Cardiac Evaluation & Application

Joe Rogowski MA, A.T.C./L, C.S.C.S.
- Orlando Magic Strength & Conditioning Coach
- NBA Combine (Cardiac Screening of 80+ players)
- Founder Athletic Heart
- Master’s Exercise Physiology
Cardiac Testing & Gas Analysis

Detroit Tigers

Olympic Gold Medalist

NBA Teams / Combine

High School Athletic Teams

University of Miami
NBA Combine
Cardiac Anatomy
Cardiac Headlines for 2007

January 17, 2007 South Florida freshman collapses, dies after workout

January 15, 2008: Medical examiner rules Pitcher Joe Kennedy died of heart disease

November 3, 2007 Field hockey player dies after collapsing at practice

Aug. 28, 2007 Sevilla's Puerta dies three days after collapse

September 29, 2007 B.C. hockey player dies during pro game in Italy

Dec. 29, 2007 Motherwell's O'Donnell dies following collapse

Friday, October 12, 2007 Wizards' Thomas Has Aortic Valve Surgery

Aug. 20, 2007 Walsall apprentice Reid dies in training

Nov. 4, 2007 Ryan Shay Tribute: Notre Dame Mourns The Death Of A Champion

Oct. 3, 2007 High school hockey player dies during practice

11:55 am MST February 25, 2007 Fallen Broncos Player May Have Had Heart Condition

Tuesday December 4, 2007 1:14PM
Following the Trail of Broken Hearts
A congenital cardiovascular abnormality has become a leading killer of young athletes in the U.S. So why isn't more being done to save those who have it?
ACSM Guidelines for Testing

**BOX 2-1. Major Signs or Symptoms Suggestive of Cardiovascular and Pulmonary Disease**

- Pain, discomfort (or other anginal equivalent) in the chest, neck, jaw, arms, or other areas that may be due to ischemia
- Shortness of breath at rest or with mild exertion
- Dizziness or syncope
- Orthopnea or paroxysmal nocturnal dyspnea
- Ankle edema
- Palpitations or tachycardia
- Intermittent claudication
- Known heart murmur
- Unusual fatigue or shortness of breath with usual activities

*These symptoms must be interpreted in the clinical context in which they appear because they are not all specific for cardiovascular, pulmonary, or metabolic disease. For clarification and discussion of the clinical significance of the signs or symptoms, see reference 11.

**BOX 2-2. Initial ACSM Risk Stratification**

**Low risk**

Younger individuals* who are asymptomatic and meet no more than one risk factor threshold from Table 2-1

**Moderate risk**

Older individuals (men ≥ 45 years of age; women ≥ 55 years of age) or those who meet the threshold for two or more risk factors from Table 2-1

**High risk**

Individuals with one or more signs/symptoms listed in Box 2-1 or known cardiovascular,† pulmonary,‡ or metabolic§ disease

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**TABLE 2-2. ACSM Recommendations for (A) Current Medical Examination* and Exercise Testing Prior to Participation and (B) Physician Supervision of Exercise Testing**

<table>
<thead>
<tr>
<th></th>
<th>Low Risk</th>
<th>Moderate Risk</th>
<th>High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate exercise†</td>
<td>Not necessary†</td>
<td>Not necessary</td>
<td>Recommended</td>
</tr>
<tr>
<td>Vigorous exercise§</td>
<td>Not necessary</td>
<td>Recommended</td>
<td></td>
</tr>
<tr>
<td><strong>B.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submaximal test</td>
<td>Not necessary</td>
<td>Not necessary</td>
<td>Recommended</td>
</tr>
<tr>
<td>Maximal test</td>
<td>Not necessary</td>
<td>Recommended†</td>
<td></td>
</tr>
</tbody>
</table>

*Within the past year (see reference 2).

†Absolute moderate exercise is defined as activities that are approximately 3–6 METs or equivalent of brisk walking at 3 to 4 mph for most healthy adults (13). Nevertheless, a pace of 3 to 4 mph might be considered to be “hard” to “very hard” by some sedentary, older persons. Moderate exercise may alternatively be defined as an intensity well within the individual’s capacity, one which can be comfortably sustained for a prolonged period of time (~30 min), which has a gradual initiation and progression, and is generally noncompetitive. If the individual’s exercise capacity is known, relative moderate exercise may be defined by the 40–60% maximal oxygen uptake.

