Supplemental Online Content

Dawson LP, Nehme E, Nehme Z, et al. Chest pain management using prehospital point-of-care troponin and paramedic risk assessment. *JAMA Intern Med*. Published online January 30, 2023. doi:10.1001/jamainternmed.2022.6409

This supplemental material has been provided by the authors to give readers additional information about their work.

eMethods. 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 (VEMD): 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 with the VEMD arrival time was 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 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.

Given different funding models and differences in cost reporting, only patients transported to public hospitals were included in the analysis with ambulance attendances resulting in transport to private hospitals (~5%) excluded from the study.

II. Definitions

Acute coronary syndromes were using the following International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) codes (note that these ICD-10-AM codes remain constant across the different ICD-10-AM editions of codes used by hospitals over 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. ST-elevation myocardial infarction: I210-I213,I220-I229, I256 (excludes ambulance diagnosed ST-elevation myocardial infarction)
2. Non-ST elevation myocardial infarction: I214, I219
3. Unstable angina: I200

Normal clinical observations were defined as heart rate >45 and <120 bpm, systolic blood pressure >90 and <180 mmHg, oxygen saturations ≥92%, respiratory rate <25 bpm, Glasgow coma score 15, afebrile. Near complete resolution of chest pain was defined as final pain score 0-2 out of 10.

III. Branch probabilities

Pre-hospital blood collection for testing on arrival to ED has been estimated to reduce ED length of stay by 72 minutes,[1] however recent studies do not present data on reductions in admission rates, which are more applicable to the probabilistic modelling approach. Therefore we identified trials of hsTn algorithms that had similar length of stay reductions and presented data on reduction in admission to short stay or hospital. The Rapid-Tnt trial was selected for this given comparable reductions in length of stay (60 minutes),[2] which resulted in a 12% reduction in admissions to short stay or hospital. Of note in the RATPAC trial assessing point-of-care cTn in EDs reduction in admissions was 19%.[3] A more conservative range for the probabilistic sensitivity analysis was used of 0-15%.

HEART and ECAMM scores were calculated using Ambulance Victoria clinical data, which records sufficiently detailed information including chest pain character, radiation, exacerbating factors, and associated symptoms to complete the 'History' component of the HEART score.

IV. Costs calculations

Costs were estimated using a 'bottom-up' approach for each component of care with adjustment using the Australian Health Price Index to reflect the Australian dollars ($A) in the 2020-2021 financial year. Ambulance costs were determined from 2021-22 estimates of cost per transport according to event location, emergency status, and transport mode, and whether the attendance resulted in transport to hospital or treatment only and referral to another health provider. ED costs were determined using Victoria-specific National Hospital Cost Data Collection (NHCDC) estimates for the financial year 2018-19,[4] which present average costs according to ED episode criteria such as whether the patient was admitted to hospital, was transferred from ED to another hospital, left following or prior to review, or died in the ED.

