Prediction and Prevention of Sudden Death in the Athlete

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Professor of Medicine
UPMC Heart and Vascular Institute
American Heart Association

Strive to Revive 2019

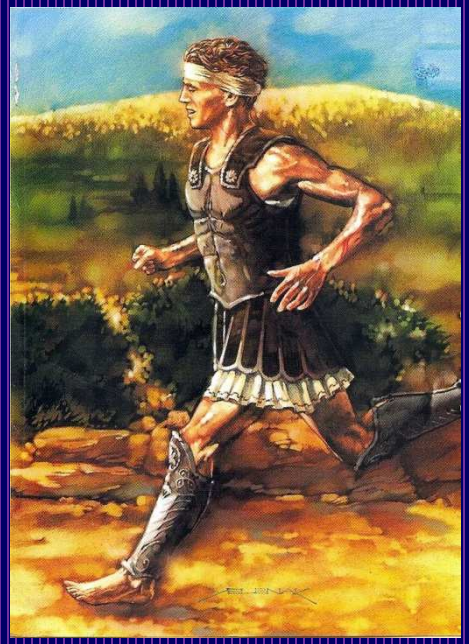
Friday October 4th , 2019

UPMC
LIFE CHANGING MEDICINE

Sudden Cardiac Death in Athletes

- Historical Perspective
- Epidemiology
- UPMC Case
- Screening
- Structural Heart Disease
- Performance Enhancing Substances
- AEDs
- Conclusions

Sudden Cardiac Death in the Sport Historical Perspective



- *Pheidippides*

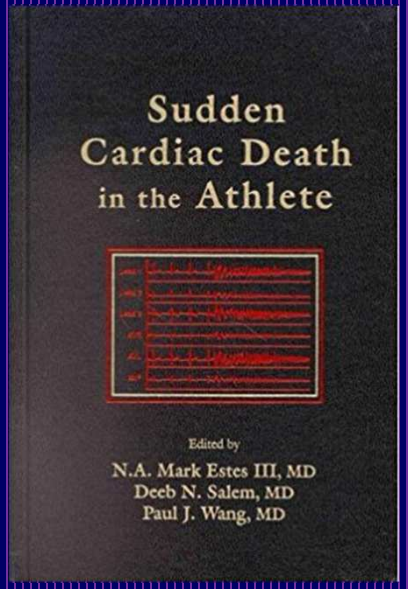
  Ran from Marathon to Athens to announce victory over the Persians.

  After running 24 miles (40 km) he he dropped dead.

Martin, Ann NY Acad Science, 1977

To an athlete dying young

Reggie Lewis
1965-1993



Evidence Based
Medicine

Antonio Puerta
1984-2007

Townsman of a stiller town.

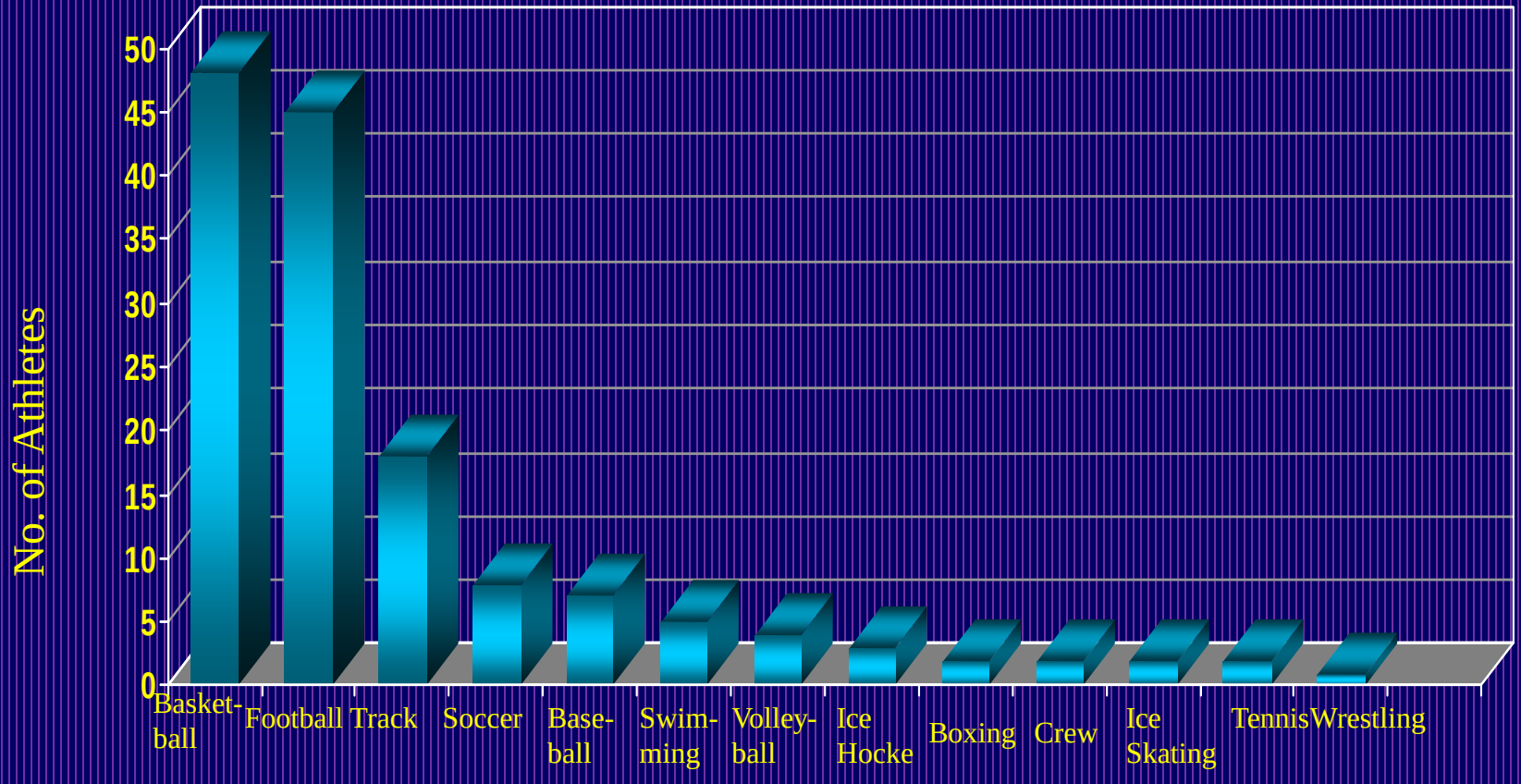
Sudden Cardiac Death Athletes Epidemiology

High school and college women	1/769,000
High school and college men	1/133,000
High school men	0.66/100,000
College men	1.45/100,000
Males> age 40	1/15,000

Risk of SCD increases 8-56X with exercise

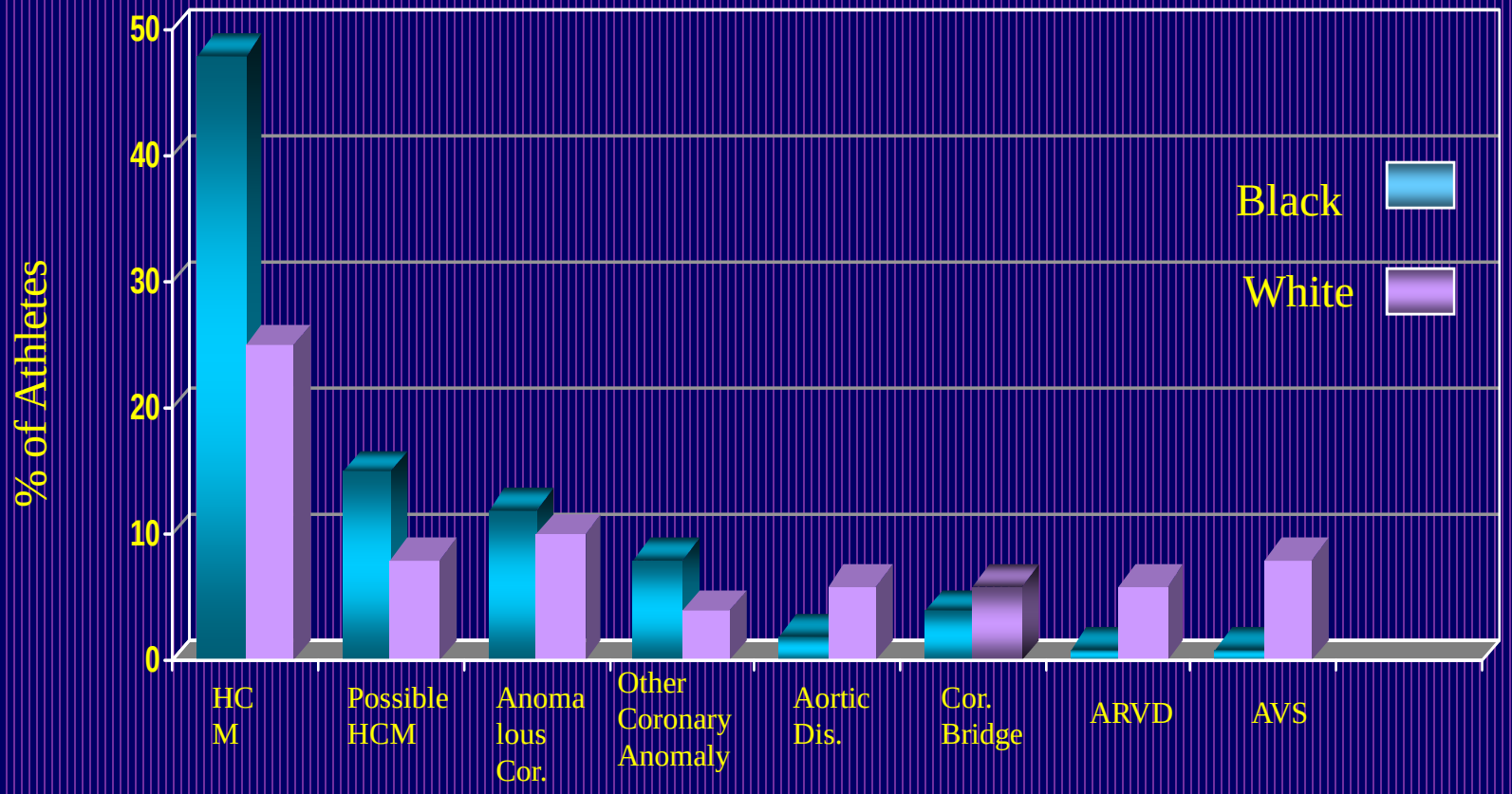
Estes NAM, Wang PJ, Salem D, Sudden Death in the Athlete, Futura, 1997

Sudden Cardiac Death in the Athlete
Deaths by Sport



Maron BJ, et al. JAMA. 2000.

Sudden Cardiac Death in the Athlete
Cardiac Condition and Race



Maron BJ, et al. JAMA. 2000.

