High-Intensity Aerobic Interval Training in Outpatient Cardiac Rehabilitation

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• Relevant financial disclosures: none
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Objectives

• Components/benefits of Cardiac Rehabilitation (some new information)
• Definition of high-intensity interval training (HIIT)
• Pioneers of HIIT in Cardiac Rehabilitation
• Why should we offer HIIT to our patients?
• Mayo Clinic experience with HIIT
Comprehensive Cardiac Rehabilitation/Secondary Prevention: Ongoing Care

- Risk factor identification/modification
- Counseling/education to facilitate self-care
- Symptom identification/control
- Medication compliance
- Exercise training/physical activity counseling
- Coordination of care

Comprehensive Cardiac Rehabilitation/Secondary Prevention

- Benefits:
  - Reduced symptoms
  - Improved risk factors
  - Increased exercise capacity
  - Reduced coronary events
  - Improved survival

Cardiac Rehabilitation and Medication Compliance

Long-term Medication Adherence after Myocardial Infarction: Experience of a Community

Wiley D. Shaw, MD, MS; Donovon A. Borley, MD; Nancy D. Ying, MD; Victor H. Nussmeier, MD, MS; Ronald J. Funderburg, MD; Mary E. Organ, RN; Rachel E. Organ, RN; and William S. Tuddenham, MD

The American Journal of Medicine (2009) 122, 96A-7-96A.12
Cardiac Rehabilitation and Medication Compliance

As cardiac rehabilitation was the sole independent predictor of improved medication adherence in this study, an ancillary analysis was performed to evaluate adherence to each medication class among cardiac rehabilitation participants versus nonparticipants. Adherence to statins (P = .002), beta-blockers (P = .002), and ACE inhibitors/ARB (P = .002) was better in those enrolling in a cardiac rehabilitation program (Figure 3). For example, at 1 year post myocardial infarction, 80% of patients enrolled in cardiac rehabilitation remained on statin therapy, versus 60% who did not attend cardiac rehabilitation. Similarly, for beta-blockers and ACE inhibitors/ARB, 1-year medication continuation rates were 78% and 74%, respectively, among those who attended cardiac rehabilitation vs 62% and 54%, respectively, among those who did not attend cardiac rehabilitation.

The American Journal of Medicine (2009) 122, 96.e17-96.e12

Cardiac Rehabilitation Participation: Rehospitalization and Mortality after MI

CLINICAL RESEARCH STUDY

Participation in Cardiac Rehabilitation, Readmissions, and Death After Acute Myocardial Infarction

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The American Journal of Medicine (2014) 127, 538-546
Cardiac Rehabilitation Participation: Rehospitalization and Mortality after MI

Figure 3: Reductions in mortality and myocardial infarction for cardiac rehabilitation. Participants and non-participants. The smoothed mean number of rehospitalizations over time (A) and Kaplan-Meier curves demonstrating time to death (B) after myocardial infarction are shown for cardiac rehabilitation participants and non-participants. The number at risk at each time is shown below the figure.

The American Journal of Medicine (2014) 127, 538-546

Cardiac Rehabilitation Participation and Survival after CABG

Participation in Cardiac Rehabilitation and Survival After Coronary Artery Bypass Graft Surgery
A Community-Based Study
Quinn R. Pack, MD; Konshel Goel, MD; Brian D. Lahr, MS; Kevin L. Gerson, MD; Ray W. Squires, PhD; Francisco Lopez-Simon, MD; MRC; Zixin Zhang, MD; Randall J. Thomas, MD, MS

(Circulation, 2013/10/09-097.)

Cardiac Rehabilitation Participation and Survival after CABG

(Circulation, 2013/10/09-097.)
CR Participation and Morality after Combined Heart Valve and CABG Surgery

Cardiac rehabilitation is associated with reduced long-term mortality in patients undergoing combined heart valve and CABG surgery

Kashish Goel, Quinn R Pack, Brian Lahr, Kevin L Greason, Francisco Lopez-Jimenez, Roy W Squires, Zixin Zhang and Randal J Thomas

European Journal of Preventive Cardiology | Published online 21 November 2013

CR Participation and Survival after Combined Heart Valve and CABG Surgery

![Graph showing survival rates after surgery]

152%
High-Intensity Aerobic Interval Training (HIIT) Versus Moderate Intensity Training (MIT)

• Alternating short periods of more intense training (80%+ of capacity, RPE >14) with periods of less intense training (≤60%) or rest
• Used by athletes to optimize VO2peak, anaerobic threshold
• Moderate intensity training: 40% to 70% of capacity; RPE 11-14; typically used in CR

High-Intensity Aerobic Interval Training (HIIT)

• Provides controlled overload of the O2 transport system, microcirculation, skeletal muscle metabolic apparatus
• Results in greater improvement in exercise capacity than moderate-intensity training

Variables in Prescribing HIIT

• Mode(s) of exercise
• Intensity: heart rate, RPE, symptoms
• Duration of high-intensity/moderate intensity intervals (recovery)
• Number of high-intensity intervals per session
• Progression of HIIT training
• Number of HIIT sessions/week
History of Exercise Training for Cardiac Patients: “Primum Non Nocere”

- 1950’s: Bedrest for 6+ weeks after MI
- 1960’s: Low to moderate-intensity exercise in earliest CR programs
- 1970’s: More CR programs, restrictions in exercise training
- 1980’s, 1990’s, 2000’s: Still restrictions on exercise training

Pioneers of HIIT in Cardiac Rehabilitation

- Dr. Terry Kavanagh
- Dr. Ali Ehsani
- Dr. Katharina Meyer
- Norway (many investigators)

Dr. Terry Kavanagh, Toronto Rehabilitation Centre

- CR pioneer in Canada
- Program started in late 1960’s
- Progressive walk-jog format for exercise training
- Eight post-MI patients made history in the early 1970’s
HIIT after MI: 1980's

- Dr. Ali Ehsani, Washington University Medical Center, St. Louis, MO
- N=10 exercise, 8 controls; >4 months post MI, 3 months of MIT before trial
- 30-60 min, 3 sessions/week for one year, walk/jog/cycle ergometer

- Intensity: 70% of VO2peak with 2-3 intervals, 2-5 min at 80% to 90% of VO2peak
- VO2peak increased by 40%!!

