High-intensity track and field training in a cardiac rehabilitation program

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A 65-year-old male athlete with coronary artery disease enrolled in our cardiac rehabilitation (CR) program after successful coronary artery bypass graft surgery following an acute myocardial infarction. Unlike the typical sedentary cardiac patient in his age group, he loved to participate in hurdle events at masters division track meets (competitions for athletes aged 30 years and older). He expressed a strong desire to return to his sport, so we designed a sport-specific, symptom-limited exercise program that enabled him to train safely but at a higher intensity than is typically allowed in conventional CR programs. Although his measured peak heart rates during the sport-specific sessions were significantly higher than the calculated maximum heart rate limits usually imposed on patients during conventional CR exercise training, the patient had no adverse events and safely reached his fitness goal. When developing a CR plan, health care professionals should consider the patient's goals, not just his or her age.

Cardiac rehabilitation (CR) is an outpatient program that provides exercise, education, counseling, and social support to patients who have had a cardiac event (1). Patients in conventional phase II CR attend the program 3 days per week and perform aerobic activities (treadmill walking and stationary cycling) (2) and may lift 1- to 3-pound hand weights (1). Because a cardiac event is a serious medical condition, the intensity of this exercise training is typically moderate.

To ensure safety during endurance training, CR professionals use responsible and reliable methods to help patients progress gradually. The intensity of exercise training is restricted by setting maximum blood pressure and heart rate limits; staff observations and patients' subjective responses are also used to determine when increases in intensity are warranted. The maximum allowable systolic blood pressure is 240 mm Hg (1), although in practice, CR staff members typically do not allow patients to reach this threshold. There are three traditional methods of calculating maximum allowable heart rate limits in conventional CR exercise programs when actual peak heart rates from an exercise stress test are not available:

- Percent maximal heart rate (3) is obtained by calculating the patient's age-predicted maximum heart rate, or 220 minus the patient's age in years, then multiplying that value by 70% to 85%. Using the high end of that range yields the following formula: (220 – age) × 0.85.
- Heart rate reserve (3), also known as the Karvonen method, takes into account the resting heart rate and is calculated as follows: {[(220 – age) – resting heart rate] × 0.85} + resting heart rate.
- Resting + 20 (2) is the simplest method of calculating the maximum heart rate limit: resting heart rate + 20 beats per minute.

Throughout the 34 years of our CR program's existence, we have followed the recommended conservative exercise guidelines. Recently, however, we have become increasingly concerned that the conservative training in conventional programs is inappropriate for patients who plan to return to a physically demanding sport. As a result, we developed a high-intensity, sport-specific exercise program to meet the needs of such patients. Unlike conventional CR exercise training, the high-intensity program incorporates exercises that mimic the patient's athletic activities, and the training intensity is symptom limited; no calculated maximum heart rate limits are imposed.

In this report, we present data from one of the first athletes to voluntarily participate in the high-intensity, sport-specific exercise program, and we compare the peak heart rates he reached during training with the calculated maximum heart rates that are typically allowed during a conventional CR exercise session.

CASE HISTORY

A 65-year-old male athlete presented to the emergency department in December 2008 with an elevated troponin level and a non–ST segment elevation acute myocardial infarction. He was taken to the catheterization lab, and four stents were placed: two in the right coronary artery, one in the diagonal coronary artery, and one in the left anterior descending artery.

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In January 2009 he had a positive stress test and underwent a second catheterization that revealed in-stent stenosis of the left anterior descending artery. The patient was referred for coronary artery bypass graft surgery and, later, CR.

The patient had an otherwise favorable risk factor profile. At the time of coronary bypass, his total cholesterol was 98 mg/dL; triglycerides, 66; low-density lipoprotein cholesterol, 47; and high-density lipoprotein cholesterol, 38. He had no family history of heart disease and had never smoked. His body mass index was 21 kg/m^2, and his waist circumference was 33 inches. Medications included clopidogrel (75 mg daily), aspirin (325 mg daily), and rosuvastatin (20 mg daily).

