THE ATHLETE'S HEART:
Sudden Cardiac Death in the Athlete

VISIONS Symposium
March 6, 2014

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Objectives

- Recognize the prevalence and most common causes of sudden death in athletes
- Understand the process of current athletic pre-participation screening guidelines and controversy.
- Discuss findings of ongoing pre-participation screening programs.

Sudden Cardiac Death

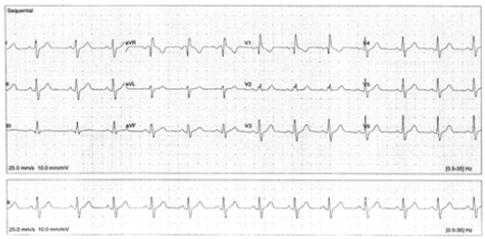
Catastrophic Death
prompts a controversial debate on appropriate pre-participation screening and emergency preparedness

Case presentation

- 15 yo female high school athlete referred for cardiac murmur on pre-participation screening.
- 2/6 systolic murmur at LUSB
- ECG: SR, IRBBB, and right axis deviation.

[redacted]

ECG



Case presentation

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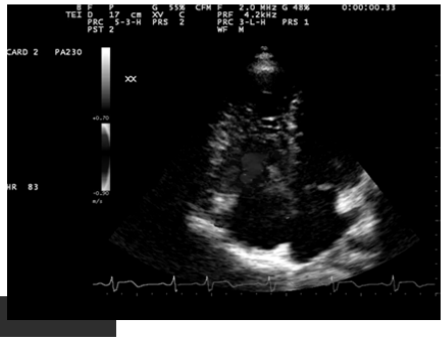
Case presentation



THE WALL STREET JOURNAL.

THURSDAY, JUNE 23, 2005

Sudden Death

Doctors Miss Signs Of Heart Defects In Young Athletes

Problem Is Both Treatable And Detectable by EKG, But Scans Don't Get Done

Two Siblings Die, Weeks Apart

By Kevin Helliker And Kathryn Kranhold

Early this month, Kenny Sirois was jogging beside his identical twin in their hometown of Madawaska, Maine. As the 16-year-olds turned onto their own street, they started sprinting toward home. Kenny never made it.

As emergency-room doctor told Vincent and Wendy Sirois their son had died of a hidden heart defect that couldn't have been detected, the parents say. But two days later, they add, a nurse from the emergency room called and said her conscience required her to tell them Kenny's death probably could have been prevented. She implored them to get their surviving twin tested.

The nurse was right: The cardiac defect that killed the boy, known as hypertrophic cardiomyopathy, is detectable and treatable. And it runs in families. If Kenny's twin has it, as initial tests suggest he might, then a battery of treatments can offer him a nearly normal life span.

HCM, as it's called for short, is a genetic abnormality that enlarges the left ventricle, leading to sometimes-fatal disturbances of the heart rhythm. Young athletes suffer sudden cardiac death at a rate thought to be two to three times as high as their less-active peers. The Siroises say no doctor had suggested that their sons, year-round competitors, undergo a heart scan. "Kenny could still be alive" if they had, says Mrs. Sirois.

Ryan Bisiet

American medicine is respected around the world for its all-out war on heart disease, with advanced drugs and procedures plus campaigns that teach the public what to watch for. But in one area of heart disease—hidden congenital defects that suddenly kill young athletes—U.S. medicine does relatively little to detect problems or raise awareness, including less than some foreign countries.

In Japan, for instance, doctors routinely give schoolchildren electrocardiograms, or EKGs, which can detect congenital heart defects that a stethoscope cannot. Italy gives EKGs to all youths who want to participate in competitive sports. The International Olympic Committee recently recommended that young athletes have EKGs every two years, and in a March statement in the European Heart Journal, about 25 European physicians endorsed a similar proposal. Physicians in Japan and Italy say their programs save lives. A screening of 30,715 young athletes in the Veneto region of Italy from 1979 to 1996 disqualified from sports 22 who turned out to have HCM; all are believed to be still alive.

