STRESS TESTING IN LOW RISK CHEST PAIN PATIENTS MIGHT NOT BE BENEFICIAL

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ABSTRACT

Background: Assessment of non-cardiac chest pain places a considerable burden on healthcare resources. A typical admission usually requires serial cardiac biomarkers, electrocardiograms (EKGs) and at times provocative (stress) testing to detect undiagnosed coronary artery disease. Provocative testing incurs costs and additional time investment. **Objective:** The purpose of this study was to identify such low risk chest pain admissions and examine the utilization of stress testing in this group to determine if they are really needed and outcome of these patients. **Patients & Methods:** This was a retrospective observational chart review of the patients admitted to Abington Memorial Hospital, from 1st January 2011 to 30th April 2011.We included all patients who were admitted to the hospital with atypical chest pain with no prior history of coronary artery disease, a normal non diagnostic EKG and an initial negative troponin on presentation. We recorded the prevalence of risk factors for coronary artery disease, risk stratified the patients based on TIMI risk scoring and determined the utilization of stress tests. We studied the stress test results and the increase in length of hospital stay if a stress test was ordered. Patient's charts were also reviewed to record any adverse events and 30 day re-hospitalizations. **Results:** Out of 272 charts, 164 patients were included based on the above mentioned criteria. Mean age was 60 years, 33.5% were male. Risk factors included: hypertension (63%), diabetes mellitus (23%), smoking (20%), hyperlipidemia (49%), and family history (38%). Two patients had positive troponin (peak level 0.43ng/ml) and subsequent negative stress tests. In the patients who were ruled out for ACS (acute coronary syndrome) no troponin elevation was seen in the third set of tests if the second set was normal. Patients were stratified to TIMI risk 0-4. A stress test was performed in 48% of the patients. 53% of patients with a TIMI=0 underwent stress testing, 37% with TIMI=1, 50% with TIMI=2, 52% with TIMI=3 and 60% with TIMI=4.There was no association between TIMI score and utilization of the stress test ($p = 0.494$). 70% of stress tests were recommended by internists and 30% by cardiologists. None of the stress tests were positive for ischemia. 97.4% were negative, 2.6% (2/78) were read as positive and were followed by a cardiac catheterization which revealed normal coronary arteries (false positive stress test). One patient with a recent negative outpatient stress test and recurrent chest pain underwent catheterization that showed normal coronaries. Performing inpatient stress tests increased the patient length of stay by 17 hours on average.There were no acute coronary syndromes, no deaths, and no 30 day re-hospitalizations due to cardiac complications in patients who did or did not had an inpatient stress test. **Conclusion:** Ordering stress tests in low risk chest pain patients is of low yield with a high false positive rate and increases the length of hospital stay. These patients can be safely managed with short term observation with rapid and early discharge from the hospital.

Key words: Stress testing, Chest Pain, Cardiac pain

INTRODUCTION

Patients presenting to the emergency department with atypical chest pain and having a low risk of acute coronary syndrome (ACS) is a very common but challenging clinical problem. In the United States, over 8 million visits to emergency + departments (EDs) are due to chest pain which makes this the second most common clinical presentation to the ED behind stomach aches and gastrointestinal symptoms.[1] A typical admission usually requires serial cardiac biomarkers, electrocardiograms (EKGs) and at times provocative (stress) testing to detect undiagnosed coronary artery disease (CAD). The real question is how to safely and cost-effectively manage these patients keeping in mind the substantial liability, physicians can face if they miss a diagnosis of CAD. Many times this type of clinical presentation leads to significantly prolonged hospital stays and likely unnecessary testing to ensure the patient does not have CAD regardless of their pre-test probability and risk.

