Saving Athlete's Hearts Screening +

Paul D. Thompson, MD, FACC
Chief of Cardiology, Hartford Hospital
Physician Co-Director, Hartford Healthcare Cardiovascular Institute
Hartford, CT

Does Screening Athletes With an ECG Save Lives ?

Financial Disclosures

- **Research Support:** **NHLBI, NIAMS, NCCAM,** Genomas, Sanofi, Regeneron, Esperion, Amarin Pfizer.
- **Consultant:** Amgen, Regeneron, Merck, Genomas, Sanofi, Esperion, Amarin
- **Speaker Honoraria:** Merck, Pfizer, Regeneron, Sanofi, Amgen, Amarin
- **Stock Shareholder:** Abbvie, Abbott Labs, J&J; General Electric, Medtronic, Serapta
- Malpractice Consultant: Statin Myopathy, Cardiac Complications of Exercise

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Does Screening Athletes With an ECG Save Lives ?

- I Do Not Know
- Because There Are No RCCTs
- But I Don't Think So
- I am Actually Concerned That ECG Screening May Cost Lives

Does Screening Athletes With an ECG Save Lives ?

- I Do Think It's An Excellent Business Strategy
- Because of Downstream Testing

Does Screening Athletes With an ECG Save Lives ?

- What Causes Exercise-Related SCD ?
- How Frequent is Exercise-Related SCD ?
- What is the Evidence ECG Screening Does / Does Not Work ?
- What Probably Does Work ?

Does Screening Athletes With an ECG Save Lives ?

- What Causes Exercise-Related SCD ?
- How Frequent is Exercise-Related SCD ?
- What is the Evidence ECG Screening Does / Does Not Work ?
- What Probably Does Work ?

In The "Young"
(< 30, 35, 40 yrs)

In "Adults"

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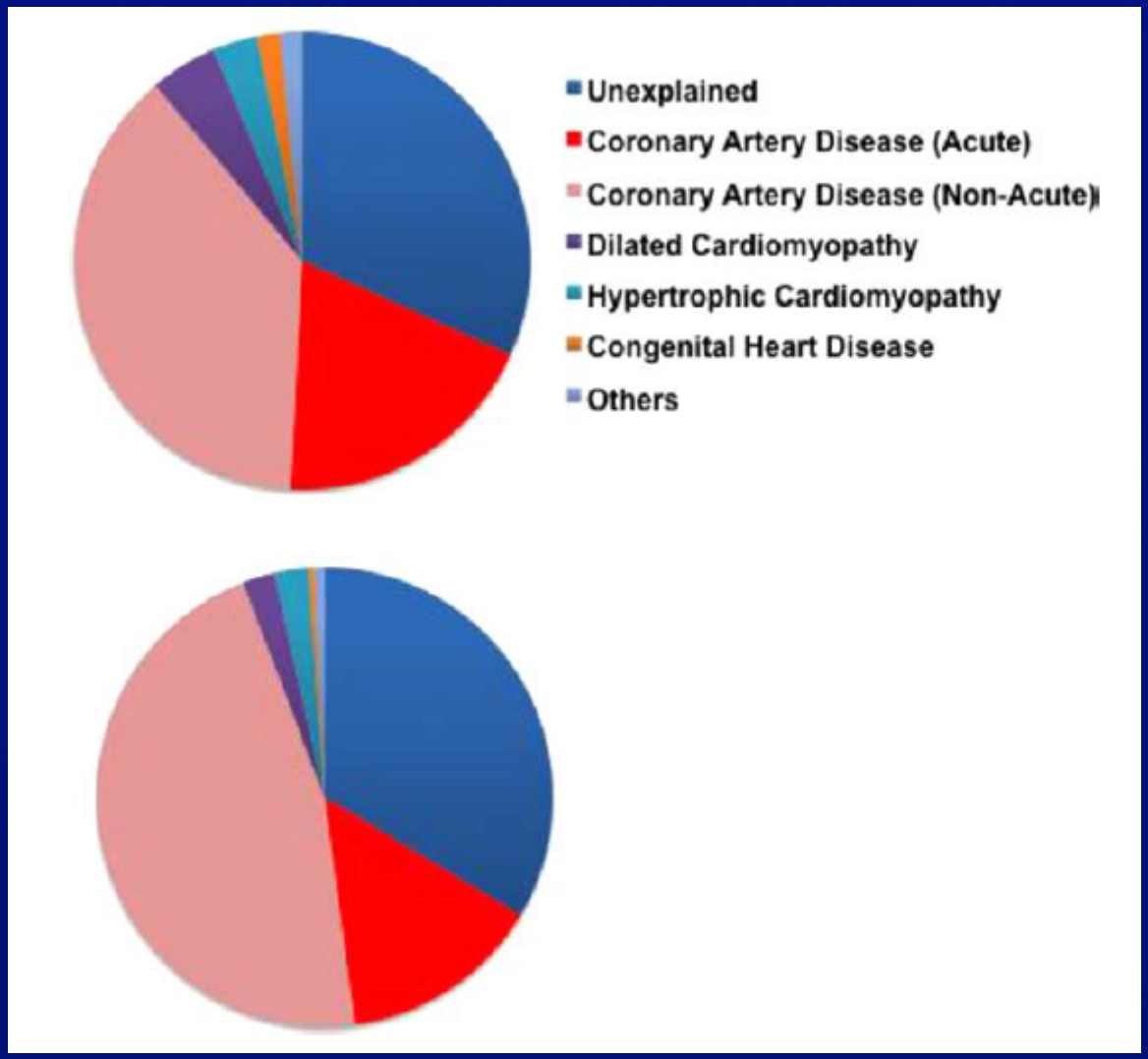
Sports Related
N=63

Not Sports Related
N=1184



Sudden Cardiac Death During Sports Participation in Middle Age
***Circulation*. 2015;131:1384-1391**

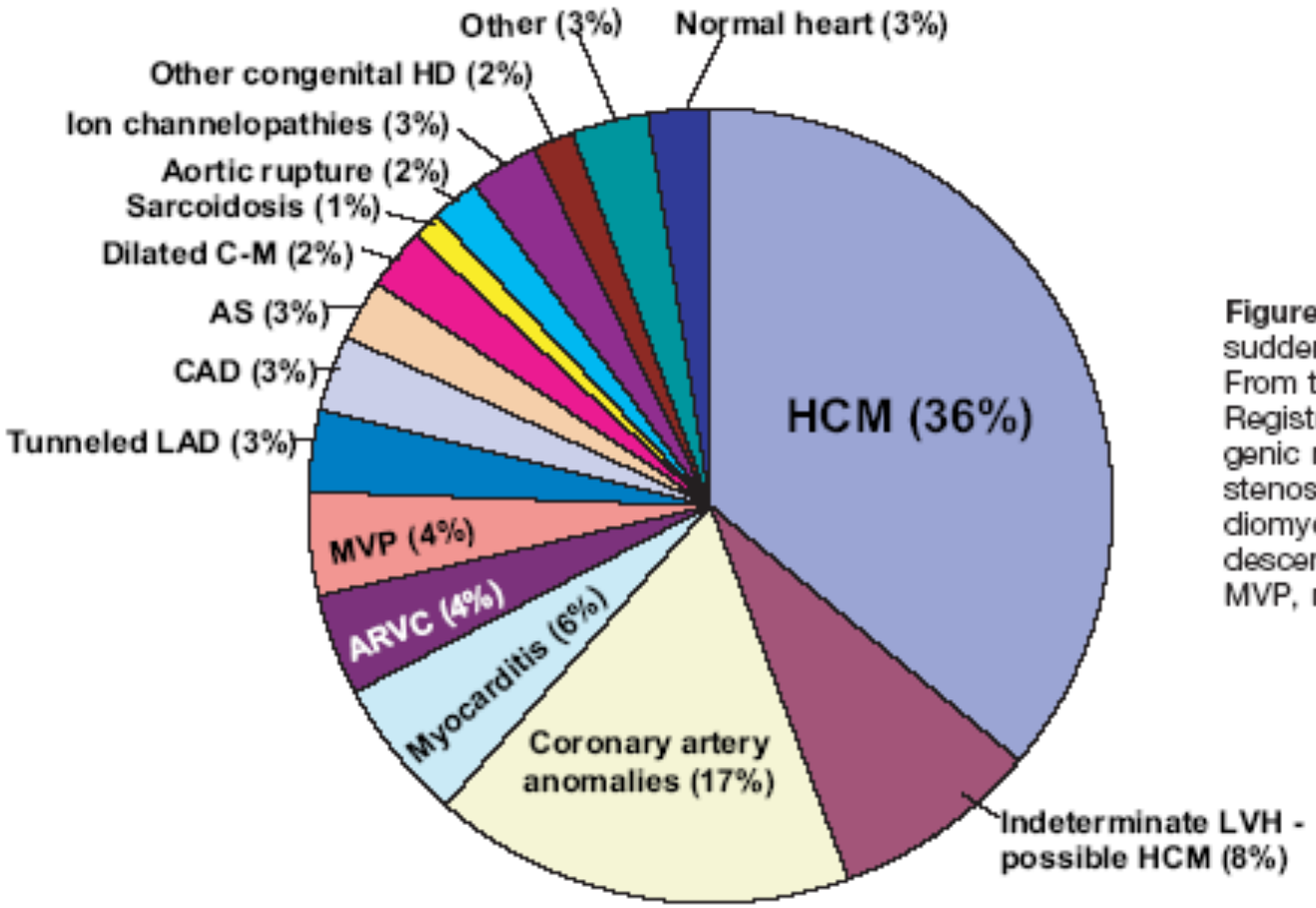


Figure. Distribution of cardiovascular causes of sudden death in 1435 young competitive athletes. From the Minneapolis Heart Institute Foundation Registry, 1980 to 2005. ARVC indicates arrhythmogenic right ventricular cardiomyopathy; AS, aortic stenosis; CAD, coronary artery disease; C-M, cardiomyopathy; HD, heart disease; LAD, left anterior descending; LVH, left ventricular hypertrophy; and MVP, mitral valve prolapse.

