Exercise Testing in Patients With Heart Disease Who Participate in Exercise Training

POINT: High Quality or Just Average—The Need for Exercise Testing Before Cardiac Rehabilitation

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In this era of evidence-based medicine, why would we not want to provide the highest level of quality, safety, and science in our cardiac rehabilitation (CR) programs? This is a question that requires attention and a thoughtful response. Perhaps in no other facet of CR is this question as relevant as it is when discussing exercise testing (ET) prior to a patient entering CR. The current status related to ET prior to starting CR is that it appears to be less and less common. This is true in spite of the fact that the current American College of Cardiology/American Heart Association (AHA) guidelines give ET after hospital discharge a class I recommendation for prognostic assessment, activity prescription, and CR in patients following myocardial infarction (MI) and a class IIa recommendation for activity counseling and CR in patients post-coronary revascularization (14). By way of review, a class I recommendation states that the benefit greatly exceeds the risk (benefit>>>risk) and the "procedure should be performed," and a class II recommendation means that the benefit exceeds the risk (benefit>>risk) and "it is reasonable to perform the procedure" (4).

BENEFITS OF ET PRIOR TO CR

The use of ET prior to starting rehabilitation is well documented over the history of CR (6,7,10-12,15,16,18,25,27,28,30,32). Safety was an initial concern, but research demonstrated that testing soon after MI is safe (17,19,23). Early and more recent publications have also emphasized that the results of ET were beneficial for developing an individualized exercise prescription (8,15,16,26,29,33).

The benefits of performing ET prior to a patient beginning CR are several, but the most direct benefit is that the results provide objective clinical data that can be used to develop a safe and effective aerobic exercise prescription. Effective aerobic exercise training in CR is based on providing an adequate physiological stimulus to produce a physiological training effect (9). Individualized exercise prescriptions are based on science and art. The science requires data from ET and the art of exercise prescription comes with a clinician's clinical experience with administering and progressing the prescription.

In patients with heart disease of various ages and with different diagnoses, symptoms, exercise capacities, comorbidities, and medications, ET provides objective data documenting the unique response of an individual to exercise. The responses to exercise (e.g., exercise capacity, heart rate (HR), blood pressure (BP), ST-segment deviations, dysrhythmias, rating of perceived exertion, and signs/symptoms) are documented for each patient, and these data are incorporated into the individualized prescription.

The American College of Sports Medicine has published eight editions of the *ACSM Guidelines for Exercise Testing and Prescription,* spanning 35 years. Every edition has emphasized ET as an important part of the initial patient assessment and collection of data for developing a safe and

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effective exercise prescription. The current guidelines recommend three methods for determining exercise intensity in patients with heart disease, and all three involve data related to the patient's response to exercise (3).

The response to exercise during ET is also useful for stratifying the risk of cardiac events during exercise training (2,3[p. 212]). The ACSM guidelines include information collected during ET to determine that risk (e.g., lowest, moderate or highest risk). Furthermore, patients who do not undergo ET may be inadequately categorized for risk, and it is recommended that those patients be treated more conservatively during CR (2[p. 62]). The AHA also has published a risk classification system that includes exercise training of patients typically seen in CR programs (13). This classification system incorporates findings from ET (e.g., peak exercise capacity, myocardial ischemia or angina pectoris, abnormal systolic BP response, and ventricular tachycardia) that are used to categorize the level of risk during exercise training.

Additionally, the measurement of functional capacity by using ET can quantify future risk of mortality in patients entering a CR program (21,22,31). In two large series of CR patients, measured peak oxygen uptake ($\dot{V}O_{2peak}$) during ET prior to starting CR was the best predictor of future cardiac death in men and women. In male CR patients, the adjusted hazard ratio was 0.45 for cardiac mortality in the most fit group (>22 mL·kg^{-1}·min^{-1} measured $\dot{V}O_{2peak}$) (21). In women, a measured $\dot{V}O_{2peak}$ of ≥13 mL·kg^{-1}·min^{-1} resulted in a hazard ratio of 0.50 for cardiac death (22). These data have implications for identifying patients who may benefit from more intensive secondary prevention and counseling during CR.

Accurately quantifying exercise capacity is essential to using it for the purposes discussed earlier (i.e., prognostic assessment and individualized exercise prescription). The gold standard for ET performed prior to starting CR is a cardiopulmonary exercise test (CPET) involving the measurement and analysis of expired ventilatory gases in addition to the standard electrocardiographic and BP monitoring during exercise (5,25). However, for a variety of reasons, most ET performed at this time does not utilize CPET but rather quantifies exercise capacity by using estimated peak metabolic equivalents (METs). Ades et al. (1) has reported that estimated peak METs overestimate measured $\dot{V}O_{2peak}$ by 30% in men and 23% in women CR patients and developed nomograms to correct for this error. These nomograms should be used to adjust estimated peak METs in CR patients.

