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# Impact of implementation of the HEART pathway using an electronic clinical decision support tool in a community hospital setting☆

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## 1. Introduction

Chest pain is a common reason for patients to present to the emergency department (ED) for evaluation, accounting for between 8 and 10 million visits per year [1]. Patients presenting with chest pain are commonly admitted to the hospital – or kept in the ED for prolonged observation – and routinely receive additional cardiac evaluation often including serial biomarkers and stress testing. There is significant variation – even within an institution – in the rate of admissions, observation, and use of stress testing [2-4]. Despite increasing evidence that "low-risk" patients without electrocardiographic evidence of ischemia and normal troponins are at extraordinarily low rates of short-term adverse events, physicians remain cautious in the evaluation of chest pain, no doubt in part driven by risk aversion [5-10]. Yet excessive admissions and overtesting carries its own, though less visible, risks. In the cohort of patients with "low risk chest pain" (i.e. low risk for acute coronary syndromes), overuse of stress testing is associated with a number of false positive tests and subsequently unnecessary and potentially harmful invasive evaluations [3,11-14].

The HEART score and HEART Pathway have been shown to successfully and safely risk stratify patients with chest pain, although with mixed results in terms of reducing potentially unnecessary testing and overall length of hospital stay [15-18]. The pathway has not been studied explicitly in the community hospital setting in the U.S., and its utility in reducing overall admission rates in this setting is unclear.

Our goal was to study the implementation of the HEART Pathway in a single community hospital setting and its impact on overall hospital admission rates, which in an ED without an observation unit serves a proxy for the intensity of testing and thus potentially exposure to overtesting. Our secondary goal was to determine the potential for an electronic ED dashboard decision tool to maximize utilization of the pathway.

## 2. Methods

### 2.1. Study design and setting

This was a single institution pre-post intervention funded by the Beth Israel Deaconess Medical Center Innovations Grant, performed at a community emergency department with approximately 47,000 annual visits. The entire study period was November 1, 2014 through June 30, 2016. Our pre-intervention period was November 1, 2014 to October 31, 2015, and following implementation of the pathway, the post-intervention period started from November 15, 2015 through June 30, 2016.

### 2.2. Study protocol and details of the intervention

Prior to the intervention, providers managed chest pain according to usual care. Since our ED does not have an observation unit, providers could either choose to admit, discharge, or briefly observe patients in the ED (usually checking two troponins at a time interval determined by each provider). For this pre-intervention period, we did not have the capability to capture HEART scores as providers did not routinely utilize or denote the HEART score. We also did not capture outcomes in our pre-intervention group, since our intent was mainly to measure any change in the admission rate from the pre- to post-intervention groups and not explicitly study the major adverse cardiac event (MACE) rate in our "usual care" cohort.

Before commencing the intervention, we presented the basic goals of the study along with brief background and instructions on utilization of the HEART Pathway at several staff meetings, and one investigator (PS) reviewed the HEART Pathway with each provider invididually. Starting on November 1, 2015, we established an electronic clinical decision support

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tool using our ED dashboard (Forerun, Inc. Waltham, MA) that flagged patients with a chief complaint of chest pain, age ≥ 30, and a normal troponin I (Access AccuTnI + 3, UniCel DxI Access Immunoassay Systems, 99th percentile upper reference limit <0.03 ng/mL with a 97.5% upper confidence limit of 0.04). Providers enrolled patients into the HEART Pathway if they felt acute coronary syndrome was a reasonable consideration and all other serious causes of chest pain had been excluded. The pathway was only used for chest pain, not for other symptoms like dizziness and shortness of breath. This is consistent with the intent of the HEART Pathway being used to risk stratify patients with acute chest pain. We included only patients with a negative troponin so as to reduce the burden on providers to consider the pathway for all patients presenting with obviously non-cardiac chest pain or for those with clearly abnormal troponins.

The pathway flag on the dashboard prompted providers to consider the pathway at multiple points: on the overall department screen, within the patient's individual record, and before signing a chart. Providers could ignore the pathway only by clicking through this prompt before signing their chart. Providers also had the option of "declining" to utilize the pathway if acute coronary syndrome was not being considered as a likely cause of their chest pain (e.g. pneumonia, pulmonary embolus, traumatic mechanism, etc.). Alternatively, providers could "enroll" patients into the pathway at which point they would calculate a HEART score. The HEART score components were then shown to the provider on a screen along with detailed descriptions of each component (see Appendix 1). These components included: history (assessment of likelihood of cardiac chest pain), EKG, age, risk factors, and troponin level, each graded on a scale from 0 to 2.

In our study, patients with a score of 4 or greater were admitted to the hospital, and patients with a score of 3 or less had two troponins drawn three hours apart and discharged if both troponins were normal and repeat EKG was unchanged, consistent with the HEART Pathway as described by Mahler [16]. The original HEART score used a single troponin at the time of initial evaluation [15]. The randomized trial in the U.S. by Mahler et al. (the HEART Pathway) demonstrated that by adding a second troponin at 3 h, the incidence of MACE was zero events at 6 weeks [16]. We did not extend the time interval of drawing the troponins based on the time of onset or duration of a patient's symptoms, but did allow for a single troponin in cases where, based on provider judgment, the patient had experienced a sufficiently long period of unremitting pain.

