Add-on tests for improving risk-stratification in emergency department patients with chest pain who are at low to moderate risk of 30-day major adverse cardiac events ☆

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ABSTRACT

Background: Chest pain patients commonly present to emergency departments (ED), and require either hospital admission and/or lengthy diagnostic protocols to rule-out myocardial infarction. We aimed to identify the best combination of add-on tests to high-sensitivity cardiac troponin (hs-cTnT) for predicting 30-day major adverse cardiac events (MACE) in adult chest pain patients presenting to an ED with suspected acute coronary syndrome.
Methods: This prospective observational study was conducted in the ED of a tertiary university hospital in Hong Kong, recruiting adult patients with chest pain of less than 24 h duration, suspected with acute coronary syndrome (ACS), and had no history of coronary artery bypass grafting or stent insertion. Patients underwent triage assessment, electrocardiography, blood sampling for laboratory hs-cTnT, and Thrombolysis in Myocardial Infarction (TIMI) and HEART score assessment. The primary outcome was the number of patients with 30-day MACE.
Results: 602 consecutive patients were recruited and completed 30-day follow-up. A 30-day MACE occurred in 42 (7.0%) patients. Out of 12 possible models for stratifying patients at risk of 30-day MACE within 2 h of ED arrival, a combination of electrocardiography (ECG) and one-time hs-cTnT (model 5) provided the simplest and most accurate model. A risk score of 0 to 5 was derived from raw coefficients of model 5. The risk score provided excellent calibration (P = 0.91) and discrimination (AUC 0.87, 95% CI: 0.82 to 0.93).
Conclusion: Appropriate early risk-stratification of patients with chest pain and possible ACS using a combination of ECG and one-time hs-cTnT may improve efficiency of care.

1. Introduction

Chest pain is one of the most common complaints in patients presenting to emergency departments (ED) globally [1–3]. Most patients presenting to the ED with symptoms suggestive of acute coronary syndrome (ACS) are ultimately likely to receive an alternative diagnosis [1]. Challenges over ED crowding and the need for acceptable risk stratification have prompted the search for safe, cheap, but effective accelerated chest pain pathways [2,4–6]. Risk stratification scores such as thrombolysis in myocardial infarction (TIMI) [2,4,7] and HEART [8–13] have been developed and validated specifically in ED patients and are likely to be more useful for our patient cohort, where generally the risk of ACS is low.

Several studies have now shown that an early low TIMI or HEART score can safely rule out patients at very low risk of an early myocardial infarction (MI) and 30-day major adverse cardiac events (MACE), resulting in safe, early discharge from hospital [14,15,16]. Other studies have clarified which patients are at very high risk and should be immediately admitted to hospital for treatment or investigation [17]. The dilemma arises especially in overstretched healthcare systems where patients are of indeterminate risk but where there is a need for efficient patient flow. Patients of indeterminate risk still need further risk-stratification to determine who should be discharged with no follow
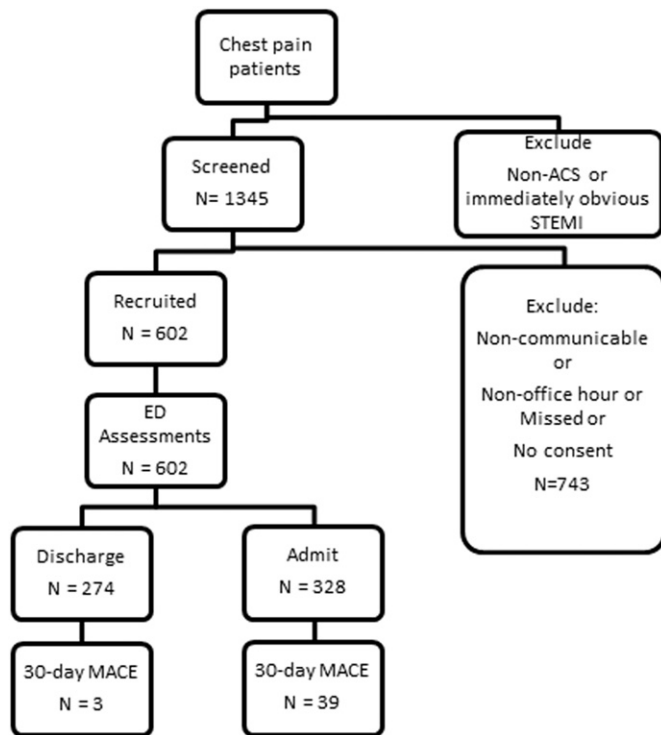
Fig. 1. Flowchart of current diagnostic pathway for chest pain patients in the emergency department.

up, who should have early follow up, and who should still be admitted either to an emergency ward, general medical ward or coronary care unit (CCU). Thus a one-stop risk-stratification process is needed to estimate risks of ACS and MACE.

