Pre-Participation Screening to Prevent Sudden Cardiac Death in Athletes

David Jones, MD FACC
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• None
OVERVIEW

• DEFINITIONS
• EPIDEMIOLOGY
• SCD in YOUNG ATHLETES
• US and EUROPEAN RECOMMENDATIONS
• CHALLENGES of SCREENING
• NORMAL and ABNORMAL ECG FINDINGS
• FOLLOWUP of ABNORMAL TESTS
• CONCLUSIONS
• **Sudden Cardiac Death**- male (9:1) and minority preponderance, occurs in up to 300 athletes per year
• **Young Athlete**- < 35, usually high school or college
• **Masters Athlete**- > 35 years of age
• **Competitive Athlete**- regular competition placing a premium on achievement, high levels of exertion without the judgment or opportunity to limit their activity
• **Recreational Athlete**- generally participate for health and/or enjoyment purposes

**DEFINITIONS**
RISK BASED ON SPORT
• ATHLETES UNDER THE AGE OF 35
  • Hypertrophic Cardiomyopathy
  • Anomalous Coronary Arteries
  • Arrhythmogenic Right Ventricular Dysplasia
  • Marfan Syndrome and Aortic Diseases
  • Myocarditis
  • Commotio Cordis
  • Inherited Arrhythmias and Ion Channelopathies

• ATHLETES OVER THE AGE OF 35
  • Coronary Artery Disease

EPIDEMIOLOGY
• CAD is the most prevalent cause of SCD
• Marathoners - <1 / 100,000 on race day
• Tri-Athletes - 1.5 / 100,000 on race day
• Recreational Runners - 1 / 10,000 per year

• Individuals with disease are 2-3 x more likely to have an event during exercise

ADULT SCD
SCD IN YOUNG ATHLETES
Causes of Sudden Death

Maron et al. Circulation. 2006;114:1633-1644
HYPERTROPHIC CARDIOMYOPATHY (HCM)

- Most common cause of SCD in athletes
- Occurs in 1/500 in the US population
- LVH usually develops between ages 12-20
- AFib causes most morbidity at age >30
- VT/VF causes death
HYPERTROPHIC CARDIOMYOPATHY (HCM)

- **Treatment**
  - Beta-blockers
  - Implantable Cardiac Defibrillator (ICD)

- Disqualified from competitive participation in all but low effort sports regardless of symptoms, phenotype, or treatment.
• Accounts for 15-20% of SCD
• 50% are symptomatic (CP, SOB, Palps, Syncope)
• Treatment involves Surgery
• May return to sports 6 months after correction
WOLFF-PARKINSON-WHITE (WPW)

- Incidence of 1 in 400
- Often diagnosed in adulthood
- Risk of VF
- Treatment = Ablation
- Re-qualifies for sports after ablation

Delta wave

Shortened PR interval
ARRHYTHMOGENIC RV DYSPLASIA (ARVD)

- Prevalent in Veneto region
- Replacement of the RV muscle with fatty fibrous tissue
- Arrhythmias
  - PVCs (LBBB pattern)
  - nsVT
  - VT/VF
- Can cause RV or BiV CHF
- Diagnosis - ARVC Criteria
- Disqualified from sports

ARRHYTHMOGENIC RV DYSPLASIA (ARVD)
BRUGADA SYNDROME

• Genetic Na+ channelopathy
• Male > Female, average age at diagnosis = 41
• Triggers - fever, nighttime, hyperthermia
• Diagnosis = ECG/EP Lab
• Disqualifies from sports if symptoms or ICD
LONG QT SYNDROME

• 3000-4000 SCD per year
• Inherited/Genetic with Variable Expression
• Acquired Form due to meds/drugs/electrolytes
• Increased risk of SCD with exercise
• Disqualified from sports if ECG +, Gene +, Symptom +
MARFAN’S SYNDROME

• Connective Tissue Disorder
• Genetic (AD) with 25% sporadic incidence
• 1 in 3000-5000
• Diagnosis = dilated aorta + ectopia lentis / gene mutation / score>7
• Echo +/- CTA or MRA
• Disqualified from contact sports
COMMOTIO CORDIS

Source of Blow
- Hockey puck
- Lacrosse ball
- Baseball
- Fist or elbow

Primary determinants and triggers
- Precordial impact site
- Timed during upstroke of T wave

Contributing variables
- Greater hardness of projectile
- Smaller sphere
- Direct orientation
- Thinner, more compliant chest wall

