Development of a risk stratification protocol for patients with cardiac chest pain in the emergency department

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SUMMARY

- This paper presents a literature review conducted to inform the development of an evidence-based guideline for risk stratification for patients with cardiac chest pain;
- Review of literature highlighted risk stratification through using point of care test approach in assessing cardiac troponin I; using Thrombolysis In Myocardial Infarction score for risk assessment, and pre-arranged stress test appointment to detect potential missed diagnosis.
- Findings suggested that utilization of cardiac troponin I; via a point of care test approach and Thrombolysis In Myocardial Infarction score, could decrease the turnaround time and facilitate clinical management decision-making, and pre-arranged stress test before emergency department discharge could minimize the missed diagnosis of discharged patients with suspected acute coronary syndrome.

INTRODUCTION

Chest pain is a common ailment leading reason for attendance of hospital emergency department (Czarnecki et al., 2013). In the United States, data from the National Hospital Ambulatory Medical Care Survey in 2010 reported 7,007,000 emergency visits that were associated with chest pain (Niska et al., 2010). In England, chest pain accounted for 25% of emergency admissions each year (Goodacre et al., 2005). In Hong Kong, the Hospital Authority reported approximately 41,000 visits due to chest pain to the emergency department (ED) in 2010 (Hospital Authority, 2010 cited in Ko, 2013). Chest pain is a common presentation of acute coronary syndrome (ACS), which is used to describe any condition where blood flowing to the heart muscle is suddenly reduced or blocked (e.g. unstable angina, chronic condition of exertional angina, and acute myocardial infarction) (Mant et al., 2004). Pain intensity is suggested to have a positive correlation with subsequent infarct size.

In 2012, published guidelines from the American College of Cardiology Foundation and the American Heart Association (ACCF/AHA) showed that early recognition of signs and symptoms (such as chest pain) and taking the right steps for ACS rapid assessment and triage are critical for effective treatment and care, leading to improved clinical outcomes for patients (Wright et al., 2011). Failure to identify a diagnosis of ACS can lead to major adverse cardiac events (MACE). Such events include: cardiac arrest, non-fatal myocardial infarction, emergency revascularization, life-threatening arrhythmia. Missed diagnosis of ACS is associated with increased risk of short-term mortality (Schull et al., 2006). It is recommended that ED nurses are trained with a visible chest pain algorithm to ensure that all patients are managed according to standard protocols.

Conventional protocols used in acute hospitals in Hong Kong vary despite adopting the recommendations from the American Heart Association in principle. For example, the management of chest pain in ED starts with taking a medical history, an electrocardiogram (ECG) and assessing risk factors using the Thrombolysis In Myocardial Infarction (TIMI). Blood samples are obtained and tested for cardiac biomarkers. Cardiac troponin I (cTnI) is a common biomarker for myocardial damage. In some instances, cTnI is ordered along with other cardiac biomarkers such as myoglobin, creatine kinase (CK) or CK-MB depending on the policy for each hospital. Upon admission to the observation ward in ED, the cTnI test is requested at time zero and again at post 3 to 6 hours. During this period, the patients are closely observed in the observation ward with cardiac monitoring or repeated 12-lead ECG at regular intervals. If any high risk features manifests during observation, the patient would be admitted and referred to the cardiologist. If the patient does not show any signs of high risk features, they would be discharged. Current practice does not include a routine referral for follow up stress test after ED discharge.

In 2013, ACCF and AHA published an updated protocol for the management of the unstable angina recommending a new approach to identify and exclude acute myocardial infarction (AMI) within 6 hours. This time reduction to 6 hours involved detecting a delta change in the measurement of the cardiac biomarker over a time interval ranging from 90 minutes to 2 hours. Traditionally, the interpretation of serial cTnI test results requires 6-8 hours, using this approach of assessing a delta change biomarker measurement will enable the triage of high risk patients for a much earlier treatment. Studies have been conducted to evaluate the effectiveness of this new approach.