The purpose of this study was to identify the best combination of add-on tests to high-sensitivity troponin T (hs-cTnT) to estimate the probability of 30-day MACE in patients presenting to ED with chest pain and possible ACS, and to produce a model for risk-stratifying such patients. Specifically, we aimed to firstly estimate the accuracy of electrocardiography (ECG), first high-sensitivity troponin T (hs-cTnT), TIMI and HEART score used at ED clinical presentation for predicting 30-day MACE. Secondly, we aimed to identify combinations of tests that would represent "very low" (≤1%), "low" (>1–5%), "moderate" (>5–70%) and "high" (>70%) risk of MACE so that optimal treatment strategies could be implemented with minimal misclassification (probabilities arbitrarily assigned). The application of this strategy would be determined by local healthcare authorities depending on a balance of the frequency of ACS, available resources, and risk threshold. For example, "very low" could be discharged from the ED with no or primary care follow up, "low" could either be admitted to the emergency medical ward (EMW) or discharged with early medical follow up, "moderate" could be admitted to the medical ward, and "high" risk groups could be admitted to CCU.

The protocol has the potential to safely reduce ED waiting time and ED crowding, and to improve risk-stratification. This process of allocation may be an important consideration in settings where demand for assessment exceeds available resources both in terms of immediate hospital admission and early versus late outpatient follow up and treatment. During the winter months in which the surging demands on hospitals require further rationing of resources, this tool may help risk-stratification and decision-making.

This is a sub-study of a prospective observational study of adult patients with potentially cardiac chest pain who underwent computer tomography (CT) scan to evaluate the usefulness of coronary calcium score in risk-stratifying chest pain patients.

Table 1
Characteristics of 602 patients by 30-day MACE group.

Characteristic	No MACE (n = 560)	MACE (n = 42)
Median age (IQR), year	66 (56–78)	66.5 (57.5–78)
Males	267 (47.7)	27 (64.3)
Ethnic Chinese	553 (98.8)	42 (100)
Smoking status		
Nonsmoker	360 (64.3)	30 (71.4)
Exsmoker	139 (24.8)	7 (16.7)
Current smoker	61 (10.9)	5 (11.9)
Obesity	28 (5.0)	2 (4.8)
Diabetes		
None	396 (70.7)	28 (66.7)
IFG	24 (4.3)	0 (0)
Diabetes	140 (25.0)	14 (33.3)
Hypertension	359 (64.1)	26 (61.9)
Renal failure	29 (5.2)	5 (11.9)
CHF	47 (8.4)	6 (14.3)
Ischaemic heart disease	118 (21.1)	11 (26.2)
Aspirin	166 (29.6)	10 (23.8)
Anti-platelet	175 (31.3)	12 (28.6)
Beta-blockers	167 (29.9)	14 (33.3)
ACEI/ARB	153 (27.3)	14 (33.3)
Median MDRD eGFR (IQR)	76.9 (62.4–91.4)	79.4 (43.7–89.4)
ECG ST deviation		
None (n = 481)	460 (82.1)	23 (54.8)
Present (n = 119)	100 (17.9)	19 (45.2)
First troponin, ng/L		
0–14 (n = 408)	404 (72.1)	5 (11.9)
>14–28 (n = 107)	95 (17.0)	8 (19.0)
>28–42 (n = 22)	22 (3.9)	4 (9.5)
>42 (n = 63)	39 (7.0)	25 (59.5)
TIMI score		
0–1 (n = 216)	212 (37.9)	5 (11.9)
2–3 (n = 286)	264 (47.1)	23 (54.8)
4–7 (n = 98)	84 (15.0)	14 (33.3)
HEART score		
0–3 (n = 220)	225 (40.2)	1 (2.4)
4–6 (n = 334)	302 (53.9)	30 (71.4)
7–10 (n = 46)	33 (5.9)	11 (26.2)
H-FABP, mg/L		
0–7 (n = 533)	509 (90.9)	24 (57.1)
>7–14 (n = 36)	33 (5.9)	3 (7.1)
>14–21 (n = 16)	11 (2.0)	5 (11.9)
>21 (n = 15)	6 (1.1)	9 (21.4)
Median hospital length of stay (IQR), days	1 (0–4)	6 (3.8–9.8)
Admission to:		
EMW	43 (7.7)	0 (0)
CCU	6 (1.1)	12 (28.6)
General ward	237 (42.3)	27 (64.3)
Surgery	3 (0.5)	0 (0)
None (discharge from ED)	271 (48.4)	3 (7.1)
Death	0 (0)	2 (4.8)
Safety MACE alone	—	*16*
STEMI	—	11
NSTEMI	—	16
Death (pneumonia 1, necrotizing fasciitis 1, VF 1, cardiac arrest 1, STEMI 1)	—	5
Effectiveness MACE alone	—	*11*
PCI	—	8
CABG	—	3
Both safety and effectiveness MACE	—	*15*
STEMI + PCI	—	6
STEMI + CABG	—	1
NSTEMI + PCI	—	7
NSTEMI + CABG	—	1

CHF, congestive heart failure; IFG, impaired fasting glucose; ACEI/ARB, angiotensin converting enzyme inhibitors/angiotensin receptor blockers; MDRD eGFR, estimated glomerular filtration rate by the Modification of Diet in Renal Disease study equation; ED, emergency department; STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, Percutaneous coronary intervention; CABG, coronary artery bypass grafting.