Optimizing Tactical Athlete Health: Feasibility of Integrating Electrocardiographic Screening into Entry-Level Training

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DISCLAIMER: The opinions and assertions expressed herein are those of the authors and do not reflect the official policy or position of the Uniformed Services University, US Air Force, or the Department of War
CONFLICT OF INTEREST: None

ERASE - Electrocardiogram Risk Assessment to reduce Sudden cardiac Events Program

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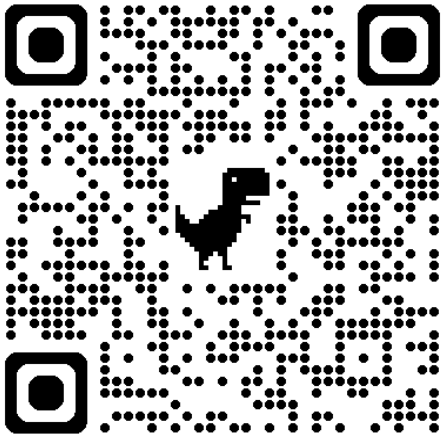

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Cardiac Insight
ScImage
Hyland

Objectives

1. Compare the diagnostic accuracy and cost-benefit potential of modern International Consensus Criteria versus traditional history-based screening for reducing sudden cardiac arrest (SCA) among tactical athletes.
2. Analyze the operational efficiency and throughput of integrating automated ECG diagnostic hardware into high-volume military accession points, specifically focusing on acquisition time and training impact.
3. Evaluate the technical integration and data interoperability between automated cardiac screening platforms and the MHS GENESIS Electronic Health Record (EHR) to ensure longitudinal medical readiness.

FEDERAL WAY MIRROR

Marine's death inspires awareness campaign for sudden cardiac arrest

Published 1:30 am Monday, August 20, 2018

By Ray Miller-Still Editor

- Average response time for Emergency Medical Services = 9 minutes
- Time to first defibrillation = 11 minutes
- These times can be further delayed on military posts due to distance to field sites
- Troops have limited CPR training
- Generally, no AEDs in the field

Photo used with family permission

FEDERAL WAY MIRROR

Marine's death inspires awareness campaign for sudden cardiac arrest

Published 1:30 am Monday, August 20, 2018

By Ray Miller-Still Editor

Navy football player David Forney died of cardiac arrest, state medical examiner office says

capitalgazette.com

UPDATED: Midshipman dies during physical readiness test

cyconannapolis.net

Your Army

ArmyTimes

101st Airborne intelligence official dies on Europe deployment

By Davis Winkie

Sep 12, 2022

Lt. Col. Nicholas Goshen died Sept. 6 while deployed to Europe with the 101st Airborne Division's Intelligence Directorate. (Army)

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Buffalo Bills Damar Hamlin incident brings sudden cardiac arrest into national headlines

Dave Fornell | *January 03, 2023* | *Cardiovascular Business* | *Heart Rhythm*

Buffalo Bills safety Damar Hamlin went into sudden cardiac arrest after a tackle during the first quarter of the game between the Cincinnati Bengals and the Buffalo Bills in Cincinnati Jan. 2, 2023. The incident has instantly raised awareness and brought sudden cardiac arrest to the forefront on news reports today. Image from Buffalo Bills

NDAA 2024 – Congressional Mandate

SEC. 547. PILOT PROGRAM ON CARDIAC SCREENINGS FOR MILITARY ACCESSIONS

ESTABLISHMENT.—Not later than September 30, 2024, the Secretary of Defense shall carry out a **pilot program** to provide an **electrocardiogram to individuals who undergo military accession screenings**. Each such electrocardiogram shall be provided—

(1) **on a mandatory basis**;

(2) at no cost to the recipient; and

(3) in a facility of the Department of Defense or by a member or employee of the military health system.

Sec 547 also directs development of "**appropriate clinical practice guidelines for cardiac screenings, diagnosis, and treatment**" and briefings to congress on the "cost of carrying out the pilot program" and that the program "shall terminate after three years after its implementation."

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THE PROBLEM: Cardiac Events are More Common in Tactical vs. Competitive Athletes

NCAA:	MILITARY RECRUITS:	MILITARY CAREER:	FIREFIGHTERS:
1.6 sudden cardiac deaths per 100,000 athlete-years NCAA athletes	11 sudden cardiac deaths per 100,000 person-years in US Military recruits	FY16-19 DoD data 5.9 SCA per 100,000 PY ages 17-24	18.1 sudden cardiac deaths PER 100,000 PY
Petek 2023	Eckart 2004	Franzos 2025	Farioli 2015

Tactical operations are distinctly different from organized sporting events

Medical response is constrained by the tactical situation

Even nonfatal events in operational environments convey risk to individual, unit, and mission

ECG can detect 80-86% of conditions associated with SCD

Mont L, et al., Europace. 2017;19(1):139-163
Malhotra A, et al., Br J Sports Med. 2020;54(12):739-745

Adoption of Emergency Action Plans

HIGH-LEVEL LEAGUES (College, Professional)

- Mandated EAPs
- CPR Training for all responders
- Access to Automated External Defibrillators (AEDs)

AMATEUR LEAGUES (Youth Clubs)

- EAPs rarely rehearsed annually (6%)
- Low CPR training for coaches (35%)
- Low access to AEDs (35%)

Mason Z et al., Clin J Sport Med 2022;32(6):617-619

Impact of Emergency Action Plans

High School Based AED Programs – 2-year study

- Prospective, captured students and adults
- 2149 schools
- 59 SCA, 27 events during physical activity
- 93% witnessed, 92% received prompt CPR, AED applied in 85%
- **89% of SCA during exercise survived to hospital discharge**

Drezner J, et al., Br J Sports Med 2013;47(18):1179-83

French National Institute of Health and Medical Research

- Retrospective, captured sports related SCA
- 18-75 years old over a 12 year period
- 377 sports related SCA, 5.3% in young
- Bystander CPR rose from 24.9% to 94.7%
- AED use increased from 1.6% to 28.8%
- **Survival to hospital discharge rose threefold**