EXERCISE PRESCRIPTION WITHOUT ET

According to the ACSM guidelines (3[p. 219]), reasons for not performing ET prior to CR include:

- Extreme deconditioning
- Orthopedic limitations
- Left ventricular dysfunction limited by shortness of breath
- Known coronary anatomy (ET not clinically necessary)
- Recent successful revascularization
- Uncomplicated or stable MI
- Recent pharmacologic stress test (although this does not provide adequate data relative to exercise capacity and exercise responses, including abnormal signs and symptoms associated with physical activity)

Functional ET for the purpose of quantifying exercise capacity, clinical responses to exercise, and providing other data for developing an individualized exercise prescription for CR has different purposes compared with those of diagnostic ET. The fact that a patient has already been diagnosed with heart disease is irrelevant for performing functional ET. Among those patients who are able to exercise and present to CR without completing ET, how can the clinical exercise physiologist be adequately informed about their exercise responses (e.g., peak HR, BP response, exercise capacity) or know whether ischemic signs or symptoms are present and, if so, at what HR and exercise intensity they occur? Are there any serious arrhythmias occurring with exercise?

The answers to these and other clinically relevant questions are unknown. So, without ET, how is exercise training prescribed? Alternatives to prescribing exercise intensity without ET prior to CR are limited and systematic (3[p. 214],24). In general, these recommendations call for an exercise HR equal to the resting HR plus 20 beats·min^{-1}, an initial MET level of 2 to 4, and/or a rating of perceived exertion (RPE) between 11 and 14 (Borg 6–20 scale). This approach treats every patient the same, does not account for differences in exercise capacity, and represents a one-size-fits-all approach to exercise prescription. In one patient, this approach could artificially decrease the exercise training stimulus to less than optimal, while another patient may be asked to exercise at an intensity that is too high, creating possible safety issues.

One study demonstrated that having CR patients walk at an intensity equal to resting HR plus 20 beats·min^{-1} and an RPE of 11 to 13 resulted in substantial interpatient variability. Prescribing exercise by using this HR or RPE criteria resulted in exercise intensities ranging from 25 to 92% of the $\dot{V}O_2$ reserve (20).

SUMMARY

Some of the evidence presented here is from guidelines and scientific statements developed and published by respected professional associations. By definition, following guidelines is not mandatory. However, with so many different published statements recommending ET prior to CR and strong evidence supporting that recommendation, it seems reasonable to perform ET whenever feasible. Are there patients for whom ET prior to CR is contraindicated? Yes—the same patients for whom ET for any purpose is contraindicated. This includes patients with certain neuromuscular or orthopedic conditions or who are extremely deconditioned. Otherwise, performing ET prior to beginning CR is a means of helping to ensure that the most effective and safe exercise prescription is being used for every patient in CR. Exercise prescribed in this manner should result in functional capacity outcomes that are optimal for individual patients and, therefore, for CR programs.

An important call to action for CR programs and staff is to educate referring physicians, administrators of ET services in hospitals and physician private practices, and CR program staff about the benefits of performing functional ET before patients start CR. Having clinically relevant information from ET available is important to the health care professional who is developing exercise prescriptions and supervising patients in CR. Would or should a physician perform a procedure without having all the relevant clinical data available to help guide decision making? Probably not. Should CR staff develop an exercise prescription and supervise exercise training in CR without having important data provided by ET? Probably not.

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COUNTERPOINT: All Patients Do Not Need an Exercise Test Before Starting Cardiac Rehabilitation

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Traditionally, patients have been required to have an exercise stress test before being admitted to an outpatient cardiac rehabilitation program. This requirement is in compliance with risk stratification recommendations that list known cardiac disease as a criterion for recommending a pre-program entry exercise test (1). For an unknown patient or one who is not clinically stable, this is prudent practice. Questions arise regarding whether exercise tests are necessary for those patients with heart disease who are clinically stable before starting cardiac rehabilitation programs. The concern is whether exercise tests performed for the sole purpose of entering a cardiac rehabilitation program is efficient resource utilization, particularly if the exercise test would not have otherwise been performed as part of the patient's clinical management. In this instance, an entry exercise test may not offer any new information for patients with known coronary artery disease whose disease status and exercise limitations are already well documented.

