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ORIGINAL RESEARCH

Association of Socioeconomic Status With Outcomes and Care Quality in Patients Presenting With Undifferentiated Chest Pain in the Setting of Universal Health Care Coverage

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BACKGROUND: This study aimed to assess whether there are disparities in incidence rates, care, and outcomes for patients with chest pain attended by emergency medical services according to socioeconomic status (SES) in a universal health coverage setting.

METHODS AND RESULTS: This was a population-based cohort study of individually linked ambulance, emergency, hospital admission, and mortality data in the state of Victoria, Australia, from January 2015 to June 2019 that included 183 232 consecutive emergency medical services attendances for adults with nontraumatic chest pain (mean age 62 [SD 18] years; 51% women) and excluded out-of-hospital cardiac arrest and ST-segment–elevation myocardial infarction. Age-standardized incidence of chest pain was higher for patients residing in lower SES areas (lowest SES quintile 1595 versus highest SES quintile 760 per 100 000 person-years; $P<0.001$). Patients of lower SES were less likely to attend metropolitan, private, or revascularization-capable hospitals and had greater comorbidities. In multivariable models adjusted for clinical characteristics and final diagnosis, lower SES quintiles were associated with increased risks of 30-day and long-term mortality, readmission for chest pain and acute coronary syndrome, lower acuity emergency department triage categorization, emergency department length of stay >4 hours, and emergency department or emergency medical services discharge without hospital admission and were inversely associated with use of prehospital ECGs and transfer to a revascularization-capable hospital for patients presenting to non-percutaneous coronary intervention centers.

CONCLUSIONS: In this study, lower SES was associated with a higher incidence of chest pain presentations to emergency medical services and differences in care and outcomes. These findings suggest that substantial disparities for socioeconomically disadvantaged chest pain cohorts exist, even in the setting of universal health care access.

Key Words: chest pain ■ disparities in care ■ emergency medical services ■ outcomes ■ quality of care ■ socioeconomic status

Lower socioeconomic status (SES) has been consistently associated with worsened cardiovascular outcomes in population-based studies.[1–4] These disparities in outcomes relate to a multitude of factors at the individual level and the social or population level, including chronic psychosocial stressors, limited

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CLINICAL PERSPECTIVE

What Is New?

- In this population-based study of adult patients attended by emergency medical services for chest pain, lower socioeconomic status groups had approximately double the incidence of chest pain with increased risks of 30-day and long-term mortality and readmissions for chest pain or acute coronary syndromes.
- Important disparities in care were observed, including less frequent use of prehospital 12-lead ECGs, less urgent triage by emergency departments, less frequent transfer to revascularization-capable centers for patients with non–ST-segment–elevation acute coronary syndromes, and lower rates of admissions to hospitals.

What Are the Clinical Implications?

- These findings suggest that, even in the setting of universal health care access, substantial disparities in care and outcomes exist for socioeconomically disadvantaged patients, which should be a focus for health policy.

Nonstandard Abbreviations and Acronyms

ED	emergency department
EMS	emergency medical services
NSTEACS	non–ST-segment–elevation acute coronary syndromes
SES	socioeconomic status

economic and education opportunities, and higher rates of traditional risk factors.[5]

In many countries, including the United States, lower SES has significant implications regarding access to health services, which might contribute to outcome disparities. Australia has a universally accessible taxpayer-funded health system, which is free at the point of use, providing a setting where SES has minimal impact on access to hospital care. Such a setting allows the assessment of disparities in hospital quality-of-care metrics and outcomes without confounding relating to disparities in access. Many countries have instituted quality improvement programs and benchmarking aimed at reducing hospital variations in care, including among patients of lower SES.[6–11] The majority of these programs are targeted at the procedure level, such as percutaneous coronary intervention (PCI) registries,[8,10] or at the disease level, such as acute coronary syndrome (ACS) registries,[2,9] with few data available assessing health care disparities at the symptom level, including chest pain, which accounts for 1 in 10 calls to emergency medical services (EMS).[12–14] Data regarding prehospital management of chest pain cohorts according to SES, in addition to hospital-based management, are especially scant.

In this large, population-based study of nontraumatic chest pain attendances by EMS, we aimed to assess whether there were disparities in incidence rates, clinical characteristics, quality-of-care metrics, and outcomes of chest pain presentations according to SES. Moreover, we aimed to assess whether any aspects of prehospital and hospital-level care might explain differences in outcomes and therefore should be a focus for changes in health policy. There is increasing awareness of the importance of the whole patient journey,[15] and therefore patients starting their care with EMS were selected to capture the prehospital and in-hospital patient experience and to allow the assessment of performance indicators from first medical contact.

METHODS

The data underlying this study are available upon reasonable request to the corresponding author. This was a population-based, observational cohort study of consecutive adult patients attended by EMS for nontraumatic chest pain between January 1, 2015, and June 30, 2019, in Victoria, Australia—a state of 6.7 million people with a land area of 227 444 km^2 in the southeastern part of the country. Australia's health services are funded through Medicare, a universal health insurance scheme cofunded by the state and national governments.[16] Australians presenting to public hospitals are guaranteed access to cost-free treatment as public patients. Private insurance is available for patients wishing to choose their own physician and for some nonsubsidized services such as dental care. To reduce pressure on public hospitals, the use of private health insurance is encouraged through a means-tested rebate available to people who take out private insurance and a Medicare levy surcharge charged to higher income earners without private insurance. In terms of acute chest pain care, patients with private insurance are able to select their own consultant clinician and may have faster access to some investigations, including angiography, but overall care is expected to be equivalent to public health care. EMS services are provided based on a cost per use or an annual membership fee system, but exemptions apply for low-income patients, pensioners, and veterans in addition to patients suffering medical conditions related to motor vehicle accidents or workplace injuries. In Victoria, the overwhelming majority of patients attended by EMS are transported to a hospital, but a small minority are referred to community services if certain strict clinical criteria are met and following discussion of the case with a centralized experienced paramedic clinician.

Study Population

Prehospital data entered into the EMS electronic patient care record (Victorian EMS Clinical Information System) by paramedics were linked to the VEMD (Victorian Emergency Minimum Dataset), the Victorian Admitted Episodes Dataset, and the Victorian Death Index to determine prehospital and in-hospital management, diagnoses, and outcomes. Full details regarding the cohort and linkage processes are included in Data S1. Recent audit data of the VEMD data set identified a concordance rate with emergency department (ED) medical records of 100% for index myocardial infarction diagnosis and 94% for index ACS diagnosis.[17] Consecutive patients attended by EMS for chest pain were included in the study if paramedics recorded either of the following criteria on the patient care record: (1) pain in the chest or central chest or (2) a final or secondary EMS diagnosis of ischemic chest pain, ACS, acute myocardial infarction, pleuritic pain, or angina. Exclusion criteria included traumatic chest pain, ST-segment–elevation myocardial infarction (either prehospital or hospital discharge diagnosis), interhospital transfers, patient refusal to be transported to a hospital, death before EMS transport to a hospital, and age <18 years. Patients with ST-segment–elevation myocardial infarction were excluded from the cohort as the urgent management of patients with ST-segment elevation in the prehospital setting is unlike the management of chest pain without ST-segment elevation, and recent data are available assessing this study question.[11] Ethics approvals for the data linkage and this study were provided by the Monash University Human Research Ethics Committee (approval number 11681) and the requirement for informed consent was waived given the study was a retrospective analysis of previously collected data.

Study Definitions

SES was determined using the Index of Relative Socio-Economic Disadvantage score, derived from 2016 Australian Bureau of Statistics national census data. Scores are provided for each residential postcode based on household income, unemployment rate, home and motor vehicle ownership, educational level, and non-English-speaking background, with the score then being converted into a percentile nationwide and within the state.[18] The Index of Relative Socio-Economic Disadvantage scoring system is a validated composite measure of SES that correlates with other Australian Bureau of Statistics measures of SES such as the index of occupation and education and has previously been used in studies of SES in cardiovascular disease.[11] In previous studies and government reports, Index of Relative Socio-Economic Disadvantage data are conventionally divided into quintiles, and therefore we used the same approach for this study by dividing the nationwide Index of Relative Socio-Economic Disadvantage percentile score into quintiles as follows: highest (percentiles 81–100), high (percentiles 61–80), middle (percentiles 41–60), low (percentiles 21–40), and lowest (percentiles 1–20). Patients with missing residential postcode data to allow derivation of SES were excluded from the primary analysis. Hospitals were classified according to revascularization capabilities as (1) non-PCI centers if no revascularization facilities were available, (2) PCI-only centers if PCI but no coronary artery bypass graft (CABG) surgery services were available, and (3) PCI and CABG centers if PCI and CABG revascularization services were available. Final diagnosis was defined according to *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification* (*ICD-10-AM*) coding as the hospital discharge primary diagnosis if discharged from hospital, the ED primary diagnosis if discharged from the ED, or "not transported" if discharged by ambulance without transport to a hospital. EMS diagnoses or final assessments were not included in the presented data.

Outcomes and Care Metrics

Outcomes reported included mortality, all-cause EMS readmission rates, and EMS readmission rates for subsequent ACS, with each reported at 30 days and long term (median follow-up, 2.3 years). Quality-of-care metrics reported included EMS triage category (lights and sirens versus urgent), rates of analgesia (ie, opioids) or nitrate administration by EMS if pain score >2 of 10, prehospital 12-lead ECG rates, ED triage category (emergent, urgent, semi-urgent), ED length of stay <4 hours, admission status (EMS or ED discharge versus hospital or short stay admission), angiography rates (for patients initially brought to hospitals with revascularization capabilities), and transfer rates (for patients initially brought to hospitals without revascularization capabilities). Prehospital 12-lead ECGs were available in high-acuity ambulances across the study period but were not available in standard ambulances in Victoria until 2017; therefore, 12-lead ECG rates before this time were significantly lower.

