Cardiac Care of the Athlete: New Fronter or Refining the Focus?

Matthew W. Martinez, MD FACC

Sports Cardiology Medical Director

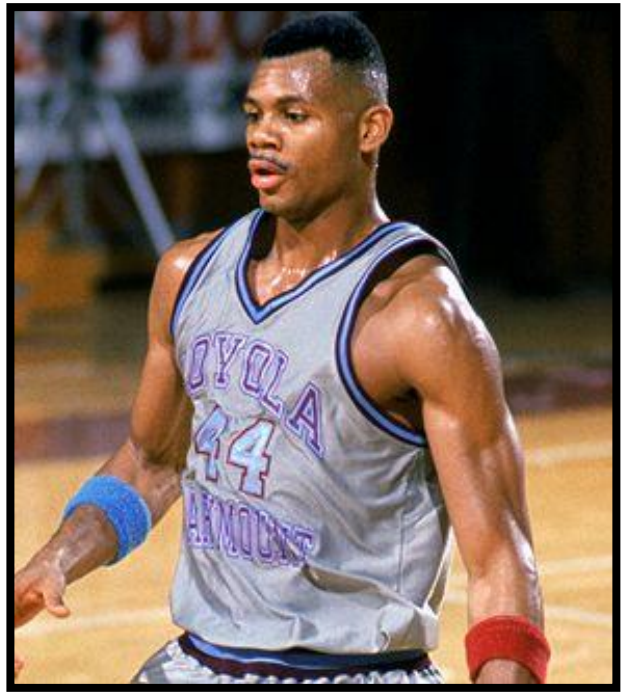
HCM Medical Director

Team Cardiologist - New York Jets

Cardiologist – Major League Soccer, NFL Medical committee, NBPA, JETS

twitter @mmartinezheart

ATLANTIC HEALTH SYSTEM



Hank Gathers
SCA March 4, 1990

Italian soccer captain found dead before game

By Associated Press March 4, 2018

Keyontae Johnson
2020 collapse

News › UK › Home News

London Marathon death: Matt Campbell, aged 29, dies after collapsing at mile 22

ATLANTIC HEALTH SYSTEM

ATLANTIC HEALTH SYSTEM

PRO BASKETBALL

The N.B.A. Is the First League to Begin Standardized Cardiac Screening

By HOWARD BECK SEPT. 17, 2006

FIFA 2006 Pilot

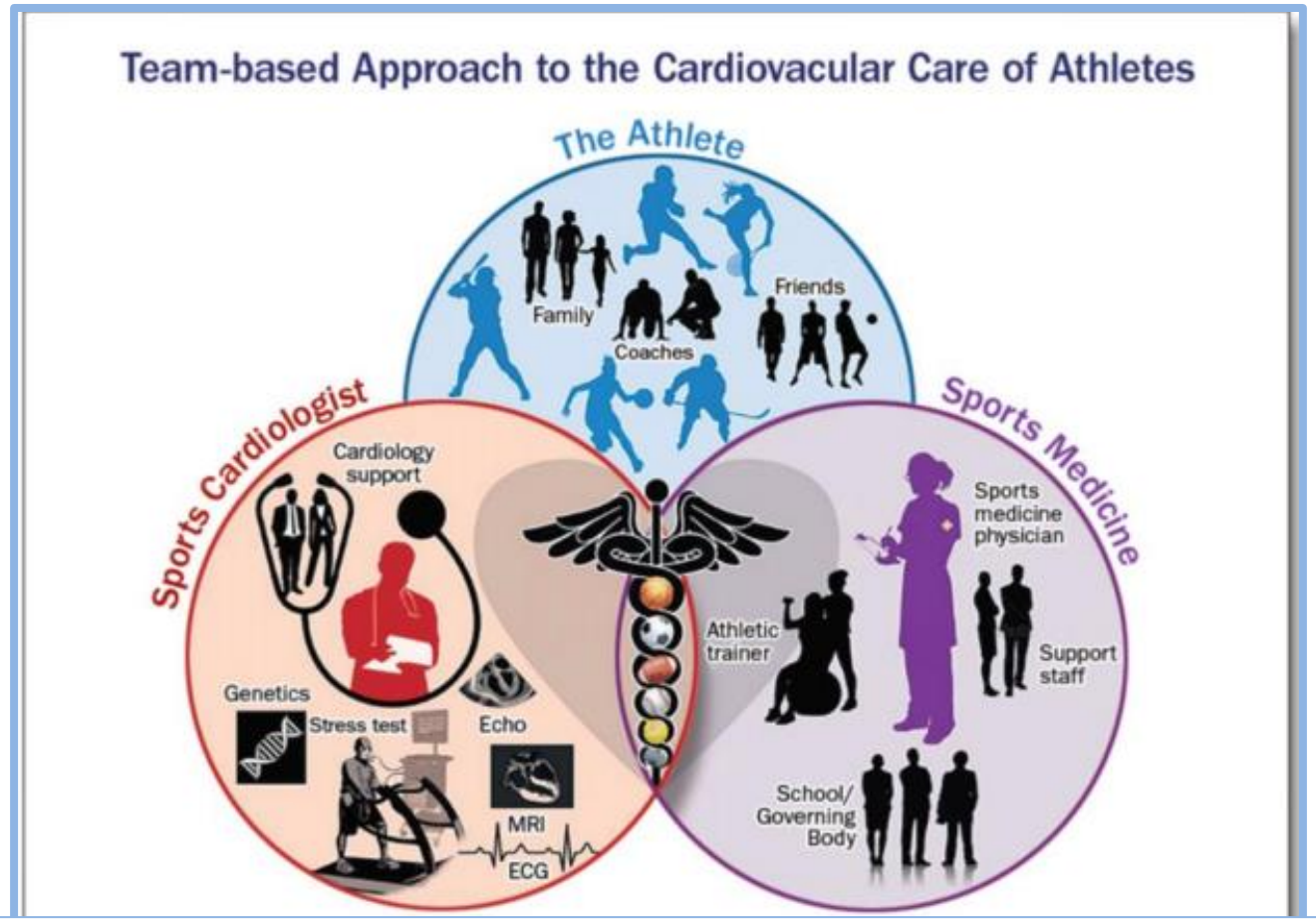
JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
© 2017 BY THE AMERICAN COLLEGE OF CARDIOLOGY FOUNDATION
PUBLISHED BY ELSEVIER

VOL. 69, NO. 11, 2017
ISSN 0735-1097/$36.00
http://dx.doi.org/10.1016/j.jacc.2017.02.009

FELLOWS-IN-TRAINING & EARLY CAREER PAGE

The Emergence of Sports Cardiology as a Specialty

Care of the Athlete

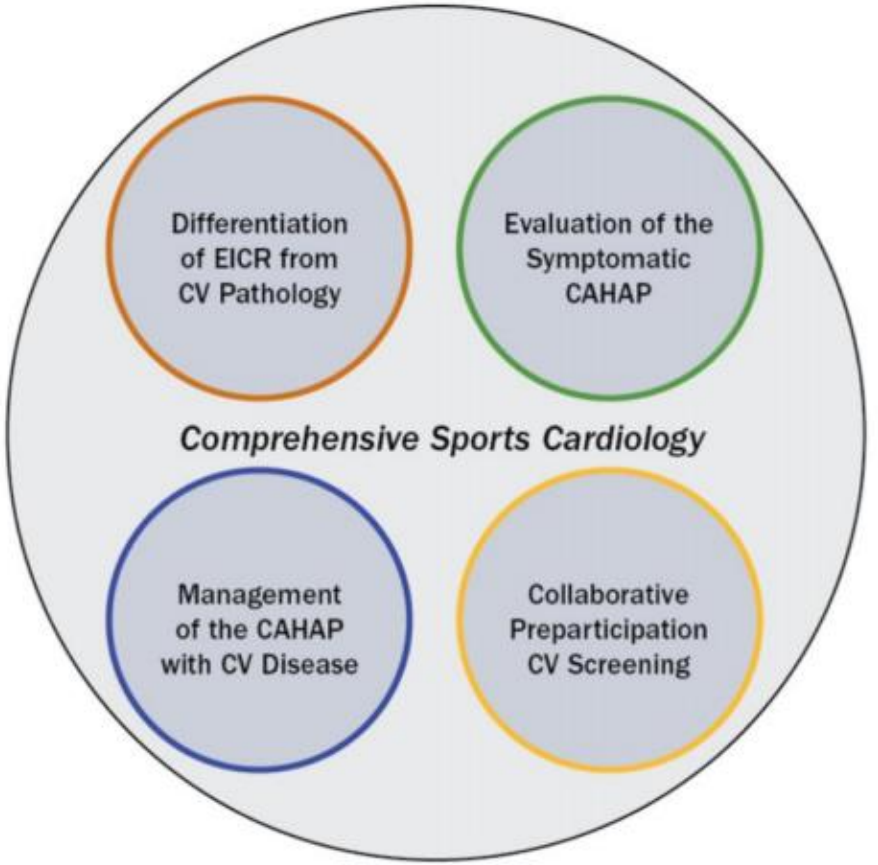


Multidisciplinary Athlete-Centered Care ("Athlete Care Team") in Evaluating and Managing Athletes at Risk of SCD

ATLANTIC HEALTH SYSTEM

Emery MS, Kovacs RJ. Sudden cardiac death in athletes. JACC Heart Fail 2018;6:30-40

Overview of Fundamental Core Competencies in Sports Cardiology



CAHAP = competitive athletes and highly active people; CV = cardiovascular; EICR = exercise-induced cardiac remodeling.

J Am Coll Cardiol 2017;70:1902-18

Which Athletes Are Highest Risk?

ATLANTIC HEALTH SYSTEM

Incidence of Male vs. Female SCA/D

Author	Year	Age of cohort	# Male SCA/D	Person-Years	Male Incidence	# Female SCA/D	# Female Person-years	Female Incidence
Corrado	2003	12-35	46	1,904,490	1:41,402	5	464,100	1:92,820
Toresdahl*	2014	high school	16	924,000	1:57,750	2	652,828	1:326,414
Harmon	2015	college	64	2,418,563	1:37,790	15	1,823,899	1: 121,593
Harmon	2016	high school	92	4,124,525	1:44,832	12	2,850,115	1:237,510
Peterson*	2020	high school	176	7,732,032	1:43,932	28	5,706,008	1: 203,786
		college	32	1,116,992	1:34,906	7	862,946	1:123,278
Total			**426**	**18,220,602**	**1:42,771**	**69**	**12,359,896**	**1:179,129**

- Males are at 4x the risk of Females

- 86% of deaths occurred in Males

*Included both SCA and SCD

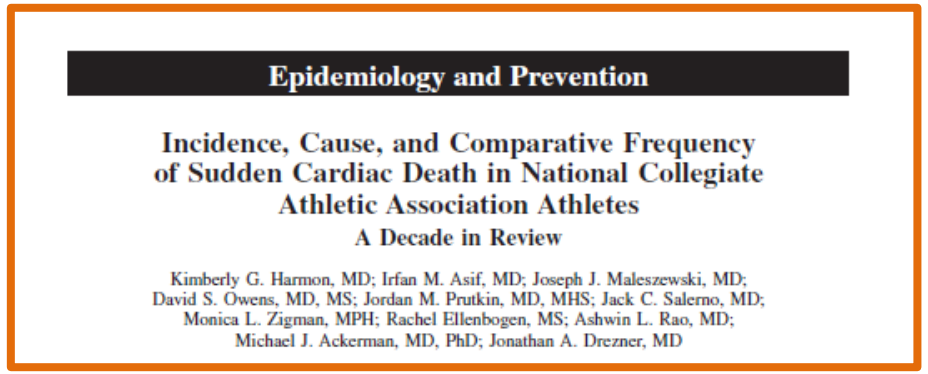
ATLANTIC HEALTH SYSTEM

Incidence of SCD in Athletes by Race

Study	Year Published	Years Studied	Age	Black	White	Relative Risk
Maron	2014	2002 - 2011	17-26	1:26,000	1:143,000	5.50
Harmon	2015	2003 - 2013	18-26	1:21,000	1:68,000	3.23
Peterson	2020	2014 – 2018	College	1:18,000 (males)	1:39,000 (males)	2.10

- Looked at NCAA college athletes
- Used similar databases

Incidence, Etiology and Comparative Frequency of NCAA Athletes: A Decade in Review



Epidemiology and Prevention

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

Sport	Incidence
Men's basketball	1 in 8,978
Men's soccer	1 in 23,689
Men's Football	1 in 35,951
Men's Swimming	1 in 42,784
Men's Cross-country	1 in 42,857
Men's Lacrosse	1 in 45,850
Women's Cross-country	1 in 47,089
Women's Volleyball	1 in 49,217
Men's Baseball	1 in 50,023
NCAA Athletes	1 in 53,703
Women's Swimming	1 in 57,611
Women's basketball	1 in 77,061
Men's track	1 in 120,521

Harmon, Circulation, 2015

ATLANTIC HEALTH SYSTEM

Comparison of Incidence Data in Male Sport

	Maron 2002-2011 (NCAA) SCD	Harmon 2003-2013 (NCAA) SCD	Peterson 2014-2018 (NCAA) SCA/D	Harmon 2007-2011 (high school) SCA/D	Peterson 2014-2018 (high school) SCA/D	Malhotra 1996-2016
American Football	1:39,000	1 :36,000			1:83,000	
Black			1:28,000			
White			1:20,000			
Male basketball		1:9,000		1:37,000	1:40,000	
Black		1:5,000	1:5,000			
White		1:15,000	1:15,000			
Male soccer		1:24,000			1:89,000	1:15,000

Which Athletes Are Highest Risk?

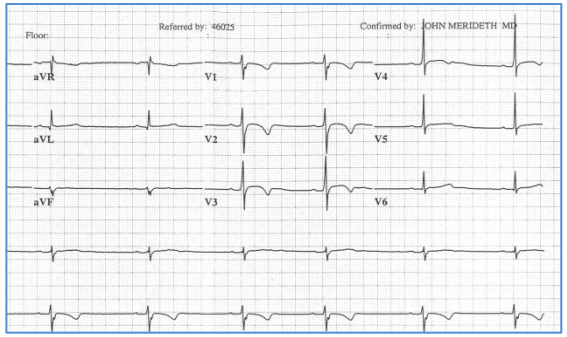
Male athletes

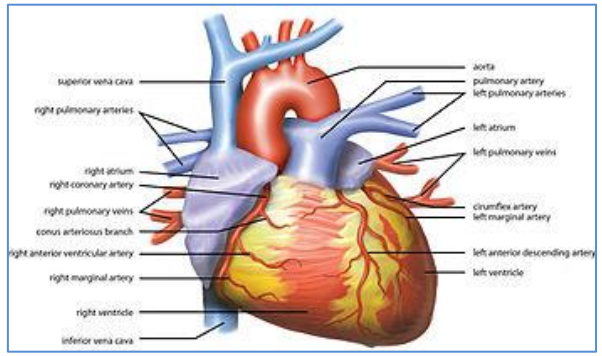
Black athletes

Male basketball, Soccer and American football athletes

ATLANTIC HEALTH SYSTEM

Sudden Cardiac Death in *Young* Athletes





Structural Abnormalities

Hypertrophic cardiomyopathy
RV cardiomyopathy
Artery anomalies
Marfan syndrome
Valve disease

Electrical Abnormalities

Wolff Parkinson White syndrome
Long QT syndrome
Brugada syndrome
CPVT

Acquired Abnormalities

Infection (myocarditis)
Trauma (commotio cordis)
Drugs
Environment (heat/cold)