‡The designation of “Not necessary” reflects the notion that a medical examination, exercise test, and physician supervision of exercise testing would not be essential in the preparticipation screening; however, they should not be viewed as inappropriate.

§Vigorous exercise is defined as activities of >6 METs. Vigorous exercise may alternatively be defined as exercise intense enough to represent a substantial cardiorespiratory challenge. If an individual’s exercise capacity is known, vigorous exercise may be defined as an intensity >60% maximal oxygen uptake.

||When physician supervision of exercise testing is “Recommended,” the physician should be in close proximity and readily available should there be an emergent need.
Outline:

- Cardiac Testing
  - Research
  - EKG
  - ECHO
- Gas Analysis
  - Research
- Magic Testing
Epidemiology (out dated?)

- Maron, MD started a registry of all cases of sudden death athletes in 1985
  - 158 sudden deaths that occurred in trained athletes throughout the United States from 1985 through 1995 were analyzed

- Sudden Death Most often Triggered by Exercise (90%)
  - Most common in basketball & football (68%)
  - Most common in male (9 to 1)
  - Most common death in black male athletes

- National Center for Catastrophic Sports Injury Research identified 160 sudden deaths in college athletes from 1983 – 1993 (78% cardiac causes)
  - College athletes had 2 times greater death rate

- Certain Heart Abnormalities revealed only during exercise
  - (i.e.) T wave inversions

American Heart Association: Routine 12 Lead EKG Screening

- Economic Cost
- Trained Personnel
- False Positives
- Thorough Hx:

AHA Circulation. 2007
Italian National Screening Study: 1979 – 2004 (33,735 young athletes)

- Sharp Decrease in annual incidence of SCD
  - A 90% reduction

- Only 4.8% needed further testing

- Overwhelming Majority were True Negatives
  - EKG 98.8% sensitive identifying abnormalities

Eur Heart J. 2005; (26): 516-524

- EKG be added to Preparticipation Process

IOC Medical Commission: December 10, 2004
<table>
<thead>
<tr>
<th>Abnormalities</th>
<th>Count</th>
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<tbody>
<tr>
<td>LQTS</td>
<td>2</td>
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<tr>
<td>Dilated aorta</td>
<td>5</td>
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<tr>
<td>Anomalous coronary artery</td>
<td>1</td>
</tr>
<tr>
<td>Possible ARVD</td>
<td>1</td>
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<tr>
<td>Ostium primum atrial septal defect</td>
<td>1</td>
</tr>
<tr>
<td>Coronary cameral fistula</td>
<td>1</td>
</tr>
<tr>
<td>Tricuspid regurgitation</td>
<td>3</td>
</tr>
<tr>
<td>Small PDA</td>
<td>1</td>
</tr>
<tr>
<td>Second degree AV block</td>
<td>2</td>
</tr>
<tr>
<td>Frequent PVCs</td>
<td>3</td>
</tr>
<tr>
<td>Vasodepressor Syncope</td>
<td>2</td>
</tr>
<tr>
<td>Mild Mitral Valve Abnormalities</td>
<td>4</td>
</tr>
<tr>
<td>Elevated Blood Pressure</td>
<td>3</td>
</tr>
<tr>
<td>PFO 10</td>
<td></td>
</tr>
<tr>
<td>Connective tissue disease variants</td>
<td>2</td>
</tr>
<tr>
<td>EDS</td>
<td></td>
</tr>
<tr>
<td>Marfan variant</td>
<td></td>
</tr>
</tbody>
</table>

