

Predictive value of a 6-hour ECG/troponin protocol in patients with chest pain

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Introduction: Patients presenting with chest pain and considered to be at low risk of acute coronary syndrome (ACS) may still have coronary heart disease. The potential risk of sudden cardiac death due to arrhythmias or progression to acute myocardial infarction still exists. To minimize this risk, we have designed a 6-hour risk stratification protocol for patients with a low risk of acute myocardial infarction on initial assessment in the Accident and Emergency Department (AED). **Materials & Methods:** This was a retrospective observational study with the aim of determining the risk of adverse cardiovascular events in chest pain patients attending an AED. These patients were subject to an ECG and cardiac troponin T tests (cTnT) at 0 hour and at 6 hours (if the two tests were negative at 0 hour), and were put under observation in the AED observation ward during the same period. The main outcome measures were adverse cardiac events at 30 days. **Results:** A total of 371 Chinese patients considered to have low risk of ACS were recruited into the protocol. Troponin T tested positive in 19 patients (5.1%) at 0 hour and 8 patients (2.2%) at 6 hours. Amongst the 332 patients that were discharged directly from the AED, there were no re-admissions for cardiac-related deaths, acute myocardial infarction, arrhythmia or heart failure. **Conclusion:** The 6-hour ECG and troponin T observation protocol is a useful tool to allow safe discharge of chest pain patients who are at low risk of acute coronary syndrome. (*Hong Kong j.emerg.med.* 2003;10:146-152)

Keywords: Chest pain, clinical protocols, observation, risk, troponin T

Introduction

Chest pain patients remain some of the most difficult ones to manage in emergency medicine. There are many patients presenting with chest pain to the Accident and Emergency Departments (AED) every day, with only a few of them requiring admission for active treatment.

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Most of them are admitted to avoid the small but catastrophic risk of adverse events resulting from acute coronary syndrome (ACS), principally arrhythmia, sudden death and cardiac failure. Numerous strategies have been proposed to risk-stratify patients with possible acute coronary syndrome.¹⁻⁷ The most effective predictors of risk of ACS appear to be history, electrocardiogram, troponin and observation followed by some form of provocative test. The cheapest, most available and most efficient combination of these predictors is still the subject of ongoing research and depends on local factors such as expertise and facilities. Lack of access to immediate provocative testing is a common issue for many AED in Hong Kong. This results in the majority of patients with possible acute coronary syndrome being discharged without a definitive diagnosis. This may be acceptable if these patients do not suffer from an adverse cardiovascular event before more definitive tests can be undertaken.

This study aimed to determine the risk of an adverse cardiac event following an initial 6-hour risk stratification protocol for patients with chest pain or discomfort and with a low risk of ACS on initial assessment in the AED.

Methods

Setting

The Prince of Wales Hospital is a 1,300-bed tertiary referral hospital in the New Territories of Hong Kong, serving a direct population of 400,000 and those of referral hospitals with a total over 1,000,000. The AED has an annual attendance of 200,000 with an admission rate of 15%. The Coronary Care Unit in the cardiology division of the hospital has six monitored beds. There are approximately 10 patients per day with "chest pain" mentioned in their presenting complaints at triage and one patient per day with a discharge diagnosis of acute coronary syndrome.

Participants

During the period from July 1, 2001 to December 31, 2001, all patients with suspected acute coronary syndrome, without a clear diagnosis of ST-elevation acute myocardial infarction (AMI) or unstable angina, based on history and ECG on presentation, were candidates for inclusion in the study. Patients were excluded if there was a co-morbidity or other clinical indication necessitating admission to a medical ward. Decision and documentation of inclusion into the study were performed by the attending doctor at the time of the first troponin test.

