



## ORIGINAL ARTICLE

## Utility of an Emergency Department Chest Pain Protocol in Ruling Out Acute Coronary Syndrome

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### Abstract

**Objective:** To assess the safety and efficacy of an Emergency Department Chest Pain Protocol in ruling out Acute Coronary Syndrome in a regional hospital in Singapore.

**Methodology:** An audit was carried out of the cases admitted to our Short Stay Unit (SSU) under the Chest Pain Protocol from June to November 2014. Patients presenting with chest pain and possible acute coronary syndrome, but with normal initial electrocardiogram (ECG) and troponin level, could undergo this rule-out protocol, which comprised serial ECGs and troponin levels, followed by selective outpatient treadmill or Coronary Computed Tomographic Angiography (CCTA) if they were discharged.

The list of patients was electronically generated from our database at fortnightly intervals. Their casenotes were then reviewed, and phone follow-up done for discharged patients at least 30 days after discharge.

Primary outcome was missed Acute Coronary Syndrome (ACS) within 30 days, as determined by 2 independent cardiologists using pre-set criteria. Secondary outcomes were adverse events, and stable coronary artery disease (CAD) requiring Percutaneous Coronary Intervention (PCI).

**Results:** During the period of audit, a total of 240 patients were admitted under the protocol, of which 3 were lost to follow-up. 4 patients were found to have ACS within 30 days, of which 3 were picked up by the protocol. There was 1 case of missed ACS, who had a negative treadmill after discharge from the SSU, but later had an ST-Elevation Myocardial Infarction (STEMI). 10 patients had stable CAD requiring PCI.

**Conclusion:** Our results suggest that the protocol is safe and can rule out ACS in most patients.

### Keywords

Emergency department, Chest pain protocol

### Background

Chest pain accounts for a significant proportion of Emergency Department attendances [1]. The challenge for physicians is to pick up potentially life-threatening conditions such as ACS, since patients with missed ACS who are discharged from the Emergency Department may have adverse consequences and increased mortality [2].

Chest pain units and accelerated diagnostic protocols have taken on an increasingly important role in the work-up of these patients [3-9]. They allow for streamlined work up for ACS and Coronary Artery Disease (CAD) without the need for inpatient admission.

### Methodology

Beginning in 2012, patients presenting to our Emergency Department with chest pain and possible ACS, but with normal initial ECG and troponin (Troponin T hs STAT; Roche; Mannheim; Germany), could be admitted

**Table 1:** Diagnostic criteria for acute coronary syndrome.

<b>STEMI</b>	Symptoms of myocardial ischemia in association with <ul style="list-style-type: none"> <li>• Persistent ECG ST elevation and subsequent release of biomarkers of myocardial necrosis</li> <li>• ST elevation at the J point in at least 2 contiguous leads of <math>\geq 2</math> mm (in men) or <math>\geq 1.5</math> mm (in women) in V2-V3, or <math>\geq 1</math> mm in other contiguous chest or limb leads</li> </ul>
<b>NSTEMI</b>	Symptoms of myocardial ischemia in association with ST and/or T wave changes, ongoing pain, and elevated troponin T
<b>Unstable angina</b>	Symptoms of rest angina (> 20 min), new-onset angina of at least CCS* class III severity, or increasing angina (more frequent, longer in duration, or lower in threshold with increase in 1 or more CCS class to at least class III severity), in association with: <ul style="list-style-type: none"> <li>• Non-diagnostic ECG or ST/T wave changes</li> <li>• Normal troponin level</li> <li>• Flow-limiting stenosis on coronary angiogram (if angiogram done)</li> </ul>

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to our Short Stay Unit (SSU), which is our observational unit, under the Chest Pain Protocol. Exclusion criteria would be patients with typical angina, definite STEMI or NSTEMI, Thrombolysis in Myocardial Infarction (TIMI) Risk score [10-12]  $\geq 3$ , hemodynamic instability, acute cardiac failure, cardiac arrhythmias, end-stage renal failure, Systemic Lupus Erythematosus (SLE), suspicion of pulmonary embolism or aortic dissection, and multi-system dysfunction requiring inpatient management. The rule-out protocol comprised serial ECGs and troponin levels (repeated 3 and 6 hours after), followed by selective outpatient treadmill stress test or Coronary Computed Tomographic Angiography (CCTA) within 48 hours, ordered at the managing physician's discretion if the patient was discharged. The patient was admitted from the SSU if there was persistent or worsening chest pain, hypotension, arrhythmia, ECG changes suggesting ischemia, or troponin rise.

We conducted an audit of cases managed under this protocol from June to November 2014. Submission was made to our Institutional Review Board, who deemed that our audit did not require ethical review. For the period of audit, the list of patients was electronically generated from our database at fortnightly intervals. The casenotes were reviewed, and phone follow-up done for discharged patients at least 30 days after discharge. Data entry was done in Microsoft Excel, and calculation of confidence intervals using VassarStats.net.