Karam N, et al., JACC 2022;79(3):238-246

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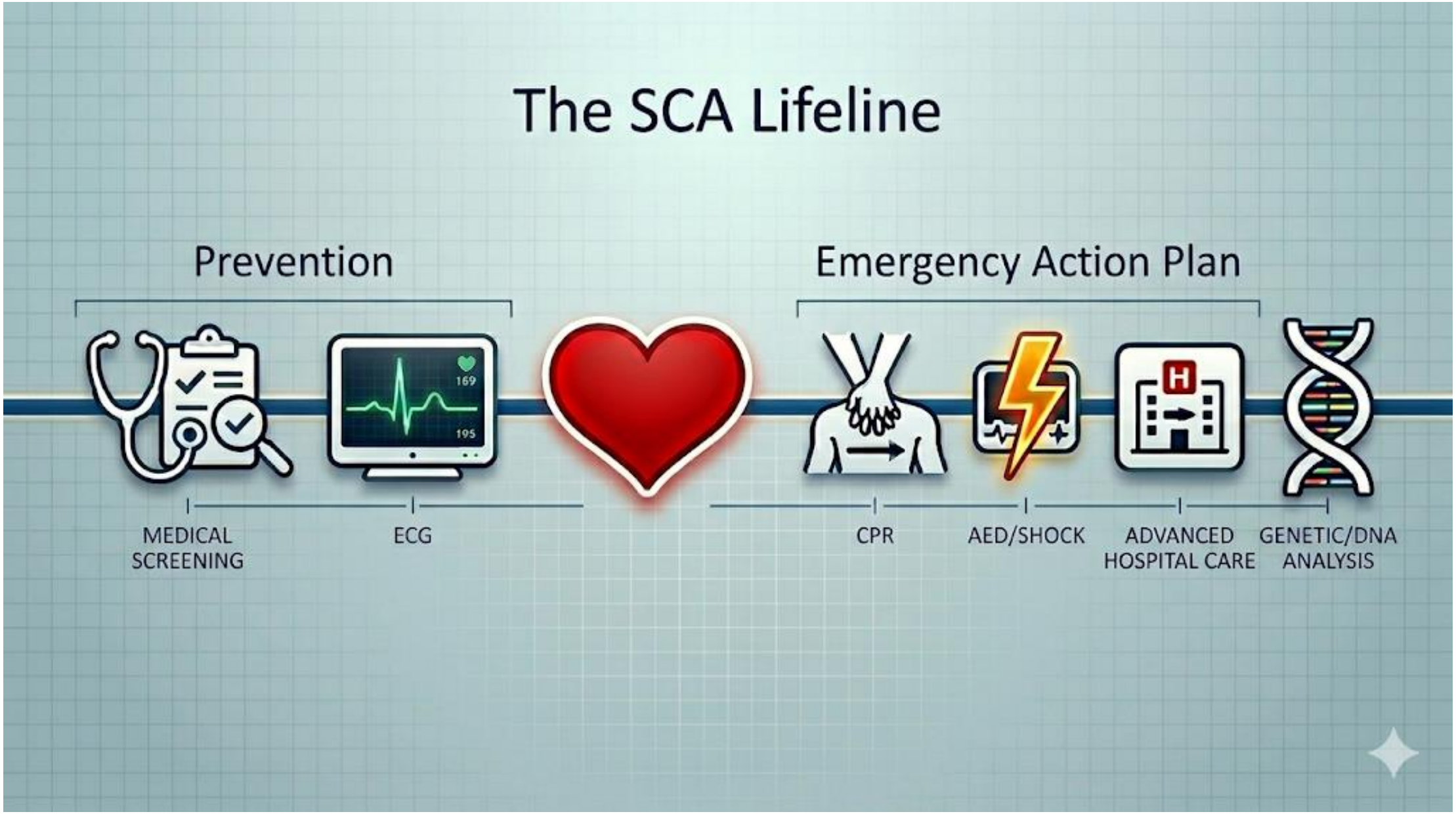
Actionable Insights on EAPs

- Key responders get trained in CPR
- AEDs should be widely available and retrievable within 1-3 minutes
- Emergency Action Plans should be
  - Clear and concise direction
  - Tailored to the specific location/evolution
  - Rehearsed at least annually, more frequently in units with high turnover

The SCA Lifeline



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Accession ECG stopped in 2002

High False Positive Rate and Low Incidence of SCD

Circulation
Volume 94, Issue 4, 15 August 1996; Pages 850-856
https://doi.org/10.1161/01.CIR.94.4.850

American Heart Association.

ARTICLE

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

DEPARTMENT OF DEFENSE
ARMED FORCES EPIDEMIOLOGICAL BOARD
5109 LEESBURG PIKE
FALLS CHURCH VA 22041-3258

JAN 2 2 2002

AFEB (15-1a) 2002-03

MEMORANDUM FOR The Assistant Secretary of Defense (Health Affairs)
The Surgeon General, Department of The Army
The Surgeon General, Department of The Navy
The Surgeon General, Department of The Air Force

SUBJECT: Medical Screening for Accession Programs - Electrocardiogram (ECG)

- 1996: AHA indicated screening ECGs “not prudent” due to many athletes, few examiners, variable healthcare, low incidence of SCD
- 2002: AFEB recommended discontinuing ECG screening because symptoms would detect risk & ECGs generate many false-positives
- FALSE POSITIVE RATE = 20-25%

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AHA 14-Element Screening Mostly Captured In Accession Screening History & Physical Exam

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

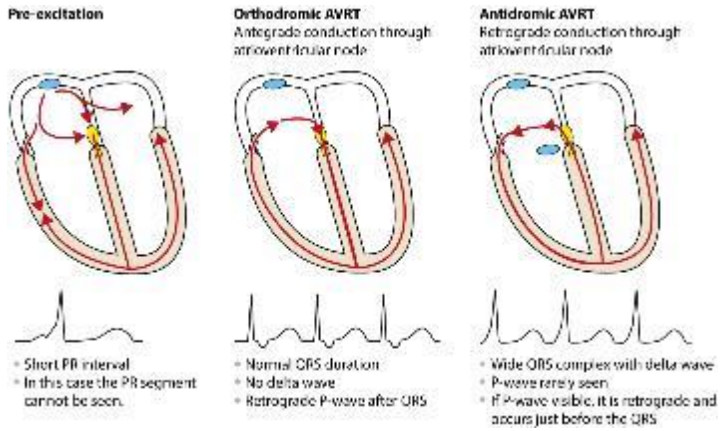
Physical examination

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

DD Form 2807-2 Accessions Medical History Report

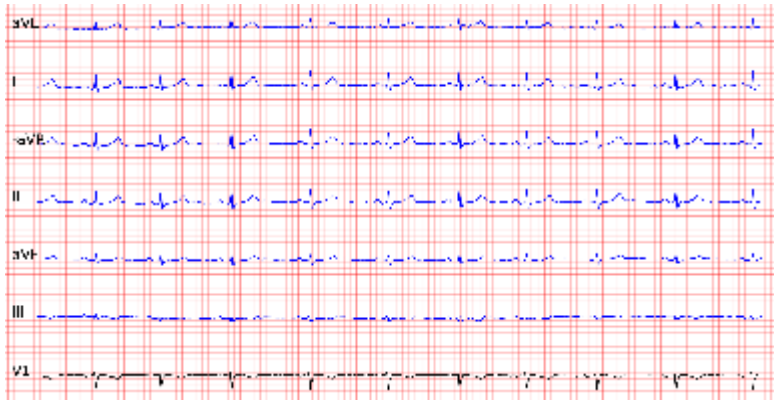
HAVE YOU EVER HAD OR DO YOU NOW HAVE:	YES	NO
EYES/VISION:		
3. Double vision	☐	☐
4. Detached retina or surgery to repair a detached retina	☐	☐
5. Keratoconus, glaucoma, cataracts or surgery for cataracts	☐	☐
6. Vision correction procedure such as Lasik, PRK, or lens implant	☐	☐
7. Night blindness	☐	☐
8. Any other eye condition, injury, or surgery/procedure	☐	☐
EARS/HEARING:		
9. Cholesteatoma	☐	☐
10. Ear drum perforation or tubes inserted into the ear drum(s) in the past 12 months	☐	☐
11. Any other ear surgery or procedure including mastoidectomy	☐	☐
12. Loss of balance or vertigo	☐	☐
13. Hearing loss or use of hearing aid(s)	☐	☐
NOSE, SINUSES, MOUTH, AND LARYNX:		
14. Ear, nose, or throat conditions such as vocal cord dysfunction	☐	☐
15. Recurrent nose bleeds, chronic sinus infections, or sinus surgery	☐	☐
16. Absence of, or disturbance of sense of smell	☐	☐
17. Any surgery of the face, throat, or jaw	☐	☐
DENTAL: *(If you wear braces/aligners, then you must submit a letter from your orthodontist stating that active orthodontic treatment will be completed before beginning active duty)*		
18. Braces or aligners	☐	☐
19. Any tooth or gum problems	☐	☐
LUNGS, CHEST WALL, PLEURA, AND MEDIASTINUM:		
20. Asthma, asthmatic bronchitis, wheezing, shortness of breath, or other breathing problems worsened by exercise, weather, pollens, etc.	☐	☐
21. Prescription for an inhaler, steroids, or any other medication for breathing problem	☐	☐
22. Pneumonia	☐	☐
23. Chronic cough or frequent coughing at night	☐	☐
24. Collapsed lung or other lung condition(s)	☐	☐
25. History of chest, chest wall, or breast surgery	☐	☐
HEART:		
26. Heart murmur or valve problem(s)	☐	☐
27. Palpitations, skipped/abnormal heartbeats, or pounding heart	☐	☐
28. Chest pain/pressure or an abnormal electrocardiogram (EKG)	☐	☐
29. Heart surgery	☐	☐
30. Any other heart condition	☐	☐

