Cardiac Risk in the Young

St George's University of London

Sudden Cardiac Death Prevention in the Athlete

Dr. Tracey Keteepe-Arachi

St. George's University Hospital

twitter

@DrTraceyKA

No disclosures

Objectives

- To discuss the background and causes of sudden cardiac death (SCD) in athletes
- To discuss preventative strategies to reduce the risk of SCD in sport
- To discuss alternative strategies and secondary prevention

Sudden Cardiac Death in Young Athletes

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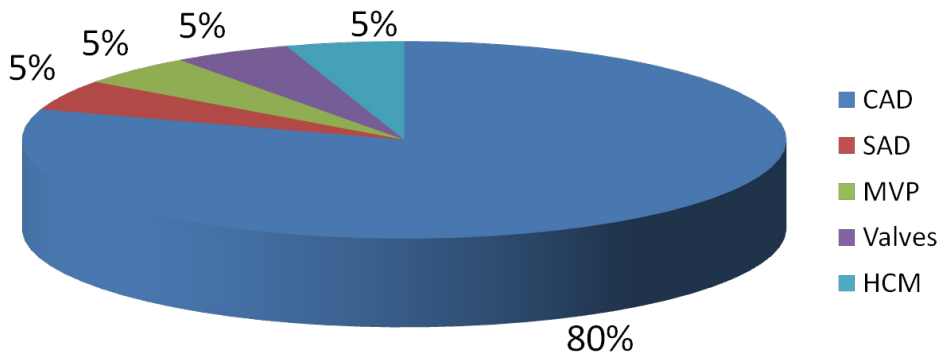
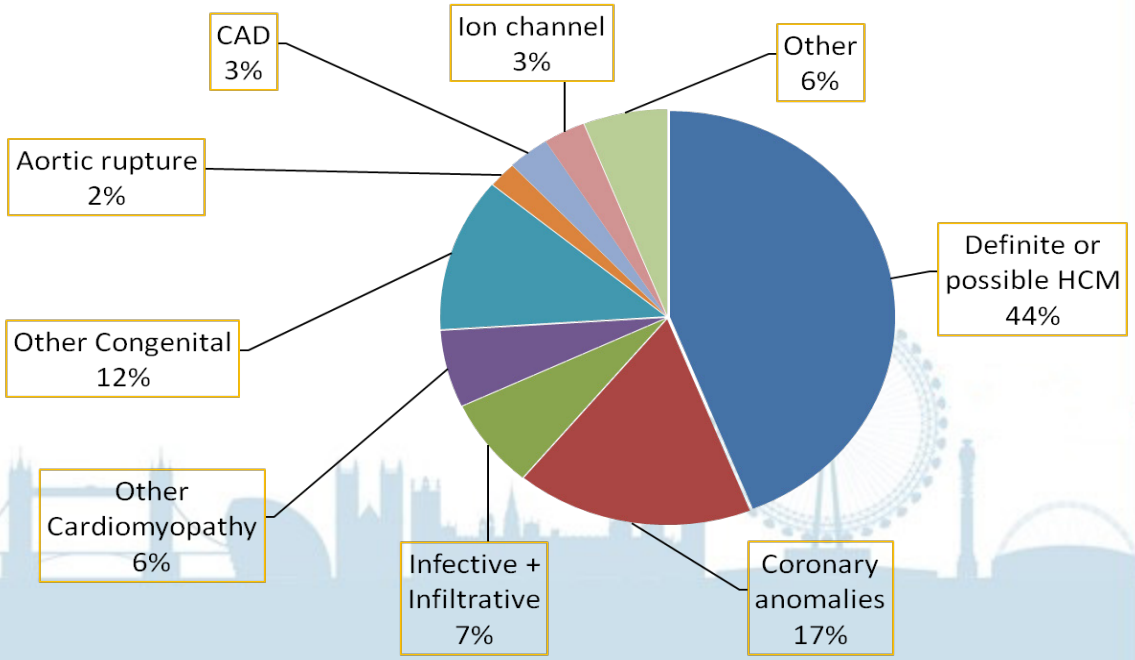
- Incidence is approximately 1/50,000
- Mean age at death in athletes 23 years-old
- 40% deaths in athletes aged < 18 years old
- More common in males than females (9:1)
- 90% deaths during or immediately after exertion

Age of the athlete





n=1435
Maron B et al. Circulation 2007;115:1643-1655

Sudden Cardiac Death in Sport

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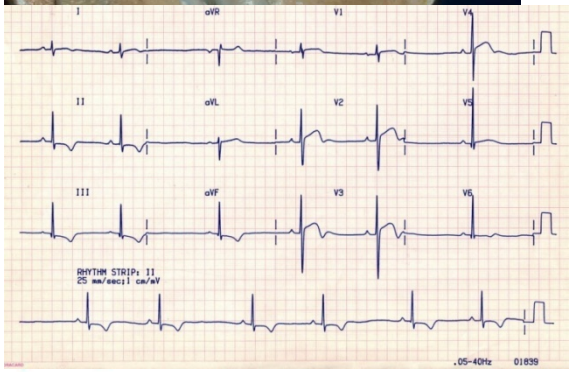
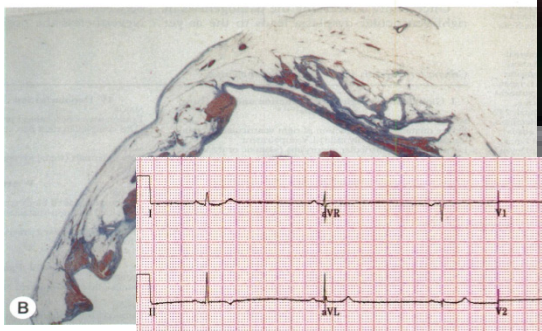
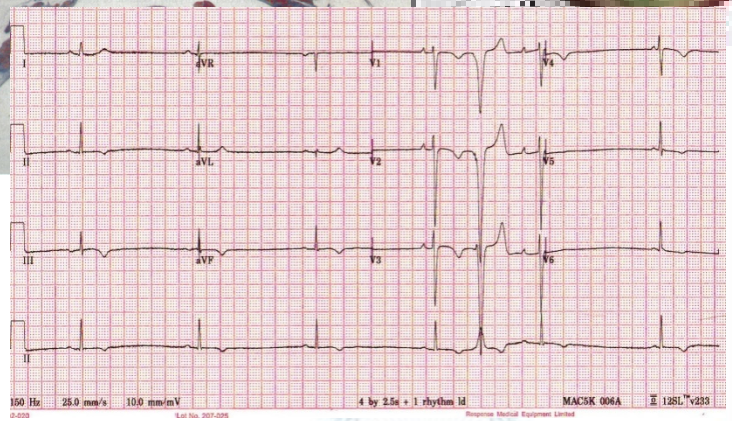