Protocol

Following initial assessment in the AED, patients were categorized into four groups. (Figure 1) Group 4 patients were admitted to the observation ward to follow a 6-hour protocol, consisting of ECG and bedside troponin T Test (Roche Cardiac T Quantitative) performed on admission and at 6 hours along with observation without ECG monitoring. A troponin test was defined as positive if the word 'positive' was displayed in the bedside machine within

15 minutes, indicating that the machine's threshold value of 0.1 ng/ml of troponin T concentration had been exceeded. If ECG changes (defined as any noticeable changes in morphology of the ST segments, T wave or Q waves from the ECG at 0 hour) or troponin positivity were present, then patients were admitted to the coronary care unit for monitoring and investigation. Unless there were specific features of concern on history or examination, the remaining patients were then discharged for follow up in medical outpatient clinics or discharged without further follow up if diagnosis was apparent after observation.

Follow up

The outcome of the patients under study were followed up over the following 30 days to find out whether they had died, re-attended the AED or been readmitted into hospital. In Hong Kong, all residents have an identity card number, which allows tracking of patients in Hospital Authority facilities across the territory through a computerized record system.

Results

During the six-month study period, a total of 492 patients presented to the AED with chest pain or discomfort. Of these, 121 patients had a discharge diagnosis of ACS. The remaining 371 patients were classified as Group 4 (low risk of ACS) and included in the 6-hour ECG/Troponin Protocol. Of these, 200 were males and 171 were females with a mean age of 58 ± 15 . Six of the 371 patients died within 30 days, three from cardiac causes, one from massive gastrointestinal haemorrhage, one from hepatocellular carcinoma and one from a stroke. All cardiac deaths occurred in the group with troponin test positive on first reading.

There were 27 patients (7.3%) tested positive on TnT either in the 0-hour or 6-hour testing. Three hundred and forty-four patients (92.7%) were tested negative on both tests. In terms of outcome in 30 days, of the 27 positive patients, 4 died (14.8%) (3 from cardiac cause and 1 from non-cardiac cause) and the rest survived (85.2%). In the TnT negative group (n=344),