ECG Findings for Conditions associated with SCD

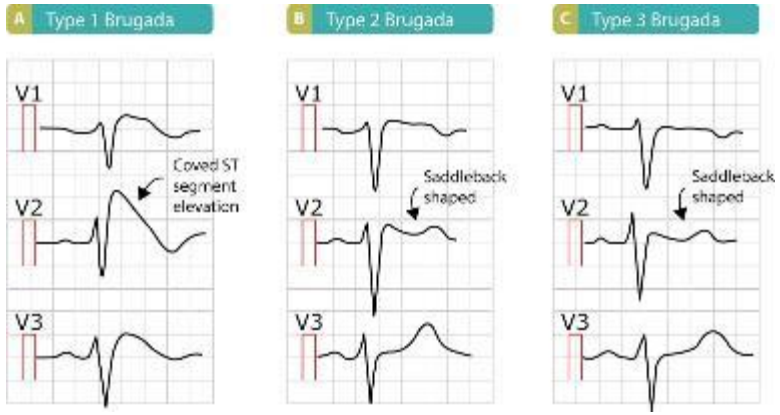


Wolf Parkinson White
1:300

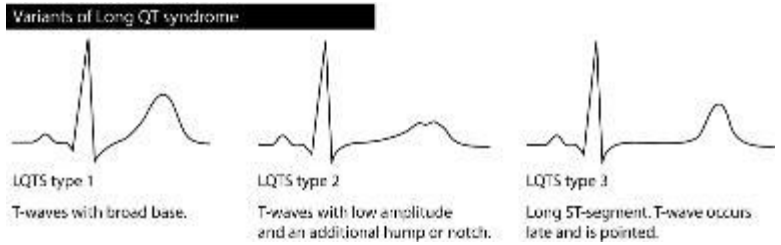
Hypertrophic Cardiomyopathy
1:500



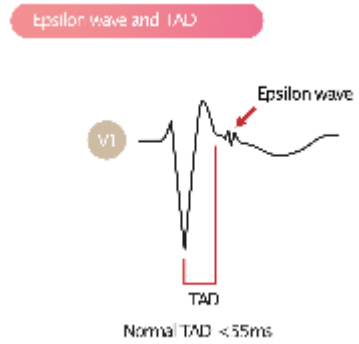
Dilated Cardiomyopathy
1:400



Brugada Syndrome
1:2000



Long QT Syndrome
1:2500 live births



Arrhythmogenic Cardiomyopathy
1:1250

ecgwaves.com

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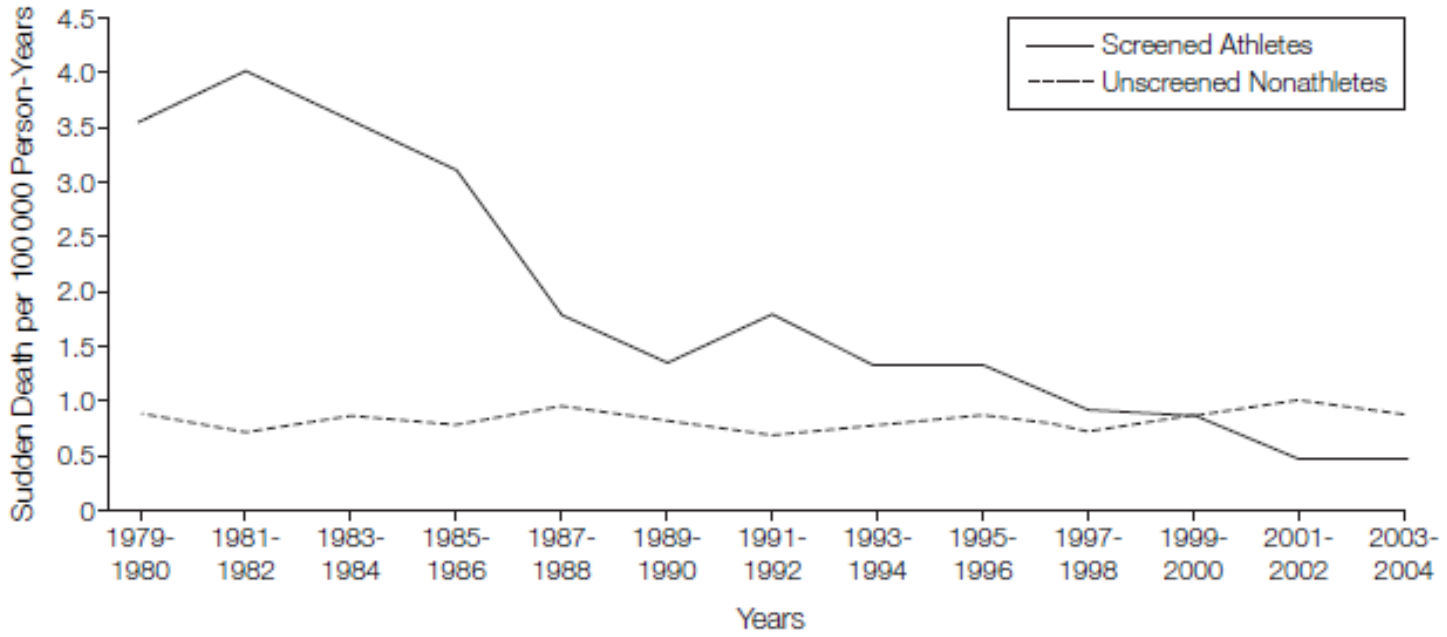
European Society of Cardiology

2005 ESC Guidelines Recommend ECG Screening in young competitive athletes

2006 Corrado shows 89% reduction in SCD among screened Italian athletes

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)



NOT a Randomized Controlled Trial (RCT)