Maron, Thompson, et al Circulation 2007

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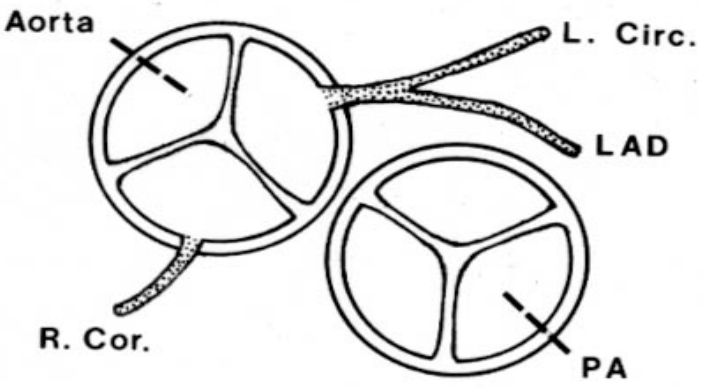
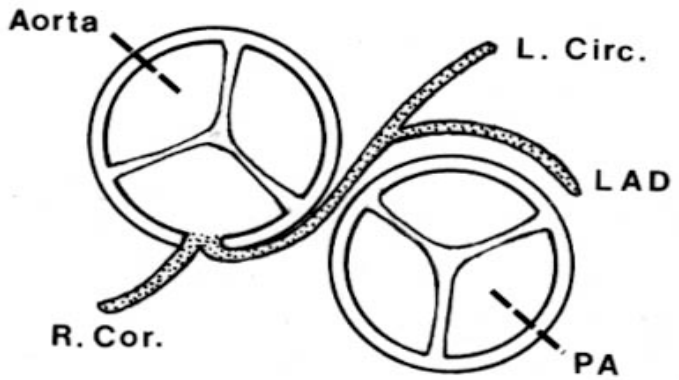


A



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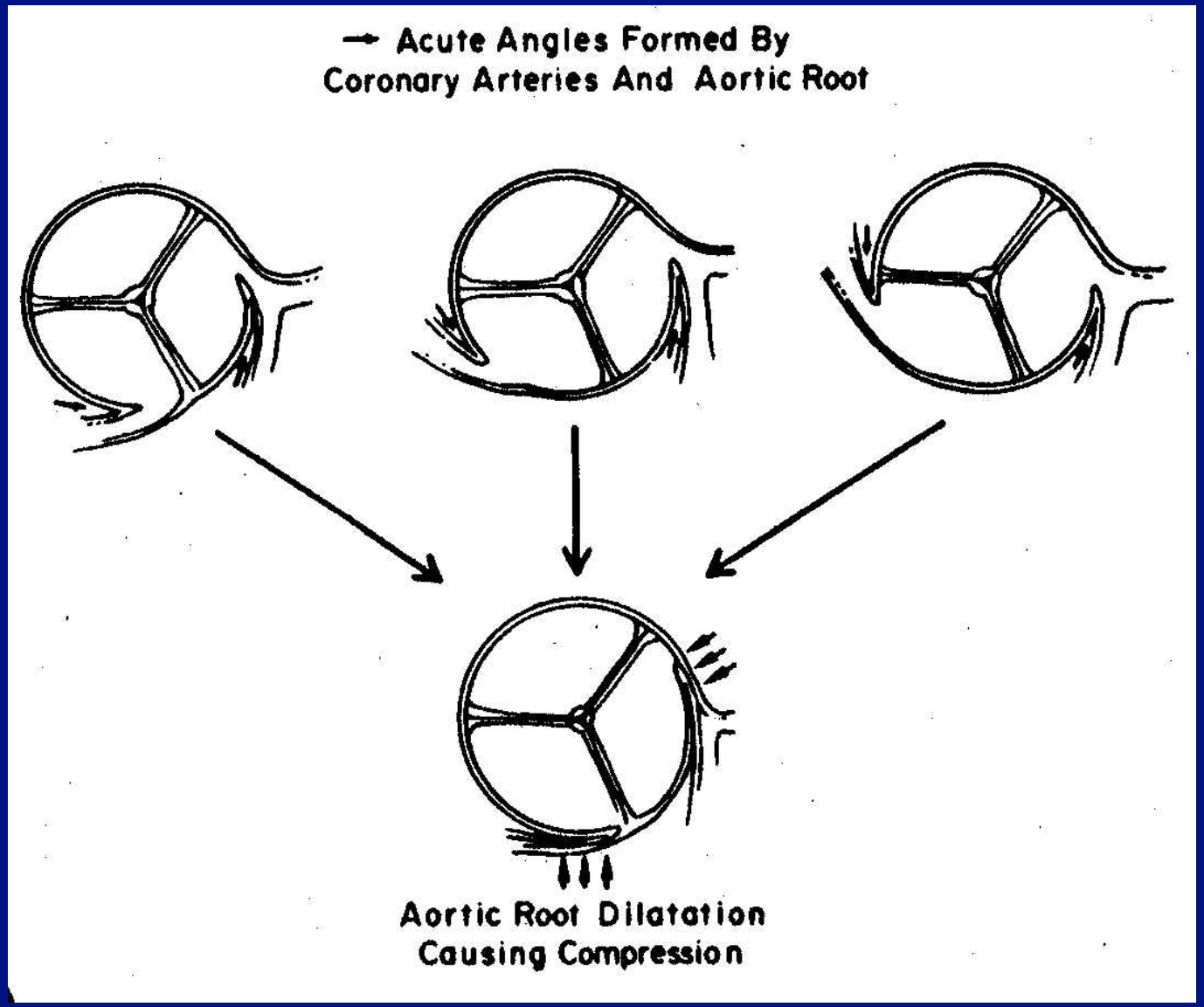
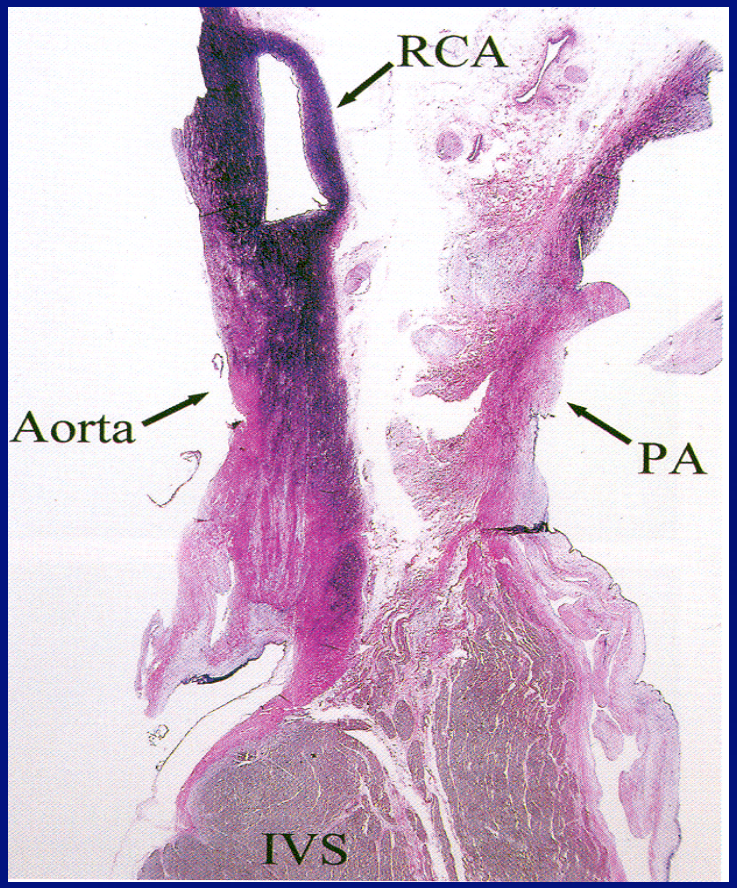


