Exercise in various Heart Diseases

Dr Peter Ting
Cardiology
Gleneagles Hospital Singapore
Exercise has many beneficial effects, and is an important component in the prevention and rehabilitation of many forms of cardiovascular disease. The key to maximizing the benefits of exercise is to follow a well-designed program that is safe and sustainable over the long term...
Benefits of Regular Physical Activity

Potential Cardioprotective Effects of Regular Physical Activity

- **Anti-atherosclerotic**
  - Improved lipids
  - Lower BP
  - Reduced adiposity
  - \( \uparrow \) Insulin sensitivity
  - \( \downarrow \) Inflammation

- **Psychologic**
  - \( \downarrow \) Depression
  - \( \downarrow \) Stress
  - \( \uparrow \) Social support

- **Anti-Thrombotic**
  - \( \downarrow \) Platelet adhesiveness
  - \( \uparrow \) Fibrinolysis
  - \( \downarrow \) Fibrinogen
  - \( \downarrow \) Blood viscosity

- **Anti-Ischemic**
  - \( \downarrow \) Myocardial \( O_2 \) demand
  - \( \uparrow \) Coronary flow
  - \( \downarrow \) Endothelial dysfunction
  - \( \uparrow \) EPCs and CACs

- **Anti-Arrhythmic**
  - \( \uparrow \) Vagal tone
  - \( \downarrow \) Adrenergic activity
  - \( \uparrow \) HR variability

Copyright © American Heart Association
Franklin B A, Cushman M Circulation 2011;123:2274-2283
London Bus study
Fitter you are, the longer you live!! (up to a point)

Figure 1. Mortality risk according to exercise capacity. Note that significant reductions in mortality are evident at >4 METs and reach an asymptote at >10 METs. Data from Kokkinos et al.2
Common questions

• Doctor, I have XXX heart problem, can I exercise? How much exercise can I do?

• More specifically can I play squash, football or run a marathon like I use to?

• Can I take part in competitive sports? Is it safe?
Safety of Exercise in Heart Diseases

Main concern is sudden cardiac death or acute decompensation

Progressive intensity required for exercise training

Progression of underlying condition (unsubstantiated)

- Valvular heart disease
- Heart failure
- Hypertrophic cardiomyopathy and other cardiomyopathies
- Congenital Heart diseases (ASD, VSD)
- Pulmonary hypertension
- Peripheral vascular disease
General Principles

1. Everyone should participate in regular physical activity – question is type and how much

2. Physical activity can be divided in recreational sports/exercise and competitive sports

3. Most heart diseases if stable or adequately controlled are eligible for the first

4. Regular monitoring required as status may change
General Principles

1. Nature of heart disease, type of abnormality and etiology

2. Clinical history and physical examination – Signs & symptoms of decompensation, e.g. dyspnea, syncope, palpations or angina

3. Comorbid conditions e.g. diabetes, hypertension

4. Severity and stability of the heart disease based on echocardiographic and clinical features

5. Presence of adverse secondary features such as left ventricular systolic dysfunction, chamber dilatation, exercise induced pulmonary hypertension on echo, or exercise induced hypotension or syncope

6. Evidence of concurrent significant arrhythmias
General Flow Chart

- Clinical assessment
- Classification & evaluation of exercise
- Additional Evaluations
- Exercise Prescription once stable

Monitoring and updating of Status
Echo important assessment

- For initial evaluation of known or suspected heart diseases (HDs)
  - For diagnosis, etiology, severity, prognosis, and evaluate timing of intervention
- Known HDs with change in symptoms or P/E findings
- Routine FU of known HDs

<table>
<thead>
<tr>
<th>Stage</th>
<th>Aortic Stenosis</th>
<th>Aortic Regurgitation</th>
<th>Mitral Stenosis</th>
<th>Mitral Regurgitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Progressive (B)</td>
<td>Mild Every 3-5 years</td>
<td>Mild Every 3-5 years</td>
<td>Mild Every 3-5 years</td>
<td>Mild Every 3-5 year</td>
</tr>
<tr>
<td>Moderate</td>
<td>Moderate Every 1-2 years</td>
<td>Moderate Every 1-2 years</td>
<td>Moderate Every 1-2 years</td>
<td>Moderate Every 1-2 years</td>
</tr>
<tr>
<td>Severe (C)</td>
<td>Severe Every 6-12 mo</td>
<td>Severe Every 6-12 mo Dilating LV: more frequently</td>
<td>Severe Every year</td>
<td>Severe Every 6-12 mo Dilating LV: more frequently</td>
</tr>
</tbody>
</table>
Additional Evaluations