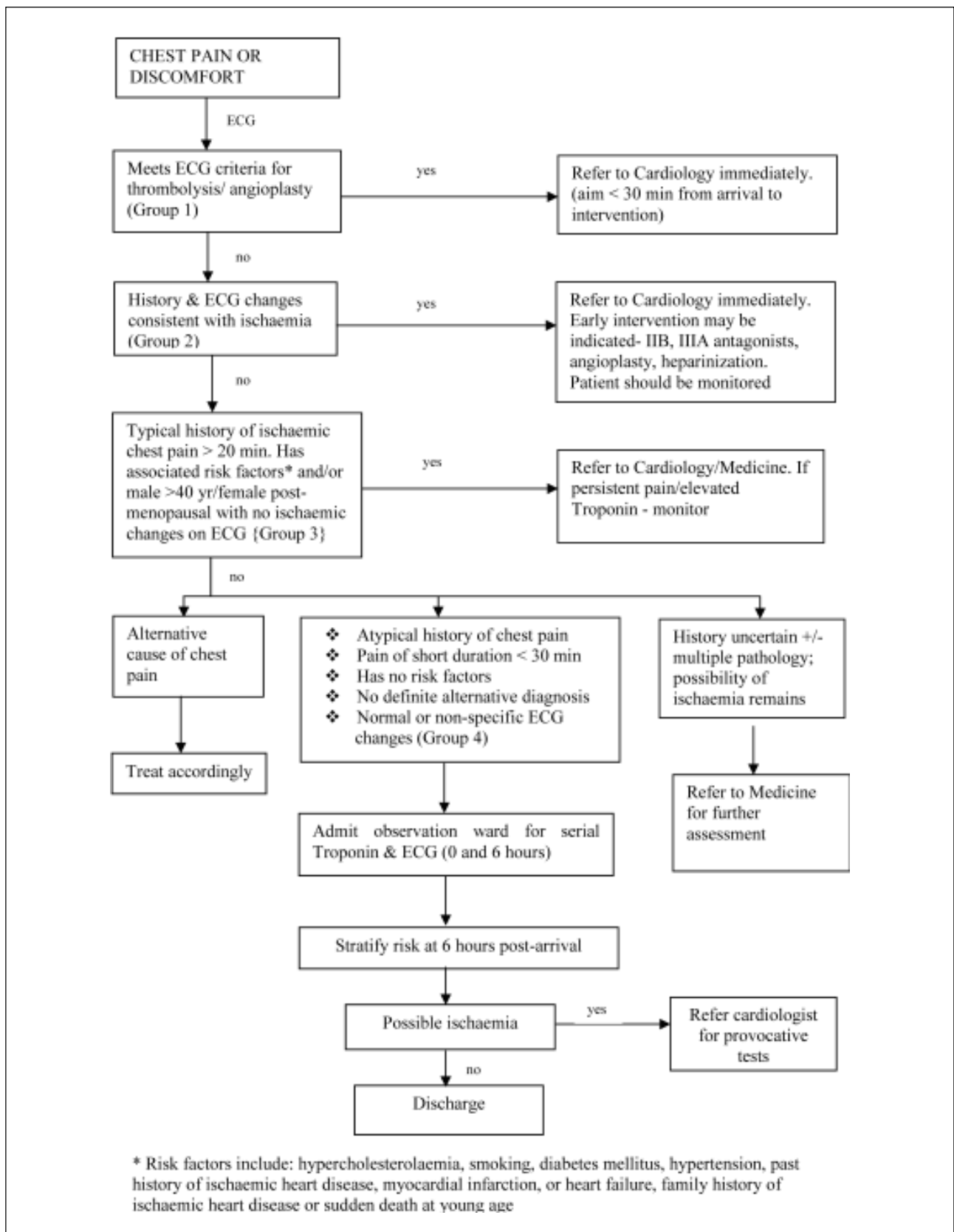


Figure 1. Protocol for management of chest pain patients in emergency department.

2 died (0.6%) (both from non-cardiac causes) and 342 (99.4%) survived. (Figure 2) In terms of cardiac mortality at 30 days, the positive predictive value of the test was 11% (95% CI -0.7 %-23%). The negative predictive value of the test was 100% (95% CI 100%-100%).

Nineteen of the 27 troponin-positive patients had a positive troponin on first assessment. Three of these 19 patients died on first admission. The cause of death in all three was acute myocardial infarction. Eight patients had a positive troponin test at 6 hours. One of these eight patients was diagnosed with an alcohol related disorder upon first admission and was discharged from the medical unit. He subsequently had a sudden collapse at home and died at the second AED attendance. The post-mortem report showed massive peptic ulcer bleeding with no evidence of myocardial infarction. In this patient, the troponin test was not repeated in the ward upon the first admission, and the explanation of the positive troponin test in AED was not documented in the medical record.

A further 12 patients were admitted to a medical ward after the 6 hour observation protocol and normal troponin tests because of medical concern of the attending doctor. (Figure 3) Six of these were for

definite non-cardiac causes and six were for possible cardiac causes. (Table 1) Of these 12 patients, only one died, and this was from hepatocellular carcinoma. The six admitted patients with possible cardiac cause received creatine kinase (CPK) assay, echocardiogram and repeated ECG during hospitalization. Only one of these six patients had a slightly high CPK level of 651 U/L. In this patient the initial ECG findings in the AED observation ward were biphasic T waves over the anterior leads. The other five patients' CPK results were all normal and they were given follow-up medical outpatient clinic appointments after discharge. After 30 days follow-up, these 11 patients all survived with no further documented cardiac events.

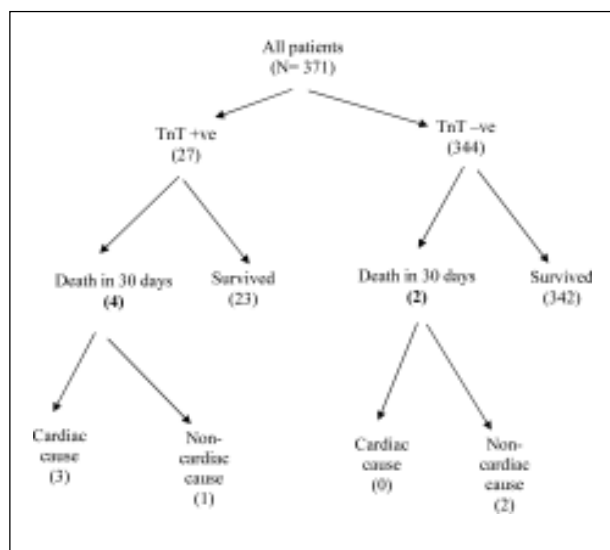


Figure 2. Outcome of patients subjected to the protocol.