Circulation 1981; 64:1116
HIIT for CHF Patients: 1990’s

- N=18, LVEF 21%, VO2peak 12.2 ml/kg/min
- Ramp cycle GXT; workload increases every 10s (“steep”)
- Interval training: 30s high/60s low
HIIT for CHF Patients: 1990's

- After 3 weeks, VO2peak increased from 12.2 to 14.6 ml/kg/min (↑ 20%)
- Several patients were removed from consideration for heart transplant

Am J Cardiol 1996; 78:1017

HIIT in Norway

- Wisloff, Rognmo, Munk, Larsen, et al
- Multiple publications 2004-present
- Standardized HIIT protocol
- World's largest experience with HIIT in CR (thousands of patients)
Standard HIIT Protocol for CR in Norway

Why Offer HIIT to Our Patients?

- Enhanced "training effect"; greater improvement in VO2peak, anaerobic threshold vs MIT
- Greater improvement in endothelial function vs MIT

Fitness and Survival in CHD Patients
Fitness and Survival in CHD Patients

• At one year, each 1 MET (3.5 ml/kg/min) improvement in fitness during CR was associated with a 25% reduction in all-cause mortality.

HIIT Meta-Analysis

• Six studies; N=153, all with CVD or Metabolic Syndrome
• Compared with MIT, HIIT increased VO2peak by an additional 3.6 ml/kg/min

HIIT (AIT) Compared with MIT (MCT) in CHF Patients

Wisloff, Circulation 2007; 115:3086
Why Offer HIIT to Our Patients

- Enhanced “training effect”; greater improvement in VO2peak, anaerobic threshold
- Greater improvement in endothelial function
- Increased patient confidence to be active; they are not fragile
- Patients often enjoy it, appreciate the benefits, “better workout”, higher energy expenditure

Safety of Exercise Training in CR

- Exercise is a “two-edged sword”
- CR including exercise training reduces mortality by 30+% 
- Acute exercise transiently increases the risk of an event: 1/50,000 to 120,000 patient-hours of MIT [Leon, Circulation 2005; 111:369]
- For HIIT, is the risk/benefit ratio acceptable?

Norwegian Experience: Safety of HIIT

- N=4,846, 70% men in 3 Norwegian CR centers, 2004-2011
- 175,820 hours of supervised exercise
- Separate MIT and HIIT sessions (36% included HIT)
- Outcome measures: cardiac arrest, MI during or within 1 hour after exercise
Norwegian Experience: Safety of HIIT

• Results: 1 fatal cardiac arrest during MIT; 2 non-fatal cardiac arrests during HIIT; no MI
• Event rates: 1/129,456 patient-hours of MIT; 1/23,182 patient-hours of HIIT (p=ns)
• Conclusion: Event rates are very low, inadequate power to detect difference between MIT and HIT

Mayo Clinic Experience with HIIT in Phase II Cardiac Rehabilitation

• Began in 2009
• Started with "model" patients first
• Patients also perform strength training, balance exercises, independent MIT
• To date >1,000 patients (70%+ of all patients), >20,000 exercise sessions with HIIT
• No major adverse cardiovascular events; no major musculoskeletal injuries

Mayo Clinic Experience with HIIT in Phase II Cardiac Rehabilitation

• Exclusion criteria:
  • Patient refusal
  • Impaired cognition
  • Language barrier
  • Musculoskeletal limitations
  • Angina with MIT (initial exclusion)
Mayo Clinic Experience with HIIT in Phase II Cardiac Rehabilitation

- Patients start CR within 1-2 weeks of hospital discharge
- CPX for medical patients, 6-minute walk for surgicals
- Start with standard MIT for first few sessions (1st-2nd week)

Mayo Clinic Experience with HIIT in Phase II Cardiac Rehabilitation

- Begin HIIT (30 days post event) with 2-3 intervals of 30s-60s RPE 15-17, interspersed with 1-5 minutes of MIT
- Progress to 5 intervals of 1-2+ minutes, RPE 15-17, during a 30 minute session
- Two to three supervised sessions per week include HIIT
- Exercise modes: TM walk/jog, cycle, elliptical, NuStep, etc.

What Do the Patients Think About HIIT?

Patient video clips
Summary

• HIIT provides additional fitness benefits vs MIT
• There are several different models of HIIT in CR
• HIIT appears to be safe and well-tolerated
• Patients appreciate the effects of HIIT on both fitness and their confidence to perform physical activity

Summary

• Additional research is needed to determine long-term outcomes:
  • Improved compliance with exercise?
  • Greater improvements in body composition?
  • Greater improvements in coronary risk factors?
  • Lower mortality/morbidity?

Thank you!
Aerobic Exercise Intensity Assessment and Prescription in Cardiac Rehabilitation

A Joint Position Statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation, and the Canadian Association of Cardiac Rehabilitation

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