Corrado DA, et al. JAMA 2006; 296(13):1593-601

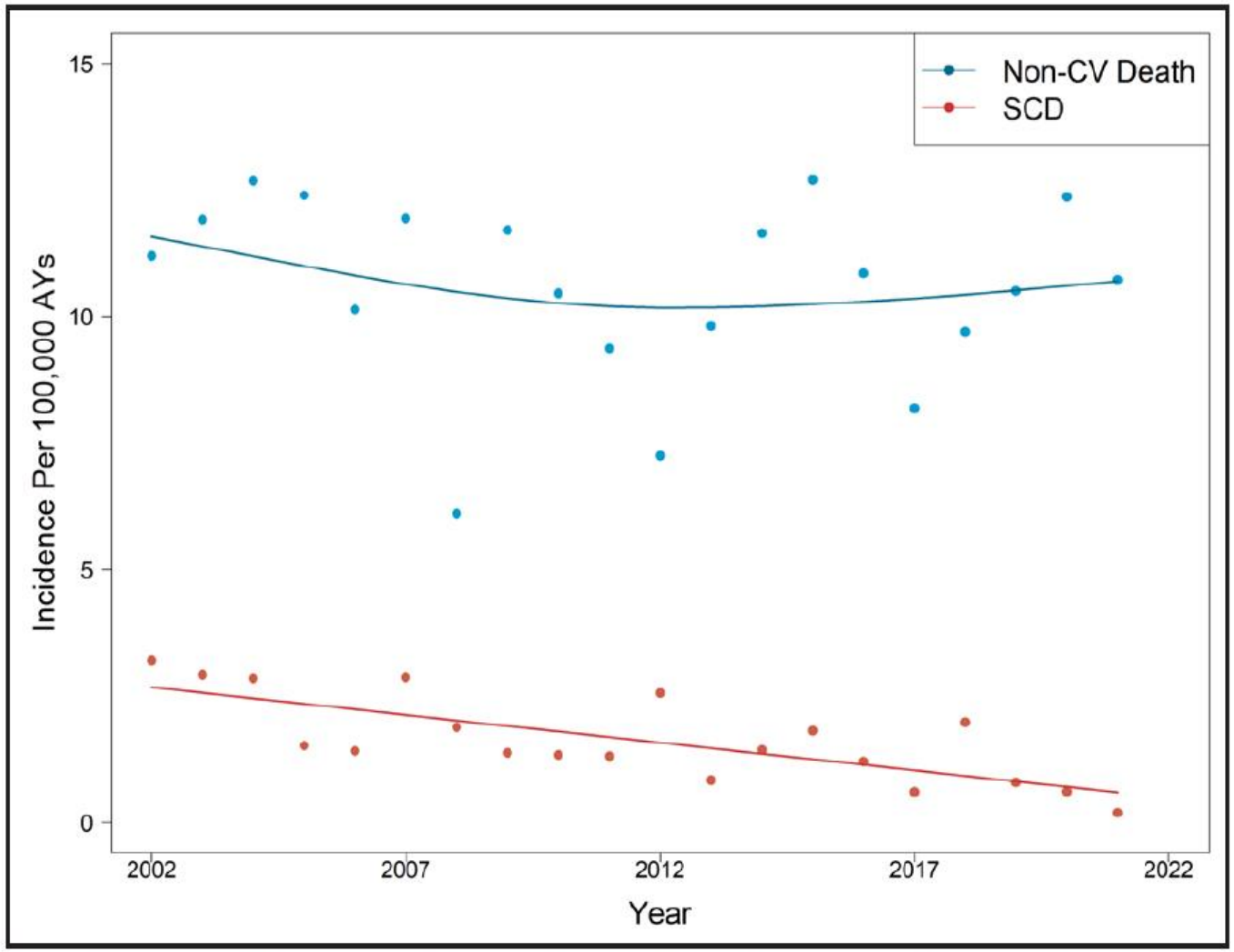


Figure 2. Yearly non–cardiovascular death and sudden cardiac death incidence among National Collegiate Athletic Association athletes.

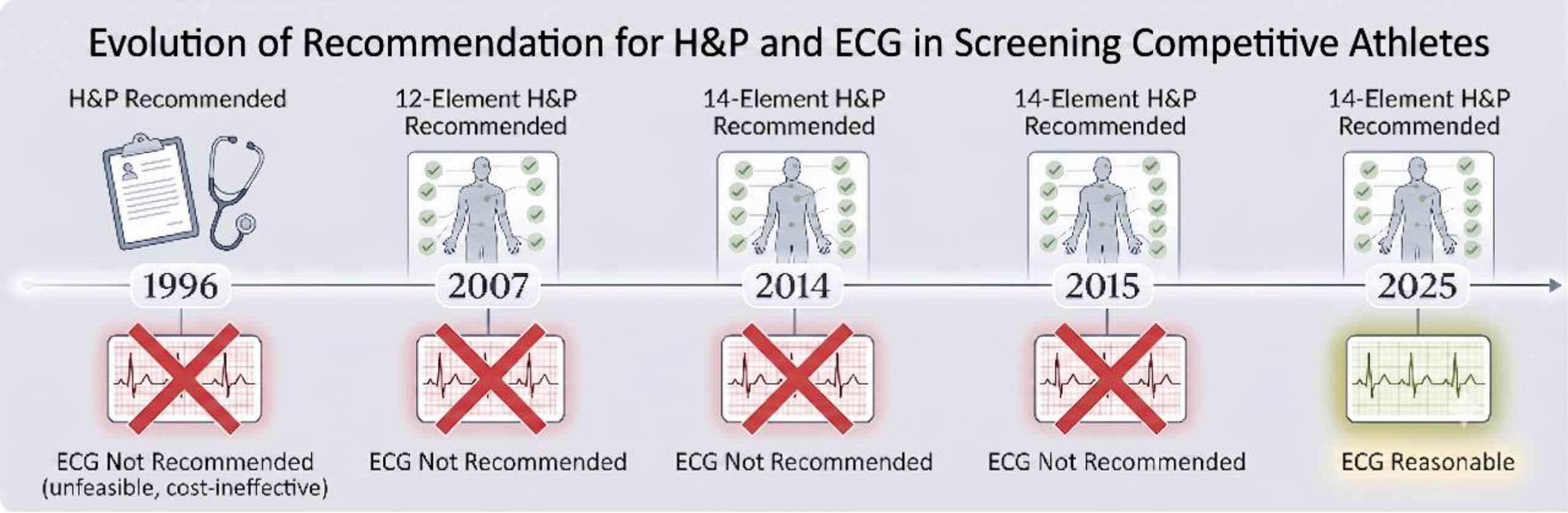
INCIDENCE (Athlete-Years)

- Overall = 1.57 per 100K
- Male = 2.31
- Female = 1.55
- Black = 3.74
- White = 1.74

INCIDENCE RATE RATIO (95% CI):

- CV = 0.71 (0.61-0.82)
- Non-CV = 0.98 (0.94-1.04)

Petek BJ, et al., Circulation. 2024;149(2):80-90



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- **BARRIERS TO SCREENING ECG**
  - Struggle to Differentiate the Athlete's Heart from pathology
  - High False-Positive Rates (25%)
  - Unfeasible, Cost-Ineffective
- **EVOLUTION TO "ECG REASONABLE"**
  - Clear Algorithm
  - Low False-Positive Rates (2%)
  - Improved feasibility, Cost Uncertain