In American medicine, it's generally accepted that universal screening of young adults for heart abnormalities wouldn't be a good idea. Far too many healthy athletes would need to be screened to find a single defective heart, cardiologists say.

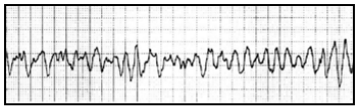
U.S. cardiologists, instead of widespread screening, favor efforts to raise awareness about the symptoms and risk factors, leading to testing of those at risk. They favor a focus on kids who have cardiac murmurs, fainting spells, chest pain or shortness of breath, plus any who have had sudden cardiac death in their families. "If you screen the ones with symptoms and warning signs, you'll have lower costs and a much higher yield," says Robert Campbell, chief medical officer of Sibley Heart Center of Children's Healthcare of Atlanta.

The problem is that their plan for focused screening emerged nine years ago, after a medical conference, and there is

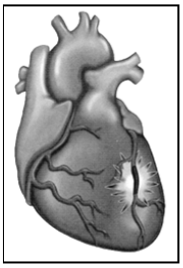
Please Turn to Page A6, Column 3

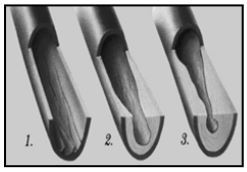
Sudden Cardiac Arrest

- VF is the most frequent initial rhythm in sudden cardiac arrest
- VF is a useless quivering of the heart that results in no blood flow
- Defibrillation is the only effective treatment for VF



Heart Attack





1. Vessel lining splits
2. Fat deposits collecting
3. Artery narrows

SUDDEN DEATH IN ATHLETES AGE GREATER THAN THIRTY

- Atherosclerotic coronary disease-97%
- Hypertrophic cardiomyopathy
- Congenital coronary anomalies
- Primary ventricular rhythm disturbances

[redacted]

SUDDEN DEATH IN ATHLETES AGE GREATER THAN THIRTY

- Most have significant risk factors for coronary artery disease: (+)family history; hyperlipidemia; hypertension; smoking history

[redacted]

Padres reliever has angioplasty

38-year-old Brocail had 99-percent blockage of artery

San Diego Padres reliever Doug Brocail underwent angioplasty yesterday morning at Peoria, Ariz.

The 38-year-old Brocail, who last pitched Wednesday, had complained of chest tightness that radiated into both arms. He already was being treated for an abscessed tooth and asthma.

Dr. Harry Albers ordered a stress test, which came back abnormal.

"We found a large abnormality on the front wall of the heart, a blockage," Albers said. "He wasn't getting significant blood to the heart under stress."

Brocail

Brocail was admitted to Boswell Memorial Hospital in nearby Sun City. Doctors found a 99-percent blockage of the left anterior descending artery, one of three coronary arteries that supply blood to the heart.

After the angioplasty, in which a balloon is inserted to open the artery, a stent was inserted to assure the artery remains open.

Brocail is expected to remain in the hospital for three or four days and could resume exercising in two weeks.

"Doug pitching again isn't our main concern," Padres general manager Kevin Towers said. "The biggest thing here is that the medical staff saved Doug's life. The key thing is that we caught this early or we could have been dealing with a disaster.

"If he pitches again, it will be a bonus."

Brocail and his wife, Lisa, have five daughters, ranging in age from 5 to 16.

Brocail pitched in 61 games for the Texas Rangers last season and was signed as a free agent by the Padres on Dec. 15.