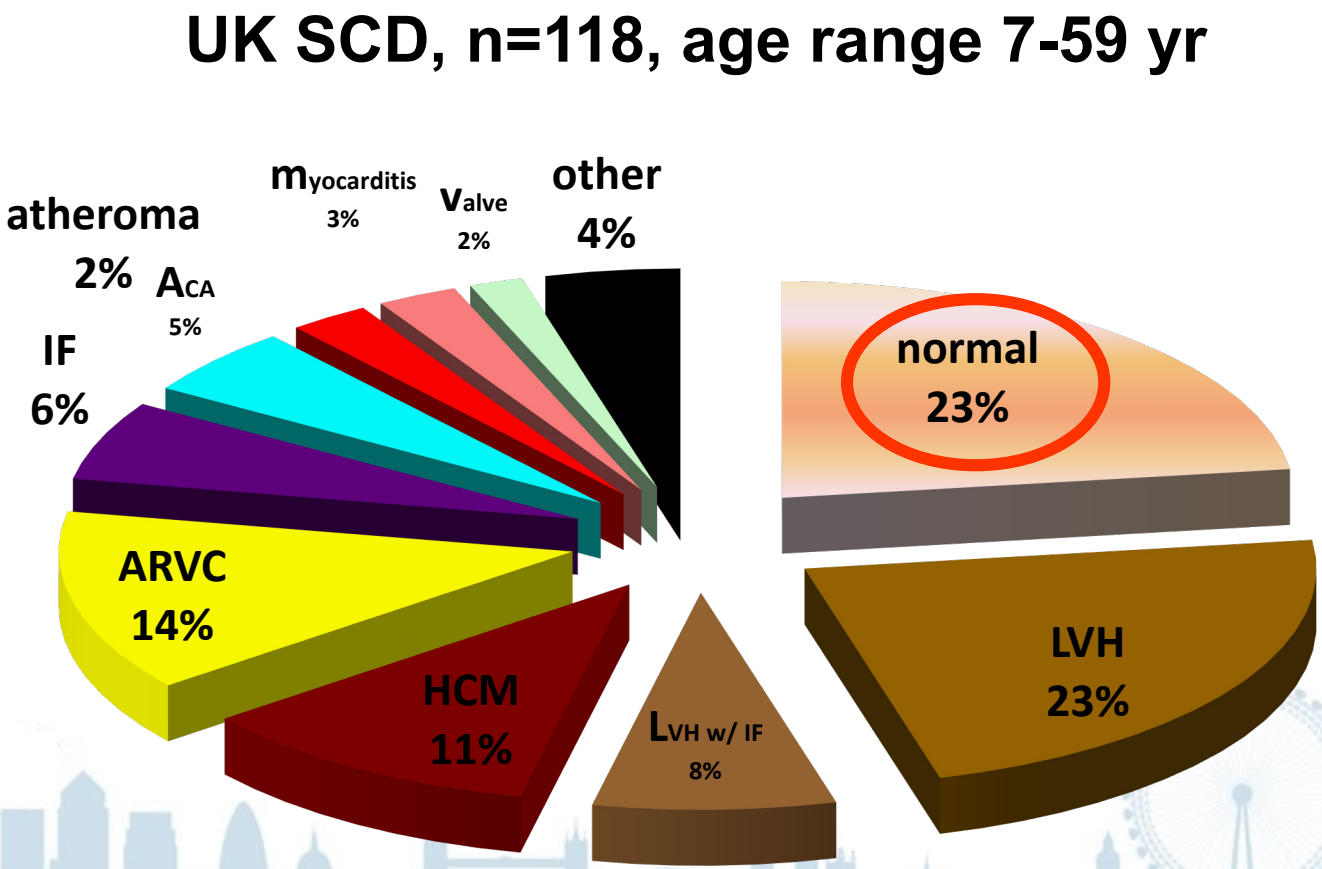




Hypertrophic Cardiomyopathy

Arrhythmogenic right ventricular cardiomyopathy

Sudden Death in Athletes: The British Experience



Sudden Cardiac Death with a Normal Heart

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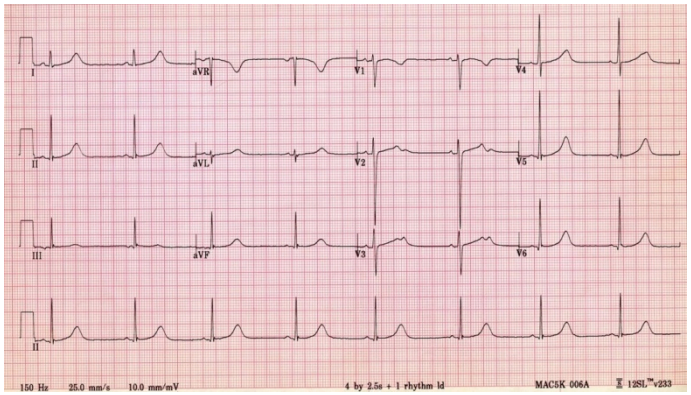
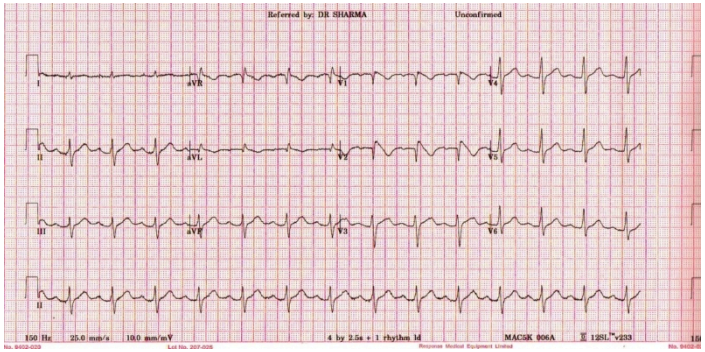
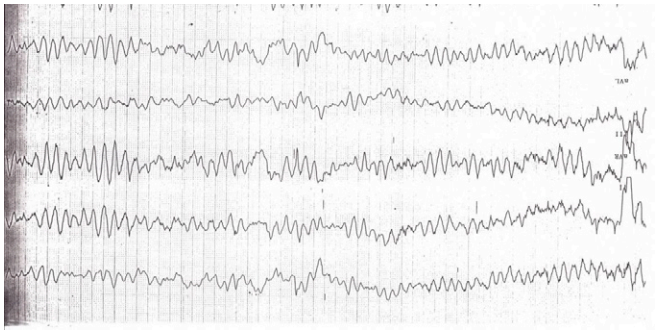
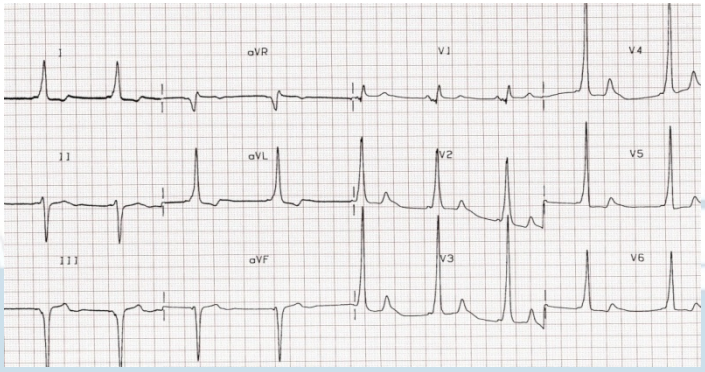