- Stress testing – TMX test, CPET, stress echo
- Supervised sessions with telemetry
- Ambulatory holter monitoring
AHA/ACC SCIENTIFIC STATEMENT

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Preamble, Principles, and General Considerations

A Scientific Statement From the American Heart Association and American College of Cardiology
Classification of sports
## Risk of Impact

*Danger of bodily collision (see Table for more detail on collision risk). †Increased risk if syncope occurs. Modified from Mitchell et al\(^3\) with permission. Copyright © 2005, *Journal of the American College of Cardiology.*

<table>
<thead>
<tr>
<th>Impact expected</th>
<th>Junior High School</th>
<th>High School/College</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>American football Ice hockey Lacrosse Wrestling Karate/judo Fencing Boxing</td>
<td>American football Soccer Ice hockey Lacrosse Basketball Wrestling Karate/judo Downhill skiing Squash Fencing Boxing</td>
</tr>
<tr>
<td>Impact may occur</td>
<td>Soccer Basketball Field hockey Downhill skiing Equestrian Squash Cycling</td>
<td>Field hockey Equestrian Cycling Baseball/softball Gymnastics Figure skating</td>
</tr>
<tr>
<td>Impact not expected</td>
<td>Baseball/softball Cricket Golf Riflery Gymnastics Volleyball Swimming Track and field Tennis Figure skating Cross-country skiing Rowing Sailing Archery Weightlifting Badminton</td>
<td>Cricket Golf Riflery Volleyball Swimming Track and field Tennis Cross-country skiing Rowing Sailing Archery Weightlifting Badminton</td>
</tr>
</tbody>
</table>

**Table** Sports According to Risk of Impact and Educational Background

<table>
<thead>
<tr>
<th>Impact expected</th>
<th>Junior High School</th>
<th>High School/College</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>American football Ice hockey Lacrosse Wrestling Karate/judo Fencing Boxing</td>
<td>American football Soccer Ice hockey Lacrosse Basketball Wrestling Karate/judo Downhill skiing Squash Fencing Boxing</td>
</tr>
<tr>
<td>Impact may occur</td>
<td>Soccer Basketball Field hockey Downhill skiing Equestrian Squash Cycling</td>
<td>Field hockey Equestrian Cycling Baseball/softball Gymnastics Figure skating</td>
</tr>
<tr>
<td>Impact not expected</td>
<td>Baseball/softball Cricket Golf Riflery Gymnastics Volleyball Swimming Track and field Tennis Figure skating Cross-country skiing Rowing Sailing Archery Weightlifting Badminton</td>
<td>Cricket Golf Riflery Volleyball Swimming Track and field Tennis Cross-country skiing Rowing Sailing Archery Weightlifting Badminton</td>
</tr>
</tbody>
</table>
Limitations to the Scheme

- Different position players may have quite different cardiovascular loads.
- Low-intensity sports such as yoga can be practiced at much higher intensities.
- Cardiovascular load may be different at different times during the competition.
- The types and intensities of exercise required for training may be different from competition.
- These guidelines may not apply to participation in sports at a recreational level. Moreover, many higher-class activities (such as cycling and running) can be performed by patients with cardiovascular disease after they have received counseling about intensity restriction and competition avoidance as part of healthy secondary prevention.
- Environmental conditions may alter the cardiovascular load for a given sport substantially. E.g. Heat or altitude.
- The psychological and emotional demands of sports are also relevant.
Specific Disease Conditions
Exercise for VHD patient

• Exercise is good.....but is it safe?
• Regular aerobic exercise is recommended to maintain cardiorespiratory fitness
• Heavy isometric training will increase afterload of LV and is discouraged
Sports with AR/MR

- In general, exercise causes no change or slight reduction in regurgitant fraction (decrease SVR)
- Generally more tolerant of physical activity
- **BUT**, elevated HR or BP and cause increased regurgitation

### AR

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild to moderate AR with normal LV size</td>
<td>No restrictions</td>
</tr>
<tr>
<td>Mild to moderate AR with moderate LV enlargement</td>
<td>Low/moderate static and low/moderate/high dynamic sports *if tested</td>
</tr>
<tr>
<td>Severe AR</td>
<td>No competitive sports</td>
</tr>
<tr>
<td>Dilated aortic root (&gt; 4.5 cm)</td>
<td>IA sports only</td>
</tr>
</tbody>
</table>