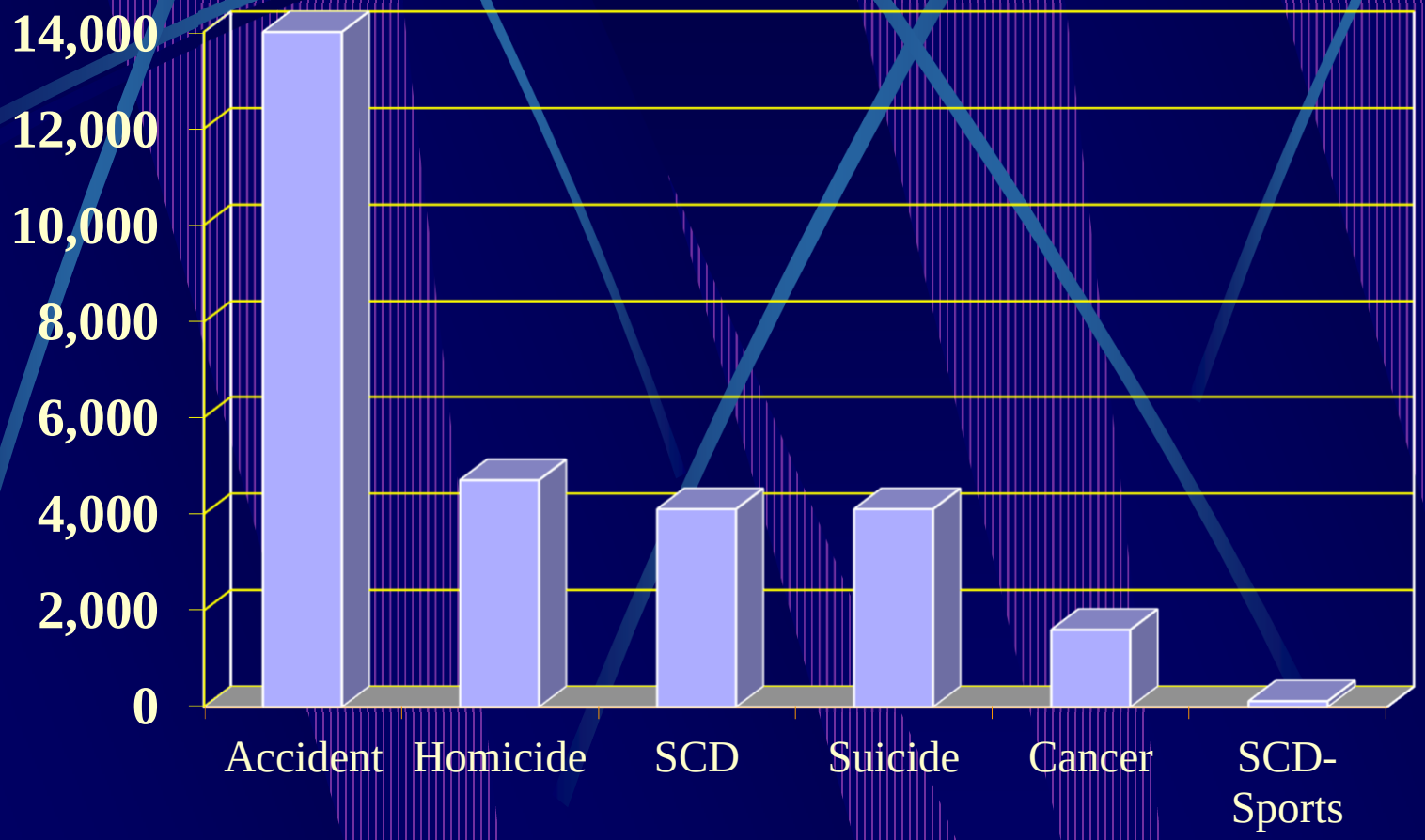
Incidence of sudden death stratified by athletic or general population and the years of the study population

Country	Author	Population	Years	Incidence /100,000/year
Italy	Corrado	Athletes	1980-1981	**3.6**
Italy	Corrado	Athletes	2007-2008	**0.40**
US	Maron	Athletes	1985-2006	**0.44**
Israel	Steinvil	Athletes	1985-1997	**2.54**
Israel	Steinvil	Athletes	1998-2009	**2.66**
US	Van Camp	Athletes	1983-1993	**0.33**
Denmark	Holst	Athletes	2000-2006	**1.21**
Denmark	Holst	All children	2000-2006	**3.76**
Japan	Tanaka	All children	1989-1996	**1.32**
Canada	Atkins	Children 1-11	2005-2007	**3.73**
Canada	Atkins	Children 12-19	2005-2007	**6.37**

The general population has a higher risk of SCD in comparison with an athletic population

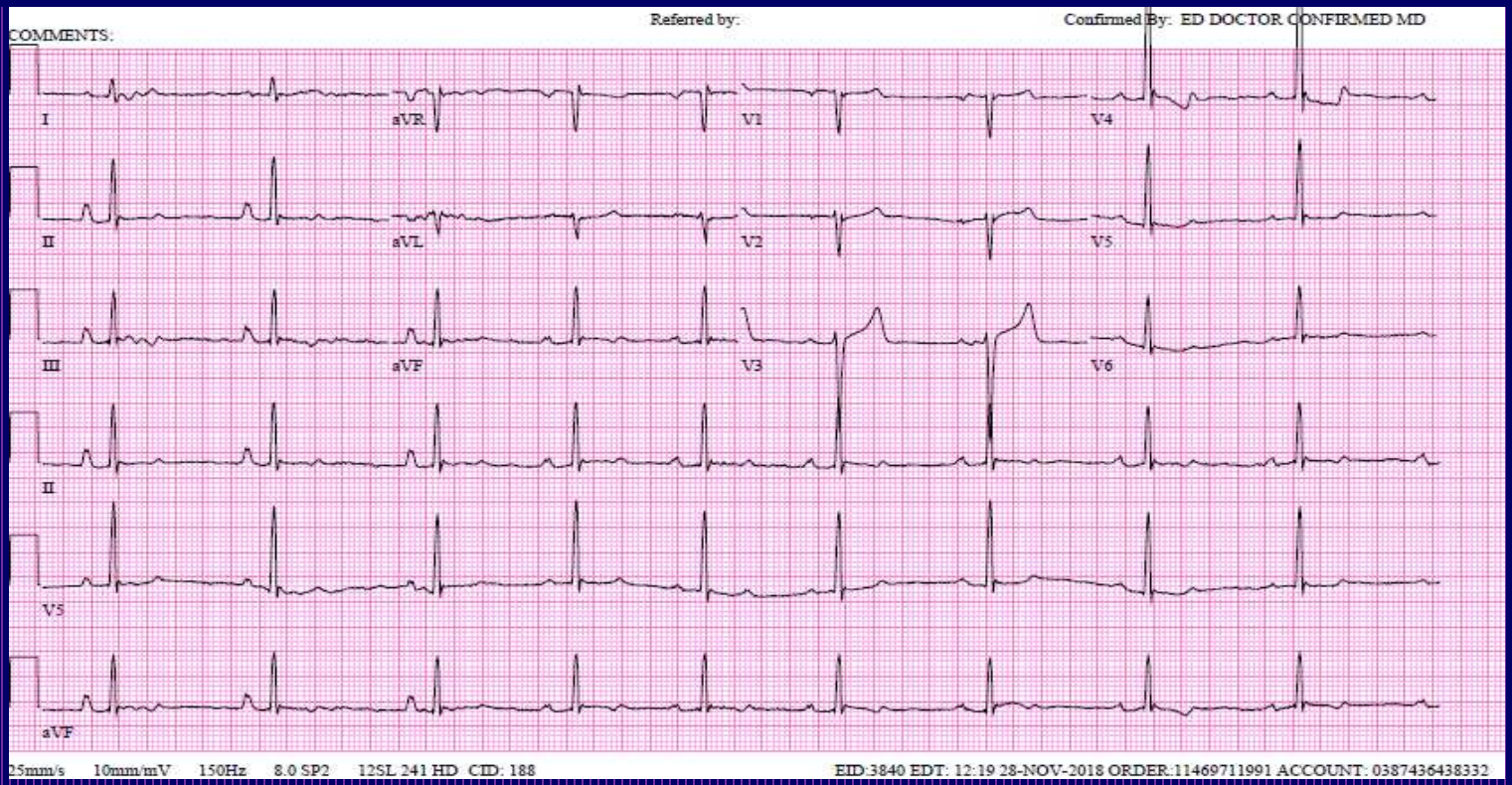
Doherty et al J Interv Card Electrophysiol (2013) 36:167–175

Annual Causes of Death in U.S. Population Age 1-21 (CDC) 79,000,000



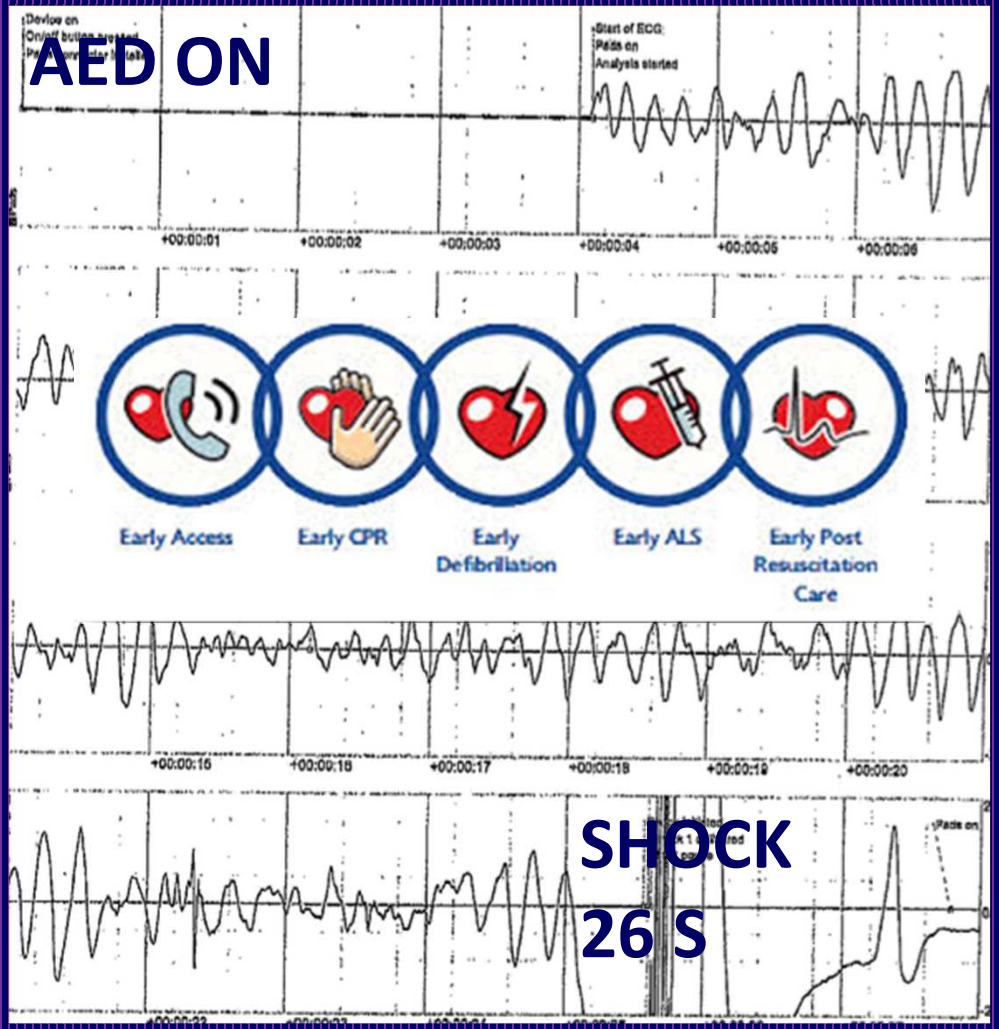
(http://webappa.cdc.gov/sasweb/ncipc/leadcaus10.html)

27 year old marathon runner (US Olympic Team Qualifier) with 7 months of exertional palpitations and syncope



UPMC LIFE CHANGING MEDICINE

27 year old marathon runner (US Olympic Team Qualifier) with 7 months of exertional palpitations and syncope