- 9.0% Previously heart abn.
- 2.2% Serious conditions treated with meds, surgery and/or restrictions
- 1% SBE prophylaxis
January 10th
Database of 12,550 trained athletes
<table>
<thead>
<tr>
<th>Athlete</th>
<th>Sport</th>
<th>Level</th>
<th>Age (yr)</th>
<th>Duration of Follow-up (yr)</th>
<th>Cardiovascular Disorder</th>
<th>Initial ECG</th>
<th>Response of ECG to Exercise</th>
<th>Change in ECG during Follow-up</th>
<th>Clinical Outcome</th>
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</thead>
<tbody>
<tr>
<td>Canoeing</td>
<td>National</td>
<td>24</td>
<td>1</td>
<td>Arrhythmogenic right ventricular cardiomyopathy</td>
<td>Inverted T waves V₁-V₂, II, III, aVF</td>
<td>No change</td>
<td>None</td>
<td>None</td>
<td>Sudden death</td>
</tr>
<tr>
<td>Tennis</td>
<td>Regional</td>
<td>34</td>
<td>16</td>
<td>Hypertrophic cardiomyopathy</td>
<td>Inverted T waves V₁-V₂, flat aVF</td>
<td>No change</td>
<td>None</td>
<td>None</td>
<td>Survived cardiac arrest</td>
</tr>
<tr>
<td>Soccer</td>
<td>Regional</td>
<td>26</td>
<td>7</td>
<td>Hypertrophic cardiomyopathy</td>
<td>Inverted T waves V₂-V₆, I-III, aVF</td>
<td>No change</td>
<td>T-wave inversion extended to aVL</td>
<td>Asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Rowing</td>
<td>International</td>
<td>19</td>
<td>13</td>
<td>Hypertrophic cardiomyopathy</td>
<td>Inverted T waves V₂-V₆, flat V₆, aVF, I, II</td>
<td>No change</td>
<td>None</td>
<td>Symptomatic (non-sustained ventricular tachycardia)</td>
<td></td>
</tr>
<tr>
<td>Basketball</td>
<td>National</td>
<td>38</td>
<td>9</td>
<td>Dilated cardiomyopathy</td>
<td>Inverted T waves V₁-V₂, II, aVF</td>
<td>No change</td>
<td>None</td>
<td>None</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>Basketball</td>
<td>Regional</td>
<td>20</td>
<td>4</td>
<td>Myocarditis</td>
<td>Inverted T waves V₁-V₂, flat V₂, I, aVL</td>
<td>No change</td>
<td>None</td>
<td>Asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Long-distance running</td>
<td>Regional</td>
<td>23</td>
<td>17</td>
<td>Hypertension</td>
<td>Inverted T waves V₁-V₂, flat V₂, I, aVL</td>
<td>Improved</td>
<td>Decrease in T-wave inversion</td>
<td>Asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td>National</td>
<td>25</td>
<td>7</td>
<td>Supraventricular tachycardia</td>
<td>Inverted T waves V₁-V₂, II, aVF</td>
<td>Improved</td>
<td>None</td>
<td>Radiofrequency ablation; asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Soccer</td>
<td>Regional</td>
<td>26</td>
<td>26</td>
<td>Coronary artery disease</td>
<td>Inverted T waves V₁-V₂, I, II, aVF</td>
<td>Worsened</td>
<td>Decrease in T-wave inversion</td>
<td>Asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Cycling</td>
<td>Regional</td>
<td>28</td>
<td>25</td>
<td>Hypertension</td>
<td>Inverted T waves V₁-V₂, II, aVF</td>
<td>No change</td>
<td>None</td>
<td>Asymptomatic</td>
<td></td>
</tr>
<tr>
<td>Cycling</td>
<td>Regional</td>
<td>38</td>
<td>24</td>
<td>Hypertension</td>
<td>Inverted T waves V₁-V₂, II, aVF; flat II</td>
<td>Worsened</td>
<td>None</td>
<td>Asymptomatic</td>
<td></td>
</tr>
</tbody>
</table>

EG denotes electrocardiogram.
† Age at initial evaluation is given.
‡ The tunneled (bridged) segment of the left anterior descending coronary artery without atherosclerotic coronary artery disease was identified by coronary angiography.
§ This athlete was a wheelchair competitor.
Sudden Cardiac Death in Young

How common are the conditions that cause SCA?

- Hypertrophic Cardiomyopathy: 1/500
- Other CM/Myocarditis: 1/1000
- Long QT Syndrome: 1-3/3000
- WPW: 1-3/1000
- Brugada Syndrome: 1-3/10,000
- Other Primary Electrical Conditions: 1/1000
- Coronary Artery Anomalies: 1-3/1000
  - ~6-7/1000

JAMA. 2002; (287): 1308-1320
## Causes of Cardiac Death Among Young Athletes

<table>
<thead>
<tr>
<th>Cause</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertrophic cardiomyopathy</td>
<td>48 (36)</td>
</tr>
<tr>
<td>“Possible hypertrophic cardiomyopathy”</td>
<td>14 (10)</td>
</tr>
<tr>
<td>Aberrant coronary arteries</td>
<td>17 (13)</td>
</tr>
<tr>
<td>Other coronary anomalies</td>
<td>8 (6)</td>
</tr>
<tr>
<td>Ruptured aortic aneurysm</td>
<td>6 (5)</td>
</tr>
<tr>
<td>Tunnelled coronary artery</td>
<td>6 (5)</td>
</tr>
<tr>
<td>Aortic valve stenosis</td>
<td>5 (4)</td>
</tr>
<tr>
<td>Lesion consistent with myocarditis</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Idiopathic myocardial scarring</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Remaining 8 causes</td>
<td>22 (15)</td>
</tr>
</tbody>
</table>