ATLANTIC HEALTH SYSTEM

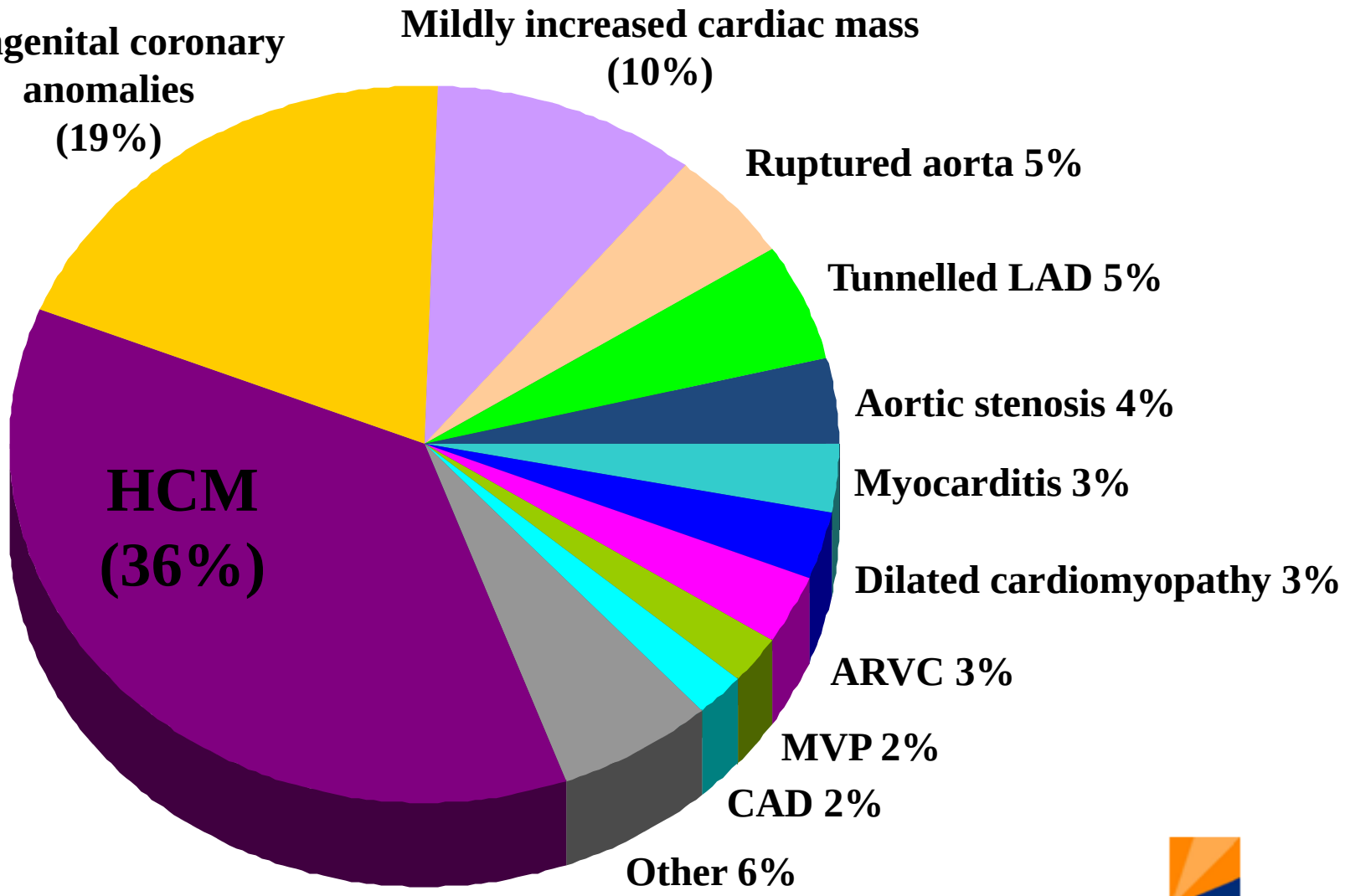
Traditional etiologies of SCD in Athletes (<40 years)

1980 - 2005

Multiple updates:
2007, 2009, 2016

N = 2406
Confirmed CV deaths = 840+

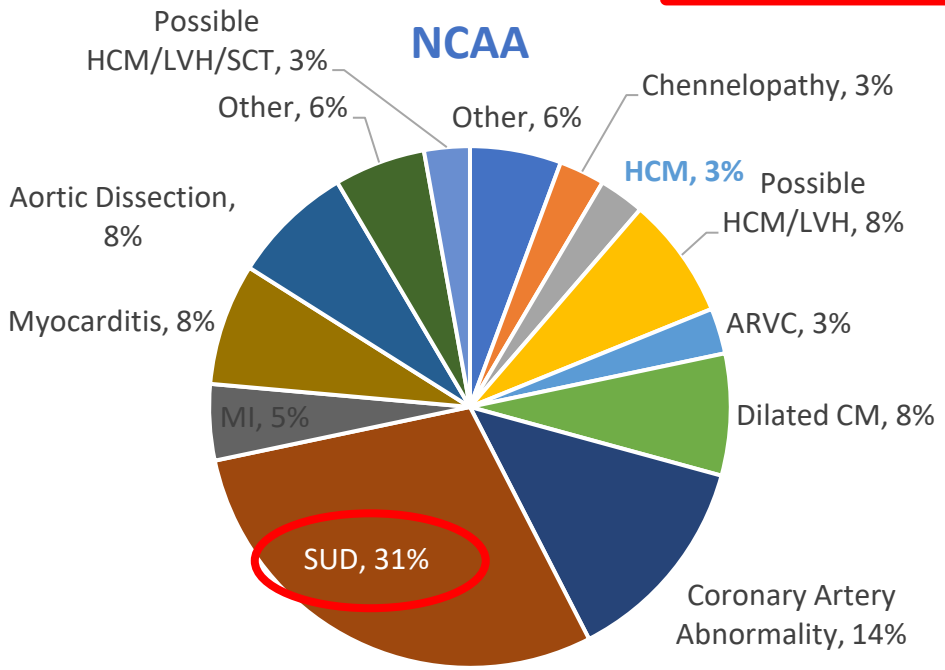
The data and message remains largely unchanged

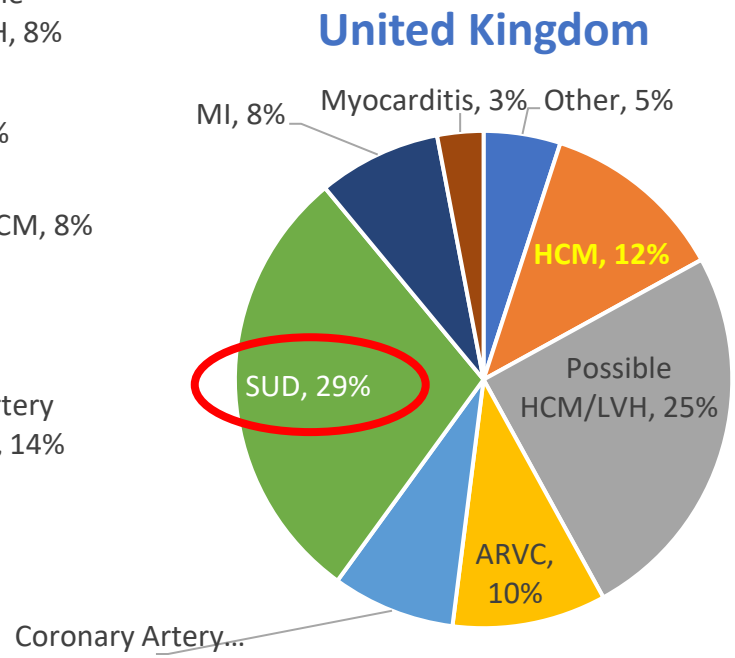


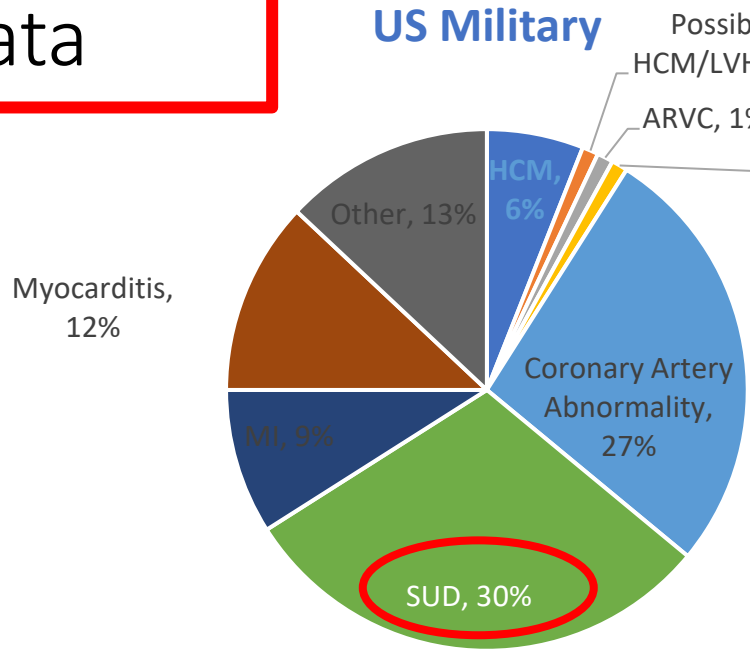
Maron BJ et al. *Circulation.* 1996;94:850-56.

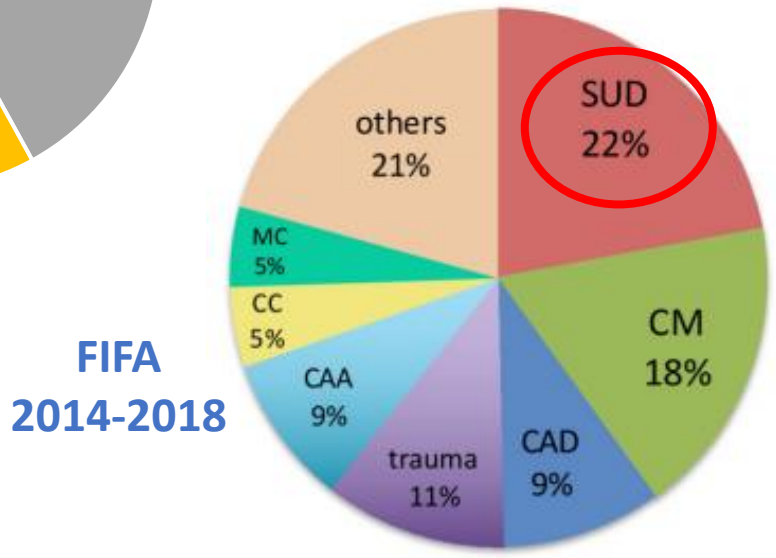
ATLANTIC HEALTH SYSTEM

Contemporary Estimates of SCD - > challenge prior data









Eckart RE et al. Ann Intern Med. 2004;141:829-834.
Harmon KG et al. Circ Arrhythm Electrophysiol. 2014;7:198-204.
De Noronha SV et al. Heart. 2009;95:1409-1414.

How to identify those at highest risk?

ATLANTIC HEALTH SYSTEM

Preparticipation evaluations

- HS, Collegiate, Elite/Pro
- PPE CV screening
- Comprehensive personal, family history and physical exam
  - AHA 14-point
- Additional testing
  - ECG, Echocardiogram, Cardiac MRI

PREPARTICIPATION PHYSICAL EVALUATION
HISTORY FORM
(Note: This form is to be filled out by the patient and parent prior to seeing the physician. The physician should keep this form in the chart.)
Date of Exam
Name
Date of birth

New Jersey Department of Education
ANNUAL ATHLETIC PRE-PARTICIPATION PHYSICAL EXAMINATION FORM
Part A: HEALTH HISTORY QUESTIONNAIRE-Completed by the parent and student and reviewed by examining provider
Part B: PHYSICAL EVALUATION FORM-Completed by examining licensed provider with MD, DO, APN or PA

Part A: HEALTH HISTORY QUESTIONNAIRE

Today's Date: _____ Date of Last Sports Physical: _____
Student's Name: _____ Sex: M F (circle one) Age: ___ Grade: ___
Date of Birth: ___/___/___ School: _____ District: _____
Sport(s): _____ Phone: _____ Home Phone: (___) _____
Provider Name (Medical Home): _____ Fax: _____

EMERGENCY CONTACT INFORMATION
Name of parent/guardian: _____ Relationship to student: _____ Phone (cell): _____
Phone (work): _____ Phone (home): _____
Additional emergency contact: _____ Relationship to student: _____ Phone (cell): _____
Phone (work): _____ Phone (home): _____

Directions: Please answer the following questions about the student's medical history by CIRCLING the correct response. Explain all "yes" responses on the lines below the questions. Please respond to all questions.

1. Have you ever had, or do you currently have:
   a. Restriction from sports for a health related problem? Y / N / Don't Know
   b. An injury or illness since your last exam? Y / N / Don't Know
   c. A chronic or ongoing illness (such as diabetes or asthma)? Y / N / Don't Know
      (1.) An inhaler or other prescription medicine to control asthma? Y / N / Don't Know
   d. Any prescribed or over the counter medications that you take on a regular basis? Y / N / Don't Know
   e. Surgery, hospitalization or any emergency room visit(s)? Y / N / Don't Know
   f. Any allergies to medications? Y / N / Don't Know
   g. Any allergies to bee stings, pollen, latex or foods? Y / N / Don't Know
      (1.) If yes, check type of reaction:
      ☐ Rash ☐ Hives ☐ Breathing or other anaphylactic reaction
      (2.) Take any medication/Epipen taken for allergy symptoms? (List below.) Y / N / Don't Know
   h. Any anemias, blood disorders, sickle cell disease/trait, bleeding tendencies or clotting disorders? Y / N / Don't Know
   i. A blood relative who died before age 50? Y / N / Don't Know

Explain all "yes" answers here (include relevant dates):

Cardiovascular Preparticipation Screening of Competitive Athletes

A Statement for Health Professionals From the Sudden Death Committee (Clinical Cardiology) and Congenital Cardiac Defects Committee (Cardiovascular Disease in the Young), American Heart Association

Barry J. Maron, Paul D. Thompson, James C. Puffer, Christopher A. McGrew, William B. Strong, Pamela S. Douglas, Luther T. Clark, Matthew J. Mitten, Michael H. Crawford, Dianne L. Atkins, David J. Driscoll, and Andrew E. Epstein

Originally published 15 Aug 1996 | Circulation. 1996;94:850–856

"The American Heart Association recommends that some form of preparticipation cardiovascular screening for high school and collegiate athletes

August 1996

Cardiovascular Preparticipation Screening of Competitive Athletes

A Statement for Health Professionals From the Sudden Death Committee (Clinical Cardiology) and Congenital Cardiac Defects Committee (Cardiovascular Disease in the Young), American Heart Association

Barry J. Maron, Paul D. Thompson, James C. Puffer, Christopher A. McGrew, William B. Strong, Pamela S. Douglas, Luther T. Clark, Matthew J. Mitten, Michael H. Crawford, Dianne L. Atkins, David J. Driscoll, and Andrew E. Epstein

Originally published 15 Aug 1996 | Circulation. 1996;94:850–856

"The American Heart Association recommends that some form of preparticipation cardiovascular screening for high school and collegiate athletes

"We conclude that a complete and careful personal and family history and physical examination . . . ***is the best available and most practical approach to screening populations of competitive sports participants"***

"The standard history and physical examination *intrinsically lack the capability to reliably identify many potentially lethal cardiovascular abnormalities*. Indeed, it is an unrealistic expectation that screening can reliably exclude most important cardiac lesions."

August 1996

ATLANTIC HEALTH SYSTEM


THE WALL STREET JOURNAL.

Subscribe Now | SPECIAL OFFER: JOI

Home World U.S. Politics Economy Business Tech Markets Opinion Arts Life Real Estate

A C-Section Designed for Mother-Baby Bonding

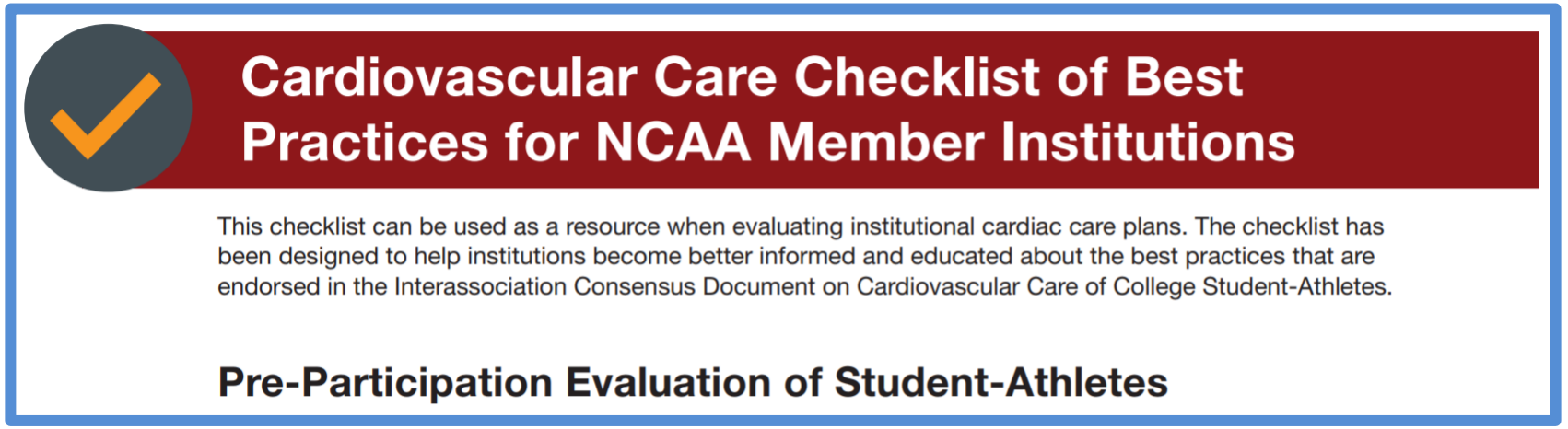
BONDS What Keeps Couples Happy Long Term

Stress Raises Cholesterol More Than You Think

LIFE | SPORTS

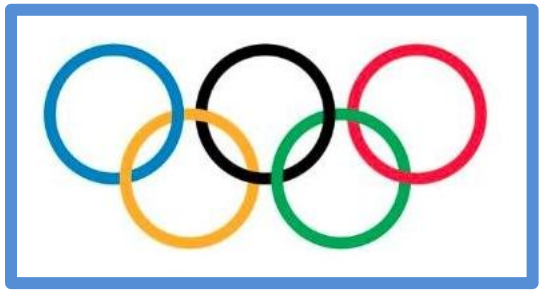
In the NCAA, a Push to Reform Health Standards

25 years after Hank Gathers's death, the NCAA's first-ever chief medical officer gets behind cardiac screening of athletes


Cardiovascular Care Checklist of Best Practices for NCAA Member Institutions

This checklist can be used as a resource when evaluating institutional cardiac care plans. The checklist has been designed to help institutions become better informed and educated about the best practices that are endorsed in the Interassociation Consensus Document on Cardiovascular Care of College Student-Athletes.