For patients being discharged, our providers reviewed a shared decision making (SDM) document with them that reviewed the rationale for the testing, their risk of missing an acute coronary syndrome, and the importance of 7-day follow-up with their primary care provider. This SDM was modified based on one publicly available from the University of Maryland Medical System [19]. We did not explicitly instruct patients to undergo outpatient stress testing.

### 2.3. Outcomes

Study variables included race, age, and gender, and vital signs. Race categories included Black, White, Hispanic, Asian, and other.

Our primary outcome was the rate of hospital admissions, with the denominator being all patients who presented to our ED for evaluation of chest pain in each period. To ensure a meaningful and accurate comparison of the groups, for the primary outcome comparison both the pre-intervention and post-intervention denominator included all International Classification of Diseases (ICD)-9 or ICD-10 codes for chest pain (based on ED coded diagnosis regardless of whether the patient was discharged or admitted). We excluded acute coronary syndrome, myocardial infarction (MI), ST elevation MI, and transfers. The ICD-9 codes used were 786.50,786.51, 786.52, 786.59, 413.9, and the corresponding ICD-10 codes were R07.9, R07.2, R07.1, R07.81, R07.82, R07.89, I20.8, I20.9, I25.111, I25.118, I25.119, I25.701, I25.708, I25.709, I25.711, I25.718, I25.719, I25.721, I25.728, I25.729, I25.731, I25.738, I25.739, I25.751, I25.758, I25.759, I25.761, I25.768, I25.769, I25.79, I25.798, I25.799.

Our secondary outcome was utilization of the HEART score pathway using the electronic clinical decision support tool. For this secondary outcome, we looked at the rates of "enrolled", "declined," or "ignored" for patients either flagged by the dashboard or manually enrolled by the providers. We were mainly interested in how often providers ignored the pathway, i.e. whether the use of the electronic tool resulted in meaningful utilization of the HEART Pathway, understanding there was no control group for comparison.

While the safety of the HEART Pathway has been well established and was not our primary intent, we felt it would be meaningful to collect the 30-day MACE rates within the limitations of our resources. This was only meant as a descriptive analysis and only done for those patients discharged from the ED after utilization of the HEART Pathway. For the post-intervention group we reviewed our hospital's on-line medical record to determine 30-day MACE rates in discharged patients. MACE included all-cause mortality, myocardial infarction, or coronary revascularization. Our available resources precluded telephonic followup or review of the social security death index.

For the chart review components of this study, two research assistants were trained in the use of the online medical record and quality of data abstraction was monitored at random intervals by the principle investigator (PS). The data abstractors reviewed all charts for patients discharged via the HEART Pathway for up to 30 days after discharge. Since we only reviewed patients discharged from the ED, the data abstractors were consequently not able to be blinded to the patient's initial disposition. Any potential MACE was initially reviewed by the research assistant and secondarily by the principle investigator, with any uncertainty in terms of MACE definition referred to a second reviewer (LJ). Only one case required secondary review and is described below.

### 2.4. Data analysis

For descriptive statistics, we presented categorical variables as count (%), continuous variables with normal distribution as means (±SD), and continuous variables with non-normal distribution as medians and inter quantile range (IQR). For comparative statistics, Pearson's Chi-square test was performed for categorical variables, Independent *t*-test for continuous variables with normal distribution, and Man-Whitney *U* test for continuous variables with non-normal distribution.

For the main statistical analysis, we utilized an Interrupted Time Series (ITS) analysis, which is the quasi-experimental approach for evaluating longitudinal effects of interventions [20]. A time series is a sequence of values of a measure taken at regularly spaced intervals over time. We measured the monthly admission rates and divided the trial period into two time segments - before and after implementation of the HEART score pathway. In ITS approach two parameters define each segment: level and trend. The level is the value of the series at the beginning of a given time interval (intercept). The trend is the rate of change of a measure (in other words, the slope) during a segment. In segmented regression analysis, each segment of the series can exhibit both a level and a trend [21]. A change in level indicates an abrupt intervention effect. A change in trend, defined by change in the slope of the segment after the introduction of the pathway, points to a more gradual change.

Using ITS approach, we employed autoregressive integrated moving-average (ARIMA) models to estimate the changes in level and trend following the HEART pathway [22].

Analyses were performed using SPSS software (version 21, SPSS Inc. Chicago, Illinois). The level of significance was 0.05. The study was approved by the institutional review board at Beth Israel Deaconess Hospital-Plmouth.

## 3. Results

There were a total of 1675 patients in our pre-intervention group and 1092 patients in the post-intervention group. The pre- and post-pathway groups were comparable with respect to age and race, while there were more males in the post-pathway group. Demographic and clinical characteristics of the groups are demonstrated in Table 1.

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