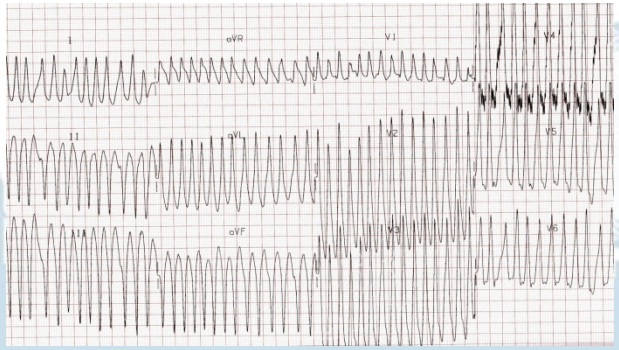
LQTS





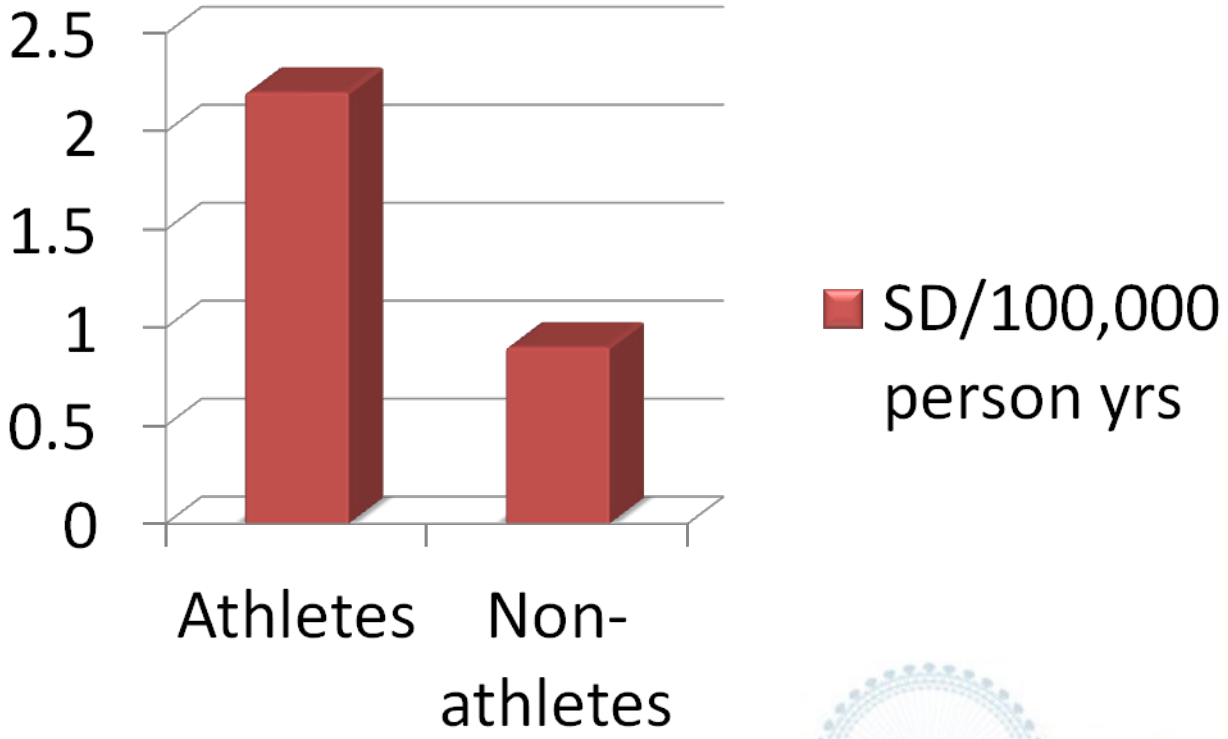
Brugada





WPW

Relative Risk of SCD



Corrado D JACC 2003

Triggers for Sudden Cardiac Death

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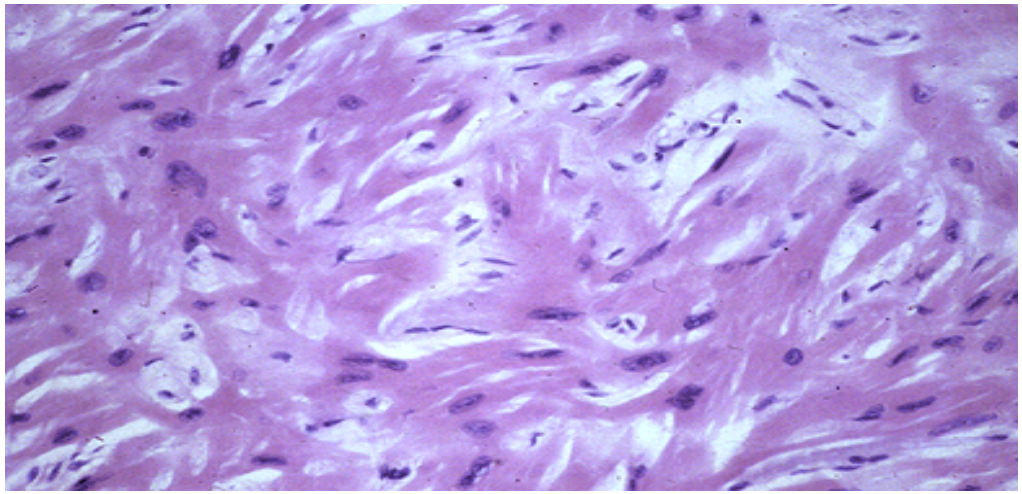
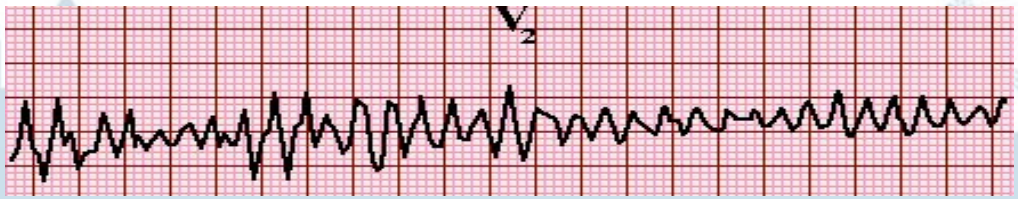
Dehydration

Adrenergic surges



Electrolyte imbalance

Acid/base disturbance



Screening: The Argument

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American Heart Association

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Medical history*

Personal history

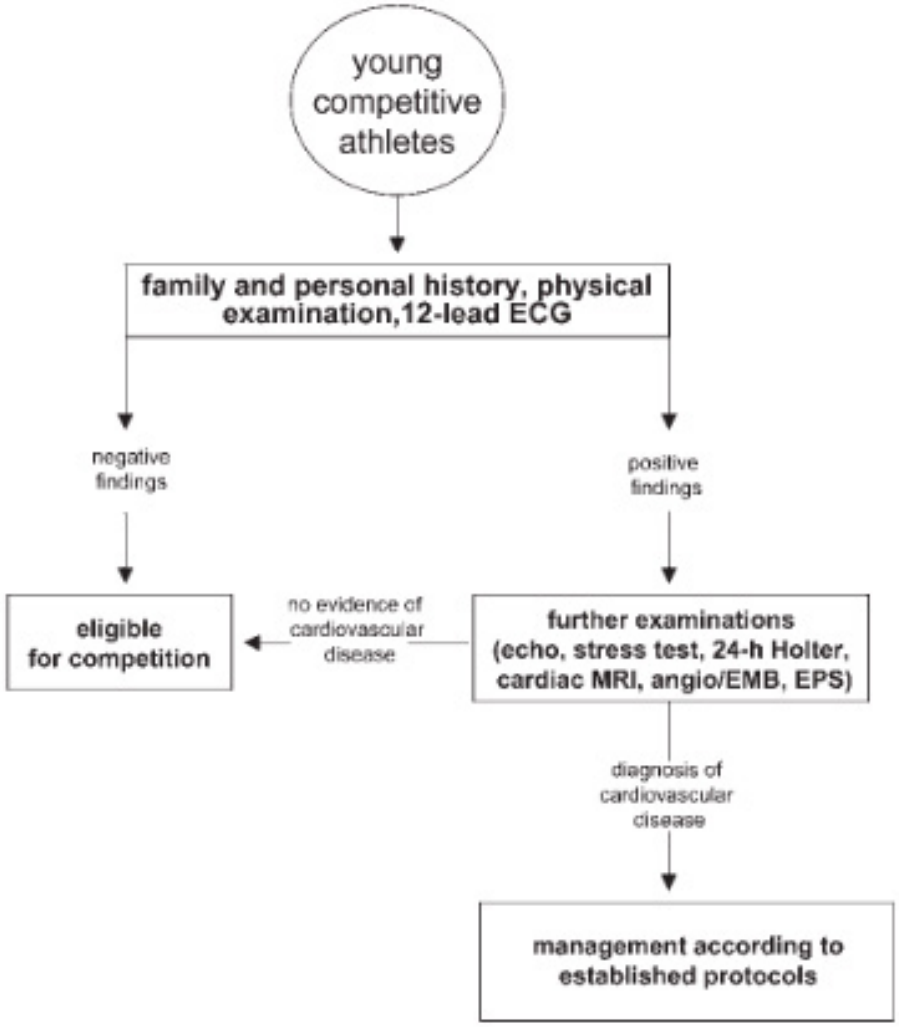
1. Exertional chest pain/discomfort
2. Unexplained syncope/near-syncope†
3. Excessive exertional and unexplained dyspnea/fatigue, associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure

Family history

6. Premature death (sudden and unexpected, or otherwise) before a 50 years due to heart disease, in ≥1 relative
7. Disability from heart disease in a close relative <50 years of age
8. Specific knowledge of certain cardiac conditions in family membe hypertrophic or dilated cardiomyopathy, long-QT syndrome or oth ion channelopathies, Marfan syndrome, or clinically important arrhythmias