### MR

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild to moderate MR with normal LV size</td>
<td>No restrictions</td>
</tr>
<tr>
<td>Mild to moderate MR with increased LV size</td>
<td>Low/moderate static and low/moderate/high dynamic sports</td>
</tr>
<tr>
<td>Severe MR and LV enlargement, LV dysfunction or pulmonary HTN</td>
<td>No competitive sports</td>
</tr>
</tbody>
</table>
Competitive Sports with MS

- Exercise may increase pulmonary capillary and pulmonary artery systolic pressure which may result in acute pulmonary edema
- AS patients in competitive sports need annual evaluation

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild AS</td>
<td>No restrictions</td>
</tr>
<tr>
<td>Moderate AS</td>
<td>IA sports</td>
</tr>
<tr>
<td></td>
<td>IB and IIA sports in selected patients</td>
</tr>
<tr>
<td>Severe AS</td>
<td>No competitive sports</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild MS (with exercise PASP &lt; 50 mm Hg)</td>
<td>No restrictions</td>
</tr>
<tr>
<td>Moderate MS (and PASP &lt; 50 mm Hg)</td>
<td>Low/moderate static and low/moderate dynamic sports</td>
</tr>
<tr>
<td>Severe MS (or any with exercise PASP &gt; 50 mm Hg)</td>
<td>No competitive sports</td>
</tr>
</tbody>
</table>

*Patients with anticoagulation should avoid sports with risk of bodily collision
Sports with Bicuspid Aortic Valve/Prosthetic valves

- BiAOV there is increased risk of aortic

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No significant AS/AR and aortic root &lt; 4.0 cm</td>
<td>No restrictions</td>
</tr>
<tr>
<td>Aortic root 4.0-4.5 cm</td>
<td>Low/moderate static and low/moderate dynamic sports</td>
</tr>
<tr>
<td></td>
<td>*Avoid collision sports</td>
</tr>
<tr>
<td>Dilated aortic root (&gt; 4.5 cm)</td>
<td>IA sports only</td>
</tr>
</tbody>
</table>

- Insufficient long term data on exercise effects

<table>
<thead>
<tr>
<th>Patient group</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioprosthetic mitral valve</td>
<td>Low/moderate static and low/moderate dynamic sports</td>
</tr>
<tr>
<td>Bioprosthetic or mechanical aortic valve</td>
<td>Low/moderate static and low/moderate dynamic sports</td>
</tr>
<tr>
<td></td>
<td>*if tested</td>
</tr>
</tbody>
</table>
Exercise testing in VHD – Stress echo/CPET

- Assessing presence of symptoms
- Functional status, suitability for participation in competitive sports
- Assess dynamic nature of VHD (severity)
- Help determine timing for surgery
Heart Failure

• Exercise therapy in systolic heart failure (HFREF)
• Exercise therapy in diastolic heart failure (HFPEF)
• Alternative modes of exercise
  – HIIT
  – High caloric
Efficacy and Safety of Exercise Training as a Treatment Modality in Patients With Chronic Heart Failure: Results of A Randomized Controlled Trial Investigating Outcomes of Exercise Training (HF-ACTION)

David J. Whellan, MD, MHS
Jefferson Medical College, Philadelphia, PA

Christopher M. O’Connor, MD
Duke University Medical Center, Durham, NC

HF-ACTION Steering Committee, Investigators, and Coordinators
Funded by NHLBI
Study Design

Chronic heart failure, NYHA Class II-IV, LVEF ≤ 35%, optimal medical therapy, and capable of exercising

Pre-randomization CPX and ECHO

Randomization 1:1 (Stratified by center and HF etiology)

n = 2331
NYHA II-III

Usual Care
- Optimized medical treatment
- Patient education
- Phone calls

Exercise Training
- Optimized medical treatment
- Patient education
- Phone calls
  - Recommendation: Moderate intensity activity 30 minutes/day
  - Supervised training
  - Home training

Median FU 30mths
Time to All-Cause Mortality or All-Cause Hospitalization

**HR 0.93 (95% CI: 0.84, 1.02), \( P=0.13 \)**
### Summary of Major Outcomes

<table>
<thead>
<tr>
<th>Hazard Ratio</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All-cause mortality and hospitalization (primary)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main analysis</td>
<td>0.93</td>
<td>0.84, 1.02</td>
</tr>
<tr>
<td>Adjusted analysis</td>
<td>0.89</td>
<td>0.81, 0.99</td>
</tr>
<tr>
<td><strong>CV mortality and HF hospitalization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main analysis</td>
<td>0.87</td>
<td>0.75, 1.00</td>
</tr>
<tr>
<td>Adjusted analysis</td>
<td><strong>0.85</strong></td>
<td><strong>0.74, 0.99</strong></td>
</tr>
</tbody>
</table>

---

**Poor Adherence! Failure to Achieve therapeutic dose**


HF-ACTION – modest benefit?

