MAYO CLINIC

AN UPDATE ON SUDDEN CARDIAC ARREST IN ATHLETES

MAYO CLINIC SYMPOSIUM ON SPORTS MEDICINE

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DISCLOSURES

- I have no relevant financial relationships to disclose.
- I will be making no references to off-label or investigational pharmaceuticals or instruments.

LEARNING OBJECTIVES

- Discuss critical components of the pre-participation plan beyond the ECG
- Review opportunities for improvement in emergency action plans for athletes with sudden cardiac arrest
- Examine the latest research from registries on sudden cardiac arrest in athletes
- Highlight new research on the safety of exercise in patients with hypertrophic cardiomyopathy

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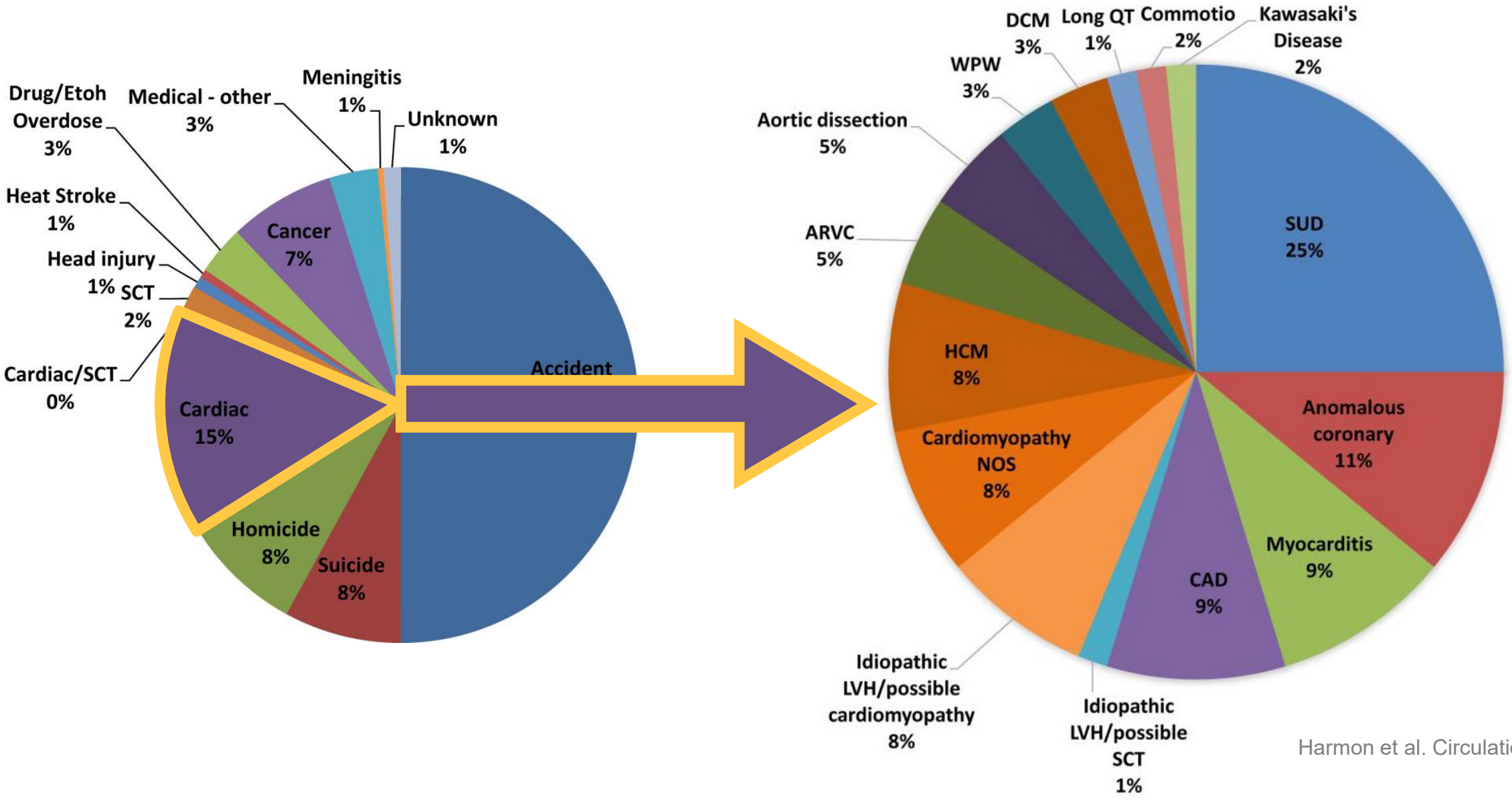
IMPROVING PREPARTICIPATION SCREENING

Sudden cardiac arrest (SCA) = sudden cessation of cardiac activity with hemodynamic collapse, typically due to sustained ventricular arrhythmia

Sudden cardiac death (SCD) = death that occurs within 1 hour of onset of symptoms in witnessed cases, or within 24 hours of last being seen alive when unwitnessed

Stiles et al. 2020 APHRS/HRS Expert Consensus Statement.