Statistical Analysis

Age-standardized incidence rates per 100 000 person-years were calculated using mid-year age-specific and sex-specific population estimates available from the Australian Bureau of Statistics by 5-year age brackets using total case numbers (both linked and unlinked cases; see cohort derivation in Figure S1), with CIs calculated assuming a Poisson distribution. For illustrative purposes, a bivariate choropleth map presenting the distribution of socioeconomic disadvantage compared with age-standardized incidence rates of chest pain by Australian Bureau of Statistics statistical area 2 were generated using ArcGIS (ESRI, Redlands, CA). Continuous data are expressed as mean±SD and median (interquartile range [IQR]), as appropriate, whereas categorical variables are presented as number (percentage). *P* values for trends across groups were calculated using the Cochran–Armitage test for categorical data, linear regression for normally distributed continuous data, and the Jonckheere–Terpstra test for nonbinary categorical data and skewed continuous data. Associations of SES quintiles with outcomes and care metrics were assessed using multilevel mixed-effects regression models with inclusion of the hospital to which each patient was transported (or nontransport if not transported to a hospital) as a random effect to account for clustering. A parametric survival model based on the Weibull distribution reporting hazard ratios (HRs) and 95% CIs was used with a censorship date of September 30, 2019, for long-term mortality and June 30, 2019, for EMS reattendances. Models were adjusted for age, sex, comorbidities, clinical status (initial hypotension [systolic blood pressure ≤90 mm Hg], tachycardia [heart rate >100 bpm], tachypnea [respiratory rate >30 breaths per minute], or hypoxia [oxygen saturation ≤90%]) and final diagnosis. For multivariable models, missing comorbidity data were assumed to represent the absence of the comorbidity, whereas complete case analysis was used for other covariates. The proportion of missing data in the analysis cohort was <5%. Kaplan–Meier failure curves were used to plot long-term mortality and readmission rates for chest pain or ACS, with comparison by SES quintile using the log-rank test. For specific care metrics where lower SES quintiles were independently associated with lower care quality, we assessed for a modification effect in 30-day outcomes by stratifying poor performing care metrics using the same multivariable model with SES percentile included as a restricted cubic spline. Effect modification was assessed using interaction terms between the SES spline variables and these care metrics. The number of knots were selected by fitting models with 3, 4, and 5 knots for each 30-day end point, and the model that resulted in the minimum Akaike information criterion was selected. To address missing data relating to patients who could not be linked to hospital admission data sets, we performed a sensitivity analysis with the same multivariable analysis using EMS data with adjustment for age, sex, comorbidities, and clinical status (n=216 467). To address missing residential SES data, we repeated the multivariable analysis using event location postcode to determine SES rather than residential postcode with adjustment for age, sex, comorbidities, and clinical status (n=239 479). To account for potential differences in management in private compared with public hospitals, we repeated the multivariable analysis excluding private hospitals (n=170 776). To account for lower rates of prehospital ECGs before 2017, we included a sensitivity analysis limiting the cohort to the years 2017 to 2019 when prehospital ECGs were universally available and repeated the multivariable analysis for performance of a prehospital ECG. Finally, we performed a subgroup analysis presenting unadjusted data for prehospital and hospital care quality metrics by SES quintile limited to patients with an index hospital discharge diagnosis of non–ST-segment–elevation ACS (NSTEACS). Statistical analysis was conducted using StataMP version 17.0 (College Station, TX).

RESULTS

A total of 240 466 patients with chest pain attended by EMS during the study period met the inclusion criteria (Figure S1). Of these, 37 321 patients (15.5%) were transported to a hospital but could not be linked to index emergency or hospital admission records and were excluded, and 19 923 patients (8.3%) had missing data regarding SES and were excluded, leaving 183 232 patients in the primary analysis. Patients were transported to private hospitals in 4.8% of the cohort and more commonly among higher SES groups (11.8% for highest SES quintile versus 1.9% for lowest SES quintile; Table 1). Age-standardized incidence rates are shown in comparison to SES by statistical area in Figure 1. Incidences of chest pain were higher in regions of socioeconomic disadvantage (1595 per 100 000 person-years in lowest SES quintile versus 760 per 100 000 person-years in highest SES quintile; *P*<0.0001; Table 1 and Figure S2).

Clinical Characteristics and Diagnoses

Lower SES quintiles were younger and more commonly of Aboriginal or Torres Strait Islander heritage, whereas sex was similar across groups (Table 1). EMS transports were more frequently in regional locations to public hospitals and to hospitals without revascularization capabilities. Rates of comorbidities, including hypertension, hyperlipidemia, diabetes, chronic kidney disease, coronary disease, stroke, and chronic obstructive pulmonary disease, were higher among patients of lower SES, as were rates of tachycardia, hypoxia, tachypnea, and chest pain categorized as severe (pain score ≥8 of 10). The proportions of chest pain presentations with a final emergency or hospital discharge diagnosis of cardiac disease (non–ST-segment–elevation myocardial

Table 1. Clinical Characteristics by SES Quintile

Variable	SES quintile					P value for trend
	Lowest	Low	Middle	High	Highest	
Patients	50 616	39 585	36 322	33 341	23 368	
Age-standardized incidence of chest pain attendances per 100 000 person-y	1595 (1593–1606)	1131 (1105–1124)	1115 (1105–1124)	1033 (1023–1052)	760 (752–768)	<0.001
Age, y	61±19	63±18	63±18	63±19	63±18	<0.001
Sex						
Male	24 601 (48.6)	19 244 (48.6)	17 752 (48.9)	16 307 (48.9)	11 206 (48.4)	0.888
Female	25 996 (51.4)	20 334 (51.4)	18 562 (51.1)	17 027 (51.1)	12 055 (51.6)	
Aboriginal/Torres Strait Islander	1665 (3.6)	647 (1.8)	584 (1.8)	247 (0.9)	111 (0.6)	<0.001
Attendance location						
Metropolitan	32 983 (65.2)	25 622 (64.7)	26 446 (72.8)	27 524 (82.5)	20 916 (89.5)	<0.001
Inner regional	14 379 (28.4)	11 690 (29.6)	8220 (22.6)	5220 (15.7)	2367 (10.1)	
Outer regional	3254 (6.4)	2273 (5.7)	1656 (4.6)	597 (1.8)	85 (0.4)	
Hospital type						
Public	47 688 (98.1)	37 055 (97.0)	33 393 (95.2)	30 046 (93.5)	20 003 (88.6)	<0.001
Private	943 (1.9)	1158 (3.0)	1690 (4.8)	2099 (6.5)	2554 (11.4)	
Hospital capability						
PCI and CABG surgery	11 159 (23.0)	9193 (24.1)	10 539 (30.0)	12 680 (39.5)	10 001 (44.3)	<0.001
PCI only	19 185 (39.4)	13 987 (36.6)	11 836 (33.7)	9195 (28.6)	5600 (24.8)	
No revascularization	18 287 (37.6)	15 033 (39.3)	12 708 (36.3)	10 270 (31.9)	6956 (30.9)	
Medical history						
Hypertension	19 688 (40.3)	15 513 (40.7)	13 894 (39.9)	12 437 (39.2)	8437 (38.4)	<0.001
Hyperlipidemia	14 214 (29.1)	11 029 (28.9)	10 182 (29.2)	9056 (28.6)	6041 (27.5)	<0.001
Diabetes	10 787 (22.1)	7514 (29.7)	6338 (18.2)	5283 (16.7)	3005 (13.7)	<0.001
Chronic kidney disease	1548 (3.2)	1125 (3.0)	1003 (2.9)	802 (2.5)	535 (2.4)	<0.001
Prior coronary disease	16 640 (34.0)	12 437 (32.6)	10 774 (30.9)	9311 (29.4)	6038 (27.5)	<0.001
Prior stroke	3313 (6.8)	2376 (6.2)	2004 (5.8)	1789 (5.6)	1153 (5.3)	<0.001
PVD	519 (1.1)	435 (1.1)	333 (1.0)	355 (1.1)	198 (0.9)	0.127
COPD	5433 (11.1)	3429 (9.0)	2729 (7.8)	2111 (6.7)	1138 (5.2)	<0.001
Obstructive sleep apnea	723 (1.5)	598 (1.6)	553 (1.6)	430 (1.4)	284 (1.3)	0.024
Clinical status						
Tachycardic	14 304 (28.3)	10 113 (25.6)	8903 (24.6)	8094 (24.3)	5417 (23.2)	<0.001
Hypotensive	754 (1.5)	657 (1.7)	566 (1.6)	475 (1.4)	452 (1.9)	0.018
Hypoxic	2194 (4.4)	1577 (4.1)	1256 (3.5)	1058 (3.2)	647 (2.8)	<0.001
Tachypnoea	3131 (6.2)	2251 (5.7)	1988 (5.5)	1712 (5.1)	1158 (5.0)	<0.001
Pain scores						
0–3	16 774 (34.8)	13 984 (36.7)	13 300 (37.9)	12 472 (38.7)	9315 (41.1)	<0.001
4–7	20 829 (43.2)	16 720 (43.9)	15 411 (43.9)	14 374 (44.6)	10 078 (44.5)	
8–10	10 586 (22.0)	7392 (19.4)	6382 (18.2)	5412 (16.8)	3267 (14.4)	

Data are provided as number, number (percentage), mean±SD, or median (interquartile range). CABG indicates coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; PCI, percutaneous coronary intervention; PVD, peripheral vascular disease; and SES, socioeconomic status.

infarction, unstable angina, other cardiac) or nonspecific chest pain were lower with lower SES, whereas the proportions of chest pain presentations with a respiratory, rheumatological, mental health, or other medical diagnoses were higher.

Treatment Quality Metrics by SES

Prehospital and hospital quality metrics are shown in Table 2. Among prehospital metrics, rates of prehospital aspirin and analgesia or nitrate administration were similar across SES quintiles, prehospital 12-lead ECGs