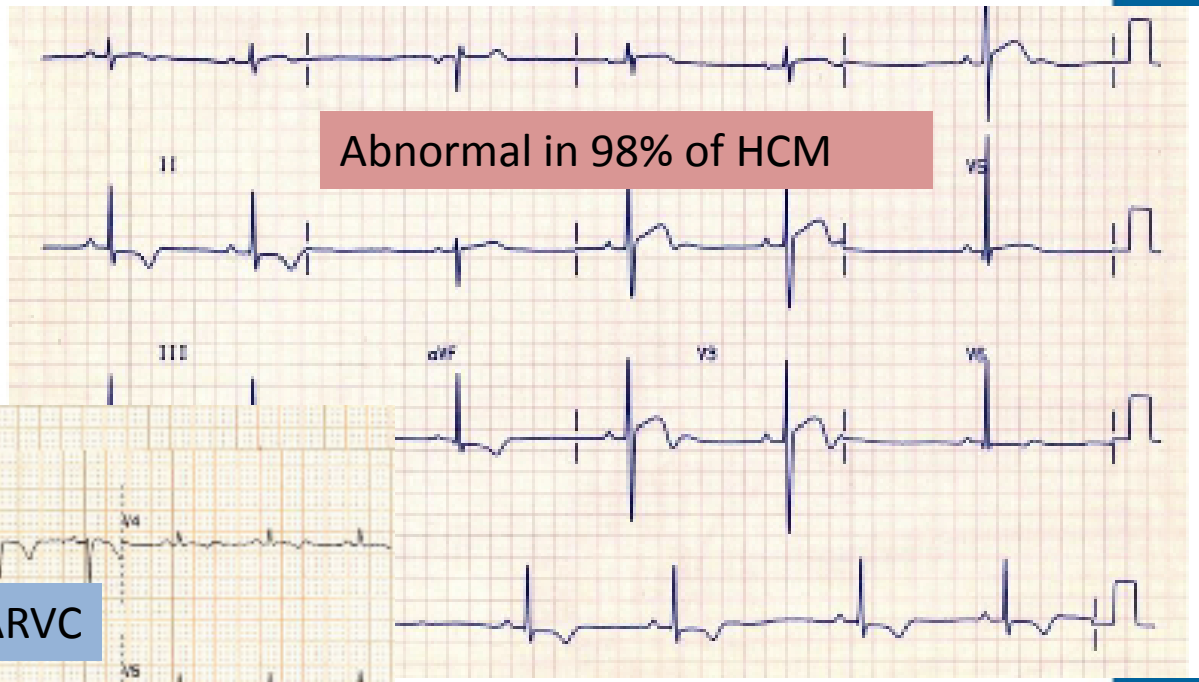
Physical examination

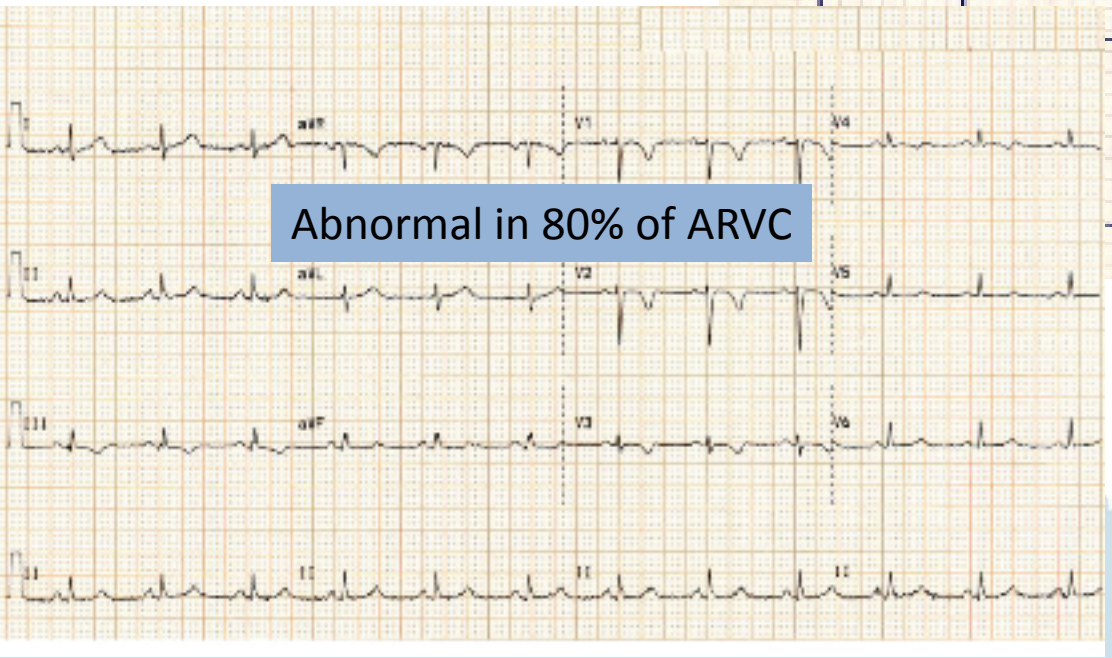
9. Heart murmur‡
10. Femoral pulses to exclude aortic coarctation
11. Physical stigmata of Marfan syndrome
12. Brachial artery blood pressure (sitting position)§



How effective is the ECG as a screening tool?