Sommers, Pathology Annual, 1985



17 year old Died During B-Ball

Note: RCA In AO Wall
Δ In AO Wall Thickness; Distance From PA

Angelini, Tex Heart Inst J. 2002

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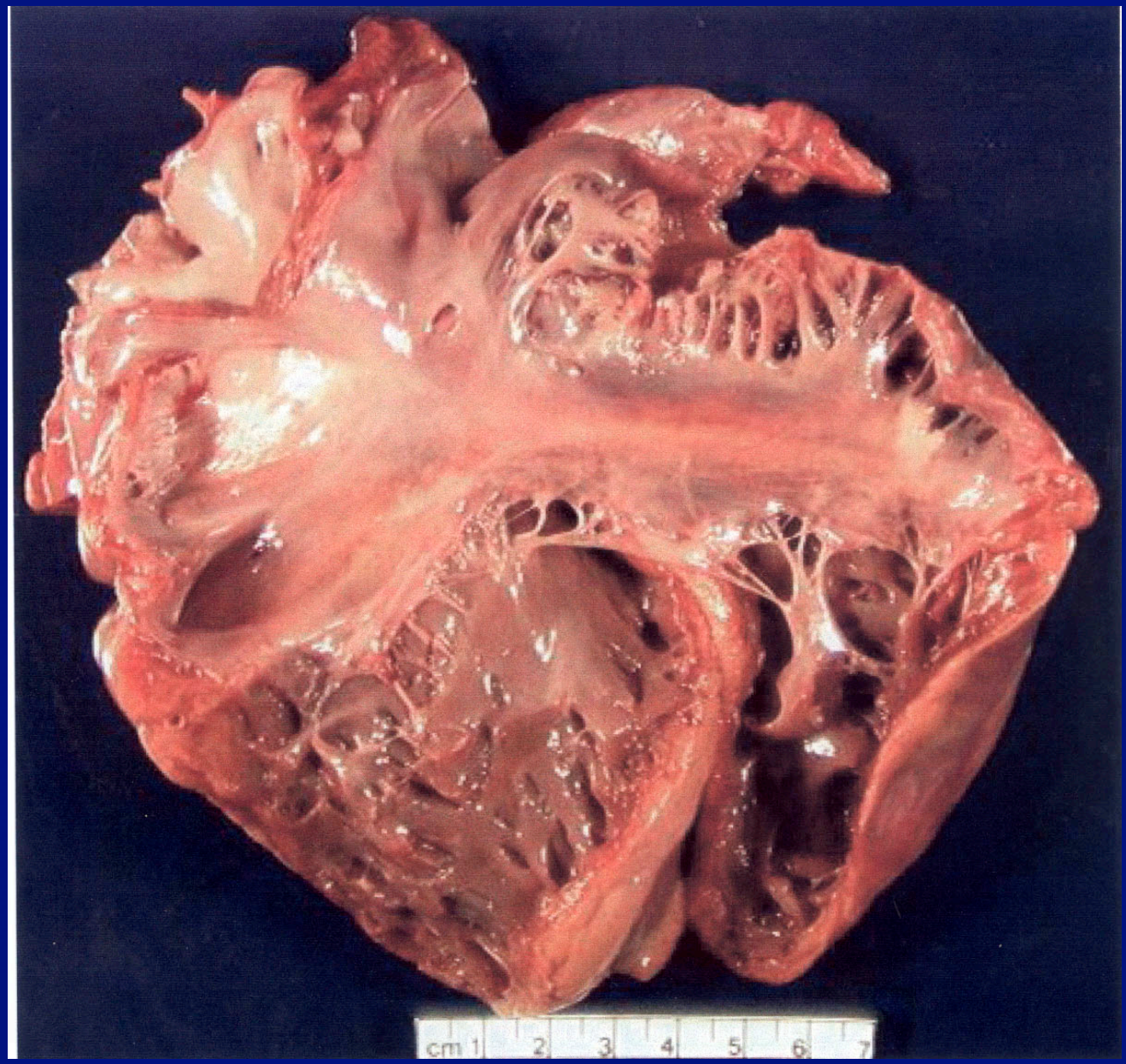
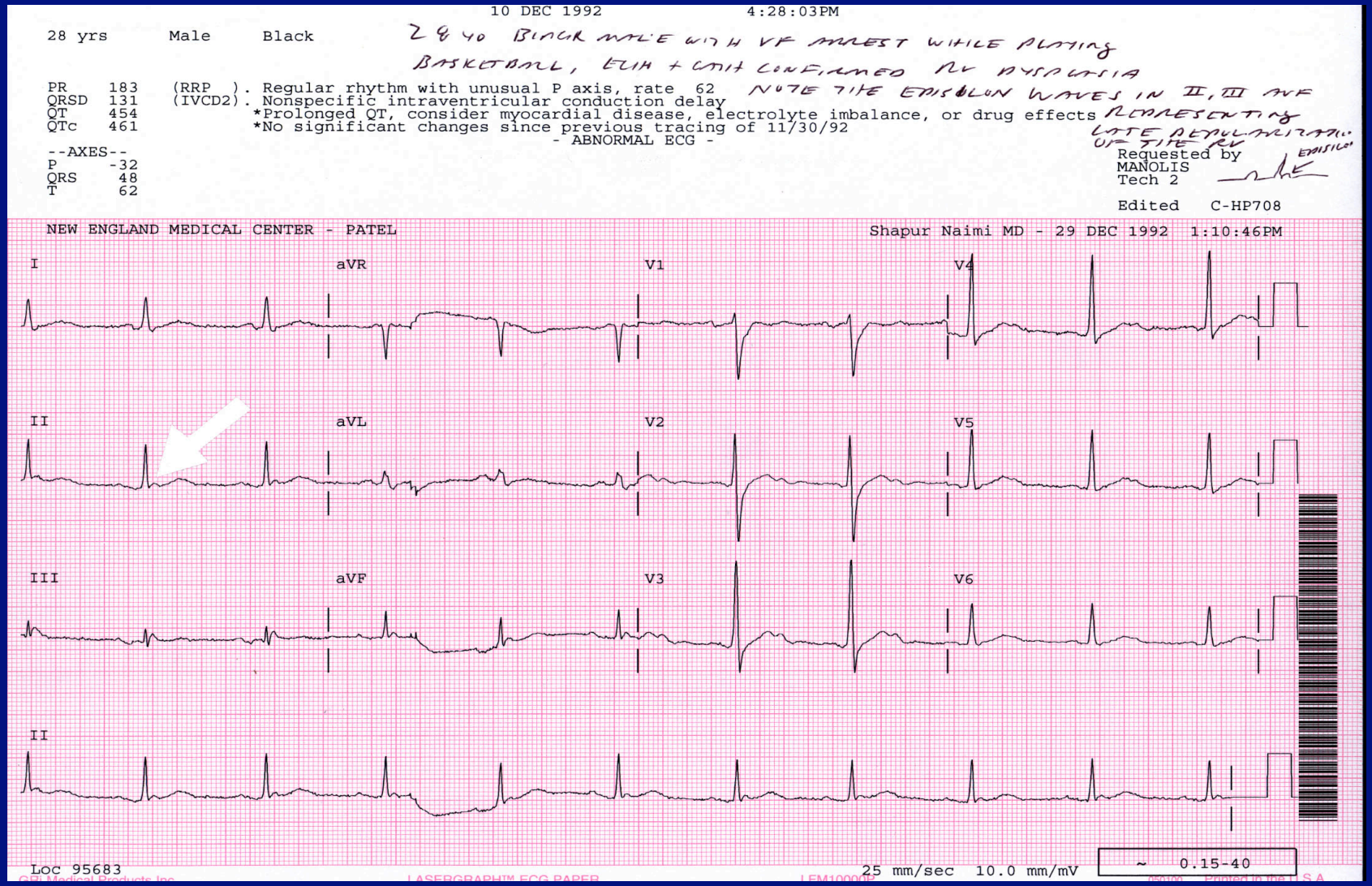


Gemeyal
JACC 2001

37 year old woman - CHF



29 year old AA male VF during B-ball
Note Epsilon Waves

But Is HCM Really the Most Common Cause ?

PUBLISHED BY ELSEVIER http://dx.doi.org/10.1016/j.jacc.2016.02.062

Etiology of Sudden Death in Sports

Insights From a United Kingdom Regional Registry

Gherardo Finocchiaro, MD,[a] Michael Papadakis, MBBS, MD,[a] Jan-Lukas Robertus, MD,[b] Harshil Dhutia, MBBS,[a] Alexandros Klavdios Steriotis, MD, PhD,[a] Maite Tome, MD, PhD,[a] Greg Mellor, MBChB,[a] Ahmed Merghani, MBBS,[a] Aneil Malhotra, MBBChir,[a] Elijah Behr, MBBS, MD,[a] Sanjay Sharma, MBChB, MD,[a] Mary N. Sheppard, MBBCh, BAO, MD[b]

- 357 Referred to The CRY Autopsy Center
- Sudden Arrhythmic Death Syndrome– 42%
  - LVH -16%, ARVCM – 13%, HCM – 6%
  - Coronary Anomalies - 5%

Incidence, Cause, and Comparative Frequency of Sudden Cardiac Death in National Collegiate Athletic Association Athletes

A Decade in Review

Kimberly G. Harmon, MD; Irfan M. Asif, MD; Joseph J. Maleszewski, MD; David S. Owens, MD, MS; Jordan M. Prutkin, MD, MHS; Jack C. Salerno, MD; Monica L. Zigman, MPH; Rachel Ellenbogen, MS; Ashwin L. Rao, MD; Michael J. Ackerman, MD, PhD; Jonathan A. Drezner, MD

Circulation. 2015;132:10-19

Incidence, Cause, and Comparative Frequency of Sudden Cardiac Death in National Collegiate Athletic Association Athletes

- 514 NCAA Athlete Deaths Over 10 Years
- SCD in 79 (15%) of All Deaths
- 64 With Autopsy
  - No explanation 25%
  - Coronary Anomalies – 11%
  - Myocarditis - 10%
  - CAD – 10%
  - HCM -5%
  - LVH – 5%
  - CM – 5%

Does Screening Athletes With an ECG Save Lives ?

- What Causes Exercise-Related SCD ?
- How Frequent is Exercise-Related SCD ?
- What is the Evidence ECG Screening Does / Does Not Work ?
- What Probably Does Work ?

We Really Don't Know

Because There in No Comprehensive National Death Registry

Incidence of Death During Jogging in Rhode Island From 1975 Through 1980

Paul D. Thompson, MD; Erik J. Funk, MD; Richard A. Carleton, MD; William Q. Sturner, MD

(*JAMA* 1982;247:2535-2538)

Table 4.—Incidence of Death During Jogging for Rhode Island Male Joggers

Age Group, yr	% of Population Jogging (Mean±SE$_t$*)	Total Joggers	Joggers per Death	Jogging per Death, hr	Deaths per Activity-Hour: Jogging/Other Activities
30-39	2.9±2.8	1,550	9,281	482,600	99
40-49	16.7±7.6	7,464	8,993	467,600	13
50-64	5.4±3.7	3,987	5,950	309,400	5
30-64	7.4±2.6	12,728	7,620	396,000	7

*SE$_t$ indicates standard error of the estimate.

How Dangerous Is Exercise For Healthy Adults?