Sudden Cardiac Death in Young

Causes of Sudden Death

- MARFAN: 5%
- AORTIC STENOSIS: 4%
- MYOCARDITIS: 3%
- ARVD: 3%
- CORONARY ANOMALY: 24%
- OTHER: 25%
- HYPERTROPHIC CARDIOMYOPATHY: 36%
- LQTS & PED

JAMA. 1996; 276: 199-204
Number of Sudden Athlete Deaths Compared by Sport

Figure 2.—Sports engaged in at the time of sudden death in 134 young competitive athletes. Those competing in track events were either distance runners or sprinters.
Number of Sudden Athlete Deaths Compared by Race

Figure 4.—Effect of race on cardiovascular causes of sudden death in competitive athletes, shown for those diseases with 5 or more deaths. The 5 Asian, Hispanic, or Native American athletes were not included in this analysis. Possible hypertrophic cardiomyopathy (HCM), as defined in the text, denotes those hearts with some morphologic features consistent with, but not diagnostic of, HCM. CAs indicates coronary arteries; ARVD, arrhythmogenic right ventricular dysplasia; and AVS, aortic valve stenosis.
Routine Screening For Heart Disease in Athletes

- What conditions are we screening for?
  - The conditions that cause Sudden Cardiac Arrest may be subtle and not apparent on routine physical exam
  - The most common categories include:
    - Cardiomyopathies
    - Primary Electrical Disease
    - Congenital Heart Disease
    - Coronary Artery Anomalies
    - Acquired Heart Disease
Routine Screening For Heart Disease in Athletes

What conditions are we screening for?

- Congenital heart disease occurs in 0.8% of births (8/1000)
- Half of these are diagnosed shortly after birth, but some are missed
- Congenital heart defects most commonly missed
  - ASD and PAPVR
  - AS and Bicuspid aortic valve
  - HCM
  - Coronary artery anomalies and coronary cameral fistulae
  - Mitral Valve Prolapse
  - PDA
  - VSD, usually small
  - PS
Sudden Death in Elite Athletes

- Jason Collier (NBA) 27 y/o
  - HCM
- Thomas Herrion (NFL) 23 y/o
  - Ischemic heart disease
- Hank Gathers (NBA) 23 y/o
  - HCM
- Reggie Lewis (NBA) 27 y/o
  - HCM
- Pete Marovich (NBA) 40 y/o
  - Congenital Coronary Artery Anomaly

fp.uni.edu/evans/Gen med con/.../SuddenDeathAmongAthletes notes.htm
Sudden Death in Elite Athletes

- Mickey Renaud (NHL) 19 y/o
  - ?
- Antonio Puerta (Soccer) 22 y/o
- Anton Reid (Soccer) 16 y/o
- Ryan Shay (TRACK) 28 y/o
  - HCM
- Darryl Kile (MLB) 33 y/o
  - Congenital Coronary Artery Anomaly
- Damien Nash (NFL) 24 y/o
  - HCM
- Phil O'Donnell (NHL) 35 y/o
  - HCM
- Joe Kennedy (MLB) 28 y/o
  - HCM
Heart Complications

- Jesse Sapolu (NFL) 36 y/o
  - Enlarged aortic root
- Etan Thomas (NBA) 29 y/o
  - Aortic root leak
- Juwan Howard (NBA) 33 y/o
  - Myocarditis
- Fred Hoiberg (NBA) 33 y/o
  - Enlarged aortic root
- Eddie Curry (NBA) 22 y/o
  - HCM?
- Teddy Bruschi (NFL) 32 y/o
  - Stroke
- Ronny Turaif (NBA) 22 y/o
  - Enlarged aortic root
The Athletic Heart

"Gray zone" of LV Wall Thickness

HCM*  Athlete's Heart

+ Unusual Patterns of LVH†
+ LV Cavity < 45 mm
- LV Cavity > 55 mm
+ LA Enlargement
+ Bizarre ECG Patterns
+ Abnormal LV Filling
+ Female Gender
- ↓ Thickness with Deconditioning
+ Family History HCM
Recent Estimates (2007)