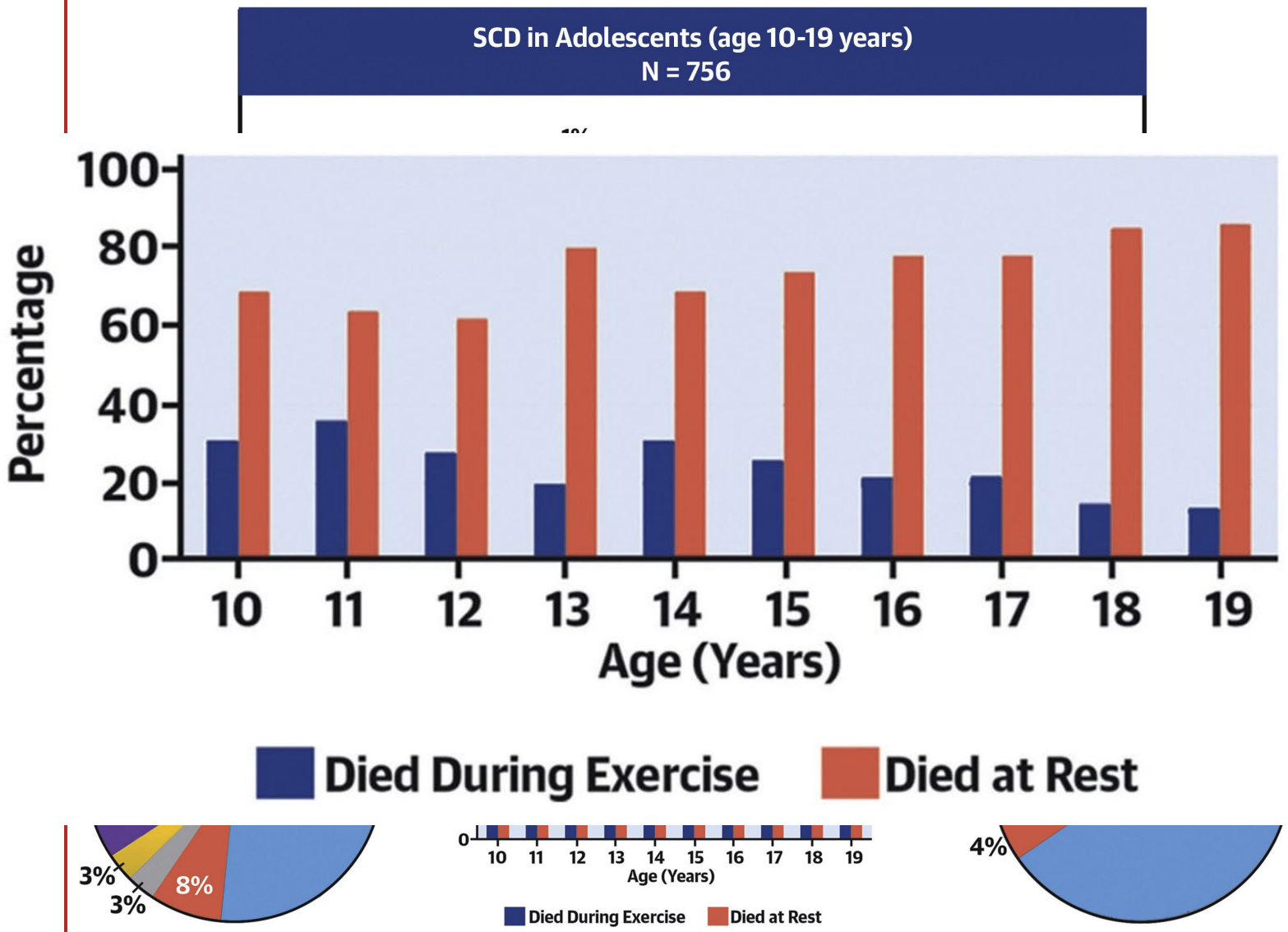
HOW COMMON IS SCD IN ATHLETES?



Harmon et al. Circulation. 2015.