Associated Press

The Honolulu Advertiser, Sunday, March 12, 2006

CARDIAC EVALUATION AGE GREATER THAN THIRTY

Considerations

- Assess risk profile
- Imaging stress test for those with symptoms or abnormal ECG
- Coronary calcium scoring
- Provide platform for risk factor modification or treatment
- Other testing (ECHO, etc.) based on clinical indications

SCD in the Athlete < 30 years Population at Risk

- 10 million high school athletes in the United States
- 500,000 college athletes
- 5,000 professional athletes
- Rate has previously been estimated to be 1/200,000 athletes per year

Sudden Cardiac Death

- Sudden cardiac arrest (SCA) in athletes occurs most predominantly between 15-25 years of age
- 60-80% of athletes have no symptoms prior to their SCA
- 90% of SCA occurs during training or competition

Prevalence
Young Athletes

- Exact numbers unknown – no national database
- 5X more common in males than females
- Estimated that up to 300 high school athletes die at an organized sporting event each year from SCA

Incidence of SCD in NCAA athletes

- Prior estimates 1:23,000- 1:300,000
- 2004-2008 2 million athlete participation-years
- SCD incidence- 1:43,770
- 2x more common in males (33,134) vs. females (76,646)
- Black > white: 1:17,696 vs 1:58,653
- Highest in Div 1 black male basketball 1:3,126 vs white 1:12,810.
- Basketball >swimming>lacrosse >football>CC

Asif IM et al Circulation 2011,123:1594-1600

Causes of Sudden Death in 387 Young Athletes

Cause	No. of Athletes	Percent
Hypertrophic cardiomyopathy	102	26.4
Commotio cordis	77	19.9
Coronary artery abnormalities	53	13.7
LVH of indeterminate causation	29	7.5
Myocarditis	20	5.2
Ruptured AA (Marfan syndrome)	12	3.1
Arrhythmogenic RV cardiomyopathy	11	2.8
Tunneled (bridged) coronary artery	11	2.8
Aortic valve stenosis	10	2.6
Artherosclerotic CAD	10	2.6
Dilated cardiomyopathy	9	2.3
Myxomatous mitral valve degeneration	9	2.3
Asthma (or other pulmonary condition)	8	2.1
Heat stroke	6	1.6
Drug abuse	4	1.0
Other cardiovascular cause	4	1.0
Long QT syndrome	3	0.8
Cardiac sarcoidosis	3	0.8
Trauma causing structural cardiac injury	3	0.8
Ruptured cerebral artery	3	0.8

BJ Maron, et al. JACC 2005;45:1318-21

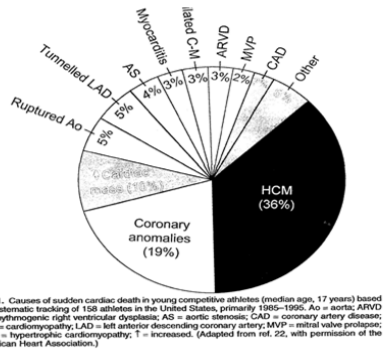
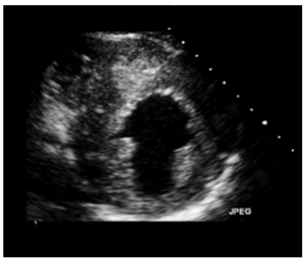


FIG. 1. Causes of sudden cardiac death in young competitive athletes (median age, 17 years) based on systematic tracking of 158 athletes in the United States, primarily 1985–1995. Ao = aorta; ARVD = arrhythmogenic right ventricular dysplasia; AS = aortic stenosis; CAD = coronary artery disease; C-M = cardiomyopathy; LAD = left anterior descending coronary artery; MVP = mitral valve prolapse; HCM = hypertrophic cardiomyopathy; ↑ = increased. (Adapted from ref. 22, with permission of the American Heart Association.)

Hypertrophic Cardiomyopathy

- Most common cause of SCD in youth
- Familial disorder of increased wall thickness with normal LV size (family history)
- Most have premonitory symptoms
- Most (75%) non-obstructive "no murmur"
- ECG abnormal in 95%
- Echo for diagnosis vs. "Athlete's heart"
- Recommendations: no competitive sports