- An estimated 600,000 Americans with hypertrophic cardiomyopathy
- Some 6,000 will die from HCM each year, more than from asthma and Hodgkin's disease combined

Sports Illustrated December 4, 2007
Moran et al. - Abnormal EKG in up to 95% of Patients with Hypertrophic Cardiomyopathy

JAMA. 2002; (287): 1308-1320.
Long QT Syndrome in Children

- Initial Presentation

- Cardiac Arrest 9%
- Syncope 26%
- Seizures 10%

Coronary Artery Abnormalities

- 10-20% of sudden death in athletes
- 97% with sudden death from coronary artery abnormalities are < 22 yrs
- 78% with coronary artery abnormalities and sudden death died with or immediately after exercise
Koester et al. – Normal Coronary Artery Anatomy vs. Abnormal Coronary Artery Anatomy.
Anatomy of An EKG

Use of ECG to Screen for Cardiac Conditions Associated with SCA

- Electrocardiogram (ECG or EKG)
Electrical Firing of the Heart
ECG
Hypertrophic Cardiomyopathy

75-95% Abnormal
Long QT Syndrome

85-90% abnormal
Wireless EKGs
Anatomy of An Echo

Use of Echocardiogram to Screen for Cardiac Conditions Associated with SCA

- HCM
- Dilated CM
- Coronary artery anomalies
- Congenital heart disease
HCM ECHO

Thick Septum

Normalize for Age and Body Size (BSA) Z score

1.5 cm – 1 cm Ratio
3D Echocardiography in Assessment of Cardiac Function
Volumetric Echocardiography

- Fast & Accurate
- EF is not enough!
- Serial Volume Changes with Medical Therapy for Hypertension
- Regional Wall Motion
- Fast Analysis for Mechanical Dyssynchrony
- Validated
3D Echo Video

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## Bruce vs. Athlete: Critical!

### Athlete Ramp

<table>
<thead>
<tr>
<th>TIME</th>
<th>STAGE</th>
<th>SPEED</th>
<th>GRADE</th>
<th>METS</th>
<th>HEART RATE</th>
<th>RPE</th>
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<tr>
<td></td>
<td>Baseline</td>
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<tr>
<td>0-1</td>
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<td>0.0</td>
<td>1.8</td>
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<tr>
<td>1-2</td>
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<td>3-4</td>
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<td>3.6</td>
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<td>9.3</td>
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<td>5-6</td>
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<td>4.8</td>
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<td>10.2</td>
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<td>6-7</td>
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<td>11.7</td>
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<td>7-8</td>
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<td>6.0</td>
<td>7.5</td>
<td>13.3</td>
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<td>8-9</td>
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<td>6.6</td>
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<td>9-10</td>
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<td>7.2</td>
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<td>16.7</td>
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<td>10-11</td>
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<td>7.8</td>
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<td>18.6</td>
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<td>11-12</td>
<td>12</td>
<td>8.4</td>
<td>11.5</td>
<td>20.5</td>
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## Bruce Test

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<tr>
<th>Stage</th>
<th>Speed/Grade</th>
<th>METS</th>
<th>Heart Rate</th>
<th>Blood Pressure</th>
<th>RPE</th>
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<td>Supine</td>
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<td>Baseline</td>
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</tr>
<tr>
<td>Modified Bruce</td>
<td>1.7/0.0%</td>
<td>2.3</td>
<td></td>
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</tr>
<tr>
<td>Modified Bruce</td>
<td>1.7/5.0%</td>
<td>3.5</td>
<td></td>
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<tr>
<td>1</td>
<td>1.7/10.0%</td>
<td>4.6</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>2.5/12.0%</td>
<td>7.0</td>
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<tr>
<td>3</td>
<td>3.4/14.0%</td>
<td>10.2</td>
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<td>4</td>
<td>4.2/16.0%</td>
<td>13.5</td>
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<tr>
<td>5</td>
<td>5.0/18.0%</td>
<td>17.2</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>5.5/22.0%</td>
<td>23.8</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Cardiac Testing in the NBA

