High Exercise Capacity Attenuates the Risk of Early Mortality After a First Myocardial Infarction: The Henry Ford Exercise Testing (FIT) Project

Gabriel E. Shaya, MS; Mouaz H. Al-Mallah, MD, MSc; Rupert K. Hung, BA; Khurram Nasir, MD, MPH; Roger S. Blumenthal, MD; Jonathan K. Ehrman, PhD; Steven J. Keteyian, PhD; Clinton A. Brawner, PhD; Waqas T. Qureshi, MD; and Michael J. Blaha, MD, MPH

Abstract

Objective: To examine the effect of objectively measured exercise capacity (EC) on early mortality (EM) after a first myocardial infarction (MI).

Patients and Methods: This retrospective cohort study included 2061 patients without a history of MI (mean age, 62±12 years; 38% [n=790] women; 56% [n=1153] white) who underwent clinical treadmill stress testing in the Henry Ford Health System from January 1, 1991, through May 31, 2009, and suffered MI during follow-up (MI event proportion, 3.4%; mean time from the exercise test to MI, 6.1±4.3 years). Exercise capacity was categorized on the basis of peak metabolic equivalents (METs) achieved: less than 6, 6 to 9, 10 to 11, and 12 or more METs. *Early mortality* was defined as all-cause mortality within 28, 90, or 365 days of MI. Multivariable logistic regression models were used to assess the effect of EC on the risk of mortality at each time point post-MI adjusting for baseline demographic characteristics, cardiovascular risk factors, medication use, indication for stress testing, and year of MI.

Results: The 28-day EM rate was 10.6% overall, and 13.9%, 10.7%, 6.9%, and 6.0% in the less than 6, 6 to 9, 10 to 11, and 12 or more METs categories, respectively ($P<.001$). Patients who died were more likely to be older, be less fit, be nonobese, have treated hypertension, and have a longer duration from baseline to incident MI ($P<.05$). Adjusted regression analyses revealed a decreased risk of EM with increasing EC categories. A 1-MET higher EC was associated with an 8% to 10% lower risk of mortality across all time points (28 days: odds ratio [OR], 0.92; 95% CI, 0.87-0.98; $P=.006$; 90 days: OR, 0.90; 95% CI, 0.86-0.95; $P<.001$; 365 days: OR, 0.91; 95% CI, 0.87-0.94; $P<.001$).

Conclusion: Higher baseline EC was independently associated with a lower risk of early death after a first MI.

 ■ Mayo Clin Proc. 2016;91(2):129-139

The relationship between low exercise capacity (EC) and all-cause and cardiovascular mortality and morbidity has been established in a wide range of patient populations; however, nearly all studies have assessed adverse outcomes over long-term follow-up.[1-8] Little is known about the effect of EC on early mortality (EM), particularly death after another medical illness such as myocardial infarction (MI). A protective effect of high EC in this setting may reasonably be posited, given association with various favorable physiological effects including increased cardiac stroke volume and cardiac reserve, enhanced autonomic stability, and advantageous changes in thrombogenic and fibrinolytic factors.[9-12] Empirically, participation in cardiac rehabilitative programs after acute MI can increase EC and has been shown to protect against all-cause and cardiovascular mortality over long-term follow-up.[13-15] Despite the wealth of literature identifying increased EC as a protective factor against adverse long-term outcomes in both primary and secondary prevention, whether higher antecedent EC affects EM after a first MI has not been established.[16] Such results would have important and actionable implications

For editorial comment, see page 125; for related articles, see pages 140 and 149

From the Johns Hopkins Ciccarone Center for the Prevention of Heart Disease, Baltimore, MD (G.E.S., M.H.A.-M., R.K.H.,

Affiliations continued at the end of this article.