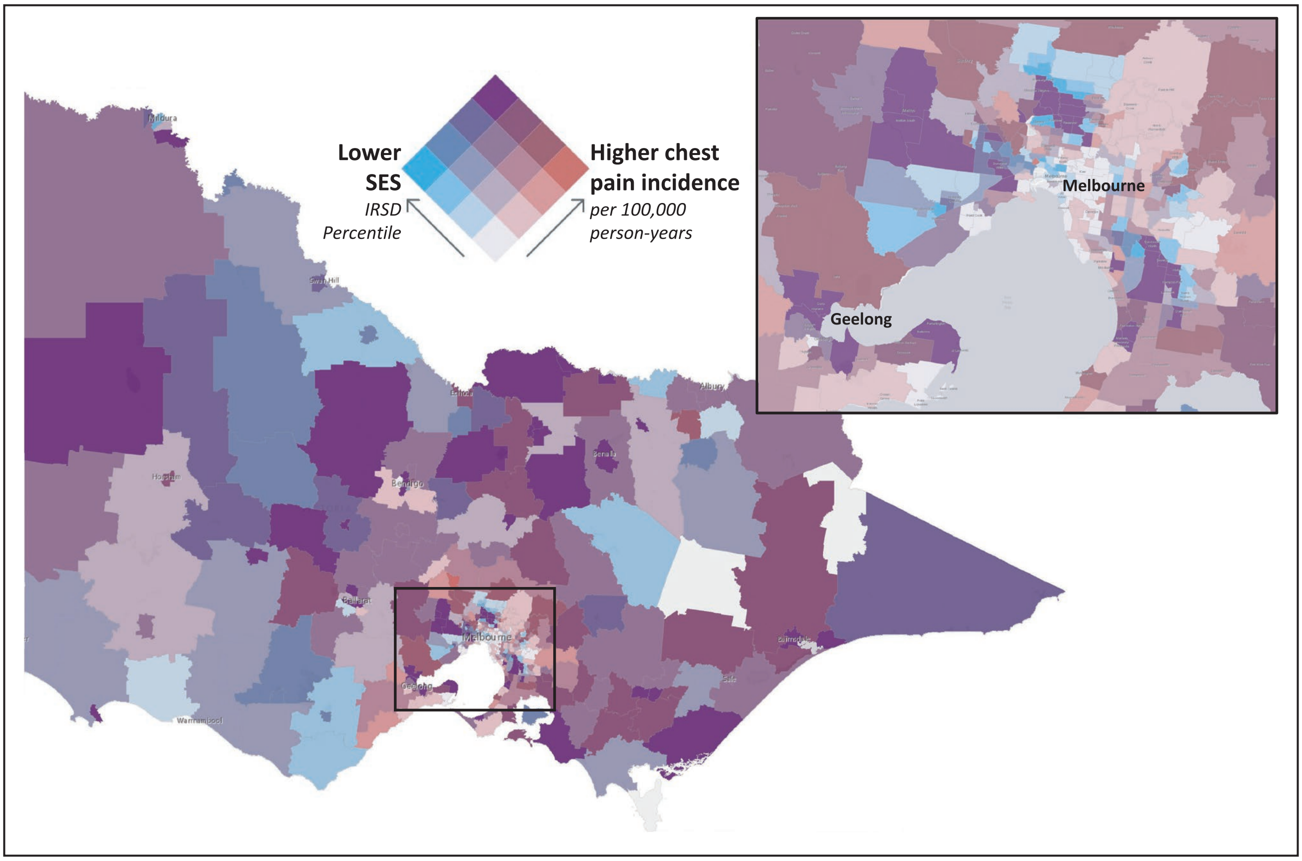

Figure 1. Incidence of chest pain attendances compared with SES according to statistical area in Victoria, Australia.
Bivariate map showing the relationship between age-standardized incidence of chest pain attendances per 100 000 person-years compared with SES percentile according to Australian Bureau of Statistics statistical area 2 in the state of Victoria, Australia, and for the 2 most populous metropolitan regions Melbourne and Geelong (inset). Higher chest pain incidence is shown in red, whereas lower SES is shown in blue. Purple shades indicate a high level of correlation between SES and chest pain incidence. IRSD indicates Index of Relative Socio-Economic Disadvantage; and SES, socioeconomic status.

were less commonly performed, and total EMS time was lower among lower SES groups. Patients of lower SES were more likely to be assessed as not requiring transport to a hospital, rates of hospital and short stay admission were lower, rates of prehospital or ED discharge to usual place of residence were higher, and ED length of stay was longer.

In the subgroup analysis for patients discharged from index hospital presentation with a diagnosis of NSTEACS (Table S1), patients of lower SES were more likely to be treated with prehospital aspirin and discharged from the ED to the usual place of residence and have a longer ED length of stay. For patients with NSTEACS brought to CABG surgery and PCI capable centers, rates of angiography, PCI, and CABG were similar across SES quintiles. For patients diagnosed with NSTEACS brought initially to PCI-only centers, rates of angiography were higher among lower SES quintiles, whereas rates of PCI were similar. For patients diagnosed with NSTEACS brought initially to centers without revascularization facilities, rates of transfer to PCI centers were lower for lower SES groups.

Outcomes

Unadjusted rates of index non–ST-segment–elevation myocardial infarction and 30-day mortality were higher, whereas rates of revascularization were lower (Table 2). Further unadjusted outcomes by SES quintile are shown in Table S2, demonstrating higher rates of reattendance for chest pain and ACS with lower SES. By specific diagnosis, rates of 30-day mortality were higher for non-ACS cardiac conditions and nonspecific chest pain among patients of lower SES, but similar for other diagnoses. Rates of long-term mortality, reattendance for chest pain, and reattendance for ACS were higher among lower SES quintiles across a median follow-up period of 2.3 years (IQR, 1.3–3.5 years) for mortality and 1.9 years (IQR, 0.9–3.2 years) for reattendance. Kaplan–Meier curves depicting long term outcomes according to SES quintile are shown in Figure 2.

Multivariable Analysis

In multivariable models adjusted for age, sex, comorbidities, and diagnosis, lower quintiles of SES were

Table 2. Prehospital and Hospital Quality Metrics and Outcomes by SES Quintile for Patients Presenting With Chest Pain

Variable	SES quintile					*P* value for trend
	Lowest	Low	Middle	High	Highest	
Number	50 616	39 585	36 322	33 341	23 368	
Aspirin prehospital	19 744 (39.0)	15 565 (39.3)	14 124 (38.9)	12 992 (39.0)	9034 (38.7)	0.290
Analgesia or nitrate given if pain score >2 of 10	33 167/38 792 (85.5)	25 835/29 987 (86.2)	23 474/27 232 (86.2)	21 182/24 791 (85.4)	14 841/17 341 (85.6)	0.795
Prehospital ECG*	23 029 (45.6)	19 072 (48.3)	17 965 (49.6)	16 308 (49.1)	11 226 (48.2)	<0.001
Attendance outcome						
Referred to local doctor	698 (1.4)	551 (1.4)	497 (1.4)	507 (1.5)	312 (1.3)	<0.001
Transfer not required	1191 (2.4)	728 (1.8)	634 (1.8)	609 (1.8)	418 (1.8)	
Brought to ED	48 727 (96.3)	38 306 (96.8)	35 191 (96.9)	32 335 (96.7)	22 638 (96.9)	
ED discharge	15 271 (30.1)	11 081 (28.0)	9493 (26.1)	8229 (24.7)	5098 (21.8)	
Short stay discharge	15 212 (30.1)	12 637 (31.9)	12 368 (34.1)	11 868 (35.6)	8470 (36.3)	
Hospital admission	18 244 (36.0)	14 588 (36.9)	13 330 (36.7)	12 128 (36.4)	9070 (38.8)	
EMS triage category						
Lights and sirens	44 619 (88.2)	34 744 (87.9)	32 096 (88.5)	29 404 (88.3)	20 693 (88.7)	0.038
Urgent/acute	5952 (11.8)	4794 (12.1)	4193 (11.6)	3885 (11.7)	2648 (11.3)	
ED triage category						
Emergent	22 942 (50)	18 109 (50)	16 465 (51)	14 461 (50)	9532 (50)	0.008
Urgent	19 964 (43)	15 369 (43)	13 884 (43)	12 896 (44)	8504 (44)	
Semi-urgent	3435 (7)	2442 (7)	2075 (6)	1810 (6)	1126 (6)	
Total EMS time, min	99 (81–121)	102 (84–124)	104 (86–125)	103 (87–123)	103 (87–122)	<0.001
ED length of stay, h	3.9 (2.8–6.4)	3.9 (2.8–6.2)	3.8 (2.8–6.0)	3.7 (2.7–5.9)	3.6 (2.6–5.5)	<0.001
Hospital length of stay, d	3 (1–5)	3 (1–5)	3 (1–5)	3 (1–5)	3 (1–5)	<0.001
Index ED/hospital discharge diagnosis						
NSTEMI	2550 (5.2)	2144 (5.6)	1978 (5.6)	1851 (5.7)	1323 (5.8)	<0.001
Unstable angina	1567 (3.2)	1419 (3.7)	1307 (3.7)	1179 (3.7)	793 (3.5)	0.011
Other cardiac	6166 (12.7)	5163 (13.5)	4863 (13.8)	4697 (14.6)	3382 (14.9)	<0.001
Pulmonary emboli	317 (0.7)	302 (0.8)	261 (0.7)	270 (0.8)	210 (0.9)	<0.001
Respiratory	5022 (10.3)	3608 (9.4)	3172 (9.0)	2584 (8.0)	1713 (7.6)	<0.001
Gastrointestinal	2479 (5.1)	1847 (4.8)	1774 (5.0)	1663 (5.2)	1132 (5.0)	0.703
Rheumatological	1268 (2.6)	976 (2.6)	855 (2.4)	749 (2.3)	506 (2.2)	<0.001
Mental health	1116 (2.3)	686 (1.8)	637 (1.8)	590 (1.8)	373 (1.6)	<0.001
Other specific medical	4589 (9.4)	3338 (8.7)	2928 (8.3)	2652 (8.2)	1752 (7.7)	<0.001
Nonspecific pain	23 653 (48.5)	18 823 (49.1)	17 416 (49.5)	15 990 (49.6)	11 455 (50.6)	<0.001
Revascularization†	897 (1.8)	858 (2.2)	873 (2.4)	893 (2.7)	749 (3.2)	<0.001
30-d mortality	941 (1.9)	704 (1.8)	604 (1.7)	537 (1.6)	372 (1.6)	<0.001

Data are provided as number, number (percentage), or median (interquartile range). ED indicates emergency department; EMS, emergency medical services; NSTEMI, non–ST-segment–elevation myocardial infarction; and SES, socioeconomic status.

*Prehospital ECG not available in all EMS vehicles until 2017.

†Includes revascularization following transfer from non–percutaneous coronary intervention centers; revascularization data limited to non–ST-segment–elevation acute coronary syndromes subgroup stratified by hospital capabilities presented in Table S1.

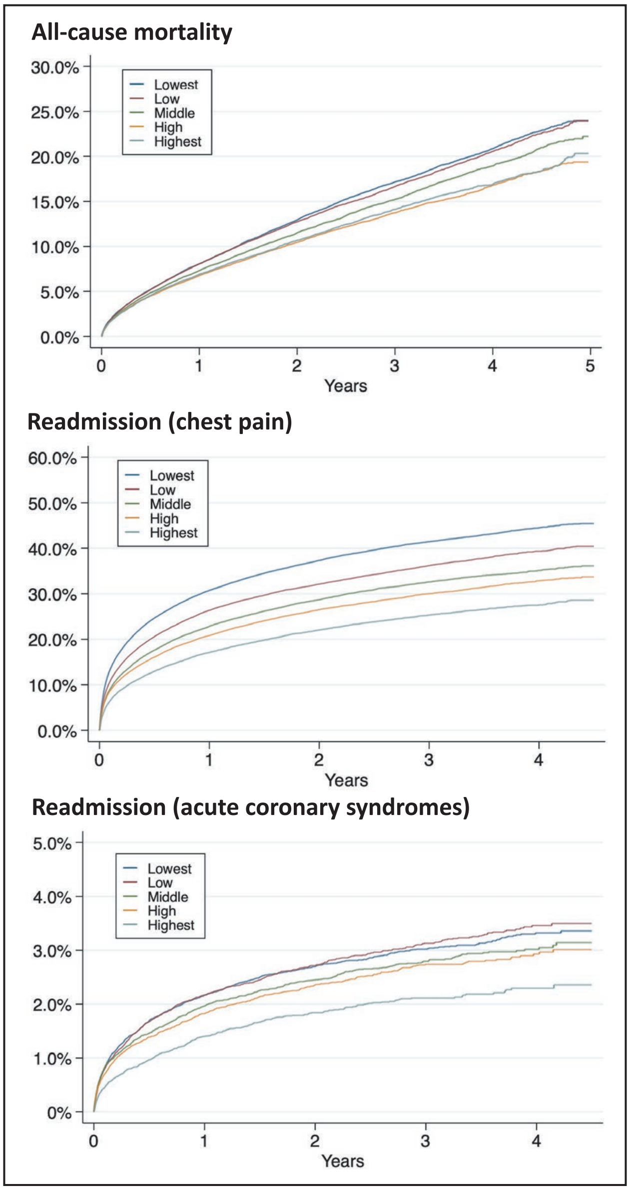

Figure 2. Outcomes according to socioeconomic status quintile.
Top, All-cause mortality (log-rank, *P*<0.001). **Middle**, All-cause readmissions (log-rank, *P*<0.001). **Bottom**, Readmissions for acute coronary syndromes (log-rank, *P*<0.001).