Hypertrophic Cardiomyopathy



Hypertrophic Cardiomyopathy

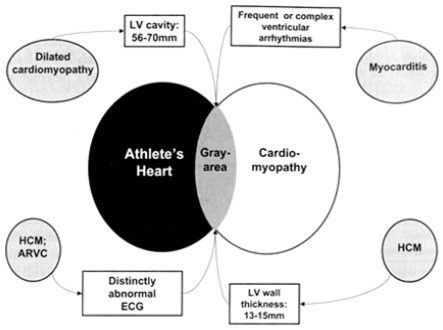
Causes of Sudden Cardiac Death in Young Athletes Less common

- Coronary artery anomalies
- Myocarditis
- Wolf-Parkinson-White Syndrome
- Long QT Syndrome
- Dilated cardiomyopathy
- Marfan's Syndrome
- Drugs
- Other (sickle cell trait, wt. loss/fluid-electrolyte imbalances – bulimia)

Athlete's Heart

- Structural changes related to intensity of training
- Physiologic, not pathologic
- Not related to sudden cardiac death
- No long term associated risk
- Regresses with stopping training

Gray Areas of Overlap Between Athlete's Heart and Cardiomyopathy



BJ Maron, et al. JACC 2005;45:1322-6

Pre-participation Screening Controversy

- Sudden death in a young athlete is a rare but tragic event
- Most die from previously unsuspected heart disease…
- That more comprehensive screening would likely have identified (ECG and Echocardiogram)
- So why not screen everyone?

Pre-participation challenge: Can we prevent SCD?

- How do you do it? Logistics
- Can it be accomplished? Qualified personnel
- Is it truly effective? False positives/negatives
- Cost concerns
- Prospective Data

AHA Consensus Panel Recommendations for Preparticipation Athletic Screening

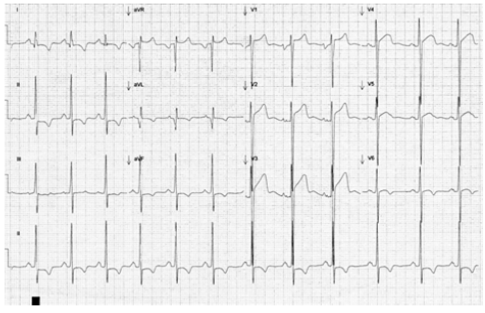
Family History
- Premature sudden cardiac death
- Heart disease in surviving relatives < 50 years old

Personal History
- Heart murmur
- Systemic HTN
- Fatigue
- Syncope/near-syncope
- Excessive/unexplained exertional dyspnea
- Exertional chest pain

Physical Examination
- Heart murmur (supine/standing*)
- Femoral arterial pulses (to exclude coarctation of aorta)
- Stigmata of Marfan syndrome
- Brachial blood pressure measurement (sitting)

BJ Maron, et al. JACC 2005;45:1322-6
BJ Maron et al. Circ 2007;115:1643-1655

ECG



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Relation of Race to Electrocardiographic Patterns in Elite American Football Players

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Objectives The purpose of this study was to establish an electrocardiographic (ECG) profile in a biracial population of highly-trained American football players.

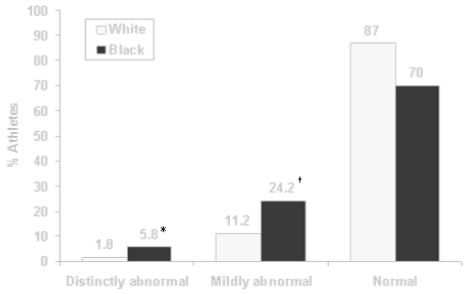
Background Intense physical training can induce cardiac structural and functional changes ("athlete's heart"), including 12-lead ECG alterations. That race might play a role in determining ECG patterns has been suggested, although not studied in a large athletic population comparing black and white athletes.

Methods Electrocardiographic analysis of 1,959 elite male athletes attending the National Football League Invitational Camp from 2000 to 2005 was performed. Subjects were classified by race and player position and judged free of structural heart disease.