A study conducted by AHA evaluated different timeframes using a point of care test (POCT) for multi-biomarkers at 90 minutes or 3 hours to diagnose AMI. Results showed that with the combination of testing myoglobin and cTnI on admission and again 90 minutes post admission produced a sensitivity of 96.9% (McCord et al., 2001). In a more recent study by Ko et al. (2013), a time point of 0 and post 2 hour biomarker test was examined for its effectiveness and was validated in patients presenting with chest pains. However, it is important to note that rsults from non-randomized studies may not be able to provide sufficient evidence to support a change in the clinical management protocol.

Potential service gaps in current practice are identified. First, despite risk assessment was performed, using systematic TIMI risk score estimation for guiding risk stratification and referral was unclear. Second, traditional serial cTnI tests using central laboratory processing may increase the turnaround time for clinical interpretation of cTnI results. Subsequently, the patients are required to wait in the observation ward for a longer period of time, making the conventional chest pain protocol a time-consuming process affecting timely referral to specialist management. Third, without timely referral for a follow-up stress test in a conventional chest pain management protocol, it might increase the potential risk of a missed diagnosis in discharged patients. As such, there is a need to identify and address the service gap between the current practice and diagnostic strategies with evidence-based practice for risk stratification of cardiac chest pain patients attending ED.

OBJECTIVES

A literature review was performed to review and identify the best available evidence for practice of difference diagnostic strategies for acute cardiac patients with chest pain to improve risk stratification. The objectives of the literature review were:

- To search and identify relevant evidence for diagnostic strategies in risk stratification in patients with acute cardiac pain attending the ED.
- To critically appraise the evidence to determine its applicability in clinical settings.

METHODS

To obtain evidence, a systematic search for relevant studies was performed on following databases: CINAHL plus, MEDLINE, Ovid Nursing Database, and EMBASE from 2000 to 2013. The search used a series of keywords, “Risk stratification” AND “emergency department” AND “chest pain”; “point of care” AND “troponin” OR “cardiac biomarker”; “stress test”; “thrombolysis in myocardial infarction score”; “acute coronary syndromes” AND “myocardial infarction”.

Initially 1274 potential relevant articles were generated from the keywords that were used for the search. Systematic reviews, meta-analyses, and randomized controlled trials (RCT) were included. Upon removal of records that did not fulfil the inclusion criteria, five eligible literature were identified. One quasi-experimental study was retrieved by hand from the reference lists of the five eligible searches. Therefore, a total of six articles, consisting of one systematic review, one quasi-experimental study, and four RCT were included in the literature review.

The methodological quality of the included studies was assessed by the appraisal tool retrieved from Scottish Intercollegiate Guideline Network (SIGN). Following the recommendation of the guidelines, the quality of the studies was classified into high quality, acceptable, and low quality. A higher quality indicates less bias. Finally, four studies were rated with high quality and two studies were with acceptable quality.

REVIEW FINDINGS

Diagnostic efficiency of cardiac biomarkers

Acute myocardial infarction can lead to myocardial cell injury (Hamm, 2001). Serum cardiac biomarkers of necrosis are released into bloodstream from necrotic myocardial cells. Detection of cardiac biomarkers, including CK-MB, troponin, and myoglobin, in peripheral circulation is essential for AMI diagnosis (McCord et al., 2001). Myoglobin and CK-MB are detectable first, but troponin is more sensitive and specific for myocardial injury (McCord et al., 2001). Analyzing cTnI by POCT in ED has been studied by a RCT conducted by Renaud et al. (2008). In this study, 53 patients underwent POCT and 60 underwent central hospital laboratory (CLT) testing. In comparison with CLT, POCT can contribute to earlier identification of myocardial infarction by allowing shorter turnaround time for decision-making and treatment (Renaud et al., 2008).