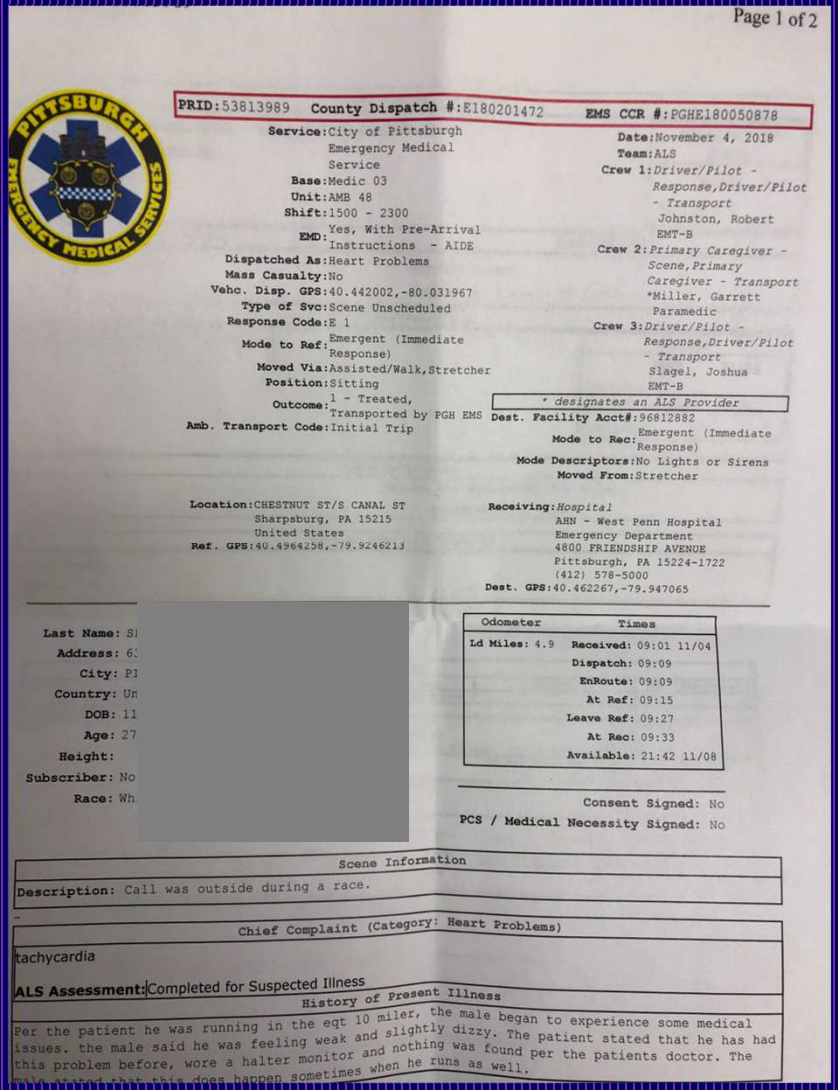


UPMC LIFE CHANGING MEDICINE

UPMC Mercy HVI Team

Semsa Comor, Jackie Dustevitch, Stacey Tomer, Sue Davis, Alyssa Sukay
Julia Tornabene, Erica Byers, Kelsey Thimons

27 year old marathon runner (US Olympic Team Qualifier) with 7 months of exertional palpitations and syncope



Page 1 of 2

PRID:53813989 County Dispatch #:E180201472 EMS CCR #:PGHE180050878

Service:City of Pittsburgh Emergency Medical Service
Base:Medic 03
Unit:AMB 48
Shift:1500 - 2300
EMD:Yes, With Pre-Arrival Instructions - AIDE
Dispatched As:Heart Problems
Mass Casualty:No
Vehc. Disp. GPS:40.442002,-80.031967
Type of Svc:Scene Unscheduled
Response Code:E 1
Mode to Ref:Emergent (Immediate Response)
Moved Via:Assisted/Walk,Stretcher
Position:Sitting
Outcome:1 - Treated, Transported by PGH EMS
Amb. Transport Code:Initial Trip

Date:November 4, 2018
Team:ALS
Crew 1:*Driver/Pilot - Response,Driver/Pilot - Transport*
Johnston, Robert
EMT-B
Crew 2:*Primary Caregiver - Scene,Primary Caregiver - Transport*
*Miller, Garrett
Paramedic
Crew 3:*Driver/Pilot - Response,Driver/Pilot - Transport*
Slagel, Joshua
EMT-B

** designates an ALS Provider*

Dest. Facility Acct#:96812882
Mode to Rec:Emergent (Immediate Response)
Mode Descriptors:No Lights or Sirens
Moved From:Stretcher

Location:CHESTNUT ST/S CANAL ST
Sharpsburg, PA 15215
United States
Ref. GPS:40.4964258,-79.9246213

Receiving:*Hospital*
AHN - West Penn Hospital
Emergency Department
4800 FRIENDSHIP AVENUE
Pittsburgh, PA 15224-1722
(412) 578-5000
Dest. GPS:40.462267,-79.947065

Last Name: Sl
Address: 6
City: Pl
Country: Un
DOB: 11
Age: 27
Height:
Subscriber: No
Race: Wh

Odometer	Times
Ld Miles: 4.9	Received: 09:01 11/04
	Dispatch: 09:09
	EnRoute: 09:09
	At Ref: 09:15
	Leave Ref: 09:27
	At Rec: 09:33
	Available: 21:42 11/08

Consent Signed: No
PCS / Medical Necessity Signed: No

Scene Information

Description: Call was outside during a race.

Chief Complaint (Category: Heart Problems)

tachycardia

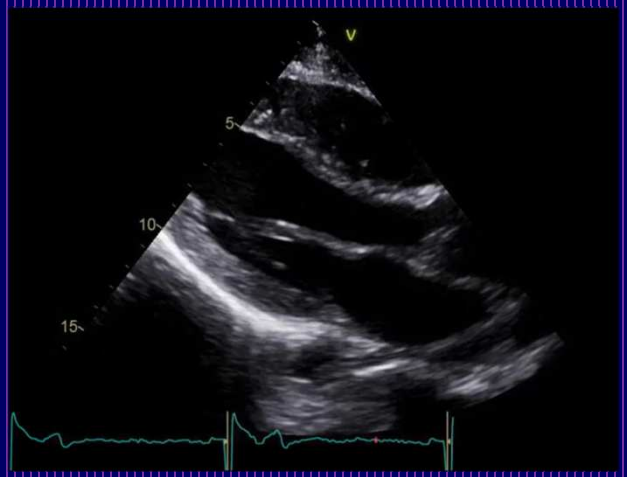
ALS Assessment:Completed for Suspected Illness

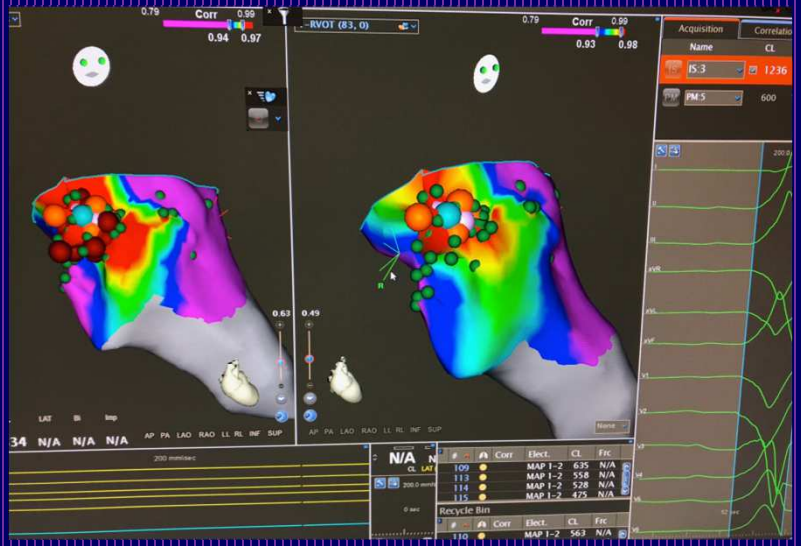
History of Present Illness

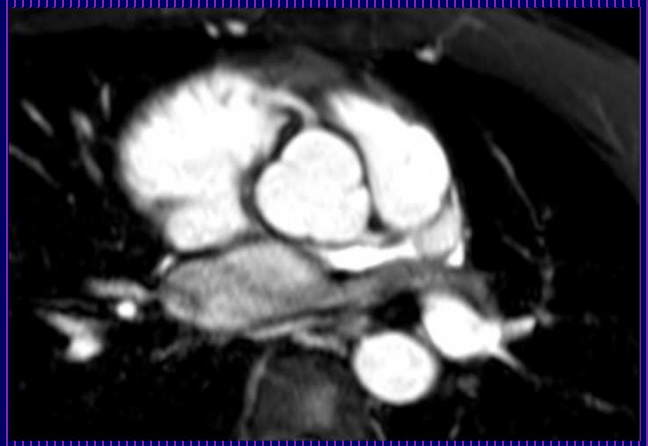
Per the patient he was running in the eqt 10 miler, the male began to experience some medical issues. the male said he was feeling weak and slightly dizzy. The patient stated that he has had this problem before, wore a halter monitor and nothing was found per the patients doctor. The [illegible] this does happen sometimes when he runs as well.

27 year old marathon runner (US Olympic Team Qualifier) with 7 months of exertional palpitations and syncope

- Frequent LBBB, RAD PVCs
- Echo- Normal
- CT-Normal
- MRI with LGE- Normal
- EP study- Normal
- Spontaneous RVOT PVCs
- Ablation of RVOT PVCs

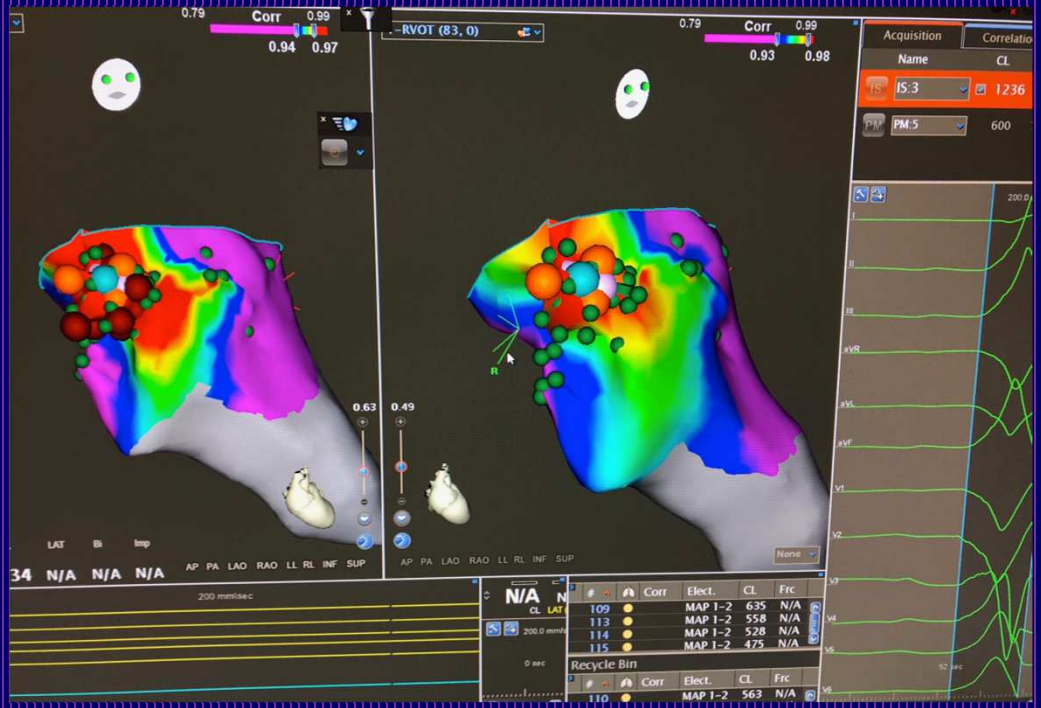




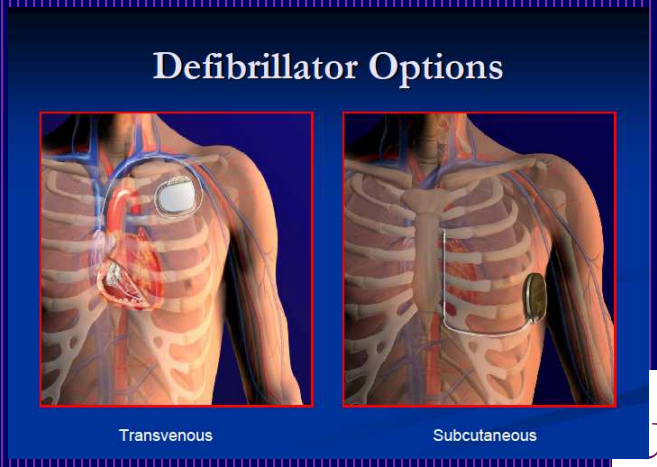


UPMC LIFE CHANGING MEDICINE

27 year old marathon runner (US Olympic Team Qualifier) with 7 months of exertional palpitations and syncope

