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Original Contribution

The impact of high-sensitivity troponin implementation on hospital operations and patient outcomes in 3 tertiary care centers☆,☆☆

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ABSTRACT

Objective: High-sensitivity troponin T (hs-TnT) assays detect myocardial injury sooner, possibly improving throughput times for emergency department (ED) assessment of suspected acute myocardial infarction (AMI). This study evaluates the influence of hs-TnT implementation on ED length of stay (LOS), consultations and admissions, as well as ED revisits with cardiology admissions for patients undergoing testing for suspected AMI.
Methods: This control pre-post design analysis included patients evaluated using hs-TnT or conventional troponin T. Data were collected from 3 ED databases for patients who had a troponin assay for suspected AMI for the periods February 12, 2011-April 22, 2011 (Ctrl); November 20, 2011-January 28, 2012 (Pre); and February 12, 2012-April 21, 2012 (Post). The primary outcome was ED LOS; secondary outcomes included the proportions of patients who received ED cardiology consultations, patients who were admitted to hospital, and discharged patients who revisited the ED within 30 days.
Results: Data were analyzed from 6650 (Ctrl), 6866 (Pre), and 5754 (Post) patients. Median ED LOS decreased following hs-TnT implementation (6.60 hours in Ctrl and Pre vs 6.10 hours in Post, $P < .001$). There was no change in cardiology consultations or admissions following hs-TnT implementation. Fewer ED revisits occurred within 30 days in Post (16.0% Ctrl, 16.5% Pre vs 14.9% Post; $P < .01$). These results were preserved after adjusting for age and Canadian Triage Acuity Score.
Conclusions: This hs-TnT implementation strategy, using an equivalent cutoff for the conventional troponin T and hs-TnT assays, decreased ED LOS for patients with suspected AMI and did not increase cardiology resource utilization or ED revisits.

1. Introduction

Acute coronary syndromes (ACSs) are an important cause of mortality in North America. In 2013, estimates from the American Heart Association attribute 17% of national mortality to coronary artery disease [1] Chest pain and symptoms suspicious for acute myocardial infarction (AMI) may account for up to 10% of annual emergency department (ED) visits [2]. Because of the potential for ACS-related morbidity and mortality, ED patients with suggestive symptoms undergo thorough evaluation. The sensitivity of ED evaluation for potential acute coronary syndromes using conventional troponin assays has been previously estimated at approximately 2% to 5% [3,4] and is likely even better in current practice.

Serial cardiac troponin (cTn) assays are a cornerstone of the diagnostic process [5,6]. Currently available fourth-generation cTn assays can detect clinically important levels of cTn within 4 hours of symptom onset. However, their sensitivity does not exceed 90% until more than 8 hours from symptom onset. This means that non–ST segment elevation myocardial infarctions (NSTEMI) can potentially be diagnosed within 4 hours but cannot be reliably excluded without a more prolonged ED stay [6].

Newer high-sensitivity troponin T (hs-TnT) assays can detect serum cTn levels that are approximately 1/10 of the lower detectable limit of conventional assays [5]. These assays may make it possible to diagnose NSTEMI earlier, and raise the possibility of excluding NSTEMI in a substantially shorter time [7–12]. However, increased test sensitivity is

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usually accompanied by decreased specificity resulting in more frequent false-positive test results [5]. False-positive tests have detrimental downstream effects including increased investigation and referral rates, prolonged ED stays, ED crowding, higher health care costs, unnecessary investigations, and iatrogenic complications [7,13,14]. As hs-TnT assays are broadly implemented to replace fourth-generation conventional assays, it is imperative to quantify the effect of hs-TnT assay implementation on hospital operations, resource utilization, and patient outcomes.

The objective of this study was to quantify the impact of implementing an hs-TnT assay on ED operations, cardiology consultation rates, hospital admission rates, and patient outcomes in 3 large urban Canadian hospitals using a diagnostic strategy designed to maximize hs-TnT specificity while preserving the sensitivity of previous diagnostic approaches. It was hypothesized that although the implementation of the hs-TnT assay may be associated with a decreased ED length of stay (LOS), it might also result in an increased proportion of cardiology consultation and admission because of its relatively poor specificity in identifying patients with true ACS.

2. Methods

2.1. Study design and setting

This is an observational study using prospectively collected administrative data from 3 discrete time periods before and after the implementation of the hs-TnT assay. The University of Calgary Conjoint Health Research Ethics Board deemed this project exempt from review after using the "A Project Ethics Community Consensus Initiative" screening tool [15], as it was considered a quality improvement activity.

