

## Editorial Comment

# Role of Exercise Testing After Myocardial Infarction\*

DONALD A. WEINER, MD, FACC

Boston, Massachusetts

Every year, approximately 700,000 patients in the United States survive an acute myocardial infarction, but nearly 10% of these survivors will die during the first year after discharge from the hospital. The period of greatest risk for cardiac morbidity and mortality is the first 6 months after the initial event (1). In general, the risk of future cardiac events among survivors is related to the extent and functional significance of the underlying coronary artery disease as well as the degree of left ventricular dysfunction. An important aspect of the management of survivors of myocardial infarction is the identification of those patients at increased risk for subsequent cardiac events. An imposing array of noninvasive tests is now available for the early evaluation of the postinfarction patient and for the identification of high and low risk subsets of patients.

**Exercise testing early after myocardial infarction.** The use of low level exercise testing early after infarction (within 3 weeks) can serve two purposes. It can identify those patients who are at high risk for a future coronary event and who should be given more intensive medical or surgical therapy. It can also identify low risk patients who would not require additional noninvasive or invasive studies and could have an accelerated rehabilitation and return to normal daily activities.

*The screening of patients for the early exercise test is the first step in risk stratification.* Those patients deemed unable to undergo exercise testing, usually because of recurrent chest pain, congestive heart failure or complex ventricular arrhythmias, are at increased risk for a recurrent event. In a multicenter postinfarction study (2), the 1 year mortality rate was 17% in the 192 patients who did not undergo early exercise testing, compared with 6% in the 607 patients who were tested.

Among patients able to undergo early exercise testing,

important predictors of recurrent cardiac events include the presence of ischemic ST segment depression (especially greater than 2 mm), low exercise capacity, complex ventricular arrhythmias and inadequate blood pressure response (3-6). In early studies evaluating the significance of early postinfarction exercise testing, the most important predictor of cardiac mortality was the presence of myocardial ischemia (3,4). In the most recent postinfarction trial (2), however, an inadequate blood pressure response (peak systolic blood pressure less than 110 mm Hg) and the presence of ventricular couplets were the only exercise predictors of increased mortality. It may be that continued evidence of myocardial ischemia on the exercise test influenced the decision to recommend revascularization procedures and that this therapy altered the poorer survival of patients with postinfarction ischemia.

*Equally important in the early risk stratification of patients after a myocardial infarction* is the identification of low risk patients who would require less intensive diagnostic evaluations and therapeutic interventions (7). Among patients whose exercise test does not disclose evidence of myocardial ischemia, the first year mortality rate is less than 2% (8). In fact, among the 298 patients in the postinfarction trial (2) who had no pulmonary congestion by chest X-ray film and who increased their exercise systolic blood pressure to at least 110 mm Hg and completed the 9 minute modified exercise protocol (representing 46% of the patients performing the early exercise test), there were no deaths in the year after infarction.

*Some of the controversial areas involving early exercise testing that require further studies include* 1) the best end point of exercise testing (heart rate-limited versus symptom limited), 2) the optimal timing of the exercise test (7 to 10 days versus 3 to 6 weeks), and 3) the role of adjunctive exercise nuclear procedures such as thallium-201 scintigraphy and radionuclide ventriculography.

**Exercise testing late after myocardial infarction.** The role of exercise testing late after myocardial infarction has not been clarified. Because cardiac morbidity and mortality are highest in the first 6 months after a myocardial infarction, the identification of higher risk subsets of patients after this period would be more difficult. Many prior studies (9-11) in patients with or without previous myocardial infarction undergoing cardiac catheterization have identified variables on the exercise test that have been associated with increased mortality. These predictors include severe ischemic ST segment depressions occurring at a low work load or low peak heart rate, an inadequate blood pressure response to exercise and poor exercise capacity (9-11).

The current study by Stone et al. (12) used data available from the Multicenter Investigation of the Limitation of Infarct Size (MILIS) and evaluated the role of exercise testing

\*Editorials published in *Journal of the American College of Cardiology* reflect the views of the authors and do not necessarily represent the views of JACC or the American College of Cardiology.

From the Evans Memorial Department of Clinical Research and the Department of Medicine, University Hospital, Boston University Medical Center, Boston, Massachusetts.

Address for reprints: Donald A. Weiner, MD, University Hospital, Department of Cardiology, 75 East Newton Street, Boston, Massachusetts 02118.