**Trial design:** Patients with symptomatic systolic CHF on optimal medical therapy were randomized to either exercise training or usual medical care. Clinical outcomes were compared at 3 years. However only 30% in intervention group achieved targets and 8% in control exercised regularly.

**Results**
- No difference in mortality/hospitalizations between the two arms (HR 0.93, 95% CI 0.84-1.02, p = 0.13). On adjustment for other prognostic factors, was ↓ in exercise training arm (p = 0.03)
- CV mortality & CV hospitalizations (p = 0.14), 6-minute walk distance similar, but peak VO\(_2\) higher in the exercise training arm
- Serious side effects similar between two arms

**Conclusions**
- Prescribed exercise training program in patients with systolic CHF safe and effective, when added on to optimal medical therapy
- Strengthens current recommendations for exercise in CHF patients

O’Connor CM, et al. JAMA 2009;301:1439-50
Limitations

- Adherence in exercise training group and physical activity by the usual care group may have diminished the identified benefit of exercise training
- Blinding of subjects and research personnel not possible
  - Core labs blinded
  - Clinical Endpoint Committee blinded
- Home exercise adherence data are difficult to collect and to precisely quantify
Relation between Volume of Exercise and Clinical Outcomes in Patients with Heart Failure

Dr. Steven J. Keteyian, PhD, Dr. Eric S. Leifer, PhD, Ms. Nancy Houston-Miller, BSN, Dr. William E. Kraus, MD, Mr. Clinton A. Brawner, MS, Dr. Christopher M. O’Connor, MD, Dr. David J. Whellan, MD, Dr. Lawton S. Cooper, MD, Dr. Jerome L. Fleg, MD, Dr. Dalane W. Kitzman, MD, Dr. Alain Cohen-Solal, MD, Dr. James A. Blumenthal, PhD, Mr. David S. Rendall, PA-C, and Dr. Ileana L. Piña, MD, MPH for the HF-ACTION Investigators

Figure 2. Hazard Ratios for All-cause Mortality or Hospitalization
Among patients event-free for at least three months, adjusted hazard ratios (filled circles, log scale) for all-cause mortality or hospitalization with 95% confidence intervals; reference category is 0–1 MET-hr per week. Unadjusted hazard ratios are plotted with open circles.

Figure 3. Hazard Ratios for Cardiovascular Mortality or Heart Failure Hospitalization
Among patients event-free for at least three months, adjusted hazard ratios (filled circles, log scale) for cardiovascular mortality or heart failure hospitalization with 95% confidence intervals; reference category is 0–1 MET-hr per week. Unadjusted hazard ratios are plotted with open circles.
Exercise volume and Outcome in HF ACTION

- 30% reduction
- 6% increase VO2 → 5% and 8%
HFPEF

- >=50% of HF patients older than 65 (Kiitzman et al 1991)
- Morbidity and mortality comparable to HFREF
- Exercise intolerance with major impact on QOL
Exercise training in HFPEF

No large RCT as yet
Smaller studies suggest exercise training is at least as effective and safe as for HFREF
CR in Peripheral arterial disease

- Exercise training is key, accessibility and utilization is poor
- Not always considered mainstream in CR
- Home-based programs can improve utilization
- RCT of 119 with intermittent claudication compared quantified home-based exercise (using a step activity monitor) with traditional supervised exercise and usual care controls
- Adherence to both groups was high (>80%)
CR in Peripheral arterial disease

- After 12 weeks:

<table>
<thead>
<tr>
<th></th>
<th>Home based</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claudication time</td>
<td>+165 sec</td>
<td>+134 sec</td>
</tr>
<tr>
<td>Peak walking time</td>
<td>+215 sec</td>
<td>+124 sec</td>
</tr>
</tbody>
</table>

