The Journal of Emergency Medicine, Vol. 39, No. 2, pp. 135–143, 2010

0736-4679/$–see front matter

doi:10.1016/j.jemermed.2007.12.034

Original Contributions

PROGNOSTIC VALUE OF THE DUKE TREADMILL SCORE FOR EMERGENCY DEPARTMENT PATIENTS WITH CHEST PAIN

Alex F. Manini, MD,* Andrew T. McAfee, MD, MSC,†‡ Vicki E. Noble, MD,§ and J. Stephen Bohan, MD, MS†

*Harvard Affiliated Emergency Medicine Residency, Boston, Massachusetts, †Department of Emergency Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, ‡i3 Drug Safety, Auburndale, Massachusetts, and §Department of Emergency Medicine, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts
Corresponding Address: Alex F. Manini, MD, Mount Sinai School of Medicine, One Gustave L. Levy Place, Box 1620, New York, NY 10029

□ **Abstract—Background: The potential clinical utility of the Duke Treadmill Score (DTS) in the Emergency Department (ED) to risk-stratify patients with chest pain but negative cardiac biomarkers and non-diagnostic electrocardiograms is unclear. Objective: We evaluated whether DTS was associated with 30-day adverse cardiac outcomes for low-risk ED patients with chest pain. Methods: For this prospective, observational cohort study, the primary outcome was any of the following at 30 days: cardiac death, myocardial infarction, or coronary revascularization. DTS risk categories (low, intermediate, high) were compared with 30-day cardiac outcomes. Results: We enrolled 191 patients, of whom 20 (10%) were lost to follow-up, leaving 171 patients (mean age 53.3 ± 12.4 years, 54% female, 3.5% adverse event rate) for evaluation. Sensitivity and specificity of DTS for 30-day events were 83.3% and 71.5%, respectively, with a 99.2% negative predictive value (confidence interval 95.4–99.9) for 30-day event-free survival. Conclusions: In this cohort of low-risk ED patients with chest pain, DTS demonstrated excellent negative predictive value for 30-day event-free survival and facilitated safe disposition of a large subset of patients.** © 2010 Elsevier Inc.

□ **Keywords—treadmill test; myocardial infarction; chest pain**

INTRODUCTION

Patients who present to the Emergency Department (ED) with symptoms suggestive of myocardial ischemia and non-diagnostic electrocardiograms (ECG) present a diagnostic challenge. Despite history and physical examination, ECG interpretation, and biomarker assays, up to 2–5% of patients with myocardial infarction (MI) still go undetected (1,2). Risk stratification to identify patients at highest risk for adverse events is essential to diagnostic and therapeutic management of patients with suspected acute coronary syndrome (3). However, patients with negative cardiac biomarkers and non-diagnostic ECG may still be at risk for short-term and future adverse events.

The exercise ECG test is a popular, well-established, inexpensive procedure for assessing exercise tolerance and heart disease. In 2001, the American Heart Association (AHA) issued standards for testing and training for health care professionals and subsequently, in 2002, re-

The study was supported by the Richard C. Wuerz Scholarship for emergency medicine research from the Harvard Affiliated Emergency Medicine Residency, and an unrestricted grant provided by the Dade Behring Corporation.

This study was presented in abstract form at the Society of Academic Emergency Medicine annual meeting in San Francisco, CA, May 20, 2006.

RECEIVED: 4 September 2006; FINAL SUBMISSION RECEIVED: 2 December 2007;
ACCEPTED: 14 December 2007

leased the American College of Cardiology (ACC)/AHA updated guidelines for exercise testing (4,5).

The exercise ECG test indirectly detects myocardial ischemia, which is the physiologic consequence of coronary obstruction. The sensitivity and specificity of this test have been derived from studies correlating the ECG response to exercise with coronary angiographic data, and subsequent reports have confirmed the utility of the Duke Treadmill Score (DTS) in several subgroups, including those with baseline ST-segment and T-wave abnormalities (6–10). Patient gender, age, coronary risk factors, and the characteristics of the chest pain are also important determinants of the pretest probability of coronary heart disease and, therefore, of the diagnostic accuracy of exercise ECG testing (11). Exercise ECG testing is usually performed in patients who are able to attain a sufficient level of exercise and who do not have baseline ECG abnormalities that can interfere with interpretation (12,13).

