Arrhythmias and sport
Sport and arrhythmias

Rami Fogelman
Schneider Children’s Medical Center
3/2009
Sport used to be simple
Physical activity – Benefits
J.A.M.A – Jul 18, 1896

- General Miles calls for half an hour every day of gymnastic exercises.
- It will make life more interesting, gives muscular development, grace and suppleness, grit, energy and determination to win.
- It will keep men at home in barracks and away from evil resorts.
Physical activity - Benefits

  Observational cohort study- 25341 men
  7080 women

Low fitness is an important precursor of mortality. The protective effect of fitness held for smokers and nonsmokers, those with and without elevated cholesterol or elevated blood pressure, and unhealthy and healthy persons.
Trends in sudden cardiovascular death in young competitive athletes after implementation of a preparticipation screening program.

3.6/100,000 (1979-80) to 0.4/100,000 (2003-04)


Sudden death in young competitive athletes.
Annual rate – 0.6/100,000.

Comparison of the incidence of underlying heart disease in young athletes dying suddenly in the U.S.A and Italy

Etiology of heart disease

USA
Italy
Sudden death in young competitive athletes


- 80% exertional, 20 non exertional.
- 56% definite cardiac cause, 22% blunt trauma, 4% commotio cordis, 8% unresolved cases, 10% miscellaneous.
Sport increases the risk of sudden death in young adults

RR=2.8
p =0.001

That's why I play it safe...

Sport increases the risk of sudden death in young adults

Corrado, JACC 2003
Athletes and arrhythmias
Clinical significance of abnormal ECG pattern in trained athlete

Pelliccia et al., Circ. 102:278-84, 2000

- Compare ECG pattern with cardiac morphology (echo) in the same individual

- 1005 athletes 1993-1995
  - 440 Olympic level, 565 national level
ECG in Athletes
Pelliccia et al

A- Normal or minor alternation:

1. Increased PR interval
2. Mild ↑ in R or S (25-29mm), any lead.
3. Early repolarization-ST ↑ >2mm in 2 leads
4. IRBBB (≤0.12 sec)
5. Sinus bradycardia <60
ECG in Athletes cont’

B – Mildly abnormal – ECG compatible with C.V disease

1. R or S – 30-34 mm in any lead.
2. Q 2-3 mm in >2 leads.
3. Repolarization pattern – flat T, minimally inverted, tall (>15 mm) in 2 leads.
4. Abnormal R wave progression in ant. precordial leads.
ECG in Athletes cont’

5. RBBB
6. RAE (peaked P > 2.5mm in lead 2,3 or v1)
7. LAE (prolonged P in lead 2 or v1)
8. Short PR (< 0.12sec)
ECG in Athletes cont’

  1. Striking R or S (>35mm in any lead)
  2. Q > 4mm in > 2 leads
  3. Repolarization- inverted T>2mm in>2 leads
  4. LBBB
  5. Marked Lt(<-30) or RT (>110) QRS axis deviation
  6. WPW
Results

- Abnormal ECG – 402 (40%): 145 distinctly
  257 mildly

- Normal – 603 (60%): 188 completely
  415 minor alternation

- Echo – Abnormal 53 (5%)
  MVP+Mild MR-19, B.Ao.V-10, ASD-6
  DCM-4, WPW-3

- Of the 53 – 27 had abnormal ECG
  26 had normal ECG (false negative)
Results cont’

- Of 952 without C.V disease
  - 577 – Normal ECG
  - 375 – Mildly or distinctly abnormal (false positive)

- Sensitivity – 51%, Specificity – 61%
- Positive predictive accuracy – 7%
- Negative predictive accuracy – 96%
Distinctly abnormal ECGs

Total study group 1005

145 Distinctly Abnormal

No C.V disease 131

C.V disease 14

Normal cardiac dimension echo 53

cardiac dimension echo 78

LV cavity (>55mm) LV wall (>13mm) 74

LV cavity (55-68mm) LV wall >13mm 3

LV wall (>13mm) 1
Results cont’

- Abnormal ECG
  - Male sex
  - Endurance disciplines
  - Younger athletes (<20y)
Follow-up

- Of 145 with distinctly abnormal ECG, only 1 with DCM (disqualified) developed cardiac symptoms with A.Fib
- Major determinant of altered ECG-
  Morphological cardiac remodeling:
  Increased LV cavity size, wall thickness, Lt atrial dimension.
Arrhythmia and sport
Major References

What is competitive?