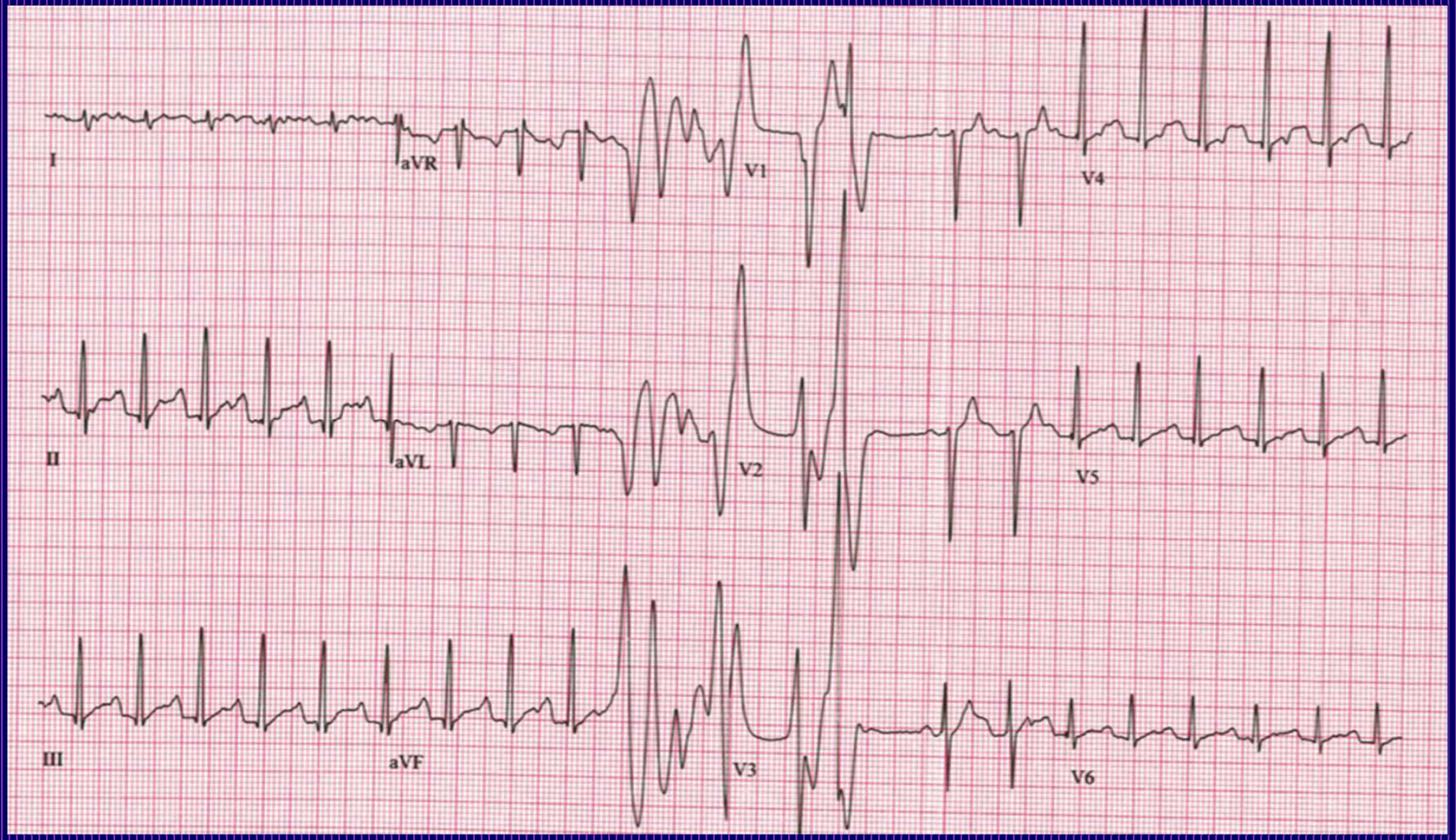


- What would you do next?
- A) Beta blockers
- B) ICD-Transvenous
- C) ICD-Subcutaneous
- D) Observation



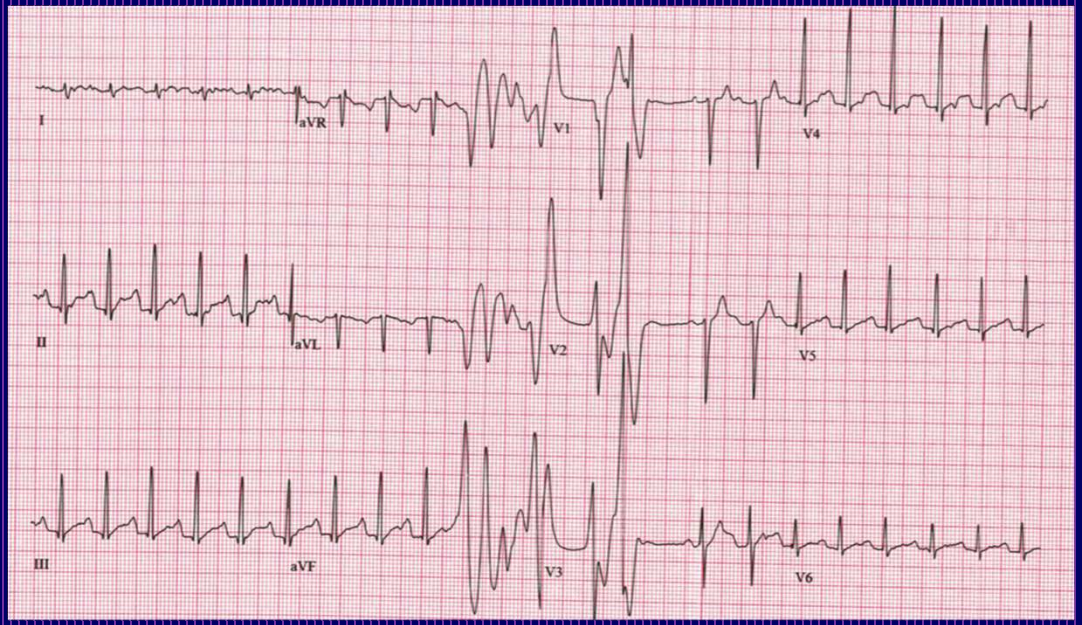
UPMC LIFE CHANGING MEDICINE

6 weeks post ICD
21 minutes on Bruce Protocol



1 minute into recovery

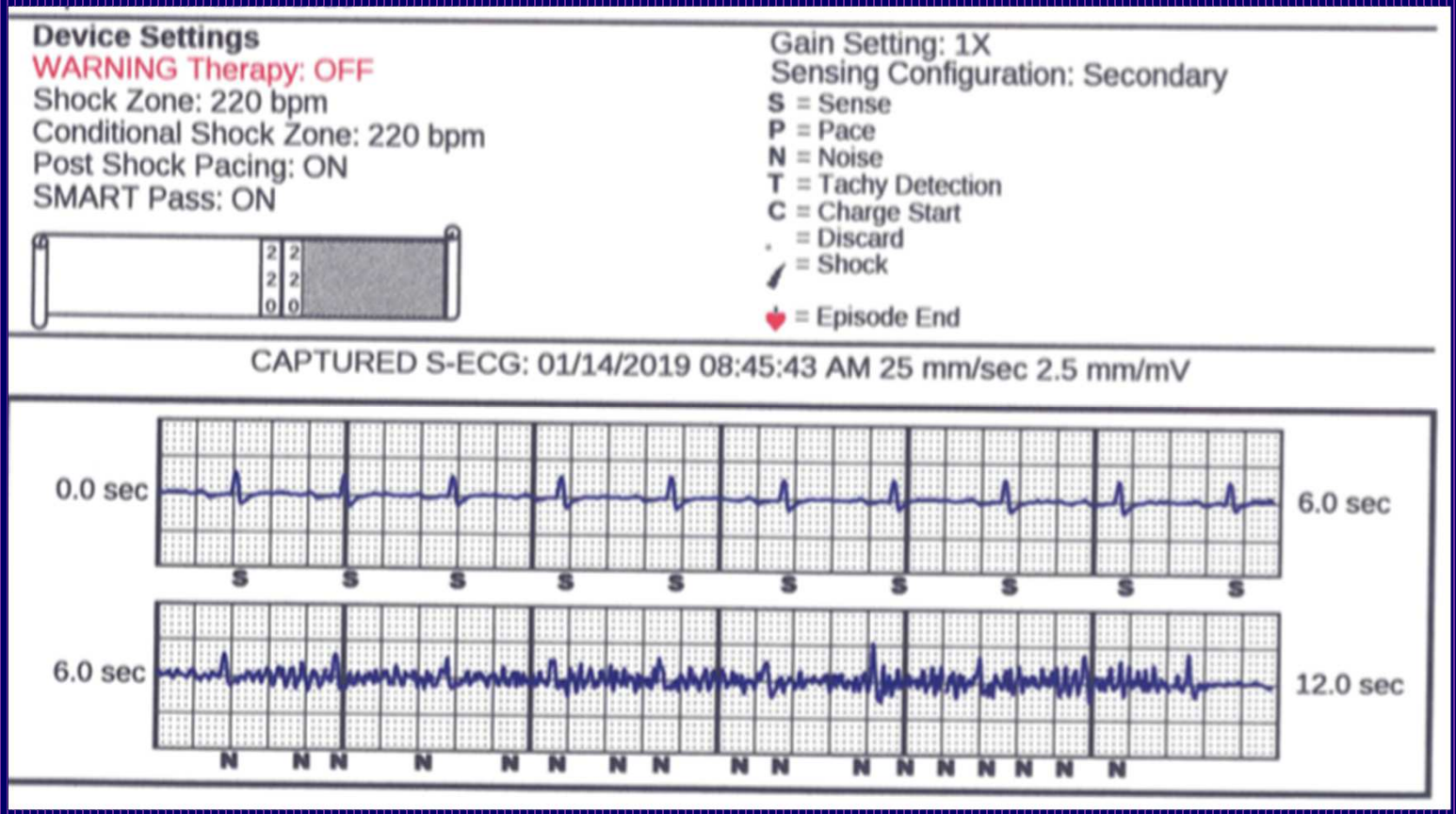
27 year old marathon runner (US Olympic Team Qualifier) with 7 months of exertional palpitations and syncope