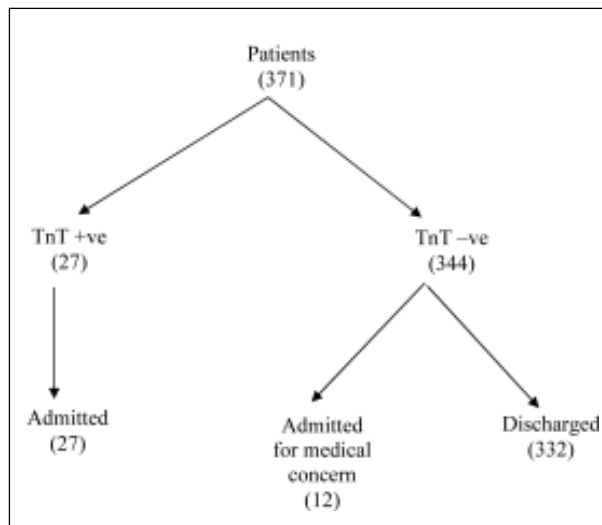


Figure 3. Disposal of patients under the protocol.

Table 1. Outcome of patients whose two cTnT tests were normal (but still admitted because of medical concern)

Admission diagnosis	Survived	Died
Chest pain for investigation	3	0
Ischaemic heart disease	1	0
Palpitation	1	0
Unstable angina	1	0
Oesophageal reflux	1	0
Obstructive Jaundice	1	0
Carcinoma of liver	0	1
Right upper quadrant pain	1	0
Tenosynovitis	1	0
Type 2 respiratory failure	1	0
Total	11	1

Of the 332 patients who were directly discharged from AED after following the protocol, 127 were referred to the medical outpatient clinic for further assessment. Forty-nine of these 332 patients re-attended the AED within 30 days of their first attendance. Of these 49 patients, 34 were discharged with a diagnosis other than acute coronary syndrome but 15 were admitted. (Figure 4) Three of these admitted patients had a diagnosis of probable acute coronary syndrome based on clinical features, borderline CPK results and non-diagnostic ECG abnormalities. These three patients all had normal ECGs, and troponins on first AED attendance. There were no re-admissions for cardiac-related deaths, acute myocardial infarction, arrhythmia or chronic heart failure within 30 days.

Discussion

Ideally patients should have a definitive diagnosis on discharge from AED after observation with a chest pain observation protocol. Available resources limit the ability to provide definitive investigations such as exercise ECG and/or echocardiography immediately. This study shows that there is a very low risk of cardiac death within 30 days following this chest pain

protocol. The bedside troponin test correctly identified all patients with subsequent cardiac death within 30 days. The three clinically diagnosed cardiac deaths all occurred in the 19 patients with a positive troponin test on first reading.

Even more important is the finding that none of the patients who were discharged after following the protocol developed any clinically documented cardiac-related events at 30 days. One may argue that some of these patients may have died in a private hospital or have attended the general practitioner for AMI. However, as the Hospital Authority is providing hospital service to over 90% of the patients in Hong Kong, it is likely that contribution from the private sector is very small. Thus, it would appear to be relatively safe to discharge patients for up to 30 days before definitive investigation of acute coronary syndrome is performed. Our results compare favourably with protocols used in other studies.^{2,6,8-11}

Our study also shows that there were some patients whose second TnT test was positive while the first test was negative. In other words, eight out of the 27 (29.6%) patients had a TnT test positive only on second testing. This confirms the findings from previous studies that a second TnT test, 6-12 hours later will give additional information.¹²⁻¹⁴ Although no patients died from cardiac causes in this group, positive TnT implied myocardial damage. It is possible that those with delayed TnT rise are at lower risk from adverse events, though that was not reported in previous studies. This study was too small to make that conclusion. Even if the risk is very low, the information is very useful in expediting follow up and investigation.