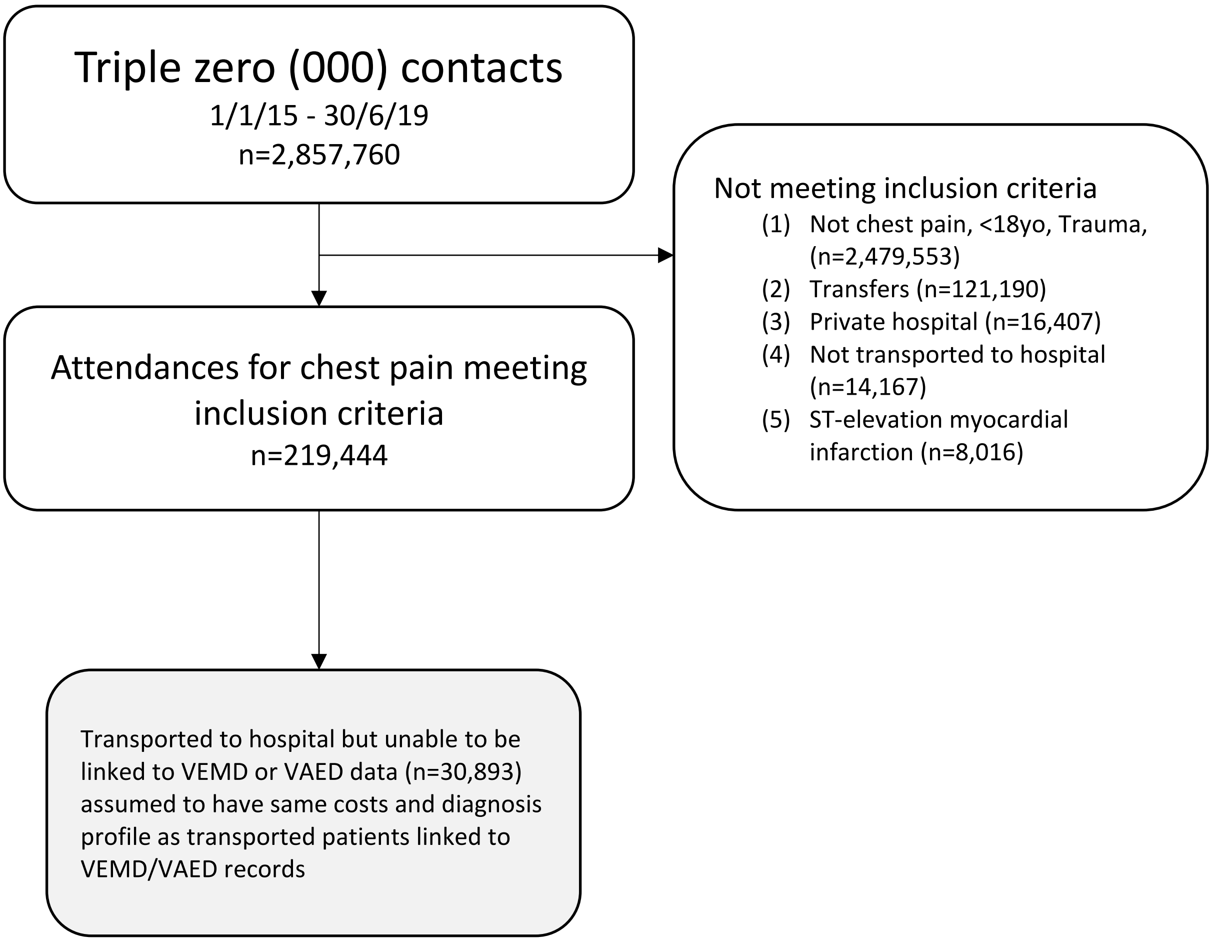
Hospital admission costs for public hospitals are funded through casemix funding, which is a method of funds allocation according to hospital activities and patients treated. Basic casemix funding involves classifying patients according to Diagnosis Related Groups (DRGs) with each like episode funded at the same rate.[5] Refinement of this method has resulted in the development of the Weighted Inlier Equivalent Separation (WIES) model, which applies cost weighting to basic casemix funding to account for length of stay. Admission costs were determined by multiplying the episode WIES weight recorded in the VAED dataset by the appropriate WIES price for that financial year.[6] For patients that were transferred to another hospital from the index hospital, costs for the second admission following transfer were estimated using the average overall admission cost for non-transferred episodes according to discharge diagnosis. Costs for each component of care and annual WIES prices are presented in Tables S1 and S2.

Paramedic education costs were calculated based on 6,000 staff at the midpoint of Advanced Life Support paramedic pay scale ($27.91 per hour).

V. Literature search

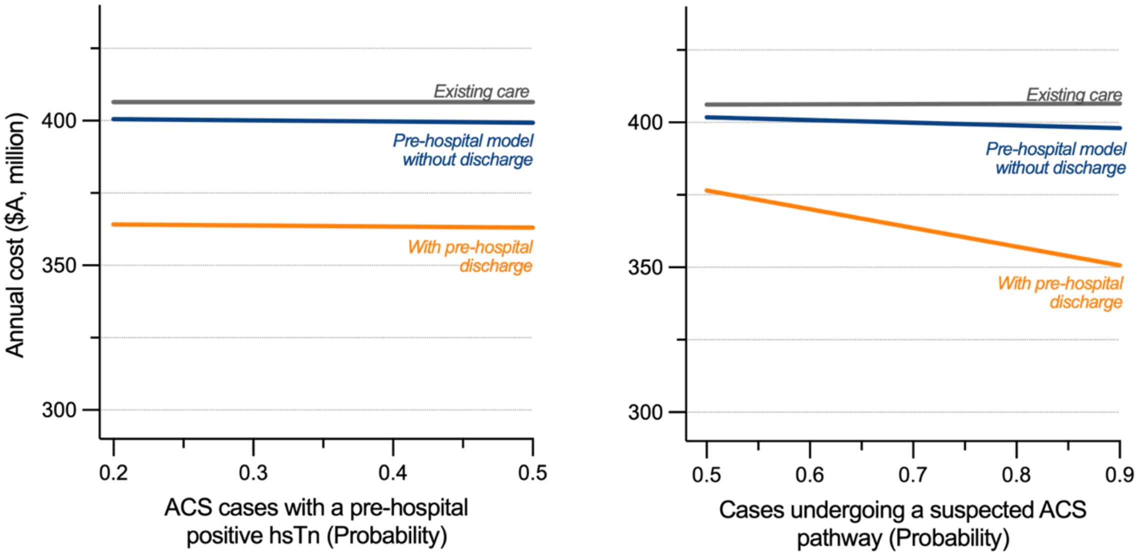
To identify articles assessing pre-hospital risk-stratification and point-of-care troponin use by paramedics we performed a systematic literature search using PubMed limited to Title/Abstract on July 27, 2022. Search terms relating to paramedics included "paramedic", "emergency medical services", "pre-hospital", "ambulance" combined with the OR function. Search terms relating to risk stratification and point-of-care troponin testing included "risk-stratification", "risk score", and "troponin" combined with the OR function. These two searches were combined with the AND function yielding 193 results, which were screened for relevance. From this search in addition to reference screening and backward snowballing, seven relevant studies were included to inform probability assumptions in the decision tree model (see Table 1, main manuscript).