- What would you do next?
- A) No athletics
- B) Recreational athletics
- C) Competitive athletics
- D) Add beta blocker and repeat ETT

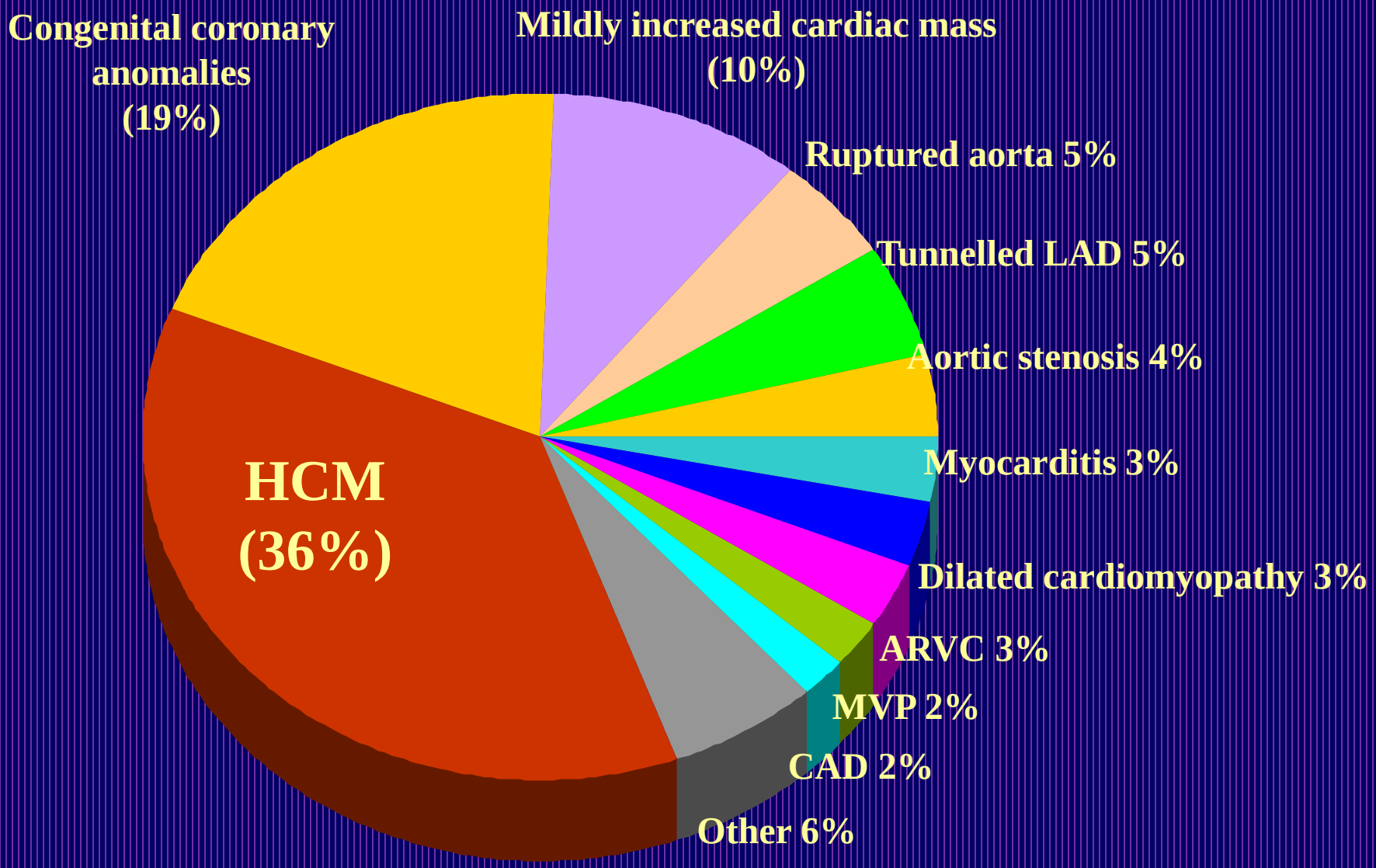
UPMC LIFE CHANGING MEDICINE

6 weeks post ICD
21 minutes on Bruce Protocol-No ”noise” on S-ICD



6 weeks post ICD
Isometric arm exercise

Causes of SCD in Athletes (<40 years)

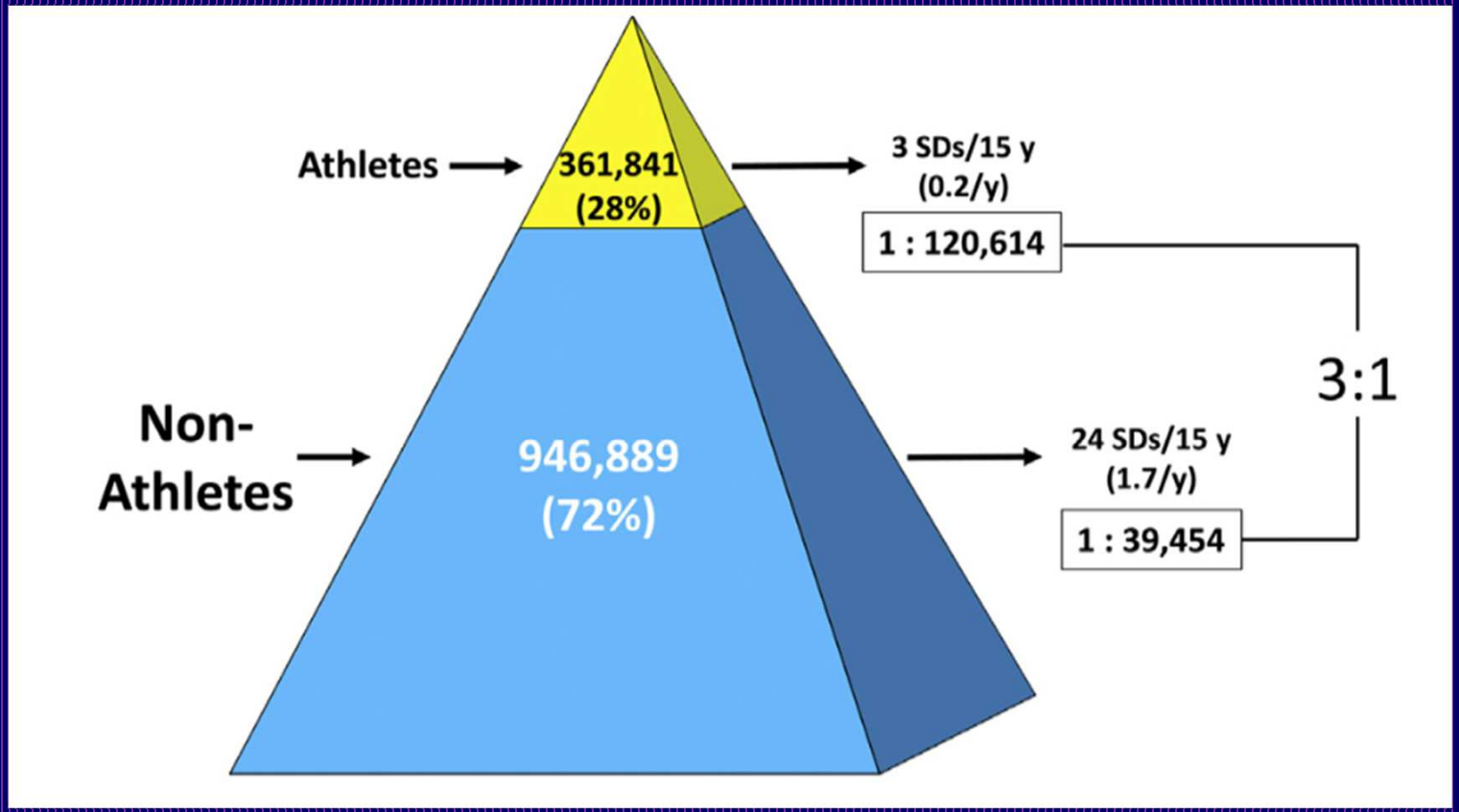


Maron BJ et al. *Circulation.* 1996;94:850-56.

Pre-particpation athletic screening and athletic restriction in Italy, the United States and Israel

Country	Years	Screening	Initial	Examiner	Death
Italy 	1981-2008	Mandatory	History, PE, ECG ETT, Echo	Sports Medicine MD	Decreased
United States 	1985-2006	Recommended	History, PE	MD Non-MD	No decrease
Israel 	1985-2009	Mandatory	History, PE, ECG, ETT, Echo	Certified MD	No decrease

Is It Fair to Screen Only Competitive Athletes for Sudden Death Risk, or Is It Time to Level the Playing Field



Maron and Estes Am J Cardiology 2018

36th Bethesda Conference: Task Force 9
Drugs and Performance Enhancing Substances

"You don't w *on mineral water" (Jacc* *winner)*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AHA/ACC SCIENTIFIC STATEMENT

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 11: Drugs and Performance-Enhancing Substances

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

N.A. Mark Estes III, MD, FACC, *Chair**
Richard J. Kovacs, MD, FAHA, FACC*
Aaron L. Baggish, MD, FACC*
Robert J. Myerburg, MD, FACC*

Cycling deaths
1896 European Competition
1960 Olympics
1967 T
Lance A
consec

Safety of Sports for Athletes With Implantable Cardioverter-Defibrillators

Long-Term Results of a Prospective Multinational Registry

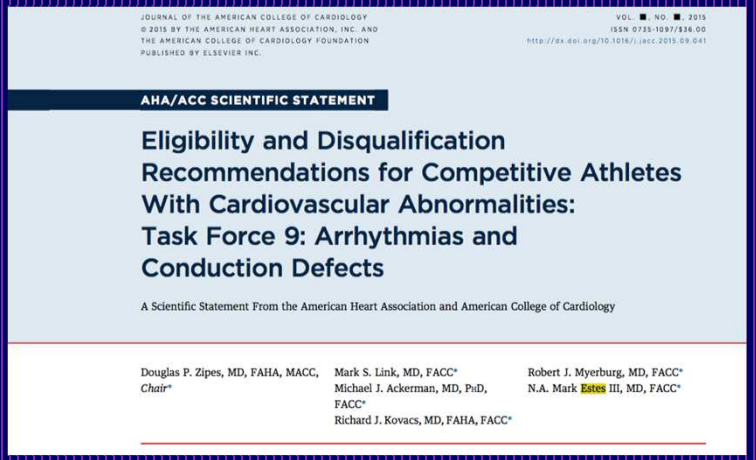
Rachel Lampert, MD
Brian Olshansky, MD
Hein Heidbuchel, MD, PhD
Christine Lawless, MD
Elizabeth Saarel, MD
Michael Ackerman, MD
Hugh Calkins, MD
N.A. Mark Estes, MD
Mark S. Link, MD
Barry J. Maron, MD
Frank Marcus, MD
Melvin Scheinman, MD
Bruce L. Wilkoff, MD
Douglas P. Zipes, MD
Charles I. Berul, MD
Alan Cheng, MD
Luc Jordaens, MD, PhD
Ian Law, MD
Michele Loomis, APRN
Rik Willems, MD, PhD
Cheryl Barth, BS
Karin Broos, BA
Cynthia Brandt, MD
James Dziura, PhD
Fangyong Li, MS
Laura Simone, BA
Katleen Vandenberghe, PhD
David Cannom, MD

Until 2015, consensus statements[1,2] advised against sports participation more vigorous than golf for patients with implantable cardioverter-defibrillators (ICDs) because of the postulated risks of death caused by failure to defibrillate, injury resulting from arrhythmia-related syncope or shock, or device damage. The multinational, prospective, observational ICD Sports Safety Registry quantified risks associated with sports participation for athletes receiving ICDs on the basis of standard criteria. Initial results (2013[3]) demonstrated no death, failure to defibrillate, or injury resulting from arrhythmia or shock during sports. On the basis of these data, the 2015 eligibility and disqualification recommendations for competitive athletes with cardiovascular disease[4] now state that competitive sports may be considered for athletes with ICDs. This report describes 4-year follow-up of the completed registry.[3] Methods are as reported previously.[3] The Yale University Human Investigation Committee approved the study. All participants gave written informed consent.