Pre-Participation Evaluation of Student-Athletes



Comparison of Screening Strategies for Elite Athletes

	IOC/ USOC	FIFA	MLB	MLS	NBA/ WNBA	NFL	NHL	Premier League
Combine					X	X	X	
H&P	X[ι]	X[ι]	X	X	X	X	X[ι]	X
ECG	X	X	X	X^	X	X	X	X^
Echo		X		X	X	X		X^
Stress test ECG	X*	X*						
Stress Echo					X			
Additional Testing As needed	X	X	X	X	X	X	X	X

ι Unique H&P; others use AHA
^ Every 2 years
* Stress ECG if >35 years old

ATLANTIC HEALTH SYSTEM

Home » About » Resources » Media Center » News

New guidance on preventing sudden cardiac death in athletes published

NCAA, medical specialists recommend all universities have well-rehearsed emergency action plan for sudden cardiac arrest

April 15, 2

TABLE 1 Cardiovascular Care Checklist of Best Practices for NCAA Member Institutions

Pre-Participation Evaluation of Student-Athletes
❑ The purpose of the evaluation, as stated in the *2014-15 NCAA Sports Medicine Handbook* (19), is explained to the student-athlete.
❑ The cardiac evaluation includes, at minimum, a comprehensive personal and family history, and physical examination, such as the AHA 14-point evaluation or the Pre-participation Physical Evaluation Monograph, Fourth Edition.
❑ The pre-participation evaluation is either conducted on campus under the supervision of the institution's director of medical services or is reviewed by a process that is supervised by the institution's director of medical services.
❑ If an ECG is included in addition to history and physical screening, best practices include:
❑ Pre-ECG screening planning is performed with a multidisciplinary team.
❑ The student athlete is provided an in-depth explanation for the rationale of ECG screening and the possible risk vs. benefit of adding ECG screening.
❑ Modern athlete-specific ECG interpretation standards are used.
❑ Skilled cardiology oversight is available.

ATLANTIC HEALTH SYSTEM

ATLANTIC HEALTH SYSTEM

Home » About » Resources » Media Center » News

New guidance on preventing sudden cardiac death in athletes published

NCAA, medical specialists recommend all universities have well-rehearsed emergency action plan for sudden cardiac arrest

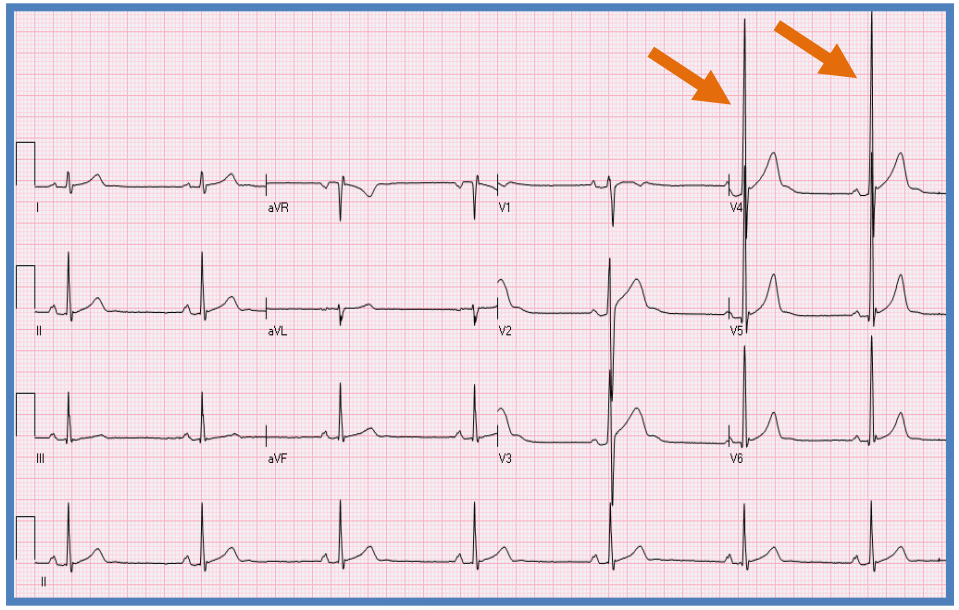
April 15, 20

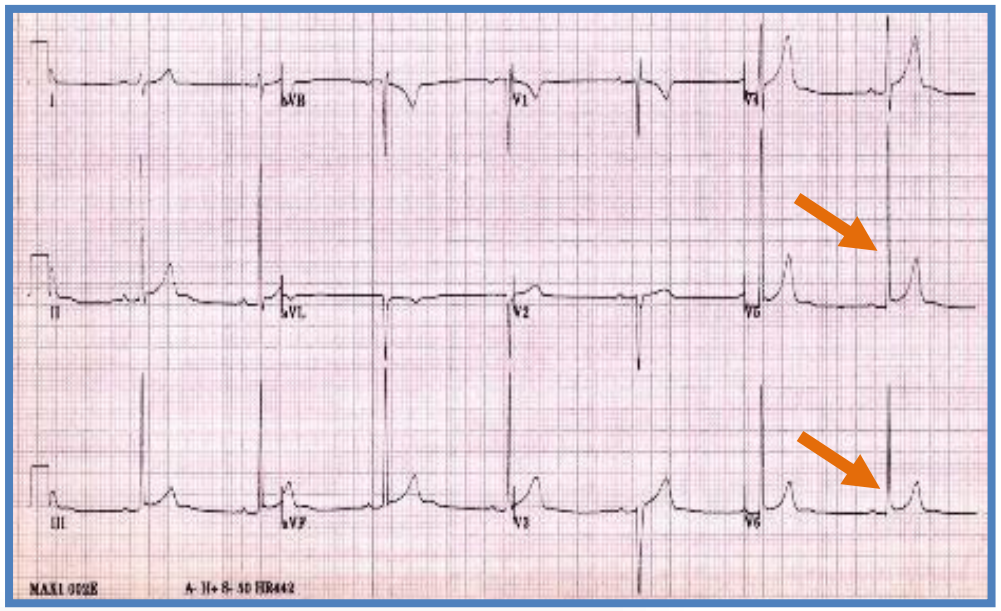
TABLE 1 Cardiovascular Care Checklist of Best Practices for NCAA Member Institutions

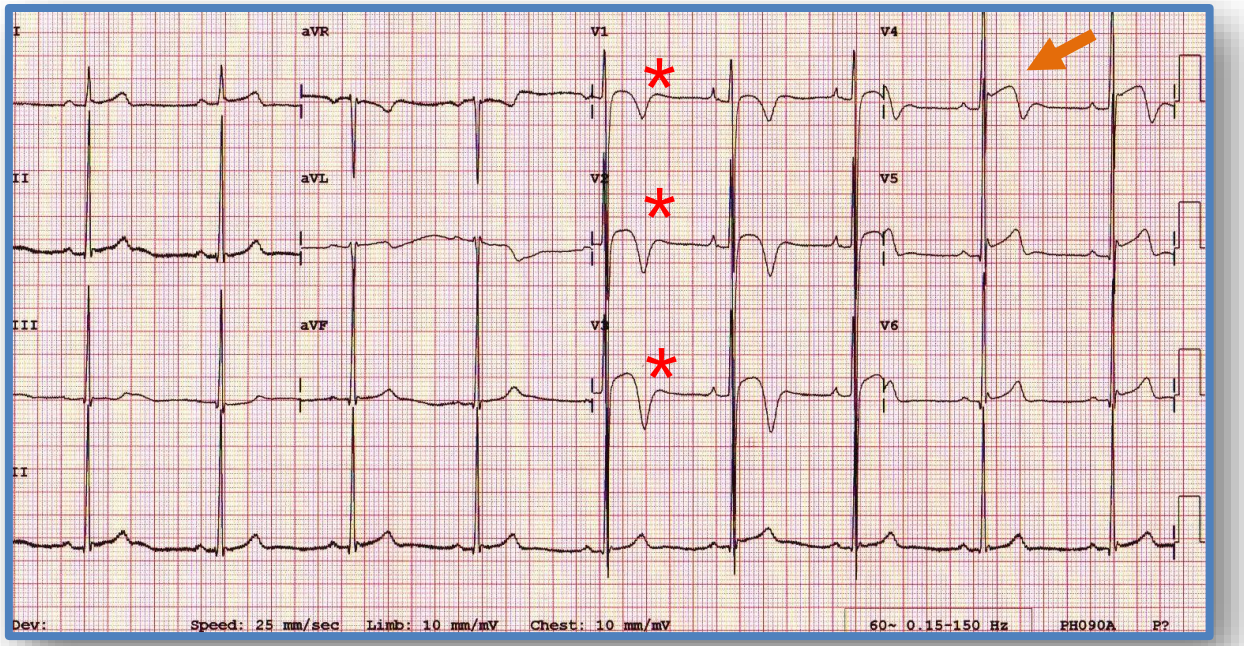
The field of sports cardiology is a highly specialized segment of cardiology and very few physicians and institutions across the country have the knowledge base, skill and experience in this discipline to accurately interpret an athlete's ECG. This could put smaller colleges and universities located in low-density population areas at a disadvantage when it comes to accessing expertise in sports cardiology. The task force recommended establishing regional referral centers that can provide pre-participation ECG interpretation, clarity on the cardiovascular status of athletes with irregular findings during their pre-participation screening, evaluations of new cardiovascular symptoms that develop during training or competition, and consultations on when a player with a cardiac issue is cleared to play.

rationale of ECG screening and the possible risk vs. benefit of adding ECG screening.

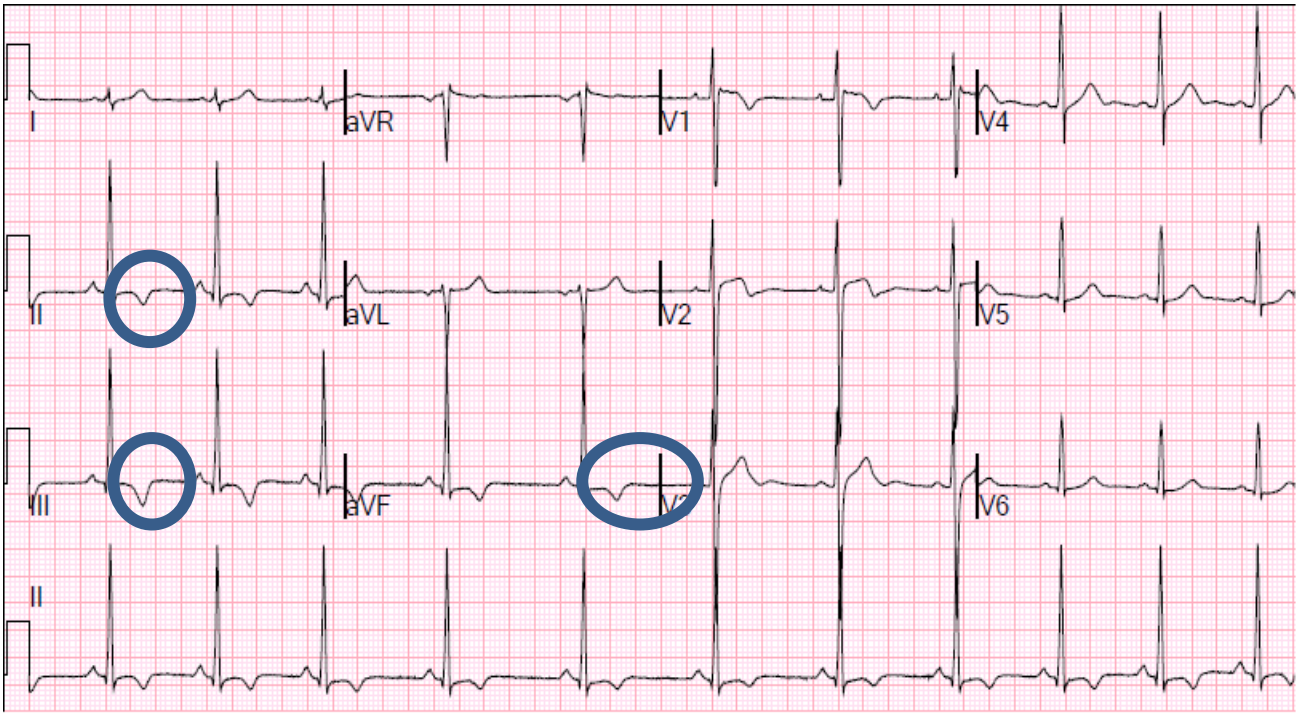
- ☐ Modern athlete-specific ECG interpretation standards are used.
- ☐ Skilled cardiology oversight is available.

