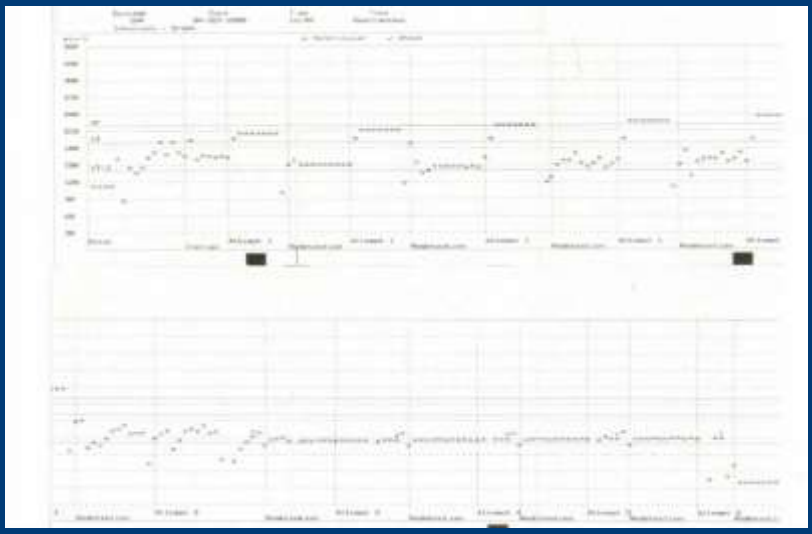
Benign shocks ??
(THIS Is THE LUCK WE NEED)

Mohammad H.Khedr
MD Cardiology, Zagazig University
EP fellowship, McMaster University

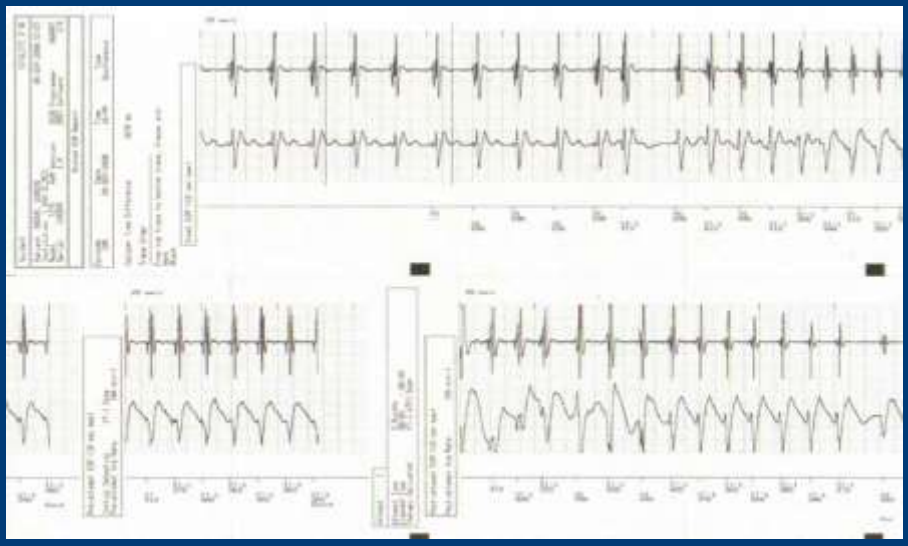
Case

- 74Y Male admitted to the Hospital after receiving one shock
- **He has past medical history of**
- ICM EF 29%
- Single chamber GUIDANT ICD IN 2005 for secondary prevention
- Had previous history of VT and shocks.
- DM, HTN

