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Supporting Information

Supplementary methods and results

This appendix was part of the submitted manuscript and has been peer reviewed.
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Appendix to: Dawson LP, Andrew E, Stephenson M, et al. The influence of ambulance offload time on 30-day risks of death and re-presentation for patients with chest pain. *Med J Aust* 2022; doi: 10.5694/mja2.51613.

SUPPLEMENTAL MATERIAL

Supplementary methods

Supplementary methods

I. Dataset linkage processes

Ambulance Victoria is the sole provider of emergency medical services in 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 that captures patient and case details, and any management provided. Data from these records are uploaded to and stored in a clinical data warehouse, the Victorian Ambulance Clinical Information System (VACIS).

For this study, data linkage combined pre-hospital electronic patient care record data with key datasets:

1. Victorian Emergency Minimum Dataset: Victorian Department of Health administrative and clinical data related to emergency department (ED) presentations at public hospitals. 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, with the Victorian Emergency Minimum Dataset (VEMD) arrival time being required to be within one hour of the ambulance ED arrival time.
2. Victorian Admitted Episodes Dataset: Victorian Department of Health demographic, clinical and administrative data related to admitted episodes of care occurring in public and private hospitals, rehabilitation centres, extended care facilities and day procedure centres. 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 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 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 during the study period.