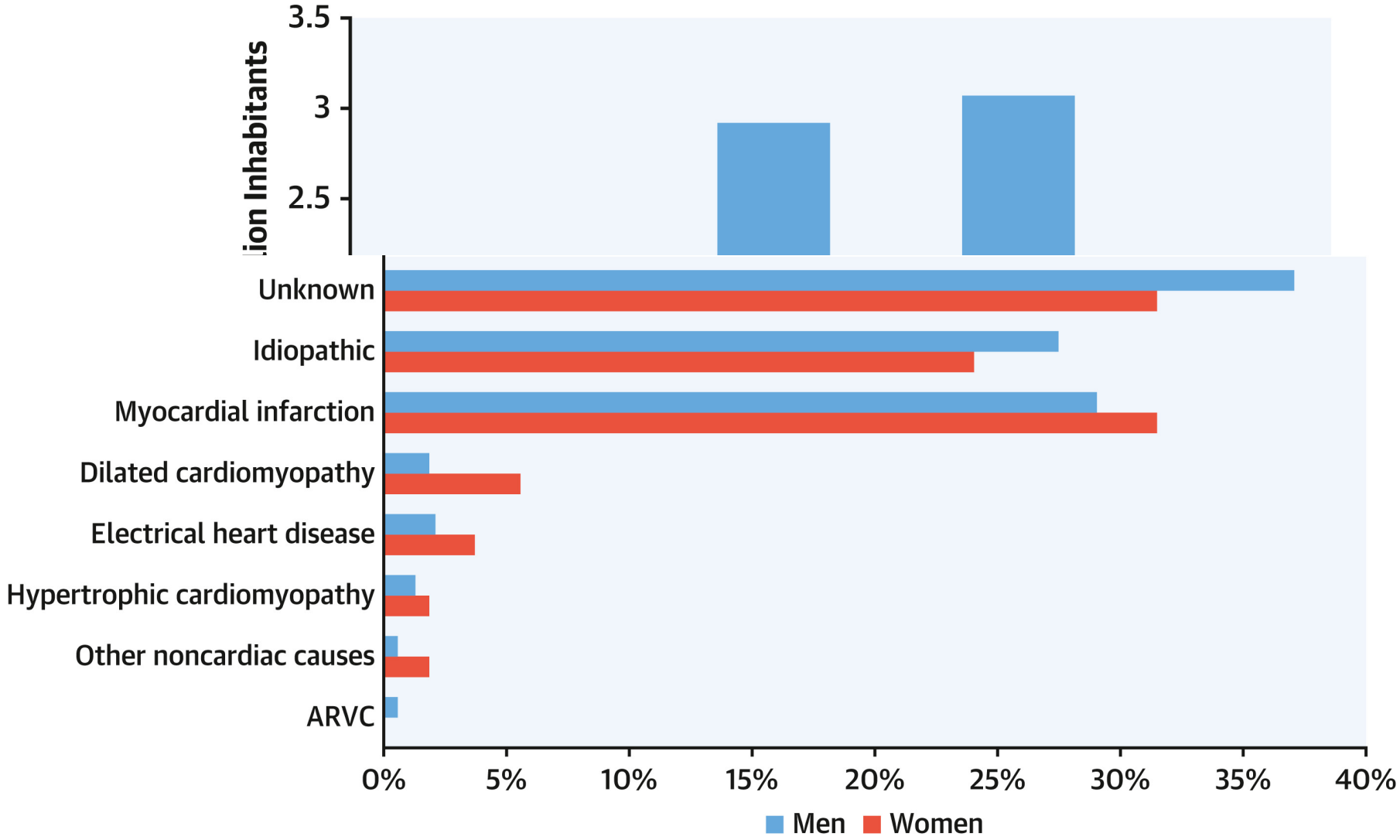
WHAT DOES THE MOST RECENT DATA SAY?

CENTRAL ILLUSTRATION: Causes of Sudden Cardiac Death in Adolescents (Athletes and Nonathletes)



Finocchiaro G, et al. J Am Coll Cardiol. 2023;81(11):1007-1017.

WHAT ABOUT FEMALE ATHLETES?



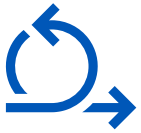
Weizman O. et al. JACC. 2023.

What can we do to improve pre-participation exams?

A few suggestions:

Understand the limits of testing.

Educate athletes.



Bring them back.

Have a plan.

HOW GOOD ARE WE AT IDENTIFYING ATHLETES "AT RISK"?

	Physical exam
Sensitivity	9%
Specificity	97%

Harmon KG et al. J Electrocardiology 2015.

MORE TESTING DOES NOT ALWAYS MEAN BETTER TESTING.

- **Echocardiography**:
  - High prevalence of “structurally normal hearts” among athletes with SCD
  - Interpretation of “normal” athletic remodeling vs. “abnormal”
  - Complexity, variability, and cost of the exam
- **Exercise ECG**:
  - ↑ sensitivity, ↓ positive predictive value
  - Choosing a proper protocol
  - Lack of standard interpretation criteria

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.

Malhotra et al. NEJM 2018.