associated with increased risks of both 30-day and long-term readmissions for chest pain or ACS in comparison with the highest SES quintile (Table 3). For all-cause mortality, the lowest quintile (but not low, middle, or high quintiles) was associated with an increased risk of 30-day mortality in comparison with the highest quintile, whereas the lowest, low, and middle quintiles were associated with an increased risk of long-term mortality in comparison with the highest quintile. Lower quintiles of SES were independently associated with nonurgent or semi-urgent ED triage and inversely associated with performance of a prehospital 12-lead ECG, admission to hospital or short stay, ED length of stay <4 hours, and transfer if initially presenting to a nonrevascularization center. No association was observed between lower SES and angiography rates at revascularization centers. Several sensitivity analyses were performed demonstrating that findings were robust when EMS data only were used for patients who could not be linked to hospital admission data (Table S3), when event location data were used for SES in place of residential data (Table S4), when private hospitals were excluded (Table S5), and when limited to years when prehospital ECG facilities were universally available in ambulances (Table S6).

Effect Modification by Care Metrics

Effect modification was assessed for hospital quality-of-care metrics that were associated with lower SES in the multivariable analysis (ED/EMS discharge, nonurgent/semi-urgent ED triage, ED length of stay <4 hours, and transfer from non-PCI centers). For EMS reattendance for chest pain within 30 days, significant interactions were observed between lower SES and ED/EMS discharge, nonurgent ED triage, and ED length of stay <4 hours (Figure S3). No significant interactions were observed for 30-day EMS reattendance for ACS (Figure S4) or 30-day mortality (Figure S5).

DISCUSSION

In this population-based cohort study, we assessed the impact of SES on chest pain incidence, management, and outcomes among patients attended by EMS in a setting of universal health care access. The major findings can be summarized as follows: (1) a socioeconomic gradient for age-standardized incidence of chest pain was observed, with approximately double the incidence among the lowest versus highest quintile of SES; (2) lower SES cohorts had greater comorbidities and clinical instability; (3) patients of lower SES were more likely to present to regional centers without revascularization capabilities and less likely to be triaged as emergent or urgent, receive a prehospital 12-lead ECG, be admitted to hospital or short stay, or be transferred to centers with revascularization capabilities from non-revascularization-capable centers; (4) in multivariable models, lower SES was associated with increased risks of mortality and readmission at both 30 days and long term; (5) for risk of reattendance with chest pain within 30 days, significant interactions were observed between lower SES and discharge directly from EMS or ED, nonurgent triage, and ED length of stay <4 hours.

In the past 2 decades, multiple studies have shown a higher incidence of ischemic heart disease and coronary events in socially disadvantaged communities.[19–21]

Table 3. Multivariable Analysis

	SES quintile									
	Lowest		Low		Middle		High		Highest	
	HR/OR (95% CI)	*P* value	HR/OR (95% CI)	*P* value	HR/OR (95% CI)	*P* value	HR/OR (95% CI)	*P* value	HR/OR (95% CI)	*P* value
30-d outcomes*										
All-cause mortality	1.14 (1.00–1.30)	0.049	1.06 (0.93–1.21)	0.388	1.01 (0.88–1.15)	0.890	1.02 (0.89–1.17)	0.757	1.00	–
Reattendance,chest pain	2.06 (1.94–2.19)	<0.001	1.66 (1.56–1.77)	<0.001	1.39 (1.30–1.48)	<0.001	1.32 (1.23–1.41)	<0.001	1.00	–
Reattendance, ACS	1.66 (1.31–2.10)	<0.001	1.62 (1.27–2.05)	<0.001	1.66 (1.31–2.10)	<0.001	1.48 (1.16–1.88)	0.002	1.00	–
Long-term outcomes*										
All-cause mortality	1.26 (1.20–1.32)	<0.001	1.19 (1.14–1.25)	<0.001	1.08 (1.03–1.13)	0.002	0.99 (0.95–1.04)	0.78	1.00	–
Reattendance, chest pain	1.82 (1.76–1.89)	<0.001	1.55 (1.49–1.60)	<0.001	1.34 (1.29–1.39)	<0.001	1.22 (1.18–1.26)	<0.001	1.00	–
Reattendance, ACS	1.44 (1.27–1.63)	<0.001	1.41 (1.25–1.60)	<0.001	1.27 (1.12–1.44)	<0.001	1.24 (1.10–1.41)	0.001	1.00	–
Quality metrics†										
Prehospital ECG performed	0.82 (0.79–0.85)	<0.001	0.94 (0.91–0.98)	0.001	1.00 (0.97–1.04)	0.865	1.00 (0.96–1.03)	0.840	1.00	–
Admitted to short stay or hospital‡	0.86 (0.82–0.90)	<0.001	0.93 (0.89–0.90)	0.001	0.97 (0.92–1.01)	0.133	0.96 (0.92–1.00)	0.059	1.00	–
ED time <4 h‡	0.91 (0.87–0.94)	<0.001	0.91 (0.88–0.95)	<0.001	0.93 (0.90–0.97)	<0.001	0.99 (0.95–1.03)	0.591	1.00	–
Nonurgent or semi-urgent ED triage‡	1.37 (1.26–1.48)	<0.001	1.24 (1.14–1.34)	<0.001	1.16 (1.07–1.26)	<0.001	1.09 (1.00–1.18)	0.047	1.00	–
Angiography, PCI centers, n=111 255§	0.92 (0.83–1.02)	0.104	1.01 (0.91–1.13)	0.798	1.01 (0.91–1.12)	0.896	0.98 (0.88–1.09)	0.687	1.00	–
Transfer, non-PCI centers, n=52 106‖	0.78 (0.68–0.88)	<0.001	0.85 (0.75–0.96)	0.009	0.87 (0.77–0.99)	0.031	0.91 (0.80–1.04)	0.173	1.00	–

ACS indicates acute coronary syndrome; ED, emergency department; HR, hazard ratio; OR, odds ratio; PCI, percutaneous coronary intervention; and SES, socioeconomic status.

*HR (95% CI) represent comparisons to the highest SES quintile with a time-to-event analysis using a multilevel regression model adjusted for age, sex, comorbidities, clinical status (tachycardia, hypoxia, hypotension, tachypnoea), and final diagnosis based on a Weibull distribution with admission hospital (or nonadmission if not transported to hospital) included as a random effect to account for clustering.

†OR (95% CI) represent comparisons to the highest SES quintile using a multilevel logistic regression model adjusted for age, sex, comorbidities, clinical status (tachycardia, hypoxia, hypotension, tachypnoea), and final diagnosis with admission hospital (or nonadmission if not transported to hospital) included as a random effect to account for clustering.

‡Analyses only include patients transported to the ED (patients not transported to the ED were excluded).

§Analyses represent adjusted ORs for undergoing an angiogram limited to patients initially brought to a revascularization-capable hospital.

‖Analyses represent adjusted ORs for being transferred to a revascularization-capable hospital limited to patients initially brought to non-revascularization-capable centers.

Similarly, socioeconomic disadvantage is associated with worsened cardiovascular outcomes at both the individual and community levels.[1–3] This association is present across a broad spectrum of cardiovascular diseases, including ACS, heart failure, atrial fibrillation, and cardiac arrest.[11,22–27] The current study demonstrates that the higher incidence of ischemic heart disease in lower SES cohorts represents the tip of the iceberg, reflecting approximately 10% of a larger burden of substantially higher rates of chest pain presentations. The substantial socioeconomic gradient for age-adjusted chest pain incidence in our study represents not only greater ACS rates in patients of lower SES but also greater presentations for nonspecific chest pain; non-ACS cardiac disorders; and disorders of the respiratory, gastrointestinal, rheumatological, mental health, and other organ systems. Importantly, these findings were observed among patients seeking assistance from EMS rather than self-presenting to ED, and previous data suggest that patients transported by EMS are often clinically more unwell and more likely to be of lower SES.[28–30]

The current study identified an independent association between SES and outcomes in a large undifferentiated chest pain cohort, independent of final diagnosis, and in a setting with universal health care, suggesting that disparities in SES outcomes are substantially more complex than accessibility alone. The social determinants of health are multifactorial and complex, resulting from an array of biological, behavioral, and psychosocial factors more prevalent in individuals of lower SES.[1] In cardiovascular disease, SES is associated with several specific factors that play a contributory role. Rates of comorbidities and risk factors are higher,[31] an observation also shown in our study. Participation in primary prevention or risk-factor screening programs before cardiac events and cardiac rehabilitation following events is lower.[32–34] Adverse lifestyle factors, such as poor physical fitness and smoking, have higher prevalence.[1,35] Finally, there are disparities in access to and delivery of health care, such as angiography and revascularization rates.[2,24] Several socioeconomic markers demonstrate a consistent association with cardiovascular outcomes including income level, educational attainment, employment status, and environmental factors.[1] A strength of the current study is the use of a composite measure of neighborhood SES, including measures of household income, educational level, unemployment rate, home and vehicle ownership, and language.

