1.3 (0.0 to 2.6)	0.036	–0.1 (–0.9 to 0.6)	0.747	0.233
ED length of stay <4 h	2133/3789 (56.3)	105,693/184,715 (57.2)	–0.8 (–2.4 to 0.8)	0.312	–1.5 (–3.0 to 0.1)	0.066	0.040
Myocardial infarction care							
Aspirin administered	109/183 (57.7)	10,583/17,789 (59.5)	0.0 (–7.0 to 7.2)	0.984	1.3 (–5.8 to 8.4)	0.721	0.008
12-lead ECG	125/183 (68.3)	11,365/17,789 (63.9)	4.6 (–2.7 to 11.8)	0.216	1.8 (–4.4 to 8.0)	0.572	0.178
Analgesia if pain >2/10	128/148 (86.5)	11,671/14,028 (83.2)	3.8 (–2.9 to 10.4)	0.266	2.0 (–4.7 to 8.7)	0.555	0.004
IV cannula inserted	141/183 (77.1)	13,881/17,789 (78.0)	–1.0 (–6.9 to 5.0)	0.750	–1.1 (–6.7 to 4.6)	0.710	0.091
Reviewed in target time	138/168 (82.1)	12,707/15,265 (83.2)	–0.8 (–6.4 to 4.7)	0.771	0.0 (–5.4 to 5.5)	0.994	0.044
Off-load <40 min	164/177 (92.7)	14,771/16,862 (87.6)	5.8 (–3.4 to 11.8)	0.064	3.4 (–2.2 to 9.0)	0.230	0.051
ED length of stay <4 h	90/168 (53.6)	8029/15,278 (52.6)	1.1 (–6.4 to 8.6)	0.770	1.5 (–5.7 to 8.8)	0.677	0.053
Angiography[b]	83/105 (79.1)	10,215/14,238 (71.7)	8.0 (–1.5 to 17.6)	0.100	–3.8 (–12.3 to 4.8)	0.390	0.082
Transfer[c]	48/78 (61.5)	2309/3551 (65.0)	–3.4 (–13.9 to 7.1)	0.524	–18.0 (–27.7 to –8.2)	<0.001	0.092

Risk differences are presented as percentage points difference. ICC (intra-class correlation coefficient) indicates the proportion of the total variance for each quality and process measure that occurs between classes i.e. at the hospital facility level. CI, confidence interval; ECG, electrocardiogram; ED, emergency department; IV, intravenous; MI, myocardial infarction. [a]Adjusted risk differences were calculated using the multiply-imputed dataset using a multilevel logistic regression model with age, sex, comorbidities, clinical status, private hospital status, hospital capabilities, socioeconomic status, region included as fixed effects and hospital facility included as a random effect to account for clustering. [b]Rates of angiography for patients diagnosed with myocardial infarction initially presenting to a cardiac catheterization capable centre. [c]Rates of transfer for patients diagnosed with myocardial infarction initially presenting to a non-cardiac catheterization capable centre.

Table 3: Care quality and process measures among Indigenous Australians with undifferentiated chest pain and among patients with a final diagnosis of myocardial infarction.

aspects of health care that can be targeted to improve outcomes.

The current study identified several disparities in health service adherence to care and process measures for Indigenous patients and should prompt consideration of mechanisms by which they can be improved. We identified differences in both pre-hospital (intravenous cannulation and analgesia administration) and hospital level care (ED review within target time and transfer or angiography rates for MI). However, differences were not present across all care measures—5 of 9 measures assessed demonstrated comparable rates in adjusted analysis. Similarly, outside of lower rates of transfer for MI, differences in care were not present among the MI subgroup, which might suggest at least some care differences relate to differences in presenting diagnoses (although this may in part be explained by smaller sample size). A limitation of the current analysis was the absence of mandatory Indigenous status data collection in the ambulance clinical record, which would allow assessment of further aspects of pre-hospital care such as non-transport rates, and allow assessment of outcomes for patients that were not able to be linked to the VAED and VEMD datasets. Differences were present between linked and unlinked ambulance records but it is difficult to draw conclusions from these—the higher rates of regional presentation could suggest a higher rate of Indigenous presentation within the unlinked cohort, while the lower comorbidities, higher

SES, and higher presentation to private centred might suggest the opposite. Mandating collection of Indigenous status by ambulance services could be strongly considered to be consistent with other health services.