Among 440 participants, 393 in organized sports and 47 in high-risk sports, the most common diagnoses were long-QT syndrome (n=87, 20%), hypertrophic cardiomyopathy (n=75, 17%), and arrhythmogenic right ventricular cardiomyopathy (n=55, 13%). Of 201 subjects with a preimplantation history of ventricular fibrillation (VF) or tachycardia (VT), 61 (30%) had VT/VF during sports. At enrollment, median time since implantation was 26 months (interquartile range, 11–59 months), with 126 subjects (29%) enrolled within 1 year of implantation. The most common organized sports were running, basketball, and soccer; the most common dangerous sport was skiing. Seventy-seven subjects (18%) engaged in varsity/junior varsity/traveling team competition, (highly competitive subgroup). Seventy-two postcollege athletes (16%) participated at a national/international level.

Median follow-up was 44 months (interquartile range, 30–48 months), totaling 1446 person-years. Thirty-seven participants did not complete the study: 20 were lost to follow-up (all confirmed alive), 5 withdrew, 6 developed worsening cardiac/medical conditions, 4 had the ICD removed, and 2 died (neither death was sports related, as reported previously[3]).

- No increased risk of death
- Increased shocks
- Consider underlying heart disease
- Sports participation with ICD-shared decision



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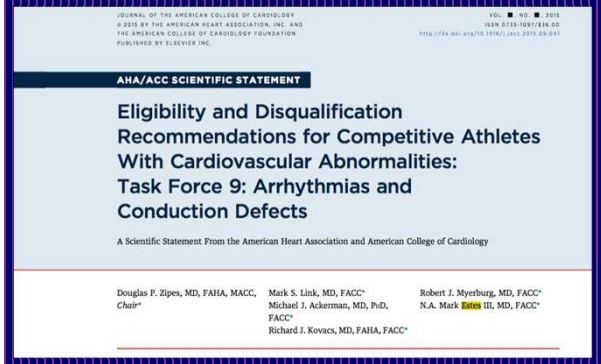
AHA/ACC SCIENTIFIC STATEMENT

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 9: Arrhythmias and Conduction Defects

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

Douglas P. Zipes, MD, FAHA, MACC, *Chair**
Mark S. Link, MD, FACC*
Michael J. Ackerman, MD, PhD, FACC*
Richard J. Kovacs, MD, FAHA, FACC*
Robert J. Myerburg, MD, FACC*
N.A. Mark Estes III, MD, FACC*

1. ICD indications for competitive athletes should not differ from those applicable to the general population with appropriate diagnoses and clinical profiles (Class I; Level of Evidence C).
2. Recommendations should be based on existing evidence for benefit and risk and should include discussions of potential impact on sport-specific participation and performance (Class I; Level of Evidence C).
3. Participation in sports classified as IA for athletes with an ICD is reasonable if they are free of episodes of ventricular flutter or ventricular fibrillation requiring device therapy for 3 months (Class IIa; Level of Evidence C).



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4. Participation in sports with higher peak static and dynamic components than class IA may be considered if the athlete is free of episodes of ventricular flutter or ventricular fibrillation requiring device therapy for 3 months. The decision regarding athletic participation should be made with consideration of, and counseling of, the athlete regarding the higher likelihood of appropriate and inappropriate shocks and the potential for device-related trauma in high-impact sports (Class IIb; Level of Evidence C).

5. The desire of the athlete to continue athletic competition should not represent the primary indication for use of an ICD (Class III; Level of Evidence C).

AEDs Available for Home Use With Rx

CARDIOLOGY PATIENT PAGE

Automated External Defibrillators in the Public Domain

Am I Ready to Use One?

N.A. Mark Estes III, MD

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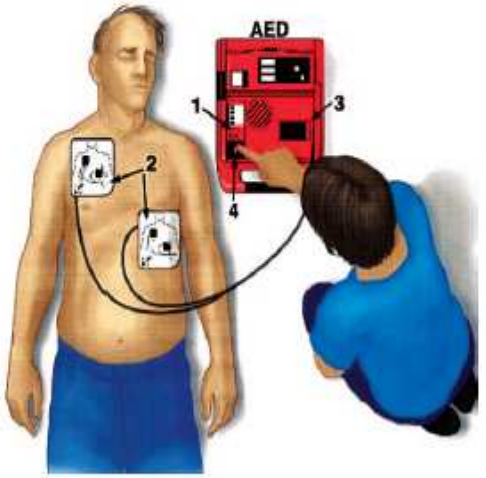
AHA/ACC SCIENTIFIC STATEMENT

Eligibility and Disqualification Recommendations for Competitive Athletes With Cardiovascular Abnormalities: Task Force 12: Emergency Action Plans, Resuscitation, Cardiopulmonary Resuscitation, and Automated External Defibrillators

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

Mark S. Link, MD, FACC, *Chair**
Robert J. Myerburg, MD, FACC*
N.A. Mark Estes III, MD, FACC*

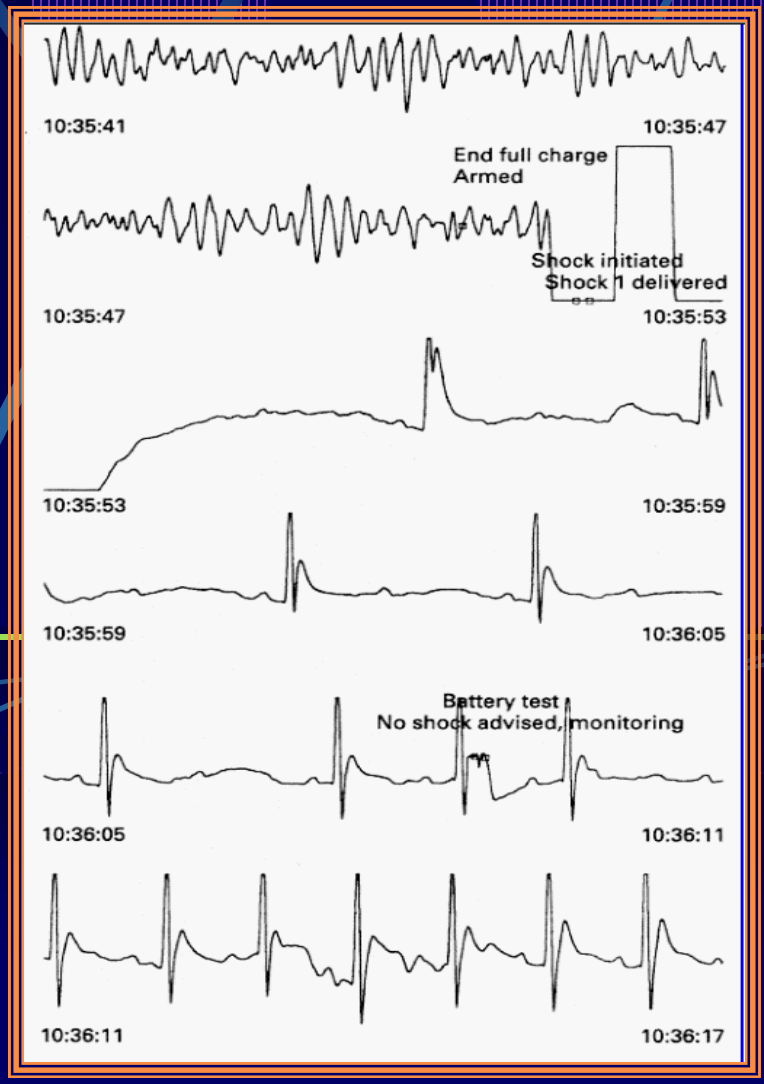
1. Activate AED.
2. Apply pads.
3. AED analyzes heart rhythm.
4. When prompted by voice command, press shock.



An AED is used on a victim of sudden cardiac arrest. After 911 has been called, the AED is turned on (1). The adhesive pads are then applied (2). The AED automatically analyzes the cardiac rhythm (3). If a life-threatening cardiac rhythm disturbance is present, a voice prompt from the AED advises that a button be pushed to deliver a shock (4).

Estes NAM Circulation 2005

AED Termination of VF



Jiří Fischer Cardiac Arrest 2005

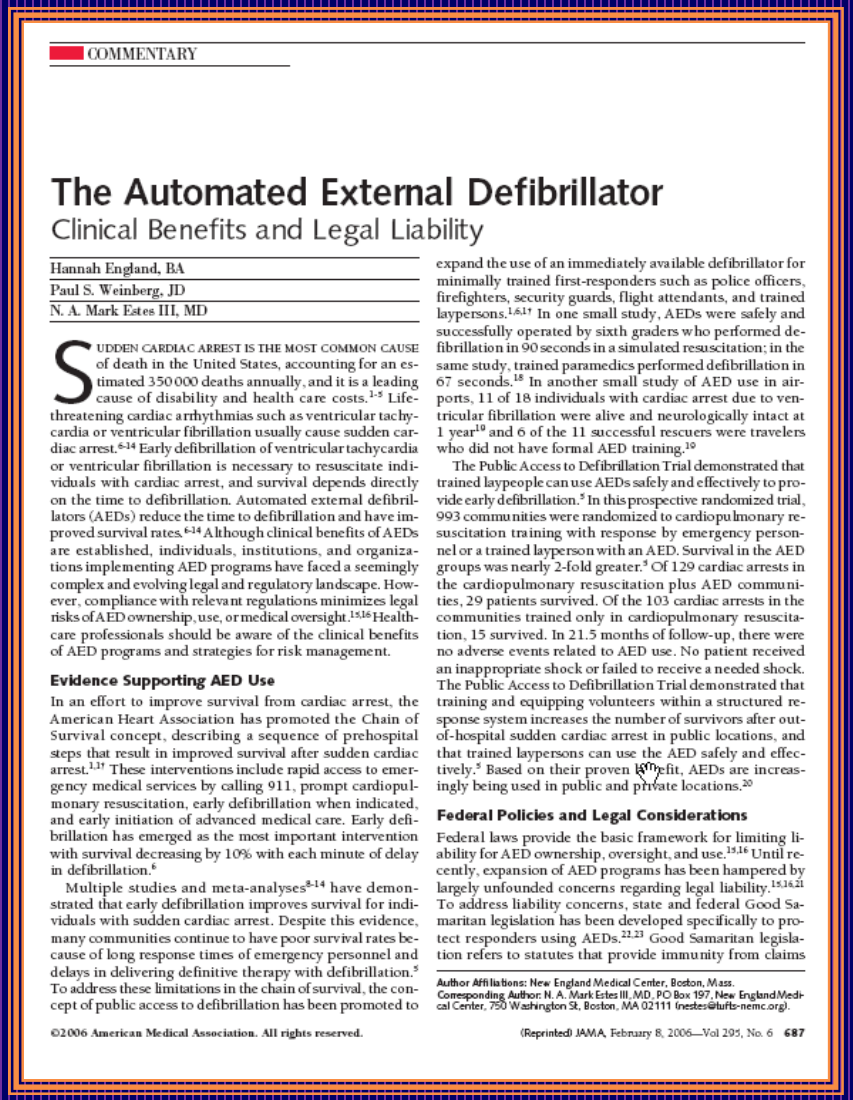
AED-Public Policy, Legislation and Legal Liability

State and Federal Polices

Legal Protection for Owners, Users, Medical Directors

Court Opinions

As evidence-based medicine has defined the clinical benefits of AED use, public policy, laws, funding programs, and court decisions have served the societal interest of promoting use of AEDs by minimizing legal liability.