Results Abnormal ECG patterns were present in 480 (25%) athletes and were significantly more common among black players (n = 396; 30%) compared with white players (n = 78; 13%) or other races (n = 6; 15%) ($p < 0.0001$). Distinctly abnormal ECG patterns, suggestive of cardiac disease, were also more common in blacks (n = 76; 6%) than whites (n = 11; 2%) ($p = 0.0005$). In multivariable analysis, black race was an independent predictor of abnormal ECGs (risk ratio [RR] 2.03, 95% confidence interval [CI] 1.56 to 2.64, $p < 0.0001$), including patterns judged distinctly abnormal (RR 2.59, 95% CI 1.18 to 5.67, $p = 0.02$). Abnormal ECGs were also related to player position: most frequent in wide receivers (n = 91; 35%) and least common in quarterbacks (n = 16; 14%) and place kickers (n = 8; 11%). Echocardiograms, obtained in 203 athletes (10%), did not show structural cardiac abnormalities.

Conclusions Electrocardiographic abnormalities were 2-fold more common in black than in white highly-trained male American football players, with race an independent determinant of ECG pattern. These findings have important implications for pre-participation cardiovascular screening of athletes with ECGs. (J Am Coll Cardiol 2008;51: 2250–5) © 2008 by the American College of Cardiology Foundation

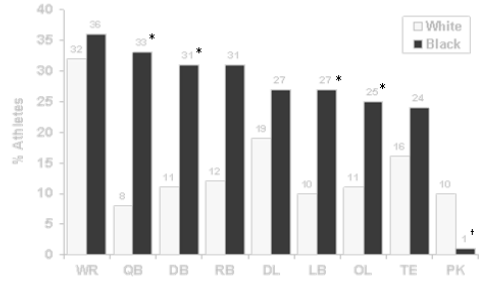
Relation of Abnormal and Normal ECG Pattern to Race in 1,959 Professional Football Players



*p<0.0001, †p=0.0005 for comparisons by race.

A. Magalski et al. *J Am Coll Cardiol* 2008;51:2250-5

Abnormal ECG with Respect to Race and Player Position



*p<0.05 for comparisons by race; †only 1 black athlete at this position (ECG was abnormal).
DB=defensive back; DL=defensive lineman; LB=linebacker; OL=offensive lineman; PK=place kicker; QB=quarterback; RB=running back; TE=tight end; WR=wide receiver.

A. Magalski et al. *J Am Coll Cardiol* 2008;51:2250-5

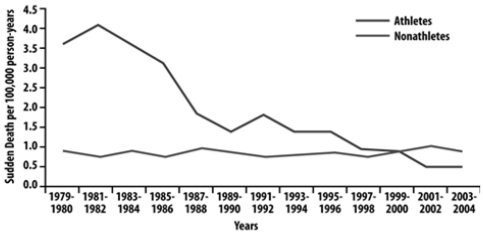
Italian Experience

- Required by law since 1980's
- From grade school to pro every competitive athlete must undergo a government subsidized screening ECG
- Sudden death rate fell 89%
- 2% disqualified
- 50% cardiovascular abnormality
- ARVD most common

[redacted]

Annual Incidence Rates of Sudden Cardiac Death Among Screened Competitive Athletes and Unscreened Nonathletes

Veneto Region of Italy 1979-2004



Corrado et al. JACC 2006;52:1981-9

Screening with ECG and Echo: Athlete-specific criteria

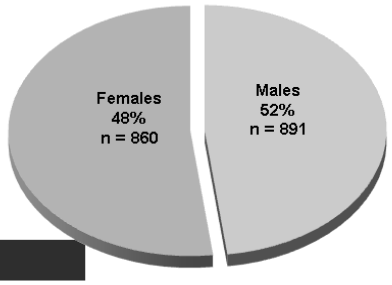
- 1751 consecutive collegiate varsity athletes at The University of Kansas from 2004-present. (48% female)
- History, Physical, ECG, and Echo in all.
- 16 (0.9%) significant findings- 10 WPW
- 3 (0.2%) excluded: 1 Long QT, 1 HCM, 1 Dilated aorta.
- 1 Dilated aorta and 2 Atrial septal defects played

[redacted]