Primary outcome assessed was missed ACS within 30 days. The diagnosis of ACS was assigned using pre-set criteria (Table 1), which were derived from American College of Cardiology/American Heart Association (ACC/AHA) guidelines [13,14]. The upper limit of normal at our institution for troponin T levels is 30 ng/L. The definition of missed ACS was any case discharged from the SSU under the protocol but admitted for ACS within 30 days. Other outcomes studied were the number of stable coronary artery disease (CAD) requiring Percutaneous Coronary Intervention (PCI) within 90 days, and the incidence of adverse events (including death, cardiovascular collapse, respiratory failure requiring ventilatory support, cardiac arrhythmias or hypotension

**Table 2:** Patient demographics.

Characteristic	Chest pain protocol patients n = 240
Age in years	53.5 (13.3)
Mean (SD)	
Gender	
Male	144 (60%)
Female	96 (40%)
Race	
Chinese	135 (56.2%)
Malay	73 (30.4%)
Indian	21 (8.8%)
Others	11 (4.6%)
Cardiovascular risk factors	
Diabetes mellitus	43 (17.9%)
Hypertension	93 (38.8%)
Hyperlipidaemia	99 (41.3%)
Pre-existent CAD	42 (17.5%)
Smoking*	49 (20.9%)

\*n = 235.

requiring treatment, and proven pulmonary embolism or aortic dissection). All outcomes were determined by 2 independent cardiologists. If there was disagreement between the 2 cardiologists, a 3<sup>rd</sup> cardiologist would adjudicate.

## Results

A total of 240 patients were admitted to our SSU under the protocol during the audit period. Of these, 3 patients were lost to follow-up (uncontactable by phone and did not come for follow-up appointments). Mean age of the patients was 53.5 years. Patient demographics have been summarized in Table 2.

Four patients were found to have ACS within 30 days, of which three were diagnosed and admitted from the SSU. Of the three cases diagnosed from the SSU, one patient had ST-Elevation Myocardial Infarction (STEMI), one had Non-ST-Elevation Myocardial Infarction (NSTEMI), and one was a case of Unstable Angina who had PCI done during the same admission.

There was one case of missed ACS, who had a nor-

**Table 3:** Results.

<b>Results</b>	<b>Chest pain protocol patients</b>
<b>Clinical outcomes, No. (%; 95% confidence interval)</b>	<b>n = 237</b>
Admitted from SSU <sup>a</sup>	17 (7.2; 4.5-11.2)
ACS <sup>b</sup> within 30 days	4 (1.7; 0.7-4.3)
ACS not picked up by protocol	1 (0.4; 0.07-2.35)
Adverse events within 30 days	1 (0.4; 0.07-2.35)
Stable CAD <sup>c</sup> requiring PCI <sup>d</sup> within 90 days	10 (4.2; 2.3-7.6)
<b>Outcomes of treadmill stress testing, No. (%)</b>	<b>n = 87</b>
Positive	13 (14.9)
Negative	67 (77)
Equivocal	7 (8.1)
<b>Outcomes of CCTA<sup>e</sup>, No. (%)</b>	<b>n = 34</b>
Severe stenosis	6 (17.6)
Moderate stenosis	6 (17.6)
Mild Stenosis	12 (35.3)
Normal	9 (26.5)
Anomalous coronary artery	1 (3)

<sup>a</sup>Short stay unit; <sup>b</sup>Acute coronary syndrome; <sup>c</sup>Coronary artery disease; <sup>d</sup>Percutaneous coronary intervention; <sup>e</sup>Coronary computed tomographic angiography.

mal treadmill stress test one day after discharge from the SSU, but reattended three days later for STEMI. Emergency coronary angiography showed triple vessel disease, with spontaneous recanalization of the culprit lesion in the left anterior descending (LAD) artery. The patient was transferred to a tertiary centre for Coronary Artery Bypass Graft Surgery (CABG), where post-operatively he developed hypotension requiring Extracorporeal Membrane Oxygenation (ECMO) life support, and eventually passed away.

Besides this single case of mortality, there were no other adverse events within 30 days. Ten patients were found on follow-up to have stable CAD requiring PCI within 90 days. Patient outcomes, and results of Treadmill stress test and CCTA, are summarized in [Table 3](#).

## Discussion

The limitations of our audit were that it was conducted in a single centre, and data collection was observational in nature. However, it would not have been feasible in this context to perform a randomised controlled study. The incidence of ACS in our patients was also low, indicating that this was a relatively low-risk cohort.

Our protocol utilised CCTA as an alternative investigation to treadmill stress test, as Myocardial Perfusion Imaging (MPI) is currently not available at our centre and has to be done at another hospital. CCTA was ordered at the physician's discretion for patients who could not run or were deemed unsuitable for treadmill. CCTA has been increasingly used to work up low to intermediate risk chest pain patients in the emergency department and has been shown in several trials to have good negative predictive value, and better efficiency compared to standard care [15-18]. Our results support this, as none of the patients with CCTA showing no or mild stenosis had ACS or an adverse event within 30 days, nor did any of them have significant CAD requiring PCI.

Other centres have demonstrated the safety of discharging chest pain patients with outpatient treadmill stress test [5,19,20], and this is also supported by the AHA scientific statement [3] on testing of low risk chest pain patients. However, there are limitations of treadmill stress testing in diagnosing CAD [21]. Previous meta-analysis [22,23] has found considerable variability in reported diagnostic accuracy, and mean sensitivity was calculated to be 68%. The patient who had a STEMI after a normal treadmill had CAD which was not detected by the stress test, and later most likely had plaque rupture leading to the acute myocardial infarction. During his SSU stay, he had normal ECGs and troponin levels. Polanczyk, et al. [24] demonstrated a major cardiac event rate of about 2% in patients with a negative exercise tolerance test after presentation to the emergency department with chest pain. Our event rate after a normal treadmill stress test was comparable to that.

## Conclusion

The results of this audit suggest that the Chest Pain Protocol is safe and can rule out ACS in most patients. The audit also demonstrates the demographic pattern and outcomes of chest pain patients managed in the emergency department observational unit of a regional hospital in Asia.

## Authors' Declaration of Interest

None.

## Financial Support for Article

None.

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