Summary Of The Events

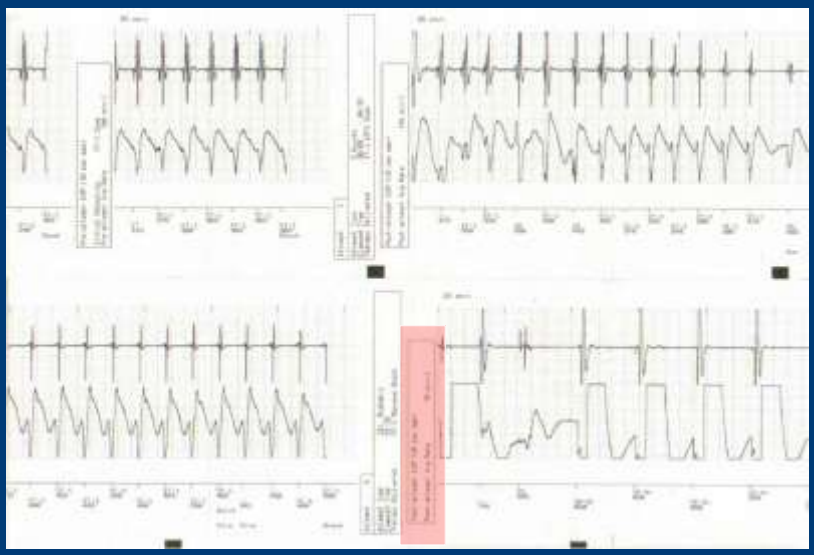


Interrogation Of The Device



The 2nd and 3rd attempt

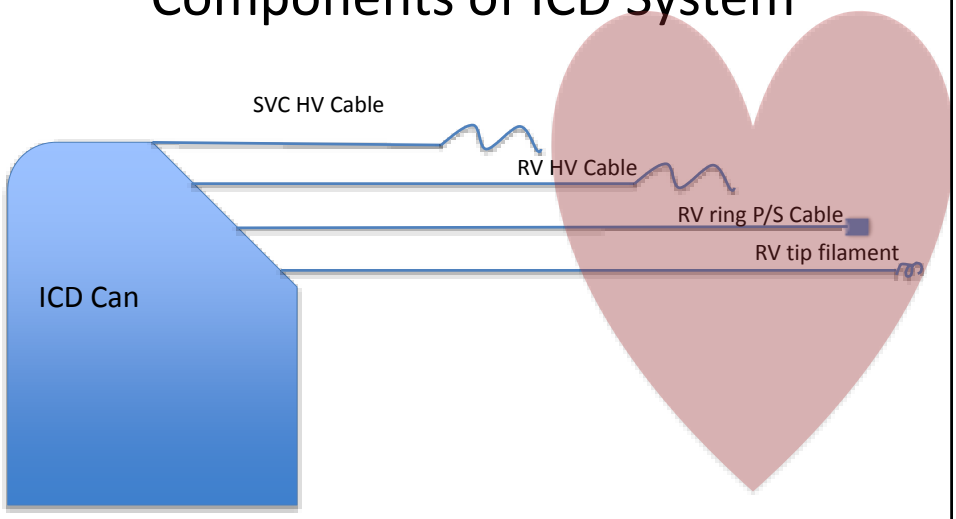
The 6th attempt succeed to terminate the attack



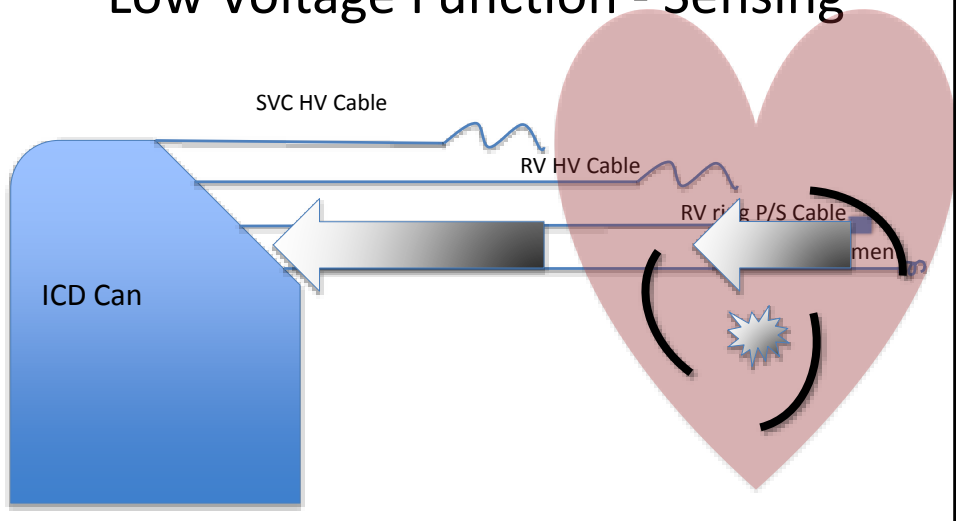
HOW TO EXPLAIN?

- So the patient felt one shock although there is five shocks recorded. four of them failed to terminate the episode of VT1.