COMMENTARY

The Automated External Defibrillator
Clinical Benefits and Legal Liability

Hannah England, BA
Paul S. Weinberg, JD
N. A. Mark Estes III, MD

SUDDEN CARDIAC ARREST IS THE MOST COMMON CAUSE of death in the United States, accounting for an estimated 350 000 deaths annually, and it is a leading cause of disability and health care costs.[1-5] Life-threatening cardiac arrhythmias such as ventricular tachycardia or ventricular fibrillation usually cause sudden cardiac arrest.[6-14] Early defibrillation of ventricular tachycardia or ventricular fibrillation is necessary to resuscitate individuals with cardiac arrest, and survival depends directly on the time to defibrillation. Automated external defibrillators (AEDs) reduce the time to defibrillation and have improved survival rates.[6-14] Although clinical benefits of AEDs are established, individuals, institutions, and organizations implementing AED programs have faced a seemingly complex and evolving legal and regulatory landscape. However, compliance with relevant regulations minimizes legal risks of AED ownership, use, or medical oversight.[15,16] Healthcare professionals should be aware of the clinical benefits of AED programs and strategies for risk management.

Evidence Supporting AED Use

In an effort to improve survival from cardiac arrest, the American Heart Association has promoted the Chain of Survival concept, describing a sequence of prehospital steps that result in improved survival after sudden cardiac arrest.[1,17] These interventions include rapid access to emergency medical services by calling 911, prompt cardiopulmonary resuscitation, early defibrillation when indicated, and early initiation of advanced medical care. Early defibrillation has emerged as the most important intervention with survival decreasing by 10% with each minute of delay in defibrillation.[6]

Multiple studies and meta-analyses[8-14] have demonstrated that early defibrillation improves survival for individuals with sudden cardiac arrest. Despite this evidence, many communities continue to have poor survival rates because of long response times of emergency personnel and delays in delivering definitive therapy with defibrillation.[5] To address these limitations in the chain of survival, the concept of public access to defibrillation has been promoted to expand the use of an immediately available defibrillator for minimally trained first-responders such as police officers, firefighters, security guards, flight attendants, and trained laypersons.[1,6,17] In one small study, AEDs were safely and successfully operated by sixth graders who performed defibrillation in 90 seconds in a simulated resuscitation; in the same study, trained paramedics performed defibrillation in 67 seconds.[18] In another small study of AED use in airports, 11 of 18 individuals with cardiac arrest due to ventricular fibrillation were alive and neurologically intact at 1 year[19] and 6 of the 11 successful rescuers were travelers who did not have formal AED training.[19]

The Public Access to Defibrillation Trial demonstrated that trained laypeople can use AEDs safely and effectively to provide early defibrillation.[5] In this prospective randomized trial, 993 communities were randomized to cardiopulmonary resuscitation training with response by emergency personnel or a trained layperson with an AED. Survival in the AED groups was nearly 2-fold greater.[5] Of 129 cardiac arrests in the cardiopulmonary resuscitation plus AED communities, 29 patients survived. Of the 103 cardiac arrests in the communities trained only in cardiopulmonary resuscitation, 15 survived. In 21.5 months of follow-up, there were no adverse events related to AED use. No patient received an inappropriate shock or failed to receive a needed shock. The Public Access to Defibrillation Trial demonstrated that training and equipping volunteers within a structured response system increases the number of survivors after out-of-hospital sudden cardiac arrest in public locations, and that trained laypersons can use the AED safely and effectively.[5] Based on their proven benefit, AEDs are increasingly being used in public and private locations.[20]

Federal Policies and Legal Considerations

Federal laws provide the basic framework for limiting liability for AED ownership, oversight, and use.[15,16] Until recently, expansion of AED programs has been hampered by largely unfounded concerns regarding legal liability.[15,16,21] To address liability concerns, state and federal Good Samaritan legislation has been developed specifically to protect responders using AEDs.[22,23] Good Samaritan legislation refers to statutes that provide immunity from claims

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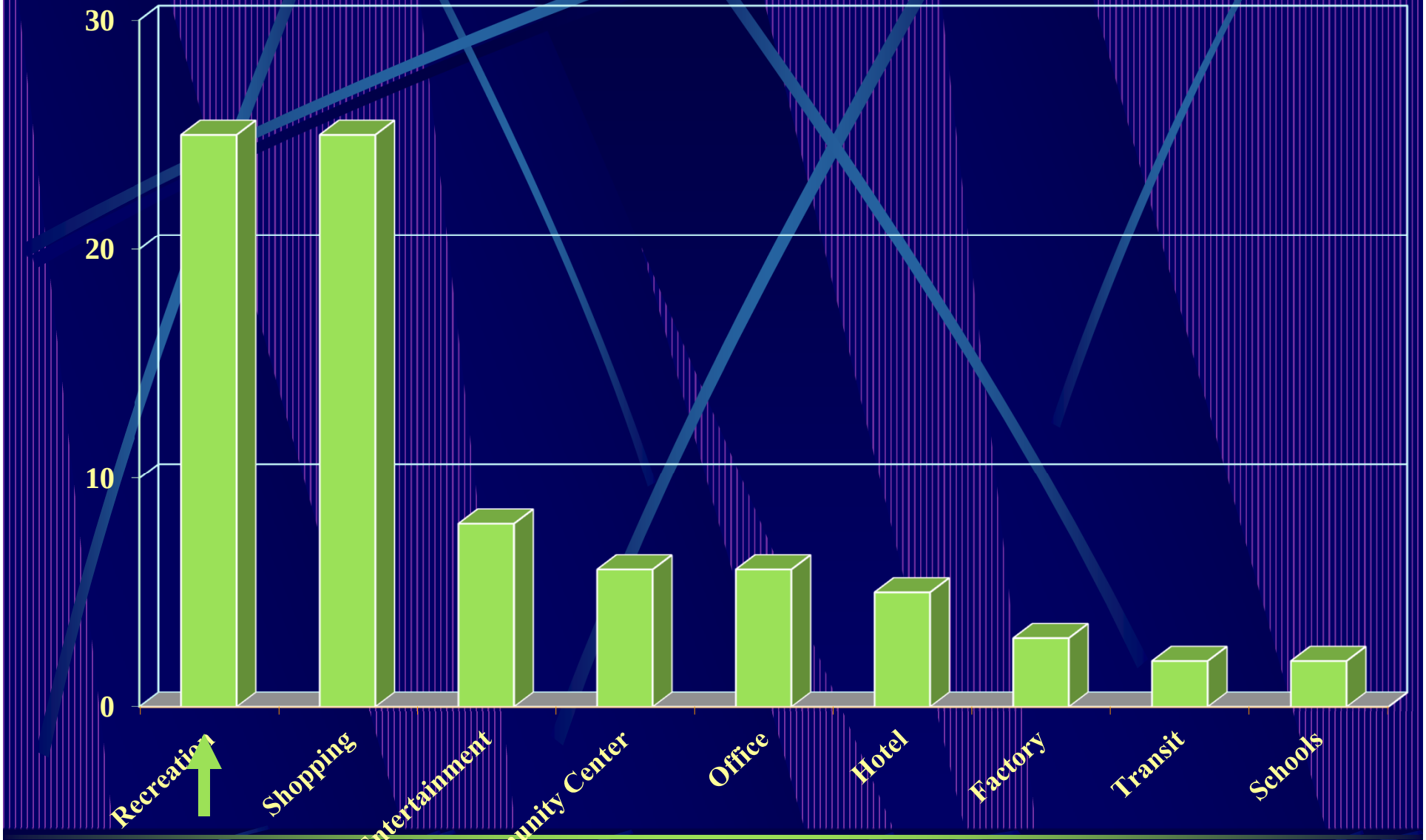
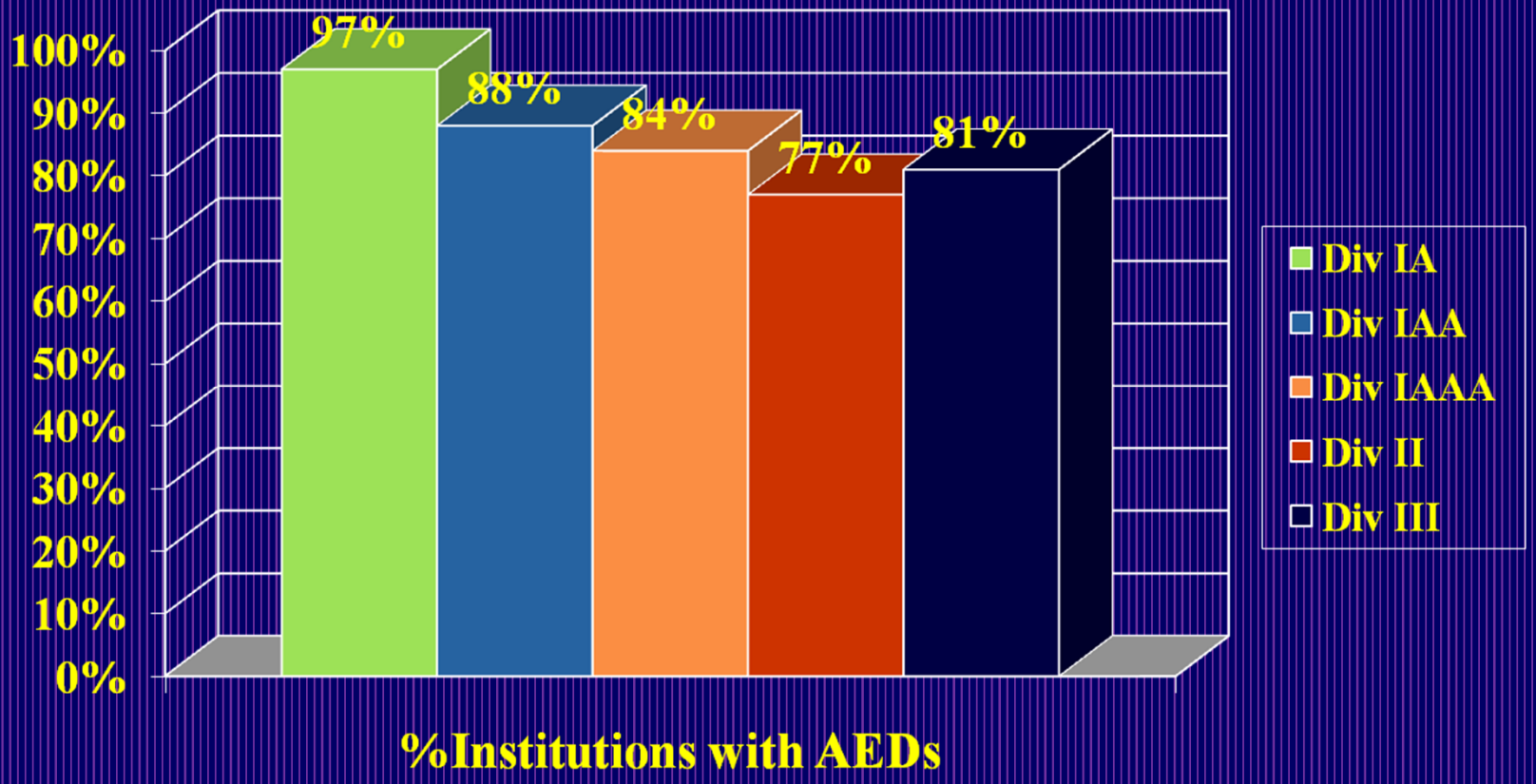
England, H Weinberg P, Estes N JAMA 2006