- WPW
- Brugada
- LQTS



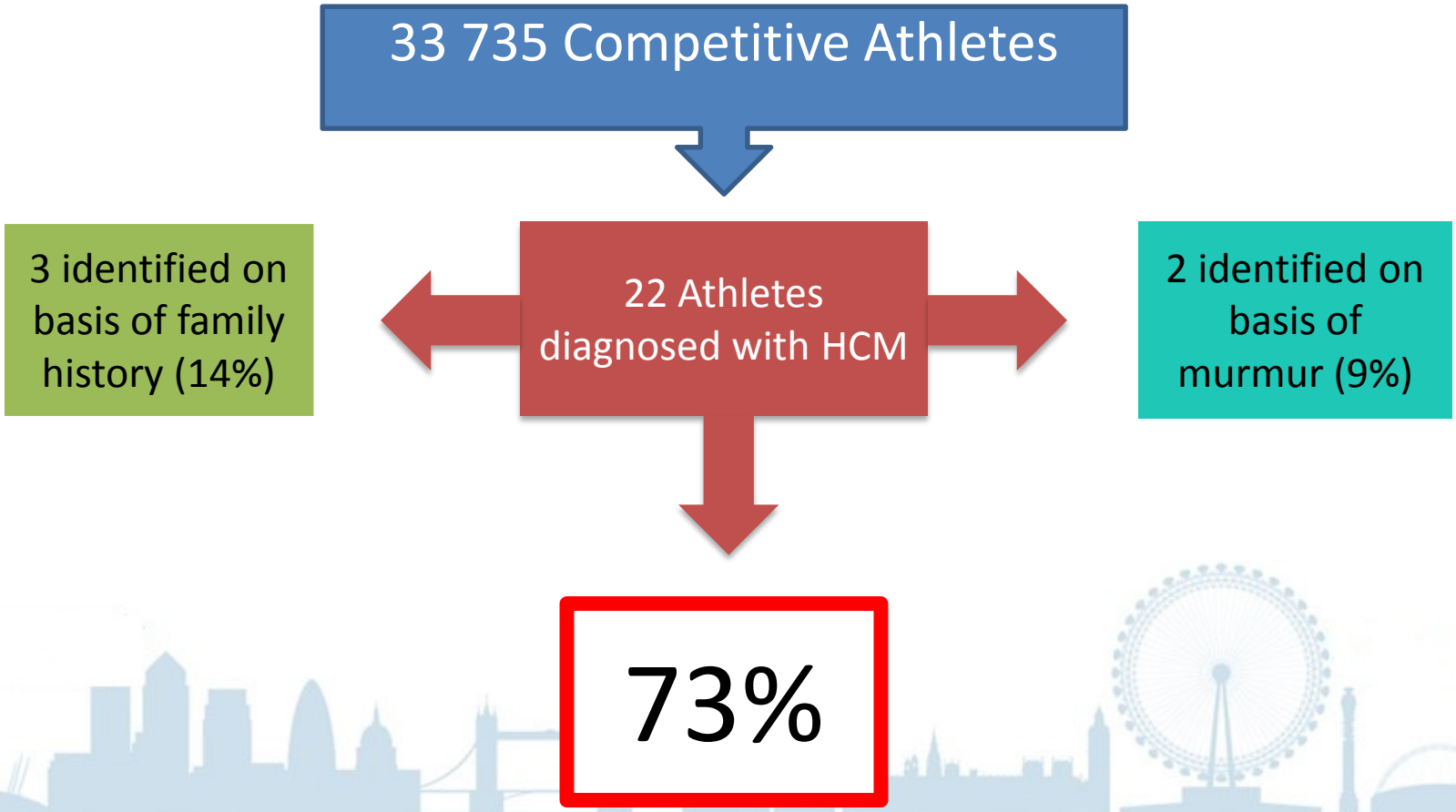


The New England Journal of Medicine

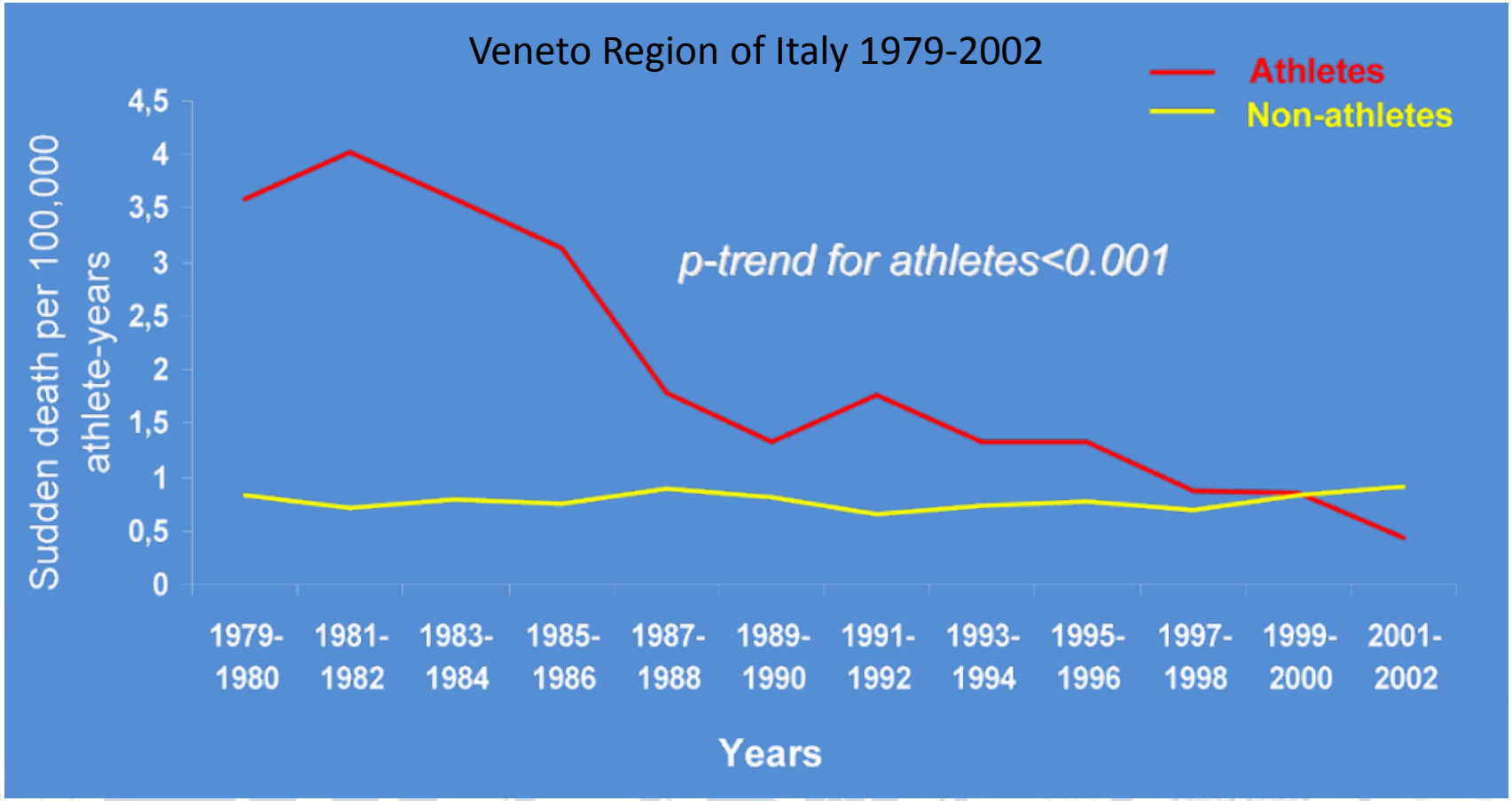
NEJM, 1998; 339(6):364-369

SCREENING FOR HYPERTROPHIC CARDIOMYOPATHY IN YOUNG ATHLETES

DOMENICO CORRADO, M.D., CRISTINA BASSO, M.D., MAURIZIO SCHIAVON, M.D., AND GAETANO THIENE, M.D.



Incidence of Sudden Cardiac Death in Athletes Vs. Non-Athletes Over Time



Corrado et al. JAMA 2006;296:1593-1601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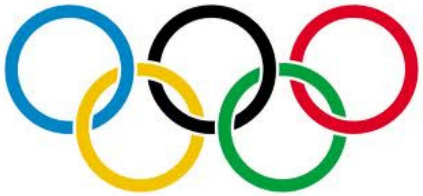


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NFL


NBA


UEFA
CUP


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Screening Concerns

1. Is it an Important health problem?
   - Low incidence of SCD
2. Is there a suitable screening test?
   - False positives
   - False negatives

Incidence of Sudden Cardiac Death

Population	Age	Duration	Incidence
Organised high school and college athletes	13-17	12 years	0.5/100 000
Competitive athletes	**14-35**	**25 years**	**2/100 000/yr**
Marathon (London)	42 (mean)	26 years	2.2/100 000 runs
Rhode island jogger	30-65	7 years	13/100 000/yr

Prevalence of conditions predisposing to SCD in young athletes

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Reference	Population	Prevalence
Fuller 1997	5 617 high school athletes (US)	0.3%
Corrado 2006	42 386 athletes aged 12-35yrs (Italy)	0.2%
AHA 2007	Competitive athletes (US)	0.3%
Wilson 2008	2 720 athletes/children aged 10-27 yrs	0.3%
Bessem 2009	428 athletes aged 12-35 yrs (Netherlands)	0.7%
Baggish 2010	510 collegiate athletes (US)	0.6%

Screening Concerns

1. Is it an Important health problem?
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   - False positives
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Recommendations for interpretation of 12-lead electrocardiogram in the athlete

Classification of abnormalities of the athlete's electrocardiogram

Group 1: common and training-related ECG changes	Group 2: uncommon and training-unrelated ECG changes
Sinus bradycardia	T-wave inversion
First-degree AV block	ST-segment depression
Incomplete RBBB	Pathological Q-waves
Early repolarization	Left atrial enlargement
Isolated QRS voltage criteria for left ventricular hypertrophy	Left-axis deviation/left anterior hemiblock
	Right-axis deviation/left posterior hemiblock
	Right ventricular hypertrophy
	Ventricular pre-excitation
	Complete LBBB or RBBB
	Long- or short-QT interval
	Brugada-like early repolarization

High False Positive Rate

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Performance of the 2010 European Society of Cardiology criteria for ECG interpretation in

Rory B Weiner,[1] Adolph M Hutter,[1] Francis Wang,[2] Jonath
Malissa J Wood,[1] Thomas J Wang,[1] Michael H Picard[1]

%

Annals of Internal Medicine

Cardiovascular Screening
Electrocardiography

A Cross-sectional Study

Aaron L. Baggish, M
Michael H. Pi

Weiner, MD; Eli Kupperman, BA;

16.9%

Unacceptably high

The Se ase the specificity of prepartic screening among elite athletes

Maria Brosnan, La Gerche,[1,2] Jon Kalman,[3] Wilson Lo,[4] Kieran Fallon,[5]
Andrew MacIsaac, David Prior[1,2]

17.3%

T-Wave inversion in Black Athletes

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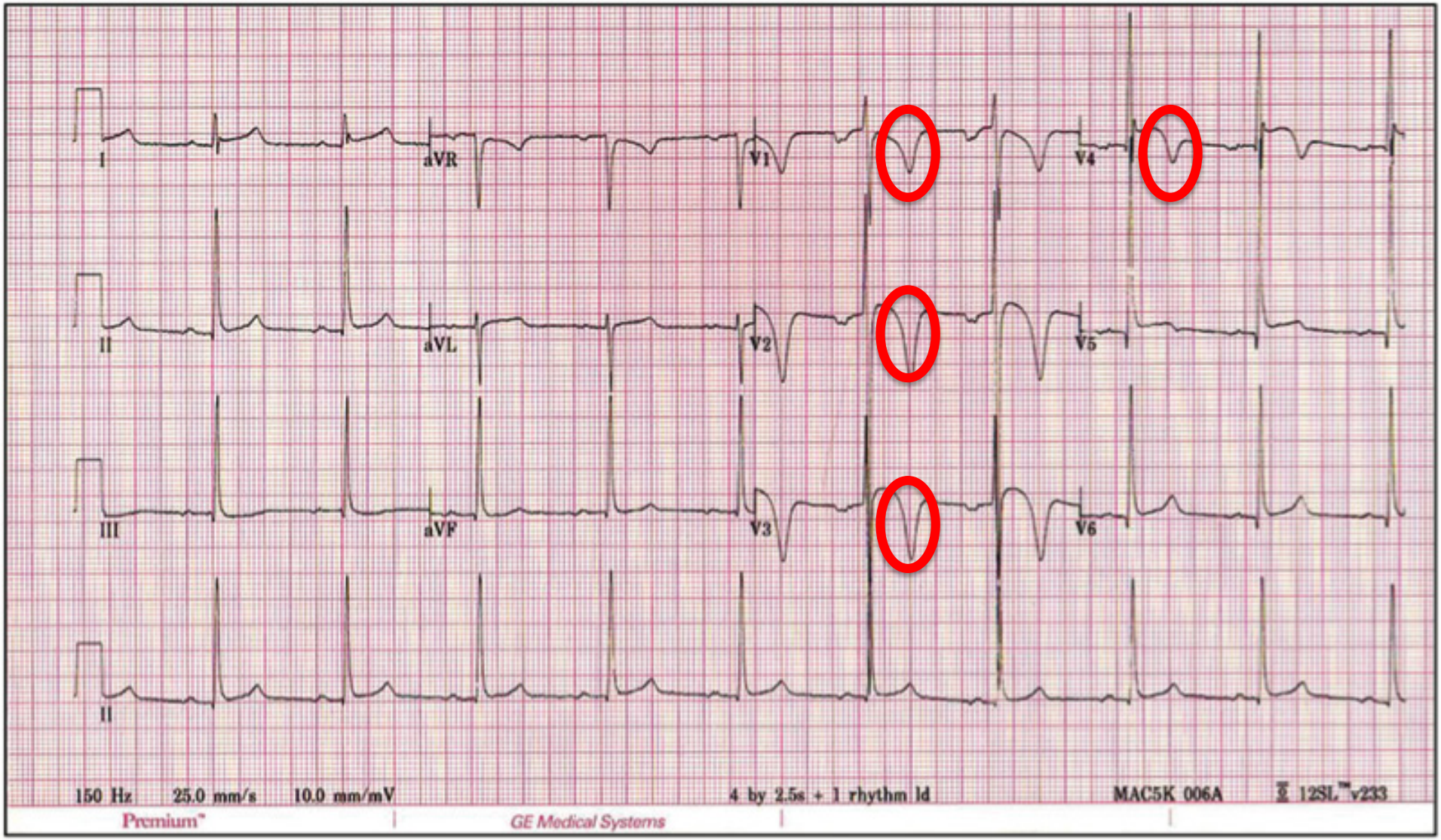