Because different markers have optimal sensitivity for AMI at different times, biochemical marker panel is proposed. It was hypothesized that combining markers could optimize sensitivity. Goodacre et al. (2011) conducted a multicenter randomized controlled trial to evaluate the effectiveness of using a point-of-care cardiac marker panel (the combination of CK-MB, myoglobin, and cTnI). Participants were diagnosed either using the point-of-care biochemical marker panel (n = 1132) or conventional diagnostic assessment (n = 1131). The results showed that point-of-care testing increased the proportion of patients successfully discharged home [odds ratio (OR): 3.81, 95% confidential interval (CI): 3.01 to 4.82], and reduced the median length of hospital stay (8.8 hours versus 14.2 hours, $p < 0.001$) (Goodacre et al., 2011). Collinson et al. (2012) further conducted a prospective randomized trial to compare the diagnostic efficiency of cardiac biomarkers among patients with chest pain. Participants were randomly assigned to either POCT group or CLT group. The CLT group only received the cardiac troponin assessment. On top of cardiac troponin assessment, the POCT group received the measurement of the triple marker panel of cTnI, myoglobin, and the CK-MB on admission and 90 minutes after admission. The results showed that troponin measured by POCT alone is sufficient, with a sensitivity of 0.85 (0.75-0.92) and specificity of 0.976 (0.96-0.98) (Collinson et al., 2012). Measurement of additional cardiac markers does not have incremental value for early diagnosis of ACS. Considering that the POCT offers convenient, rapid, and safe diagnosis, point-of-care cTnI could be utilized to allow early diagnosis or the exclusion of AMI.

The TIMI risk score is a scoring tool developed for risk stratification in patients with unstable angina or non-ST-segment elevation myocardial infarction. To estimate the performance of the TIMI risk score in the incidence of cardiac events, Hess et al. (2010) conducted a systematic review and meta-analysis which included 10 prospective cohort studies with a total of 17,265 patients. Their results supported the strong linear relationship between TIMI risk score and the occurrence of cardiac events. The TIMI score had 97.2% in sensitivity and 25% in specificity. However, the low specificity score indicates that TIMI should not be used as the sole means of clinical decision-making (Hess et al., 2010).

Stress test is a noninvasive testing which could be applied among patients with low or intermediate risk of ACS. A stress test (also called a treadmill test or exercise test) can be performed within 72 hours upon discharge or outpatient review. Richards et al. conducted a RCT to address the compliance issue for the stress test (Richards et al., 2007). Two-hundred and thirty-one participants were enrolled. In the intervention group (n = 123), stress test was prescribed and patients were notified upon being discharged from emergency department. In the control group (n = 115), participants were advised to contact their family physician to arrange stress test. Participants in the intervention group reported higher completion rates for

stress test than the control group (72.5% versus 56.1%, p < 0.001) (Richards et al., 2007). A similar study was conducted by Chung et al. The intervention group (n = 96) was given an appointment time for stress test while the control group was given a referral to arrange their own appointment. The results also showed that pre-arranged appointment could enhance the compliance with stress test among patients discharged from the ED with intermediate-risk ACS (Chung et al., 2012).

In summary, testing of cTnI using POCT, TIMI score, and stress test arrangements are essential components to improve the diagnostic efficiencies in patients with chest pains and reduce possible adverse cardiac events.

IMPLICATIONS FOR PRACTICE

Based on the literature review findings and ACCF/AHA guidelines, several recommendations are proposed and a risk stratification flow chart for patients with cardiac chest pain in ED is outlined in Figure 1.

Objectives

The objectives are to enhance clinical differentiation of patients with acute cardiac chest pain in the ED:

- To facilitate early detection of ACS and safely discharge low and intermediate risk patients.
- To minimise missed diagnosis.
- To accelerate the time to treatments for high-risk patients with ACS.

Recommendation 1: testing troponin using point of care testing

Before the implementation of POCT, the analytical performance requirements for the troponin test should be defined. The quality control procedures would be utilized to ensure appropriate performance (Renaud et al., 2008; Shaw, 2016; Singer et al., 2015). Criteria for the acceptance of quality control results would be specified and documented. Technical support would be provided by the manufacturer during office hours as well as 24 hours telephone hotline contact number for enquiry.

