Tri-City Cardiovascular Symposium

August 17, 2024

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- Joined Tri-City Cardiology in July of 2021 as an Electrophysiologist.
- Board certified in Clinical Cardiac Electrophysiology, Cardiovascular Disease, and Internal Medicine.
- Completed his Clinical Cardiac Electrophysiology and Cardiovascular Disease Fellowship at the Texas Heart Institute in Houston, Texas.
- During his fellowship, he earned a Master of Business Administration from Brandeis University concurrently.
- Medical education includes an Internal Medicine Internship and Residency at the University of Texas Southwestern Medical Center in Dallas, Texas.
- Holds a Doctor of Medicine Degree from the Medical College of Wisconsin in Milwaukee, Wisconsin.
- Specializes in ablation of atrial and ventricular arrhythmias.
- Expertise in cardiac implantable electronic devices, including pacemakers, defibrillators, cardiac resynchronization devices, and the Watchman left atrial appendage occlusion device.

TRI-CITY
CARDIOLOG

Risk Stratification and Prevention of Sudden Cardiac Death

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Outline

- ICD fundamentals
- Risk stratification of non-ischemic cardiomyopathy
- Risk stratification of ischemic cardiomyopathy
- Role of wearable defibrillators
- Role of sub-cutaneous ICDs in preventing sudden cardiac death
- Sudden death in athletes
  - Hypertrophic cardiomyopathy
  - Wolff Parkinson White syndrome
  - Long QT Syndrome

What Is an ICD?

IMPLANTABLE CARDIOVERTER DEFIBRILLATOR

- AN ICD IS ALSO A PACEMAKER

because some patients have a pacemaker indication as well …

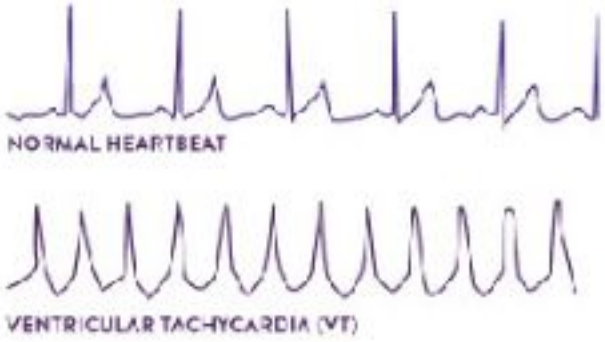
… but an ICD has the added ability to ***rapidly pace and shock*** to rescue a patient from a lethal ventricular arrhythmia.

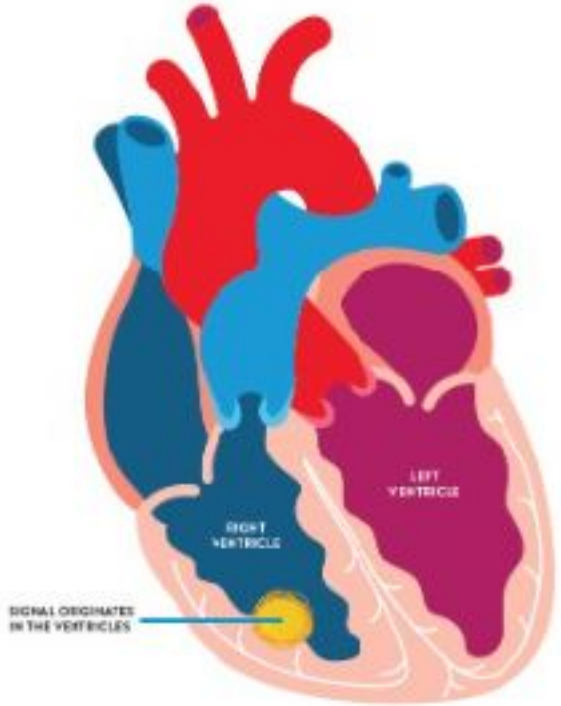
In general, ICDs are indicated in patients with:

or those likely to have one of these arrhythmias

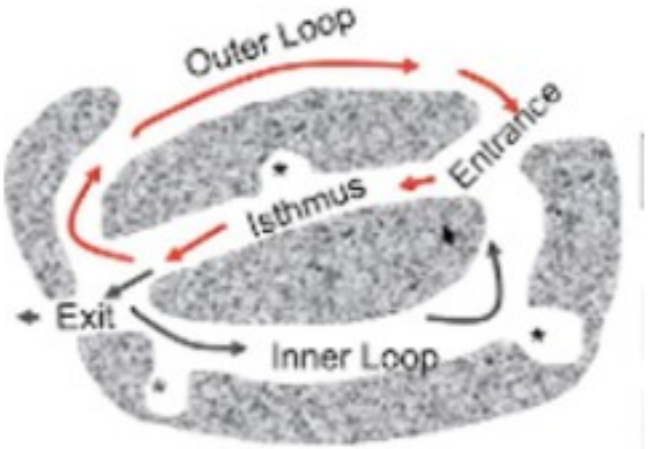
What Is Ventricular Tachycardia (VT)?

- **THE HEART MAKES ABNORMALLY FAST ELECTRICAL SIGNALS**
  - Too fast to maintain Cardiac Output
  - Signal originates in the lower chambers



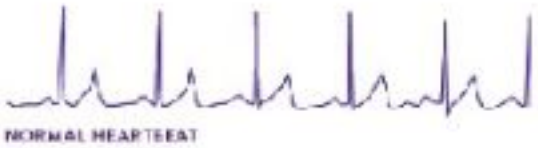


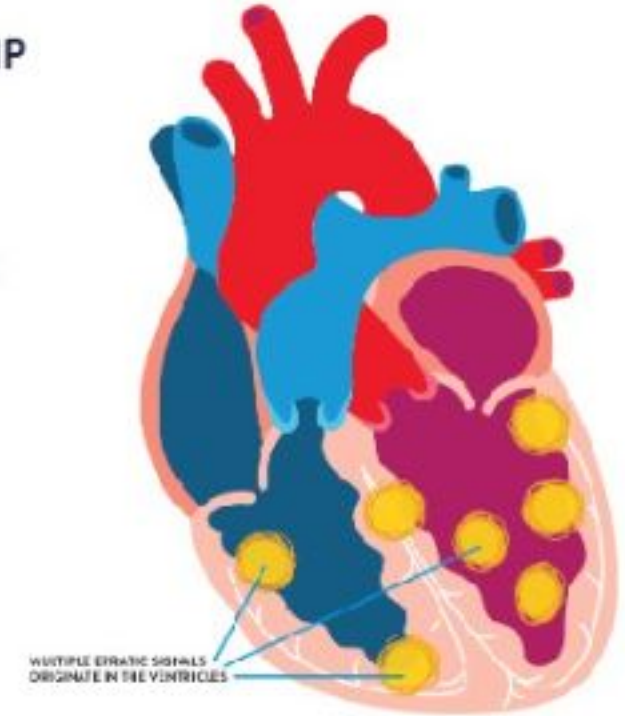
Ventricular Tachycardia



What Is Ventricular Fibrillation (VF)?