eFigure 1. Cohort Derivation



VEMD = Victorian Emergency Minimum Dataset, VAED = Victorian Admitted Episodes Dataset

eFigure 2. Univariable Sensitivity Analyses of Prehospital Risk Stratification and Point-of-Care Troponin Costs



Dark grey horizontal lines indicate costs associated with existing care models, navy lines indicate costs associated with pre-hospital point-of-care troponins without using pre-hospital discharge, and orange lines indicate costs with the use of pre-hospital discharge. Other univariate sensitivity analyses shown in Figure 2 in main manuscript.

eTable 1. Summary of Single Rule-Out High-Sensitivity Troponin (hsTn) Assay Validation Studies Presenting Data Regarding Proportion of Patients Classified as Low Risk (Acute Coronary Syndrome Ruled Out) and Negative Predictive Value[a]

Study	Classification of low risk	% classified as low risk	Negative predictive value
Bandstein et al[8]	hsTn <5 (single rule-out)	61.0%	99.8%
Body et al[9]	Single rule out Single rule out (validation)	37.7% 40.4%	99.3% 99.3%
Body et al[10]	Single rule out	27.7%	99.4%
Boeddinghaus et al[11]	**0/1h protocol (point of care)** **Single rule out (point of care)**	**55.0%** **45.0%**	**100.0%** **100.0%**
Boeddinghaus et al[12]	Single rule out (Limit of detection hsTn<2) Single rule out (hsTn<5) 0/1h protocol 0/1h ESC protocol	16.0% 54.0% 52.0% 52.0%	100.0% 99.1% 99.5% 99.5%
Carlton et al[13]	Single rule out (hsTnI <1.2)	18.8%	99.5%
Chapman et al[14]	Single rule out (hsTnI <5) 0/3h protocol ESC 0/1h protocol ESC	63.0% 64.5% 65.0%	99.5% 99.0% 98.0%
Goodacre et al[15]	Single rule out (cTn)	73.5%	98.9%
Greenslade et al[16]	Single rule out (hsTnI <2)	34.1%	99.8%
HiSTORIC (Anand et al)[17]	Single rule out (hsTnI <5)	71.0%	99.7%
Mokhtari et al[18]	Single rule out (hsTn <5, normal ECG) Single rule out (hsTn <14, normal ECG)	29.2% 66.7%	99.7% 98.7%
Neumann et al[19]	Single rule out (hsTnI <3)	35.0%	99.3%
Pickering et al[20]	**Single rule out (point of care)** **Single rule out (hsTn)**	**56.7%** **43.5%**	**100.0%** **100.0%**
Sandoval et al[21]	Single rule out (hs TnI <1.9) Single rule out (hsTnI <5)	27.0% 50.0%	99.6% 98.9%
Shah et al[22]	hsTn <5 (single rule-out) hsTn <5 (validation)	61.0% 56.0%	99.6% 99.4%
Wildi et al[23]	Single rule out (limit of detection,hs TnT) 0/1h protocol (hsTnT) 0/2h protocol (hsTnT) 2h ADP (hsTnT) 2h NICE protocol (hsTnT) 0/3h ESC protocol (hsTnT) Single rule out (limit of detection,hsTnI) 0/1h protocol (hsTnI) 0/2h protocol (hsTnI) 2h ADP (hsTnI) 2h NICE protocol (hsTnI) 0/3h ESC protocol (hsTnI)	26.8% 60.4% 64.8% 36.7% 51.6% 44.6% 15.7% 51.7% 53.2% 36.6% 80.0% 54.9%	99.8% 99.8% 99.9% 100.0% 99.8% 99.8% 100.0% 99.9% 100.0% 100.0% 99.1% 99.7%