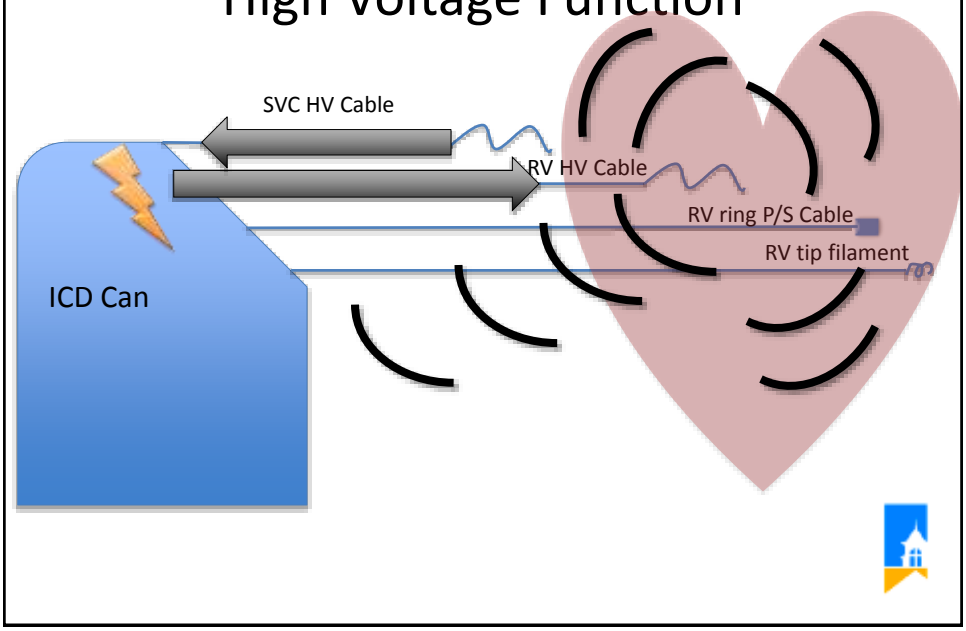
Components of ICD System



Low Voltage Function - Sensing



High Voltage Function

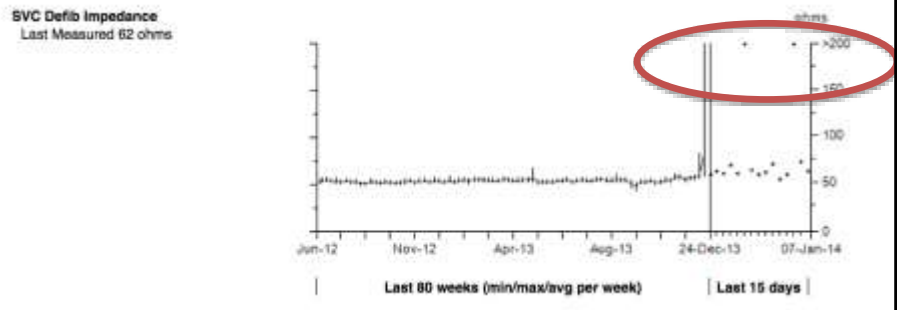


High Voltage Failure is Tough to Detect

- Impedance is only measured parameter
  - No sensing/noise alerts, no pacing threshold
- Testing amplitude is order of magnitude less than working stress on lead
- Failure may be **asymptomatic** and go **undetected** for years
- **First presentation may be sudden cardiac arrest or death**
  - High voltage failure is "quiet"
  - May go undiagnosed if no postmortem interrogation

How does HV Failure Present?

- Silent failure, picked up with remote notification



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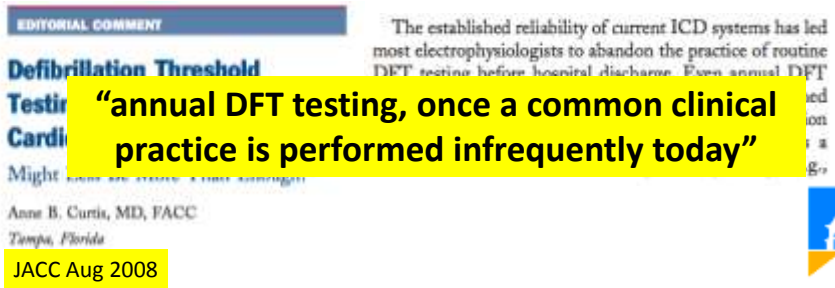
- Silent failure, seen w/hospital shock testing


EDITORIAL COMMENT

Defibrillation Threshold Testi… Cardi…

Might …

Anne B. Curtis, MD, FACC

Tampa, Florida

The established reliability of current ICD systems has led most electrophysiologists to abandon the practice of routine DFT testing before hospital discharge. Even annual DFT …ed …on …a …g.