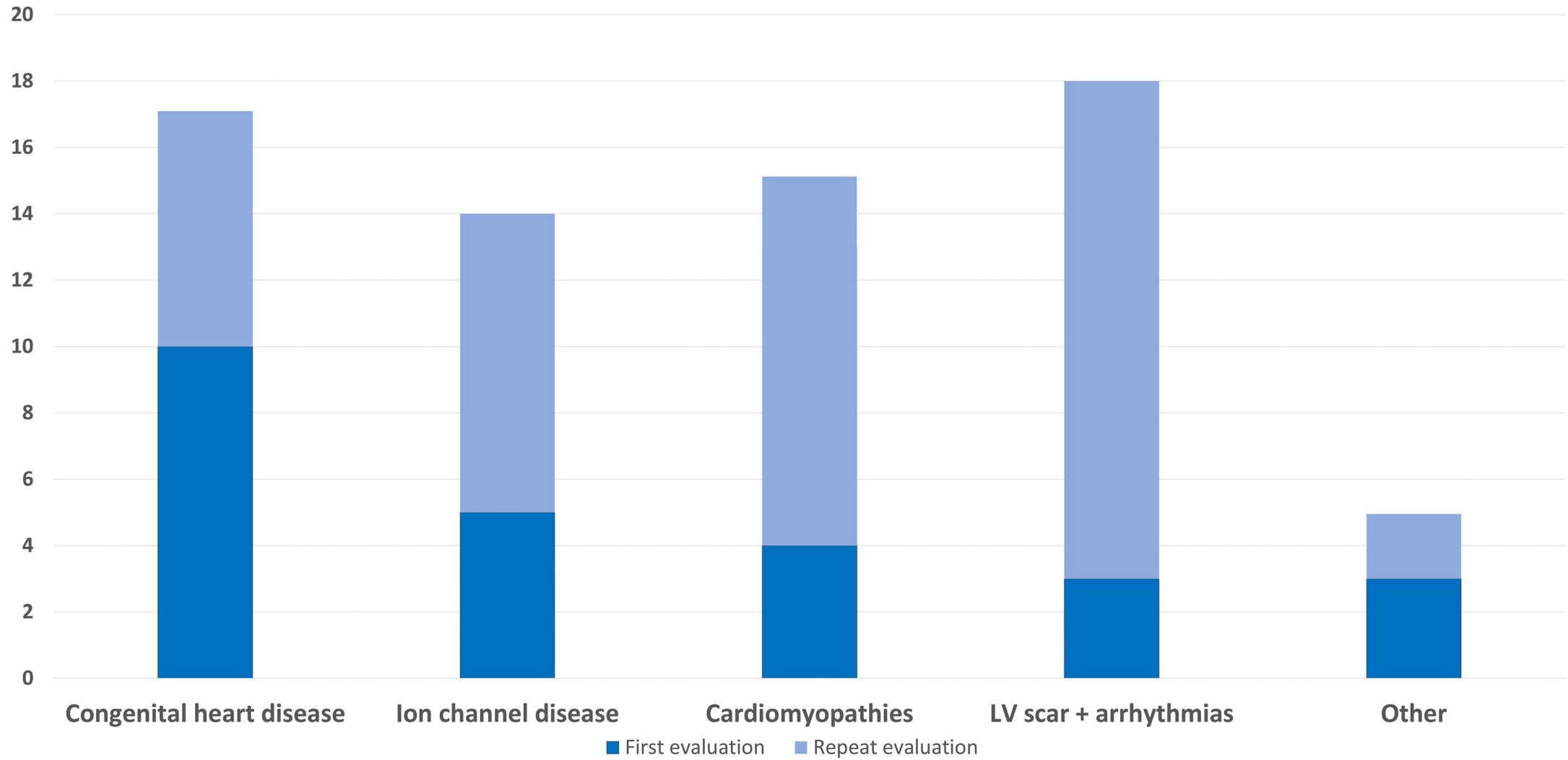
EDUCATE ATHLETES ABOUT SYMPTOMS.

“Video-enhanced preparticipation evaluation”

UT Southwestern Medical Center

Parizher, G et al. A Video-Enhanced, Electronic Modality for Preparticipation Examination of Young Athletes. Current Sports Medicine Reports 20(9):p 485-488, September 2021.

BRING THEM BACK.



Sarto, P. et al. Eur Heart J. 2023.

What can we do to improve pre-participation exams?

A few suggestions:

Understand the limits of testing.

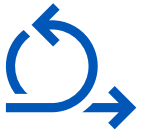
Rarely are findings black and white.

More testing does not always mean better screening.

Educate athletes.

Symptoms need to be identified and reported.

Family history is critical.



Bring them back.

Cardiac pathology can emerge over time.

Have a plan.

Know when and where to refer.

Have an emergency action plan for the athlete and the institution.

2

EMERGENCY ACTION PLANS

HAVE A PLAN.

Population	Survival rate	Study
US HS athletes in schools with AEDs	**64%** survival to hospital discharge	Drezner et al. Circulation. 2009.

EMERGENCY ACTION PLANS

- Teach the skills – CPR and AED use
- Make AEDs widely available
- Establish a communication system
- PRACTICE.