The American Heart Association (AHA) recommends that patients who do not have hemodynamic derangements or arrhythmias, have normal or near-normal EKG, and negative initial cardiac biomarkers should be considered as low risk for ACS.[2] The simplest low risk criteria reported from recent research includes one set of cardiac biomarkers, an ECG, and a history of CAD. If none of these parameters are present or abnormal, the patient can be considered low risk, with a probability

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of myocardial infarction <6%.[3] Chest pain patients are commonly risk stratified on the basis of TIMI risk scoring criteria.[4] Scores such as ACI-TIPI score and GRACE score are also present that look at admission variables for risk stratification.[5,6] Methods such as the North American Chest Pain Rule are currently undergoing validation in prospective trials to accurately and safely access the patients risk and avoid prolonged hospital stays and unnecessary testing.[7] Because of the recent changes in the health care system, most of these low risk patients are now being admitted to observation units with a significant reduction in reimbursements. Physicians are now asked to push for an early and safe discharge and to try to decrease the length of hospital stay.[8] However, the question still remains, "Should physicians order an inpatient stress test for a low risk chest pain patient"?

Our study was designed to answer this question. We studied a group of low risk chest pain patients at Abington Memorial Hospital. Our goals were to determine the utilization of stress tests in this population, risk stratify the patients and see if there is an association between the patient's risk and stress test utilization. In addition, we reviewed patient medical records to identify adverse cardiac outcomes, deaths and re-hospitalizations. The objective of the study was to assist the clinician in their decision making regarding the utilization of provocative (stress) testing to detect undiagnosed CAD in low risk patients.

PATIENTS AND METHODS

A list of patients admitted to Abington Memorial Hospital (AMH) and Lansdale Hospital (LH) with the primary diagnosis of chest pain from 1st January 2011 to 30th April 2011 was obtained. Out of 392 patients, 120 patients were admitted to LH and were excluded. The remaining patients were selected based on the criteria included in Table I.

The study was approved by the Institutional Review Board of Abington Memorial Hospital. A retrospective chart review was conducted by the principal investigator. To maintain anonymity, patients were assigned a unique study identification number. Charts were reviewed and data was collected and charted on a data collection form for each patient.

Table I: Inclusion and Exclusion Criteria

Inclusion Criteria:
1. Patients admitted to AMH with primary diagnosis of chest pain
2. Atypical chest pain
3. Initial troponin level negative (< 0.10 ng/ml) in the emergency department
4. Normal or near normal initial EKG
5. No prior history of coronary artery disease

Exclusion Criteria:
1. Typical chest pain that should include all of the following:
   a. Typical substernal pressure like chest pain without pleurisy and chest wall tenderness
   b. Pain that is aggravated by exertion or relieves with rest and sublingual nitroglycerin
2. Initial troponin level positive (> 0.10ng/ml) in the emergency department
3. Initial EKG showing any of the following changes suggestive of ACS:
   a. ST segment elevation ≥1mm in two contiguous chest or limb leads
   b. New left bundle block pattern
   c. ST segment depressions or T wave inversions in two contiguous leads
4. Prior history of coronary artery disease determined by presence of any of the following:
   a. Prior PCI
   b. Known coronary lesion >50% stenosis
   c. Prior ACS (STEMI, NSTEMI, unstable angina)

ACS, acute coronary syndrome; AMH, Abington Memorial Hospital; PCI; Percutaneous Coronary Intervention; EKG, electrocardiogram; STEMI, ST-elevation Myocardial Infarction; NSTEMI, non ST-elevation Myocardial Infarction

Patients were divided into two groups; those who underwent an inpatient stress test (stressed group) and those who did not undergo one (not stressed group). Data collected included: population characteristics, risk factors of CAD, troponin elevations, stress test utilization, TIMI risk stratification, cardiac catheterizations and angioplasties. Clinical outcomes such as ACS, deaths and 30 day re-hospitalizations were compared between the two groups. Increase in length of hospital stay was determined by the time interval between the second negative set of troponins and the stress test results in the stressed group.

Descriptive statistics including means, standard deviations and frequencies were calculated for predetermined variables. Subgroup analysis was performed to determine any association between TIMI risk score and stress test utilization using chi square analysis. SPSS version 15.0 for Windows was used for all statistical analysis.