[a]Studies using point-of-care assays are highlighted in bold. Adapted from Dawson et al,[7] 2022.

eTable 2. Weighted Inlier Equivalent Separation Prices Used to Estimate Hospital Admission Costs With Adjustment for Inflation to 2020-2021 Levels

	WIES Price ($A), original year and adjusted for inflation to 2020-2021 levels							**National Health Price Index**
Financial year	**Metropolitan**		**Subregional**		**Small rural**			**%**
	Original	Adjusted	Original	Adjusted	Original	Adjusted		
2014-2015	4385	4816	4459	4898	4678	5138		1.84
2015-2016	4545	4902	4768	5142	4654	5019		1.59
2016-2017	4640	4926	4857	5156	4724	5015		0.84
2017-2018	4732	4982	4978	5241	4795	5048		1.45
2018-2019	4833	5015	5083	5275	4877	5061		2.04
2019-2020								1.70

Data available from Department of Health and Human Services policy and funding guidelines 2014 to 2019, Chapter 3.1.1 Acute admitted services Price Tables.[6] https://www2.health.vic.gov.au/about/policy-and-funding-guidelines

eTable 3. Costs for Each Component of Care Used to Derive Each Episode Cost

Care component	**$A (adjusted to 2020-2021)**
Ambulance costs	
Ambulance treatment without transport (metropolitan)	665
Ambulance treatment without transport (rural)	741
Transport to emergency (metropolitan)	1634
Transport to emergency (rural)	2132
Transport to emergency (helicopter)	34158
Emergent transfer (metropolitan)	1634
Non-emergent transfer (metropolitan)	382
Emergent transfer (rural)	2132
Non-emergent transfer (rural)	508
Emergency department costs	
Not admitted – complete treatment	507
Not admitted – left at own risk after review	472
Not admitted – did not wait to be seen	172
Not admitted – died in emergency department	2369
Not admitted – dead on arrival	263
Admitted – index hospital	1070
Admitted – transfer to other hospital	2121

Ambulance costs were estimated from 2022 March margin reporting with adjustment to 2020-21 levels. Emergency department costs were estimated Victoria-specific National Hospital Cost Data Collection (NHCDC) estimates for financial year 2018-19,[4]

eTable 4. Cohort Characteristics

Variable	**N (%)**
Total	188,551
Age, mean (SD)	61.9 (18.3)
18-49 years	49,273 (26.1)
50-64 years	48,315 (25.6)
≥65 years	90,963 (48.2)
Sex	
Women	95,260 (50.5)
Men	93,246 (49.5)
Event location	
Metropolitan	138,353 (73.9)
Inner regional	41,418 (22.1)
Outer regional/remote	7,419 (4.0)
Socioeconomic status	
Lowest	48,362 (28.3)
Low	37,594 (22.0)
Middle	33,941 (19.9)
High	30,625 (17.9)
Highest	20,381 (11.9)
Comorbidities	
Hypertension	80,016 (44.3)
Hyperlipidaemia	58,058 (32.2)
Diabetes mellitus	38,041 (20.2)
Prior coronary disease	63,045 (34.9)
Chronic kidney disease	5,833 (3.2)
Peripheral vascular disease	2,120 (1.2)
Chronic obstructive pulmonary disease	17,067 (9.5)
Obstructive sleep apnoea	2,954 (1.6)
Diagnoses	
ACS	18,109 (9.6)
Cardiovascular (non-ACS)	26,343 (15.5)
Non-cardiovascular	43,894 (24.2)
Non-specific pain	93,205 (49.4)

eTable 5. Episode Outcome and Disposition

Variable	**N**	**Rate**
Non-revascularisation centre –		
ED discharge	21730	0.115
short stay discharge	16542	0.088
admission (non-ACS)	19534	0.104
transfer (ACS)	3065	0.016
not suspected ACS	n/a*	0.000*
Revascularisation centre –		
ED discharge	33214	0.176
short stay discharge	44431	0.236
admission (non-ACS)	39010	0.207
admission (ACS)	11025	0.058
not suspected ACS	n/a*	0.000*