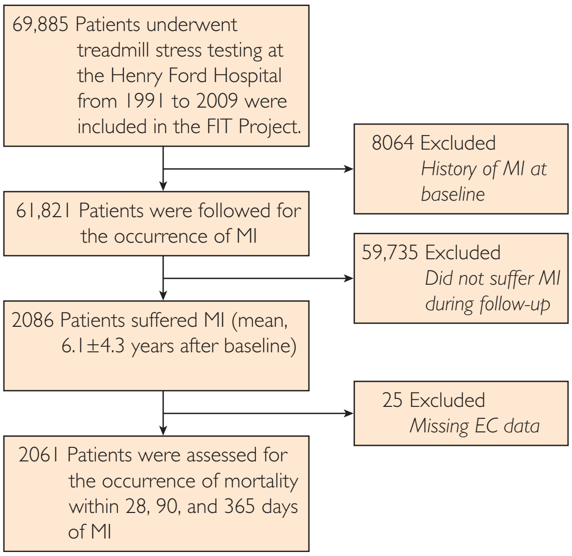

FIGURE 1. Study population selection and timeline. EC = exercise capacity; MI = myocardial infarction.

for recommendations in the primary prevention of cardiovascular death.

Accordingly, we sought to assess the effect of EC on EM after a first MI in a multiethnic cohort of clinically referred patients. We hypothesized that EC, measured remotely before the index MI, would be associated with a lower likelihood of near-term death after MI.

PATIENTS AND METHODS

Study Design

This study was based on data from the Henry Ford Exercise Testing Project (the FIT Project), a retrospective cohort study aimed at investigating the implications of EC on cardiovascular outcomes and total mortality.[17]

The FIT Project population is a registry of 69,885 consecutive patients who underwent physician-referred treadmill exercise testing at the Henry Ford Health System in metropolitan Detroit, Michigan, between 1991 and 2009. Treadmill, medical history, and medication data were collected by clinical exercise physiologists and nurses at the time of testing and entered into a common clinical reporting tool used to generate clinical reports and to directly populate the electronic medical record (EMR). Supporting clinical data and follow-up for cardiovascular outcomes were derived from the EMR and administrative databases shared in common across Henry Ford–affiliated subsidiaries. The FIT Project was approved by the Henry Ford Hospital Institutional Review Board.

In the present study, we included 2086 patients from the FIT Project who had no history of MI at the baseline examination and subsequently suffered a first MI during the follow-up period. Patients missing EC data (n=25) were excluded, leaving 2061 patients for analysis (Figure 1). The mean age at baseline was 62 years and ranged from 18 to 93 years. The mean time from the treadmill exercise test to MI was 6.1±4.3 years in the study population.

EC Testing

All patients underwent routine, clinically referred, symptom-limited maximal treadmill stress testing following the standard Bruce protocol.[18] For individuals with repeat exercise testing, the results from only the first test were considered. Patients younger than 18 years at the time of exercise testing or patients undergoing modified Bruce and non-Bruce protocol tests were not included in the registry.

In accordance with clinical guidelines,[19] treadmill testing was terminated at the discretion of the supervising clinician for reasons that included marked arrhythmias, abnormal hemodynamic responses, diagnostic ST-segment changes, exercise-limiting symptoms such as chest pain or shortness of breath, or the patient's unwillingness or inability to continue. Resting heart rate and blood pressure were measured before exercise testing. The treadmill speed was set initially at 2.7 km/h and then increased to 4.0, 5.4, 6.7, 8.0, and 8.8 km/h at minute 3, 6, 9, 12, and 15, respectively. In the first 3 minutes, the grade was set at 10%, followed by a 2% increase every 3 minutes. The patient exercised for 3 minutes in each stage. If necessary to complete the test, patients were allowed to hold on to the handrail for support and balance. Exercise capacity, expressed in estimated metabolic equivalents (METs), was calculated with the treadmill controller system (Q-Stress, Quinton Instruments) using achieved speed and elevation and was categorized into 4 groups: less

Mayo Clin Proc. ■ February 2016;91(2):129-139 ■ http://dx.doi.org/10.1016/j.mayocp.2015.11.012
www.mayoclinicproceedings.org