6 months after a myocardial infarction in predicting recurrent cardiac events in the following year. By 6 months, 15% of the patients originally entering the MILIS study had died, and 2% had had a recurrent myocardial infarction. In the year after the performance of the exercise test, only 3% of the exercised patients died and 5% had a nonfatal recurrent myocardial infarction. Among the 719 patients alive at 6 months, 473 (66%) performed the exercise test. One potential bias of the study was the exclusion of 16% of the patients from performing the exercise test because of lack of consent. The investigators did find that one of the best predictors of recurrent coronary events was inability of the patient to perform the exercise test because of cardiac limitations, a finding similar to that documented in the post-infarction study of early exercise testing (2). In addition, there were four exercise predictors of increased mortality during the year after the 6 month exercise test: ST segment elevation, inadequate blood pressure response, development of any ventricular premature depolarizations and inability to exercise beyond stage 1 of the modified protocol. The 1 year mortality rate varied from 17% for patients having three or more of these variables to 1% for patients having none. This study verifies the significance of the exercise variables that are most associated with impaired left ventricular function and deemphasizes the importance of exertional ischemia (ST segment depression and angina), confirming the findings of the postinfarction trial evaluating early exercise testing (2).

A limitation of this study was the failure to evaluate in great detail the role of clinical variables in the risk stratification, because patients with severe angina and heart failure were excluded from the exercise test. In addition, other potentially important clinical variables such as the age, gender and risk factors of the patient, and the resting electrocardiogram were not analyzed. Thus, the interactions between clinical and exercise variables are still unclear.

Another important question that remains unanswered by this study is the role of exercise testing at 6 months after infarction in patients who have already undergone earlier exercise testing. It is not clear how much more information the late exercise test would add to the risk stratification of patients who had performed a test soon after myocardial infarction.

**Clinical implications.** Graded exercise testing has been used for many years as the standard noninvasive procedure to help confirm or exclude the diagnosis of coronary artery

disease. In recent years, the ability of the exercise test to assess the relative risk for subsequent cardiac events in the patient with known coronary artery disease has been recognized. Many previous studies have documented the importance of the exercise test in assessing the prognosis of patients with coronary disease (9-11) and in stratifying the risk of patients early after myocardial infarction (3-6). The study by Stone et al. (12) now establishes the role of the exercise test in classifying the risk of a patient 6 months after a myocardial infarction.

## References

1. Davis HT, DeCamilla J, Bayer LW, Moss AJ. Survivorship patterns in the posthospital phase of myocardial infarction. *Circulation* 1979;60:1252-8.
2. Krone RJ, Gillespie JA, Weld FM, Miller JP, Moss AJ and the Multicenter Postinfarction Research Group. Low-level exercise testing after myocardial infarction: usefulness in enhancing clinical risk. *Circulation* 1985;71:80-9.
3. Theroux P, Waters DD, Halphen C, Debaisieux J-C, Mizgala HF. Prognostic value of exercise testing soon after myocardial infarction. *N Engl J Med* 1979;301:341-5.
4. Sami M, Kraemer H, DeBusk RF. The prognostic significance of serial exercise testing after myocardial infarction. *Circulation* 1979;60:1238-46.
5. Starling MR, Crawford MH, Kennedy GT, O'Rourke RA. Exercise testing early after myocardial infarction: predictive value for subsequent unstable angina and death. *Am J Cardiol* 1980;46:909-14.
6. Weld FM, Chu K-L, Bigger JT Jr, Rolnitzky LM. Risk stratification with low-level exercise testing 2 weeks after acute myocardial infarction. *Circulation* 1981;64:306-14.
7. DeBusk RF, Blomqvist CG, Kouchoukos NT, et al. Identification and treatment of low-risk patients after acute myocardial infarction and coronary-artery bypass graft surgery. *N Engl J Med* 1986;314:161-6.
8. DeBusk RF, Kraemer HC, Nash E. Stepwise risk stratification soon after acute myocardial infarction. *Am J Cardiol* 1983;52:1161-6.
9. McNeer JF, Margolis JR, Lee KL, et al. The role of the exercise test in the evaluation of patients for ischemic heart disease. *Circulation* 1979;57:64-70.
10. Hammermeister KE, DeRouen TA, Dodge HT. Variables predictive of survival in patients with coronary disease: selection by univariate and multivariate analyses from the clinical, electrocardiographic, exercise, arteriographic, and quantitative angiographic evaluation. *Circulation* 1979;59:421-30.
11. Weiner DA, Ryan TJ, McCabe CH, et al. The prognostic importance of a clinical profile and exercise test in medically treated patients with coronary heart disease. *J Am Coll Cardiol* 1984;3:772-9.
12. Stone PH, Turi ZG, Muller JE, et al. Prognostic significance of the exercise treadmill test performance six months after myocardial infarction. *J Am Coll Cardiol* 1986;8:1007-17.