Rapid increase in intracavitary pressure
20-msec window
Upstroke of T wave
VF

Heart wall
Left lung
Rib
Chest wall

[Diagram of heart with arrows and labels]
• ASD/VSD/Patent Ductus Arteriosus
• Congenital Pulmonic Stenosis
• Congenital Aortic Stenosis
• Coarctation
• Tetralogy of Fallot
• Transposition of the Great Arteries
• Ebstein Anomaly

CONGENITAL HEART DISEASE

REFER TO A CONGENITAL HEART DISEASE CLINIC
MYOCARDITIS/DILATED CM
• 5-10% of SCD in young athletes
• Causes - viral, genetic, idiopathic
• Symptoms
  • CP/SOB, MI, CHF, Palps, Fatigue, Syncope
• Diagnosis - clinical picture, CMR, and/or biopsy
• Treatment - meds, time, ICD, transplant
• Disqualifies from sports, ICD = no participation

MYOCARDITIS/DILATED CM
• Most ubiquitous CV risk factor in athletes
• Stage I (> 140/90)
  • Monitor HTN every 2-4 months with BP diary
  • Echo to look for LVH (limit sports until controlled)
• Stage II (> 160/100)
  • Limit high static exertion until BP controlled

HYPERTENSION
U.S. RECOMMENDATIONS
• YOUNGER ATHLETES
  • Pre-Participation Personal History
    • Exertional Chest Pain/Discomfort
    • Unexplained Syncope/Near Syncope (not vasovagal)
    • Unexplained/Excessive Dyspnea on Exertion
    • Prior Murmur
    • Elevated Blood Pressure
    • Prior Restriction or Testing

U.S. RECOMMENDATIONS
• YOUNGER ATHLETES (continued)
  • Pre-Participation Family History
    • Premature Death in One Relative < 50 due to Heart Disease
    • Disability from Heart Disease in a Close Relative < 50
    • Specific Knowledge of Inherited Condition in a Family Member
  • Pre-Participation Physical Exam
    • Heart Murmur
    • Brachial BPs and Femoral Pulses (Coarctation of the Aorta)
    • Physical Stigmata of Marfan Syndrome

• Routine ECG, Stress Testing, Echo, and Other Testing is **NOT** Recommended

U.S. RECOMMENDATIONS
• MASTERS ATHLETES

• Pre-Participation Personal History
  • Exertional CP/Dyspnea
  • Syncope (thought to be arrhythmic)
  • Fatiguability
  • Prior Murmur
  • Elevated Blood Pressure

• Pre-Participation Family History
  • Premature Death in One Relative < 50 due to Heart Disease
  • Disability from Heart Disease in a Close Relative < 50

U.S. RECOMMENDATIONS
• MASTERS ATHLETES (continued)
  • Pre-Participation Physical Exam
    • Murmur, Brachial BP/Femoral Pulses/Stigmata of Marfan’s
  • Electrocardiogram
    • For All Patients > 40 (USPSTF disagrees for low to intermediate patients)
  • Stress Testing
    • For All Patients > 65
    • For Moderate to High Risk Patients
      • Men > 40 or Women > 50 with >1 Risk Factor for CAD

U.S. RECOMMENDATIONS
• YOUNGER ATHLETES
  • Same as US except that ALL younger athletes should have an Electrocardiogram

• MASTER ATHLETES
  • Too Complicated to go over the Risk Score Form

EUROPEAN RECS
U.S. RECOMMENDATIONS

• High School Athletes
  • History and Physical every 2 years
  • History every year

• College Athletes
  • History and Physical every year

• Master Athletes
  • ???
  • Every one to four years based on risk
- Absolute Benefit is SMALL
- Only 3% of Sudden Cardiac Deaths can be prevented by a pre-participation H&P
- Sensitivity/Specificity of Tests
  - History- 20%/94%
  - Physical- 9%/97%
  - ECGs- 94%/95%
- Italian Studies

EFFICACY OF SCREENING
• Large Numbers and Logistical Constraints
  • 4 million high school, 500k college athletes
  • False-negative and false-positive

• Low Prevalence of Disease
  • 0.3% of all athletes
  • $80,000 to detect one abnormality

• Diverse Diseases

• Low Event Rates
  • Uncertainty of whether restricting reduces risk

• Legal Consequences

CHALLENGES OF SCREENING
• Screen ALL High School/College/Masters Athletes
• Perform a Complete Pre-Participation H&P
• ECG Controversy
  • If < 35, it is your choice
  • If > 35, every patient should get an ECG
• No Routine Stress Testing in Patients < 65
• Repeat Screening Every One to Two Years