The potential clinical utility of DTS in the ED or chest pain observation unit is to further risk-stratify patients with chest pain but negative cardiac biomarkers and non-diagnostic ECG. We conducted a prospective, observational study to evaluate whether DTS is correlated with 30-day adverse cardiac outcomes for low-risk ED patients with chest pain.

MATERIALS AND METHODS

This was a prospective, observational cohort study that analyzed the association between DTS and 30-day adverse cardiac events for low-risk ED patients with chest pain. The study and protocol for written informed consent were approved by the Institutional Review Board at the study institution.

The study institution was an urban, tertiary-care university hospital with an annual ED volume of approximately 55,000 adult visits. Our population included a convenience (non-consecutive due to research assistant availability, typically during business hours) sample of low-risk ED patients with chest pain or symptoms suggestive of myocardial ischemia. We defined low-risk patients as those with normal or non-diagnostic ECG and negative initial cardiac biomarkers (creatine kinase isoenzyme MB and cardiac troponin I). We included patients scheduled for rapid exercise ECG by the emergency attending physician. Patients with suspected unstable angina, unstable vital signs, positive second set of biomarkers, or any ECG changes consistent with acute ischemia or infarction were excluded from data analysis because these patients no longer represented a diagnostic challenge for the emergency attending. Patients with contraindications to exercise ECG testing (inability to exercise, pre-excitation syndrome, a paced ventricular rhythm, $>$ 1 mm of ST depression at rest, complete left bundle branch block, patients taking digoxin, and ECG criteria for left ventricular hypertrophy with strain) were also excluded (12,13).

Patients meeting inclusion criteria were approached for enrollment by either a research assistant or a co-investigator. Written informed consent was obtained for all subjects. Study staff members completed a questionnaire identifying demographics and cardiac risk factors.

Enrolled patients were admitted to the ED chest pain observation unit (CPU). All patients were pain free on arrival to the unit and were placed on telemetry monitoring. Serial ECGs and two sets of cardiac biomarkers (total creatine kinase, creatine kinase isoenzyme MB, and troponin I) were performed over an 8-h period. Patients with resolved symptoms and negative serial cardiac markers underwent exercise stress testing the same or next day in all cases. Stress testing with or without myocardial perfusion imaging occurred at the discretion of the Emergency attending physician. Follow-up chart review of electronic medical records and a telephone call after 30 days were performed by one of the co-investigators.

Cardiac markers were measured using Bayer reagents (Bayer Healthcare, Cambridge, MA) on the Bayer Advia Centaur analyzer. Standard cutoff concentrations were used for total creatine kinase (41–266 U/L), creatine kinase MB (0–5 ng/mL), and cardiac troponin I (0–0.10 ng/mL).

Clinical assistants obtaining ECGs were trained to complete a brief series of questions to obtain accurate information for acute cardiac ischemia time-insensitive predictive instrument (ACI-TIPI) scores, which were computer generated in real time. ACI-TIPI is a continuous scale reported as a percentage that indicates the probability of MI, computed as a function of the following categorical variables: age, gender, chest pain as chief complaint, abnormal Q waves, ST-segment elevation, ST segment depression, T-wave elevation, T-wave inversion. Relative weights of these predictor variables are reported in the technical manual for the algorithm as log-odds ratios and the exact numerical values are reported elsewhere (14).

The DTS uses three exercise parameters (exercise time in minutes based on the Bruce protocol, maximum ST-segment deviation in mm, and presence or absence of exercise angina) incorporated into a formula that has been previously described (7,8). DTSs were calculated by the study investigators using data from the attending staff cardiologist, who performed the stress test as part of each patient's routine clinical care. The cardiology service did not incorporate a calculation of the DTS in the official stress test report. DTS incorporates duration of