CARDIAC REHABILITATION EXERCISE TRAINING

In our CR program in Dallas, Texas, patients are required to attend an orientation session prior to their first day of exercise rehabilitation. During this orientation, an exercise physiologist evaluates each patient's medical history and current physical condition, and patients are asked to describe the goals they want to reach during their CR stay (6 to 36 sessions, depending on the patient's schedule and insurance coverage). During this visit, the 65-year-old patient informed the exercise physiologist that he was involved in masters division track and field competitions (for athletes aged 30 years and older), the next of which would occur in 5 months. He wanted to compete in sprinting and hurdling at the upcoming meet and asked if that would be a reasonable goal. The exercise physiologist responded favorably, telling the patient that if he was willing to put in the time and effort and his vital signs remained within normal limits, he could very well reach his goal.

Table. The patient's heart rate (HR) measurements during high-intensity training and the calculated HR limits used in conventional cardiac rehabilitation

	Measured HR		Calculated HR limits		
Session	Resting	Peak	Percent maximal	HR reserve	Resting + 20
1	80	166	133	145	100
2	86	166	133	146	106
3	94	169	133	147	114
4	83	165	133	145	103
5	70	143	133	143	90
6	73	153	133	144	93
7	82	149	133	145	102
8	75	162	133	144	95
9	81	155	133	145	101
Mean (SD)	80 (7)	159 (9)	133 (0)	145 (1)	100 (7)

During the 18 training sessions, the patient participated in gradually increasing high-intensity exercise. The last nine sessions, specifically designed to simulate the tasks and demands of his hurdling event, included block starts, sprinting, ladder and agility drills, resistance sprinting, hurdles, and weight training. During CR training sessions, the patient's heart rate and electrocardiographic rhythm were continuously monitored via telemetry, and his blood pressure was taken every third session. He was monitored for adverse events (ST depression, arrhythmia, shortness of breath, and angina). He had no adverse arrhythmia, blood pressure, or heart rate events while performing the high-intensity, sport-specific training. He did have occasional asymptomatic atrial ectopy (premature atrial contractions), but this did not require any exercise session to be stopped and did not accompany any negative symptoms.

HEART RATE COMPARISONS

The *Table* lists the patient's resting heart rate and peak heart rate for each high-intensity session, along with the three calculated heart rate limits: percent maximal heart rate, heart rate reserve, and resting + 20.

We used the Wilcoxon signed rank test to determine whether the patient's peak heart rate was significantly higher than the calculated heart rate limits across all nine sessions. The Wilcoxon signed rank test is a nonparametric test, most suitable for a small sample size when the assumption of normality is usually not met. Comparing the patient's peak heart rate with the heart rate reserve value yielded a z-test statistic of 2.66 with a derived two-sided P value of 0.008. Similarly, comparing the peak heart rate with the percent maximal and the resting + 20 values yielded an identical P value as small as 0.004 (z value, 2.88). Thus, all three Wilcoxon tests suggested that at each high-intensity training session, the patient's measured peak heart rate was significantly higher than his calculated heart rate limits.

The peak blood pressures that were recorded during four of the nine high-intensity training sessions were 130/82, 142/82, 138/84, and 168/86 mm Hg, indicating that the patient's peak systolic blood pressure remained well below the safety threshold of 240 mm Hg.

DISCUSSION

The patient reached higher peak heart rates during the high-intensity CR exercise sessions than would have been allowed in a conventional program that imposes maximum heart rate limits, yet his peak systolic blood pressure stayed far below the allowable limit. As the *Figure* shows, this patient reached his goal and has participated in masters track meets at the same physical fitness level required before his cardiac event.

Some patients aspire to return to a high-intensity sport after a cardiac event, but they may be fearful about the level of training that would be required for them to do so. We believe, however, that accelerating patients' return to athletics can result in improved physical ability and confidence. Therefore,

Figure. Left: The patient competing in 2004. **Right:** Competing at the 2010 USA Masters Outdoor Track and Field Championships 4 months after bypass surgery and cardiac rehabilitation—and winning gold and bronze medals.

staff members at our CR facility feel ethically obligated to ensure that patients can safely and confidently resume their desired sport after completing CR training. Tailoring the exercise regimen to meet the goals of each patient, regardless of his or her age, is a major component of meeting that obligation.

The symptom-limited exercise training described in this case report should be implemented carefully and on an individual basis. Conventional CR should be prescribed for patients who have a prolonged perioperative course and/or certain postoperative complications. Nevertheless, as in a previous case report (4), we have demonstrated that high-intensity, sport-specific CR training can be done safely, and we encourage further study of this approach in appropriately selected patients.

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