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	Brugada-like early repolarization

53%

6%

The Seattle Criteria

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<u>Differences from the ESC 2010</u>

Following included in the normal category:

- T wave inversion in V1-V4 in black athletes.
- T wave inversions in V1-V2 in all athletes.
- QTc <470 M and < 480 F
- Criteria for RVH also include RAD

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	Brugada-like early repolarization

50%

Evidence based ECG interpretation 2004-2014

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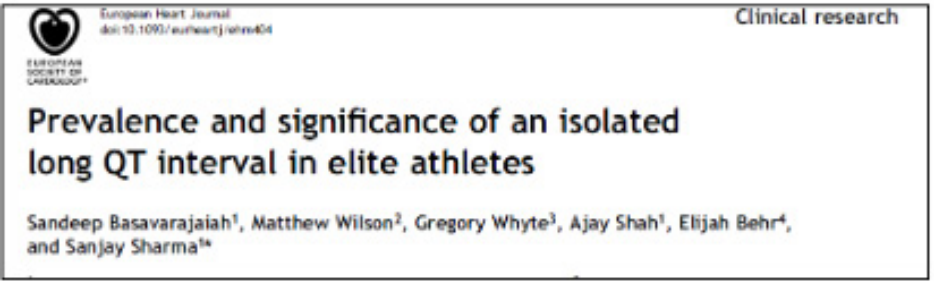
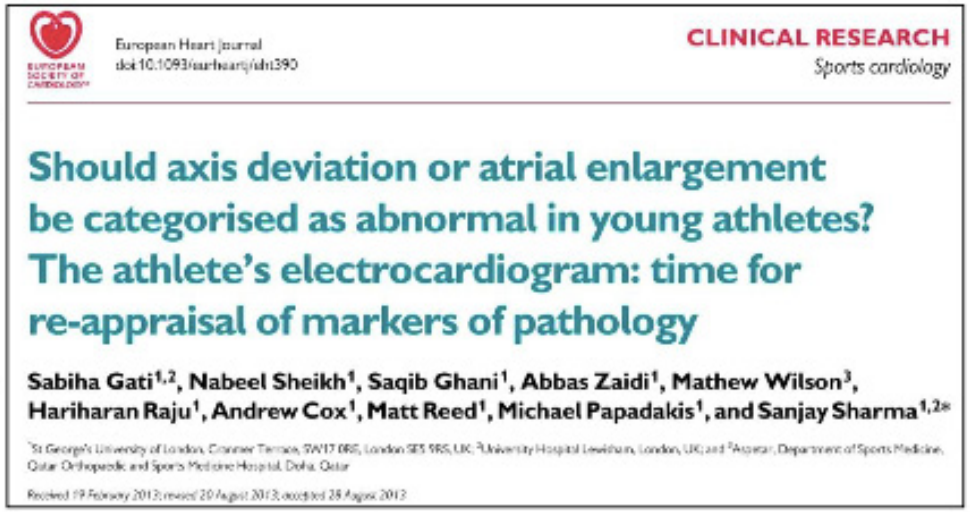


European Heart Journal
doi:10.1093/eurheartj/ehm404

Clinical research

Prevalence and significance of an isolated long QT interval in elite athletes

Sandeep Basavarajaiah[1], Matthew Wilson[2], Gregory Whyte[3], Ajay Shah[1], Elijah Behr[4], and Sanjay Sharma[1]*



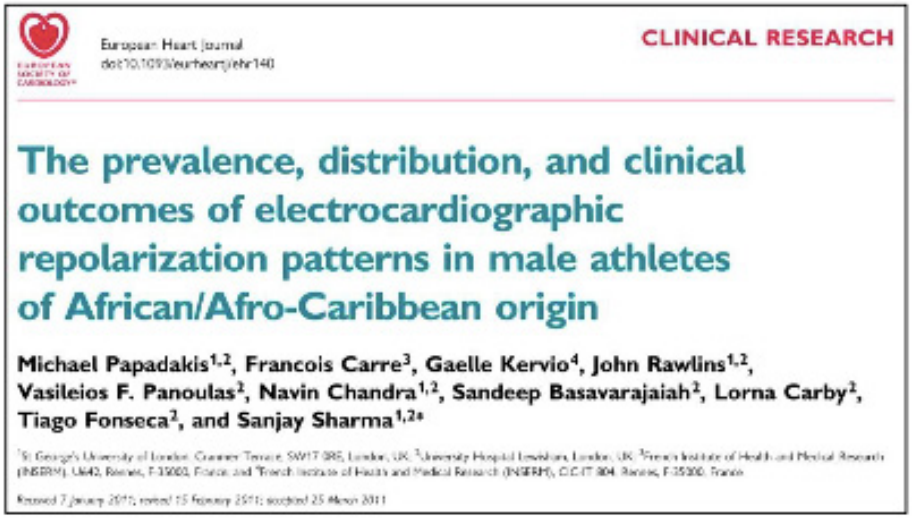
European Heart Journal
doi:10.1093/eurheartj/ehr390

CLINICAL RESEARCH
Sports cardiology

Should axis deviation or atrial enlargement be categorised as abnormal in young athletes? The athlete's electrocardiogram: time for re-appraisal of markers of pathology

Sabiha Gati[1,2], Nabeel Sheikh[1], Saqib Ghani[1], Abbas Zaidi[1], Mathew Wilson[3], Hariharan Raju[1], Andrew Cox[1], Matt Reed[1], Michael Papadakis[1], and Sanjay Sharma[1,2]*

Received 19 February 2013; revised 20 August 2013; accepted 28 August 2013



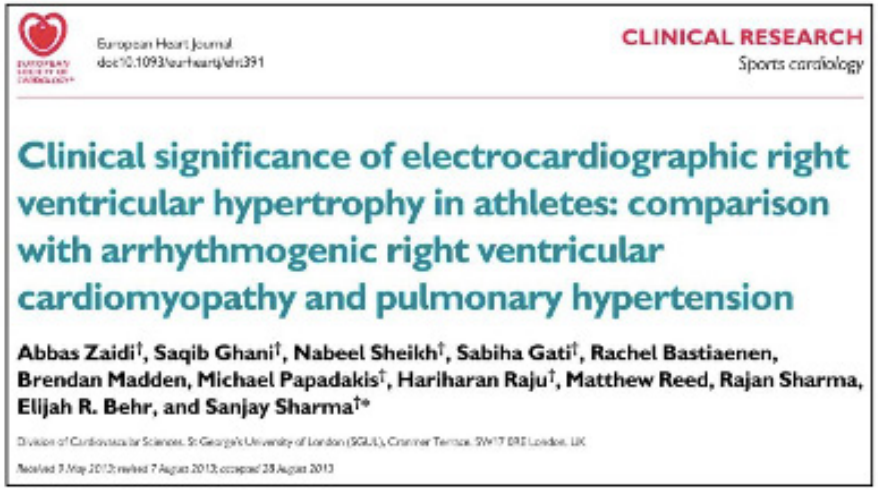
European Heart Journal
doi:10.1093/eurheartj/ehr140

CLINICAL RESEARCH

The prevalence, distribution, and clinical outcomes of electrocardiographic repolarization patterns in male athletes of African/Afro-Caribbean origin