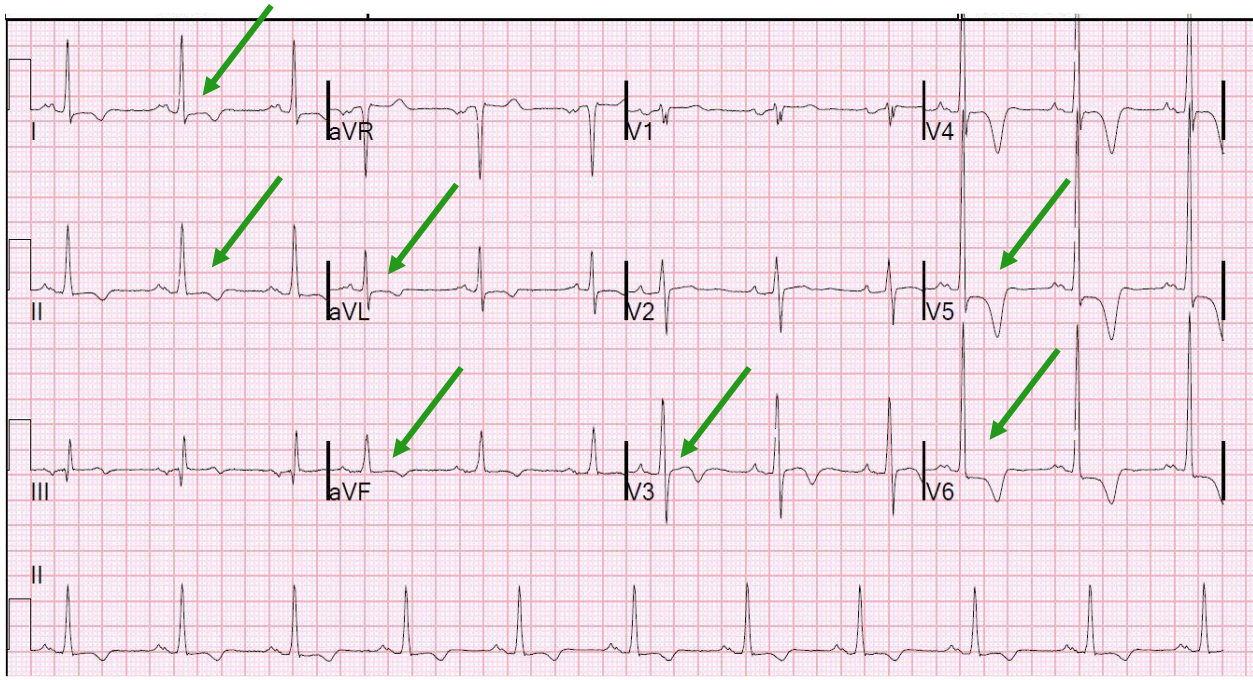


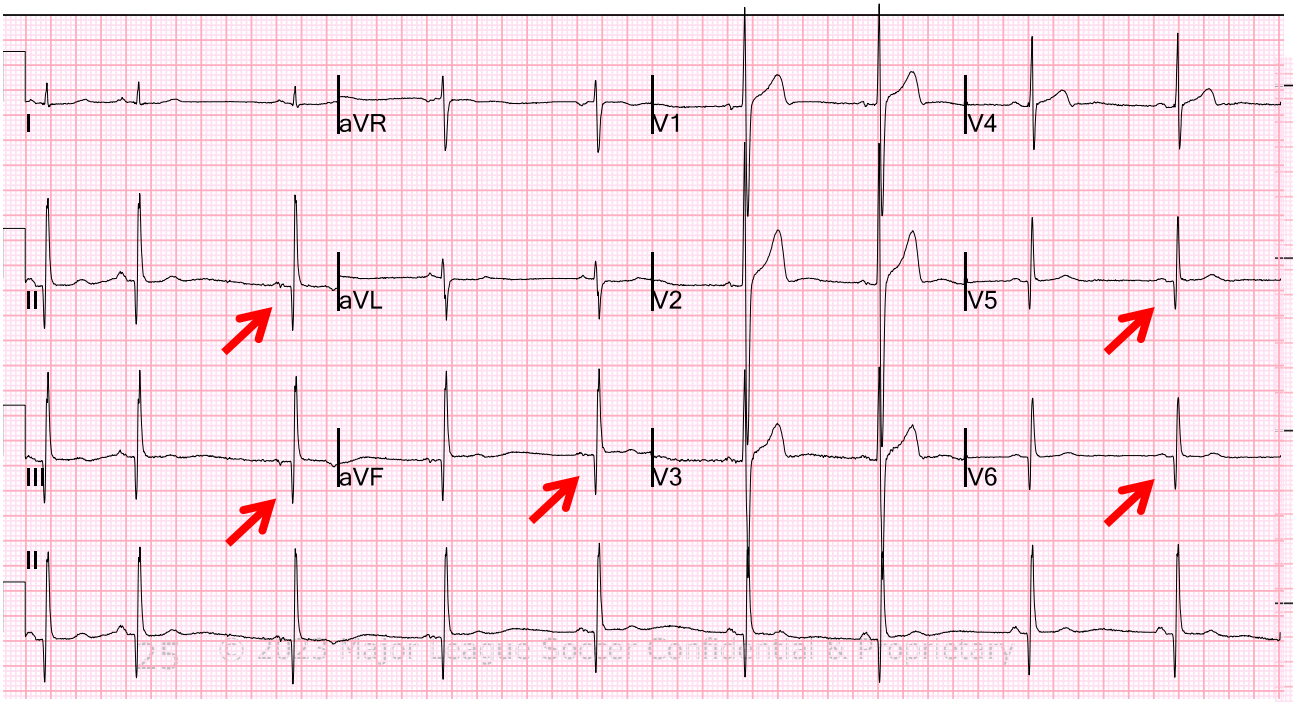


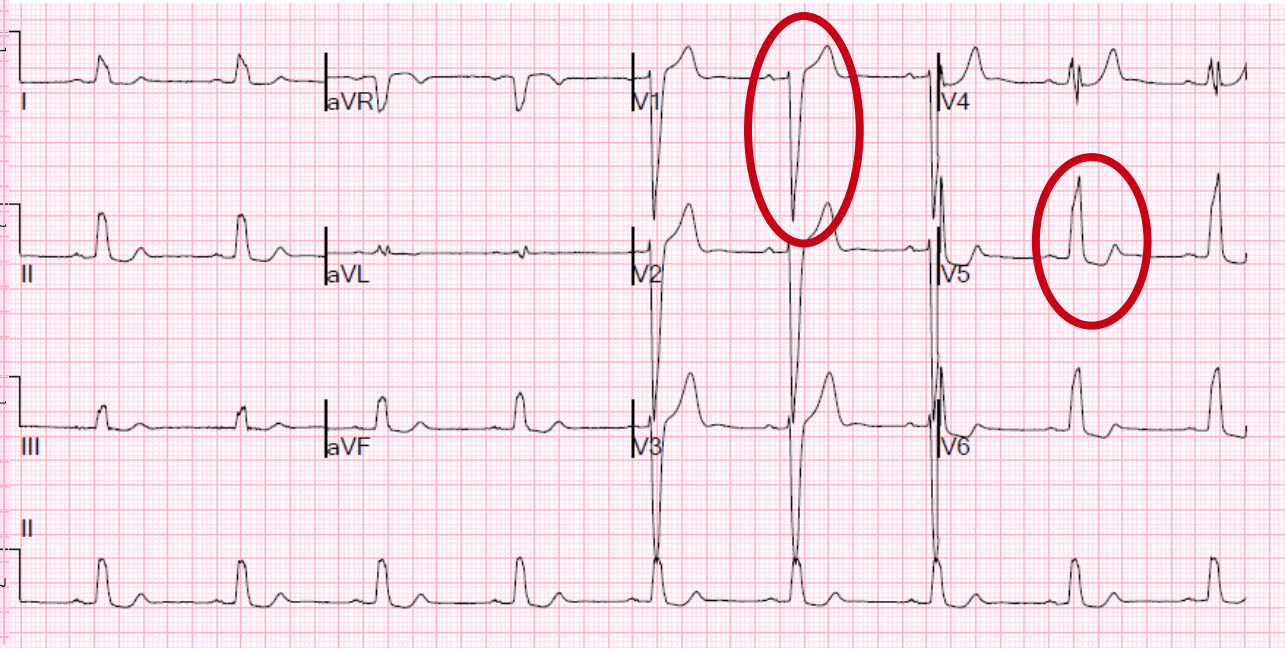


ATLANTIC HEALTH SYSTEM

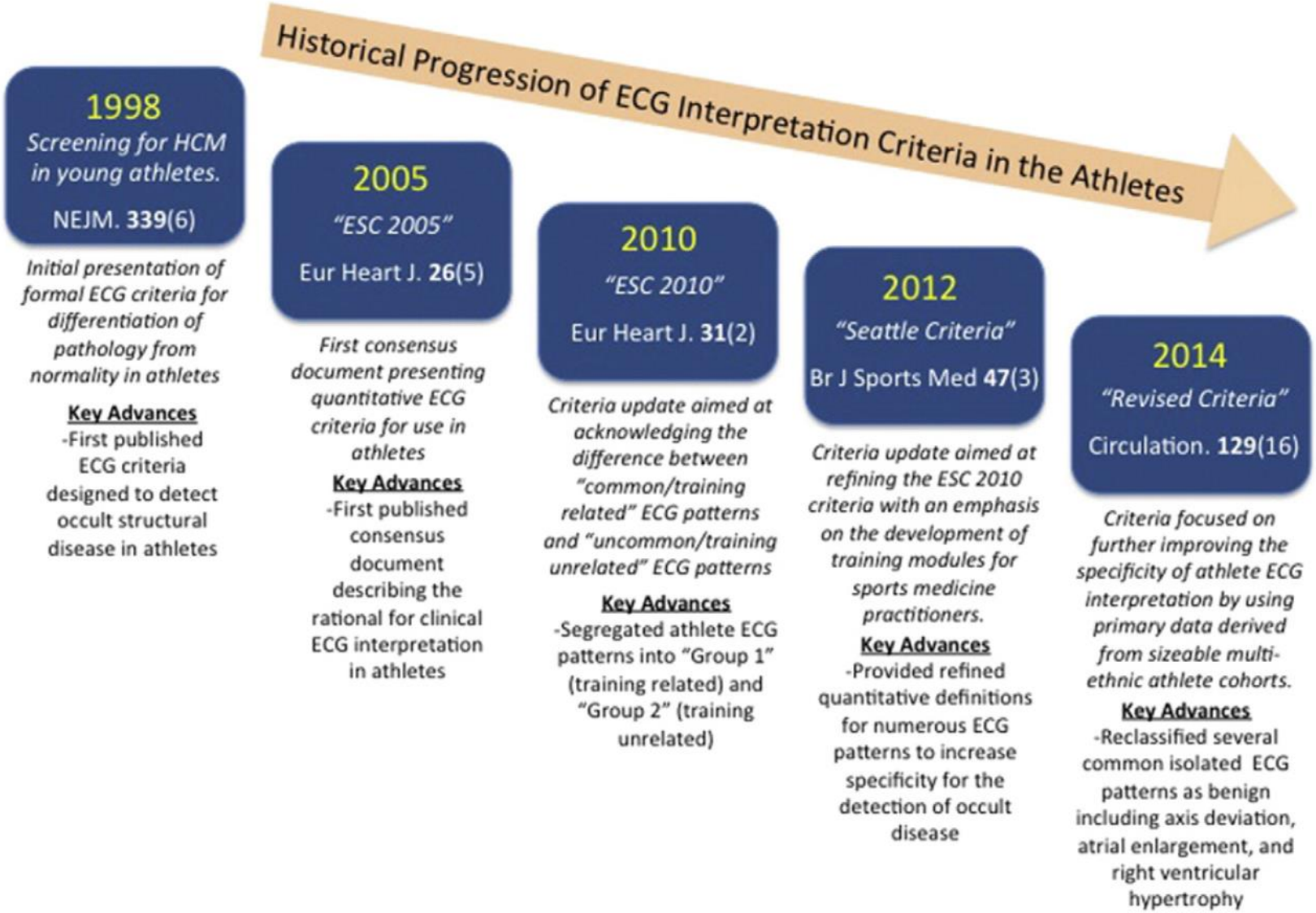

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II

ATLANTIC HEALTH SYSTEM



Baggish AL, Journal of Electrocardiology 2015; 48:324–328

Methodology to classify athlete ECG

DISEASE PROBABILITY		PREVALENCE IN THE HEALHTY ATHLETE
LOW (<5%)	NORMAL	HIGH (>5%)
LOW (<5%)	BORDERLINE	LOW (<5%)
HIGH (>5%)	ABNORMAL	LOW (<5%)

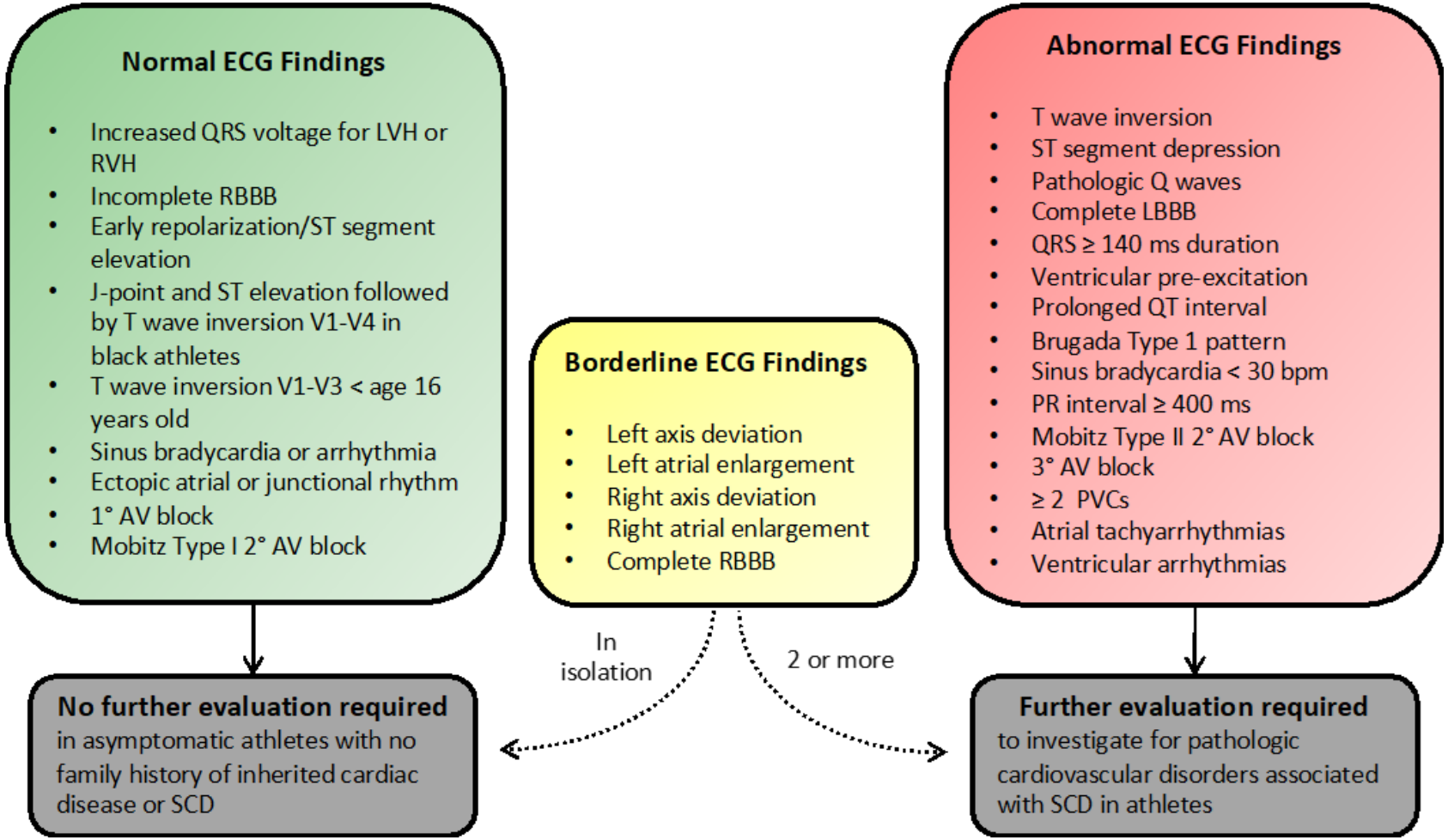
ATLANTIC HEALTH SYSTEM

The Evolution of ECG Interpretation Criteria

	ESC 2005	ESC 2010	Seattle Criteria	International Criteria
False Positive Rate	15-20%	10-15%	3–6%	1–2%

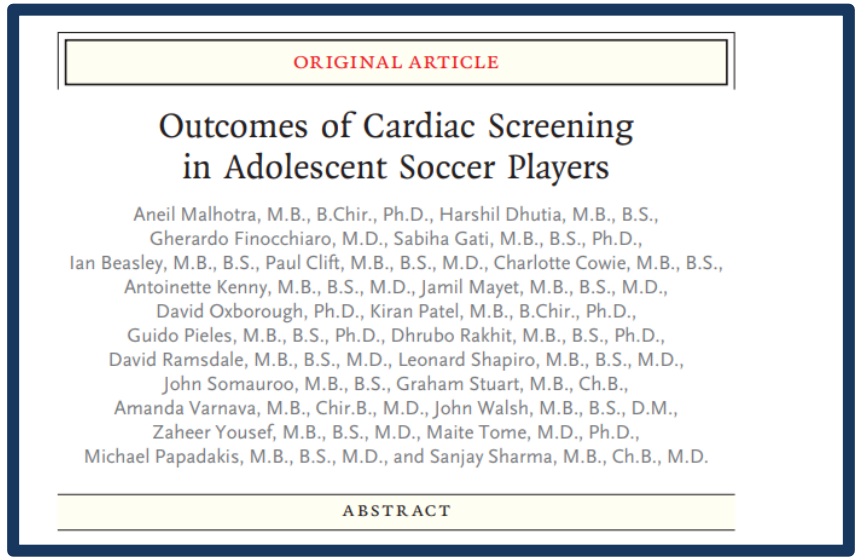
Courtesy of K Harmon et al

2017 International recommendations



The good, the bad and the uncertain

	Prevalence	Specificity	Utility
HCM	+++	+++	Good
LQTS	+	++/+++	OK
ARVC	+	+	Poor
Anomalous coronaries	++/+++	-	Poor
Brugada	+	++	Poor



ORIGINAL ARTICLE

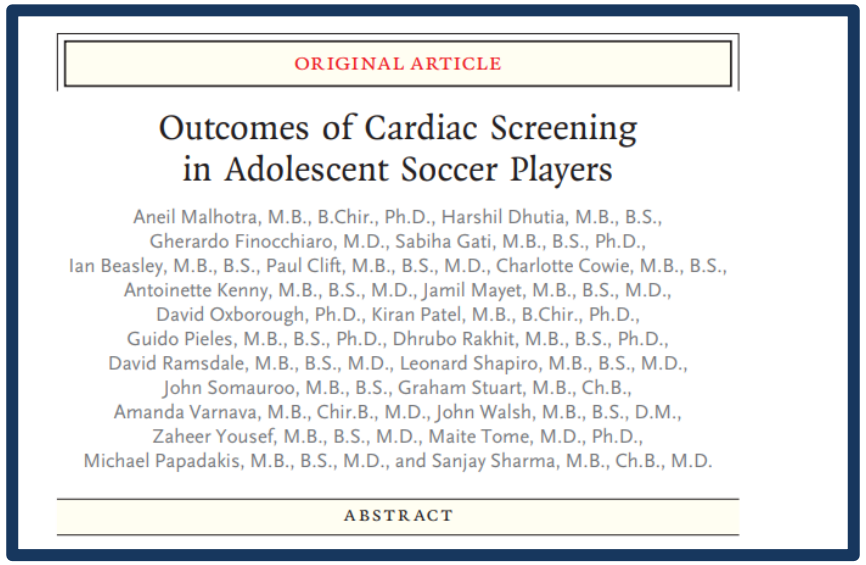
Outcomes of Cardiac Screening in Adolescent Soccer Players

Aneil Malhotra, M.B., B.Chir., Ph.D., Harshil Dhutia, M.B., B.S., Gherardo Finocchiaro, M.D., Sabiha Gati, M.B., B.S., Ph.D., Ian Beasley, M.B., B.S., Paul Clift, M.B., B.S., M.D., Charlotte Cowie, M.B., B.S., Antoinette Kenny, M.B., B.S., M.D., Jamil Mayet, M.B., B.S., M.D., David Oxborough, Ph.D., Kiran Patel, M.B., B.Chir., Ph.D., Guido Pieles, M.B., B.S., Ph.D., Dhrubo Rakhit, M.B., B.S., Ph.D., David Ramsdale, M.B., B.S., M.D., Leonard Shapiro, M.B., B.S., M.D., John Somauroo, M.B., B.S., Graham Stuart, M.B., Ch.B., Amanda Varnava, M.B., Chir.B., M.D., John Walsh, M.B., B.S., D.M., Zaheer Yousef, M.B., B.S., M.D., Maite Tome, M.D., Ph.D., Michael Papadakis, M.B., B.S., M.D., and Sanjay Sharma, M.B., Ch.B., M.D.