	1 Death Per Year Per
Thompson JAMA 247:2535,1982	15,640
Siscovick NEJM 311:874,1984	18,000

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In Young Athletes
(per 100,000)

	Men	Women
High School (n=126)	0.66	0.12
College (n=34)	1.45	0.28

(1 / 133,333 Men & 769,230 Women)

Van Camp 1995

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Minnesota High School Athletes 1993–2012

Evidence That American Screening Strategies and Sideline Preparedness Are Associated With Very Low Rates of Sudden Cardiac Deaths*

Christine E. Lawless, MD, MBA

Chicago, Illinois

JACC Vol. 62, No. 14, 2013
October 1, 2013:1302–3

SCD In US 1 / 200,000…Fairly Constant

4 SCDs in 19 Years…Only Events @ Games / Practice…No Resuscitations

1 / 416,000 for 19 Yrs -1 / 909,000 for 10 Yrs

Sudden Deaths in Young Competitive Athletes

Analysis of 1866 Deaths in the United States, 1980–2006

Barry J. Maron, MD; Joseph J. Doerer, BS; Tammy S. Haas, RN;
David M. Tierney, MD; Frederick O. Mueller, PhD

Background—Sudden deaths in young competitive athletes are highly visible events with substantial impact on the physician and lay communities. However, the magnitude of this public health issue has become a source of controversy.

Methods and Results—To estimate the absolute number of sudden deaths in US competitive athletes, we have assembled a large registry over a 27-year period using systematic identification and tracking strategies. A total of 1866 athletes who died suddenly (or survived cardiac arrest), 19±6 years of age, were identified throughout the United States from 1980 to 2006 in 38 diverse sports. Reports were less common during 1980 to 1993 (576 [31%]) than during 1994 to 2006 (1290 [69%], $P<0.001$) and increased at a rate of 6% per year. Sudden deaths were predominantly due to cardiovascular disease (1049 [56%]), but causes also included blunt trauma that caused structural damage (416 [22%]), commotio cordis (65 [3%]), and heat stroke (46 [2%]). Among the 1049 cardiovascular deaths, the highest number of events in a single year was 76 (2005 and 2006), with an average of 66 deaths per year (range 50 to 76) over the last 6 years. 29% occurred in blacks, 54% in high school students, and 82% with physical exertion during competition/training, whereas only 11% occurred in females (although this increased with time; $P=0.023$). The most common cardiovascular causes were hypertrophic cardiomyopathy (36%) and congenital coronary artery anomalies (17%).

Conclusions—In this national registry, the absolute number of cardiovascular sudden deaths in young US athletes was somewhat higher than previous estimates but relatively low nevertheless, with a rate of <100 per year. These data are relevant to the current debate surrounding preparticipation screening programs with ECGs and also suggest the need for systematic and mandatory reporting of athlete sudden deaths to a national registry. (***Circulation***. **2009;119:1085-1092.**)

Key Words: cardiomyopathy ■ death, sudden ■ cardiovascular diseases

Editorial

Preparticipation Screening of Competitive Athletes

Seeking Simple Solutions to a Complex Problem

Paul D. Thompson, MD

would occur while waiting. And that is the key issue. Is extensive preparticipation screening a solution for a major problem or a solution in search of a problem?

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Incidence of Sudden Cardiac Death in National Collegiate Athletic Association Athletes

Kimberly G. Harmon, Irfan M. Asif, David Klossner and Jonathan A. Drezner

Circulation 2011;123;1594-1600; originally published online Apr 4, 2011;
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http://circ.ahajournals.org/cgi/content/full/123/15/1594

unknown causes. Cardiovascular-related sudden death was the leading cause of death in 45 (56%) of 80 medical cases, and represented 75% of sudden deaths during exertion. The incidence of SCD was 1:43 770 participants per year. Among NCAA Division I male basketball players, the rate of SCD was 1:3100 per year. Thirty-nine (87%) of the 45

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- How Frequent is Exercise-Related SCD ?
- What is the Evidence ECG Screening Does / Does Not Work ?
- What Probably Does Work ?

Trends in Sudden Cardiovascular Death in Young Competitive Athletes After Implementation of a Preparticipation Screening Program

Domenico Corrado, MD, PhD
Cristina Basso, MD, PhD
Andrea Pavei, MD
Pierantonio Michieli, MD, PhD
Maurizio Schiavon, MD
Gaetano Thiene, MD

Context A nationwide systematic preparticipation athletic screening was introduced in Italy in 1982. The impact of such a program on prevention of sudden cardiovascular death in the athlete remains to be determined.

Objective To analyze trends in incidence rates and cardiovascular causes of sudden death in young competitive athletes in relation to preparticipation screening.

Design, Setting, and Participants A population-based study of trends in sudden cardiovascular death in athletic and nonathletic populations aged 12 to 35 years in the Veneto

JAMA 2006; 296: 1593-1601

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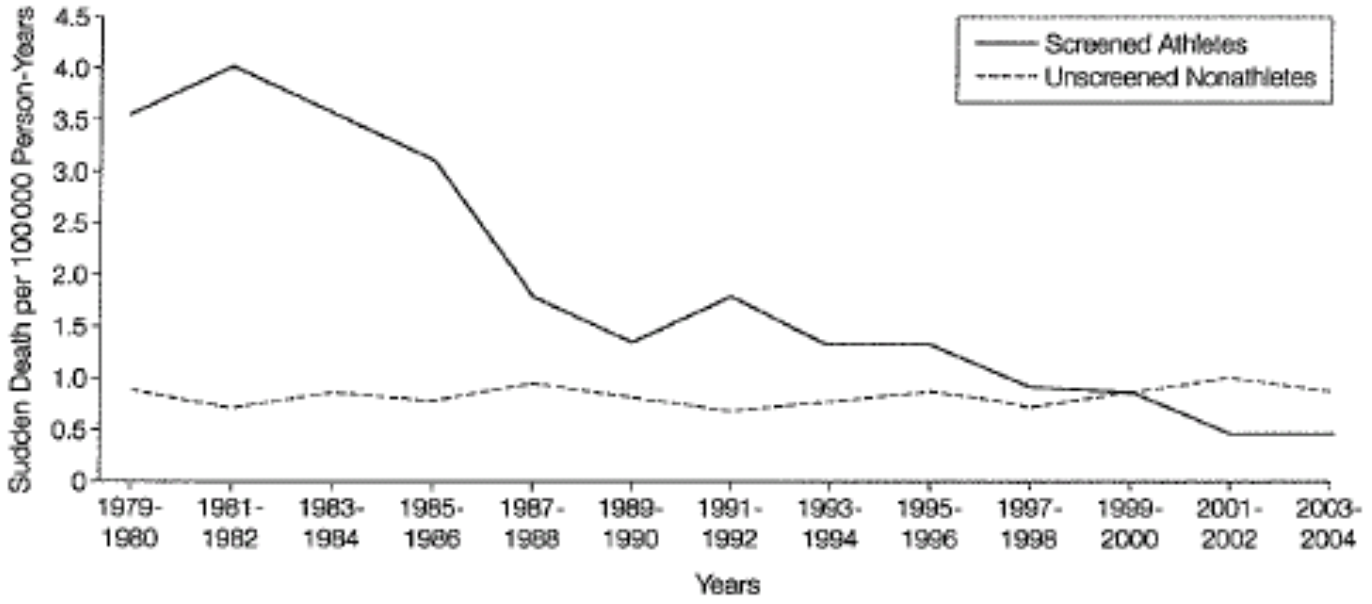
Figure. Annual Incidence Rates of Sudden Cardiovascular Death in Screened Competitive Athletes and Unscreened Nonathletes Aged 12 to 35 Years in the Veneto Region of Italy (1979-2004)



During the study period, the annual incidence of sudden cardiovascular death decreased by 89% in screened athletes (P for trend $<.001$). In contrast, the incidence rate of sudden cardiovascular death did not demonstrate consistent changes over time in unscreened nonathletes.

JAMA 2006; 296: 1596

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Screening With ECG

- Both AHA & Europeans Recommend Screening
- Only Europeans Recommend ECG
- Corrado et al Reported a Decrease from 1 Death Per 27,777 Athletes '70-81 to 1 Per 250,000 Athletes '03-04.
- Primarily Due to CM & ARVD
- 9% Needed More Tests
- 2% Excluded

Corrado et al VS Thompson & Levine, JAMA 2006

Protecting Athletes From Sudden Cardiac Death

Paul D. Thompson, MD
Benjamin D. Levine, MD

in deaths among nonathletes, suggesting that this reduction was not due to changes in the population death rate. Most of the decrease in death was due to fewer deaths at-

JAMA, 2006; 296: 1648.