ACC/AHA Scientific Statement on Tactical Athletes pending publication 2026

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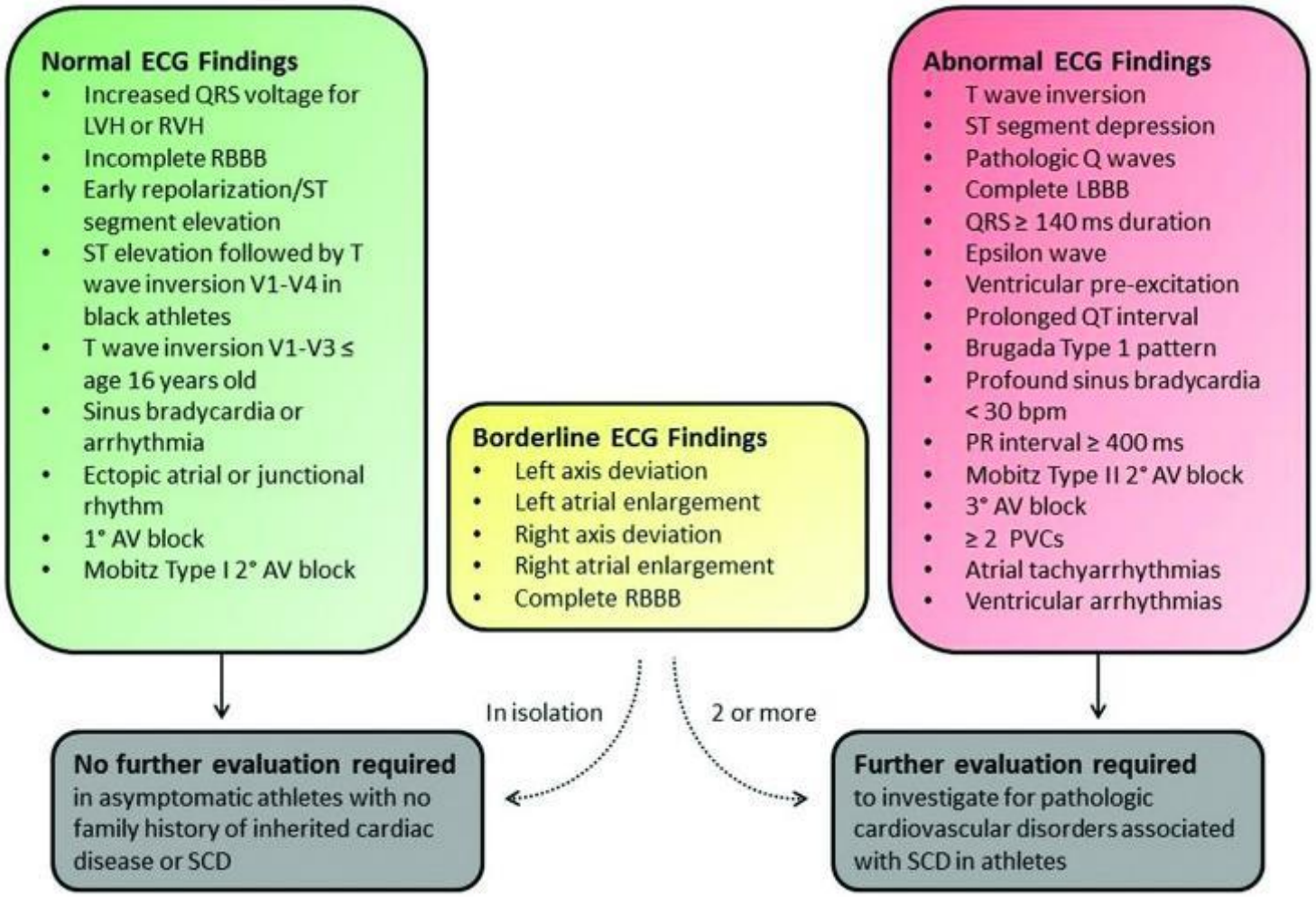
Cardiac Insight Cardea 20/20 Newest Algorithm Embedded



LOW FALSE POSITIVE RATE < 2%

LOW DISQUALIFICATION RATE

Achieved an Authority to Operate (ATO) allowing direct connection to DHA networks

Revised International Criteria pending publication 2026

Drezner J, et al. BJSM 2017; 51(9)704-731

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Cardea 20/20 Output

NORMAL:

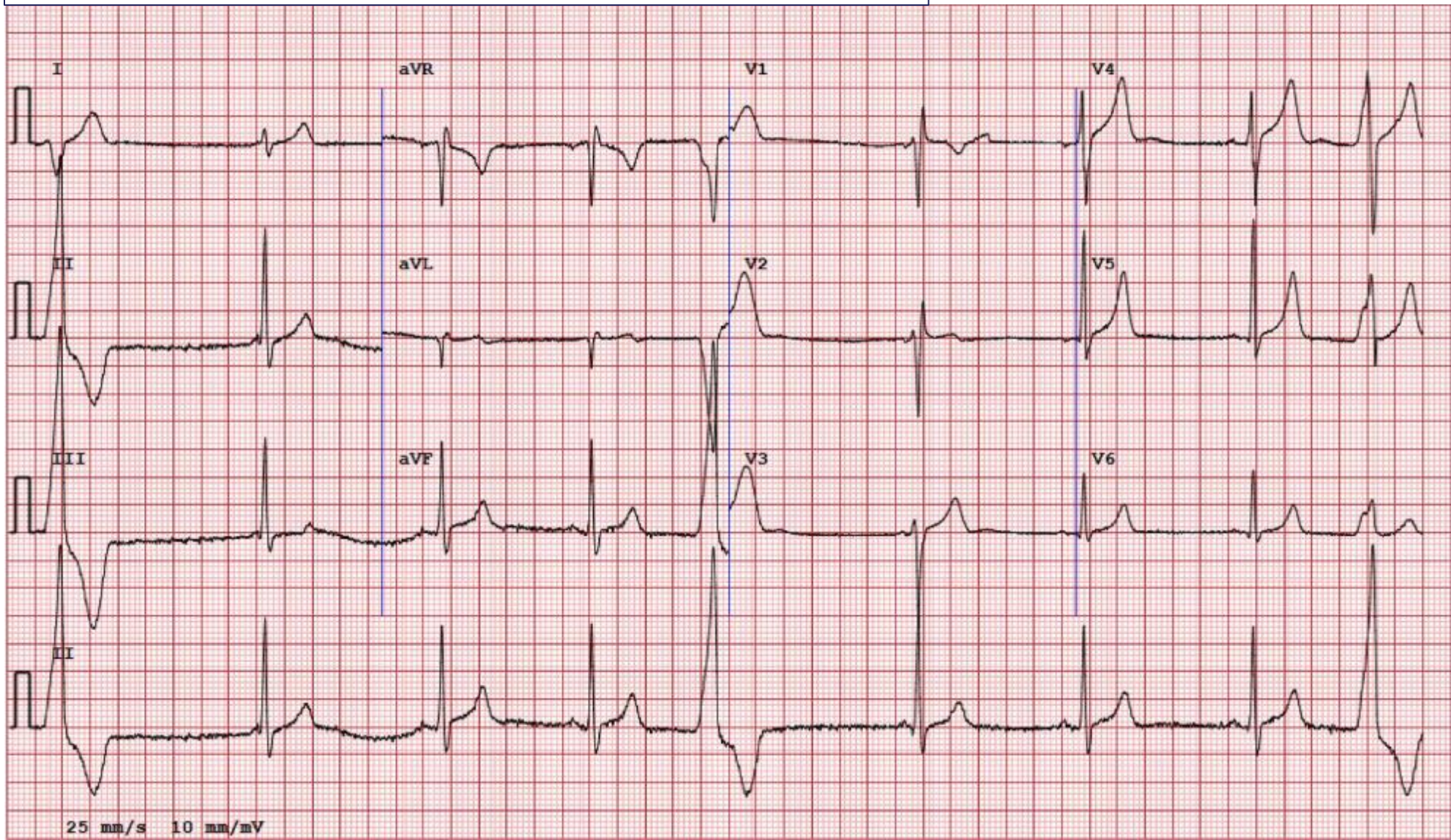
Q&A: None
ECG Normal

ABNORMAL HISTORY:

Q&A: SCD
ECG Normal

ABNORMAL ECG:

Q&A: None
3 Ectopic beats in 10 sec – QRS Duration: 124
ECG ABNORMAL further evaluation recommended

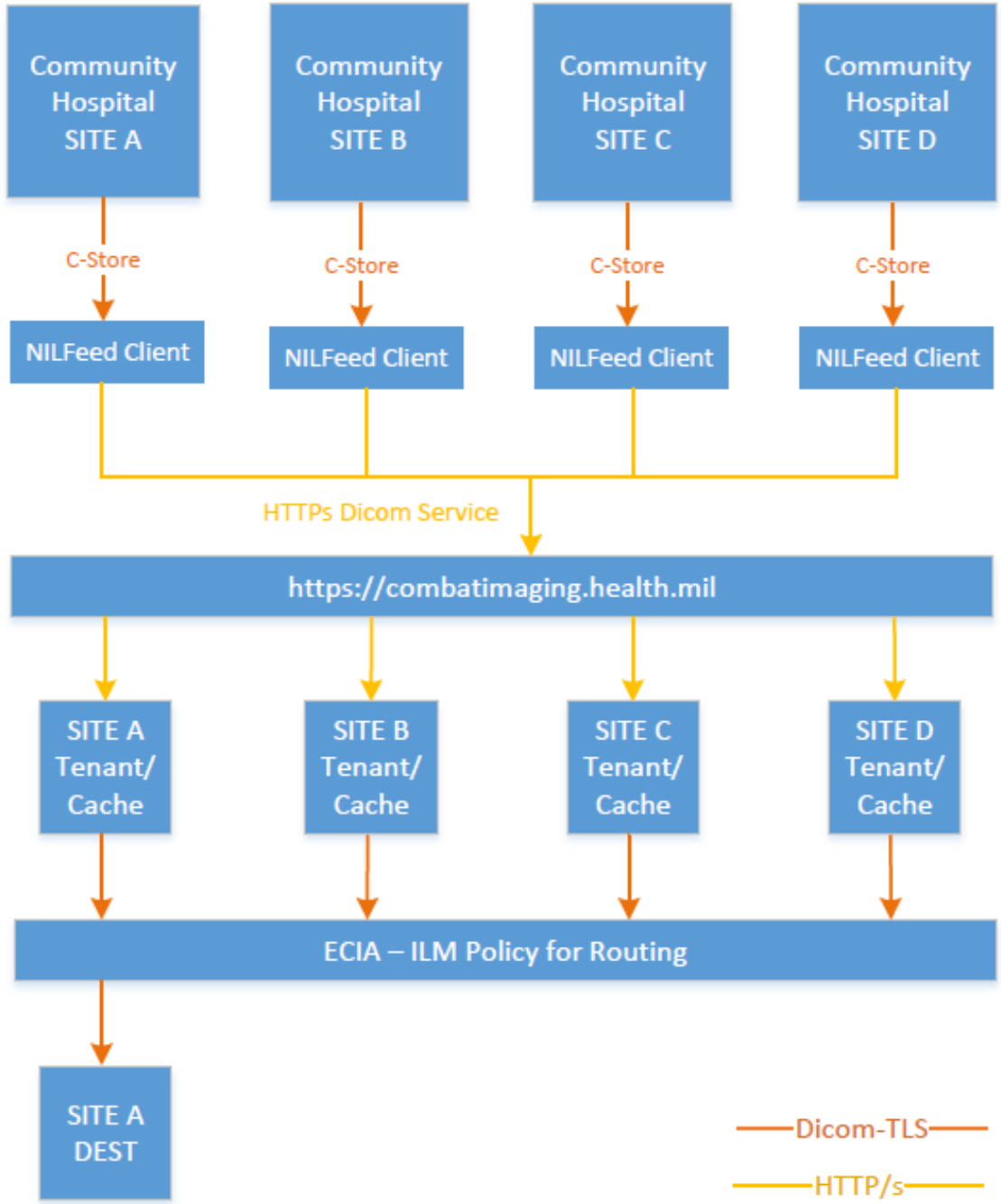


NILFeed

DICOM = Digital Imaging and Communication in Medicine (standard format)

DMZ = Demilitarized Zone (servers with higher scrutiny and protection levels)

ECIA = Enterprise Clinical Image Archive



PUBLIC DOMAIN

DMZ

MILITARY DOMAIN

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ERASE Rates by Screening Intervention (n=10,316)

Flag	False+	True+	False-	DQ
Abnormal ECG	**1.50%**	**0.24%**	**0.01%**	**0.14%**
Abnormal History [1]	7.64%	0.08%	0.01%	0.10%
	p<0.001	p<0.04		

Flag	Screen+	Echo	Monitor	CCTA	CMR	GXT	EP	ESE	TEE
ECG	**2.03%**	**1.78%**	**0.20%**	**0.07%**	**0.12%**	**0.22%**	**0.02%**	**0.02%**	**0.01%**
History	8.01%	2.20%	0.19%	0.23%	0.08%	0.65%	0	0.03%	0.01%

1. True+ and DQ cases with **ABNL Q&A** also had **ABNL ECG** in 7 of 10. Three isolated Q&A+ cases showed abnormal findings in three trainees:
   - CCTA = long myocardial bridge
   - Peak exertion = CPVT vs. atypical WPW
   - Recovery = 4-beat run of SVT

Unpublished data from 2024-2026

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Cost-Benefit Analysis (ages 17-24 years

Test	Echo	Monitor	CCTA	CMR	GXT	EP	ESE	TEE
Component Cost	$300	$200	$676	$672	$170	$2,676	$376	$500
TOTAL COST	$127 per Trainee Screened **($12.7M per 100K Trainees**)							

MORTALITY COST

- SCD rate 2 per 100K
- Life Insurance $500K
- Death Gratuity $100K
- Dependency and Indemnity Compensation $1,500/mo (Lifetime $900K)
- Burial Benefits $2,000
- TOTAL = $1.5M/SCD

MORBIDITY COST

- SCA survivor 6 per 100,000
- ICU $257K[1]
- Disability $2,000/mo (Lifetime $1.2M)
- TOTAL = $1.45M/SCA

REPLACEMENT COST

- Recruiting $75,000
- Initial Training $80K (high-tech $200K)
- Pre-Deployment Training $20K
- Total = $175K per replacement