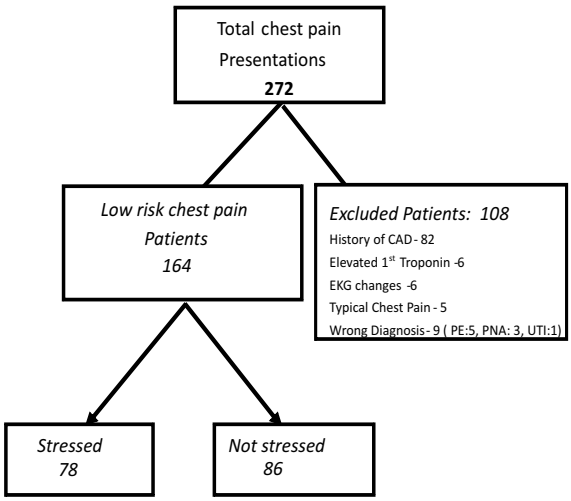
RESULTS

Of the 272 patients admitted to Abington Memorial Hospital, 108 patients were excluded (Fig. I). 164 patients were determined to be low risk based on the established criteria (Table I).

The mean age of patients was 59.9±13.8 years, 33.5% were male. Patient characteristics included: hypertension (63%), diabetes mellitus (23%), smoking (20%), hyperlipidemia (49%), and family history of CAD (38%)(Table II).

Figure I: Inclusion and Exclusion of Study Subjects

CAD, coronary artery Disease; EKG, electrocardiogram; PE, pulmonary embolism; PNA, pneumonia; UTI, urinary tract infection, Stressed, underwent provocative (stress) testing.



Of the 164 patients in the study, troponin elevation in 2nd set was seen in only two patients. Peak troponin level was 0.43ng/ml. The results of subsequent stress tests for both patients did not show any evidence of CAD. In the patients who were ruled out for ACS, no troponin elevation was seen in the third set of tests if the second set was normal.

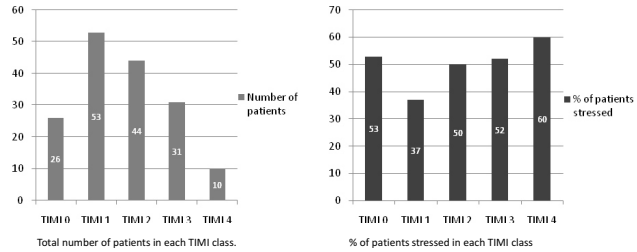
Table II: Patient Characteristics (N = 164)

Characteristics	Frequency (%)
Male	55 (33.5)
Hypertension	104 (63)
Diabetes Mellitus	38 (23)
Current Smoker	32 (20)
Hyperlipidemia	80 (49)
Family History CAD	62 (38)
Troponin Elevation	2 (1.2)
Stress Test Performed	78 (48)

Patients were stratified by TIMI risk 0 to a maximum score of 4. TIMI risk scores higher than 4 were not possible since patients with high risk factors such as history of CAD, EKG changes and positive cardiac biomarkers were excluded.

A stress test was performed in 48% of the patients. 53% of patients with TIMI= 0 underwent stress testing, 37% with TIMI =1, 50% with TIMI= 2, 52% with TIMI= 3 and 60% with TIMI= 4 (Fig. II).

Figure II: Patients in TIMI classes and percentage of stressed in each class.



Pearson chi-square analysis was performed to determine if patients with higher TIMI scores (>4) underwent more stress tests. No association was found between TIMI score and utilization of the stress test (p =0.494). 56% of the stress tests were exercise and 44% were pharmacological. All the tests included myocardial perfusion imaging by Technetium (^{99m}Tc) sestamibi (cardiolite). Seventy percent of stress tests were recommended by internists and 30% by cardiologists. However, cardiology was not consulted on most of the patients or a stress test was already ordered before the cardiologist made his recommendations. Reversible wall motion abnormalities were found in 2.6% (2/78) of patients undergoing stress tests. Both these patients underwent subsequent cardiac catheterization that showed normal coronary arteries making the stress tests false positives. None of the patients had a true positive stress test secondary to undiagnosed coronary artery disease.

In addition to the two cardiac catheterizations performed in patients with false positive stress tests, one more patient underwent cardiac catheterization. This patient had a recent outpatient stress test which was negative but had recurrent episodes of chest pain. Cardiac catheterization was also negative for the presence of coronary artery disease in this patient. Performing inpatient stress tests increased the length of stay by 17.47±13.8 hours. There were no documented acute coronary syndrome cases or inpatient deaths for any study patients. Three patients were hospitalized within 30 days of discharge but all were due to non-cardiac conditions (1-chronic obstructive pulmonary disease exacerbation,1-urinary tract infection, and 1 elective surgery).