- **LOWER CHAMBERS QUIVER AND CAN'T PUMP EFFECTIVELY, CAUSING CARDIAC ARREST**
  - Chaotic, irregular
  - Most serious cardiac rhythm disturbance
  - Most often associated with Coronary Artery Disease



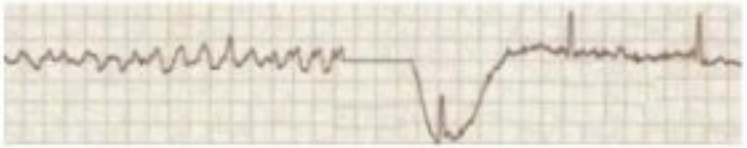


Device Therapy Options for Ventricular Arrhythmias

PACING or SHOCKING

- ANTI-TACHYCARDIA PACING (ATP)
  - Pacing Therapy
  - Used to treat monomorphic VT

- HIGH VOLTAGE SHOCKS
  - Used to treat non-stable VT and VF

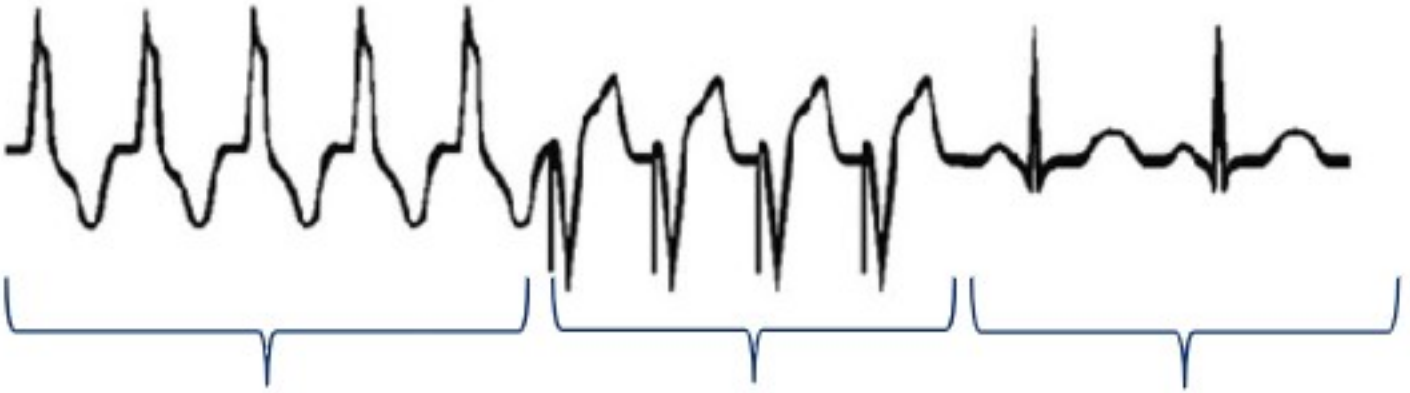


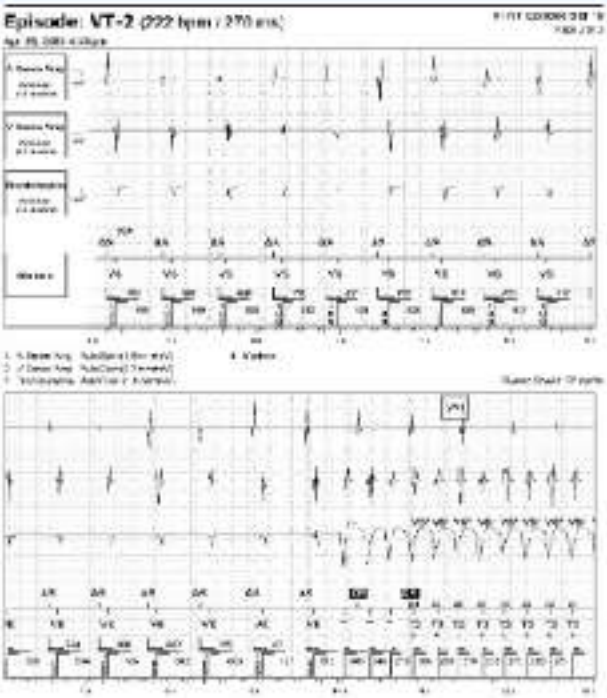
Anti-Tachycardia Pacing (ATP) Basics

- **ATP USES A SEQUENCE OF RAPID PACING PULSES TO TERMINATE TACHYCARDIAS**

- BENEFITS
  - Painless
  - No charge time
  - Uses little battery energy
  - Can be delivered before the patient is symptomatic
- **DRAWBACKS**
  - ATP is not always effective
  - If ineffective, it could (but not always) delay the time to high voltage shock
  - It may accelerate a VT

Anti-Tachycardia Pacing (ATP) in Action

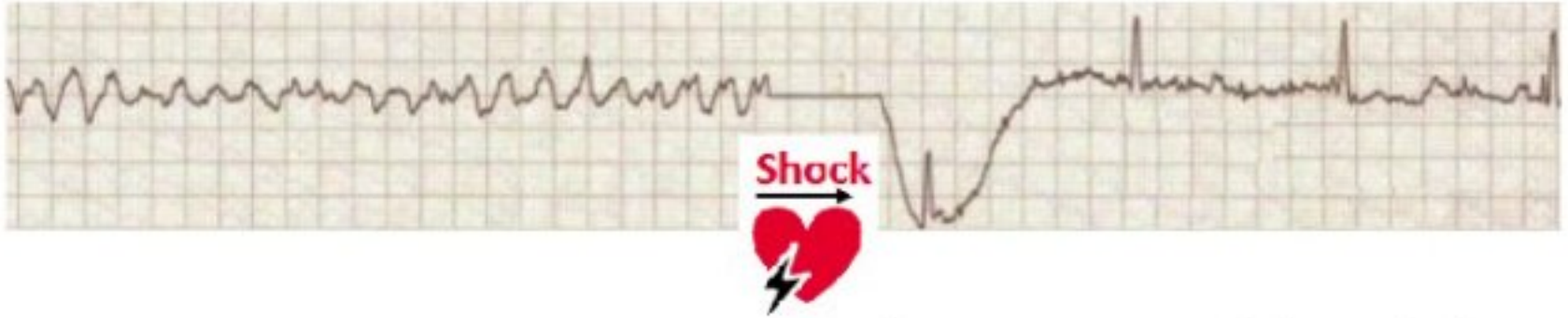



Episode: VT-2 (222 bpm / 270 ms)


Episode: VT-2 (222 bpm / 270 ms)

What Does a Defibrillation Shock Do?

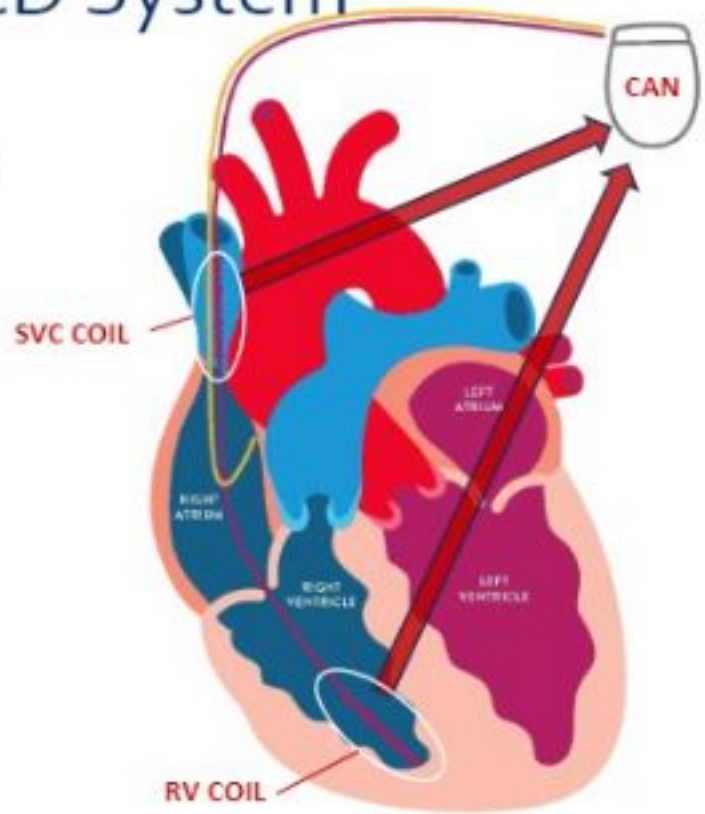
A DEFIBRILLATION SHOCK is an attempt to "silence" chaotic cardiac cells ...



... and **restore** normal sinus rhythm.