These data support a role for public reporting, or at least regular internal assessment, of institutional adherence rates to state government key performance measures for Indigenous patients to identify outlier hospitals where access and care provision can be improved. This includes asking the standard Indigenous question "Are you of Aboriginal or Torres Strait Islander origin?". Indigenous status is collected in the same datasets (VAED and VEMD) that are used to determine institutional adherence to state government performance indicators, thereby making such an approach readily applicable with existing infrastructure. Moreover, this would provide a much more detailed overview of care provision and access for Indigenous Australians in comparison to the national key performance indicators for primary health care that are reported biannually,[25] or national cardiac care reports based on Medicare benefit scheme coding.[1] Lower rates of revascularisation for Indigenous Australians suffering MI have been previously shown,[2] and in our study while rates of angiography were similar, there were lower rates of transfer from non-revascularisation capable hospitals suggesting the need for ongoing improvements especially in non-revascularisation capable centres. Importantly, despite not receiving care of equal
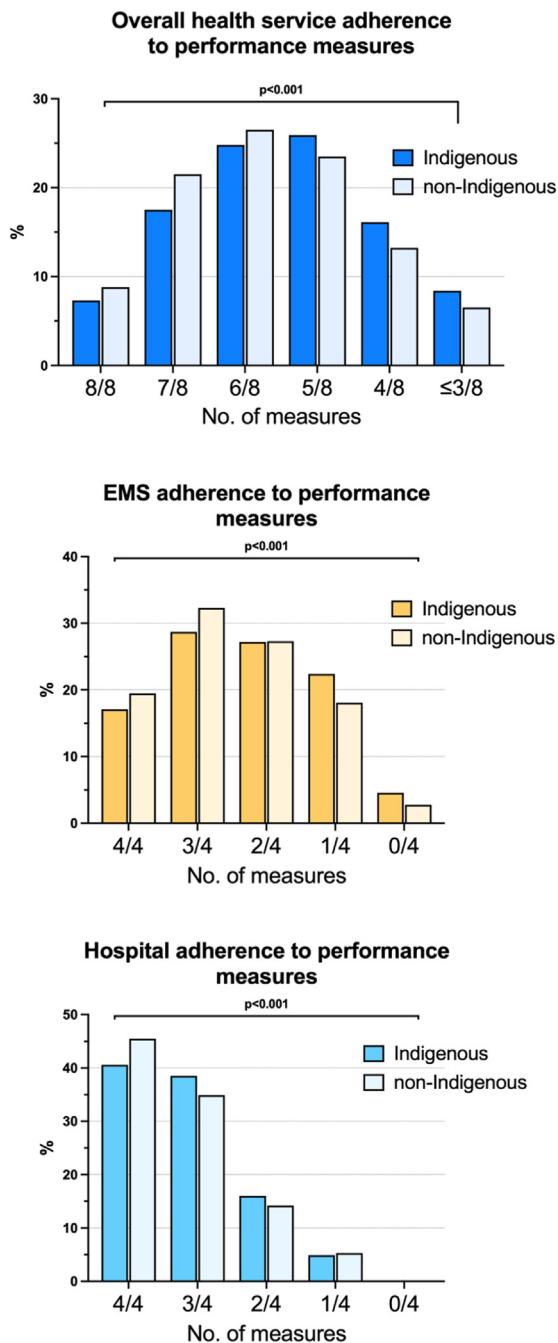
Overall health service adherence to performance measures

EMS adherence to performance measures

Hospital adherence to performance measures

Fig. 2: **Health service adherence to care quality and process measures among Indigenous Australians.** Top panel shows adherence to all quality measures included in the study, middle panel shows adherence for pre-hospital care measures, and bottom panel shows adherence to hospital measures. P values derived using a chi-square test across groups.

quality to others, Indigenous people were more likely to call on these services again—with higher adjusted rates of representation with chest pain, both in the short and long-term. While rates of cardiovascular causes of chest pain were lower among Indigenous men, it is important to interpret this finding in the setting of the higher incidence rate of chest pain.

Culturally appropriate health care that promotes health literacy remains inadequate in much of Australia, and is a major driver of readmissions.[26] Risk of readmissions with chest pain within 30-days and longer term were substantially higher in our study consistent with previous data,[19] and represent a significant cost to health systems. Similarly, rates of self-discharge from ED were higher in this study consistent with previous evidence,[27,28] which is associated with higher risk of readmission and relates to unmet needs in several categories including confidence in care quality, respectful treatment, and information provision.[29] Implicit racial bias among clinicians and healthcare workers, in addition to structural racism, are possible major drivers of disparities in care.[30,31] Collaborative approaches driven by Indigenous voices are required to develop novel approaches towards improving cultural safety in ambulances, EDs and hospitals, for example through improved recognition and identification of Indigenous people leading to improved access to culturally safe Indigenous health workers and Aboriginal health units.[32] In one study, the institution of a designated Indigenous health care team comprising a senior ED clinician and an Aboriginal healthcare worker in combination with flexible care approaches and early telephone follow-up, reduced the rate of incomplete treatment from 25% to 5%.[33] Primary prevention programs through Aboriginal community-controlled health services have been improving.[34] Further novel approaches that account for cultural safety, similar to the successful way barbershops have been used for hypertension screening and treatment among Black communities in the United States, might be considered.[35] Evidence regarding interventions that target health literacy in Indigenous Australian adults is currently limited and should also be a focus for improvements.[36] The development of the Victorian Aboriginal Research Accord led by the Victorian Aboriginal Community Control Health Organisation (VACCHO) and planned for implementation later in 2022, is likely to facilitate substantial improvements in ethical Aboriginal health research and community engagement.[37]