EMERGENCY ACTION PLANS FOR INDIVIDUAL ATHLETES

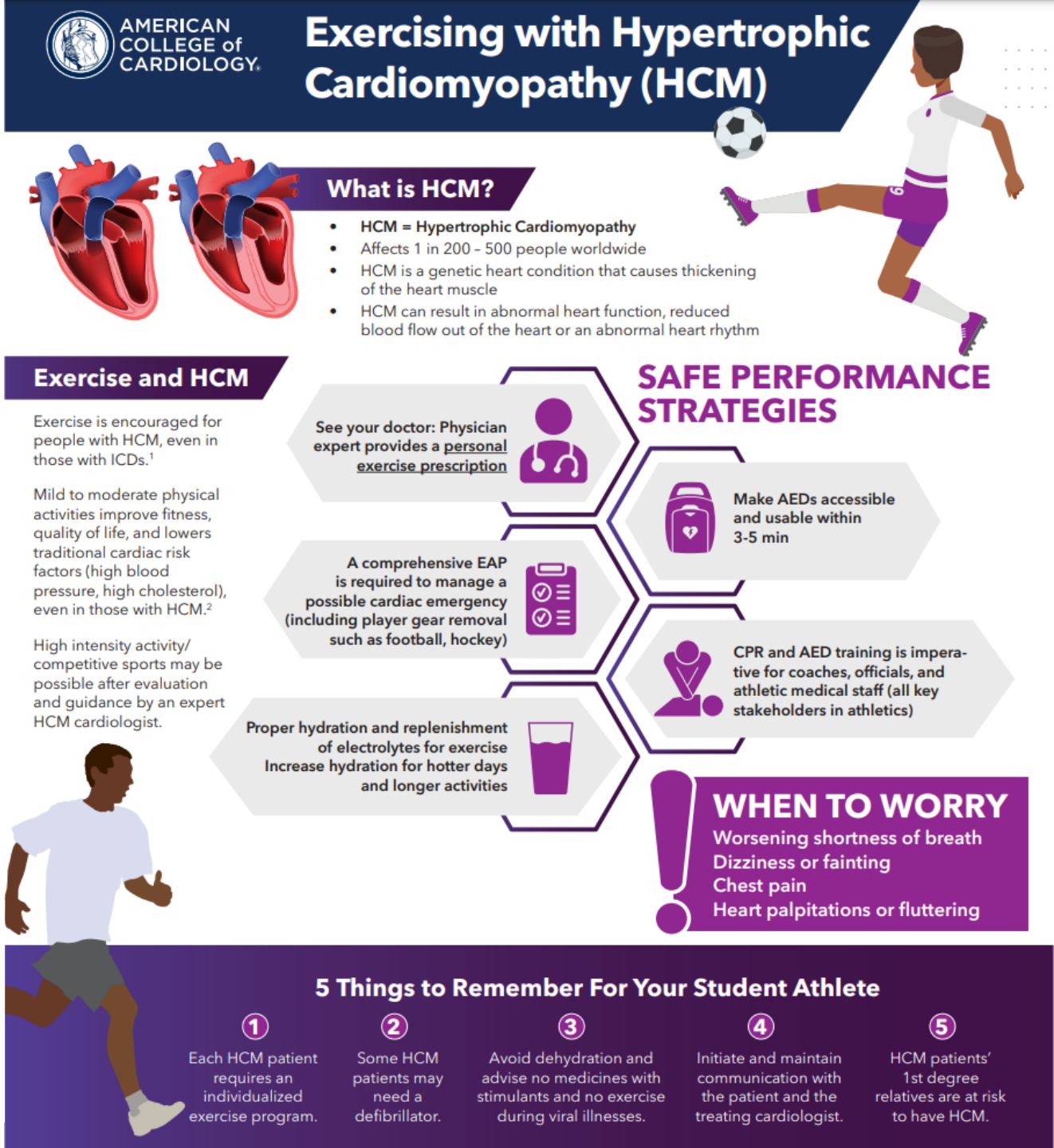


Image from the American College of Cardiology, 2023. Used with permission.

HOW ELSE CAN WE IMPROVE EMERGENCY ACTION PLANS?

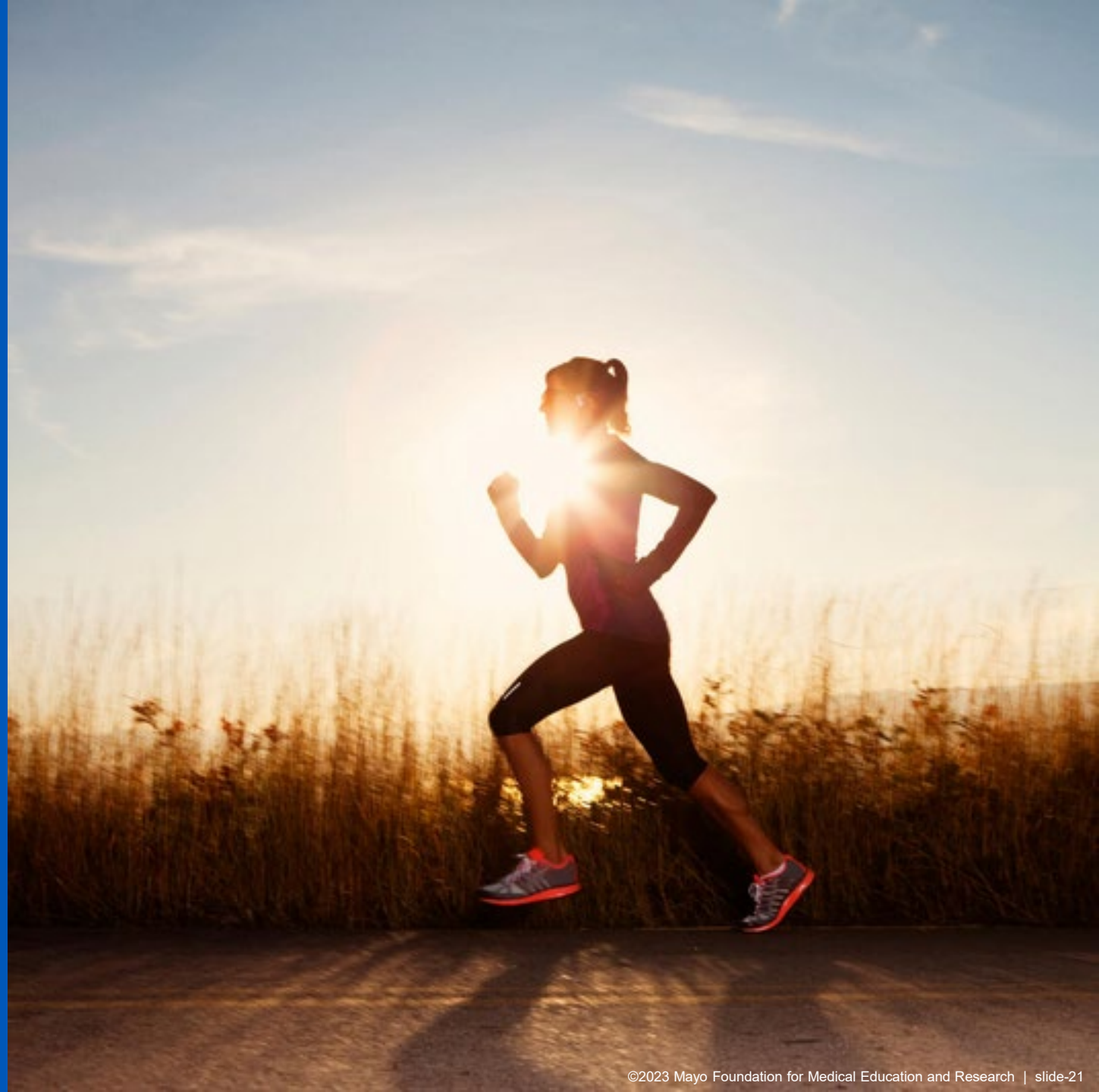
- States with laws mandating CPR/AED education in high schools*
  - Have higher rates of bystander CPR
  - Have higher rates of AED use
- There is an increase in bystander CPR after the law is enacted