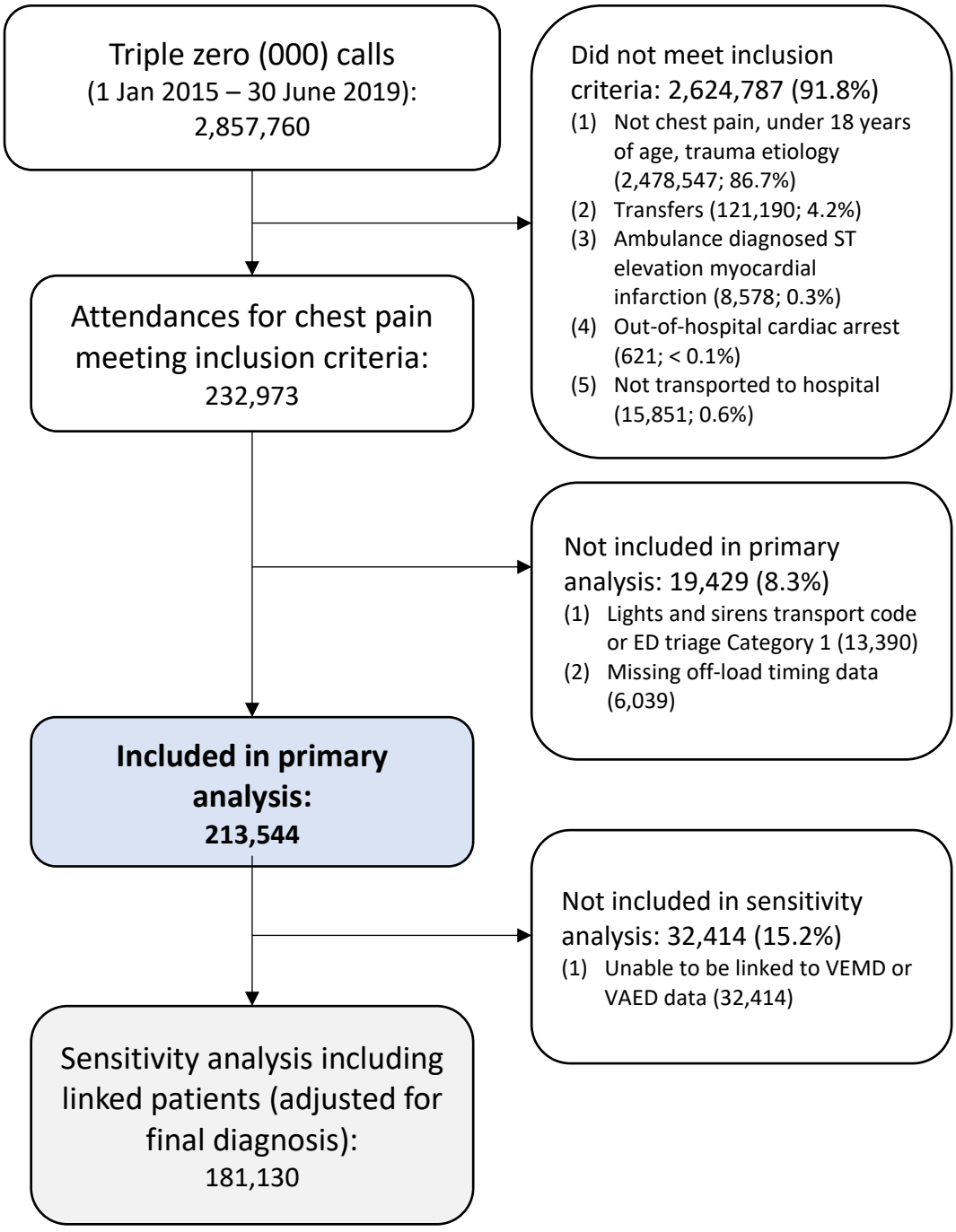
II. Study definitions

Geographic remoteness was determined by 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’) according to relative access to services in non-metropolitan Australia. Because of low patient numbers from ‘remote’ or ‘very remote’ regions, these groups were combined with the ‘outer regional’ group for this study.

The final diagnoses for patients transported to hospital used in Table 3 were categorised using the following International Statistical Classification of Diseases (ICD) 10 criteria. These definitions as below remained constant across the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) editions used by hospitals during the study period (i.e., ICD-10-AM: 8th edition in 2014-15; 9th edition in 2015-16 & 2016-17; 10th edition in 2017-18 & 2018-19).

1. Cardiovascular diagnoses: I00-I99
2. ST-elevation myocardial infarction: I210-I213,I220-I229, I256
3. Non-ST elevation myocardial infarction: I214, I219
4. Unstable angina: I200
5. Heart failure: I420-I438, I500-I509
6. Arrhythmia: I480-I489, I471, I441, I442, I456, I458- I461, I469, I470, I472, I479, I490-I499
7. Other cardiac: I00-I1528 excluding codes categorised above
8. Pulmonary embolism: I260, I269
9. Other vascular: I600-I99 excluding codes categorised above
10. Respiratory diagnoses: J00-J998
11. Pneumonia: J100, J110, J120-J189, J22
12. Exacerbation of COPD: J431-J449, J47-J709, J982, J983
13. Other respiratory: J00-J998 excluding codes categorised above
14. Gastrointestinal diagnoses: K000-K938
15. Rheumatological diagnoses: M0000-M99923
16. Mental Health diagnoses: F000-F99
17. Other medical diagnoses: A000- G899, H000-H959, L00-L998, M0000-M99923, N000-N999, O000-O998, P000-Q999, S001-Z999
18. Non-specific pain: R000-R99

Figure 1. Selection of patients for inclusion in our analyses



ED = emergency department, VEMD = Victorian Emergency Minimum Dataset, VAED = Victorian Admitted Episodes Dataset.

Table 1. Source of data for each included variable

Dataset	Variables
Victorian Ambulance Clinical Information System (VACIS)	Age, sex, attendance location, receiving hospital, public/private hospital, hypertension, hyperlipidaemia, diabetes mellitus, chronic kidney disease, prior coronary disease, prior stroke, peripheral vascular disease, chronic obstructive pulmonary disease, Charlson index, heart rate, systolic blood pressure, oxygen saturations, respiratory rate, temperature, Glasgow coma scale, pain score, ambulance off-load times, day of week, season, year, in/out hours, medical facility, total bed numbers, 30-day ambulance re-attendance for chest pain
Victorian Emergency Minimum Dataset (VEMD)	Discharge diagnosis (if discharged from ED), ED triage category, ED disposition, ED length of stay, ED length of stay >4 hours
Victorian Admitted Episodes Dataset (VAED)	Discharge diagnosis (if discharged from hospital), hospital length of stay
Victorian Death Index (VDI)	30-day mortality

ED = emergency department.
To manage missing data, complete case analysis was used for descriptive tables and multiple imputation was used for multivariable analysis.

Table 2. Missing data

Variable	Number
Total patients	213,544
Age	24 (0.01%)
Sex	63 (0.03%)
Attendance location	1,828 (0.86%)
Hospital type (public/private)	720 (0.34%)
Hypertension	9,755 (4.6%)
Hyperlipidaemia	9,755 (4.6%)
Diabetes mellitus	9,755 (4.6%)
Chronic kidney disease	9,755 (4.6%)
Prior coronary disease	9,755 (4.6%)
Prior stroke	9,755 (4.6%)
Peripheral vascular disease	9,755 (4.6%)
Chronic obstructive pulmonary disease	9,755 (4.6%)
Heart rate	139 (0.07%)
Systolic blood pressure	306 (0.14%)
Oxygen saturations	4,224 (1.98%)
Respiratory rate	141 (0.07%)
Temperature	18,913 (8.9%)
Glasgow Coma Scale	8,772 (4.1%)
Pain scores	7,470 (3.5%)
Charlson index score	9,771 (4.6%)

Data for variables not included in table were complete: in/out hours, day of week, season, and calendar year. To manage missing data, complete case analysis was used for descriptive tables and multiple imputation was used for multivariable analysis.