ABSTRACT

- 11,168 English 15-17yr old soccer player
- Mandatory H&P, ECG and Echo
- 20 yr study period
- 225 (2%) with congenital, valve disorders
- 42 (0.38%) with findings assoc with SCA

Malhotra A. *Br J Sports Med* 2019.



ORIGINAL ARTICLE

Outcomes of Cardiac Screening in Adolescent Soccer Players

Aneil Malhotra, M.B., B.Chir., Ph.D., Harshil Dhutia, M.B., B.S., Gherardo Finocchiaro, M.D., Sabiha Gati, M.B., B.S., Ph.D., Ian Beasley, M.B., B.S., Paul Clift, M.B., B.S., M.D., Charlotte Cowie, M.B., B.S., Antoinette Kenny, M.B., B.S., M.D., Jamil Mayet, M.B., B.S., M.D., David Oxborough, Ph.D., Kiran Patel, M.B., B.Chir., Ph.D., Guido Pieles, M.B., B.S., Ph.D., Dhrubo Rakhit, M.B., B.S., Ph.D., David Ramsdale, M.B., B.S., M.D., Leonard Shapiro, M.B., B.S., M.D., John Somauroo, M.B., B.S., Graham Stuart, M.B., Ch.B., Amanda Varnava, M.B., Chir.B., M.D., John Walsh, M.B., B.S., D.M., Zaheer Yousef, M.B., B.S., M.D., Maite Tome, M.D., Ph.D., Michael Papadakis, M.B., B.S., M.D., and Sanjay Sharma, M.B., Ch.B., M.D.

ABSTRACT

23 died

8 deaths from cardiac causes

7 (88%) due to cardiomyopathy

6 were not identified by screening

Malhotra A. *Br J Sports Med* 2019.

Table 3. Characteristics of Athletes with Sudden Cardiac Death.

Athlete No.	Sex and Age	Race*	Years from Screening to Death	Diagnosis	Initial Screening Result	Blind Reading (Reviewer 1)	Blind Reading (Reviewer 2)
1	M, 16.8 yr	Black	0.1	Idiopathic left ventricular hypertrophy	Negative	Negative	Negative
2	M, 16.6 yr	Mixed	1.0	Hypertrophic cardiomyopathy	Abnormal ECG and echocardiogram	NA	NA
3	M, 16.6 yr	Black	3.3	Hypertrophic cardiomyopathy	Negative	Negative	Negative
4	M, 16.3 yr	Black	7.7	Dilated cardiomyopathy	Negative	Negative	Negative
5	M, 17.0 yr	White	7.9	Arrhythmogenic right ventricular cardiomyopathy	Negative	Negative	Negative
6	M, 17.2 yr	White	9.7	Arrhythmogenic right ventricular cardiomyopathy	Negative	Negative	Negative
7	M, 15.7 yr	White	11.5	Hypertrophic cardiomyopathy	Abnormal ECG and echocardiogram	NA	NA
8	M, 16.8 yr	White	13.2	Sudden arrhythmic death syndrome	Negative	Negative	Negative

* Race was reported by the athlete or the parent or guardian.

Improvement in diagnosis
- No improvement in survival –
Potential risk of harm

Malhotra A. *Br J Sports Med* 2019.

ATLANTIC HEALTH SYSTEM

Electrocardiogram interpretation in NCAA athletes: Comparison of the 'Seattle' and 'International' criteria

Nicola Hyde, MD [a], Jordan M. Prutkin, MD, MHS [b], Jonathan A. Drezner, MD [a,*]

[a] *Department of Family Medicine, Sports Medicine Section, University of Washington, United States of America*
[b] *Department of Medicine, Division of Cardiology, University of Washington, United States of America*

- 5,258 NCAA athletes (73% White, 16% Black)
- 1.6% abnormal by International Criteria; 1.3% false positive (overall)

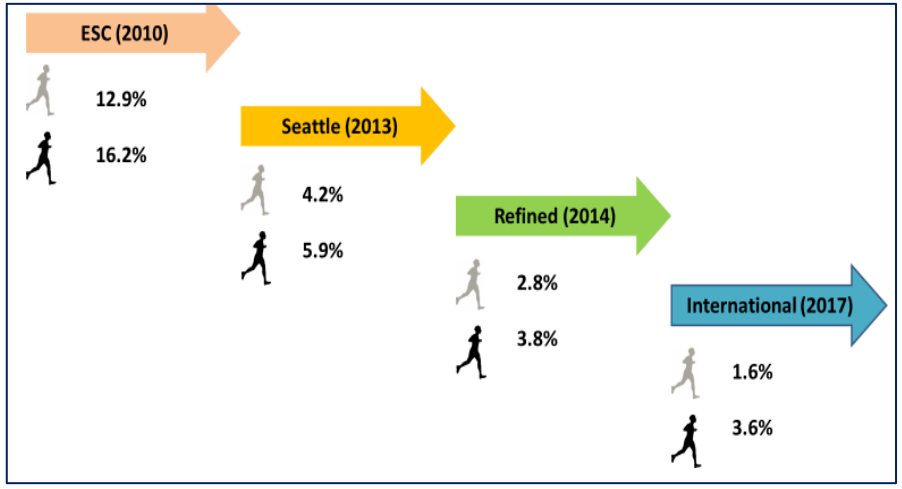
Hyde N. *J Electrocardiol* 2019.

British Journal of Sports Medicine

Accuracy of the 2017 international recommendations for clinicians who interpret adolescent athletes' ECGs: a cohort study of 11 168 British white and black soccer players

Aneil Malhotra ,[1] Harshil Dhutia,[1] Tee-Joo Yeo,[1,2] Gherardo Finocchiaro,[1] Sabiha Gati,[1,3] Paulo Bulleros,[1] Zephyr Fanton,[1] Efstathios Papatheodorou,[1] Chris Miles,[1] Tracey Keteepe-Arachi, Joyee Basu,[1] Gemma Parry-Williams,[1] Keerthi Prakash,[1] Belinda Gray,[1] Andrew D'Silva ,[1] Bode Ensam,[1] Elijah Behr,[1] Maite Tome,[1] Michael Papadakis,[1] Sanjay Sharma[1]

- 11,168 soccer players
- 1.8% abnormal by International Criteria; 1.5% false positive (overall)



- 1.4% White vs. 3.3% Black false positive
- 95% Male
- 91% White vs. 9% Black

Malhotra A. *Br J Sports Med* 2019.

ATLANTIC HEALTH SYSTEM

JAMA Cardiol. 2018;3(1):69-74.

Electrocardiographic Findings in National Basketball Association Athletes

Table 2. Abnormal Electrocardiographic (ECG) Findings

Abnormal ECG Classification	No. (%)			
	Total Athletes (n = 519)	Racial/Ethnic Subgroups: African American (n = 409)	White (n = 96)	P Value
Seattle criteria	131 (25.2)	103 (25.2)	23 (24.0)	.90
Refined criteria	108 (20.8)	87 (21.2)	16 (16.6)	
International recommendations	81 (15.6)	65 (15.8)	11 (11.5)	.34
Abnormal ECG findings				
Short QT Interval (QTc <320 ms)	0	0	0	.99
Long QT Interval (QTc >470 ms)		(4.9)	4 (4.2)	.98
Left bundle branch block		0.2)	0	.99
Intraventricular conduction delay[a]		1.0)	0	.74
Q waves[b]		1.0)	2 (2.1)	.32
ST-segment depression[c]	9 (1.7)	9 (2.2)	0	.22
Abnormal T-wave inversion[d]	32 (6.2)	27 (6.6)	3 (3.1)	.24
Ventricular preexcitation[e]	1 (0.2)	1 (0.2)	0	.99
Frequent premature ventricular contraction (>2)	2 (0.4)	2 (0.5)	0	.99
≥2 Borderline findings	29 (5.6)	22 (5.4)	6 (6.3)	.91
Borderline ECG findings[f]				
Left atrial enlargement	69 (13.3)	53 (13.0)	13 (13.5)	.87
Right atrial enlargement	46 (8.9)	40 (9.8)	6 (6.3)	.33
QRS axis deviation	21 (4.0)	15 (3.7)	6 (6.3)	.26
Right bundle branch block	25 (4.8)	20 (4.9)	4 (4.2)	.99

409/519 = 78%

11/519 = 2%

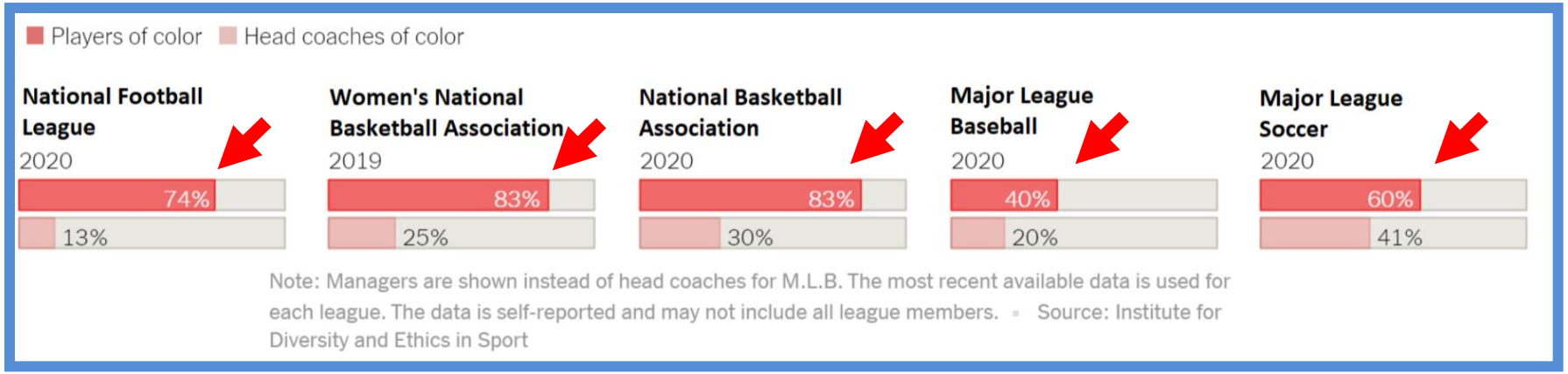
65/519 = 12.5%

CONSIDER UNINTENDED CONSEQUENCES

JAMA Cardiol. 2018;3(1):69-74.

ATLANTIC HEALTH SYSTEM

Applications in a Diverse population



ECG utility Issues & possible solutions

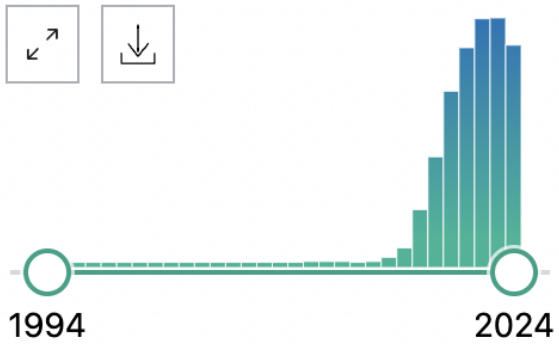
False positives (a low % is acceptable and inevitable):

- Further refining the criteria based on new evidence
- Better education
- Use of artificial intelligence?

False negatives (unacceptable and dangerous):

- Further refining the criteria based on new evidence
- Repeat the ECG periodically (particularly in the peri-pubertal phase)
- Use of artificial intelligence?

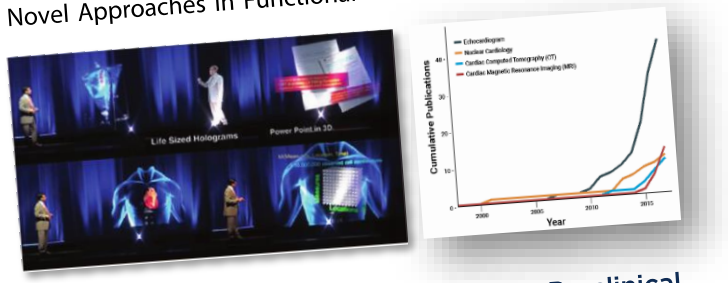
AI in Cardiology



JACC Cardiovascular Imaging

Intelligent Platforms for Disease Assessment

Novel Approaches in Functional Echocardiography



Machine Learning for Data-Driven Discovery
The Rise and Relevance*

Predicting Preclinical Heart Failure Progression
The Rise of Machine-Learning for Population Health*

Enforcing Quality in Strain Imaging Through AI-Powered Surveillance*

Building Trust in AI
Opportunities and Challenges for Cardiac Imaging

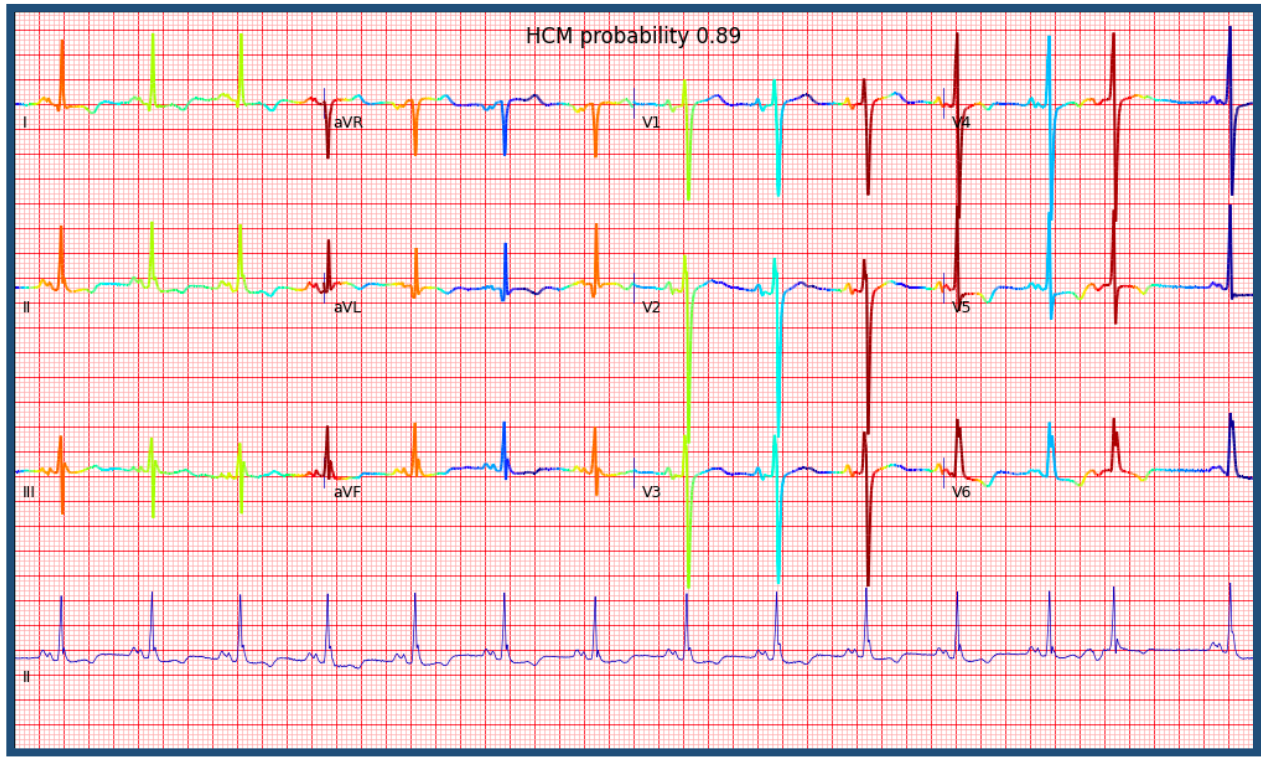
Automated Interpretation of Myocardial Perfusion Images
Tell Me AI Where to Look*