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Sounds Pretty Convincing

- Population Based Observational Study
- Using Different Populations
- No Direct ECG Yeah/Neah Comparison
- Other Things Changed - ARVD – 1977
- Italy is Not USA - Different Diseases & Doctors
- Their Best Rate is Our Present Rate
- Are Asymptomatic Folks the Same as Symptomatic

Thompson & Levine, JAMA 2006

Comparison of U.S. and Italian Experiences With Sudden Cardiac Deaths in Young Competitive Athletes and Implications for Preparticipation Screening Strategies

Barry J. Maron, MD[a,*], Tammy S. Haas, RN[a], Joseph J. Doerer, BS[a], Paul D. Thompson, MD[b], and James S. Hodges, PhD[c]

Controversy has evolved over the most practical and effective strategy for preparticipation cardiovascular screening of competitive athletes to detect unsuspected cardiovascular disease and prevent sudden death on the athletic field. Athlete screening in the Veneto region of Italy is part of a national program (with 12-lead electrocardiography) that has reported the detection of previously undiagnosed hypertrophic cardiomyopathy and a decrease in the cardiovascular death rate in young athletes. In this study, over time periods of similar length, cardiovascular-related mortality rates in Veneto athletes were compared with those of a demographically similar region of the United States (Minnesota) in which screening is limited to history and physical examination. There were 55 sudden cardiovascular deaths reported in Veneto over 26 years (2.1/year), compared with 22 deaths in 23 years (0.96/year) in Minnesota. Over the recent and comparable 11-year period, 1993 to 2004, 12 deaths were reported in Veneto and 11 in Minnesota. When analyzed as deaths per 100,000 person-years, Veneto exceeded Minnesota for all years combined (1.87 for 1979 to 2004 vs 1.06 for 1985 to 2007, respectively, $p = 0.006$), although the 2 regions did not differ significantly for 1993 to 2004 (0.87 vs 0.93, respectively, $p = 0.88$) or most recently for 2001 to 2004 (0.43 vs 0.90, respectively, $p = 0.38$). In conclusion, sudden cardiovascular deaths in young competitive athletes occurred at a low rate in both Veneto and Minnesota. Despite different preparticipation screening strategies, athlete sudden death rates in these demographically similar regions of the United States and Italy have not differed significantly in recent years. These data do not support a lower mortality rate associated with preparticipation screening programs involving routine electrocardiography and examinations by specially trained personnel. © 2009 Elsevier Inc. (Am J Cardiol 2009;104:276–280)

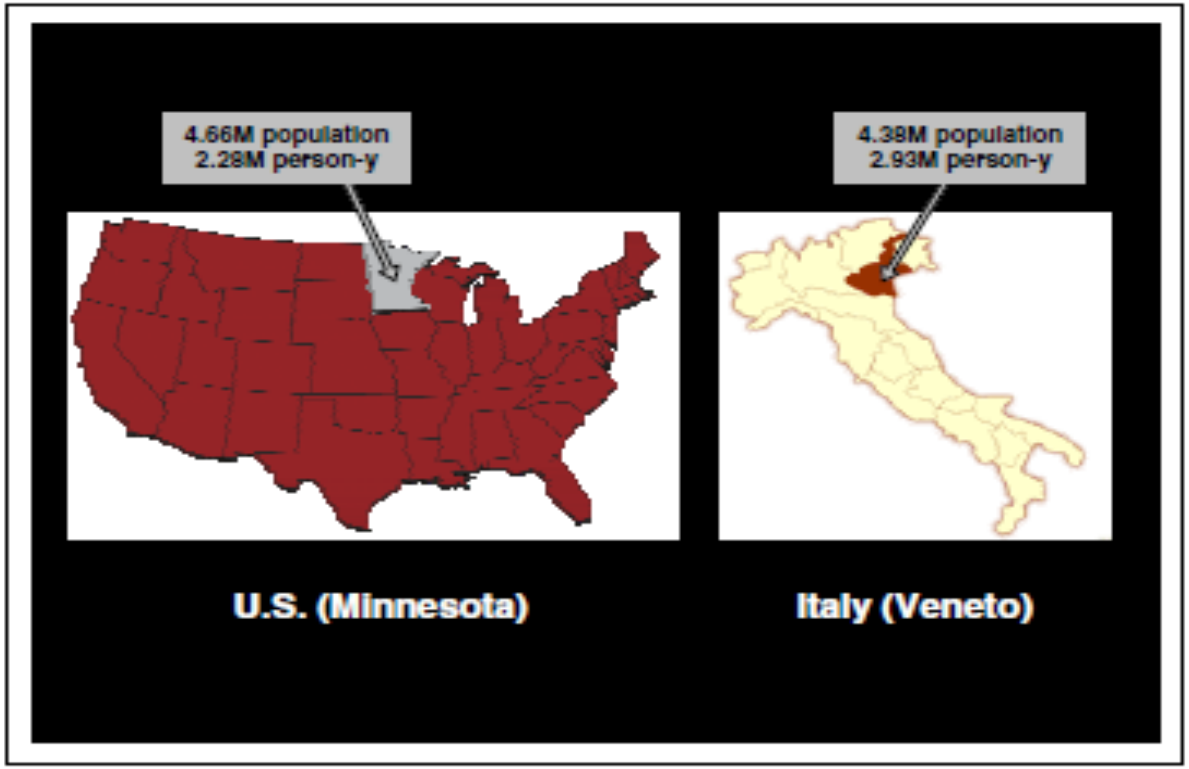

Figure 1. The Veneto region in Italy and the state of Minnesota (United States) have similar population demographics and athletic populations (in person-years), suitable for comparison of sudden death rate estimates in young athletes. M = million.

Maron et al AJC 2009

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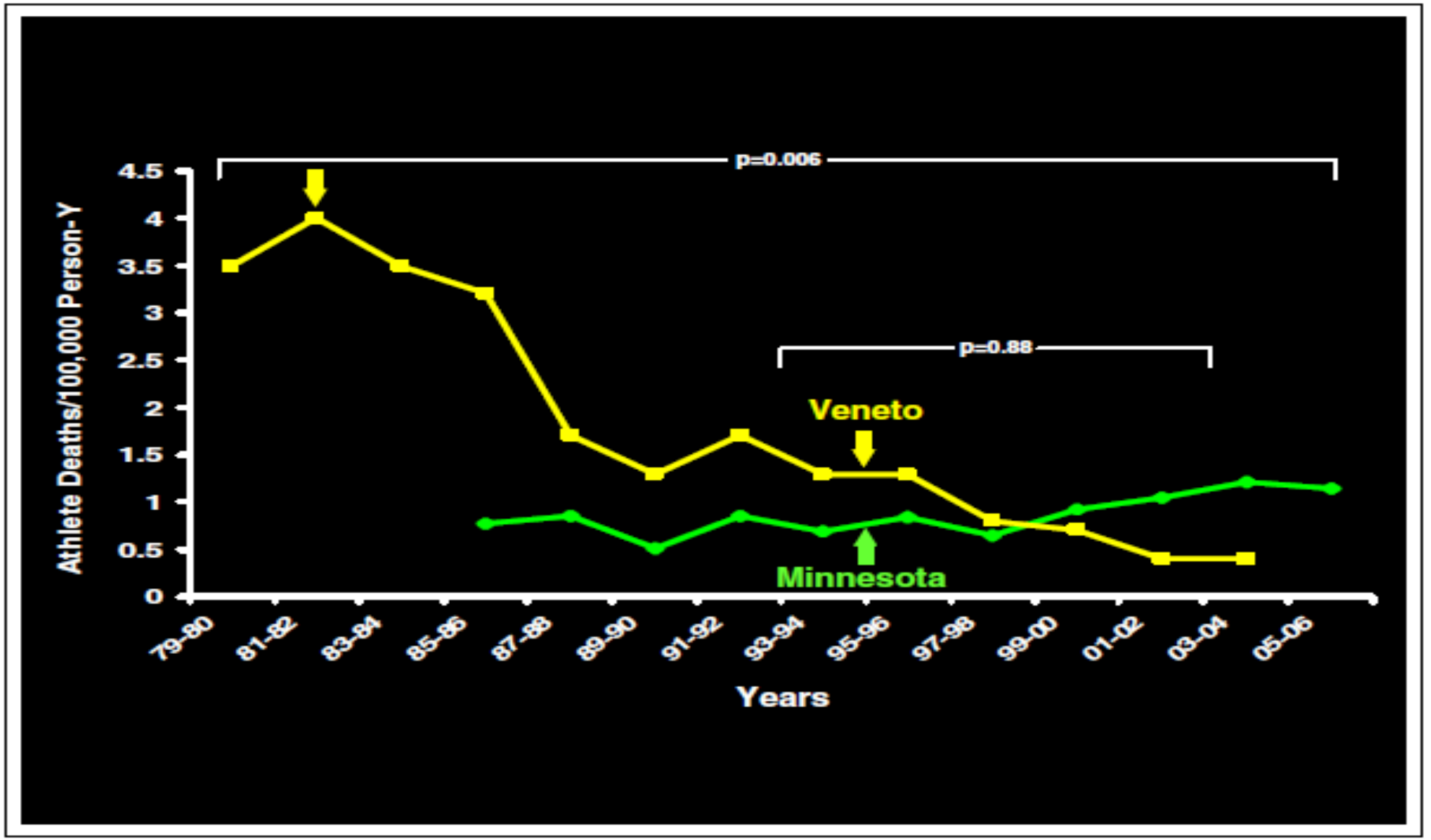

Figure 2. Plot comparing annual athlete mortality per 100,000 person-years in Veneto region and Minnesota. Italian national preparticipation screening began in 1981 *(arrow)*.