Our study demonstrates several important disparities in metrics of prehospital and hospital care among patients of lower SES neighborhoods. Importantly, these occurred in a system aimed at providing equitable care, suggesting that systemic biases that favor patients of higher SES may be present that require more consideration than cost-free access. Lower rates of admissions to hospitals and short stays were observed among socioeconomically disadvantaged patients in the models adjusted for clinical characteristics and discharge diagnosis. Although admission is clearly not an indicator of good care for patients at low risk, lower SES patients had lower index diagnosis rates of nonspecific pain, and in combination with the observed interaction between ED discharge and risk of chest pain reattendance for patients of low SES, these data suggest that socioeconomically disadvantaged patients might be inappropriately discharged in some circumstances. Similarly, there appeared to be a propensity toward nonurgent or semi-urgent triage categories by ED. Importantly, both hospital admission and ED triage categories appeared to partially explain the increased risk among patients of low SES for readmission with chest pain within 30 days, with statistically significant effect modifications identified for both care metrics. Interventions to facilitate a more cautious approach by EMS and ED clinicians in decisions surrounding discharge could therefore reduce the risk of readmission for low SES cohorts. Another observed disparity included low rates of transfer to PCI-capable centers for patients with NSTEACS from centers without revascularization capabilities. This is concerning, and standardization of ACS management pathways for non-PCI centers in addition to assessing ACS transfer rates as a hospital-level quality metric for benchmarking should be considered. Previous studies have demonstrated discrepancies of angiography and PCI rates among lower SES groups[2,24]; however, encouragingly our study showed no differences at centers with revascularization capabilities. Previous studies have demonstrated that hospital geographic factors play a role in discrepancies in the uptake of evidence-based ACS management, which might explain the seeming paradox of socioeconomic discrepancies in transfer rates at non-PCI centers, whereas no discrepancies were observed in revascularization rates at revascularization-capable centers.[36] Similarly, our study did not demonstrate discrepancies in aspirin administration, which has been observed for Medicare and Medicaid patients in the United States,[37] although the overall low rate of aspirin administration suggests that this should be a focus for improvement in EMS management of undifferentiated chest pain overall. Our study highlights 1 of the limitations of procedure-focused and disease-focused registries, which may not be able to assess the disparities of care upstream of a diagnosis. Quality improvement programs that address hospital practices at the symptom level before diagnosis might be of benefit in improving outcomes for at-risk groups.

Given these substantive discrepancies in both chest pain incidence and outcomes, improvements in these disparities should be a focus for health policy. Targeted interventions at each of the primary, secondary, and tertiary prevention levels are required. At the primary level, improved involvement in risk-factor screening programs and population-based measures to improve lifestyle factors such as smoking, diet, and exercise would be beneficial. For patients presenting to EMS with chest pain, our study highlights that greater caution with decisions regarding discharge should be applied by clinicians. Not only do these patients have greater risks of poor outcomes and re-presentation but also our data suggest that ED or EMS discharge increases the risk of re-presentation within 30 days. Hospital systems that can flag patients at increased risk of readmission or complications following discharge, such as patients of lower SES, could assist clinicians in ensuring adequate follow-up is in place. Hospital electronic medical records have increased the capabilities of automated systems to highlight patients who are at risk.[38] Some studies have identified lower attendance rates at specialist appointments for patients of low SES,[39] which might contribute to higher readmission rates. Similar low attendance rates at cardiac rehabilitation programs[32–34] have been shown to increase with financial incentives.[40] An average chest pain presentation and ED admission for nonspecific pain costs in the vicinity of $2500USD.[41] Although financial incentives for follow-up might seem expensive, a similar approach for chest pain cohorts might assist in reducing re-presentation rates and overall health system costs.

Limitations

This study has several limitations. First, although the study is population based, the data are representative of the state of Victoria, Australia, and may not be generalizable to other jurisdictions that may have different social profiles, health care systems and access, and clinical practices. In other jurisdictions with universal health care, discrepancies have been observed in the management and outcomes of ACS and cardiac disease, but we were not able to identify any comparable studies assessing undifferentiated chest pain.[24,42,43] Similarly, these findings apply to patients presenting to EMS with chest pain, a cohort that may be more clinically unwell and more likely to be of lower SES in comparison with patients that self-present to ED.[28,30] Second, although the study has a large sample size, a proportion of ambulance cases could not be linked to a hospital admission, and data were not available regarding neighborhood SES for some patients, both which may have influenced the results. We attempted to address this with 2 sensitivity analyses including EMS data only. In the multivariable models, adjustment for missing comorbidity data were managed by assuming absence of the comorbidity, which is a limitation, although overall rates of missing data were low. Third, the composite measure of SES reflects neighborhood SES, and data were not available regarding individual SES. Similarly, specific measures that comprise the composite SES index, such as income, employment status, and education level, were not assessed separately. Prehospital ECG facilities were not universally available until 2017, which might have impacted the results; however, we aimed to address this through the sensitivity analysis limited to the year 2017 onward. Finally, details regarding some aspects of hospital care such as results of investigations, medication prescriptions, and follow-up plans and whether these appointments were attended were not available in our data set and would be an important focus for further research.

CONCLUSIONS

In this population-based study of patients attended by EMS for chest pain, lower SES was associated with a substantially higher incidence of chest pain presentations, greater comorbidities and clinical instability, and worse outcomes in a universal health care setting. Important disparities in care were observed, including less frequent use of prehospital 12-lead ECGs, less urgent triage by ED, less frequent transfer to a revascularization-capable center for patients with NSTEACS, and lower risk-adjusted and diagnosis-adjusted rates of admission to hospital. These appeared to partly explain the increased risk of reattendance with chest pain among low SES groups. Interventions to improve disparities in incidence, care, and outcomes among low SES groups are urgently required, and a more cautious approach to early discharge should be considered by clinicians and health-policy makers.

ARTICLE INFORMATION

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Supplemental Material

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SUPPLEMENTAL MATERIAL

Data S1.

Supplemental Methods

I. Dataset linkage processes

Ambulance Victoria is the sole provider of emergency medical services in the state of Victoria, dispatching Advanced Life Support and Intensive Care paramedics to medical emergencies. At the conclusion of each case, paramedics complete an electronic patient care record which captures patient and case details, as well as any management provided. Data from these records are uploaded to and stored within a clinical data warehouse, termed the Victorian Ambulance Clinical Information System (VACIS).

For this study, data linkage was performed to combine electronic patient care record data with key Victorian datasets. These included:

1. Victorian Emergency Minimum Dataset: Victorian Department of Health administrative and clinical data related emergency department (ED) presentations at public hospitals in the state. Data is submitted by individual health services and is then subject to validation checks. For this study, ambulance patient identifiers were matched with Department of Health identifiers using a fuzzy matching process. ED presentations for matched patients were then linked to ambulance cases as follows:

    a. Where the patient was transported to hospital by ambulance, the VEMD arrival time was required to be within one hour of the ambulance ED arrival time.

    b. Where the patient contacted ambulance but was not transported to hospital, the VEMD arrival time was required to be within 48 hours of the emergency call for ambulance. If multiple VEMD records existed within the 48-hour period, the presentation occurring closest in time to the ambulance call was used.

2. Victorian Admitted Episodes Dataset: Victorian Department of Health demographic, clinical and administrative data relating to each admitted episode of care occurring in public and private hospitals, as well as rehabilitation centres, extended care facilities and day procedure centres in the state. For this study, ambulance patient identifiers were matched with Department of Health identifiers using a fuzzy matching process. For matched patients, individual admitted episodes of care occurring up to 48 hours after the emergency ambulance call were linked to the ambulance patient care record data. Where multiple admitted episodes were recorded within the 48 hours, the episode occurring closest in time to the ambulance call was used.

3. Victorian Death Index: Victorian Department of Justice and Community Safety data capturing the date and cause of all deaths in Victoria. For this study, ambulance patient identifiers were matched with Department of Health identifiers using a fuzzy matching process. For matched patients, death records were then linked to all ambulance contacts occurring in the study period.

II. Study Definitions

Geographic remoteness was determined through the residential area postcode of each event using The Accessibility and Remoteness Index of Australia (ARIA) – a geographic accessibility index that divides Australia into five classes of remoteness (‘Major City’, ‘Inner Regional’, ‘Outer Regional’, ‘Remote’, and ‘Very Remote’) to reflect relative access to services in non-metropolitan Australia.[1] Due to low numbers of patients from ‘remote’ or ‘very remote’ regions, these groups were combined with the ‘outer regional’ group for the purposes of this study. Socio-economic status was determined using The Index of Relative Socio-Economic Disadvantage (IRSD) score, a validated system using national Census data that ranks each residential postcode into deciles based on household income, unemployment rate, home and motor vehicle ownership, educational level, and non-English speaking background.[2] For the purposes of this study, we divided the IRSD score into quintiles, with the 1st quintile including patients living in the lowest 2 IRSD score deciles (most disadvantaged) and the 5th quintile including patients living in the highest 2 IRSD score deciles (least disadvantaged).

The final diagnoses for patients transported to hospital used in Table 3 were categorised using the following International Classification of Diseases [ICD] 10 criteria:

1. Non-ST elevation myocardial infarction: I214, I219
2. Unstable angina: I200
3. Other cardiac: I00-I99 excluding I200-I259
4. Pulmonary emboli: I260, I269
5. Respiratory diagnosis: J00-J998
6. Gastrointestinal diagnosis: K000-K938
7. Rheumatological diagnoses: M0000-M99923
8. Mental Health diagnoses: F000-F99
9. Other specialties: A000-E899, G000-H959, L00-L998, N000-Q999, S001-Z999
10. Non-specific chest pain: R000-R99

Procedures rates presented in Table 2 were defined according to ICD 10 procedural codes as follows:

1. Coronary angiography: 3820300, 3820600, 382500, 3821800-3821802
2. Percutaneous coronary intervention: 3830600-3830605, 3831200, 3831201, 3831800, 3831801
3. Coronary artery bypass graft surgery: 3849700-3849707, 3850000-3850005, 3850300-3850305, 9020100-9020103

Table S1. Pre-hospital and hospital quality metrics by SES quintile for patients diagnosed with Non-ST Elevation Acute Coronary Syndrome (NSTEACS) at index presentation (n=16,111)

	Socioeconomic Status Quintile					
	Lowest	**Low**	**Middle**	**High**	**Highest**	**$P_{for\ trend}$**
Variables						
Number	4,117	3,563	3,285	3,030	2,116	
Aspirin pre-hospital	2,207 (54%)	1,885 (52%)	1,601 (49%)	1,464 (48%)	1,049 (50%)	0.025
Call outcome						0.001
ED discharge	260 (6%)	209 (6%)	194 (6%)	138 (5%)	63 (3%)	
Short stay discharge	500 (12%)	506 (14%)	470 (14%)	524 (17%)	405 (19%)	
Hospital admission	3,357 (82%)	2,848 (80%)	2,621 (80%)	2,368 (78%)	1,648 (78%)	
EMS triage category						0.125
Time critical	346 (9%)	274 (8%)	249 (8%)	221 (7%)	151 (7%)	
Urgent/acute	3,672 (90%)	3,191 (91%)	2,934 (91%)	2,742 (91%)	1,923 (92%)	
Non-urgent	45 (1%)	35 (1%)	49 (2%)	25 (1%)	10 (0%)	
ED triage category						0.739
Emergent	2,545 (67%)	2,110 (66%)	1,955 (67%)	1,705 (66%)	1,066 (67%)	
Urgent	1,207 (32%)	1,043 (33%)	924 (32%)	847 (33%)	524 (33%)	
Semi-urgent	50 (1%)	28 (1%)	33 (1%)	28 (1%)	13 (1%)	
Total EMS time (min)	104 (86-126)	105 (87-126)	107 (89-126)	105 (89-125)	105 (89-124)	0.008
ED length of stay (hr)	5.4 (3.6-9.0)	5.1 (3.4-8.4)	5.3 (3.5-8.9)	4.9 (3.4-8.6)	4.6 (3.3-8.0)	<0.001
Hospital length of stay (d)	2 (1-4)	2 (1-4)	2 (1-4)	2 (1-4)	2 (1-4)	0.024
CABG & PCI centres:	*n=913*	*n=777*	*n=898*	*n=1,108*	n=784	
Angiography rate	417 (46%)	363 (47%)	421 (47%)	503 (45%)	378 (48%)	0.546
PCI rate	200 (22%)	163 (21%)	211 (24%)	263 (24%)	190 (24%)	0.106
CABG rate	46 (5%)	44 (6%)	43 (5%)	54 (5%)	33 (4%)	0.330
PCI only centres:	*n=782*	*n=685*	*n=528*	*n=405*	*n=274*	
Angiography rate	782 (51%)	685 (54%)	528 (50%)	405 (48%)	274 (48%)	0.023
PCI rate	323 (21%)	301 (24%)	253 (24%)	183 (22%)	136 (24%)	0.351
Non-PCI centres:	*n=1,648*	*n=1,510*	*n=1,314*	*n=1,053*	*n=748*	
Transfer rate	794 (53%)	737 (56%)	628 (58%)	456 (60%)	252 (72%)	<0.001