Shocking Vectors of an ICD System

- COMMON LOCATION(S) OF SHOCKING COILS
  - RV Apex
  - SVC
- SHOCKING CONFIGURATIONS
  - RV Coil → Can
  - RV Coil and SVC Coil → Can



Favors single chamber

Permanent atrial fibrillation

Primary prevention, without any of the atrial lead indications listed in right panel

Favors dual chamber

Need for atrial- or dual-chamber pacing

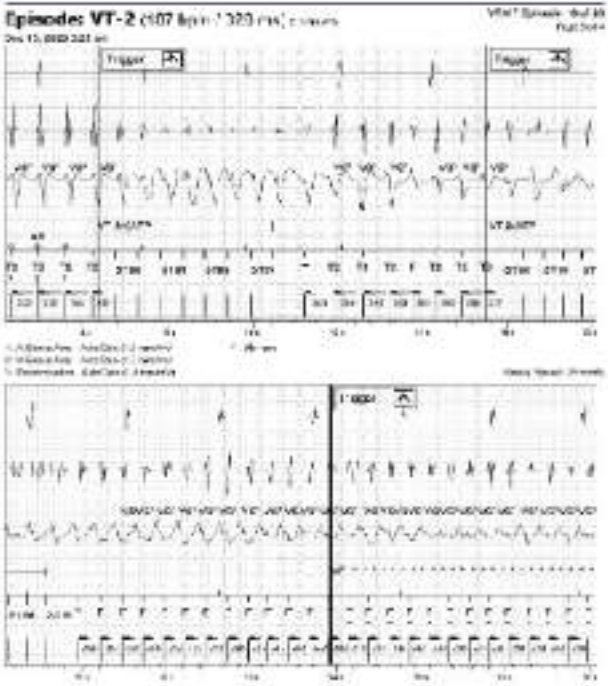
- Symptomatic bradycardia
- Bradycardia due to or limiting the use of evidence-based dose of medications such as beta blockers or AADs
- Pause-dependent or bradycardia-induced ventricular VT/VF in patient with sinus rhythm

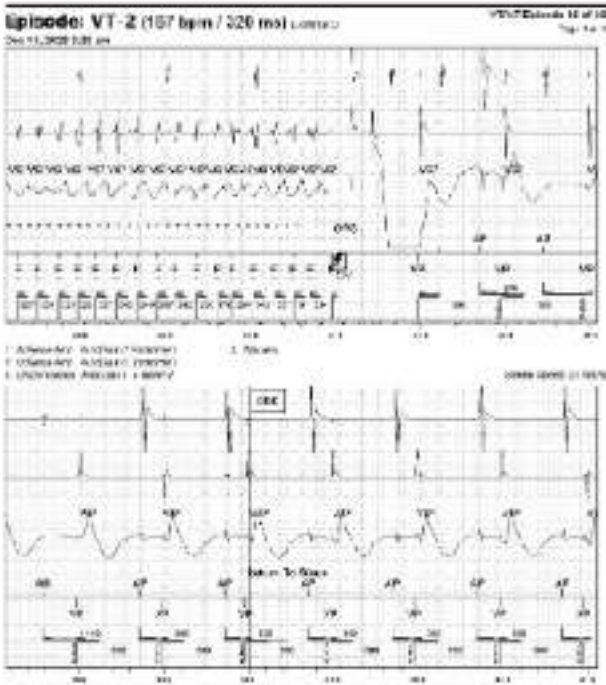
Rhythm discrimination (VT rate overlaps SVT rate, not permanent AF)

HCM with significant LV outflow gradient

ICDs Have Multiple Treatment Zones

- ZONES ALLOW TIERED THERAPY
  - VT-1 (slow VT) can be treated with ATP
  - VT-2 (fast VT) can be treated with lower-energy shocks
  - VT and VF allows for lower and higher energy therapies
- ZONES ARE APPROPRIATE FOR PATIENTS WITH MULTIPLE RHYTHM DISORDERS
  - Patient may have VF but also well-tolerated episodes of VT that respond to ATP
  - Zones allow the clinician to delivery different therapies to rhythm disorders of different rates


Episodes: VT-2 (167 bpm / 320 ms)
Trigger
Trigger
VT-2
VT-2


Episode: VT-2 (167 bpm / 320 ms)
VT
VT
Return To Sinus

Patient FC

- 43 y/o M w/ a history of hypertension, insulin dependent DM who presented with a three month history of shortness of breath and chest tightness
- EF 25% with moderate MR; telemetry notable for non-sustained VT
- Left heart catheterization w/o coronary disease; diagnosed w/ a non-ischemic cardiomyopathy
- LifeVest wearable defibrillator ordered

LifeVest WCD

- **Primary Function:**
  - Detect and treat sustained VT/VF
- **Secondary Functions:**
  - Symptomatic event ECG recorder
  - Arrhythmic event monitor
- LifeVest looks at heart rate & morphology to define a treatable arrhythmia
  - VT – Within 60 seconds
  - VF – Within 25 seconds

LifeVest Components

LifeVest consists of a garment, an electrode belt, and a monitor.

GARMENT
Worn under your normal clothing, directly against skin

Includes the electrode belt

ELECTRODE BELT
Designed to detect dangerous heart rhythms and deliver treatment shocks

MONITOR
Worn around waist or with shoulder strap

Continuously records heart rate

Who Qualifies for LifeVest?

Primary Preventions – EF ≤ 35% and MI, NICM, or DCM

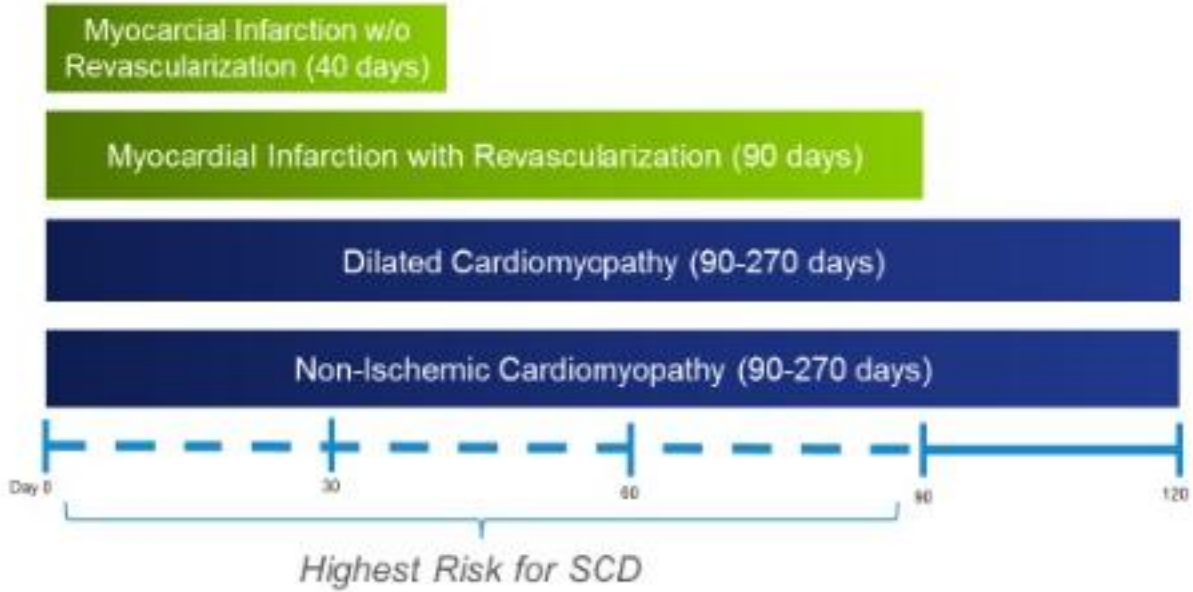
- MI with an EF ≤ 35%
  - Recent or Prior MI
  - CABG or PCI
- Types of Cardiomyopathy with EF ≤ 35%
  - Viral-induced CM
  - Newly diagnosed NICM
  - Dilated CM – left or right ventricle
  - Tachy-induced CM
  - Alcohol-induced CM
  - Peripartum CM
  - Takotsubo
- Cardiac transplant