When considering the diagnostic role of exercise testing (2,4), the diagnostic significance of an exercise test result is moot when you are already aware of a patient's coronary anatomy, the success of chosen treatment intervention, such a percutaneous coronary intervention (PCI) or coronary artery bypass revascularization surgery (CABS), and symptomatology. Therefore, for a patient who has been admitted to the hospital for angina or a myocardial infarction (MI)—with or without PCI or CABS—and who had a stable recovery—in hospital course and acute home recovery period—a pre-cardiac rehabilitation program exercise test is redundant and not necessary.

RESOURCE MANAGEMENT

Concerns for resource management have resulted in many cardiac rehabilitation programs accepting patients who have not undergone an exercise test. There are an estimated 566,000 coronary artery revascularization surgeries each year (5) and 1,500,000 MIs (11). If 15% of these patients were referred to cardiac rehabilitation and were required to have an entry exercise test, the cost would approximate $124,000,000 (based on $400 per test). Therefore, prudent judgment, as opposed to a standard requirement for all, concerning the use of exercise tests before entering cardiac rehabilitation could result in considerable cost savings.

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POINT/COUNTERPOINT

EXERCISE PRESCRIPTION

Exercise tests do help the exercise professional establish a safe and appropriate exercise prescription (10). When an exercise test is not available, though, a safe and effective exercise program can be prescribed from the discharge summary and a thorough pre-program or orientation interview that questions the patient regarding the presence of signs or symptoms, activity while in the hospital, and activity level since his or her return home from the hospital (6,7).

For patients entering a cardiac rehabilitation program without an entry exercise test, exercise programs should be implemented conservatively with close patient surveillance during the initial phases of the program. Their exercise program should be gradually titrated to provide the most efficacious program possible while maintaining patients within their physical limitations and below their symptomatic threshold. An example of an effective program may take the format of treadmill walking (5 to 10 min), cycle ergometry (5 to 10 min), combined arm and leg ergometry (5 to 10 min), upper-body exercise (5 min), and hand weights (2 to 5 lbs [1 to 2 kg]). Initial intensities may approximate 2 to 3 METs (multiple of resting oxygen uptake of 3.5 $ml·kg^{-1}·min^{-1}$). The patient's heart rate (HR), blood pressure, rating of perceived exertion, and signs and symptoms should be monitored. Programs can be titrated during the initial sessions to obtain a rating of perceived exertion of 11 to 14 (6 to 20 Borg scale) (3) in the absence of any abnormal signs or symptoms. Intensities may be progressed by 0.5 to 1.0 MET increments (e.g., 0.5 mph [0.8 kph] or 2% grade on the treadmill or 12.5 to 25 watts on the cycle) (7).

Monitoring

During the initial phases of the program, patient monitoring should include electrocardiogram (ECG) telemetry, signs and symptoms, blood pressure, rating of perceived exertion, and signs of overexertion. The degree of monitoring can be tapered as the patient progresses to a consistent exercise program that is well tolerated.

Target Heart Rates

For patients who had a dobutamine stress test, the highest HR obtained during the test may be used as a training HR guide. For those with negative test results, this could serve as the initial upper limit of the desirable training HR. If the dobutamine test is positive, the patient's ischemic HR threshold during exercise will not be known. More conservative HRs may then be applied. There are no published data translating pharmacologic test results to exercise prescription, so the results of pharmacologic tests must be used with caution.

For patients without stress tests, using resting HRs plus 20 $beats·min^{-1}$ has been shown to be safe while allowing the patient room for the advancement of exercise intensity and duration (9). As the patient comfortably progresses, further advancement can be based on the patient's signs and symptoms, monitored response, and his or her rating of perceived exertion. If the patient remains asymptomatic, exercise intensity may be gradually increased up to a perceived exertion of 12 to 14 (moderately hard on the 6 to 20 Borg scale) (3). The HR at that intensity may be used as the patient's new training threshold guide.

Exercise Duration

Exercise duration may also be titrated as tolerated, beginning with planned 5 to 10 min work cycles interspersed with adequate rest periods. The initial duration should be based on the patient's exercise habits while in the hospital and at home since discharge. For those patients who cannot tolerate 5 min of continuous exercise during their initial visit, their demonstrated tolerated duration can be their starting point. For those who tolerate more than 5 min, allow up to 10 min on multiple pieces of equipment for a cumulative exercise duration of 30 to 45 min. During the initial phases of the program, it may be safer and better tolerated by the patient if the emphasis is on increasing duration first (up to a continuous 20 to 30 min of cardiovascular exercise) followed by gradual increases in intensity.