Table S2. Outcomes by SES quintile

	Socioeconomic Status Quintile					
	Lowest	**Low**	**Middle**	**High**	**Highest**	**$P_{for\ trend}$**
30-day outcomes						
Mortality	941 (1.9%)	704 (1.8%)	604 (1.7%)	537 (1.6%)	372 (1.6%)	<0.001
Mortality by diagnosis:						
NSTEMI	99 (3.9%)	84 (3.9%)	83 (4.2%)	67 (3.6%)	42 (3.2%)	0.214
Unstable angina	20 (1.3%)	13 (0.9%)	28 (2.1%)	10 (0.9%)	9 (1.1%)	0.857
Other cardiac	179 (2.9%)	140 (2.7%)	108 (2.2%)	93 (2.0%)	76 (2.3%)	<0.001
Pulmonary emboli	14 (4.4%)	12 (4.0%)	5 (1.9%)	9 (3.3%)	5 (2.4%)	0.161
Respiratory	190 (3.8%)	137 (3.8%)	108 (3.4%)	106 (4.1%)	68 (4.0%)	0.667
Gastrointestinal	47 (1.9%)	35 (1.9%)	26 (1.5%)	26 (1.6%)	17 (1.5%)	0.232
Rheumatological	11 (0.9%)	9 (0.9%)	8 (0.9%)	4 (0.5%)	6 (1.2%)	0.973
Mental health	8 (0.7%)	6 (0.9%)	5 (0.8%)	4 (0.7%)	3 (0.8%)	0.988
Other specific medical	210 (4.6%)	157 (4.7%)	152 (5.2%)	132 (5.0%)	90 (5.1%)	0.606
Non-specific pain	145 (0.6%)	104 (0.6%)	76 (0.4%)	67 (0.4%)	53 (0.5%)	0.005
Reattendance (Chest pain)	6,256 (12%)	3,933 (10%)	3,054 (8%)	2,685 (8%)	1,398 (6%)	<0.001
Reattendance (ACS)	369 (0.7%)	293 (0.7%)	273 (0.8%)	216 (0.7%)	98 (0.4%)	<0.001
Long-term outcomes						
Mortality	7,614 (15%)	5,748 (15%)	4,781 (13%)	3,976 (12%)	2,896 (12%)	<0.001
Reattendance (Chest pain)	17,871 (35%)	11,951 (30%)	9,639 (27%)	8,212 (25%)	4,859 (21%)	<0.001
Reattendance (ACS)	1,282 (2.5%)	1,007 (2.5%)	826 (2.3%)	726 (2.2%)	398 (1.7%)	<0.001

Table S3. Sensitivity analysis including patients with missing linkage data but complete residential socioeconomic status data (n=216,467)

	Socioeconomic Status Quintile									
	Lowest		Low		Middle		High		Highest	
	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P
30-day outcomes*										
All-cause mortality	1.15 (1.02-1.30)	0.023	1.08 (0.96-1.23)	0.212	1.04 (0.92-1.18)	0.542	1.05 (0.92-1.19)	0.495	1.00	-
Reattendance (chest pain)	1.90 (1.80-2.01)	<0.001	1.61 (1.52-1.71)	<0.001	1.38 (1.30-1.47)	<0.001	1.35 (1.27-1.43)	<0.001	1.00	-
Reattendance (ACS)	1.63 (1.31-2.03)	<0.001	1.67 (1.33-2.09)	<0.001	1.70 (1.36-2.14)	<0.001	1.50 (1.18-1.89)	0.001	1.00	-
Long-term outcomes*										
All-cause mortality	1.22 (1.17-1.27)	<0.001	1.19 (1.14-1.25)	<0.001	1.07 (1.02-1.12)	0.003	0.99 (0.95-1.04)	0.787	1.00	-
Reattendance (chest pain)	1.72 (1.67-1.77)	<0.001	1.49 (1.44-1.54)	<0.001	1.31 (1.27-1.36)	<0.001	1.22 (1.18-1.26)	<0.001	1.00	-
Reattendance (ACS)	1.43 (1.28-1.61)	<0.001	1.47 (1.31-1.65)	<0.001	1.31 (1.16-1.48)	<0.001	1.29 (1.14-1.46)	<0.001	1.00	-

*Hazard ratios (HR) 95% confidence intervals (95% CI) represent comparison to the highest SES quintile with a time to event analysis using a cox regression model adjusted for age, sex, comorbidities, and clinical status (tachycardia, hypoxia, hypotension, tachypnoea).

†Odds ratios (OR) 95% confidence intervals represent comparison to the highest SES quintile using a logistic regression model adjusted for age, sex, comorbidities, and clinical status (tachycardia, hypoxia, hypotension, tachypnoea).

Table S4. Sensitivity analysis including patients with missing linkage data and using event postcode location for socioeconomic status rather than residential postcode (n=239,479)

	Socioeconomic Status Quintile									
	Lowest		Low		Middle		High		Highest	
	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P
30-day outcomes*										
All-cause mortality	1.09 (0.98-1.21)	0.104	1.23 (1.10-1.36)	<0.001	1.09 (0.98-1.21)	0.103	1.16 (1.05-1.28)	0.003	1.00	-
Reattendance (chest pain)	1.34 (1.29-1.40)	<0.001	1.11 (1.06-1.16)	<0.001	1.03 (0.98-1.08)	0.201	1.14 (1.10-1.19)	<0.001	1.00	-
Reattendance (ACS)	1.38 (1.17-1.63)	<0.001	1.43 (1.20-1.70)	<0.001	1.28 (1.08-1.52)	0.004	1.26 (1.07-1.48)	0.007	1.00	-
Long-term outcomes*										
All-cause mortality	1.20 (1.16-1.24)	<0.001	1.12 (1.08-1.17)	<0.001	1.12 (1.08-1.16)	<0.001	1.09 (1.05-1.13)	<0.001	1.00	-
Reattendance (chest pain)	1.36 (1.32-1.39)	<0.001	1.20 (1.17-1.23)	<0.001	1.12 (1.09-1.15)	<0.001	1.15 (1.12-1.17)	<0.001	1.00	-
Reattendance (ACS)	1.27 (1.16-1.40)	<0.001	1.44 (1.31-1.58)	<0.001	1.23 (1.12-1.35)	<0.001	1.23 (1.12-1.34)	<0.001	1.00	-

*Hazard ratios (HR) 95% confidence intervals (95% CI) represent comparison to the highest SES quintile with a time to event analysis using a cox regression model adjusted for age, sex, comorbidities, and clinical status (tachycardia, hypoxia, hypotension, tachypnoea).

†Odds ratios (OR) 95% confidence intervals represent comparison to the highest SES quintile using a logistic regression model adjusted for age, sex, comorbidities, and clinical status (tachycardia, hypoxia, hypotension, tachypnoea).

Table S5. Sensitivity analysis excluding private hospitals (n=170,776)

	Socioeconomic Status Quintile									
	Lowest		Low		Middle		High		Highest	
	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P	HR/OR (95% CI)	P
30-day outcomes*										
All-cause mortality	1.16 (1.00-1.33)	0.043	1.09 (0.94-1.26)	0.248	1.04 (0.90-1.21)	0.551	1.05 (0.91-1.22)	0.506	1.00	-
Reattendance (chest pain)	2.07 (1.94-2.21)	<0.001	1.67 (1.56-1.78)	<0.001	1.40 (1.31-1.50)	<0.001	1.33 (1.25-1.43)	<0.001	1.00	-
Reattendance (ACS)	1.57 (1.23-1.99)	<0.001	1.57 (1.23-2.01)	<0.001	1.60 (1.26-2.05)	<0.001	1.44 (1.13-1.85)	0.004	1.00	-
Long-term outcomes*										
All-cause mortality	1.26 (1.20-1.32)	<0.001	1.20 (1.14-1.26)	<0.001	1.08 (1.03-1.14)	0.003	1.00 (0.95-1.05)	0.949	1.00	-
Reattendance (chest pain)	1.83 (1.76-1.90)	<0.001	1.55 (1.50-1.61)	<0.001	1.33 (1.29-1.38)	<0.001	1.22 (1.18-1.27)	<0.001	1.00	-
Reattendance (ACS)	1.42 (1.25-1.61)	<0.001	1.40 (1.23-1.59)	<0.001	1.25 (1.23-1.59)	0.001	1.26 (1.10-1.43)	0.001	1.00	-
Quality metrics†										
Pre-hospital ECG performed	0.82 (0.79-0.85)	<0.001	0.94 (0.90-0.97)	0.001	1.00 (0.97-1.04)	0.903	1.00 (0.96-1.04)	0.927	1.00	-
Admitted to short stay or hospital‡	0.84 (0.80-0.87)	<0.001	0.92 (0.88-0.96)	<0.001	0.96 (0.92-1.00)	0.069	0.95 (0.91-1.00)	0.037	1.00	-
ED time < 4 hours‡	0.91 (0.87-0.94)	<0.001	0.91 (0.88-0.95)	<0.001	0.93 (0.90-0.97)	<0.001	0.99 (0.95-1.03)	0.558	1.00	-
Non- or semi-urgent ED triage‡	1.36 (1.26-1.48)	<0.001	1.24 (1.14-1.34)	<0.001	1.16 (1.07-1.26)	<0.001	1.08 (1.00-1.18)	0.051	1.00	-
Angiography (PCI centres, n=111,255)§	0.93 (0.84-1.03)	0.180	1.04 (0.93-1.15)	0.518	1.02 (0.93-1.15)	0.746	0.99 (0.89-1.09)	0.789	1.00	-
Transfer (non-PCI centres, n=52,106)‖	0.78 0.67-0.88)	<0.001	0.85 (0.75-0.96)	0.010	0.87 (0.77-0.99)	0.035	0.91 (0.80-1.04)	0.172	1.00	-

Hazard ratios (HR) 95% confidence intervals (95% CI) represent comparison to the highest SES quintile with a time to event analysis using a multilevel regression model adjusted for age, sex, comorbidities, clinical status (tachycardia, hypoxia, hypotension, tachypnoea) and final diagnosis based on a Weibull distribution with admission hospital (or non-admission if not transported to hospital) included as a random effect to account for clustering.