Table 3. Emergency and hospital care by ambulance offload tertile, for 181,130 patients who could be linked to the VAED and VEMD

	Offload tertile		
	Tertile 1	**Tertile 2**	**Tertile 3**
VEMD Variables	0-17 mins	18-28 mins	>28 mins
No. of patients	49,121	59,077	60,551
ED triage category:			
Emergent (Category 2)	24,903 (50.7%)	30,645 (51.9%)	24,963 (41.2%)
Urgent (Category 3)	19,367 (39.4%)	24,686 (41.8%)	32,260 (53.3%)
Semi-urgent Category 4/5)	4,851 (9.9%)	3,746 (6.3%)	3,328 (5.5%)
ED disposition:			
ED planned discharge	12,927 (26.3%)	15,786 (26.7%)	15,595 (25.8%)
Short stay admission	18,697 (38.1%)	25,982 (44.0%)	26,838 (44.3%)
Self-discharge	1,798 (3.7%)	1,593 (2.7%)	1,810 (3.0%)
Hospital admission	15,699 (32.0%)	15,716 (26.6%)	16,308 (26.9%)
ED length of stay (min), median (IQR)	214 (150-324)	221 (159-340)	239 (179-399)
ED length of stay > 4 hours	20,284 (37.9%)	22,218 (40.3%)	29,592 (49.3%)
VAED Variables			
No. of patients	37,406	44,826	43,436
Hospital length of stay (days), mean (SD)	2.49 (3.86)	2.55 (4.03)	2.53 (4.25)

VEMD = Victorian Emergency Minimum Dataset, VAED = Victorian Admitted Episodes Dataset, ED = emergency department, IQR = interquartile range, SD = standard deviation.

Table 4. Emergency or hospital discharge diagnosis according to ambulance offload tertiles for 181,130 patients who could be linked to the VAED and VEMD

	Offload tertile		
	Tertile 1	**Tertile 2**	**Tertile 3**
Discharge diagnosis	0-17 mins	18-28 mins	>28 mins
No. of patients	55,669	63,021	62,440
Non-specific pain	27,864 (50.1%)	31,892 (50.6%)	32,240 (51.6%)
Cardiovascular	12,956 (23.3%)	14,570 (23.1%)	13,247 (21.2%)
STEMI*	390 (0.7%)	384 (0.6%)	326 (0.5%)
NSTEMI	3,123 (5.6%)	3,311 (5.3%)	2,871 (4.6%)
Unstable angina	2,181 (3.9%)	2,187 (3.5%)	1,994 (3.2%)
Heart failure	1,077 (1.9%)	1,629 (2.6%)	1,526 (2.4%)
Arrhythmia	2,540 (4.6%)	2,862 (4.5%)	2,424 (3.9%)
Other cardiac	3,047 (5.5%)	3,405 (5.4%)	3,348 (5.4%)
Pulmonary emboli	369 (0.7%)	505 (0.8%)	447 (0.7%)
Other vascular (incl aortic)	229 (0.4%)	287 (0.5%)	311 (0.5%)
Non-cardiovascular	14,849 (26.7%)	16,559 (26.3%)	16,953 (27.2%)
Pneumonia	2,178 (3.9%)	2,552 (4.1%)	2,540 (4.1%)
Exacerbation of COPD	1,181 (2.1%)	1,406 (2.2%)	1,508 (2.4%)
Other respiratory	1,318 (2.4%)	1,447 (2.3%)	1,523 (2.4%)
Gastrointestinal	2,917 (5.2%)	3,230 (5.1%)	3,017 (4.8%)
Rheumatological	1,552 (2.8%)	1,496 (2.4%)	1,516 (2.4%)
Mental health	1,150 (2.1%)	1,279 (2.0%)	1,328 (2.1%)
Other medical	4,553 (8.2%)	5,149 (8.2%)	5,521 (8.8%)

*Pre-hospital diagnosed STEMI excluded.
STEMI = ST elevation myocardial infarction, NSTEMI = non-ST elevation myocardial infarction, COPD = chronic obstructive pulmonary disease, VEMD = Victorian Emergency Minimum Dataset, VAED = Victorian Admitted Episodes Dataset.