INTANGIBLE COST

- Impact to Family
- Mission Degradation
- Unit Morale
- Time to replacement
- Baseline ECG
- Prevent late wash out in pipeline (flight)

Cost per Death Avoided = ($12.7M / $3.0M) = $4.2M

Cost/Benefit EVEN for SCD, SCA, & Replacement = ($12.7M / $13.1M) < $1

1. Damluji et al, Circ Arrhythm Electrophysiol. 2018;11(4):e005689 inflation adjusted

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Backup Slides

CENTRAL ILLUSTRATION: Impact and Challenges of Cardiac Screening in the Young

Single cardiac screening
HQ, ECG + clinical consultation
Selective echocardiography

104,369 individuals

Follow-up of 6.0 ± 2.5 years

1) National hospital database
2) Electronic survey
3) Communication to screening provider

97.5%

TEST NEGATIVE

CLEAR

29 individuals experienced SCA/SCD

86 (0.08%) individuals identified with a SCD condition

4 years from screening and diagnosis of a SCD associated condition
4 years from screening and experiencing SCA/SCD

2.5%

TEST POSITIVE

REFER

6 individuals experienced SCA/SCD

280 (0.3%) individuals identified with a SCD condition

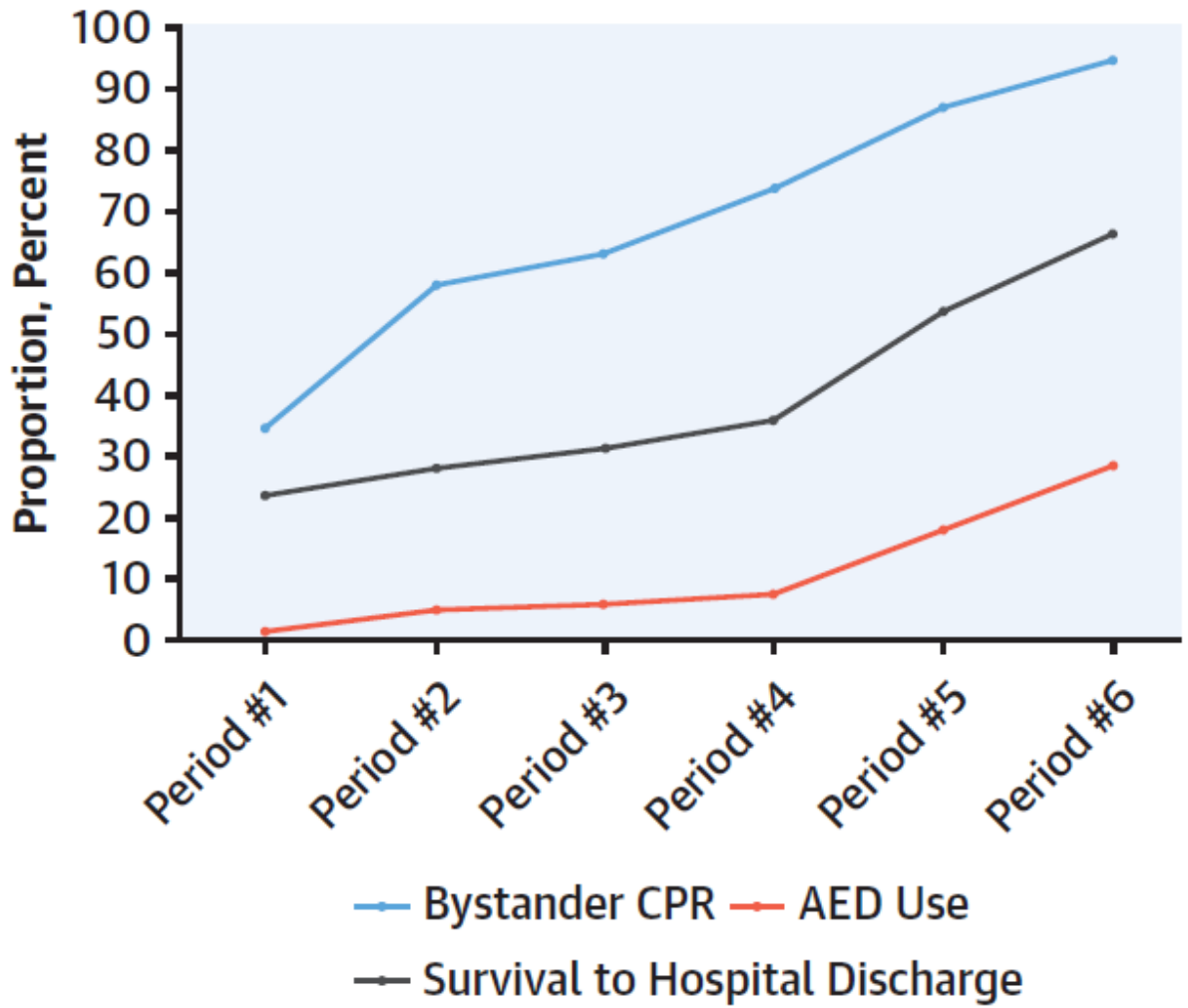
41% received risk-modifying interventions beyond pharmacological therapy

1. **77% of conditions associated with SCD detected by screening.**
   Allowing for early risk-modifying interventions.
2. **0.08% diagnosed with a condition associated with SCD despite normal screening.**
   Serial evaluations may mitigate age-related penetrance.
3. **Incidence of SCA/SCD = 5.6 per 100,000 person-years.**
   3-fold higher in men vs. women and no difference between athletes vs. non-athletes.

Findings relevant to policy debates

MacLachlan H, et al. JACC. 2026;87(7):756-768.

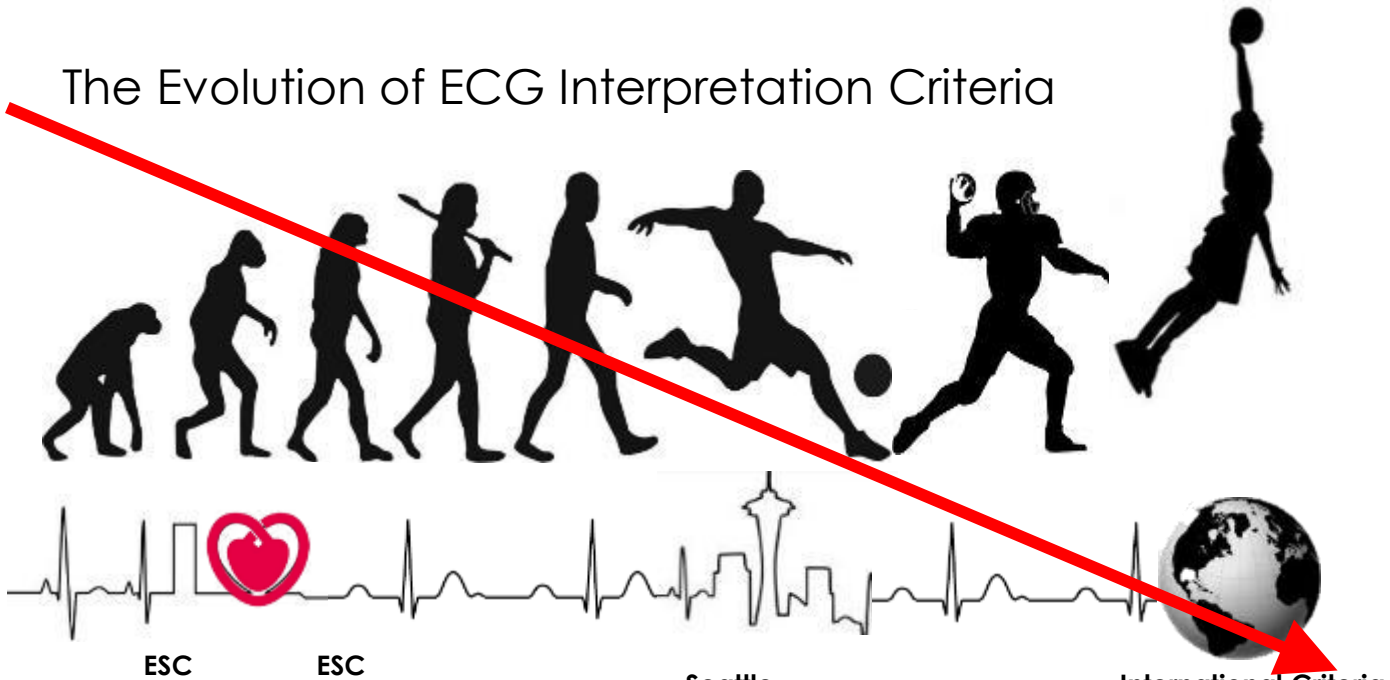
FIGURE 1 Temporal Trends Through the Six 2-Year Periods of Time (2005-2018)