Maron et al AJC 2009

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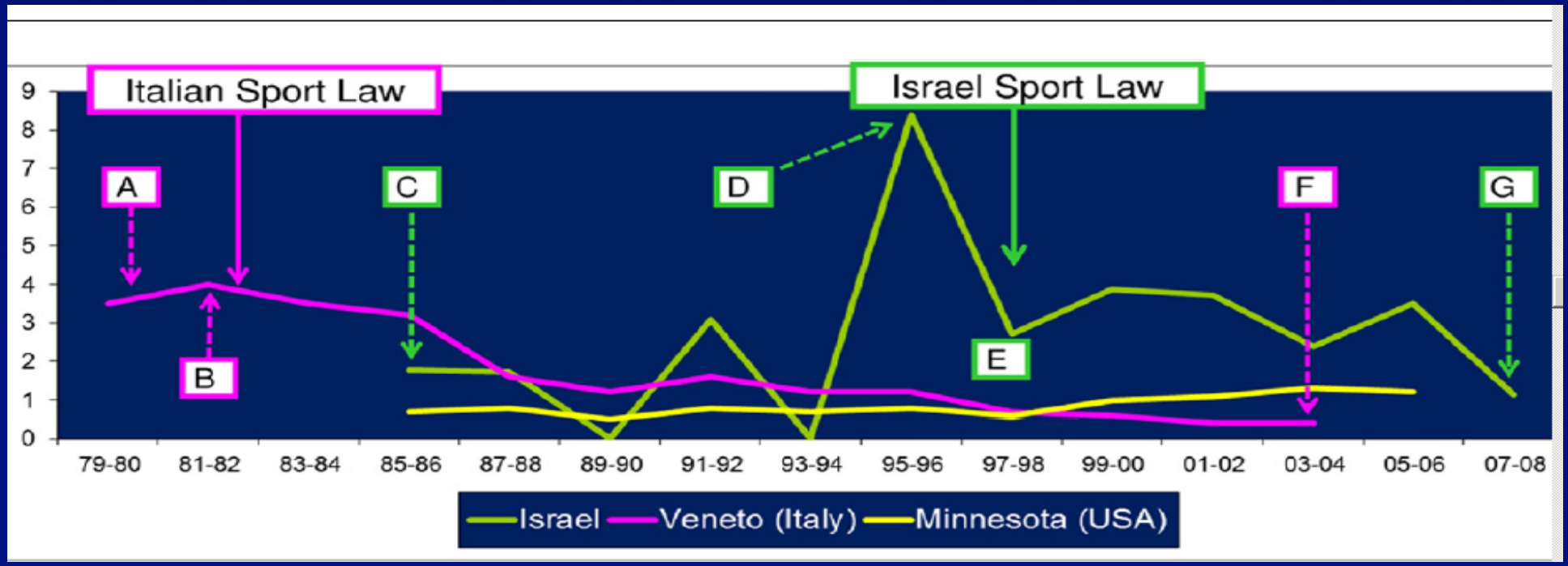
Mandatory Electrocardiographic Screening of Athletes to Reduce Their Risk for Sudden Death

Proven Fact or Wishful Thinking?

Arie Steinvil, MD,* Tamar Chundadze, MD,* David Zeltser, MD,* Ori Rogowski, MD,* Amir Halkin, MD,† Yair Galily, PHD,‡ Haim Perluk, MD,§ Sami Viskin, MD†

Tel-Aviv, Israel

JACC 2011



J Am Coll Cardiol 2011; 57:1291–6

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Tel-Aviv, Israel

Mandatory ECG Screening Had No Apparent Effect on Athletes' SCD

JACC 2011

What Are the Risks of Mandatory Screening ?

- False Positive Results
- Diagnostic Creep - Ivy League
- Cost … Deductibles
- Patient / Parental Anxiety - Sometimes Persistent
- Unnecessary Restriction
- Medical Misadventurism - Pacemakers, Defibrillators, Ablations

The Key Problem With Screening ?

Athletes Are Really Different

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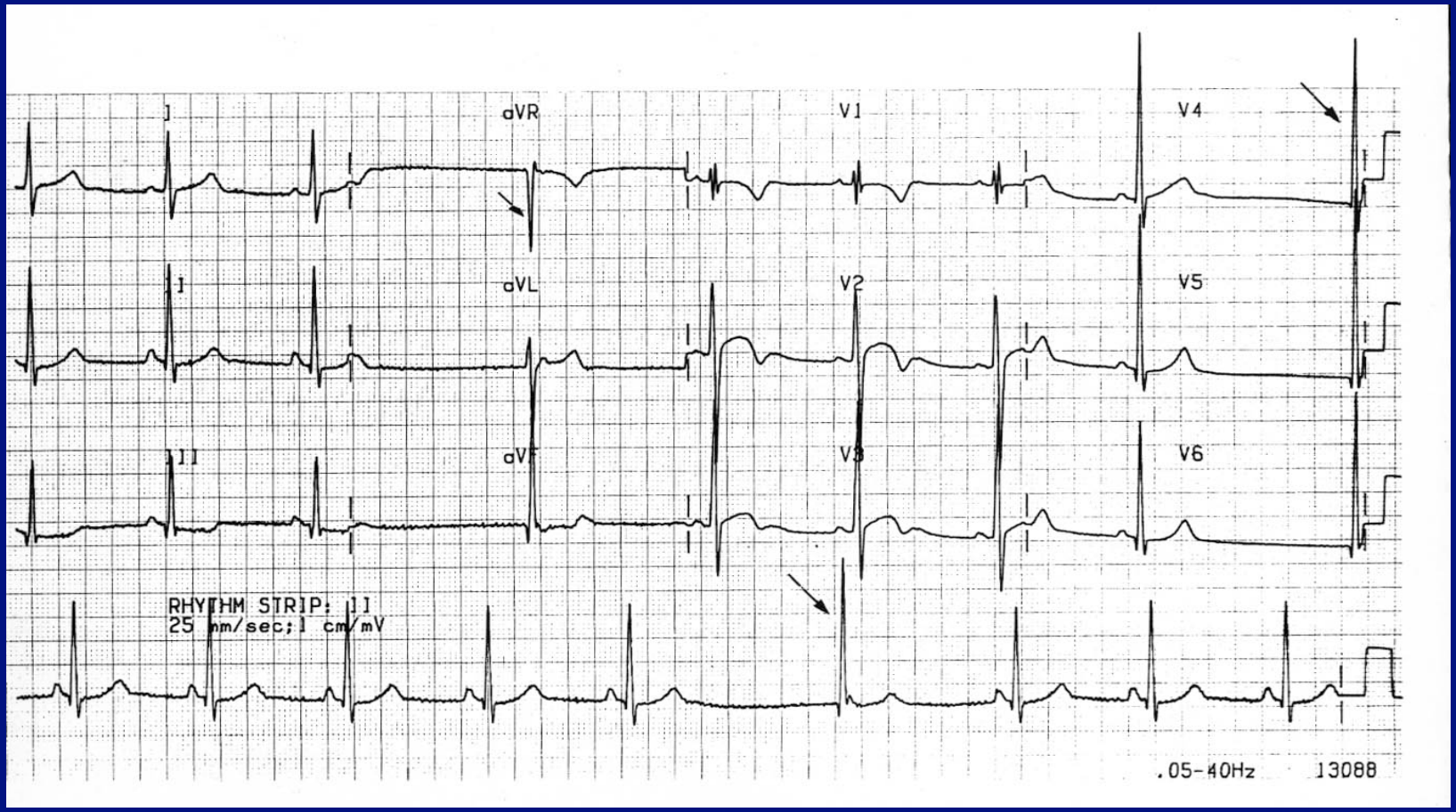

28 year old 2:17 marathoner - chest discomfort

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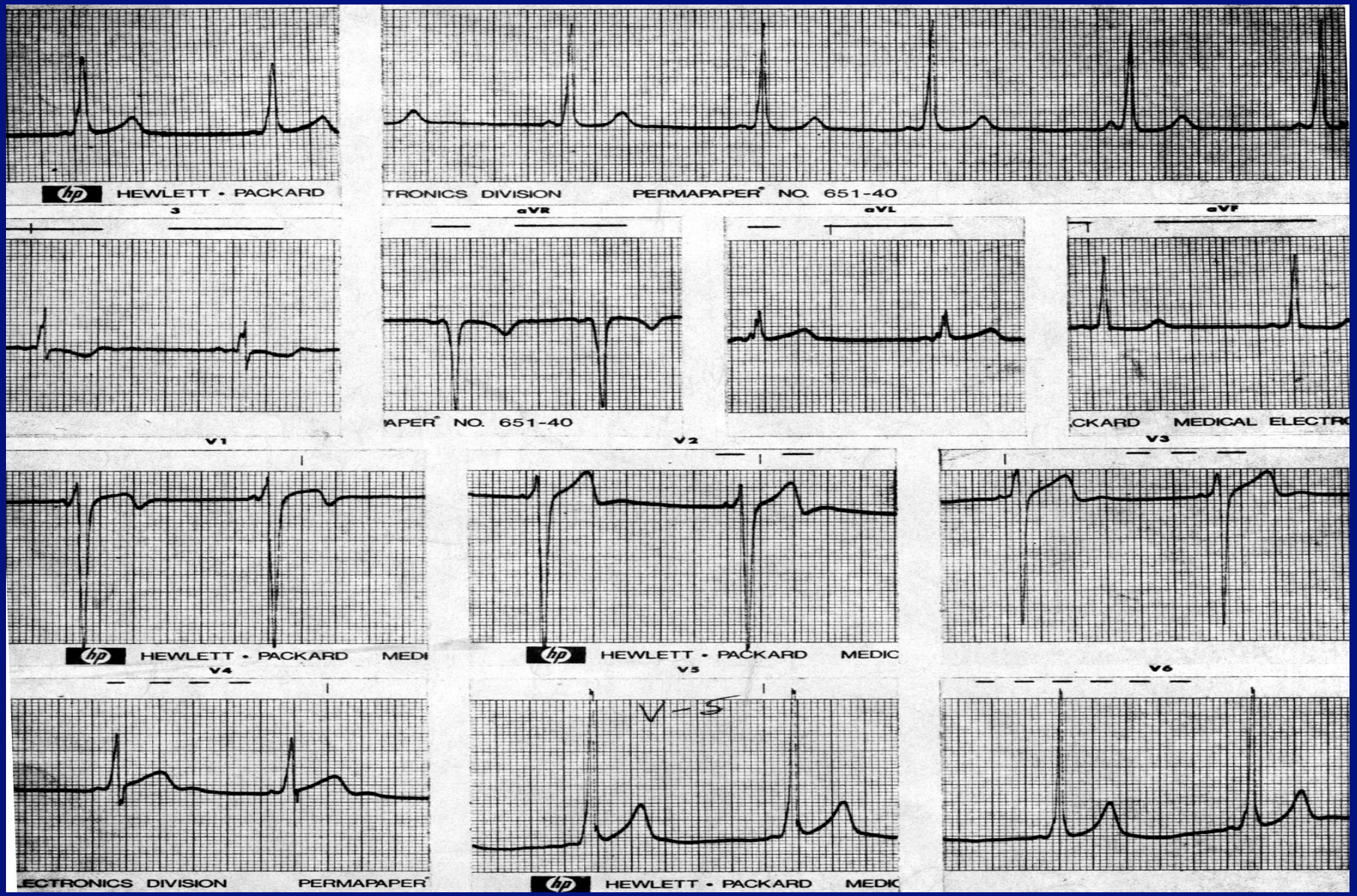