Imaging With Deep Learning
Sharpening the Cutting Edge

ATLANTIC HEALTH SYSTEM

850 HCM patients
MMC Database

80% accuracy
99% specific
68% sensitive

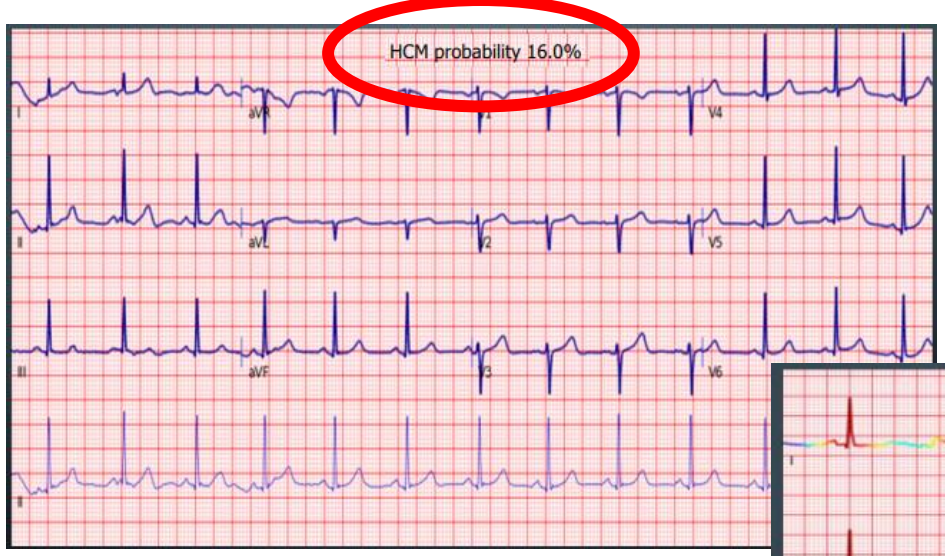


Viz HCM Algorithm Performance By Race

	ASIAN	BLACK	HISPANIC	WHITE
AUC:	0.987	0.981	1.000	0.972
Sensitivity:	73.3%	64.5%	100%	66.8%
Specificity:	98.9%	99.2%	98.2%	99.1%

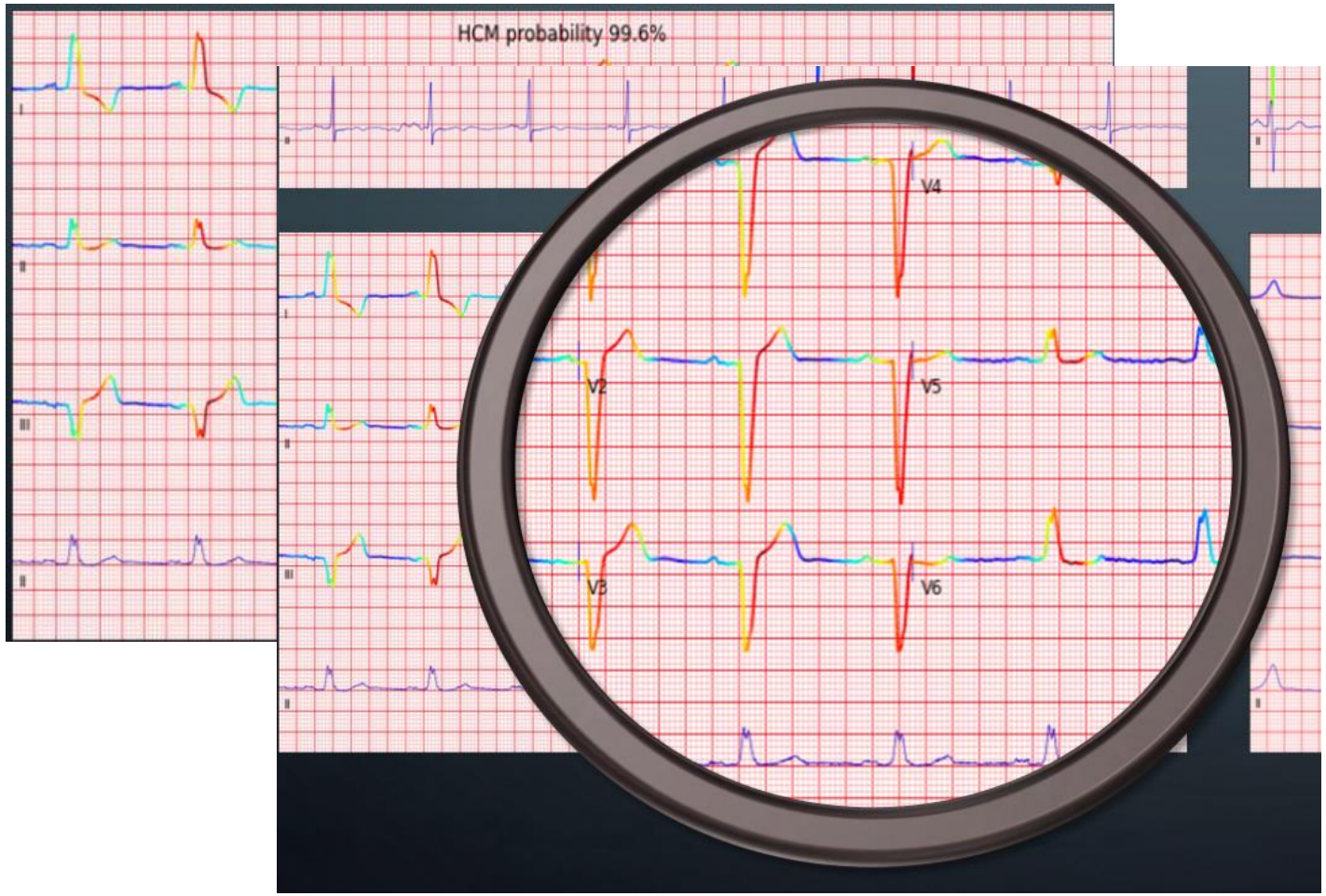
AUC = area under the curve*
PPV = positive predictive value*
Source: FDA filing