†Odds ratios (OR) 95% confidence intervals represent comparison to the highest SES quintile using a multilevel logistic regression model adjusted for age, sex, comorbidities, clinical status (tachycardia, hypoxia, hypotension, tachypnoea) and final diagnosis with admission hospital (or non-admission if not transported to hospital) included as a random effect to account for clustering.

‡Analyses only includes patients transported to ED (patients not transported to ED excluded).

§Analyses represents adjusted odds ratios for undergoing an angiogram limited to patients initially brought to a revascularisation capable hospital

‖Analyses represent adjusted odds ratios for being transferred to a revascularisation capable hospital limited to patients initially brought to non-revascularisation capable centres.

Table S6. Sensitivity analysis limited from 2017-2019 with universally available pre-hospital ECG facilities (n=112,626)

	Socioeconomic Status Quintile									
	Lowest		Low		Middle		High		Highest	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Pre-hospital ECG performed*	0.82 (0.78-0.86)	<0.001	0.92 (0.88-0.97)	0.001	0.97 (0.93-1.02)	0.242	0.96 (0.91-1.00)	0.076	1.00	-
Overall ECG rate, number (%)	19,903 (65.8%)		16,685 (68.3%)		15,9987 (69.5%)		14,392 (69.0%)		9,782 (69.6%)	

*Odds ratios (OR) 95% confidence intervals represent comparison to the highest SES quintile using a logistic regression model adjusted for age, sex, comorbidities, and clinical status (tachycardia, hypoxia, hypotension, tachypnoea).

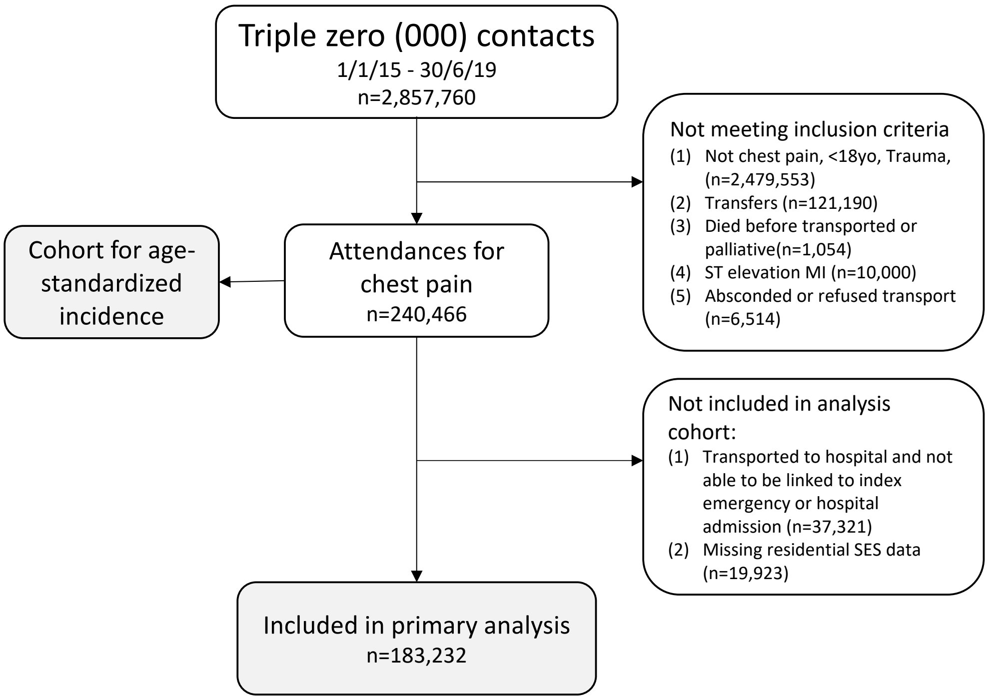

Figure S1. Cohort derivation. VACIS = Victorian Ambulance Clinical Information System

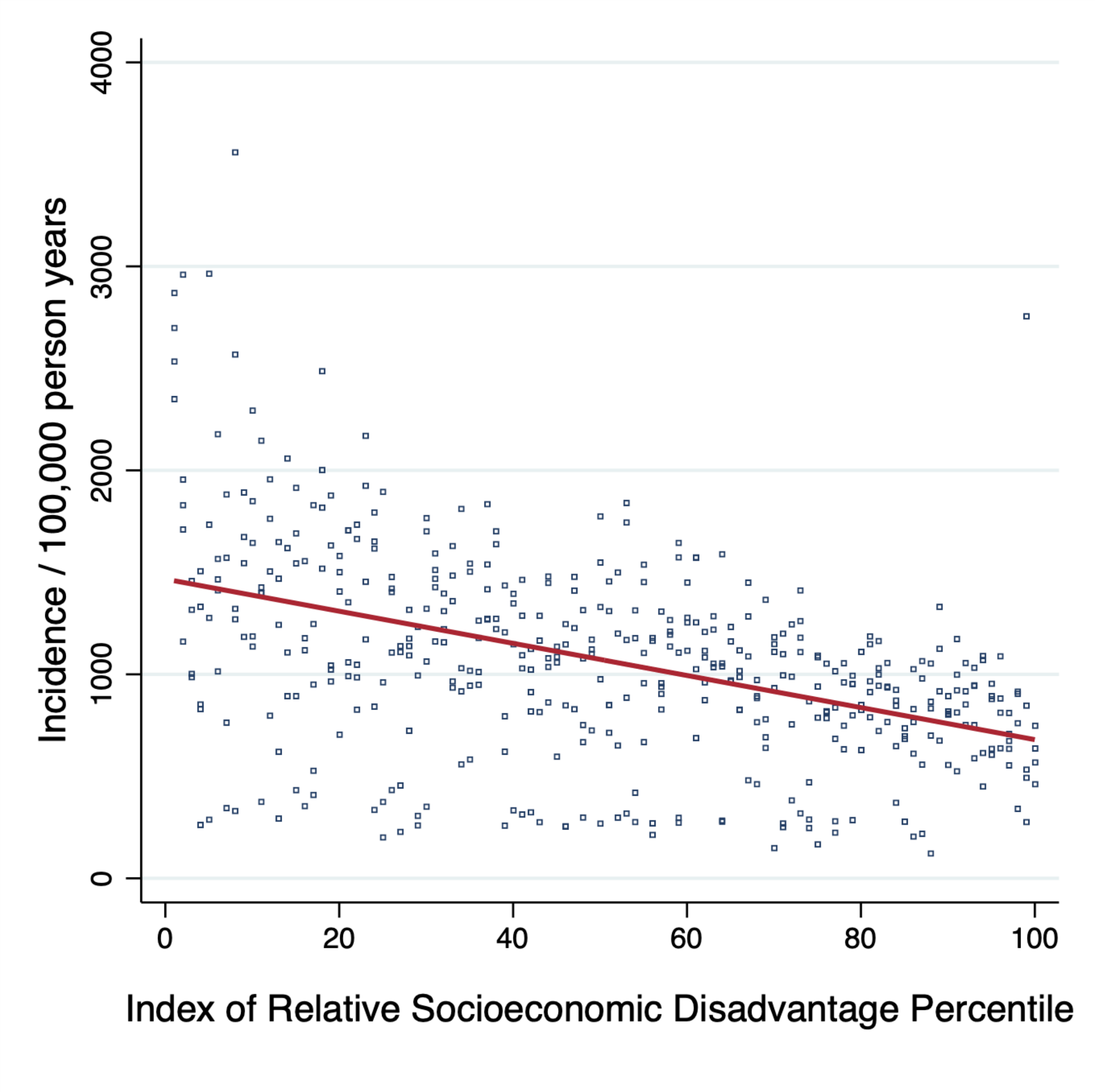

Figure S2. Association between SES and age-standardized incidence of chest pain attendances per 100,000 person years. Square dots represent 454 individual statistical areas (SA2) within Victoria, Australia according to index of relative socioeconomic disadvantage percentile (with higher percentile indicating higher SES) and age-standardized incidence of chest pain attendances per 100,000 person years. The red line represents a linear prediction model.