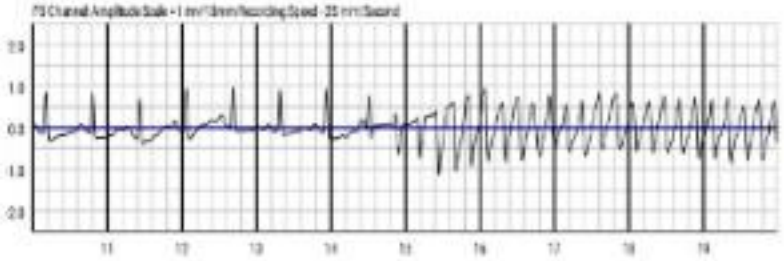
Secondary Preventions – NO EF Required

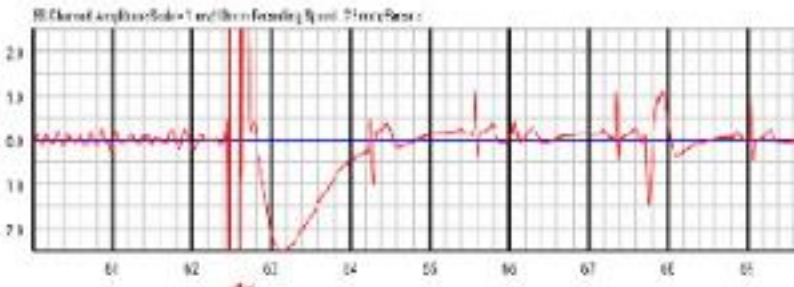
- Cardiac arrest with Defibrillation
- Documented VFib
- Sustained VT (30 secs or longer)
- Familial or inherited with SCA risk
  - Brugada syndrome
  - Long QT syndrome
  - Diagnosed Amyloidosis
  - ARVD
  - Hypertrophic obstructive or Non- Obstruc CM
  - WPW syndrome
- ICD explant or malfunction

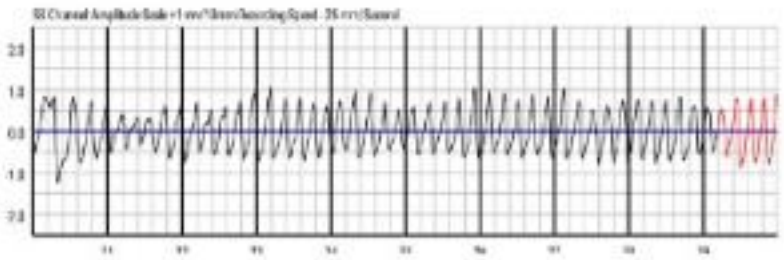
LifeVest WCD Provides Protection from SCD During ICD Waiting Periods & GDMT Optimization

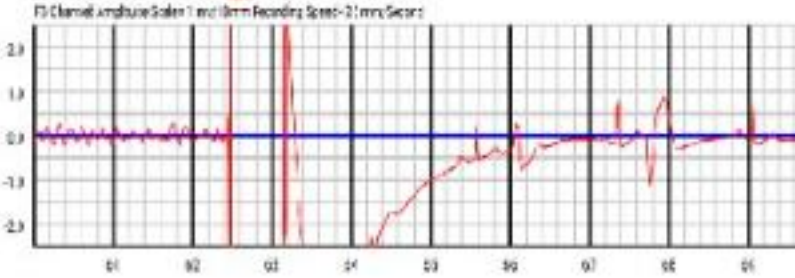
In patients with an Ejection Fraction ≤ 35%, guideline driven ICD waiting periods have been implemented



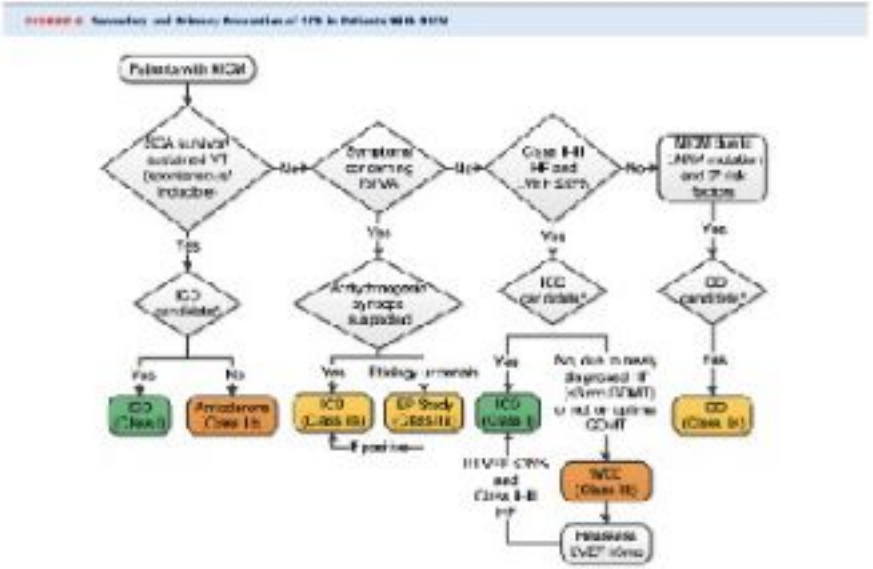








2017 Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: Non-ischemic Cardiomyopathy



Patient LJ

- 79 y/o active male M w/ no prior cardiac history presented with 4/10 chest pain
- 100% blockage of proximal LAD w/ stent placed
- EF 35%
- ASSURE wearable cardiac defibrillator ordered

ASSURE WCD

Wearable device for patients at risk of sudden cardiac arrest that can provide automatic detection and defibrillation for

1. SensorFit™ Garments
   Styled and engineered by leading athletic and sportswe designers

   Breathable, lightweight fabri

   Nonadhesive, embedded and cushioned ECG sensors

2. HeartPoint™ Alert Button
   Easily interact with WCD by hearing, feeling, and touchin

3. Monitor
   ASSURE Detection Algorithm

Programming Considerations

The ASSURE WCD provides two independently programmable therapy zones. Device settings may be specified when ordering the ASSURE WCD to address individual patient conditions.

ASSURE WCD Settings

Specify settings (all shocks 170J)	VT Zone	VF Zone
☐ **Patient history of Atrial Fibrillation, Atrial Flutter, or other SVT**	180 bpm	220 bpm
☐ **Default/Nominal Settings**	170 bpm	200 bpm
☐ **Custom Settings** (enter at right in increments of 10bpm)	_____ bpm (130–210) ☐ Monitor Only	_____ bpm (180–220) VT Zone + 10bpm (minimum)

Settings on the ASSURE WCD Medical Order Form

Rates of supraventricular and ventricular arrhythmias often overlap.[1] Consider the following strategic approach to tailor arrhythmia detection parameters* to ensure appropriate therapy.[2]

History of Atrial Fibrillation, Atrial Flutter, or other SVT?		Possibility of high sinus rates during activity?		History of hemodynamically significant slow VT?	
Consider		Consider		Consider	
VT Zone **180 bpm**	VF Zone **220 bpm**	VT Zone **180 bpm**[†]	VF Zone **220 bpm**	VT Zone at least 10 bpm below documented hemodynamic rate[‡]	VF Zone **200 bpm**

Alert-Based Follow Up

Automatic transmission of WCD episodes enables notification of conditions of interest.

Specify who on your care team should be notified, what they should be notified for, and how they should be notified (email or text/SMS).

Customize Kestra CareStation notification preferences for:

- Arrhythmic episodes (Tachy Treated, Tachy Untreated, Bradycardia/Asystole, SVT, and Patient Triggered)
- Daily usage
- Daily steps
- Data transmission

ASSURE Assist Service

Offers patients post shock support[1]

Shock Alert Received

When the ASSURE system delivers a shock for a life-threatening heart rhythm, the ASSURE Assist® service is designed to send an alert via the ASSURE patient app to an Emergency Medical Services (EMS) operator.

Operator Responds

The EMS operator attempts to contact the patient to determine if additional help is needed.