OVERALL: Sensitivity: 68.4%; Specificity: 99.1%; PPV 13.7%

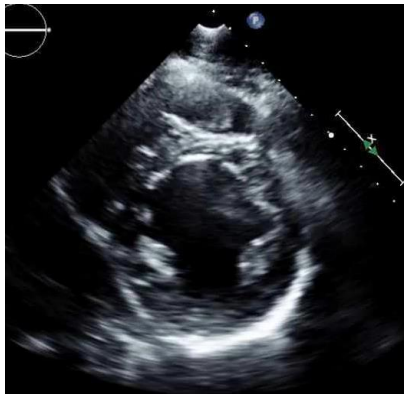

HCM probability 16.0%

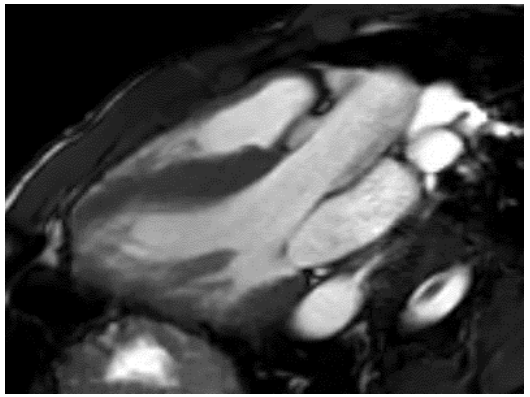

HCM probability 94.0%

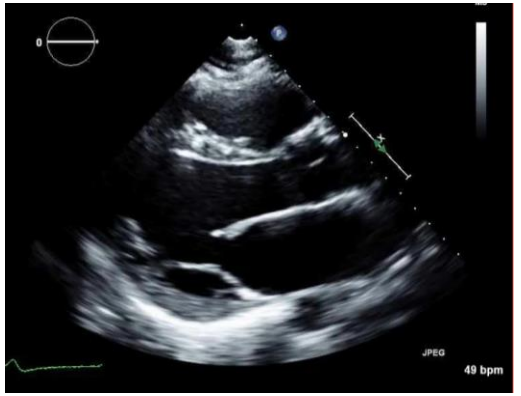

HCM probability 99.9%

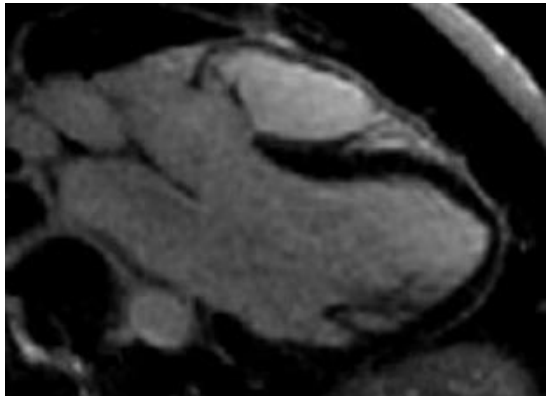

HCM probability 99.6%
V4
V2
V5
V3
V6

Cardiac Imaging



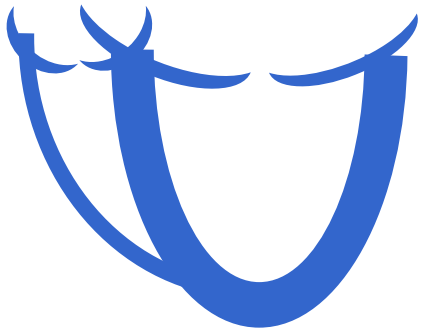






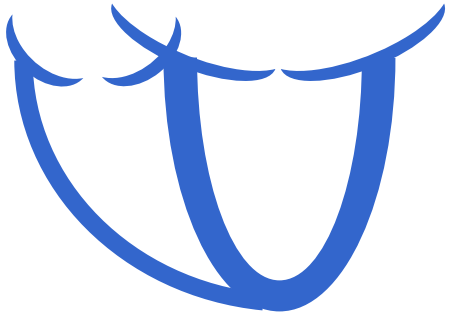
Athlete Structural Changes

Left Chamber Dilation



Myocardial Thickening

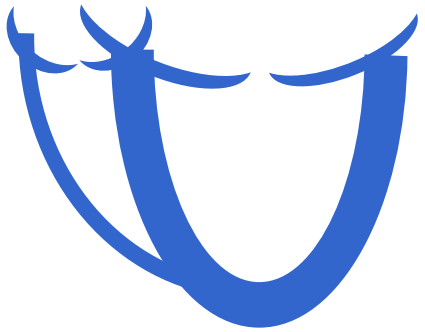
Right Chamber Dilation



ATLANTIC HEALTH SYSTEM

Athlete Structural Changes

Left Chamber Dilation

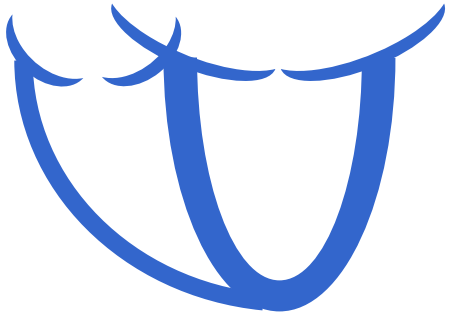


Physiologic LVH

Myocardial Thickening

Physiologic cLVH, eLVH

Right Chamber Dilation

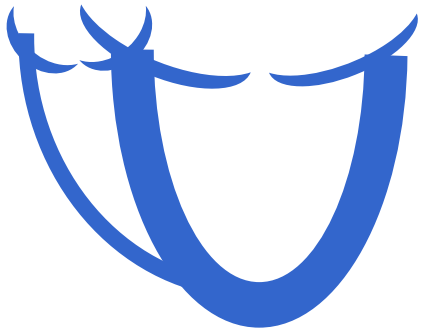


Physiologic RV Dilation

ATLANTIC HEALTH SYSTEM

Athlete Structural Changes

Left Chamber Dilation

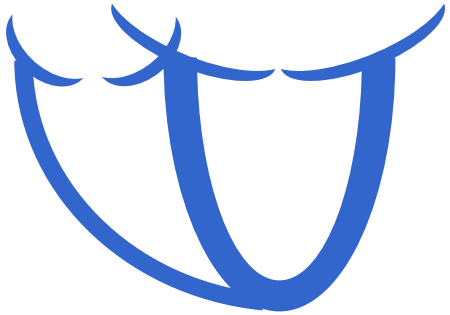


Physiologic LVH

Myocardial Thickening

Physiologic cLVH, eLVH

Right Chamber Dilation

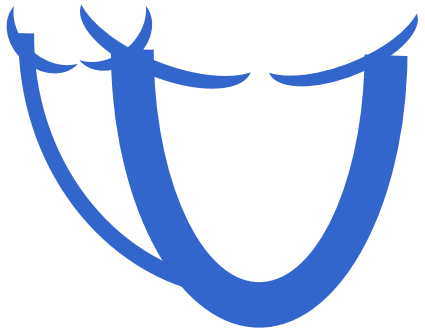


Physiologic RV Dilation

Gray-Zone

Athlete Structural Changes

Left Chamber Dilation



Physiologic LVH

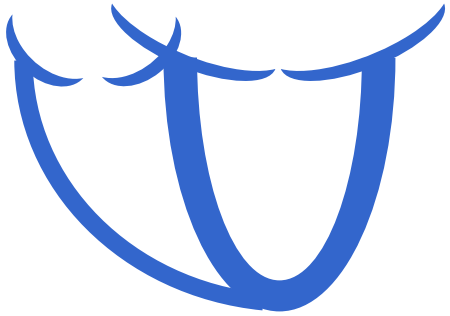
DCM
Valvular Heart Disease

Myocardial Thickening

Physiologic cLVH, eLVH

HCM
Hypertensive
Infiltrative

Right Chamber Dilation

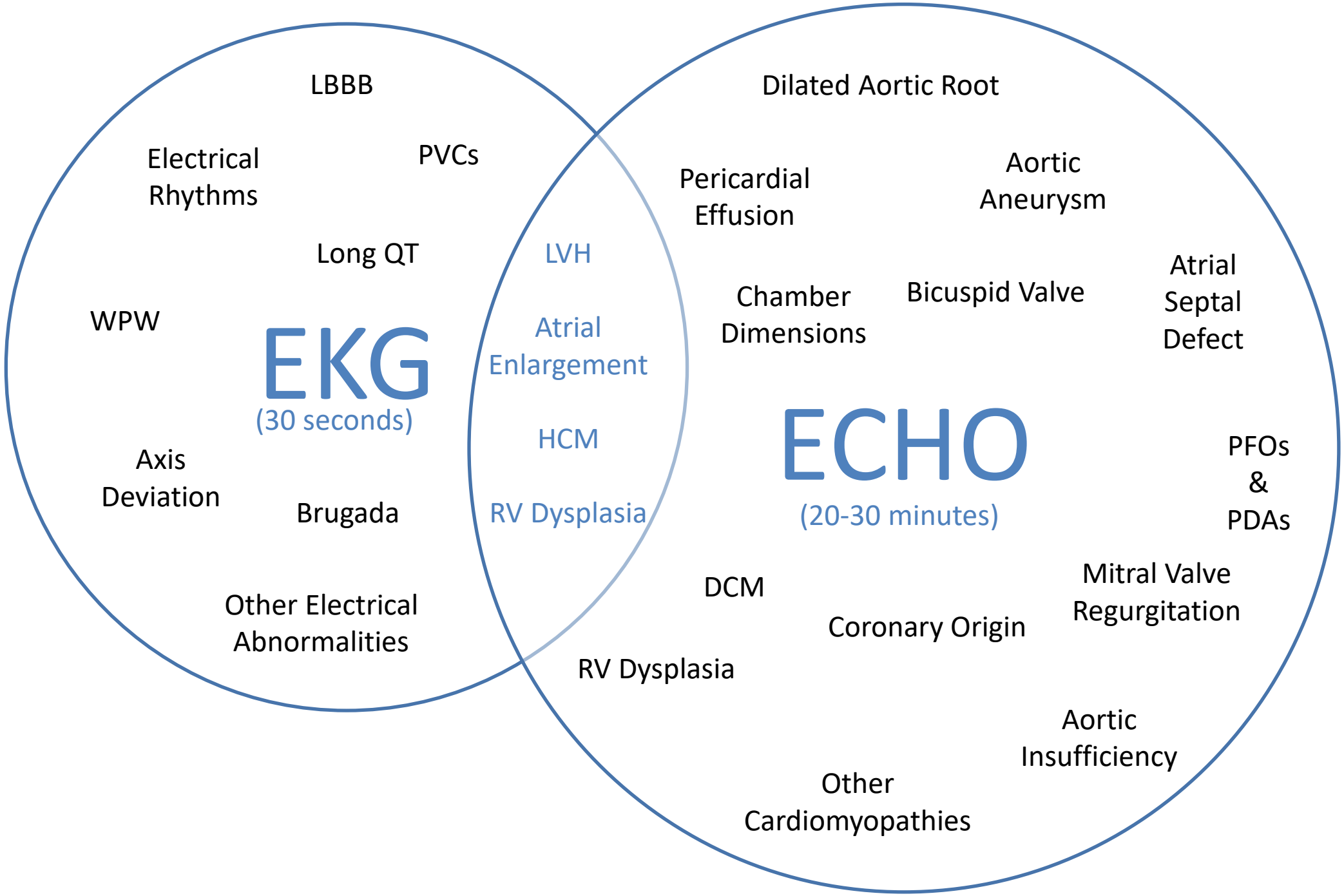


Physiologic RV Dilation

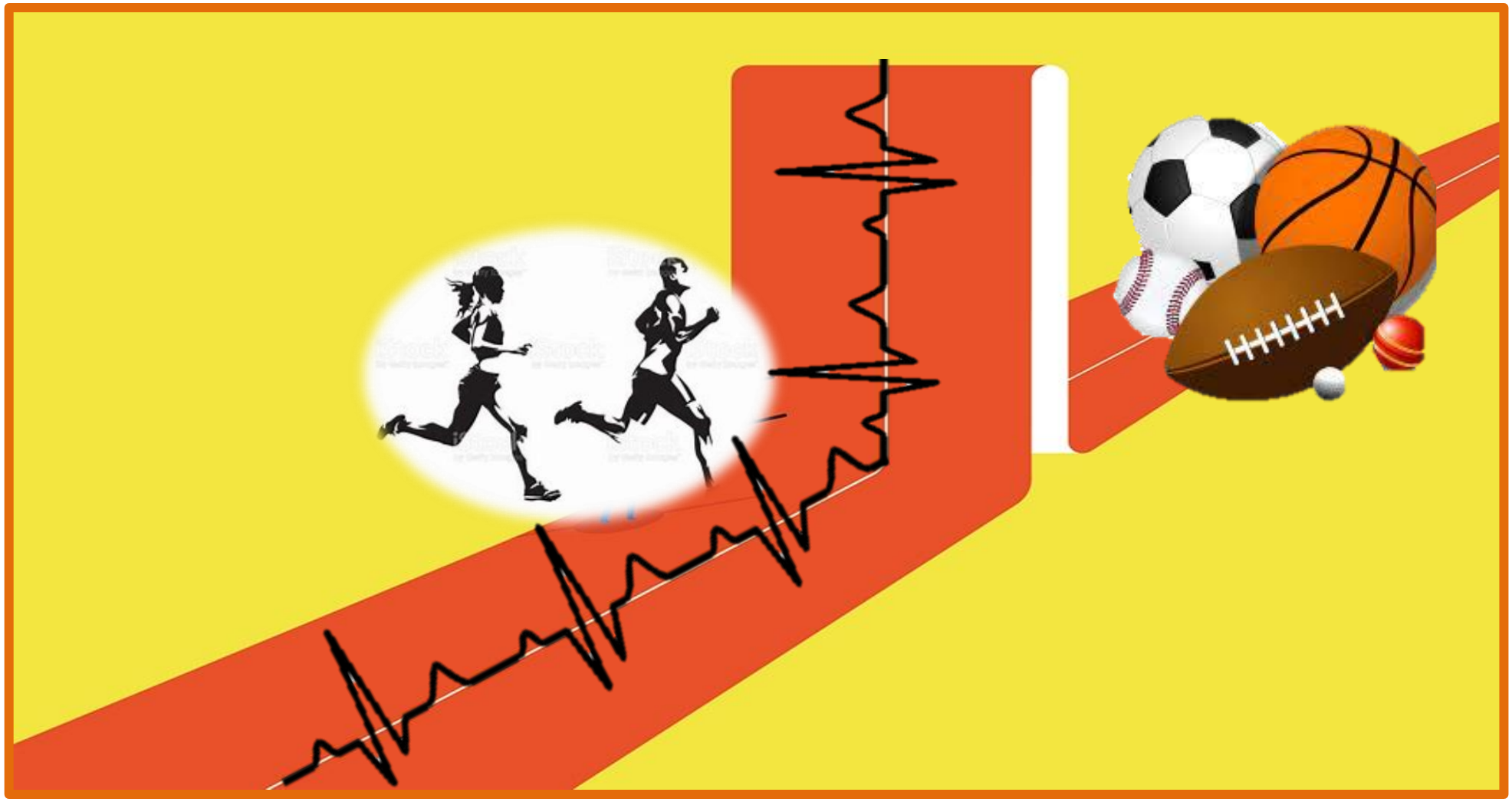
ARVC

ATLANTIC HEALTH SYSTEM

Screening findings: EKG vs ECHO

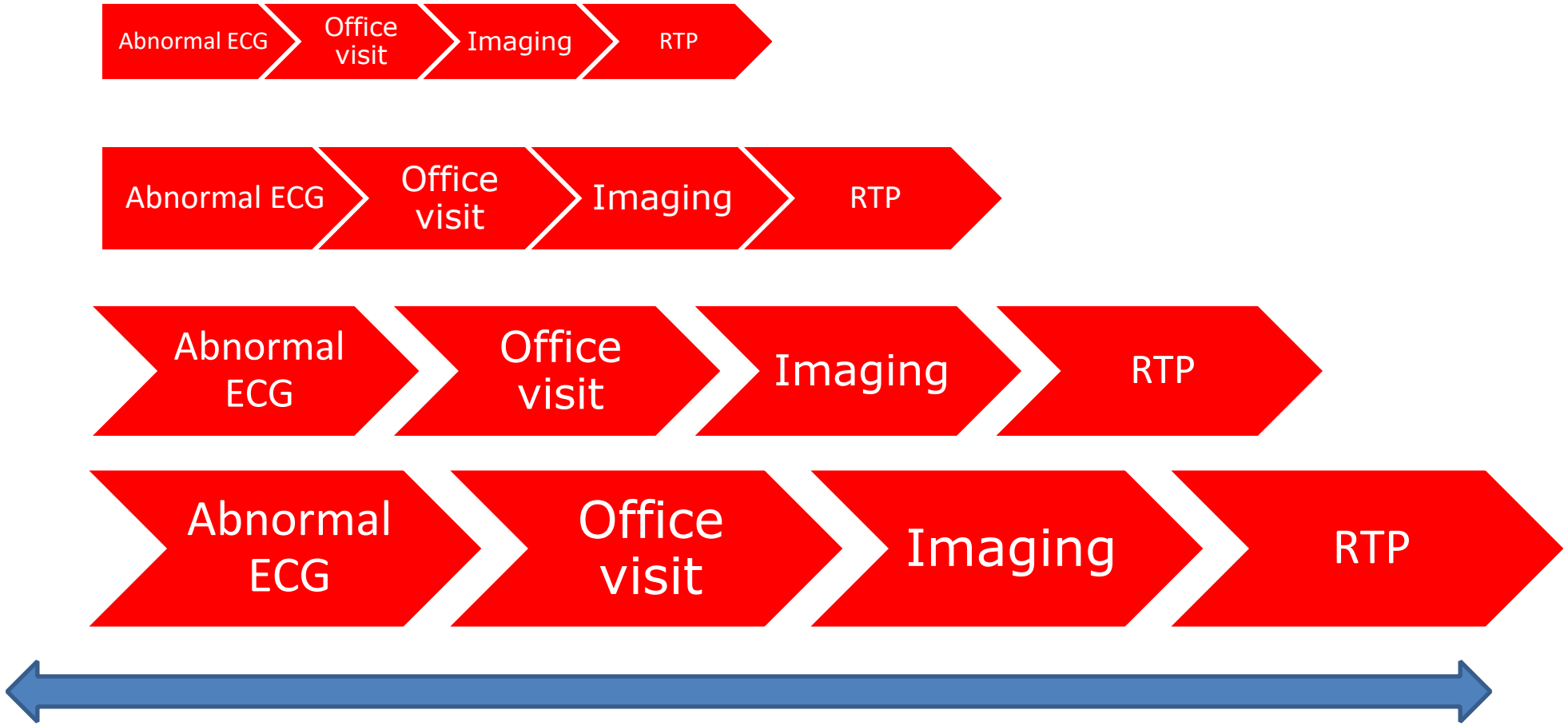


Barriers to Participation



ATLANTIC HEALTH SYSTEM

Athlete assessment



ATLANTIC HEALTH SYSTEM

Athlete Screening

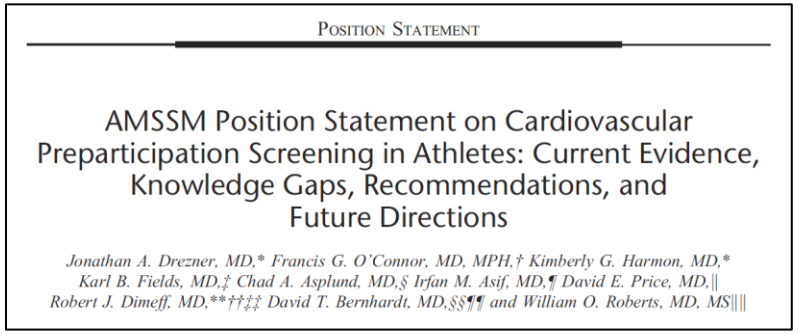
- Here to stay – ECG most often included.
- Echo imaging for higher risk groups
- Age to start? How often? Repeat?
- Expert review
  - –Who, When, How to handle any findings?
- Goals?
  - –Safety, disqualification, medical/legal?

Diagnosis →

Risk assessment →

Develop a surveillance/safety plan

Purpose of CV Screening



POSITION STATEMENT

AMSSM Position Statement on Cardiovascular Preparticipation Screening in Athletes: Current Evidence, Knowledge Gaps, Recommendations, and Future Directions

Jonathan A. Drezner, MD, Francis G. O'Connor, MD, MPH,† Kimberly G. Harmon, MD,* Karl B. Fields, MD,‡ Chad A. Asplund, MD,§ Irfan M. Asif, MD,¶ David E. Price, MD,‖ Robert J. Dimeff, MD,**††‡‡ David T. Bernhardt, MD,§§¶¶ and William O. Roberts, MD, MS‖‖*

AMSSM
AMERICAN MEDICAL SOCIETY FOR SPORTS MEDICINE

- The primary goal of cardiovascular screening in competitive athletes is to identify cardiac disorders predisposing to SCA/D with the intent of **mitigating risk through individualized, patient-centered and disease-specific medical management**.

ATLANTIC HEALTH SYSTEM

Eligibility Recommendations

Playing with Cardiovascular Disease

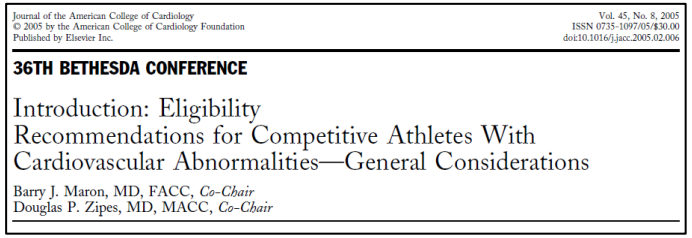
European Heart Journal (2005) 26, 1422–1445
doi:10.1093/eurheartj/ehi325

ESC Report

Recommendations for competitive sports participation in athletes with cardiovascular disease

A consensus document from the Study Group of Sports Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology

Antonio Pelliccia[1*], Robert Fagard[2], Hans Halvor Bjørnstad[3], Aris Anastassakis[4], Eloisa Arbustini[5], Deodato Assanelli[6], Alessandro Biffi[1], Mats Borjesson[7], François Carrè[8], Domenico Corrado[9], Pietro Delise[10], Uwe Dorwarth[11], Asle Hirth[3], Hein Heidbuchel[12], Ellen Hoffmann[11], Klaus P. Mellwig[13], Nicole Panhuyzen-Goedkoop[14], Angela Pisani[5], Erik E. Solberg[15], Frank van-Buuren[13], and Luc Vanhees[2]



Journal of the American College of Cardiology
© 2005 by the American College of Cardiology Foundation
Published by Elsevier Inc.

Vol. 45, No. 8, 2005
ISSN 0735-1097/05/$30.00
doi:10.1016/j.jacc.2005.02.006

36TH BETHESDA CONFERENCE

Introduction: Eligibility Recommendations for Competitive Athletes With Cardiovascular Abnormalities—General Considerations

Barry J. Maron, MD, FACC, *Co-Chair*
Douglas P. Zipes, MD, MACC, *Co-Chair*

2005

<u>Moving away from:</u>

"Disqualification"

"Ineligible"

"Not allowed"

ATLANTIC HEALTH SYSTEM

Eligibility Recommendations

Playing with Cardiovascular Disease

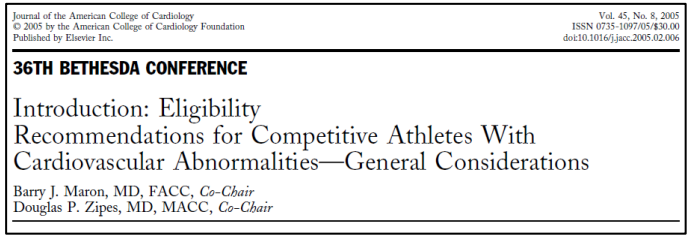
European Heart Journal (2005) 26, 1422–1445
doi:10.1093/eurheartj/ehi325

ESC Report

Recommendations for competitive sports participation in athletes with cardiovascular disease

A consensus document from the Study Group of Sports Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology

Antonio Pelliccia[1*], Robert Fagard[2], Hans Halvor Bjørnstad[3], Aris Anastassakis[4], Eloisa Arbustini[5], Deodato Assanelli[6], Alessandro Biffi[1], Mats Borjesson[7], François Carrè[8], Domenico Corrado[9], Pietro Delise[10], Uwe Dorwarth[11], Asle Hirth[3], Hein Heidbuchel[12], Ellen Hoffmann[11], Klaus P. Mellwig[13], Nicole Panhuyzen-Goedkoop[14], Angela Pisani[5], Erik E. Solberg[15], Frank van-Buuren[13], and Luc Vanhees[2]



Journal of the American College of Cardiology
© 2005 by the American College of Cardiology Foundation
Published by Elsevier Inc.