This protocol was inexpensive. The patients were admitted to the AED observation ward and no additional nursing and medical staff was needed. Only two ECGs and two bedside troponin tests were required. The cost of two troponin tests was about HK\$130.00.

The period of observation for low risk patients suggested by other authors varies considerably, ranging

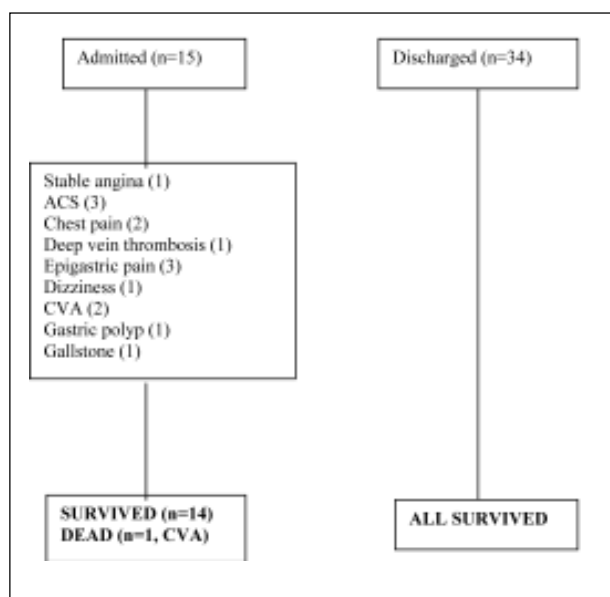


Figure 4. Outcome of patients who re-attended AED within 30 days.

from 90 minutes to 12 hours.^{1,2,7-9} The American College of Cardiology/American Heart Association 2002 guideline update for the management of patients with unstable angina and non-ST segment elevation myocardial infarction recommends that in a patient with negative cardiac markers within 6 hours of the onset of pain, another sample should be drawn in the 6-12 hours time frame.¹⁵ In this study, a 6-hour observation period appeared to detect those patients at high risk. The time of onset of chest pain as opposed to the time of arrival in the emergency department was not determined accurately and was not part of the protocol for a number of reasons. Firstly, the pain may come and go, making it difficult to pinpoint the exact time of onset of the symptoms. Secondly, the elderly patients in this local community have a low literacy rate and poor communication skills. Therefore, the history obtained may be unreliable. Thirdly, cardiac troponins start appearing in blood within 6 hours of onset of myocardial necrosis. There is a small chance that very late rises may have been missed.

The decision to admit these patients to an area with no cardiac monitoring facility was based on previous studies which had shown that patients with no ECG abnormalities, no CPK rise and who were pain free, were at low risk for any adverse cardiac event in the first 24 hours.¹⁶ In this study our patients did not suffer from arrhythmias, deaths or acute pulmonary oedema during the observation period in our AED observation ward.

In this study, the troponin test was positive in 7.3% of the studied patients despite the fact that they were considered to be in the low risk group. Therefore, clinical features and initial ECG findings could not reliably exclude acute coronary syndromes. Troponin T or other biochemical markers testing are essential in chest pain assessment even in patients with such a low risk. On the other hand, it is important to emphasize that patients may still have angina or other medical problems even with no abnormalities detected during the chest pain protocol, as demonstrated in this study. Therefore, from the diagnostic point of view, none of the tests should replace clinical

assessment and re-assessment, a point stressed in previous studies.^{4,10}

Other patients with atypical presentation of acute coronary syndrome, such as those presenting with epigastric pain and shortness of breath were excluded from our study. However this group may also benefit from a modified protocol using troponins.

A limitation of this study was that we did not audit charts for protocol violation or check history and ECG findings reported in the charts. Another limitation was that some patients might have had a cardiovascular event and attended private doctors or private hospitals. However, as mentioned before the contribution from the private sector was likely to be small.

In conclusion, the 6-hour troponin & ECG observation protocol was a useful tool to allow safe discharge of local patients who were at low risk of acute coronary syndrome.

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