Patient demographic data and information about medical history would be collected upon arrival at the ED triage station by triage nurses. A 12-lead ECG would be performed: patients identified with abnormal results of critical ECG pattern (e.g. ST segment elevation > 1 mm) will be triaged for prompt treatment; patients with ischemic changes (e.g. ST elevation ≥ 0.05mV) or unstable angina would be admitted for further observation and investigation (Jesse & Kontos, 1997; Wright et al., 2011). In patients with non-diagnostic ECG, cTnI would be measured using the POCT approach with Siemens Straus CS analyzer, from which the results could be available in around 15 minutes (Singer et al., 2005). If the cTnI reading exceed that of 0.07μg/L, the patient would be admitted; if the patient presented with non-diagnostic ECG and negative cTnI reading, the patient would be assigned to the observation ward for continuous monitoring (Renaud et al., 2008; Singer et al., 2015).

Recommendation 2: risk assessment using TIMI score

Risk assessment would be performed based on risk factors, clinical manifestation, interpretation of the ECG, and results of cardiac markers testing (Czarnecki et al., 2013). This TIMI score is calculated based on seven items:

- age 65 years or older
- three or more risk factors for coronary artery disease (such as hypertension or diabetes)
- known history of coronary heart disease
- experience two or more episodes of angina in past 24 hour
- aspirin use in the past seven years
- ST-segment elevation deviation of 0.05mv or more
- elevated cardiac markers (Hess et al., 2010; Nieuwets et al., 2016).

One point is given to each item if presented. This score is used to stratify patients with different risk of developing ACS. Patients with a TIMI score of 5 or above require the second assay of cTnI POCT at 90 minutes upon admission. An incremental value of the second assay of cTnI requires prompt hospital admission.

Recommendation 3: stress test

To safely discharge patients with low- and intermediate- risk patients, a follow-up appointment for stress test would be pre-arranged for patients within 72 hours. Information, such as preparation for the stress test on the examination day, importance of the examination and potential risks, would be explained to the patient before hospital discharge. A case nurse from electrographic diagnostic unit would be assigned to follow up target patients to facilitate their attendance for stress test. The results of the stress test would be used to determine the extent of coronary artery disease and patients' risk for AMI. Patients would be educated on the meaning of the chest pain as a sign of myocardial injury, the benefits of obtaining prompt treatment and emergency visit, and the risk of delaying treatment of chest pain (Johnson et al., 2009).

DISCUSSION

Implementation issues

While achievements in promoting evidence-based practice have been made, barriers may be encountered during the process of implementing such practices. First, the risk stratification protocol is conducted in ED that is a clinical environment with various clinical context and diverse patient conditions. The final decision of how patients are managed is largely influenced by clinical judgment and experience of attending physicians, thereby posing a great challenge to maintaining the interventions integrity. Therefore, it is necessary to collaborate with physicians in ED and the cardiology team in the process of developing and implementing new risk stratification protocol in ED for patients with chest pain.

Time constraints

Obtaining blood sampling by POCT may be regarded as time-consuming activity due to additional workload and time (Daly et al., 2005; Gustafsson et al., 2014). To address this issue, staff satisfaction and perspective on the workload should be explored. Evidence of reduction in existing workloads and of improvement in patient outcomes after implementing risk stratification protocol should be examined and disseminated to ED staff members. Training sessions should be conducted prior to the protocol implementation to increase the confidence and competence of healthcare professionals. Integration of the current guideline into routine practice may lead to a high caliber assessment and planning. It may be also necessary to introduce research nurses to assist the protocol implementation.

Resources and cost expenditure

Availability of resources is another concern in the implementation of evidence-based practice (Polit & Beck, 2008). Hospital services may not be able to provide constant resources and coordination for follow-up outpatient stress tests. The coordination among departments requires detailed discussion about the logistical plan.