"annual DFT testing, once a common clinical practice is performed infrequently today"

JACC Aug 2008

How does HV Failure Present?

- Silent failure, picked up with remote notification
- Silent failure, picked up in office
- Silent failure, picked up w/hospital HV testing
- Clinical Shock with manifest failure
  - Inappropriate

How does HV Failure Present?

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- Silent failure, picked up in office
- Silent failure, picked up w/hospital HV testing
- Clinical Shock with manifest failure
  - Inappropriate
  - Appropriate

Lee Oukrup with portrait of son Joshua
www.nbcnews.com

How Do We Detect HV Component Failure?

- What can fail?
  - Pulse Generator

How Do We Detect HV Component Failure?

- What can fail?
  - Pulse Generator
  - Generator/Lead Interface – i.e. header

Second Update of FDA Preliminary Public Health Notification*: Guidant VENTAK PRIZM® 2 DR and CONTAK RENEWAL® Implantable Cardioverter Defibrillators

This is an archived document and is no longer current information.

December 28, 2005

How Do We Detect HV Component Failure?

- What can fail?
  - Pulse Generator
  - Generator/Lead Interface – i.e. header
  - Lead
    - Weakest Link in the Chain
    - Types of Failures
      - **Conductor**
      - **Insulator**

Response to Failed Shock

Conductor Failure – High impedance

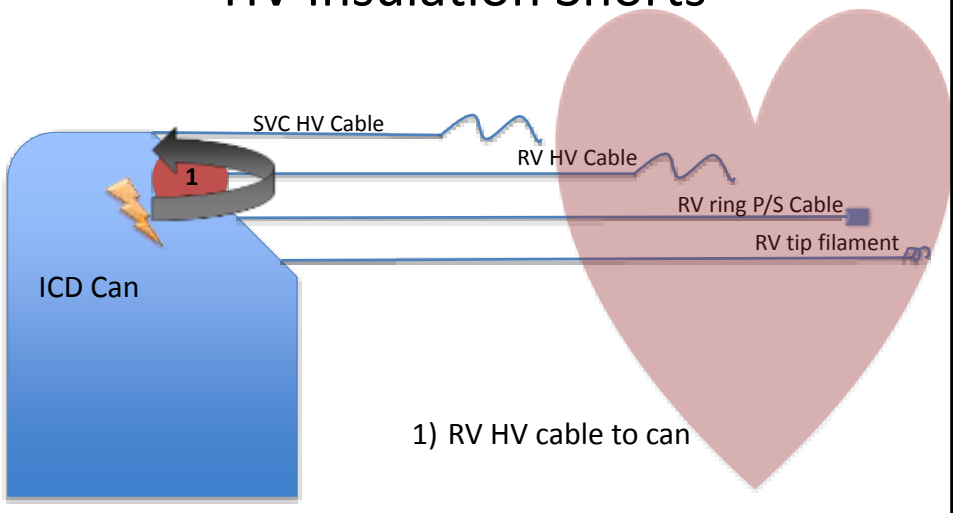
- Cable fracture, Set screw issue
  - Fidelis
- Current delivery attenuated to affected limb of circuit
  - RV coil ➔ likely ineffective shock
  - SVC coil ➔ likely effective shock *unless high DFT*
- Device will be unharmed and report out a high impedance alert

Response to Failed Shock

Insulator Failure – Low impedance

- **Abrasion**: *can/coil , coil/coil*, **Header short**
  - Riata, PRIZM 2 DR
- HV Current ➔pulse generator as a short
  - **Older devices**: current shunted from heart , electrical overstress may damage PG
  - **Newer devices**: current shunted, PG protected.
- If PG is still intact, low Ω alert issued.
- St. Jude *Dynamic Tx*
  - Reconfigures shock to remove SVC coil or can from circuit if breach detected.