There was a steady increase in the rates of bystander CPR and AED use, together with a 3-fold increase in survival rate. AED = automated external defibrillator; CPR = cardiopulmonary resuscitation.

Karam N, et al., JACC 2022;79(3):238-246

The Evolution of ECG Interpretation Criteria



	ESC 2005	ESC 2010	Seattle Criteria 2012	International Criteria 2017
False Positive Rate	15-20%	10-15%	3–6%	1–2%

Graphic courtesy of Kimberly Harmon, MD
Professor, Depts of Family Med and Ortho/Sports Med
University of Washington

AHA 14-Element Screening Mostly Captured In Accession Screening History & Physical Exam

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

Medical history*

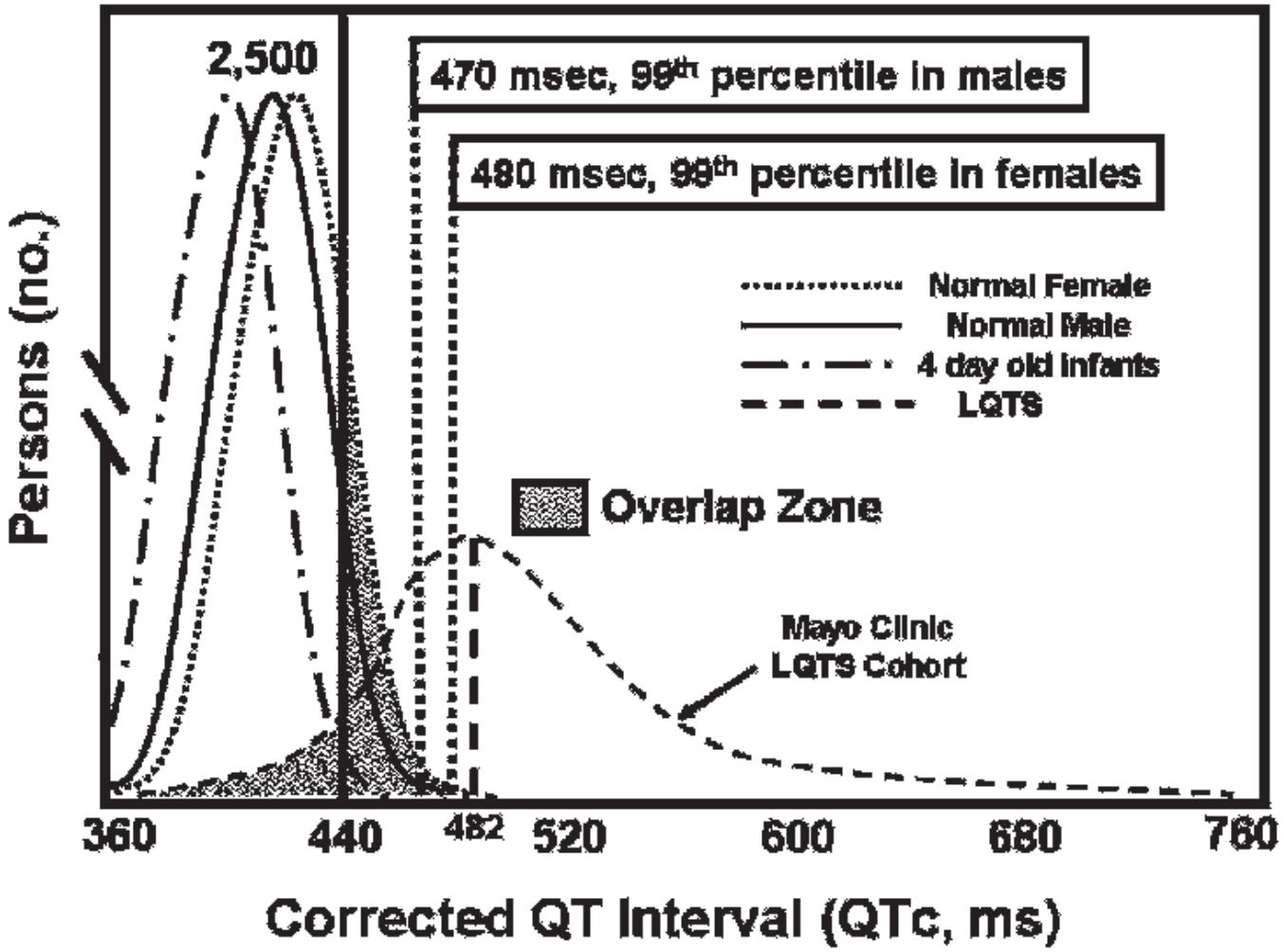
DD Form 2807-2 Accessions Medical History Report

HAVE YOU EVER HAD OR DO YOU NOW HAVE:	YES	NO
EYES/VISION:		
3. Double vision		

QUESTIONS NOT CAPTURED:

1. Have you ever passed out DURING exercise?
2. Do you get chest pain DURING exercise that makes you stop?
3. Has a close family member died from a heart problem or suffered a sudden cardiac arrest before the age of 50?
4. Does a family member have any of these genetic heart conditions:
   - ❑ Hypertrophic cardiomyopathy
   - ❑ Dilated cardiomyopathy
   - ❑ Arrhythmogenic right ventricular cardiomyopathy
   - ❑ Marfans syndrome
   - ❑ Long QT syndrome
   - ❑ Catecholaminergic polymorphic ventricular tachycardia
   - ❑ Brugada syndrome

Challenges Identifying Long QT Syndrome



- Mayo Clinic data shows 40% of LQTS have QTc < 460
- Ratio of normal-to-LQTS is 25:1
- USAF Aerospace Medicine Waiver Guide Compendium defines prolonged QT interval as > 470 male > 480 female

Johnson and Ackerman. QTc: How long is too long? Br J Sports Med 2009;43:657–662.

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