This study has several limitations. Although the study is population-based, the data are representative of ambulance attendances for chest pain, and if differences exist between Indigenous and non-Indigenous Australians in decisions surrounding contacting ambulance services compared to self-transporting to EDs this would affect the incidence rates. For example, younger people are more likely to directly present to EDs rather than contacting ambulance, which might result in an underestimation of overall chest pain incidence for Indigenous Australians

	Indigenous (n/N, %)	non-Indigenous (n/N, %)	Adjusted Hazard Ratio (95% CI)		P
30-day outcomes					
Mortality	39/3890 (1.0%)	3943/201074 (2.0%)	0.99 (0.72 to 1.36)		0.950
EMS reattendance for chest pain	884/3890 (22.7%)	19578/201074 (9.7%)	1.65 (1.54 to 1.77)		<0.001
Long-term outcomes					
Mortality	383/3890 (9.9%)	28605/201074 (14.2%)	1.36 (1.22 to 1.50)		<0.001
Follow-up (months, SD)	27.8 (16.0)	28.2 (16.3)			
EMS reattendance for chest pain	1891/3890 (48.6%)	59794/201074 (29.7%)	1.61 (1.54 to 1.69)		<0.001
Follow-up (months, SD)	13.6 (15.2)	19.1 (16.2)			

Better Indigenous outcomes ← | 0.5 1.0 1.5 2.0 | → Worse Indigenous outcomes

aHR

Fig. 3: **Outcomes for acute chest pain presentations among Indigenous Australians.** Adjusted hazard ratios were calculated using the multiply-imputed dataset using a multilevel time to first event analysis based on a Weibull distribution with age, sex, comorbidities, clinical status, private hospital status, hospital capabilities, socioeconomic status, region included as fixed effects and hospital facility included as a random effect to account for clustering. aHR, adjusted hazard ratio.

given their younger age in our cohort.[38] Additionally, mistrust of mainstream health care services stemming from their role as agents of government policies directed toward supporting the removal of Indigenous children from their families may also influence presentation patterns. There may also be differences in perceived seriousness of symptoms across populations. Conversely, one study found that Indigenous Australians were more likely to present to ED by ambulance in remote (but not metropolitan or regional), which might lead to overestimation of chest pain incidence rates in other states of Australia with more remote areas.[27] While concordance was high for MI and ACS in prior audits,[10] vague presentations, which can have multiple aetiologies such as undifferentiated chest pain may be more heterogenous and less concordant. Although Indigenous status is a mandatory data collection process during patient registration to Victorian hospitals, under-identification of Indigenous status has been described, and as previously mentioned the absence of mandatory Indigenous status data collection in ambulance records limits the analysis for pre-hospital care.[11,12] This study used the more inclusive 'ever-identified' approach to Indigenous status, which may be more likely to include non-Indigenous people and can influence disease rates and outcomes (although this needs to be balance against the risk of not capturing Indigenous Australians who may not always formally identify themselves at each health service registration).[12] The presented analysis represents the state of Victoria, Australia and may not be generalisable to other states of Australia which have a higher percentage of Indigenous Australians in their populations and may have different social profiles, health care access, and clinical practices, especially with regards to remote and very remote communities, which are not present in Victoria. The survival analysis uses time-to-first event and does not account for

recurrent multiple chest pain re-presentations or the competing risk of death, which can sometimes overestimate hazard ratios in comparison to other methods such as a Fine-Grey sub-distribution hazard model.[39] Finally, details regarding some parts of clinical care including emergency blood tests and radiography, prescription data, and follow-up were not available in our dataset and therefore differences in these aspects of care could not be assessed.

In this state-wide population-based study of Indigenous patients attended by ambulance in Victoria, Australia, we identified high incidence rates of acute chest pain presentations and higher rates of representation and long-term mortality. Important differences in care quality were observed with lower adjusted rates of pre-hospital intravenous cannulation, pre-hospital analgesia administration, ED review within target time, and transfer for myocardial infarction. These data suggest that there are systemic barriers to quality care for chest pain among Indigenous patients in Victoria, highlighting an urgent need to improve care for community members who identify as Aboriginal and Torres Strait Islander. Promising avenues for improvements include collection of data regarding Indigenous heritage data by ambulance services, public reporting or internal assessment of care quality measures with regular feedback to health services, and collaborative approaches and research focussed on improving cultural safety across the entire patient journey.

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