16 year old miler

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WPW Pattern is More Common In Endurance Athletes

Huston NEJM 1985

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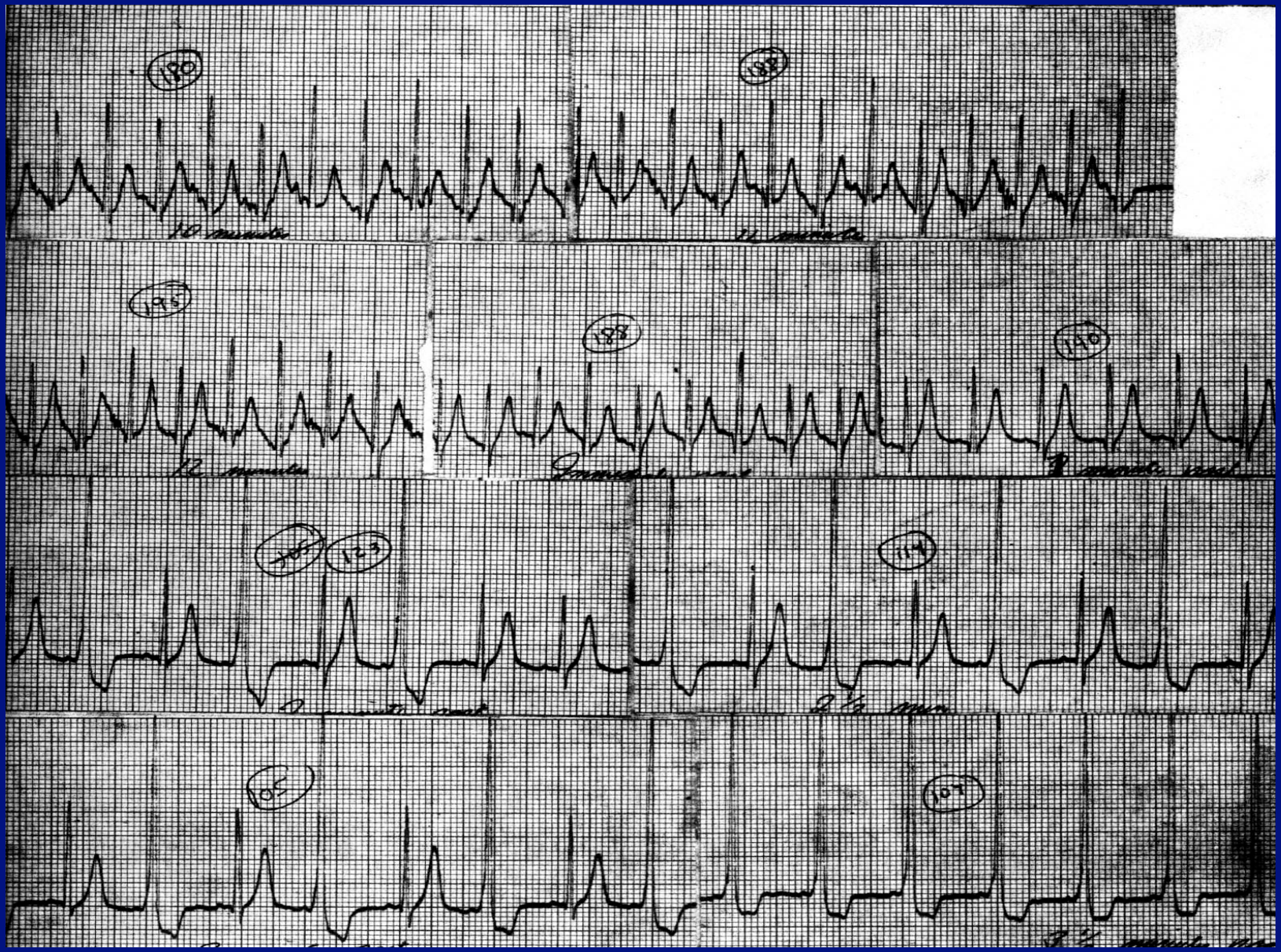

16 year old miler

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The QT Interval is Longer in Endurance Athletes

Because of Their Bradycardia

Institute of Sports Science
Rome, Italy

- 1971 Law Requires Medical Screening For Athletes
- Medical History, PE, ECG, Step Test
- 24 Hour ECG, Echo, Stress Test

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Abnormal ECG's

952 Italian National Athletes

375 "Abnormal"

Pelliccia Circ 2000

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Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

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

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

Circulation. 2014;129:1637-1649; originally published online March 11, 2014;

Criteria	Blacks	Whites
ESC	40%	16%
Seattle	18%	7%
Refined	11%	5%

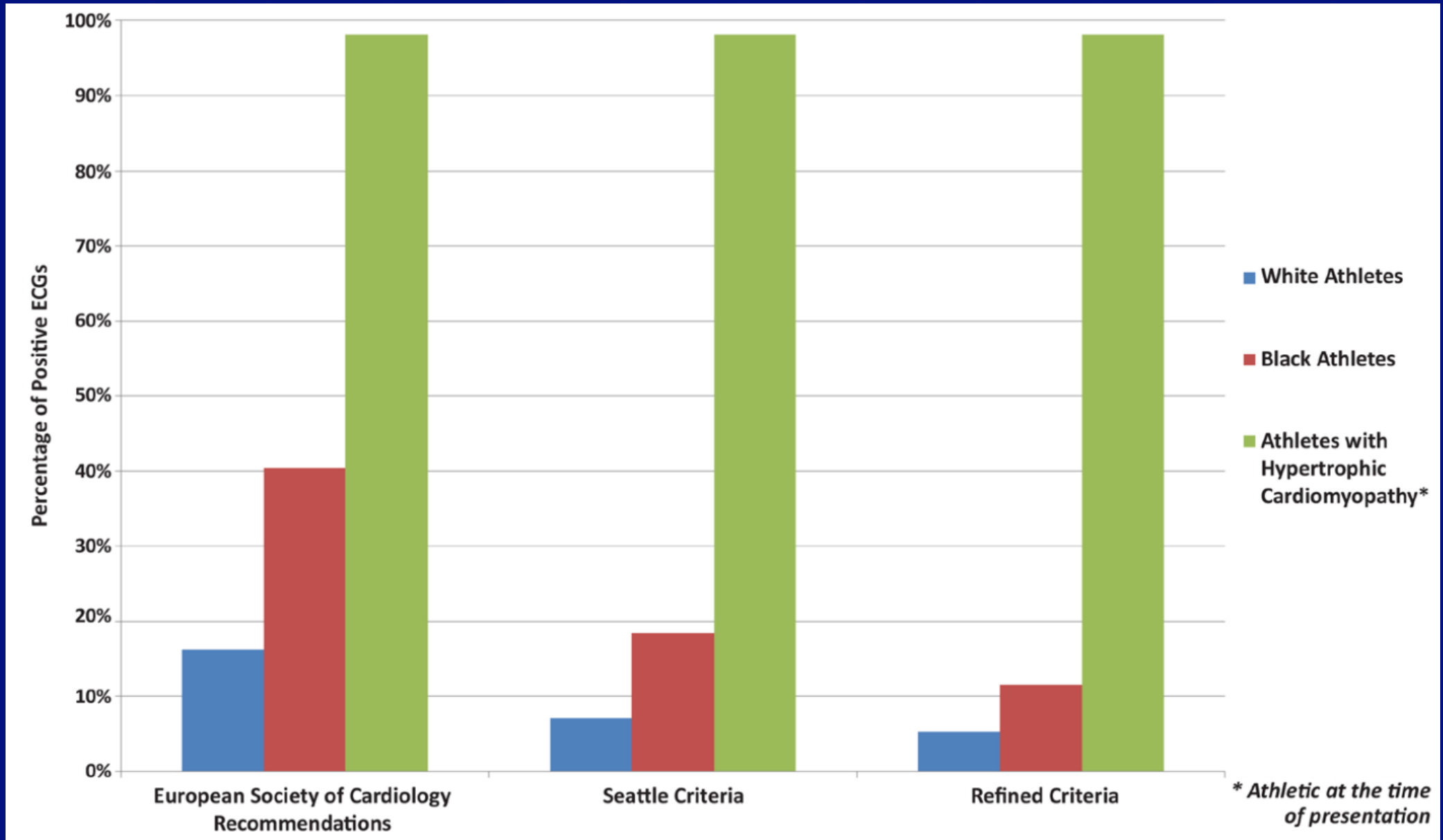

Figure 2. The number of positive ECGs produced by the 3 different ECG screening criteria.