Type of Exercise

The initial modalities selected should be those the patient can perform comfortably within the desired intensities and durations. Most patients do well with treadmill walking, cycle ergometry, and combined arm and leg ergometry. Light wrist or hand weights may also be added (1 to 5 pounds [0.5 to 2 kg]) by using two sets for 8 to 10 repetitions for 4 or more upper-extremity exercises. The hand weights can be used in the standing or seated position and may provide a needed break between more tiring modalities. Other exercise modalities are added when the patient can comfortably perform 5 to 10 min on each initial piece. Other modalities may include arm ergometry, rowing, and stepping. Eventually, more resistive training may be added by using other devices.

Warm-Ups/Cooldowns

Each session should be preceded by a warm-up and followed by a cooldown period of light aerobic activities as well as range of motion and flexibility exercises that emphasize stretching the posterior leg and lower-back muscles. Exercises may be performed in a seated position—either on a chair or on the floor.

Program Effectiveness

The previously described program resulted in an overall 82% increase in caloric expenditure during the cardiorespiratory conditioning phase of the cardiac rehabilitation sessions from week 1 to week 12, which suggests a significant increase in exercise tolerance regardless of whether the patients were tested before they started the cardiac rehabilitation program (8). Both groups were increased at a similar rate throughout the duration of the 12 wk program. The test group increased their caloric expenditure at a rate of 10.8 $kcal·wk^{-1}$, while the no-test group was increased at a rate of 9.5 $kcal·wk^{-1}$. In addition, there were no differences in complication rates between the test and no-test groups (8).

Patients Who Should Be Tested

The intent of this discussion is not to imply that all cardiac rehabilitation programs should adopt a no-test policy. Although it has been demonstrated that cardiac rehabilitation without testing can be done safely and effectively, there are a number of considerations and precautions that may impact a program's willingness to adopt a no-test policy. Such factors as staff training and experience, institutional philosophy, patient referral patterns, and facility location must be considered before adopting a no-test policy (8).

Foremost, there are a number of patient subgroups that must be given serious consideration for testing before entering cardiac rehabilitation. These include patients who 1) are symptomatic with exertion or who are unstable, 2) have exercise-induced rhythm disturbances, 3) have unknown severity of disease, 4) lack adequate medical information, and 5) plan to return to heavy occupational tasks or pursue recreational tasks that require vigorous physical exertion.

Referral patterns may also impact the decision concerning a no-test policy. A "closed institution" with a full-time medical staff may be more conducive to a no-test policy. The cardiac rehabilitation staff may work more directly with the referring physicians and their patients before they enter the cardiac rehabilitation program. In addition, the cardiac rehabilitation staff may have had the opportunity to work with patients during the in-hospitalization phase of cardiac rehabilitation. In a "private" institution where large portions of the medical staff are private practitioners, the cardiac rehabilitation staff may not know the patient or may receive incomplete information concerning the patient's clinical status.

In addition, cardiac rehabilitation staff comfort with a no-test policy is essential. The staff must be trained and have adequate clinical experience within an exercise setting. Another factor—facility location—can also impact the adoption of a no-test policy. A facility that is located within a medical center with immediate extensive acute and emergency care may be a more feasible setting for a no-test policy than a freestanding facility that is isolated.

SUMMARY

The current medical environment encourages a more conservative approach to resource use; therefore, "clinically unnecessary" exercise tests are being scrutinized and refused. It has been demonstrated, though, that patients completing a 12 wk cardiac rehabilitation program can be safely progressed in terms of their exercise intensity and duration without an entry exercise test. This is desirable in a managed care setting for reducing costs while maintaining effective patient care. Such factors as staff comfort and training, institutional philosophy, patient referral patterns, and facility location may influence the decision to adopt a no-test policy.

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POINT/COUNTERPOINT: POSTSCRIPT FROM THE EDITORS

The articles by Drs. Hamm and McConnell provide an outstanding summary of the rationale and utility in support of and opposition to exercise testing as a prerequisite to cardiac rehabilitation or exercise training in patients with cardiovascular disease. Regardless of your position, we are confident that you now better appreciate the challenges associated with either policy.

In a real-world setting, perhaps the prudent path lies in the merger of both approaches. At Henry Ford Hospital, we have learned that factors that delay starting a patient in cardiac rehabilitation, such as scheduling and completing an exercise test, negatively influence a patient's likelihood to participate and the total number of sessions completed. As a result, we now strive to start patients as soon as possible after discharge and to schedule the exercise test (as indicated) very early during program participation. That said, the goals, functional limitations, and clinical presentation of each patient are important considerations in determining how an exercise test might be useful and whether it is indicated. This is a clinical decision that is best made in concert with the referring physician, the cardiac rehabilitation medical director, and the patient.

In conclusion, we encourage you to consider the well-written positions advanced by Drs. Hamm and McConnell and use them to guide your program procedures in order to maximize program efficiencies and patient outcomes.