This study was conducted in 3 university-affiliated adult EDs in Calgary, Alberta (population 1.2 million). One of the 3 hospitals is the regional percutaneous coronary intervention referral center. All 3 hospitals have inpatient cardiology services and coronary care units. Their combined annual ED census is approximately 230,000 patients, and they share a common regional Emergency Department Information System (EDIS) with computerized physician order entry software (Sunrise Clinical Manager [SCM]). These applications record reliable electronic time stamps for ED operations metrics (ie, patient arrival, physician assessment, consultation times, admission, and discharge) as well as timing of investigations and therapeutic interventions. They also include common numeric patient identifiers that permit reliable database linkage.

Standard practice for evaluation of acute coronary syndromes includes serial electrocardiogram and troponin assays, with cardiology admission for patients diagnosed with or at high risk of ACS and discharge to outpatient follow-up for low-risk patients. There is no ED observation unit, chest pain unit, or clinical decision unit.

2.2. Patient population

We included all ED patients who had a troponin assay performed during the study periods described below. Patients with a confirmed ST-elevation myocardial infarction, as ascertained using discharge *International Classification of Diseases, 10th Revision,* codes, were excluded, as biomarkers are not used to diagnose ST-elevation myocardial infarction. Patient data were collected from the EDIS database, and laboratory data were collected via patient data numerical linkages with SCM.

2.3. Troponin testing pre– and post–hs-TnT implementation

Before February 2, 2012, all 3 EDs used the Roche fourth-generation conventional troponin T (cTnT) assay with a cutoff for the diagnosis of NSTEMI of 30 ng/L. Department protocols permitted nurses to initiate cTnT testing for patients with chest pain or potential ACS symptoms (eg, shortness of breath, epigastric pain). Troponin T assays were typically performed at the time of ED arrival and repeated 6 to 10 hours after symptom onset, according to the treating physician's discretion.

On February 2, 2012, all 3 EDs implemented the Roche hs-TnT assay. In the months prior and independent of this study, an intensive knowledge translation program was undertaken by ED administrators to educate physicians and nurses about the appropriate use of the new hs-TnT assay. In addition, departmental nursing protocols were changed to permit nurse-initiated ordering of hs-TnT assays only on patients with significant suspicion of ACS in an effort to reduce indiscriminate troponin testing. *High likelihood of ACS* was operationally defined in nursing protocols as including patients with sufficiently high pretest probability to warrant immediate aspirin therapy. Patients were to have hs-TnT levels performed at a minimum 6 hours after symptom onset before disposition decision making.

The implementation strategy used different cutoffs to rule in and rule out AMI. Results between 0 and 14 ng/L (<99th percentile in a normal reference population) taken at least 6 hours after symptom onset were considered normal and ruled out AMI. High-sensitivity TnT levels greater than 50 ng/L 6 hours after symptom onset (the cutoff level empirically determined to be equivalent to the rule-in cutoff of 30 ng/L of the previous fourth-generation assay) were considered compatible with AMI in the appropriate clinical context (ie, rule in). Occasionally, physicians may repeat initially elevated (>50 ng/L) hs-TnT assays to optimize specificity if a patient had a comorbid condition that may have chronically elevated troponin levels (ie, congestive heart failure or chronic kidney disease) (Fig. 1).

Physicians were advised that hs-TnT levels 14 to 49 ng/L 6 hours after symptom onset were undetectable by previous assays and would have been reported as "negative" test results before the implementation of hs-TnT. These patients were to undergo repeat hs-TnT testing 2 to 4 hours after the initial assay if AMI remained a diagnostic consideration.

Troponin assays were performed in each hospital's central laboratory during the control, preimplementation, and postimplementation time periods. Turnaround time for both cTnT and hs-TnT assay results are approximately 50 minutes.

2.4. Time periods

Data were collected for three 10-week periods (historical control, preimplementation, postimplementation). Historical control (Ctrl) data were collected between February 12, 2011, and April 22, 2011 (1 year before hs-TnT implementation), in an effort to account for seasonal effects on ED operations and patient presentations. Preimplementation (Pre) data were collected from November 20, 2011, to January 28, 2012. Postimplementation (Post) data were collected from February 12, 2012, to April 21, 2012. Mortality data were examined at 30 days following the index visit. Other than the implementation of the hs-TnT assay, no operational change was made to the evaluation of potential ACS patients during the study period.

2.5. Data collection

All patients who had at least 1 troponin assay (cTnT Ctrl and Pre, or hs-TnT Post) measured during the study periods were identified in our administrative database EDIS. Presenting complaint, discharge diagnosis, consultation and admission instances, as well as electronic time stamps for patient arrival, physician assessment time, consultation time, admission time, and ED LOS were also obtained for all eligible patients from the EDIS database. The number and timing of troponin assays were obtained from the SCM order entry software. The EDIS and SCM databases were linked using a deterministic linkage based on visit encounter number, medical record identifying number, and date of ED visit. The linkage rate exceeded 99%. Emergency department revisits were identified by Regional Health Record Number linkages to initial visits. Inpatient and outpatient mortality data were extracted from