Family and Caregivers Informed

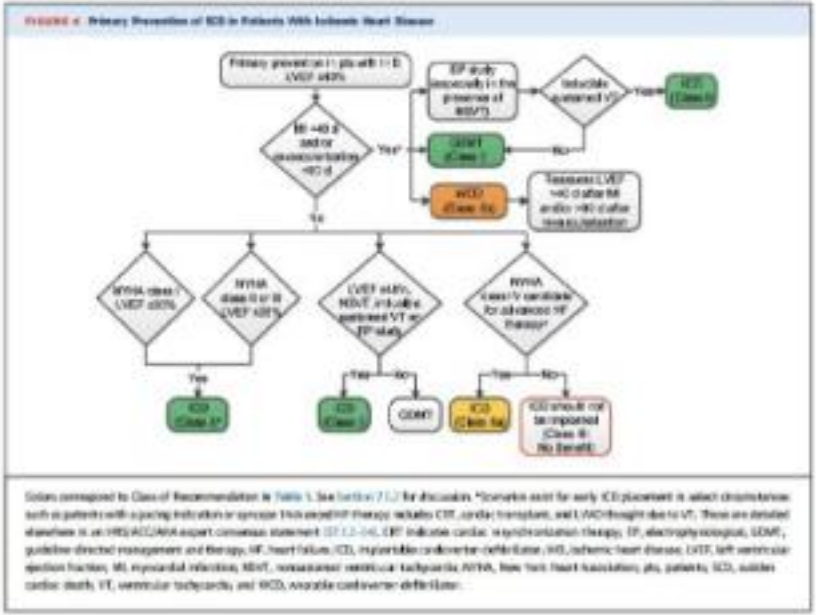
If the patient cannot be reached, the EMS operator attempts to call the emergency contact and share the patient's status and current location.

Emergency Services Dispatch Attempt

If both the patient and emergency contact cannot be reached or if eith request additional help, EMS may b dispatched to the patient's location

1 The ASSURE Assist service requires the mobile device with the ASSURE patient app to be connected to the Internet and or Wi-Fi®, powered on, location services enabled with location permissions granted and within 30 feet of the ASSURE system for proper operation. In the event of an emergency, the ASSURE Patient App is not a substitute for appropriate medical attention and should not be relied on to contact emergency services. Kestra Medical Technologies Inc. (KMT) does not represent or warrant that the ASSURE Assist service prevents death, bodily or personal injury, or damage to you. KMT makes no representation of warranty as to the promptness of the ASSURE Assist service or emergency services. See important information about your ASSURE system at kestramedical.com/safety or the ASSURE

2017 Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: Ischemic Cardiomyopathy



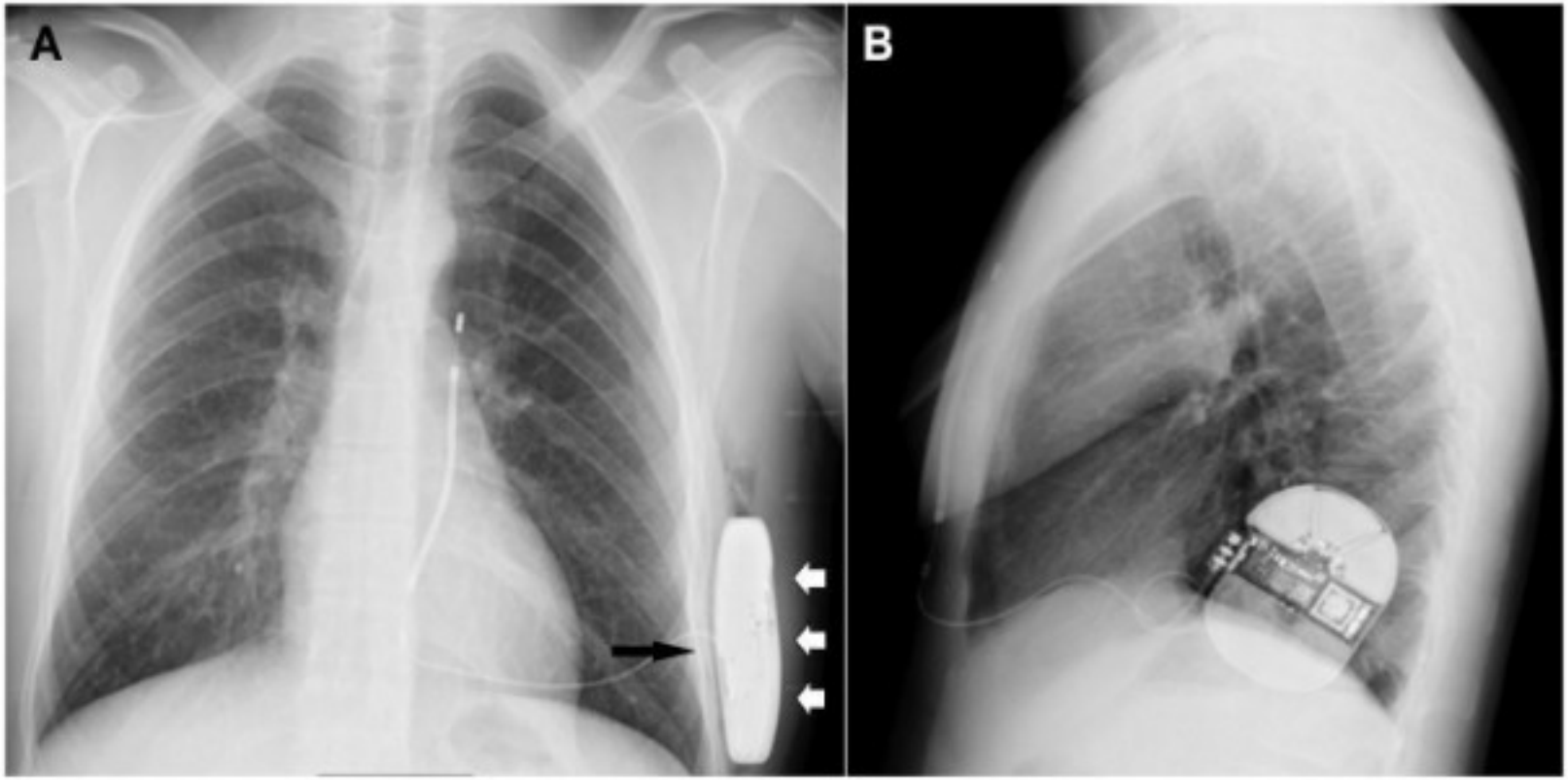
Patient RD

- 44 y/o M w/ a history of tobacco usage since age 16, insulin dependent DM and HTN had an ischemic evaluation for new onset cardiomyopathy (ejection fraction of 25%)
- Left heart catheterization revealed multi-vessel coronary disease and bypass surgery was performed (01/2023)
- Ejection fraction remained 25% 3 months after surgery
- LifeVest was used to bridge the patient to DC-ICD implantation (06/2023)
- ICD incision site became infected and his DC-ICD was explanted (08/2023)
- LifeVest again used to bridge the patient to SQ-ICD implantation (04/2024)