Rate indicates proportion of total patients that passed through the existing care pathway with a final disposition as above. Values can range from 0 (no patients) to 1 (all patients).
*note suspected ACS group determined based on input probability in Table 1 multiplied by number of non-ACS cases (with subtraction from number of non-ACS cases)

eTable 6. Sensitivity of Increasing Inpatient Costs Across a Range of 10% to 30%

	Cost per attendance ($A)		**Total annual cost ($A)***	
Scenario	**Mean (95% UI)**	**Difference (95% UI)**	**Mean (95% UI)**	**Difference (95% UI)**
Existing care pathway	$7846 ($7325 to $8390)	NA	$470.7M ($439.5M to $503.4M)	NA
Pre-hospital hsTn pathways:				
Without pre-hospital discharge	$7708 ($7143 to $8298)	-$138 (-$342 to $5)	$462.5M ($428.6M to $497.9M)	-$8.3M (-$20.5M to $5.1M)
With pre-hospital discharge (HEART)	$7012 ($6228 to $7792)	-$833 (-$1401 to -$381)	$420.7M ($373.7M to $467.5M)	-$50.0M (-$84.1M to -$22.9M)
With pre-hospital discharge (ECAMM)	$6462 ($5473 to $7406)	-$1384 (-$2239 to -$713)	$387.7M ($328.4M to $444.4M)	-$83.0M (-$134.3M to -$42.8M)

*based on 60,000 ambulance attendances for chest pain without ST-elevation per year in Victoria, Australia
95% uncertainty intervals (UI) based on output of probabilistic sensitivity analysis using Monte Carlo simulation with 50,000 iterations.

eTable 7. Sensitivity of Increasing Ambulance Attendance Costs for Attendances Using Prehospital Discharge Across a Range of 10% to 100%

	Cost per attendance ($A)		**Total annual cost ($A)***	
Scenario	**Mean (95% UI)**	**Difference (95% UI)**	**Mean (95% UI)**	**Difference (95% UI)**
Existing care pathway	$6773 ($6722 to $6826)	NA	$406.4M ($403.3M to $409.5M)	NA
Pre-hospital hsTn pathways:				
Without pre-hospital discharge	$6665 ($6486 to $6813)	-$108 (-$275 to $10)	$399.9M ($389.2M to $408.8M)	-$6.5M (-$16.5M to $0.6M)
With pre-hospital discharge (HEART)	$6108 ($5641 to $6482)	-$665 (-$1128 to -$298)	$366.5M ($338.5M to $388.9M)	-$39.9M (-$67.7M to -$17.9M)
With pre-hospital discharge (ECAMM)	$5663 ($4970 to $6207)	-$1110 (-$1804 to -$571)	$339.8M ($298.2M to $372.4M)	-$66.6M (-$108.2M to -$34.2M)

*based on 60,000 ambulance attendances for chest pain without ST-elevation per year in Victoria, Australia
95% uncertainty intervals (UI) based on output of probabilistic sensitivity analysis using Monte Carlo simulation with 50,000 iterations.

eTable 8. Sensitivity of Increasing Costs for Patients With Suspected Acute Coronary Syndrome Who Might Be Transferred to Revascularization Centers Unnecessarily[a] Due to False-Positive High-Sensitivity Troponin (hsTn) Values[b]

	Cost per attendance ($A)		**Total annual cost ($A)[c]**	
Scenario	**Mean (95% UI)**	**Difference (95% UI)**	**Mean (95% UI)**	**Difference (95% UI)**
Existing care pathway	$6773 ($6722 to $6825)	NA	$406.4M ($403.3M to $409.5M)	NA
Pre-hospital hsTn pathways:				
Without pre-hospital discharge	$6684 ($6511 to $6825)	-$88 (-$255 to $33)	$401.1M ($390.7M to $409.5M)	-$5.3M (-$15.3M to $2.0M)
With pre-hospital discharge (HEART)	$6077 ($5588 to $6469)	-$696 (-$1187 to -$309)	$364.6M ($335.3M to $388.1M)	-$41.8M (-$71.3M to -$18.5M)
With pre-hospital discharge (ECAMM)	$5593 ($4848 to $6172)	-$1180 (-$1925 to -$603)	$335.6M ($290.9M to $370.3M)	-$70.8M (-$115.5M to -$36.2M)

[a]Rather than the nearer nonrevascularization center.

[b]Estimating a potential false-positive hsTn rate range of 0% to 10% and estimating total episode cost increases of 20% to 50% for these patients.

[c]Based on 60,000 ambulance attendances for chest pain without ST-elevation per year in Victoria, Australia

95% uncertainty intervals (UI) based on output of probabilistic sensitivity analysis using Monte Carlo simulation with 50,000 iterations.

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