- Comparatively We Do an Excellent Job!!!!
- Exercise Physiologists (and Scott) vs. Stress Tests RNs
- 3D Echos
- Wireless EKGs
- Marfan’s Screening & HR Analysis (GHENT)
- Automated BP
- Gas Analysis
- Protocol i.e. Bruce
- Collective Research Effort from all ATCs
Gas Analysis – An Additional Tool

- VO2 Max
- Lactate Threshold
- Specific HR zones
- Specific Calorie Expenditure
- Specific Conditioning Programs

Magglio Ordonez
Gas Analysis Software
## Top V02 Max Scores (ml/kg/min)

<table>
<thead>
<tr>
<th>Athlete</th>
<th>V02 Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steve Prefontaine, US runner</td>
<td>84.4</td>
</tr>
<tr>
<td>Frank Shorter, US Olympic Marathon winner</td>
<td>71.3</td>
</tr>
<tr>
<td>Ingrid Kristiansen, ex-Marathon World Record Holder</td>
<td>71.2</td>
</tr>
<tr>
<td>Derek Clayton, Australian ex-Marathon World Record holder</td>
<td>69.7</td>
</tr>
<tr>
<td>Rosa Mota, Marathon runner</td>
<td>67.2</td>
</tr>
<tr>
<td>Jeff Galloway, US Runner</td>
<td>73.0</td>
</tr>
<tr>
<td>Paula Ivan, Russian Olympic 1500M Record Holder</td>
<td>71.0</td>
</tr>
<tr>
<td>Jarmila Krotochvilova, Czech Olympian 400M/800M winner</td>
<td>72.8</td>
</tr>
<tr>
<td>Greg LeMond, professional cyclist</td>
<td>92.5</td>
</tr>
<tr>
<td>Matt Carpenter, Pikes Peak marathon course record holder</td>
<td>92.0</td>
</tr>
<tr>
<td>Miguel Indurain, professional cyclist</td>
<td>88.0</td>
</tr>
</tbody>
</table>
Basketball & V02 Max Research:

- Olympic - Puerto Rican Basketball
  - V02 max
    - Mean = 58.8 (ml/kg/min)

- Israel National Collegiate Basketball
  - V02 Max
    - Mean = 50.2 (ml/kg/min)

NSCA Journal. 1998. 12(3), 199-203
Basketball & VO2 Max Research:

- Winthrop University
  - ↓ VO2

- Furman University
  - Reserves vs. Starters
  - Reserves 9.5% ↓
  - Starters 1.1% ↑

### Comparison of Fitness Mean Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Phase 1</th>
<th></th>
<th>Phase 2</th>
<th></th>
<th>Phase 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>90.27</td>
<td>9.5</td>
<td>87.69</td>
<td>6.7</td>
<td>88.05</td>
<td>6.3</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>13.26</td>
<td>3.1</td>
<td>9.77</td>
<td>1.9</td>
<td>11.74</td>
<td>2.1</td>
</tr>
<tr>
<td>Max VO2 (ml·kg⁻¹·min⁻¹)</td>
<td>62.28</td>
<td>7.2</td>
<td>65.22</td>
<td>6.2</td>
<td>61.77</td>
<td>7.8</td>
</tr>
<tr>
<td>Anaer. capacity (watts)</td>
<td>3040.42 360.3 3524.18 323.3 3537.67</td>
<td>348.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. Signif. diff., p < 0.05, between Phases 1 & 2 and between Phases 2 & 3 for body fat; between Phases 1 & 2 for anaerobic capacity.*

### Table 2: Pre- and Postseason Performance Measurement (±SD)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Starters (n=9)</th>
<th></th>
<th>Reserves (n=8)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preseason</td>
<td>Post</td>
<td>Preseason</td>
<td>Post</td>
</tr>
<tr>
<td>VO2 max (ml·kg⁻¹·min⁻¹)</td>
<td>53.0</td>
<td>53.6</td>
<td>53.8</td>
<td>48.6*</td>
</tr>
<tr>
<td>Bench press</td>
<td>112.7</td>
<td>104.2*</td>
<td>111.3</td>
<td>98.0*</td>
</tr>
<tr>
<td>1-RM (kg)</td>
<td>±11.5</td>
<td>±10.0</td>
<td>±19.2</td>
<td>±10.6</td>
</tr>
<tr>
<td>Leg press</td>
<td>272.1</td>
<td>234.0*</td>
<td>252.2</td>
<td>241.4</td>
</tr>
<tr>
<td>1-RM (kg)</td>
<td>±41.1</td>
<td>±33.0</td>
<td>±16.4</td>
<td>±27.4</td>
</tr>
</tbody>
</table>

*Maximal force exerted during a 1-RM test.