A
SKIN INCISION
ANTERIOR BELLY LATISSIMUS DORSI


B
ANTERIOR BELLY LATISSIMUS DORSI

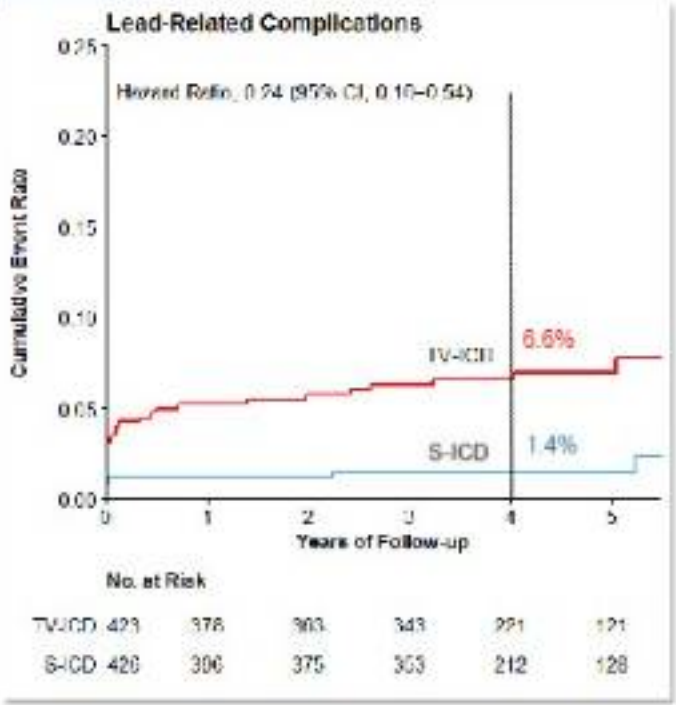

CAUDAL
CRANIAL
SERRATUS ANTERIOR
LATISSIMUS DORSI
SERRATUS ANTERIOR
LATISSIMUS DORSI


A
B

S-ICD vs TV-ICD PRAETORIAN Study

Type of complications and lead-related complications

Characteristic	S-ICD (N = 426)	TV-ICD (N = 423)
Device-related complication	31 (5.9)	44 (9.8)
Infection	4	8
Lead-related infection	1	5
Bleeding	8	2
Thrombotic event	1	2
Pneumothorax	0	4
Lead perforation	0	4
Tamponade	0	2
Lead repositioning	2	7
Other lead or device complication	19	20
Lead replacement	3	9
Dislocation/dislodgement	2	3
Myopotential oversensing	1	
Lead dysfunction		6
Device malfunction	4	6
Sensing issues	4	0
Pacing indication!	5	1
Implantation failure	0	3
Defibrillation test failure	3	0
Pain or discomfort	2	3



S-ICD

Strongly favors

- Intracardiac shunt
- Young patient (lead longevity)
- Limited vascular access
- Infection risk or history (e.g. diabetes, prosthetic valve, renal dysfunction)
- Dialysis

Weakly favors

- PFO (thromboembolism risk)

TV ICD

Strongly favors

- Need for antibradycardia pacing
- Need for antitachycardia pacing
- Failed S-ICD ECG screen

Weakly favors

- Small body habitus

Pocket infection/erosion
(may not represent typical infection/erosion).

Photo courtesy of Dr. Peter Belott

Class I Recommendation for S-ICD

11.1. Subcutaneous Implantable Cardioverter-Defibrillator

Recommendations for Subcutaneous Implantable Cardioverter-Defibrillator References that support the recommendations are summarized in Online Data Supplement 55.		
COR	LOE	Recommendations
I	B-NR	1. In patients who meet criteria for an ICD who have inadequate vascular access or are at high risk for infection, and in whom pacing for bradycardia or VT termination or as part of CRT is neither needed nor anticipated, a subcutaneous implantable cardioverter-defibrillator is recommended (1-5).
IIa	B-NR	2. In patients who meet indication for an ICD, implantation of a subcutaneous implantable cardioverter-defibrillator is reasonable if pacing for bradycardia or VT termination or as part of CRT is neither needed nor anticipated (1-4).
III: Harm	B-NR	3. In patients with an indication for bradycardia pacing or CRT, or for whom antitachycardia pacing for VT termination is required, a subcutaneous implantable cardioverter-defibrillator should not be implanted (1-4, 6-8).

Recommendation-Specific Supportive Text

"The risk of infection appears to be lower with subcutaneous implantable cardioverter-defibrillators than with transvenous ICDs (1-4). Therefore, a subcutaneous implantable cardioverter-defibrillator may be preferred in patients who are at high risk of infection, such as those with a prior device infection, ESRD, diabetes mellitus, or who are chronically immunosuppressed."

Subcutaneous ICD Therapy

Effective defibrillation without transvenous leads

- Entirely subcutaneous
- Does not require leads in the heart, leaving the vasculature untouched
- Placed using anatomical landmarks, reducing the need for fluoroscopy at implant

2002
1° generation

- SQ-RX S-ICD System
- EU Market Approval 2009
- US Market Approval 2012

2015
2° generation

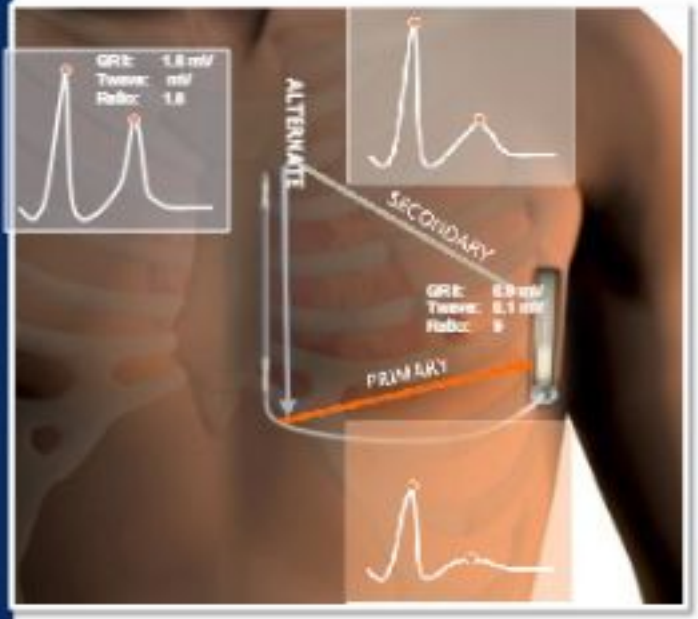
- 20% thinner
- 40% greater longevity
- LATITUDE NXT remote monitoring

2016
3° generation

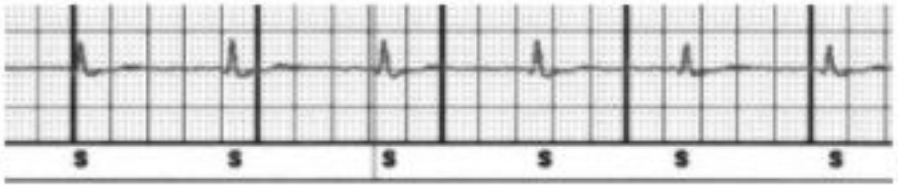
- Full-bod
- SMART P
- AF monit

Subcutaneous ICD Therapy

Sophisticated Rhythm Detection Technology[1,2]



Three far-field sensing vectors



1. Sanghera R, et al., *Ann N Y Acad Sci* 2014 (1329): 1-17.
2. Reisher A, et al., *Journal of Electrocardiology* 51 (2018) S38–S43