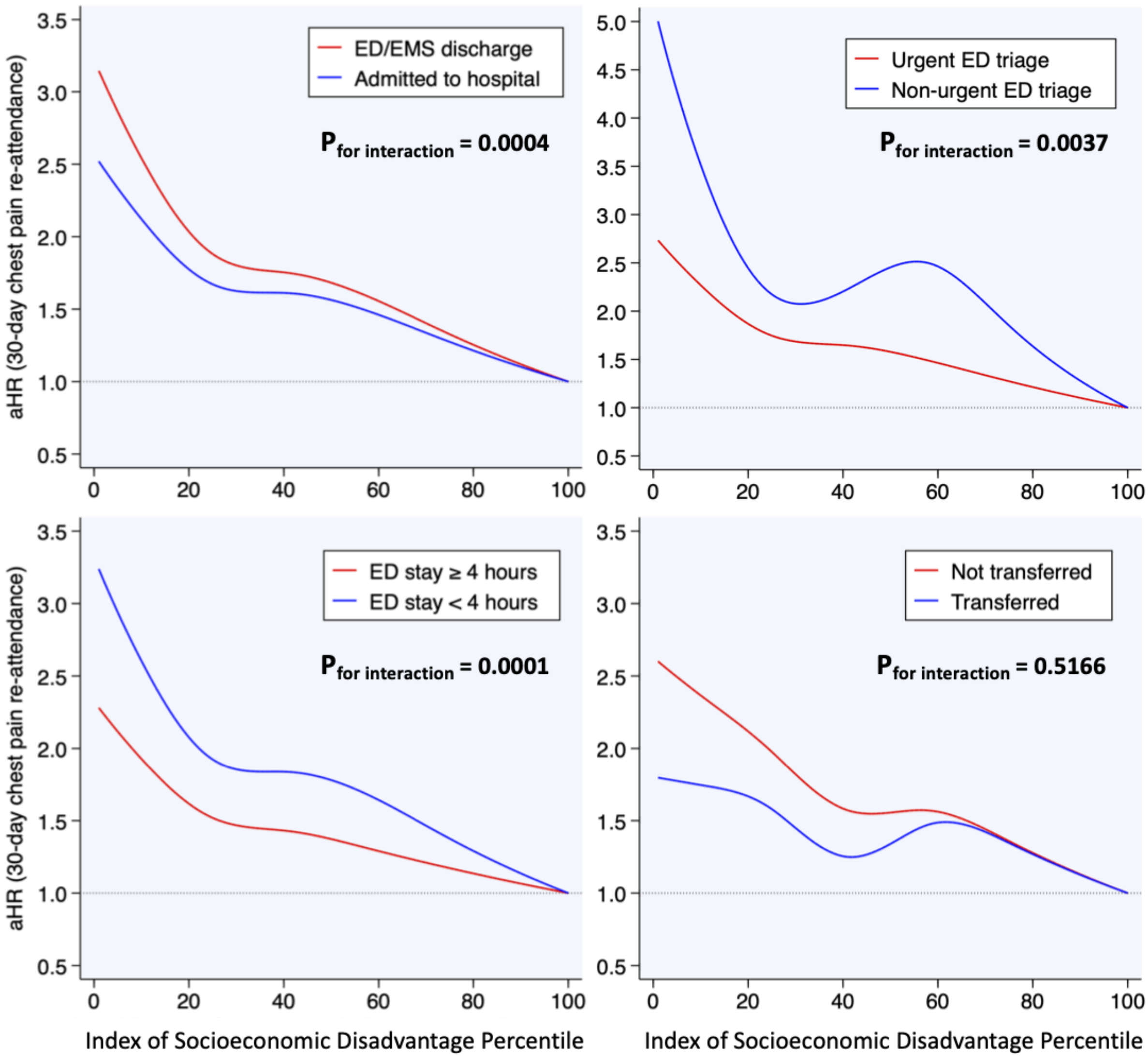

Figure S3. Association between socioeconomic status and risk of 30-day EMS readmission for chest pain with effect modification by care metrics. Stratified curves showing adjusted hazard ratios (aHR, y-axis) according to socioeconomic status percentile (x-axis) stratified by care metrics associated with SES in the multivariable analysis (Table 3). Adjusted hazard ratios are estimated from models with socioeconomic status percentile fitted as a restricted cubic spline, adjusted for clinical characteristics and diagnosis with medical centre included as a random effect. Adjusted Hazard Ratio (aHR) is in comparison to the 100th percentile as a reference. $P_{\text{for interaction}}$ = P value for interaction.

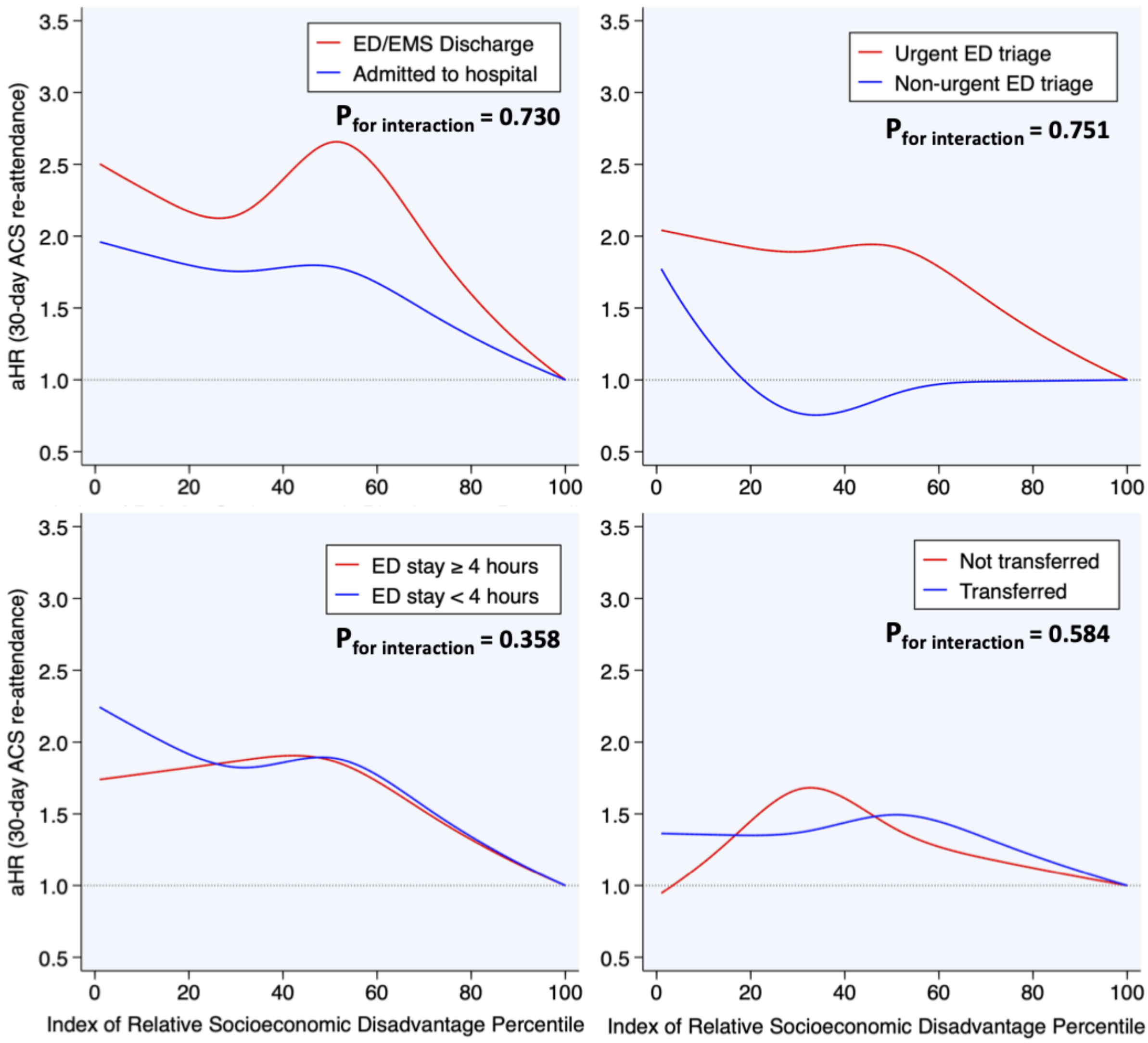

Figure S4. Association between socioeconomic status and risk of 30-day EMS re-attendance for acute coronary syndromes with effect modification by care metrics. Stratified curves showing adjusted hazard ratios (aHR, x-axis) according to socioeconomic status percentile (y-axis) stratified by care metrics associated with SES in the multivariable analysis (table 3). Adjusted hazard ratios estimated from models with socioeconomic status percentile fitted as a spline, adjusted for clinical characteristics and diagnosis with medical centre included as a random effect. Adjusted Hazard Ratio (aHR) is in comparison to the 100^{th} percentile as a reference. $P_{for\ interaction}$ = P value for interaction.

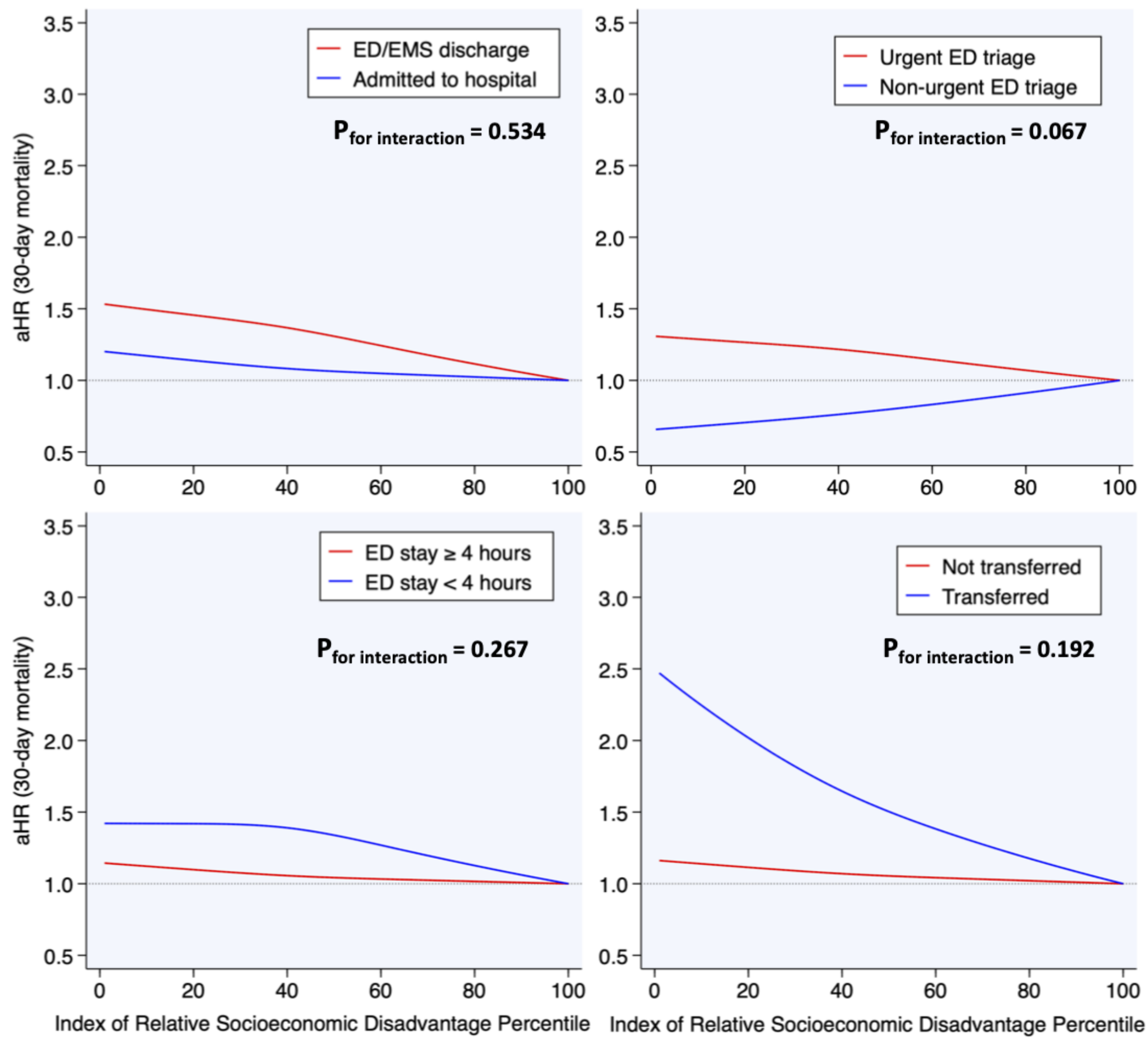

Figure S5. Association between socioeconomic status and risk of 30-day mortality with effect modification by care metrics. Stratified curves showing adjusted hazard ratios (aHR, y-axis) according to socioeconomic status percentile (x-axis) stratified by care metrics associated with SES in the multivariable analysis (table 3). Adjusted hazard ratios estimated from models with socioeconomic status percentile fitted as a spline, adjusted for clinical characteristics and diagnosis with medical centre included as a random effect. Adjusted Hazard Ratio (aHR) is in comparison to the 100th percentile as a reference. $P_{for\ interaction}$ = P value for interaction.