Table 5. 30-day mortality rates stratified by VEMD or VAED discharge diagnosis, by ambulance offload tertiles (*N* = 181,130)

	Offload tertile		
30-day mortality by discharge diagnosis	**Tertile 1** 0-17 mins	**Tertile 2** 18-28 mins	**Tertile 3** >28 mins
No. of patients	55,669	63,021	62,440
Non-specific pain	123/27,864 (0.4%)	144/31,892 (0.4%)	158/32,240 (0.5%)
Cardiovascular	272/12,956 (2.1%)	357/14,570 (2.4%)	330/13,247 (2.4%)
STEMI*	22/390 (5.6%)	31/384 (8.1%)	29/326 (8.9%)
NSTEMI	95/3,123 (3.0%)	107/3,311 (3.2%)	110/2,871 (3.8%)
Unstable angina	24/2,181 (1.1%)	32/2,187 (1.5%)	23/1,994 (1.2%)
Heart failure	54/1,077 (5.0%)	93/1,629 (5.7%)	84/1,526 (5.5%)
Arrhythmia	20/2,540 (0.8%)	25/2,862 (0.9%)	24/2,424 (1.0%)
Other cardiac	27/3,047 (0.9%)	35/3,405 (1.0%)	29/3,348 (0.9%)
Pulmonary emboli	16/369 (4.3%)	15/505 (3.07%)	9/447 (2.0%)
Other vascular (incl aortic)	14/229 (6.1%)	19/287 (6.6%)	22/311 (7.1%)
Non-cardiovascular	370/14,849 (2.5%)	455/16,559 (2.8%)	539/16,953 (3.2%)
Pneumonia	60/2,178 (2.8%)	91/2,552 (3.6%)	97/2,540 (3.8%)
Exacerbation of COPD	45/1,181 (3.8%)	54/1,406 (3.8%)	56/1,508 (3.7%)
Other respiratory	22/1,318 (1.7%)	30/1,447 (2.1%)	39/1,523 (2.6%)
Gastrointestinal	37/2,917 (1.3%)	37/3,230 (1.2%)	57/3,017 (1.9%)
Rheumatological	8/1,552 (0.5%)	19/1,496 (1.3%)	13/1,516 (0.9%)
Mental health	12/1,150 (1.0%)	9/1,279 (0.7%)	15/1,328 (1.1%)
Other medical	186/4,553 (4.1%)	215/5,149 (4.2%)	262/5,521 (4.8%)

*Pre-hospital diagnosed STEMI excluded.
STEMI = ST elevation myocardial infarction, NSTEMI = non-ST elevation myocardial infarction, COPD = chronic obstructive pulmonary disease, VEMD = Victorian Emergency Minimum Dataset, VAED = Victorian Admitted Episodes Dataset.

Table 6. Sensitivity analysis of outcomes by ambulance offload tertile, adjusted for discharge diagnosis (VEMD and VAED) (*N* = 181,130)

	Ambulance offload tertile		
Variable	**Tertile 1** (0-17 mins)	**Tertile 2** (18-28 mins)	**Tertile 3** (>28 mins)
30-day mortality			
Deaths/patients	765/55,669	956/63,021	1,027/62,440
Unadjusted rate	1.37%	1.52%	1.64%
Risk difference (percentage points) (95% CI)	Reference	0.14 (0.00-0.28)	0.27 (0.13-0.41)
Adjusted rate*	1.46%	1.57%	1.70%
Risk difference (percentage points) (95% CI)	Reference	0.10 (-0.04-0.25)	0.24 (0.09-0.39)
30-day re-attendance			
Re-attendances/patients	5,270/55,669	6,616/63,021	6,730/62,440
Unadjusted rate	9.47%	10.50%	10.78%
Risk difference (percentage points) (95% CI)	Reference	1.03 (0.69-1.37)	1.31 (0.97-1.66)
Adjusted rate*	8.98%	9.47%	9.94%
Risk difference (percentage points) (95% CI)	Reference	0.50 (0.17-0.82)	0.97 (0.62-1.31)

CI = confidence interval, VEMD = Victorian Emergency Minimum Dataset, VAED = Victorian Admitted Episodes Dataset

*Adjusted rates were determined using the multiply imputed dataset (but including only patients who could be linked to the VEMD or VAED) in a multilevel logistic regression model, with age, sex, comorbid conditions, clinical status, time of presentation (in- or out-of-hours), day of the week, season, year, total hospital bed numbers, and discharge diagnosis included as fixed effects, and hospital facility included as a random effect.