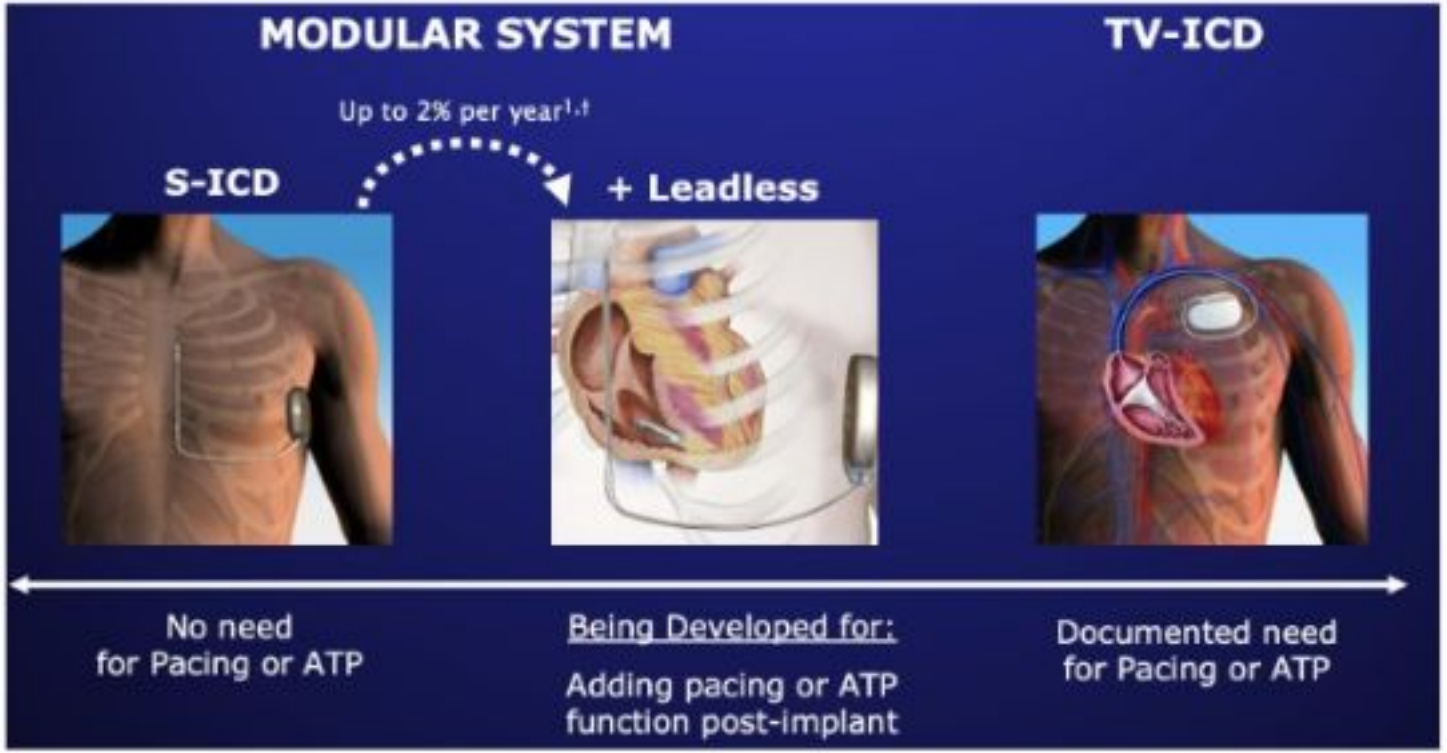
Drawbacks

- Inappropriate shocks
  - T wave over-sensing (most common)
  - Myopotentials
  - Electromagnetic interference
  - Sternotomy wire interaction
- Infection
  - Skin erosion
- System migration
  - Can lead to over-sensing —> inappropriate shocks

S-ICD Indications - ATP

- S-ICD Patient Selection

- Indications for Use
- The S-ICD System is intended to provide defibrillation therapy for the treatment of life-threatening ventricular tachyarrhythmias in patients who do not have:
  - symptomatic bradycardia
  - incessant ventricular tachycardia, or spontaneous, frequently recurring ventricular tachycardia that is reliably terminated with anti-tachycardia pacing


MODULAR SYSTEM
TV-ICD
Up to 2% per year[1,†]
S-ICD
+ Leadless
No need
for Pacing or ATP
Being Developed for:
Adding pacing or ATP
function post-implant
Documented need
for Pacing or ATP

Screening Young Athletes

- 19 y/o M w/ a history of recreational Zyn nicotine pouch usage and alcohol consumption comes to clinic w/ his mother prior to starting college at ASU. He intention is to be a non-recruited walk-on to the football team.

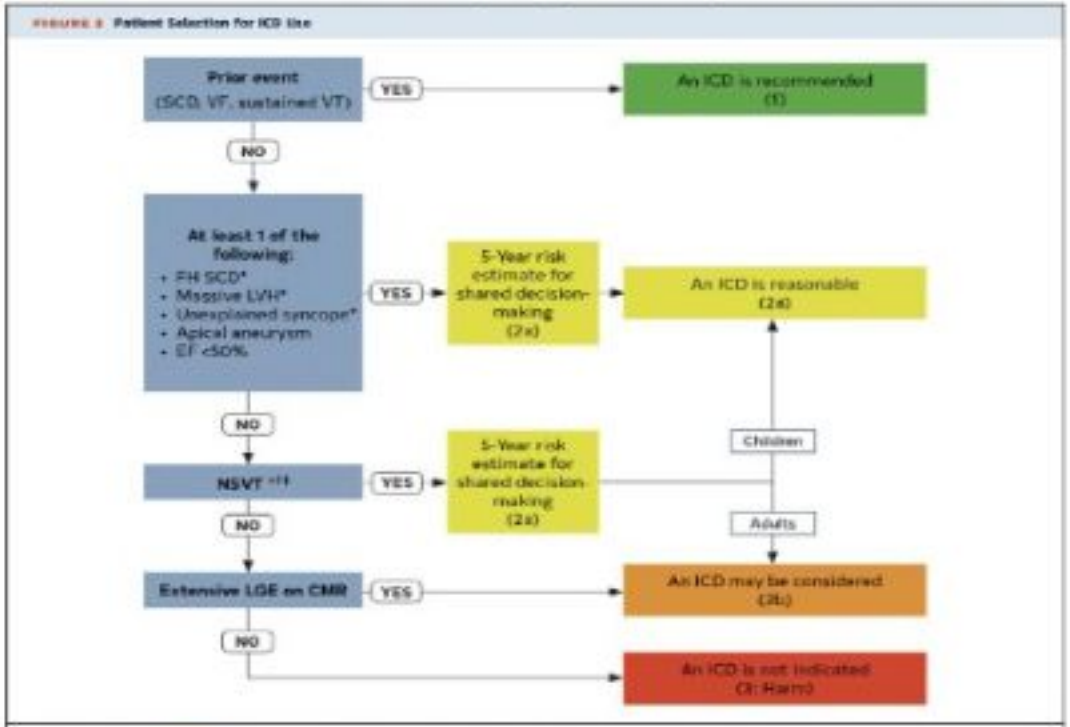
Screening Young Athletes

- Sudden cardiac death 1:80,000 to 1: 200,000 participants per year
- History and physical class 1 recommendation
- EKG or echocardiogram in association w/ H&P may be considered in select population 2b

2017 Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: Hypertrophic Cardiomyopathy

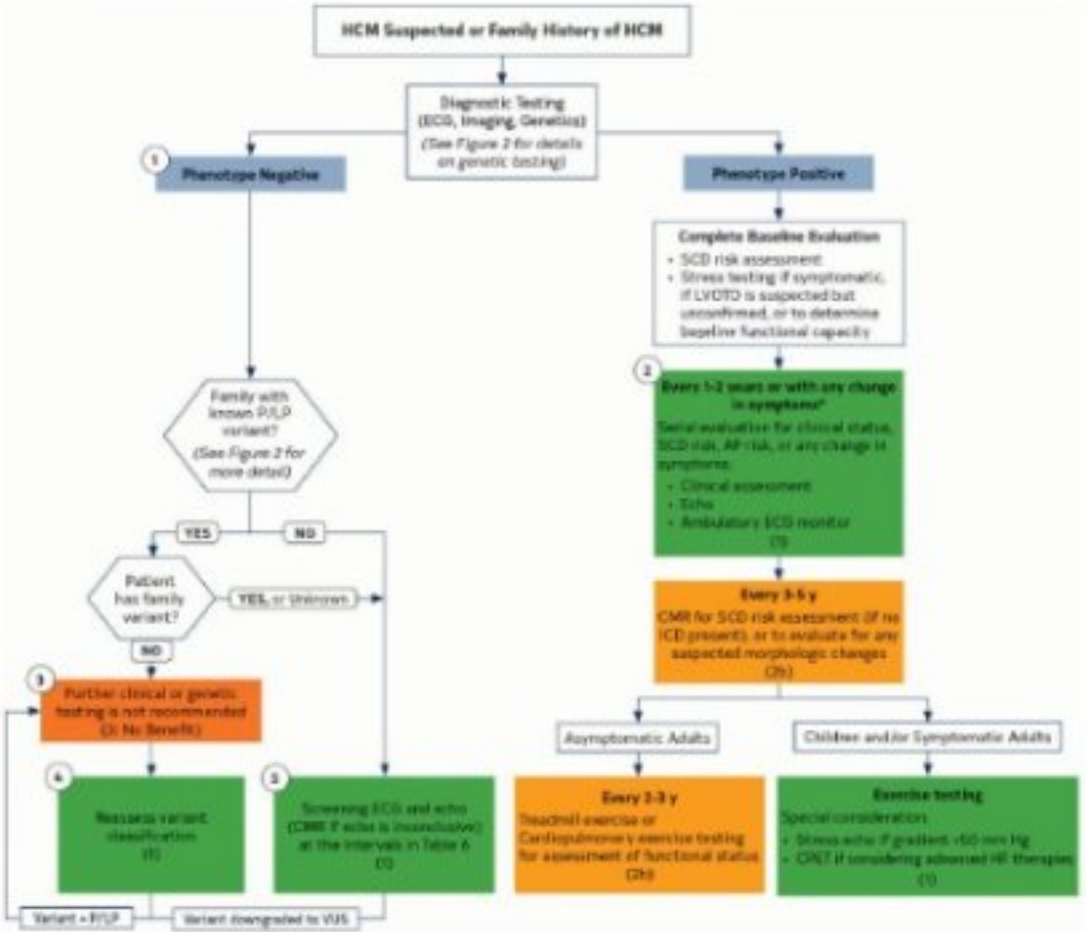
- Clinical diagnosis met if end-diastolic wall thickness > 1.5 cm anywhere in LV in absence of other cause of hypertrophy (HTN/valvular/congenital disease)
  - Basal anterior septum most common location for hypertrophy
  - Physiologic hypertrophy/athlete's heart RARELY exceeds 1.5 cm
    - LV cavity is enlarged w/ physiologic hypertrophy
  - > 1.3 cm in relative of individual w/ HCM
  - Genetic testing not required for diagnosis
- cMRI for patients where TTE is inconclusive or to assess magnitude and distribution of hypertrophy
- Peak gradient > 30 @ rest = obstructive physiology
  - > 50 @ rest or w/ provocation AND symptoms = septal reduction
- Atrial fibrillation = anticoagulation regardless of CHADS-VASC