- Competitive athlete — one who participates in an organized team or individual sport that requires regular competition against others as a central component, places a high premium on excellence and achievement and requires some form of systematic training.

- For children <12y — individual judgment is needed.

- Excessive and unnecessary restriction could potentially create physical and psychological burdens.
## Classification of Sports

<table>
<thead>
<tr>
<th>I. Low static</th>
<th>A. Low dynamic</th>
<th>B. Moderate dynamic</th>
<th>C. High dynamic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Billiard, Bowling Cricket, Golf Country, Riflery</td>
<td>Baseball, Softball Volleyball, Table tennis, Tennis(2)</td>
<td>Soccer, Squash Tennis(1), Running(long)</td>
</tr>
<tr>
<td>II. Mod. static</td>
<td>Archery, Diving Motorcycling, Archery</td>
<td>Rugby, Surfing Running(sprint) American football</td>
<td>Basketball, Ice hockey, Handball Swimming,</td>
</tr>
<tr>
<td>III. High static</td>
<td>Weight lifting, Windsurfing, Karate/Judo, Gym</td>
<td>Body building, Wrestling Downhill skiing</td>
<td>Boxing, Cycling, Decathlon, Rowing, Kayaking</td>
</tr>
</tbody>
</table>
Bradyarrhythmias

- **Sinus bradycardia** –
  
  No symptoms – no further evaluation
  Symptoms – ECG, 24 Hrs Holter, exercise test
  and if needed – echo

  Athletes with or without heart disease – If H.R
  increase appropriately with exercise – All sports
Bradyarrhythmias — Cont’

- **1st degree AVB + 2nd AVB (Mobitz I)**
  Asymptomatic, no worsening with exercise — All sports

- **2nd AVB (Mobitz II) or C.H.B**
  Asymptomatic, no structural heart disease, resting H.R>40 increasing with exercise, no ventricular arrhythmias during exercise, no or occasional PVC’s — all sports
Bradyarrhythmias — Cont’

- 2nd A.V.B (Mobiz II) or C.H.B
  Symptomatic — Pacemaker

- Patients with pacemakers — No contact sports
**RBBB and LBBB**

- Requires further work-up

- **RBBB** - If isolated (normal heart) — All sports

- **LBBB** — EPS should be considered and if normal HV and AV conduction — all sports.
  
  If abnormal — consider pacemaker.
Syncope

- No sports until cause has been determined and treated, if necessary.

- If clinically attributed to arrhythmias — can resume sports if treated and asymptomatic for 2-3M.
Supraventricular arrhythmias

- **P.A.C**
  - Asymptomatic – No further evaluation
    - All sports
  - Symptomatic – ECG, 24 Hrs Holter,
    - Exercise test, echo
    - Beta-blocker – All sports
S.V.T – A.V.N.R.T

- R.F ablation – 2-4 wks post ablation – All sports

Medical treatment – 2-3M with no SVT – All sports
W.P.W – A.V.R.T

- ECG, 24 Hrs Holter, exercise test, echo
  - Asymptomatic – Controversial
    - most expert – E.P evaluation for A.P properties. If A.P allows conduction to the ventricle > 240 BPM – Ablation
  - Symptomatic – Ablation (2-4wks – all sports)
Table 1: Summary of Selected Differences Between BC#36 and ESC Recommendations for Competitive Athletes With Selected CV Abnormalities

