A s we bask in the fading glow of the 2012 Summer Olympics games, it seems apropos to discuss the clinical application of an exercise training regimen that was systematically applied to elite athletes nearly 80 years ago. Then, Drs Woldemar Gerschler and Herbert Reindel, a professor of physical education and a physician, used the scientific method to develop the basic principles of what is referred to today as high-intensity interval training (HIIT).1 The use of HIIT, which consists of a series of repeated bouts of high-intensity exercise intervals alternated with periods of low- to moderate-intensity recovery, remains a mainstay in the training regimen of many of today’s athletes, regardless of whether they are our youth participating in middle school track or seasoned veterans competing for Olympic Gold.

Although the strength of the study by Rognmo et al6 lies in its novelty, I would be remiss if I did not point out that there are shortcomings that deserve our attention as well. First, as the authors correctly allude to in their Discussion, with a calculated power of only 23%, one is compelled to view their safety data as exploratory at best. Using their own data, they properly estimate that an adequately powered randomized trial would require >20 500 patients (and generate >750 000 exercise hours) to determine the safety of HIIT. Obviously, an exercise intervention trial of such magnitude would be a challenge both to fund and operate.

The above notwithstanding, a close look at the authors’ safety data suggests that we simply cannot ignore this issue. Specifically, an exploratory interpretation of their data might be that MCT is safer than HIIT (MCT, 1 event per 129 456 exercise hours of MCT and 23 182 exercise hours). On the basis of the low events rates observed in both group, the authors recommended that HIIT be considered in the rehabilitation of patients with CVD.

In this issue of Circulation, Rognmo and colleagues6 are the first to address the important issue pertaining to the safety of HIIT. Using a retrospective analysis involving 4846 patients with CVD (mean age, 58 years), they report on >175 000 exercise training hours gathered from 3 different rehabilitation units in Norway. On average, each patient completed 37 cardiac rehabilitation sessions, of which the majority were MCT and the balance HIIT. An event was defined as a cardiac arrest or myocardial infarction during exercise or within 1 hour afterward. They observed 1 fatal cardiac arrest per 129 456 exercise hours of MCT and 2 nonfatal cardiac arrests per 46 364 HIIT sessions (1 per 23 182 exercise hours). On the basis of the low events rates observed in both group, the authors recommended that HIIT be considered in the rehabilitation of patients with CVD.

From the Henry Ford Hospital, Detroit, MI.

Correspondence to Steven J. Keteyian, PhD, Division of Cardiovascular Medicine, Henry Ford Hospital, 6525 Second Ave, Detroit, MI 48202. E-mail sketeyi1@hfhs.org

(Circulation. 2012;126:1431-1433.) © 2012 American Heart Association, Inc.

Circulation is available at http://circ.ahajournals.org
DOI: 10.1161/CIRCULATIONAHA.112.129171

© 2012 American Heart Association, Inc.
or HIIT, so we cannot truly determine the isolated effect of HIIT on safety. Instead of testing the cumulative or repetitive effect of HIIT alone, their study helped us better understand the safety associated with a combined approach to training, one that involves both HIIT and MCT. Viewed as such, the overall event rate for a program that combines HIIT and MCT becomes 3 per 175,820 exercise hours (1 event per 58,600 exercise hours). Practically speaking, should HIIT someday become part of evidence-based care for patients with CVD, most cardiac rehabilitation programs will likely incorporate it in a manner that mixes both types of training (HIIT and MCT) into the exercise plan for their patients. So viewing safety data pertaining to HIIT in this manner may, in fact, be more generalizable.

The effect of HIIT on subsequent clinical end points has not been investigated to date. Using surrogate logic, one might hypothesize that because peak oxygen uptake is related to mortality in patients with CVD,9 and given that HIIT has might hypothesize that because peak oxygen uptake is related to mortality in patients with CVD,9 and given that HIIT has been shown to provide greater improvements in this measure of exercise capacity than MCT, HIIT should lead to a greater reduction in risk for mortality or other clinical end points. Tempting as it might be, we are all aware that such logic does not always pan out. The clinical benefit of MCT in patients with CVD is well appreciated, and similar clinical end-point information can (and should) be gathered for HIIT through a randomized trial, an endeavor that is feasible from both an operational and a funding perspective. For those who are of the mindset that large, multicenter, clinical-end-point-driven trials that rely on the adherence of humans to prescribed healthy behaviors may represent a poor use of limited resources or are operationally unfeasible, I point out that 2 current trials that have as their primary aim the study of the effects of an exercise intervention of interest do not adhere. One current trial that has as its primary aim the study of the effects of several behavioral and exercise programming strategies (eg, moderate-intensity interval training) that target improved adherence is Heart Failure Exercise and Resistance Training Camp (HEART Camp). Recently, the National Heart, Lung, and Blood Institute stated its interest to fund studies that “minimize special infrastructure” and test “novel methods that enable low-cost conduct.”17 This policy direction seems consistent with a potentially low-cost and accessible intervention such as exercise, a therapy that can be studied in various settings (facility-based versus home-based) with different types of programs (eg, HIIT, moderate-intensity interval training, MCT, resistance training) or methods of delivery (eg, Internet or computer-based).

In closing, Rognmo and colleagues6 are to be commended for both recognizing the importance of assessing the safety of HIIT and providing us with our first glimpse of such data. Their trial, however, does much more. It highlights that more work remains relative to a better understanding of the nature and scope of exercise training in the care of patients with CVD. As clinical investigators interested in the study of exercise, now is a good time to increase the “intensity” of our scientific efforts.

**Sources of Funding**

Dr Keteyian is supported by National Institutes of Health grant RO1HL112979 and Janssen Research & Development, LLC.

**Disclosures**

None.

---

**Figure.** Heart rate (HR) response during a cardiac rehabilitation session involving high-intensity interval training in a 41-year-old man 7 weeks after a percutaneous coronary intervention.
References
7. Leon AS, Franklin BA, Costa F, Balady GJ, Berra KA, Stewart KJ, Thompson PD, Williams MA, Lauer MS; American Heart Association; Council on Clinical Cardiology (Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention); Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity); American Association of Cardiovascular and Pulmonary Rehabilitation. Cardiovascular rehabilitation and secondary prevention of coronary heart disease: an American Heart Association scientific statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity), in collaboration with the American Association of Cardiovascular and Pulmonary Rehabilitation. Circulation. 2005;111:369–376.

Key Words: Editorials ◆ cardiovascular diseases ◆ exercise ◆ rehabilitation ◆ safety
Swing and a Miss or Inside-the-Park Home Run: Which Fate Awaits High-Intensity Exercise Training?

Steven J. Keteyian

_Circulation_. 2012;126:1431-1433; originally published online August 9, 2012;
doi: 10.1161/CIRCULATIONAHA.112.129171
_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2012 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/126/12/1431

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in _Circulation_ can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to _Circulation_ is online at:
http://circ.ahajournals.org//subscriptions/