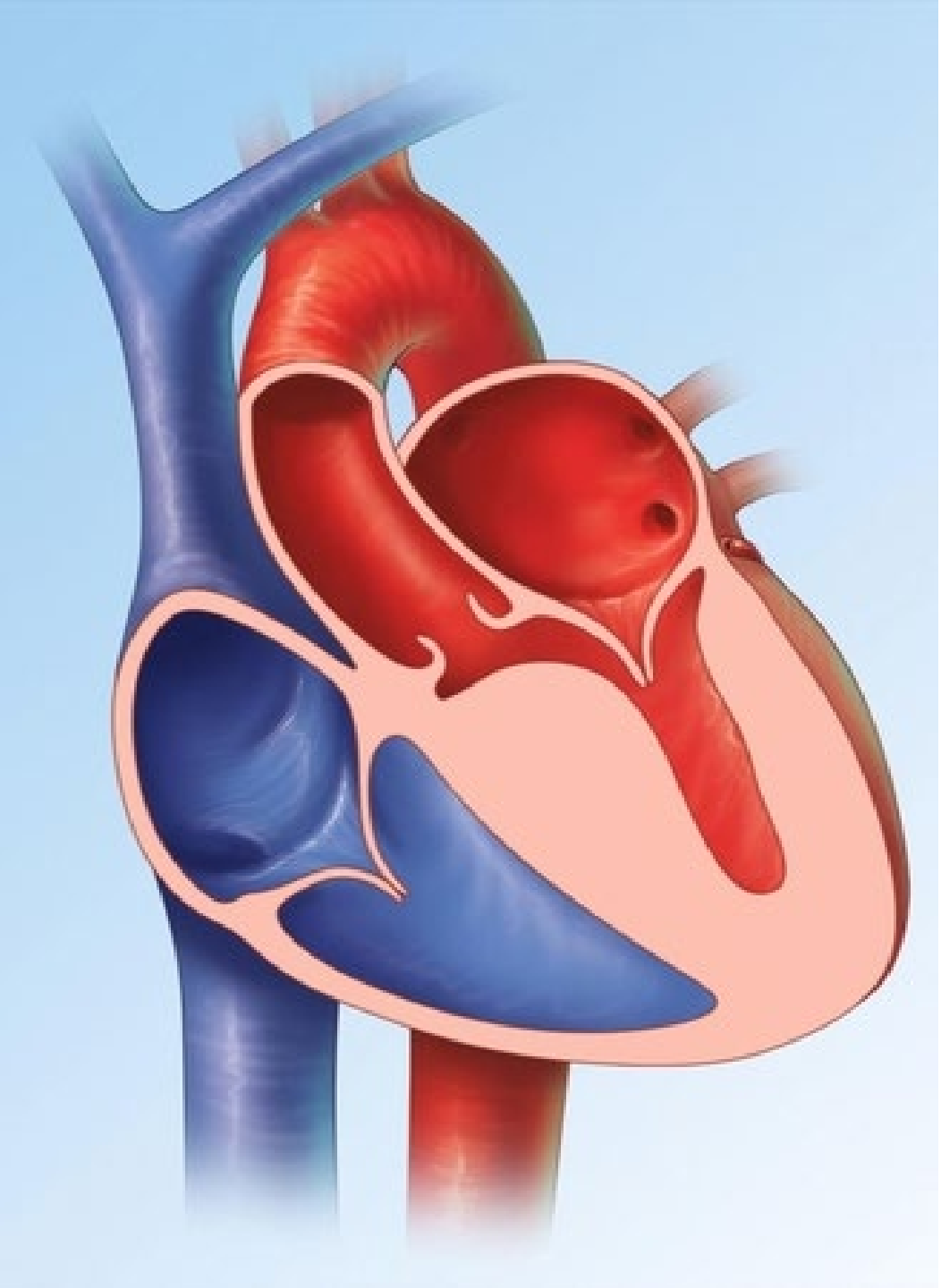
*it's not just the students who receive life-support measures!