Objective

To determine the incremental value of electrocardiography (ECG) and echocardiography added to a screening program consisting of history and physical examination in college athletes

AHC
Heart Screening Results
August 2004 – January 2014
Total: 1751



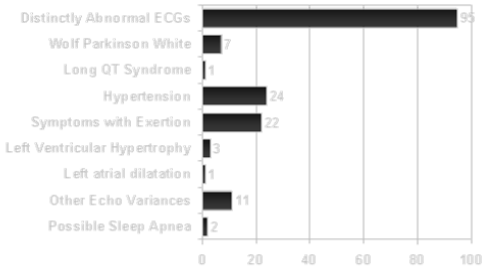
Baseline Characteristics

- Family history SCD: 1.8%
- Cardiac symptoms: 23%
- Hypertension: 2.7%
- Murmur: 2.8%

Findings

Athletic Heart Clinic Screening Results**
(964 screened, ages 18 - 21)

jm1



** Results from screening performed on University of Kansas athletes 2004 – 2009

Distinctly Abnormal Electrocardiograms[1]

	Pellicia Criteria[2]	Uberoi Criteria[3]
Abnormal (n)	136	67
Abnormal (%)	10%	4.9%
Sensitivity	91.7	91.7
Specificity	90.8	95.8
Positive predictive value	8.1	16.4
Negative predictive value	99.9	99.9

[redacted]

1. Magalski A et al *Am J Med* 2012 May125(5):e13
2. Pellicda A et al *Circulation* 2000:102(3):278-284
3. Uberoi A et al *Circulation* 2011:124(6):746-757

MAHI Athletic Heart Clinic (2004-present)

- 1751 collegiate athletes
- 734 community/highschool
- 26 professional
- 3000+ potential NFL draft choices

[redacted]

Slide 40

jm1 Can't remember how we got the following:
Sx
LVH
LAH
Other echo
apnea
a52486, 12/14/2010

Cost-Effectiveness

- Addition of ECG to pre-participation screening saves 2.06 life-years per 1000 athletes: $42,900- 68,800 per life year saved.
- ECG alone: $37,700
- Cost: $600-900,000 per life saved
- Additional general health benefits

Wheeler et al *Ann Intern Med* 2010; 152: 276-286
Schoenbaum et al *Pediatrics* 2012;130:e380-e389

Athlete's Heart Summary

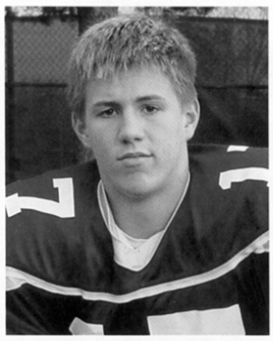
- Sudden Cardiac Death is uncommon but devastating.
- Pursue thorough pre-participation screening- the extent of which continues to evolve.
- More comprehensive evaluation is feasible, cost-effective, and beneficial.

Acceptance of Program

- Would life-threatening conditions be identified?
- Would "normal variants" lead to excessive delay, stress, and cost?
- Would it be cost-effective?

Program Acceptance

- 16 potentially life-threatening conditions- 13 were treated and returned to competition.
- Multiple other important findings
- Cost justified
- "athletes and their families have great appreciation that we are doing as much as we can to protect their health"



Thanks to a health screening that caught an undetected, potentially fatal heart condition, 19-year-old Alex Hanson gets a kick playing KU football.

Calm Waters Now that her heart abnormality has been fixed, Kelly Stromberg looks forward to smooth sailing ahead.

Athletic Heart Program

- Marcia McCoy
- Linda Bunten
- Melissa Seiter
- LeAnn Leavene
- Tracy Binkley
- Darby Riley
- Aaron Siebert
- Tina Coggins
- Andrea Fargo
- Kimberly Reid/CV Research
- Mike Zabel
- Tracy Stevens
- Brian Ramza
- Mike Main
- Bethany Austin
- Jason Hatch
- Seshu Rao
- Echo department
- EP department
- CV lab

Saint Luke's MID AMERICA HEART INSTITUTE

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