Hypertrophic Cardiomyopathy Indication for ICDs

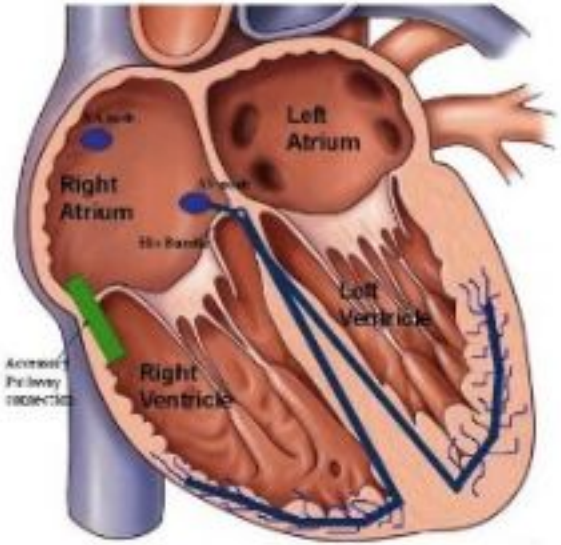


Colors correspond to Table 3. *ICD decisions in pediatric patients with HCM are based on ≥1 of these major risk factors: family history of HCM SCD, NSVT on ambulatory monitor, massive LVH, and unexplained syncope. †5-year risk estimates can be considered to fully inform patients during shared decision-making discussions. It would seem most appropriate to place greater weight on frequent, longer, and faster runs of NSVT. CMR indicates cardiovascular magnetic resonance; EF, ejection fraction; FH, family history; HCM, hypertrophic cardiomyopathy; ICD, implantable cardioverter-defibrillator; LGE, late gadolinium enhancement; LVH, left ventricular hypertrophy; NSVT, nonsustained ventricular tachycardia; SCD, sudden cardiac death; VF, ventricular fibrillation; and VT, ventricular tachycardia.

FIGURE 1 Recommended Evaluation and Testing for HCM



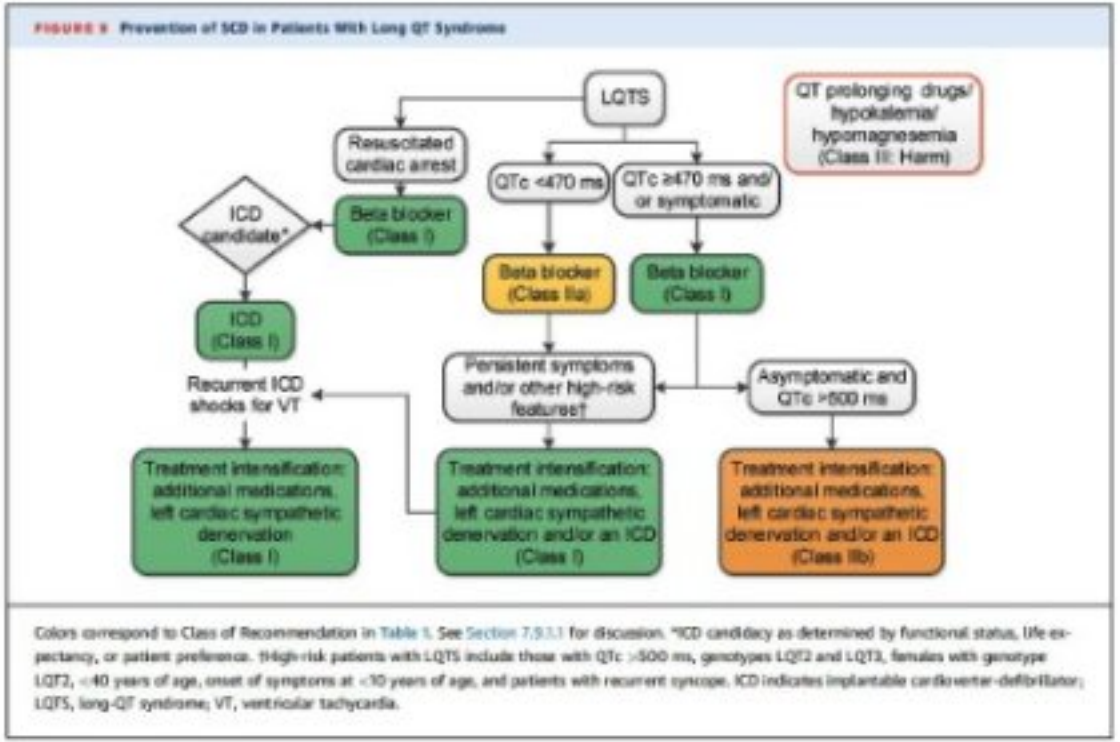
Accessory Pathways



2017 Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: Long QT Syndrome

- Most common channelopathy (1:2,000)
- Measure in lead II, V5 or V6
- > 470 ms men; > 480 ms women; > 500 ms high risk
- LQT 1 w/ activity
- LQT 2 w/ startling/sudden noises
- LQT 3 w/ sleep
- Nadolol 1 - 1.5 mg/kg/day (QD or BID)
- Propranolol 3 - 4 mg/kg/day
  - Most to least effective = LQT 1 —> 2 —> 3
    - "Curative in LQT1"
  - Want non-selective beta blocker (want beta 2 receptor blockage as well)
    - Not Metoprolol or Atenolol (both beta 1 selective)
  - BB decreases adrenergic impulses that lead to arrhythmia

Long QT Syndrome



Screening Young Athletes

- 19 y/o M w/ a history of recreational Zyn nicotine pouch usage and alcohol consumption comes to clinic w/ his mother prior to starting college at ASU. He intention is to be a non-recruited walk-on to the football team.

NORMAL

H&P, EKG, Echocardiogram

Summary

- ICDs have the capacity to painlessly terminate fatal arrhythmias
- There is a waiting period post MI (40 days) or PCI/stenting (90 days) prior to ICD implantation
- Wearable cardiac defibrillators can bridge the gap in vulnerable patients prior to ICD implantation
- Screening young athletes starts at minimum w/ an H&P and EKG w/ a low threshold for cardiac imaging

Any Questions?

Please use the QR code to submit your questions.

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Thank You For Attending the Tri-City Cardiovascular Symposium

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