*p ≤ 0.05
Vo2 Max Training Program
Advantages of Exercise Testing:

- Train Scientifically (21st Century)
  - Less pain more gain
- Quantitative values for athletes
- Maintenance of reserve athletes conditioning levels
-Accelerates rehab of injured athlete
Training
Orlando Magic Conditioning
Magic Stress Testing

09.01.07 – Hedo Turkoglu
Levels of Cardiac Screening

Levels 1 - 4
Level 1

- **Resting EKG** (high school / smaller budget universities)
  - Inexpensive:
  - Less Accurate (coronaries, HCM, exercise induced abnormalities)
  - Abnormal electrical readings during rest.
  - Total Time = 3 minutes
Level 2

- **Resting EKG & Echo** – (college / Professional)
  - Addition of Echo allows diagnosis of (HCM, Stenosis, Prolapse, etc.)
  - Total Time = 18 minutes
Stress EKG, Stress Echo, Recovery HR Analysis – (College / Professional)

- Treadmill (Athlete Ramp not Bruce).
  - Higher HR = Increased accuracy of readings
- Exercise Induced Arrhythmias
- Recovery HR Analyzed
- Max HR readings
- BP readings
- Conditioning Levels (METS)
- Recovery HR

- Total Time = 33 minutes
Level 4

- Stress EKG, Stress Echo, Recovery HR Analysis & Gas Analysis
  - Addition of Strength and Conditioning Data
  - HR’s
  - VO2 Max
  - LT
  - Recovery HR
- Total Time = 33 minutes
<table>
<thead>
<tr>
<th>Name</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trevor Ariza</td>
<td>8:00 AM</td>
</tr>
<tr>
<td>JJ Redick</td>
<td>8:45 AM</td>
</tr>
<tr>
<td>James Augustine</td>
<td>9:30 AM</td>
</tr>
<tr>
<td>Marcin Gortat</td>
<td>10:15 AM</td>
</tr>
<tr>
<td>Tony Battie</td>
<td>11:00 AM</td>
</tr>
<tr>
<td>Hedo Turkoglu</td>
<td>11:45 AM</td>
</tr>
<tr>
<td>Pat Garrity</td>
<td>12:30 PM</td>
</tr>
<tr>
<td>Jameer Nelson</td>
<td>1:15 PM</td>
</tr>
<tr>
<td>Dwight Howard</td>
<td>2:00 PM</td>
</tr>
<tr>
<td>Keith Bogans</td>
<td>2:45 PM</td>
</tr>
<tr>
<td>Bo Outlaw</td>
<td>3:30 PM</td>
</tr>
<tr>
<td>Rashard Lewis</td>
<td>4:15 PM</td>
</tr>
<tr>
<td>Adonyle Foyle</td>
<td>5:00 PM</td>
</tr>
<tr>
<td>Carlos Arroyo</td>
<td>5:45 PM</td>
</tr>
<tr>
<td>Keyon Dooling</td>
<td>6:30 PM</td>
</tr>
<tr>
<td>Stan Van Gundy</td>
<td>7:15 PM</td>
</tr>
<tr>
<td>Patrick Ewing</td>
<td>8:00 PM</td>
</tr>
<tr>
<td>Steve Clifford</td>
<td>8:45 PM</td>
</tr>
<tr>
<td>Bob Bayer</td>
<td>9:30 PM</td>
</tr>
</tbody>
</table>
Previous Screening Problems

- Affordable
- Convenience
- Specific for Athlete Population
- Current Cardiologists Politics
Previous Screening Problems Addressed:

- **Cost!!!** – Average Stress Test = $1,000 – $1,500/ player. Magic = $500.00/ player w/ gas analysis, HRR, etc.

- Convenience Factor for Players & Athletes—At Facility – 1 Day of Testing

- Specialized Athlete EKG and Echo Techs

- Advanced Technology and Equipment
  - (Treadmill, EKG, ECHO, Automated BP, Gas Analysis)

- Coaches!!!!

- Your Team’s Cardiologist Still Primary
Questions?

- Looking for Teams interested in continued Research
- Joe Rogowski Orlando Magic
- ( C ) 407-733-6424
- EMAIL: JROGOWSKI@ORLANDOMAGIC.COM