<table>
<thead>
<tr>
<th>Clinical Criteria and Sports Permitted</th>
<th>BC#36</th>
<th>ESC</th>
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<td>Gene carriers without phenotype (HCM, ARVC, DCM, ion channel diseases*)</td>
<td>All sports</td>
<td>Only recreational sports</td>
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<td>LQTS</td>
<td>&gt;0.47 s in male subjects, &gt;0.48 s in female subjects</td>
<td>&gt;0.44 s in male subjects, &gt;0.46 s in female subjects</td>
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<td>Low-intensity competitive sports</td>
<td>Only recreational sports</td>
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<td>Marfan syndrome</td>
<td>If aortic root &lt;40 mm, no MR, no familial SD, then low-moderate intensity competitive sports permitted</td>
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<td></td>
<td>All competitive sports (restriction for sports in dangerous environment)†</td>
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<td>Premature ventricular complexes</td>
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<td>Nonsustained ventricular tachycardia</td>
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*Long-QT syndrome (LQTS), Brugada syndrome, catecholaminergic polymorphic ventricular tachycardia; †sports in dangerous environments are restricted, given the risk should impaired consciousness occur, such as motor sports, rock climbing, and downhill skiing.

ARVC — arrhythmogenic right ventricular cardiomyopathy; BC#36 — Bethesda Conference #36; CV — cardiovascular; DCM — dilated cardiomyopathy; EPS — electrophysiologic study; ESC — European Society of Cardiology; HCM — hypertrophic cardiomyopathy; MR — magnetic resonance; PVC — premature ventricular complex; SD — sudden death; WPW — Wolff-Parkinson-White syndrome.
Prospective F/U 1995-2005 of 184 children after EP study (median age 10y [8-12]).

ECG and Holter every 6M.

133 – no arrhythmia and asymptomatic.

51 – arrhythmias: 19 life treatening !!! (documented sust. AF with SPERR < 250msec)

3 cardiac arrest, 3 syncope, 8 atypical symptoms, 5 minimal symptoms.
Asymptomatic WPW cont’

- Risk factors: APERP < 240msec
  Multiple accessory pathway
  Tachyarrhythmia inducibility (>1min).

- Editorial (Balaji S.)
  More malignant natural history then previously reported.
  The report reinforce the notion that children with asymptomatic WPW should undergo an EP study.
SN reentry, Atrial tachycardia

- If ventricular rate appropriate — all sports.

- Otherwise — ablation.

- 2-4 wks post ablation — all sports.
Inappropriate sinus tachycardia

- No structural heart disease and asymptomatic for 2-3M – all sports.
Atrial Flutter

- (no WPW) — no SHD 1A or no sports if SHD

- 1M post successful ablation — if no recurrence — all sports
  2-3M after conversion to S.R with no recurrence and no SHD — all sports.
A. Fib

- Asymptomatic with no S.H.D, who maintain ventricular rate that increases and slows appropriately (comparable to SR) - all sports.
- Anticoagulants — no body collision.
- 4-6 wks post ablation and no recurrence - all sports.
- S.H.D — according to the specific S.H.D
Ventricular arrhythmias

- **P.V.C’s**
  - ECG, 24 Hrs Holter, exercise test, echo
  - Normal heart, no worsening with exercise – All sports

- **N.S.V.T**
  - Monomorphic – same as P.V.C’s
  - Polymorphic – restriction from sport, Beta-blockers
Ventricular arrhythmias in athletes are common!

Holter monitoring in consecutive athletes

PVCs: 33%
Frequent PVCs: 12%
NSVT: 7%

Sudden death in athletes is rare!
Long term significance of frequent P.V.C’s and complex V.T in trained athlete

- 355 competitive athletes with PVC’s or NSVT (mean age 24.8+- 12.4Y)
- 1 - Frequent and complex P.V.C’s + N.S.V.T
- 2 – Less frequent P.V.C’s, no V.T
- 3 – Rare P.V.C’s, no V.T
# Prevalence of structural C.V.D