PAD Trial Location of Cardiac Arrest



PAD Investigators The Public Access to Defibrillation Study NEJM 2004;637-645

AEDs in the NCAA



Survival trends in the U.S. following exercise-related SCA in the youth: 2000-2006

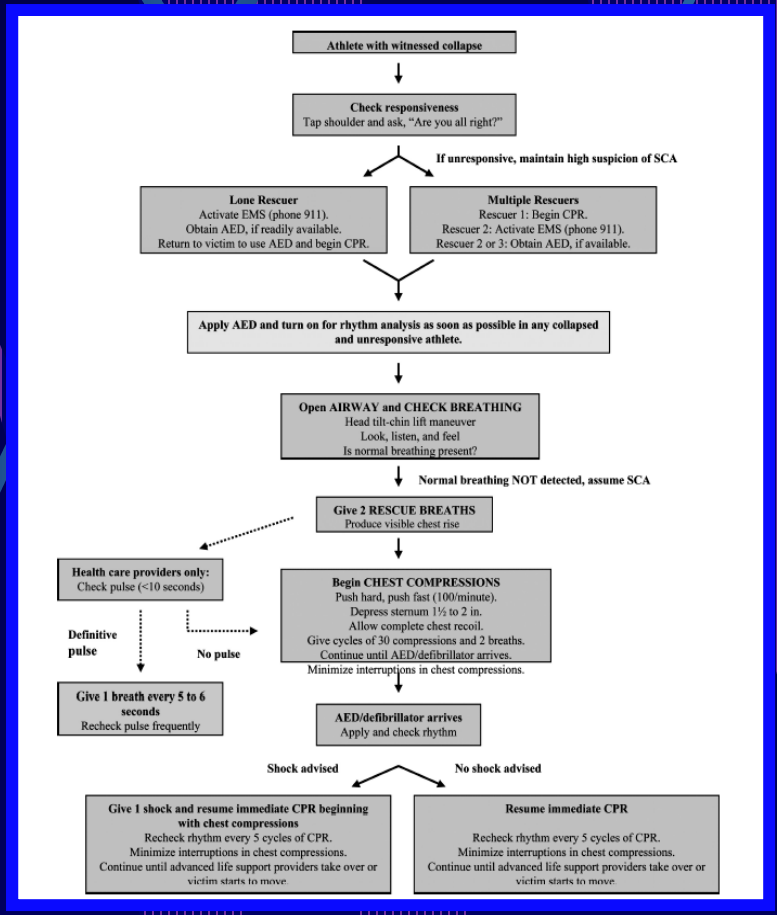
[N=486; average survival 11%; range 4-21% per year]

Low survival rate demands re-evaluation of emergency response planning for SCA in sport

Drezner; *Heart Rhythm* 2008

The Collapsed and Unresponsive Athlete
Management of SCA

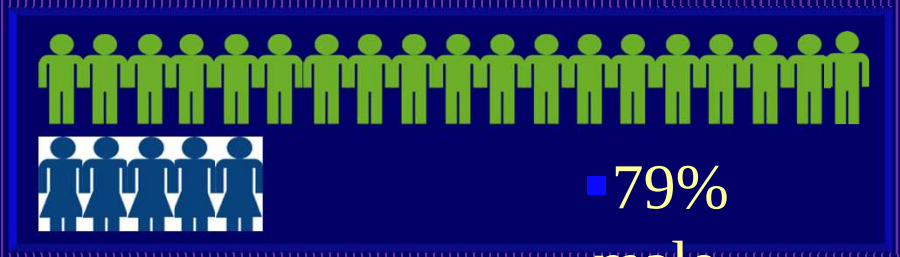
- Suspect SCA in any collapsed and unresponsive athlete
- An AED should be applied as soon as possible for rhythm analysis and defibrillation if indicated



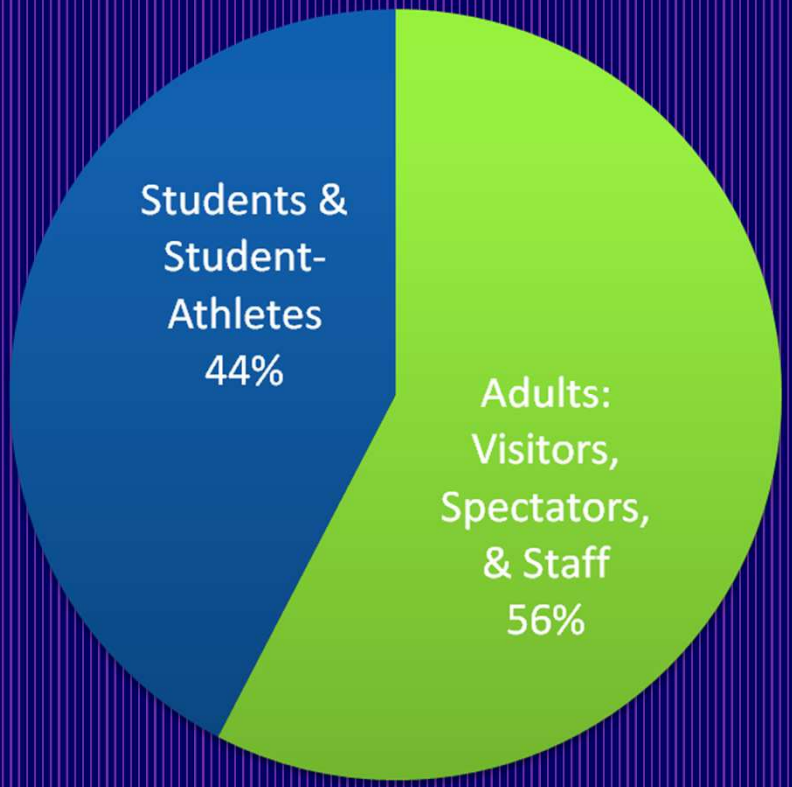
- Drezner; *Heart Rhythm* 2007

Outcomes from Sudden Cardiac Arrest in US High Schools: A Two Year Prospective Study from the National Registry for AED Use in Sports

- 2,149 high schools
  - 87% with AED program
- 95% 2-year follow-up
- 59 cases of SCA on campus



- 79% male

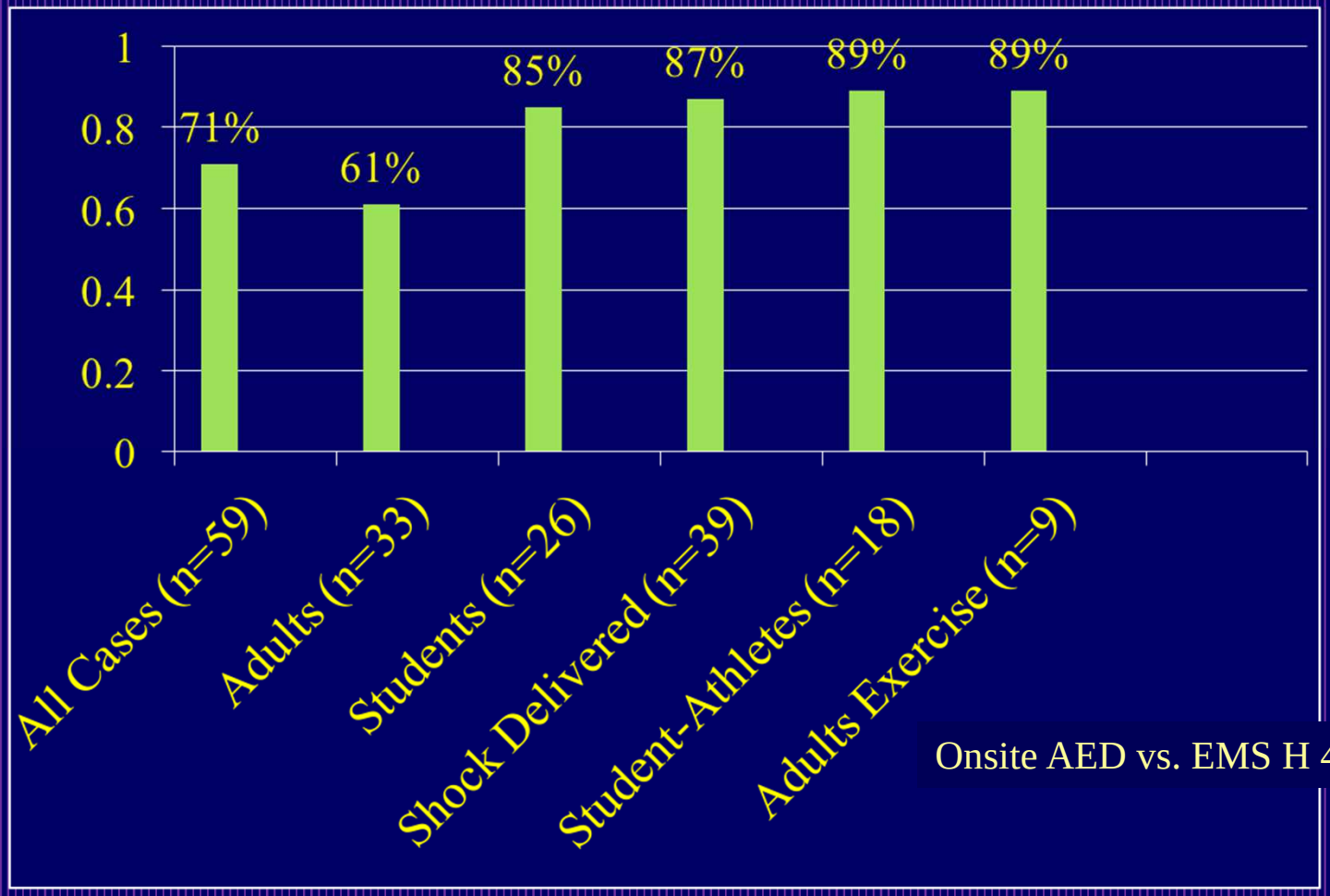


Outcomes from Sudden Cardiac Arrest in US High Schools: A Two Year Prospective Study from the National Registry for AED Use in Sports

Resuscitation Details

- 93% witnessed
- 92% prompt CPR
- AEDs applied in 85% of cases
  - Provided by school: 41 (69%)
  - Provided by off-site EMS: 15 (23%)
  - Provided by on-site EMS: 3 (5%)
- 66% shock deployed

Survival Following SCA



Onsite AED vs. EMS H 4.0, p> 0.03

Sudden Cardiac Death in Sports

- Almost all young athletes dying suddenly have underlying heart disease-males are at greater risk than females.
- Current screening techniques lack sensitivity and specificity for detecting athletes at risk for sudden death.
- Performance enhancing substances are widely used and contribute to risk of death in athletes.
- AEDs are effective in improving survival in sports.
- Gaps in evidence need to be bridged.

Prediction and Prevention of Sudden Death in the Athlete

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