Circulation. 2014;129:1637-1649; originally published online March 11, 2014;

Improved ECG Interpretation in Athletes

- In Expert Hands…Still 5%
- But Experts Don't Read ECGs
- Computers Read ECGs

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Assessment of the 12-Lead ECG as a Screening Test for Detection of Cardiovascular Disease in Healthy General Populations of Young People (12–25 Years of Age): A Scientific Statement From the American Heart Association and the American College of Cardiology

Table 1. The 14-Element AHA Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes

Medical history*

Personal history

1. Chest pain/discomfort/tightness/pressure related to exertion
2. Unexplained syncope/near-syncope†
3. Excessive and unexplained dyspnea/fatigue or palpitations, associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure
6. Prior restriction from participation in sports
7. Prior testing for the heart, ordered by a physician

Family history

8. Premature death (sudden and unexpected, or otherwise) before 50 y of age attributable to heart disease in ≥1 relative
9. Disability from heart disease in close relative <50 y of age
10. Hypertrophic or dilated cardiomyopathy, long-QT syndrome, or other ion channelopathies, Marfan syndrome, or clinically significant arrhythmias; specific knowledge of genetic cardiac conditions in family members

Physical examination

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

My First 2 Questions to the Fellow….

- Was This Found on Screening ?
- Does The Athlete Have Any Symptoms ?

If They Are Worried...

I Am Worried

The Benefits of Exercise Training Can Be Overestimated

HARTFORD HOSPITAL

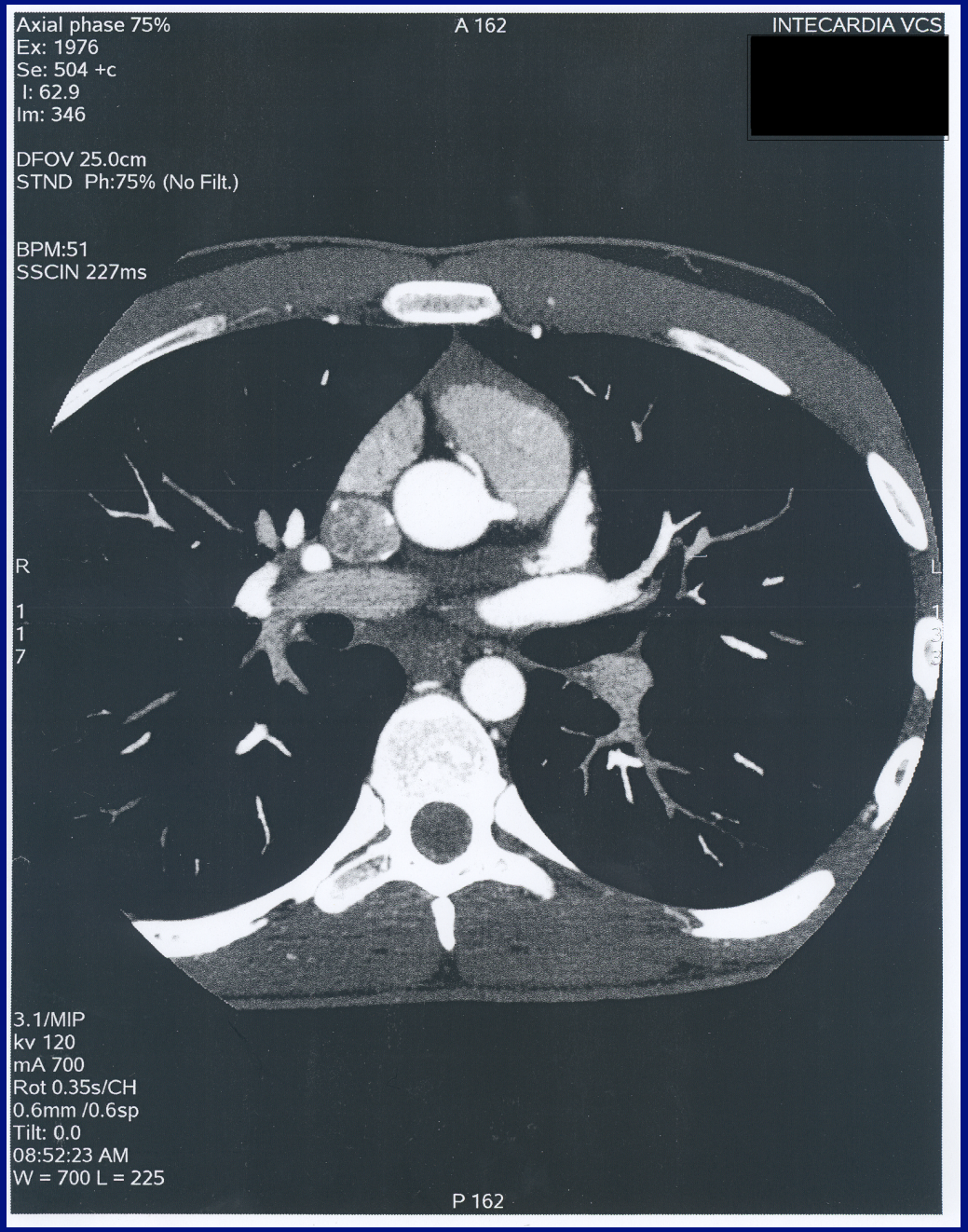
Patient MS

- 21 yrs Collegiate Distance Runner
- 5K in 15:20
- "Syncope" 7 yrs Ago During 1200 m Intervals
- Attributed to Heat Stroke
- Presents with Rest (4hr) Chest Discomfort
- "Not a Pain" - "Someone Sitting on My Chest"

HARTFORD HOSPITAL

Right

21 YO
Runner



Left

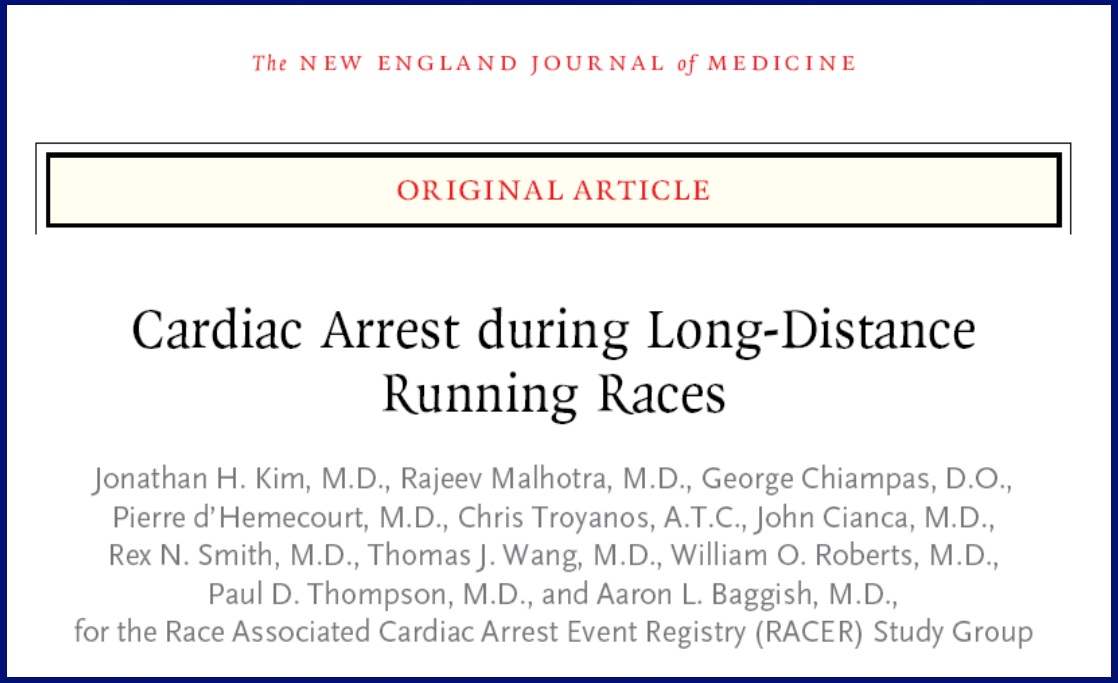
At Surgery There Was Palpable Atherosclerosis In Right Coronary Artery

What About Genetic Screening ?

- Routine Screening… Trouble
- Because of VUS (Variants of Unknown Significance)
- Best Approach - Testing the in Proband
- Only About 50% Have a Known Gene
- If A Gene is Found …. Test the Kids
- To Obviate Further Surveillance

What Probably Works ??

- Paying Attention to Symptoms
- Universal CPR



The NEW ENGLAND JOURNAL of MEDICINE

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

- **Cardiac Arrests - US Full & ½ Marathons Over 10 Years**
- **Higher in Men - 0.90 vs 0.16 per 100,000**
- **Bystander CPR & Non - HCM Predicted Survival**

NEJM-2012;366:130-40

Sudd During

Par e Age

Circ 4-1391

	Sports-Associated SCA (n=63)	Non–Sports-Associated SCA (n=1184)	*P* Value
Public occurrence, n (%)	55 (90)	242 (22)	<0.001
Sudden death witnessed, n (%)	55 (87)	614 (52)	<0.001
Bystander CPR, n (%)	28 (44)	300 (25)	0.001
First rhythm recorded on preadmission ECG, n (%)			<0.001
Ventricular fibrillation	42 (84)	437 (51)	
Asystole	4 (8)	180 (21)	
Pulseless electric activity	4 (8)	228 (27)	
Undetermined	0 (0)	9 (1)	
Call to EMS arrival			
Mean±SD, min	6.79±4	6.80±4	0.99
≤8 min, n (%)	34 (77)	631 (79)	0.44
ROSC, n (%)	24 (39)	241 (29)	0.11
Survival to hospital discharge, % (95% CI)	23.2 (11.8–34.6)	13.6 (11.6–15.5)	0.04

Sudden Cardiac Arrest During Sports Activity in Middle Age

16% Had Known Disease
36% Had Typical CV Symptoms

Saving Athlete's Hearts Screening +

Paul D. Thompson, MD, FACC
Chief of Cardiology, Hartford Hospital
Physician Co-Director, Hartford Healthcare Cardiovascular Institute
Hartford, CT