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(&gt;2000 and NSVT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>71</td>
<td>153</td>
<td>131</td>
<td></td>
</tr>
<tr>
<td>ARVD</td>
<td>7 (10%)</td>
<td>0</td>
<td>0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MVP</td>
<td>6 (9%)</td>
<td>5 (3%)</td>
<td>0</td>
<td>0.0042</td>
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<tr>
<td>Myocarditis</td>
<td>4 (5.5%)</td>
<td>0</td>
<td>0</td>
<td>0.0003</td>
</tr>
<tr>
<td>DCM</td>
<td>4 (5.5%)</td>
<td>0</td>
<td>0</td>
<td>0.0003</td>
</tr>
<tr>
<td>Total</td>
<td>21 (30%)</td>
<td>5 (3%)</td>
<td>0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Abn. ECG</td>
<td>15 (21%)</td>
<td>5 (3%)</td>
<td>2 (1.5%)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
P.V.C’s and N.S.V.T significance – cont’

- P.V.C with LBBB – less frequency of structural cardiac disease (no athlete in group B and C with LBBB had cardiac disease)
- All 71 of group 1 – disqualified (21 – structural abnormalities)
- EPS – done in 24 - 1 positive (ARVD)
- 1 – died suddenly in competitive field hockey- had ARVD, (refused EPS) disqualified but continue to compete in hockey
Most athlete showed no P.V.C’s or N.S.V.T during exercise testing.

Frequent P.V.C’s and N.S.V.T in the absence of C.V abnormalities do not convey adverse clinical significance, appear to be expression of athlete’s heart syndrome and do not per se justify a disqualification from competitive sports.
Impact of deconditioning on cardiac arrhythmias

Ventricular extrasystoles
PVCs / 24 hours.

Non-sustained VT
NSVT / 24 hours.

Training ▶️ Deconditioning

\[ p < 0.01 \] \[ p < 0.05 \]

Biffi, JACC 2004.
Impact of deconditioning on cardiac arrhythmias

Ventricular extrasystoles
PVCs / 24 hours.

<table>
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<th>Training</th>
<th>Deconditioning</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,000</td>
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<tr>
<td>15,000</td>
<td></td>
<td></td>
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<tr>
<td>20,000</td>
<td></td>
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<tr>
<td>25,000</td>
<td></td>
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</tbody>
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\[ p < 0.01 \]

Vive le’ deconditioning

Biffi, JACC 2004.
V.T

- **Idiopathic RVOT VT or LV VT**
  Ablation (3M post ablation with normal exercise test and no symptoms – all sports)
  Medical treatment

- Those with SHD – 1A
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<th>ECG</th>
<th>VT</th>
<th>Treatment</th>
<th>Sport</th>
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<tr>
<td>H.C.M</td>
<td>LVH</td>
<td>PMVT/VF</td>
<td>BB, AAD, ICD myomectomy</td>
<td>1A</td>
</tr>
<tr>
<td>A.R.V.D</td>
<td>↓T</td>
<td>LBBB</td>
<td>AAD, ICD</td>
<td>1A</td>
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<td>Epsilon w.</td>
<td>Inf axis</td>
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<tr>
<td>D.C.M</td>
<td>LBBB</td>
<td>RBBB</td>
<td>Amiodarone ICD</td>
<td>1A</td>
</tr>
<tr>
<td></td>
<td>T changes</td>
<td>LBBB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LQTS</td>
<td>Long QT</td>
<td>TDP</td>
<td>BB, PPM, ICD</td>
<td>1A</td>
</tr>
<tr>
<td>Brugada</td>
<td>RBBB</td>
<td>VF</td>
<td>ICD</td>
<td>1A</td>
</tr>
<tr>
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<td>ST↑ V1-3</td>
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Brugada type ECG

- RBBB
- “coved” type ST elevation > 0.2mv in v1 to v3 (+/- sodium channel blockers)
- “saddle” type ST elevation > 0.2mv in v2 or v3
Type I- Diagnostic

V1-V3 (at least two leads) ST segment elevation >2mm, “coved” shape, inverted T-wave.