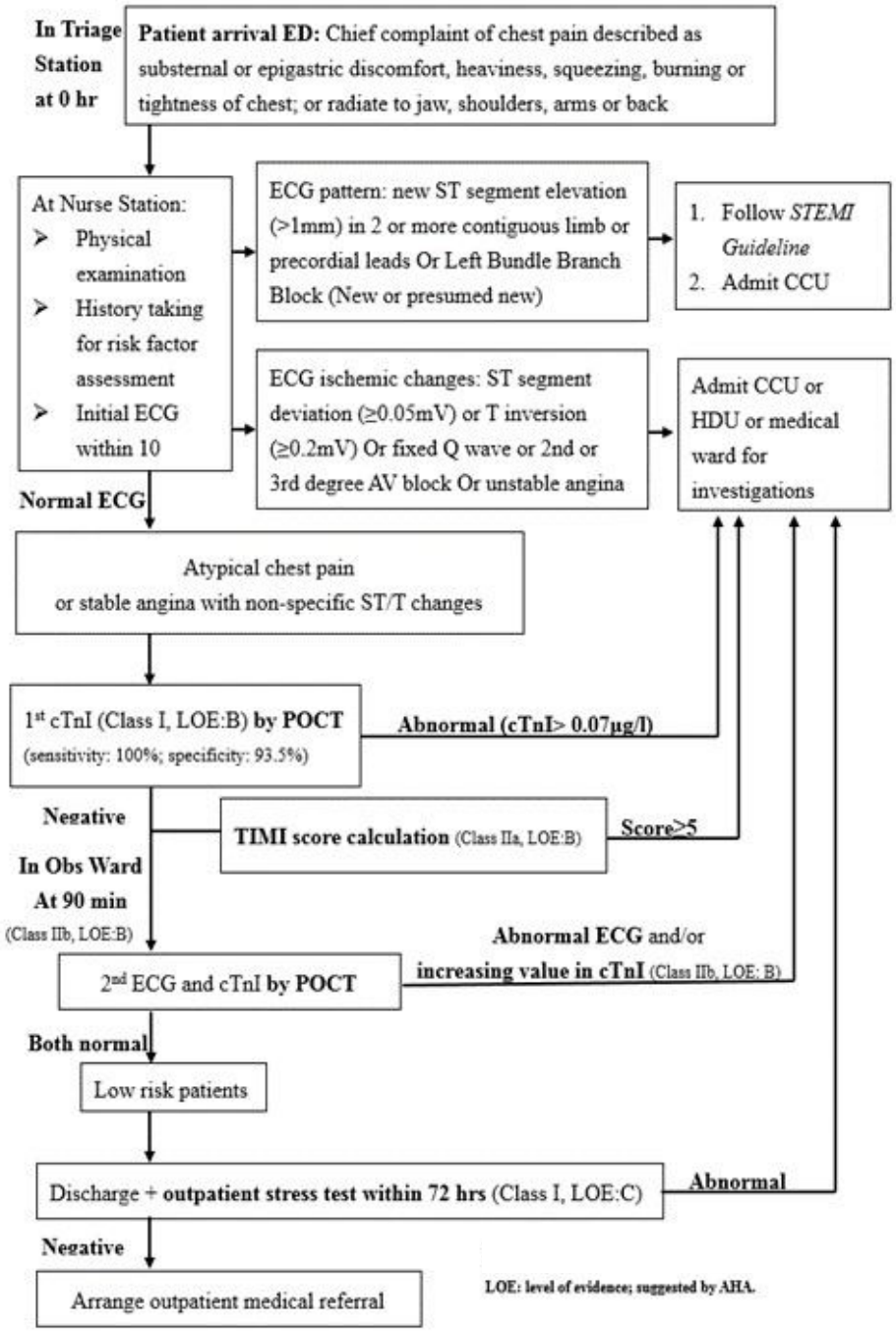

Figure 1. Risk stratification protocol for patients with cardiac chest pain in the emergency department

CONCLUSIONS

Chest pain is a common factor contributing to ED attendance. A missed diagnosis of ACS may lead to adverse cardiac events, which underscore the needs to develop a protocol to provide safe and timely risk stratification for patients with acute cardiac chest pain in the ED. Making use of currently available evidence-based components in risk stratification is likely to bring about a beneficial impact on the management of patients with chest pain.

The evidence-based literature review conducted in this article highlighted cTnI using a POCT approach, TIMI score, and pre-arranged stress test appointment. The literature review findings suggest that utilization of cTnI via POCT approach, TIMI score, and stress test can decrease the turnaround time, facilitate decision-making, and minimize the missed diagnosis of discharged patients with suspected ACS. This guideline may have potential in making clinical practice more effective and optimizing patient outcomes.

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