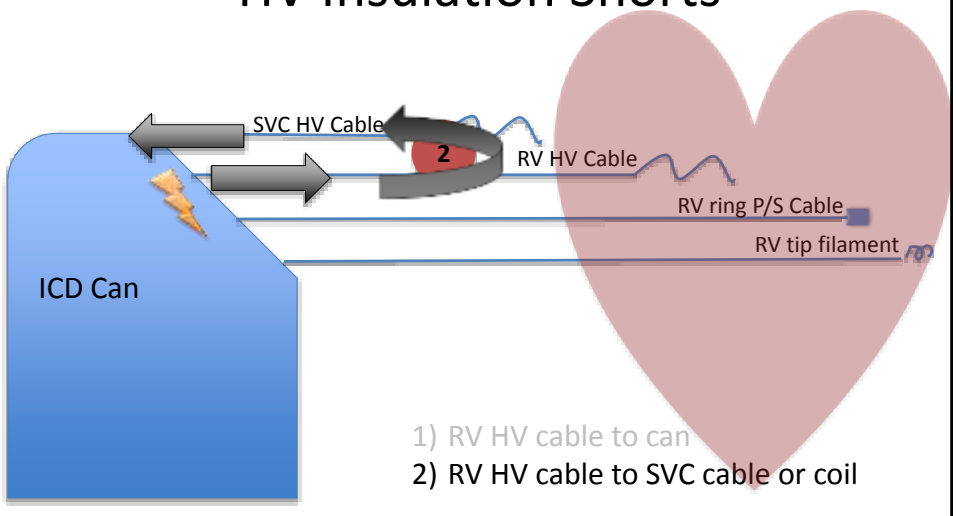
HV Insulation Shorts



1) RV HV cable to can

Programming the can out of the system may mitigate (if dual coil lead)

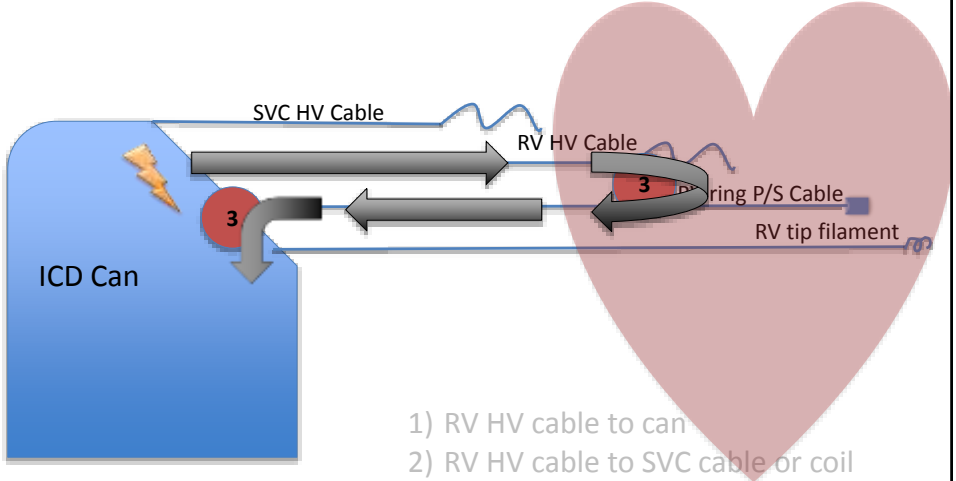
HV Insulation Shorts



1) RV HV cable to can
2) RV HV cable to SVC cable or coil

Programming SVC Coil out of system may mitigate failure

HV Insulation Shorts



1) RV HV cable to can
2) RV HV cable to SVC cable or coil
3) RV Ring P/S cable to RV HV cable and RV ring to can

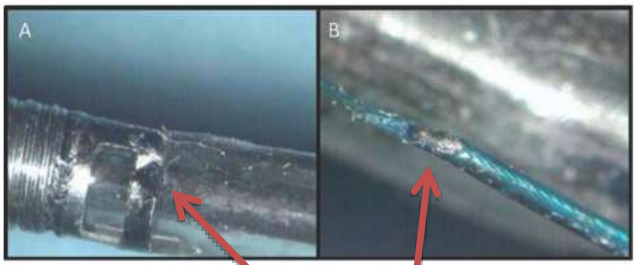
Other variations of #3 exist with alternative return circuit

Is High-Voltage Lead Integrity Measurement Adequate During Defibrillator Generator Replacement?

[1,2,3]RAHUL DOSHI, MD, FHRS, [1]STEVEN CEBALLOS, CVT and [1]FAUSTO MENDEZ, CVT

The Journal of Innovations in Cardiac Rhythm Management, 3 (2012), 1016–1019

[1]St. Jude Medical Center, Fullerton, CA
[2]University of California, Irvine, CA
[3]Fullerton Cardiovascular Medical Group, Fullerton, CA