- Coupled with
  - Documented VFib
  - Polymorphic VT
  - FH of sudden cardiac death <45 yo
  - Type I EKG in family members
  - VT inducible in EP lab
  - Syncope
  - Nocturnal agonal respiration
Types II and III- Suggestive

II: V1-V3 ST segment elevation >2mm, “saddleback” shape, pos or biphasic T.

III: <1 mm elevation, either coved or saddleback.
Brugada Syndrome in children

- Probst et al — Circ. 2007; 115:2042-2048
  30 children (<16y) from 13 referral centers in 3 European countries during 15y. (<3 for each center).
  90% males, 60% asymptomatic (found during family screening).

- Type 1 Brugada ECG is rare in children.
  0.02% - 4/21,944 children (Hioki OE et al- PACE 2005; 28:6 549-554. All had no episodes of arrhythmia or sudden death during 7-10y F/U.)
Automatic external defibrillator (A.E.D)

- Small size, low maintenance, inexpensive

- Few Hrs of training required for nonmedical or medical responders

- Greater potential for higher efficacy rate of resuscitation
Automatic external defibrillator (A.E.D)

- Cecchin et al, Circ:103, 2483, 2001
  “A.E.D has excellent rhythm analysis sensitivity (96%) and specificity (100%) in all age groups for VF and nonshockable rhythm”

- A.E.D should be available at athletic events
Wrong way to resuscitate
 спортאי עד גיל 17 יש פוטור במבדיקה ארגומטרית לפני
השתתפות במקהל ארצית או אזורית.

בדיקה גופנית כלליתFORMATION לספורטאי – עד גיל 34 מذي
שנתים.-pagination 35 מذي שנה.

ארגומטריה – בסנה בה הגיעה ל-17, 23, 27, 32, 34
ומגיע 35 שנה.

 sucker -- 19881988

-- 19961996:

。

נקודות הספורט (בדיקות רפואיות) - 1996:

תרחיב את שטח הפעילות במאמץ גופני
שהינה בתחרותית, אלא אם כן מדויק
בבגרותית ובגרות ארוצית ואזורית.

---

.Invoke liegt bei Raumtemperatur.

Invoke liegt bei Raumtemperatur.

Invoke liegt bei Raumtemperatur.

Invoke liegt bei Raumtemperatur.
מה בינ מאמץ תחרותי ל매ם לא תחרותי

- מעבר להמלצות הארגונים שונים. ומעבר
- לסופרים תחרותי על הגדרותיו של הווה, איך והיך
- שמים את קי ההגבלת
- למלש ידה עם
- MOD AS
Ritalin & Friends

- Incidence of ADHD – 5-8%
- Increase the amount of Dopamin and Norepinepherin at the synapse.
- Mode of action – unclear.
- Heart rate increase by 10%, B.P by 10mmHg.
What raise the Balagan

- Out of millions of children received Riatlin or Concerta, there were very few cases of sudden death, most of those were on children with HCM, Channelopathy.

- AHA – Recommended, beside history and P.E an ECG to be done for every child before initiating the drug and be read by an expert ECG reader.
The committee admit that there is no research base for this decision and that it is not clear that the mortality rate is different from the general population.
A.A.P Response

- The AHA recommendation is not evidence based.
- The mortality is not different from the general population.
- ECG is not recommended as a routine test.
- History: cardiac problems, palpitation, syncope, seizures, family history
- Physical examination.
Ritalin in children with no cardiac disease

- No limitation
Children with cardiac disease

- In cases where 10% increase in BP and pulse could be significant:
- Severe obstructive lesions - AS, HOCM, PS, Coarc.
- Channelopathies - LQTS, CAPMVT, Brugada.
Summery

- Ritalin is not risky for children without cardiac problems.
- History and P/E are enough before initiation.
- When cardiac problem is suspected — further evaluation is needed.
- Ritalin shouldn’t be given to children with- obstructive cardiac disease or channelopathies