- Similar home-based quantified protocols could be expanded to other conditions for which exercise programs are beneficial.
Congenital Heart Disease

- More patients with CHD surviving to adulthood (90%)
- Physical activity and exercise is recommended in American and European guidelines, but data lacking
- Recently, Dua and colleagues evaluated the effect of home based walking in 61 ACHD – increased treadmill test duration and improved QOL measures
- Holloway and colleagues noted similar improvement in exercise tolerance when 11 patients were enrolled in a formal cardiac rehabilitation program with appropriate exercise prescriptions
  - Dua JS et al. IntJ Cardiol. 2010;138:196–205
ASD & VSD

In General in ASD/VSD treated or untreated, if small defect with no cardiac enlargement or decompensation, no pulmonary hypertension – can participate in all sports at all intensities

Caution if pulmonary hypertension, arrhythmias, myocardial dysfunction, cyanosis or large right to left shunts
• Genotype-positive HCM patients but no morphological evidence of LV hypertrophy can participate in all sports, particularly in the absence of a family history of HCM-related sudden death, however education and monitoring required

• Probable or unequivocal clinical expression and diagnosis of HCM (ie, with the disease phenotype of LV hypertrophy) should not participate in most competitive sports, with the exception of those of low intensity (class IA sports)

• Pharmacological agents or prophylactic ICDs should be administered based on clinical indications and not for the purpose of permitting participation in high-intensity sports
Pulmonary arterial hypertension

- RCT evaluated the risks and benefits of moderate intensity exercise and respiratory training in 30 patients with chronic, severe pulmonary hypertension (MPAP 50 mm Hg)
- 15 weeks later: significant improvement in 6-minute walk distance by 22%, QOL scores, World Heart Organization functional classification, and peak VO2 (from 13.2 mL/kg per min to 15.4 mL/kg per min, p=0.05)
- Further trials are needed to evaluate the effect of activity training on clinical outcomes in this high-risk group.

The leanest, fastest, most powerful creatures on earth don’t do aerobics

Become the animal you are meant to be
Sprint...
Rest...
Repeat...
on the only equipment designed exclusively for High Intensity Interval Training

Go to HealthStream now for HIIT products and programs
High intensity interval training (HIIT)

- Moderate-intensity continuous exercise training (50% to 80% of maximum heart rate [HRpeak])

- Aerobic interval training involves alternating 3- to 4-minute periods of exercise at high intensity (90%–95% HRpeak) with exercise at moderate intensity (60%–70% HRpeak). Such training for 40 minutes, 3 times per week has been recently evaluated by Wisløff and colleagues,
High intensity interval training (HIIT)

- 27 patients post MI with HF (avg EF 29%)
- Up to **95%** of peak heart rate!
- Improved VO2 by 46% cf 14% (improvements also seemed more sustained)
- Favorable remodeling of the left ventricle
- Better brachial artery flow mediated dilation (endothelial function)
- Reductions in proBNP levels
- No increase in complications
- Recent metaanalyses by Haykowsky et al. greater improvements in exercise tolerance
- Evidence tends to suggest that it is safe, however more work to elucidate its use in older patients and women
High Calorie Expenditure Exercise training

- 74 Overweight/obese IHD patients
- 3000-3500kcal/week vs. 700-800kcal/week
- Lower intensity 50-60% peak VO2 for longer duration and more often
High Calorie Expenditure Exercise training - RESULTS

<table>
<thead>
<tr>
<th></th>
<th>High caloric</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight loss</td>
<td>8.2 kg</td>
<td>3.7kg (p&lt;0.01)</td>
</tr>
<tr>
<td>Fat Mass</td>
<td>5.9 kg</td>
<td>2.8kg (p=0.01)</td>
</tr>
<tr>
<td>Waist circumference</td>
<td>7cm</td>
<td>5cm (p=0.02)</td>
</tr>
</tbody>
</table>

- Improved lipid profiles and insulin resistance after 5 mths
- Prevalence of metabolic syndrome reduced from 59% to 31%
Summary

• Regular physical activity should be encouraged in all patients with stable heart disease
• Participation in competitive sports require more in-depth evaluation (see AHA/ACC 2015 statement)
• Right exercise prescription must be made for safety, health maintenance and relevant training effect
• Status should be regularly monitored for changes (frequency depending on underlying condition)
• Patients should be empowered and educated to self-monitor and adjust
• More research is required to establish specific training protocols for safe effective exercise training