Michael Papadakis[1,2], Francois Carre[3], Gaelle Kervio[4], John Rawlins[1,2], Vasileios F. Panoulas[1], Navin Chandra[1,2], Sandeep Basavarajaiah[2], Lorna Carby[2], Tiago Fonseca[2], and Sanjay Sharma[1,2]*

Received 7 January 2011; revised 15 February 2011; accepted 25 March 2011



European Heart Journal
doi:10.1093/eurheartj/ehr391

CLINICAL RESEARCH
Sports cardiology

Clinical significance of electrocardiographic right ventricular hypertrophy in athletes: comparison with arrhythmogenic right ventricular cardiomyopathy and pulmonary hypertension

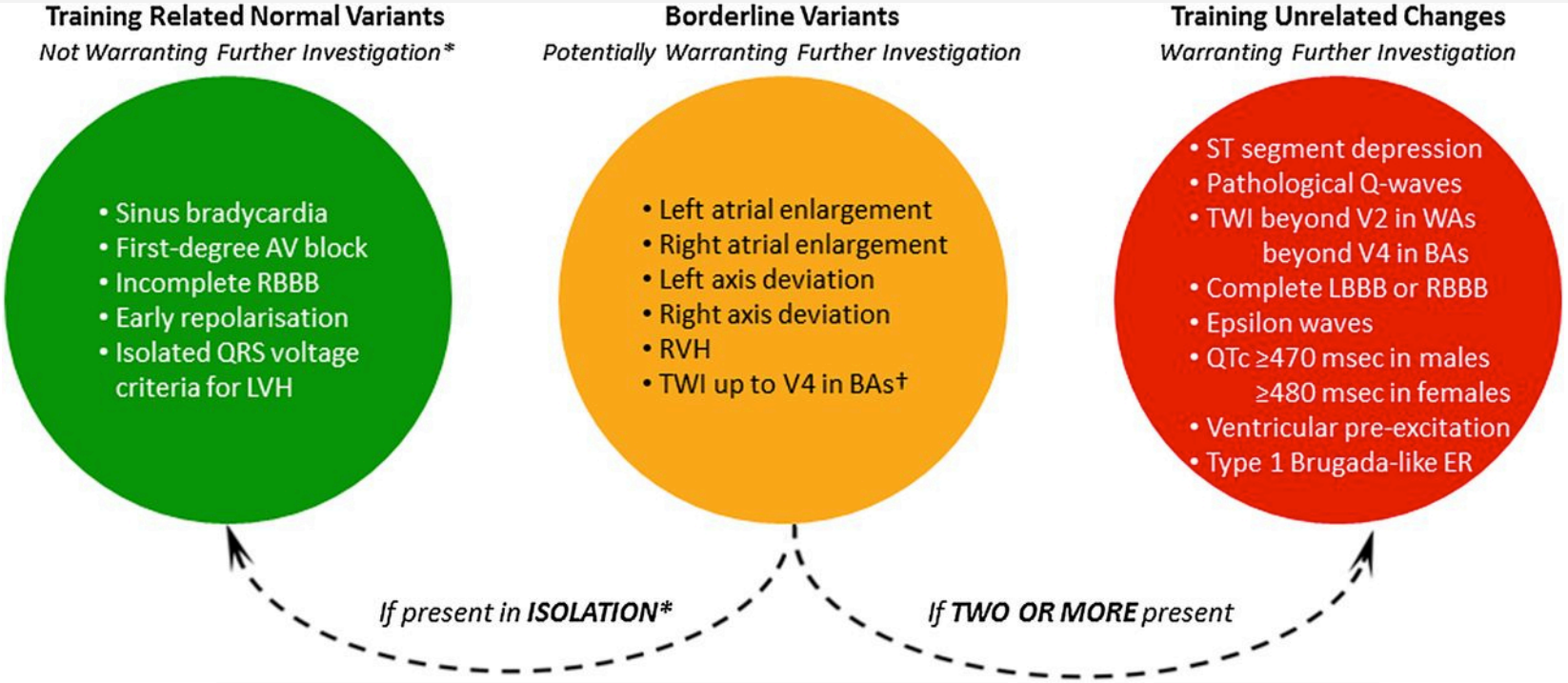
Abbas Zaidi†, Saqib Ghani†, Nabeel Sheikh†, Sabiha Gati†, Rachel Bastiaenen, Brendan Madden, Michael Papadakis†, Hariharan Raju†, Matthew Reed, Rajan Sharma, Elijah R. Behr, and Sanjay Sharma†*

Received 3 May 2013; revised 7 August 2013; accepted 28 August 2013

ORIGINAL ARTICLE

Comparison of ECG Criteria for the Detection of Cardiac Abnormalities in Elite Black and White Athletes

Nabeel Sheikh, Michael Papadakis, Saqib Ghani, Abbas Zaidi, Sabiha Gati, Paolo Adami, François Carré, Frédéric Schnell, Paloma Avila, Mathew Wilson, William McKenna and Sanjay Sharma



Sensitivity: All conditions 60%
Sensitivity: Serious conditions 100%
Specificity: 94% Caucasians
84% Black athletes

Sanjay Sharma et al. Eur Heart J 2015;36:1445-1453

False positives

European Society of Cardiology (2010)

17- 32%

30- 40%

Seattle (2013)

4- 9%

16- 18%

Refined (2014)

2- 5%

10- 12%

Brosnan *et al,* 2013; Riding *et al,* 2014; Bessem *et al,* 2014; Sheikh *et al,* 2014

False Negatives

- Conditions where there is no clue on the ECG
  - Premature atherosclerosis
  - Anomalous coronaries
  - Incomplete expression of cardiomyopathy/ion channelopathy

- Events which are not prevented by screening
  - Commotio Cordis
  - Myocarditis
  - Electrolyte disturbance

Alternative Strategies

Automated External Defibrillators

Circulation

ORIGINAL ARTICLES

Sports-Related Sudden Death in the General Population

Eloi Marijon, Muriel Tafflet, David S. Celermajer, Florence Dumas, Marie-Cécile Perier, Hazrije Mustafic, Jean-François Toussaint, Michel Desnos, Michel Rieu, Nordine Benameur, Jean-Yves Le Heuzey, Jean-Philippe Empana and Xavier Jouven

- General population in **France**
- Mean age 46.1± 15.8
- Males 93%
- Survivial 16%

- Incidence in the general population **Netherlands** (2006-2009)
- Mean age 58.8 ± 13.6.
- 95% Male.
- Survival 45%

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Exercise-related out-of-hospital cardiac arrest in the general population: incidence and prognosis

Jocelyn Berdowski[1], Margriet F. de Beus[2,3], Marieke Blom[4], Abdennasser Bardai[4], Michiel L. Bots[2], Pieter A. Doevendans[3,5], Diederick E. Grobbee[2,6], Hanno L. Tan[4], Jan G.P. Tijssen[1], Rudolph W. Koster[1], and Arend Mosterd[2,3,7*]

Exercise related cardiac arrest

Country	Netherlands	France
Age, years	58.8 ± 13.6	46.1 ± 15.8
Success rate	45%	16%
Men	93%	95%
Bystander witnessed arrest	89%	94%
Bystander CPR	87%	31%
AED use	36%	1%
Shockable initial rhythm	80%	47%
Time to first shock (min)	9.8 (6.4 – 12.5)	12.5 (10.5 – 15.5)

European Heart Journal
doi:10.1093/eurheartj/eht282

CLINICAL RESEARCH
Sports cardiology

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Major regional disparities in outcomes after sudden cardiac arrest during sports

Eloi Marijon[1,2,3,4]*, Wulfran Bougouin[1,2,3,4], David S. Celermajer[5], Marie-Cécile Perier[1,2],

- Overall 16% survival after sports-related cardiac arrest.
- But **50%** in regions with rates of bystander resuscitation >90%

ORIGINAL ARTICLE

Cardiac Arrest during Long-Distance Running Races

Jonathan H. Kim, M.D., Rajeev Malhotra, M.D., George Chiampas, D.O., Pierre d'Hemecourt, M.D., Chris Troyanos, A.T.C., John Cianca, M.D., Rex N. Smith, M.D., Thomas J. Wang, M.D., William O. Roberts, M.D., Paul D. Thompson, M.D., and Aaron L. Baggish, M.D., for the Race Associated Cardiac Arrest Event Registry (RACER) Study Group

- 10.9 million runners
- 59 cardiac arrests
- 42 deaths
- 29 % survival rate
- Association between age and cardiac-arrest outcome
- survival >40 years of age
- Age-specific pattern of underlying cardiac disease.
  - Younger - hypertrophic cardiomyopathy
  - Older - ischemic heart disease.