DISCUSSION

Our study provides further evidence of the low yield of inpatient provocative testing for low-risk patients

admitted with chest pain. These findings were established previously in a young patient population (<40 years of age) in observational studies.[9, 10] The study by Herman et al, showed a high false positive rate of exercise stress testing in low risk patients <40 years of age where the test was positive in 6/220 patient and none of the tests were true positive.[9] Additional studies report similar low yield results in patients regardless of age when conventional exercise testing was ordered without myocardial perfusion imaging.[11,12] Meta-analyses have shown that the sensitivity and specificity of exercise tolerance tests to detect CAD without myocardial perfusion imaging is 70% and 75%, respectively.[13] With addition of myocardial perfusion imaging the sensitivity of the stress test is close to 90%.[14] Irrespective of patient age, even with myocardial perfusion imaging none of our 164 patients had a true positive stress test and two patients underwent unnecessary cardiac catheterization. The low prevalence of CAD in this population decreased the positive predictive value of the stress test which resulted in more false positives, and exposed the patients to risks of unnecessary cardiac catheterizations.

The cost of an inpatient stress test ranges from several hundred to several thousand dollars depending upon the type of the test. Of the 8 million patients presenting to ED each year with chest pain, most of them belong to the low risk group.[1] Ordering an unnecessary inpatient stress test would significantly increase the length of hospital stay as shown by our study and will further burden the hospital and healthcare resources.

The absence of adverse cardiac events in these low risk patients suggests that they can be safely discharged from the hospital, once ACS is ruled out, to get an outpatient stress test. Many observational studies support this strategy with no adverse cardiac events reported during the interval between hospital discharge and outpatient exercise stress testing.[15, 16, 17] Current guidelines recommend measurement of cardiac biomarkers when a patient presents with chest pain to rule out myocardial ischemia. Patients who present early (within 6 hours of onset of symptoms) have cardiac biomarkers repeated within 6-8 hours. Those who arrive >8 hours after symptom onset may only need a single measurement to exclude myocardial infarction.[18, 19, 20] The results of our study further support this evidence. The second negative set of troponin levels ruled out ACS in all of our patients with no positive results obtained after a negative second test. These results also make one question why a patient should stay in the hospital for another six to eight hours to check a third set of troponin levels.

A degree of risk stratification as adjunct to clinical judgment is necessary in making the decision to order inpatient stress tests. Patients with intermediate to high probability of CAD will have a greater prevalence of undiagnosed CAD and hence will increase the positive predictive value of the stress test.[4] This will lead to fewer false positive tests and fewer patients having unnecessary cardiac catheterizations. Risk criteria such as TIMI risk score and the GRACE scoring system are proposed by AHA as adjuncts to clinical judgment in the evaluation of patients presenting with chest pain.[4,6] Our study failed to demonstrate an association between risk stratification of the patient on TIMI risk score and stress test utilization at our institution. It may be that active risk stratification of the patients at admission will decrease the number of inpatient stress test ordered in very low risk patients (TIMI 0-2). Thus, if we were to use our results to answer our original question, "Should physicians order an inpatient stress test for a low risk chest pain patient?" we would answer no.

However, our study was a retrospective chart review performed at one site and lacks the power of a large prospective randomized trial to detect a specific difference in outcomes. Another limitation of the study is the follow up performed was a chart review of patients readmitted to our hospital. The 30 day follow up showed no re-hospitalizations due to adverse cardiac outcomes but there still is the possibility that we might have missed patients admitted to other hospitals with adverse cardiac outcomes. Ordering fewer stress tests is likely to result in cost savings and less strain on the hospital and healthcare resources suggesting that a cost benefit analysis is needed; however it was beyond the scope of this study.

CONCLUSION

Our study reported on a cohort of patients presenting with a low risk of CAD in which inpatient stress testing did not provide any additional benefit to patient management and significantly increased the

duration of hospital stay. After accurately risk stratifying patients at the time of admission using tools such as the TIMI score, stress tests can be performed as an outpatient which would reduce the length of stay. By identifying this low risk patient population physicians can avoid exposing the patients to unnecessary financial costs and risks of false positive examinations.

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