Vetter V et al. JACC. 2022.

3

EXERCISE IN PATIENTS WITH HYPERTROPHIC CARDIOMYOPATHY





HYPERTROPHIC CARDIOMYOPATHY

- Relatively common
- A leading cause of SCA among athletes
- Substrate (HCM) + trigger (exercise)
  - Hemodynamic changes
  - Electrolyte shifts
  - Catecholamine surges
- Is exercise a “modifiable risk factor”?

2015 ACC/AHA ELIGIBILITY AND DISQUALIFICATION RECOMMENDATION FOR COMPETITIVE ATHLETES WITH CARDIOVASCULAR ABNORMALITIES

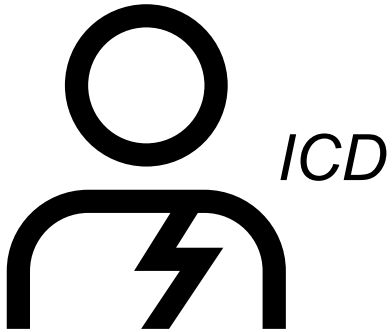
2. **Athletes with a probable or unequivocal clinical expression and diagnosis of HCM (ie, with the disease phenotype of LV hypertrophy) should not participate in most competitive sports, with the exception of those of low intensity (class IA sports) (see "Classification of Sport" [22]). This recommendation is independent of age, sex, magnitude of LV hypertrophy, particular sarcomere mutation, presence or absence of LV outflow obstruction (at rest or with physiological exercise), absence of prior cardiac symptoms, presence or absence of late gadolinium enhancement (fibrosis) on CMR, and whether major interventions such as surgical myectomy or alcohol ablation have been performed previously *(Class III; Level of Evidence C).***

"On the other hand, the present American Heart Association/American College of Cardiology recommendations do not strictly exclude in absolute terms fully informed athletes from participating in competitive athletic programs…Although this expert consensus report serves as a prudent guideline regarding sports eligibility or disqualification, there will always be tolerance in the system…"

- The paradigm of strict disqualification from sport has changed.
- Emerging data suggests that when done carefully, athletes with HCM can compete within reasonable risk.

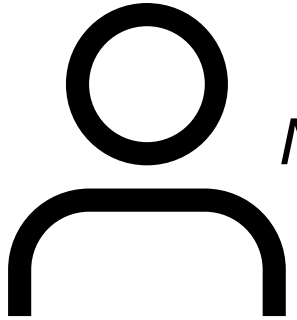
RECENT DATA: ATHLETES WITH ICDs

- 125 athletes *with* ICDs undergoing return to play evaluation (22 with HCM)



ICD

3.4 events per
100-athlete years



No ICD

2.0 events per
100-athlete years

No deaths

Tobert, K et al. Mayo Clinic Proceedings. 2022.

RECENT DATA: ATHLETES WITH GENETIC HEART DISEASE

- Retrospective multi-center study
- 76 athletes
  - 53% had HCM
  - 1/3 had an ICD
- 200 athlete years of follow-up
  - 1 exercise-associated adverse event (HCM, ICD shock while moving furniture)
  - 2 non-exercise associated adverse events (one HCM, one LQTS)
  - **No deaths**

Martinez KA et al. JACC. 2023.

WHAT DO THESE TWO STUDIES ADD TO OUR CURRENT KNOWLEDGE?

- Athletes with genetic heart disease (including HCM) who undergo evaluation at high-volume subspecialty centers *are returning to play.*
  - Athletes with ICDs *are returning to play.*

- In these cohorts, event rates are low.

- Among these cohorts, athletes undergo **very thorough** disease phenotyping, **lengthy** shared decision making discussions, and **meticulously coordinated** care and follow up
  - Athletes *and* their institutions are prepared to address events

RECENT PROSPECTIVE DATA

Research

JAMA Cardiology | Original Investigation

Vigorous Exercise in Patients With Hypertrophic Cardiomyopathy

STUDY COHORT

THESE AREN'T JUST LOW RISK PATIENTS!