Kim et al NEJM 2012

ORIGINAL ARTICLE

Cardiac Arrest during Long-Distance Running Races

Kim et al NEJM 2012

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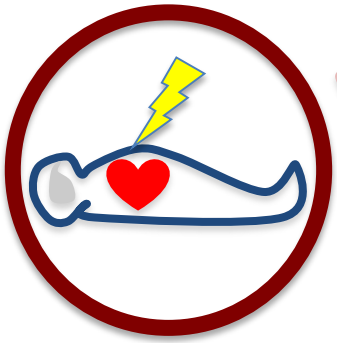
		CPR	Time taken for Emergency Arrival (mins)	VF	HCM
						
SCA	Survivor 29%	100 %	3.3	88%	0%
	Death 71%	40%	7.7	35%	66%

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

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Effectiveness of Emergency Response Planning for Sudden Cardiac Arrest in United States High Schools With Automated External Defibrillators

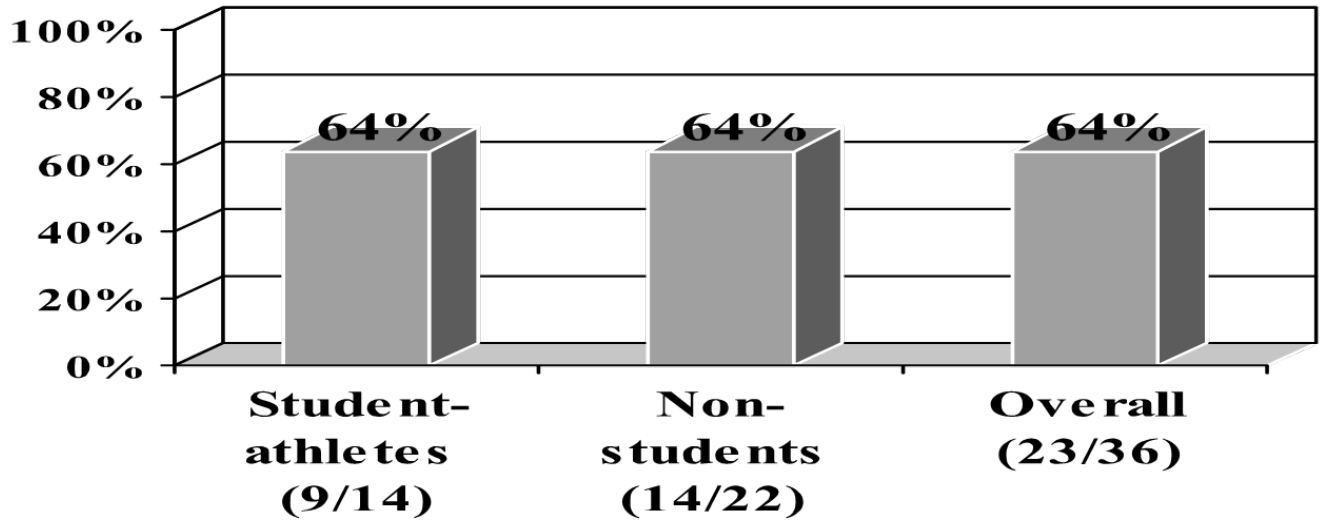
Jonathan A. Drezner, Ashwin L. Rao, Justin Heistand, Megan K. Bloomingdale and Kimberly G. Harmon

Circulation published online Jul 27, 2009;
DOI: 10.1161/CIRCULATIONAHA.109.855890

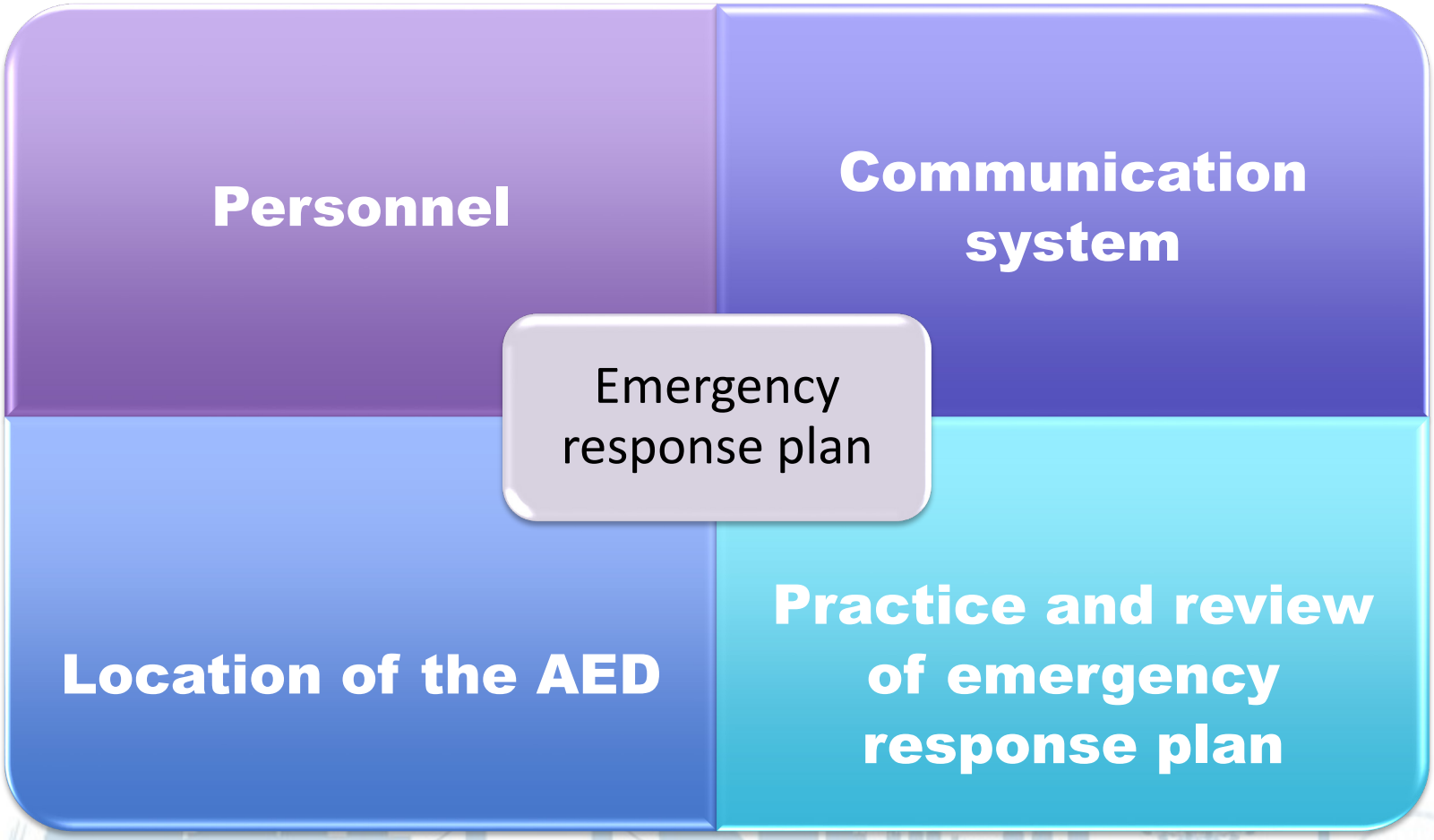
Report of 1710 US high schools with an on-site AED program. Survey relating to sudden cardiac arrest (SCA) between Jan 2006-July 2007

36 cases of SCA

Prompt CPR 94%
AED shock 83%



The Emergency Response Plan



Survival after SCA after exercise

Author	Study	Survival
Maron	Commotio cordis	16%
Drezner	Survival trends	4-21%
Drezner	Schools with AED	64%
Kim	Marathon runners	29%
Sharma	London Marathon	43%
Marion	Gen Pop 10-75	16%
Berdowsky	Gen Pop Amsterdam	46%

Conclusions

- Sudden cardiac death in young athletes is rare.
- Exercise is a trigger for SCD in predisposed athletes.
- Pre-participation screening with ECG identifies athletes with cardiomyopathy.
- Early CPR and AEDs save lives in sport.

Thank You

- Acknowledgements

- Professor Sanjay Sharma
- Cardiac Risk in the Young

Success Rates From External Defibrillation in Young Athletes

- 1999-2005. 9 Cases of sudden cardiac arrest
- Mean age 21 years old (18-30)
- Witnessed collapse (all during exercise)
- CPR within 1 min in 8 cases
- AED provided by trainer in 5 cases and by emergency services in 4 cases
- Time to defibrillation (1-7.5 min)
- 8/9 athletes died (HCM 5, commotio cordis 2, MI 1)

Drezner Heart Rhythm 2006