Table 7. Sensitivity analysis for primary cohort (*N* = 213,544): 30-day mortality, by ambulance offload time 10-minute segment

Variable	Ambulance offload time segment						
	0-9 min	**10-19 min Reference**	**20-29 min**	**30-39 min**	**40-49 min**	**50-59 min**	**≥60 min**
30-day mortality							
No. of deaths	190	**869**	857	433	202	135	229
No. of patients	14,780	**71,371**	61,003	28,526	14,389	8,283	15,192
Unadjusted rate (%)	1.29	**1.22**	1.40	1.52	1.40	1.63	1.51
RD (95% CI)	0.07 (-0.13-0.26)	**Ref**	0.19 (0.06-0.31)	0.30 (0.14-0.46)	0.19 (-0.02-0.39)	0.41 (0.13-0.70)	0.29 (0.08-0.50)
P-value	0.503		0.003	<0.001	0.080	0.004	0.007
Adjusted rate* (%)	1.26	**1.29**	1.45	1.59	1.49	1.76	1.67
RD (95% CI)	-0.02 (-0.23-0.17)	**Ref**	0.16 (0.03-0.29)	0.30 (0.12-0.47)	0.20 (-0.02-0.42)	0.47 (0.16-0.77)	0.37 (0.14-0.61)
P-value	0.819		0.013	0.001	0.078	0.003	0.002

RD = risk difference, CI = confidence interval, VEMD = Victorian Emergency Minimum Dataset, VAED = Victorian Admitted Episodes Dataset.

Risk differences (RD) indicate the percentage point difference and 95% confidence intervals (95% CI) for tertiles 2 and 3 in comparison to tertile 1.

*Adjusted rates were determined using the multiply imputed dataset (but including only patients who could be linked to the VEMD or VAED) in a multilevel logistic regression model, with age, sex, comorbid conditions, clinical status, time of presentation (in- or out-of-hours), day of the week, season, year, total hospital bed numbers, and discharge diagnosis included as fixed effects, and hospital facility included as a random effect.

Table 8. Variables associated with ambulance offload time identified by multivariable linear regression analysis of full dataset with multiple imputation (*N* = 213,544)

Variable	Estimated difference (min) (95% CI)	P
Age group		
<65 years	Reference	
65-79 years	+0.8 (+0.6 to +1.0)	<0.001
≥80 years	+1.4 (+1.1 to +1.6)	<0.001
Sex (women)	+0.8 (+0.7 to +1.0)	<0.001
Time of day		
12am – 8am	Reference	
8am – 5pm	+4.9 (+4.7 to +5.1)	<0.001
5pm – 12am	+7.5 (+7.3 to +7.7)	<0.001
Private hospital	-6.9 (-7.2 to -6.5)	<0.001
Unstable observations	+0.3 (+0.1 to +0.5)	0.005
Ongoing pain	-0.9 (-1.1 to -0.6)	<0.001
Weekend attendance	-2.2 (-2.4 to -2.0)	<0.001
Total hospital beds		
<250	Reference	
250-500	+4.7 (+4.4 to +4.9)	<0.001
>500	+8.6 (+8.4 to +8.8)	<0.001
Season		
Summer	Reference	
Autumn	-0.1 (-0.3 to +0.1)	0.35
Winter	+3.2 (+3.0 to +3.4)	<0.001
Spring	+4.5 (+4.3 to +4.8)	<0.001
Year		
2015	Reference	
2016	+1.7 (+1.4 to +1.9)	<0.001
2017	+3.9 (+3.7 to +4.2)	<0.001
2018	+3.5 (+3.3 to +3.8)	<0.001
2019	+7.1 (+6.8 to +7.4)	<0.001

CI = confidence interval.

Observations were defined as unstable if any of the following were present: heart rate less than 40 bpm or more than 100 bpm, systolic blood pressure less than 90mmHg, oxygen saturations less than 90%, temperature greater than or equal to 38°C, Glasgow coma score less than 15, or respiratory rate greater than or equal to 30 breaths per minute. Ongoing pain was defined as present if final ambulance pain score was greater than three out of ten.