Risk factors	Vigorous noncompetitive (n = 440)	Vigorous competitive (n = 259)
"Overt" HCM	94.5%	71.9%
History of cardiac arrest	4.8%	7.6%
ICD present	44.7%	32.7%
Significant LVOT obstruction	41.7%	41.0%

MAJOR FINDINGS

12 individuals with SCA or SCD

All in “overt” HCM patients

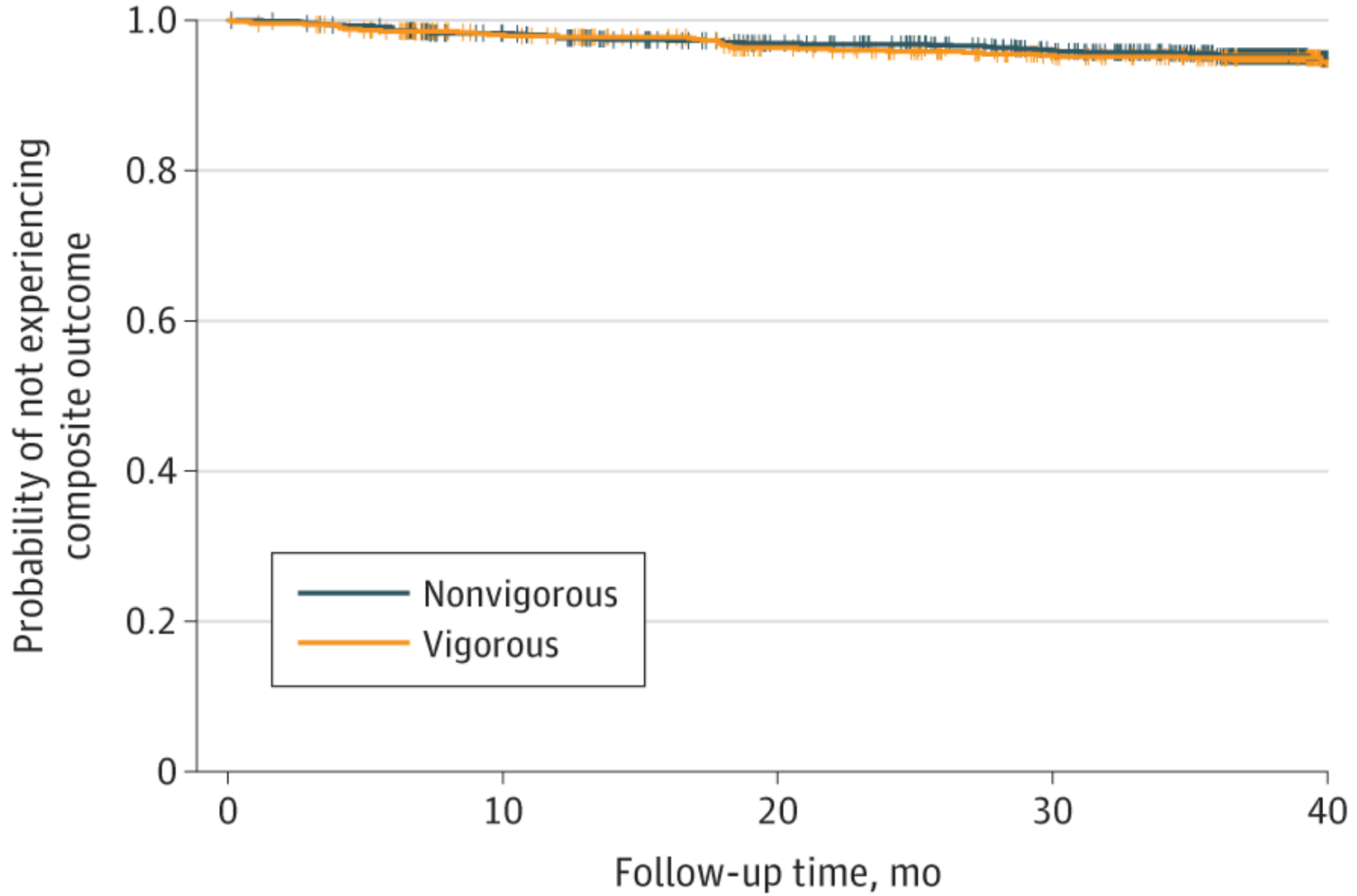
7 occurred in those in the “vigorous” exercise group

2 during recreational exercise

1 during competitive exercise

3 during activities of daily living

1 unknown setting



No. at risk			
Nonvigorous	961	852	262
Vigorous	699	608	193

TAKE-HOME POINTS

- Retrospective data from high-volume sports cardiology centers suggests athletes with genetic heart diseases return to play at low risk of serious adverse cardiac events.
- Prospective data suggests that physical activity among patients with *treated and surveilled* HCM is not as risky as we once thought.
- Coordination, follow-up, and engagement with teams/universities is critical to ensuring safe competition.

FINAL THOUGHTS

SCD/SCA is rare; know who is at greatest risk.

- Sudden unexplained death remains a problem
- Females are at lower risk

SCD/SCA prevention *and* response to can be improved.

- More tests ≠ better
- Educate athletes
- Bring them back
- Have a practiced plan at the athlete and institution level

Athletes with heart disease can compete; be prepared.

- Detailed subspecialty evaluation
- Longitudinal follow-up
- Individualized action plans

QUESTIONS & ANSWERS

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