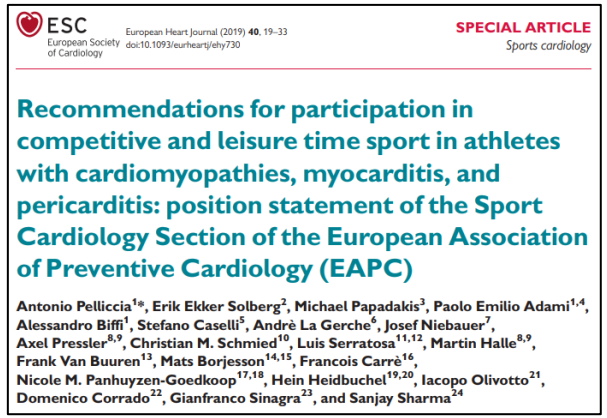
Vol. 45, No. 8, 2005
ISSN 0735-1097/05/$30.00
doi:10.1016/j.jacc.2005.02.006

36TH BETHESDA CONFERENCE

Introduction: Eligibility Recommendations for Competitive Athletes With Cardiovascular Abnormalities—General Considerations

Barry J. Maron, MD, FACC, *Co-Chair*
Douglas P. Zipes, MD, MACC, *Co-Chair*

2005



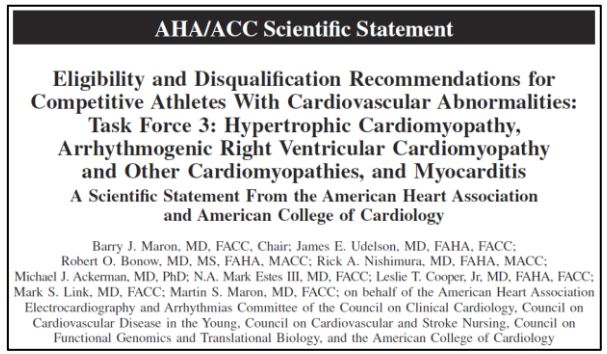
ESC European Society of Cardiology
European Heart Journal (2019) 40, 19–33
doi:10.1093/eurheartj/ehy730

SPECIAL ARTICLE
Sports cardiology

Recommendations for participation in competitive and leisure time sport in athletes with cardiomyopathies, myocarditis, and pericarditis: position statement of the Sport Cardiology Section of the European Association of Preventive Cardiology (EAPC)

Antonio Pelliccia[1*], Erik Ekker Solberg[2], Michael Papadakis[3], Paolo Emilio Adami[1,4], Alessandro Biffi[1], Stefano Caselli[5], Andrè La Gerche[6], Josef Niebauer[7], Axel Pressler[8,9], Christian M. Schmied[10], Luis Serratosa[11,12], Martin Halle[8,9], Frank Van Buuren[13], Mats Borjesson[14,15], Francois Carrè[16], Nicole M. Panhuyzen-Goedkoop[17,18], Hein Heidbuchel[19,20], Iacopo Olivotto[21], Domenico Corrado[22], Gianfranco Sinagra[23], and Sanjay Sharma[24]

2019



AHA/ACC Scientific Statement

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 3: Hypertrophic Cardiomyopathy, Arrhythmogenic Right Ventricular Cardiomyopathy and Other Cardiomyopathies, and Myocarditis

A Scientific Statement From the American Heart Association and American College of Cardiology

Barry J. Maron, MD, FACC, Chair; James E. Udelson, MD, FAHA, FACC; Robert O. Bonow, MD, MS, FAHA, MACC; Rick A. Nishimura, MD, FAHA, MACC; Michael J. Ackerman, MD, PhD; N.A. Mark Estes III, MD, FACC; Leslie T. Cooper, Jr, MD, FAHA, FACC; Mark S. Link, MD, FACC; Martin S. Maron, MD, FACC; on behalf of the American Heart Association Electrocardiography and Arrhythmias Committee of the Council on Clinical Cardiology, Council on Cardiovascular Disease in the Young, Council on Cardiovascular and Stroke Nursing, Council on Functional Genomics and Translational Biology, and the American College of Cardiology

2015

Guidelines now indicate we need more than yes or no.
-> Advocate risk assessment

ATLANTIC HEALTH SYSTEM

ATLANTIC HEALTH SYSTEM

CLINICAL SCIENCES

clinical commentary

The medical care of competitive athletes: the role of the physician and individual assumption of risk

BENJAMIN D. LEVINE and JAMES STRAY-GUNDERSEN

Institute for Exercise and Environmental Medicine,
Presbyterian Hospital of Dallas,
The Baylor/UT Southwestern Sports Science Laboratory, and
The University of Texas Southwestern Medical Center at Dallas

LEVINE, B. D. and J. STRAY-GUNDERSEN. The medical care of competitive athletes: the role of the physician and individual assumption of risk. *Med. Sci. Sports Exerc.*, Vol. 26, No. 10, pp. 1190–1192, 1994.

LQTS

Return to play? Athletes with congenital long QT syndrome

Jonathan N Johnson,[1] Michael J Ackerman[1,2,3]

BJSM 2013

- Low rate of cardiac events and no deaths in over 650 athlete-years of follow-up

Sports Participation in Genotype Positive Children With Long QT Syndrome

Peter F. Aziz, MD,* Tammy Sweeten, MS,† Ramon L. Vogel, MD,† William J. Bonney, MD,† Jacqueline Henderson, RN,† Akash R. Patel, MD,‡ Maully J. Shah, MBBS†

JACC 2015

- No cardiac events and no deaths in **treatment-compliant** children with LQTS in 755 patient-years of follow-up

Shared Decision-Making in Cardiovascular Disease

AHA/ACC CLINICAL PRACTICE GUIDELINE

2020 AHA/ACC Guideline for the Diagnosis and Treatment of Patients With Hypertrophic Cardiomyopathy

A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines

COR	LOE	RECOMMENDATIONS
1	B-NR	1. For most patients with HCM, mild- to moderate-intensity recreational* exercise is beneficial to improve cardiorespiratory fitness, physical functioning, and quality of life, and for their overall health in keeping with physical activity guidelines for the general population (1-3).
1	C-EO	2. For athletes with HCM, a comprehensive evaluation and shared discussion of potential risks of sports participation by an expert provider is recommended (4).
2a	C-EO	3. For most patients with HCM, participation in low-intensity competitive sports is reasonable (5,6).
2b	C-LD	5. For patients with HCM, participation in high-intensity recreational activities or moderate- to high-intensity competitive sports activities may be considered after a comprehensive evaluation and shared discussion, repeated annually with an expert provider who conveys that the risk of sudden death and ICD shocks may be increased, and with the understanding that eligibility decisions for competitive sports participation often involve third parties (e.g., team physicians, consultants, and other institutional leadership) acting on behalf of the schools or teams (4,7-11).

Ommen et al. Circulation. 2020;142:e558-e631.


Grouping populations that have widely varying risks can result in inaccurate or even misleading assessments

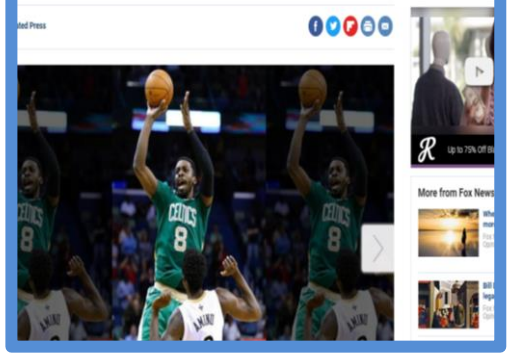
ATLANTIC HEALTH SYSTEM

Baylor's Jared Butler medically cleared to play in NBA: Sources

By Shams Charania and The Athletic Staff
July 17, 2021 Updated 7:21 PM EDT

8 Comments

For 4 NBA players with serious heart ailments, a fraternity has helped get them through it



Some young athletes with heart disease cleared to play under new recommendations

By AMERICAN HEART ASSOCIATION NEWS

Soccer

Cleared by cardiologists, Sierra Leone's Alhaji Kamara joins D.C. United

By Steven Goff
May 10, 2016

D.C. United has acquired Alhaji Kamara, a forward from Sierra Leone whose career was jeopardized by a heart condition this winter.

In the past week, the MLS cardiology consultant and a heart specialist at MedStar Georgetown University Hospital examined Kamara and determined that he could resume playing soccer, United General Manager Dave Kasper said Tuesday.

With medical clearance, United finalized a deal with Kamara's previous employer, IFK Norrkoping of Sweden. D.C. did not pay a transfer fee but will compensate the Swedish team if Kamara, 22, meets performance incentives or is sold in the future.

NBA NHL

Clint Dempsey cleared to play again after heart problems

- Seattle Sounders striker missed end of last season with medical condition
- Dempsey says he hopes to make return to US national team soon

Michigan DT Maurice Hurst, potential first-round pick, cleared to play after heart condition diagnosis

Frank Schwab
Shutdown Corner March 22, 2018

Follow

Care of the Athlete

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY
© 2017 BY THE AMERICAN COLLEGE OF CARDIOLOGY FOUNDATION
PUBLISHED BY ELSEVIER

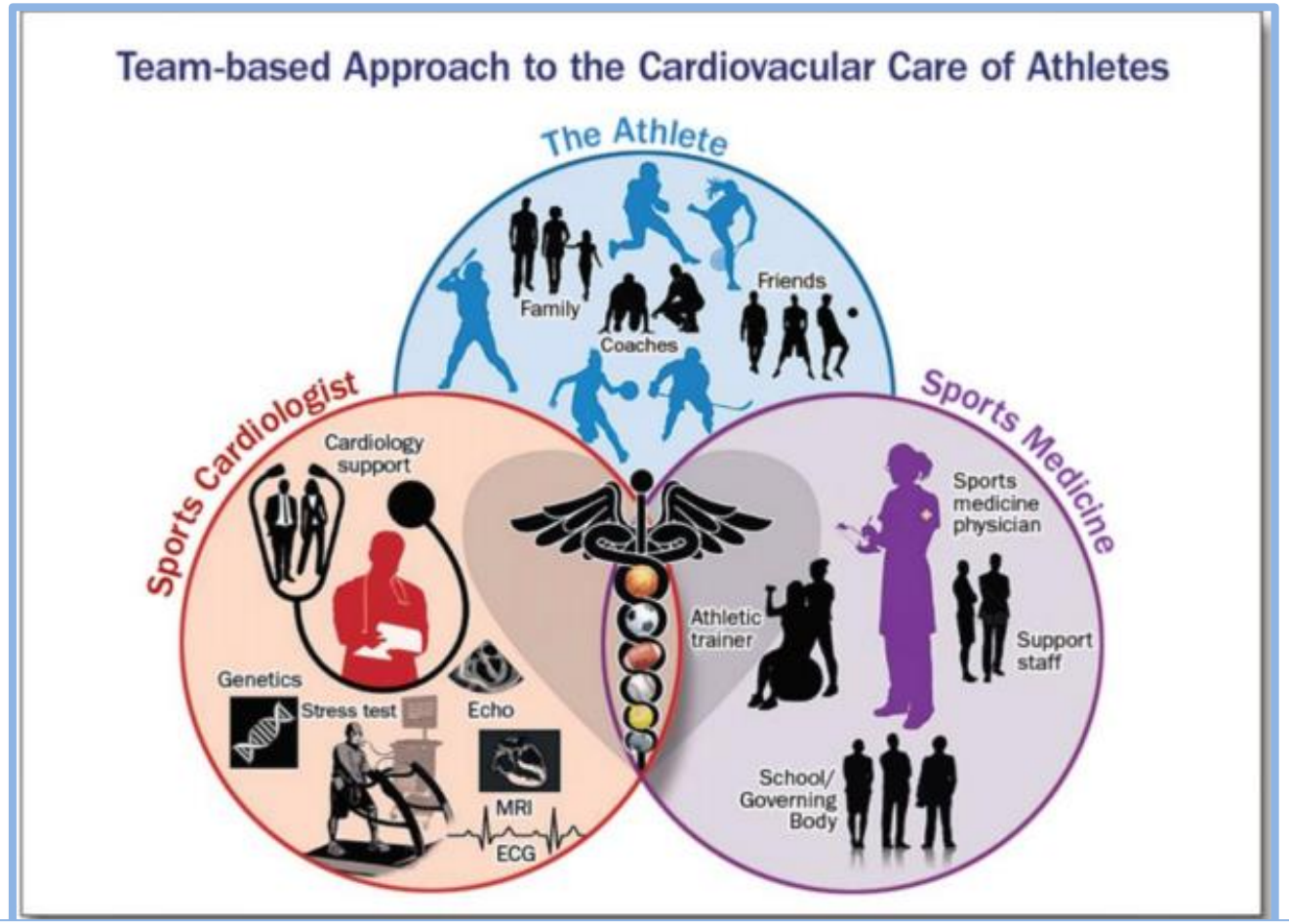
VOL. 69, NO. 11, 2017
ISSN 0735-1097/$36.00
http://dx.doi.org/10.1016/j.jacc.2017.02.009

FELLOWS-IN-TRAINING & EARLY CAREER PAGE

~~The Emergence of~~ Sports Cardiology as a Specialty

Maxwell Eyram Afari, MD

ATLANTIC HEALTH SYSTEM



Multidisciplinary Athlete-Centered Care ("Athlete Care Team") in Evaluating and Managing Athletes at Risk of SCD

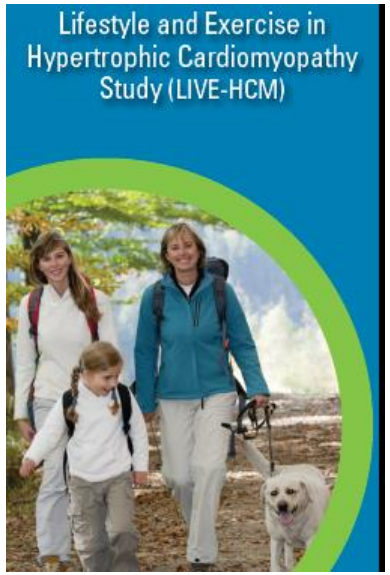
Emery MS, Kovacs RJ. Sudden cardiac death in athletes. JACC Heart Fail 2018;6:30-40

EXERCISE IN GENETIC CARDIOVASCULAR DISEASE
(LIVE-HCM)

Aim 1: Incidence **arrhythmic events** over 3 years
Comparison moderate or vigorous exercisers vs sedentary

Aim 2: **Quality of life**
Comparison moderate or vigorous exercisers vs sedentary

Age 8-60 years, with OR without ICD
Any level exercise



Enrollment completed January 2019,
Follow up completed January 2022
Events adjudication underway
1753 HCM participants

NIH R01 HL125918-01

Outcome Registry for Cardiac Conditions in Athletes

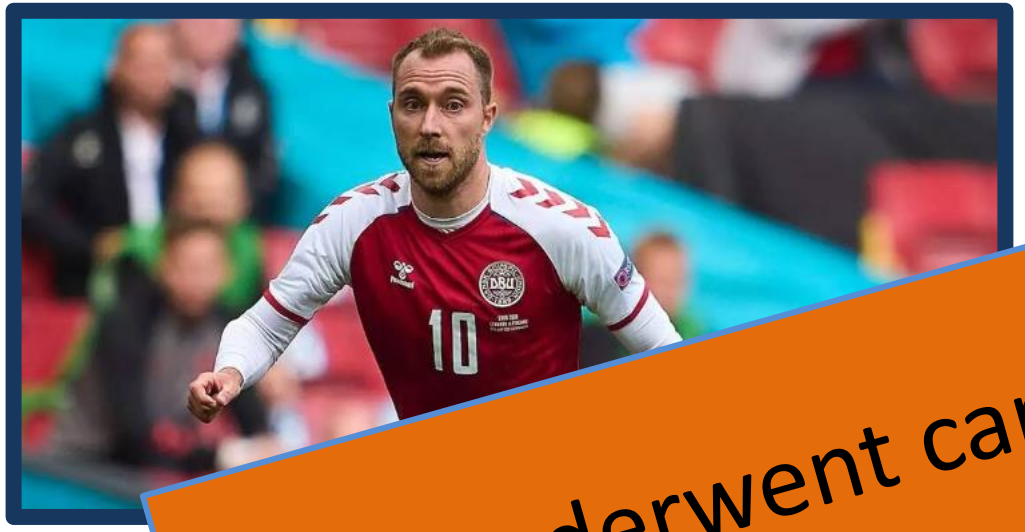
ORCCA

AMSSM AMERICAN MEDICAL SOCIETY FOR SPORTS MEDICINE

American Heart Association.

Christian Eriksen returns to Denmark squad for 1st time since collapse

Denmark plays a friendly away against the Netherlands on March 26 and hosts Serbia on March prepares for the World Cup in Qatar in November.



Keyontae Johnson
2020 collapse

All underwent cardiac screening

Bronny James

Damar Hamlin

ATLANTIC HEALTH SYSTEM

Cardiac Care of the Athlete: New Fronter or refining the focus?

- Both!
- Refining the focus
  - Athlete natural history and longitudinal follow up
  - Risk assessment knowledge and development of tools
  - Improving access to experts in the field in a timely manner
- New frontier
  - Athlete evaluations and RTP decision making
  - Better understanding of SDM (applications, uniformity)
  - On field safety

Thank you

Matthew W. Martinez, MD FACC

Sports Cardiology Medical Director

HCM Medical Director

Team Cardiologist - New York Jets

Cardiologist – Major League Soccer, NFL Medical committee, NBPA, JETS

twitter @mmartinezheart

ATLANTIC HEALTH SYSTEM