GENERAL CONSENSUS
• Echo is recommended for all murmurs and patients with suspected congenital heart disease
• Holter monitoring is recommended for patients with palpitations or syncope
• Cardiac MRI is recommended for HCM/ARVD
• First degree relative should be screened if a genetic disorder is found (HCM, Marfan, etc.)
ELECTROCARDIOGRAMS
• Sinus Bradycardia (>30 bpm)/Sinus Arrhythmia
• Ectopic Atrial or Junctional Escape Rhythm
• First Degree AV Block or Mobitz I/Wenkebach
• Incomplete RBBB
• Isolated Voltage/LVH or Early Repolarization
• Convex ST Elevation with TWI V1-V4 in AAs

NORMAL ECG VARIANTS
• P Wave
  • LAE, RAE

• QRS Complex
  • LVH, Q Waves, RBBB/LBBB, RVH

• QT Interval
  • 440ms for Males, 460ms for Females

• ST Segment
  • ST ↓, TWI, Brugada

CRITERIA FOR AN ABNL ECG
• PVCs or Ventricular Arrhythmias
  • > 2 per 10s tracing
  • Couplets, triplets, or non-sustained VT
• SVT/AFib/AFlutter
• Short PR (< 120ms) with/without Delta Wave
• Sinus Bradycardia (HR < 30 bpm)
• Second (Mobitz II) or Third Degree AV Block
• Short QT Interval (< 320ms)

RHYTHM ABNORMALITIES
ALGORITHM

Young Competitive Athletes

Family/Personal History, Physical Exam, +/- ECG

Negative Findings

Eligible for Competition

No Evidence of Cardiovascular Disease

Positive Findings

Further Exams (echo, stress, Holter, CMR, angio, EP study)

Diagnosis of Cardiovascular Disease

Management of Disease
<table>
<thead>
<tr>
<th>Disease Specific Recs</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertrophic cardiomyopathy</td>
<td>Exclusion from most competitive/non-competitive sports, with possible exception of low-intensity sports, regardless of medical treatment, absence of symptoms, or implantation of defibrillator.</td>
</tr>
<tr>
<td>Coronary artery abnormalities</td>
<td>Exclusion from all competitive sports. Participation may be considered 6 months after surgical correction and after exercise stress testing.</td>
</tr>
<tr>
<td>ARVD</td>
<td>Exclusion from all competitive sports.</td>
</tr>
<tr>
<td>Mitral valve prolapse</td>
<td>Exclusion if history of syncope associated with arrhythmia, family history of mitral valve prolapse and sudden death, documented arrhythmia, or moderate to severe mitral regurgitation.</td>
</tr>
<tr>
<td>Ebstein anomaly</td>
<td>Severe disease precludes participation in all sports. After surgical repair, low-intensity sports are permitted if tricuspid regurgitation is absent or mild, heart size is normal, and no arrhythmias are present on Holter monitoring and stress testing.</td>
</tr>
<tr>
<td>Marfan syndrome</td>
<td>Exclusion from contact sports. Patients with aortic regurgitation and marked dilation of aorta are excluded from all competitive sports. Others may participate in low-intensity sports, with biannual echocardiography.</td>
</tr>
<tr>
<td>Long QT syndrome</td>
<td>Exclusion from all competitive sports.</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>Athletes with history of myocarditis in previous 6 months are excluded from all competitive sports.</td>
</tr>
<tr>
<td>Wolff-Parkinson-White syndrome</td>
<td>Patients with normal exercise testing ± electrophysiologic study may be eligible for participation in all sports.</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>Individual risk assessment based upon ejection fraction, exercise tolerance, presence of inducible ischemia or arrhythmias, and presence of hemodynamically significant coronary stenoses on angiography.</td>
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</tbody>
</table>
• SCD in young athletes is uncommon, variety of diagnoses
• SCD in older athletes is generally from CAD
• HCM can be suspected based on ECG, diagnosed by Echo
• Think about Marfan in basketball and volleyball players
• H&Ps are necessary but not sensitive, ECGs are expensive but sensitive and specific
• Recognize ECG patterns- long QT, WPW, HCM vs LVH
• Refer for further evaluation if abnormal test or uncertain
• Make sure AEDs are available at events

CONCLUSIONS
• Maron BJ et al. Sudden death in young competitive athletes. JAMA 1996; 276:199.

REFERENCES