Short evident between SVC coil and RV shock cable

Medtronic

Shock Lead Impedance Testing

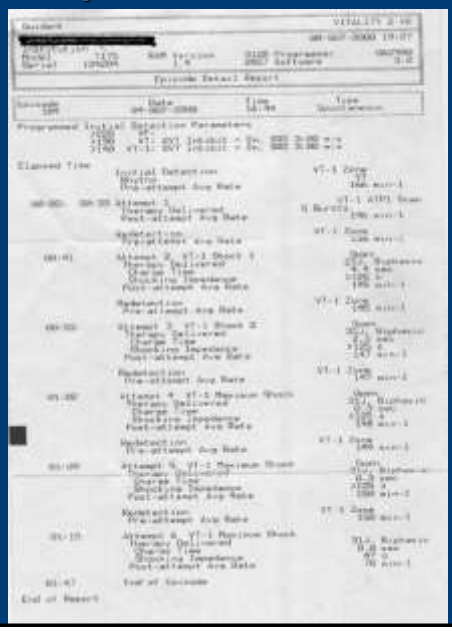
- Pulse delivered daily (up to 4 attempts)
  - 400 mV for 90 msec
- Two vectors reported
  - HV Impedance = RV coil to SVC coil+Can
  - SVC Impedance = RV coil to SVC coil
- Alarm for Impedance < 20Ω, > 200Ω (programmable)
- Triggers clinician and patient alert (not LIA)

ST. JUDE MEDICAL

Shock Lead Impedance Testing

- Atlas/Epic have no daily measurements
- Physician generated HVLI test (12v)
- Later Generations HV pulse delivered daily
  - All vectors (RV and SVC to can) –
- Alert impedances are programmable

Episode Details



High Shocking Impedance

Evidence Base for Shock Lead Integrity Testing

Subthreshold Test Pulses Versus Low Energy Shock Delivery to Estimate High Energy Lead Impedance in Implanted Cardioverter Defibrillator Patients

DIRK VOLLMANN[1], LARS LUETHJE[1], DIETER ZENKER[2], SEBASTIAN DOMHOF [3] and CHRISTINA UNTERBERG[1]

Article first published online: 28 MAR 2003
DOI: 10.1046/j.1460-9592.2003.00071.x

Pacing and Clinical Electrophysiology
Volume 26, Issue 1p2, pages 457–460, January 2003

Validation of newly developed HV testing technique
29 pts with Guidant PRIZM ICDs at implant
All pts got 0.4 µ J pulse, 1.1 J, and 16-45 J shocks
Impedances measured for all pulse strenths
Low energy pulses correlated with high energy shocks

Evidence Base for Shock Lead Integrity Testing

"**Partial insulation defects may not be identified** by low-energy pulses that deliver insufficient current to activate the shorted high-output protection feature."

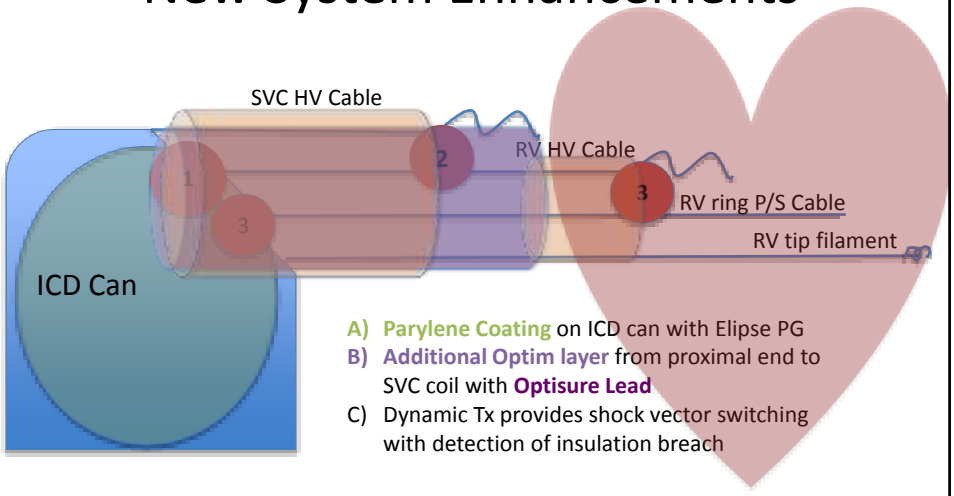
Swerdlow/Friedman Pacing Clin Electrophysiol. 2006;29(1):70-96.

When Failure means life

Airbag Reliability

- 100 drivers
  - 10 get in accident
    - 9 effective airbag deployment
    - 1 driver dies with ineffective airbag
- What is the airbag failure rate?
  - 1% or 10%?

New System Enhancements

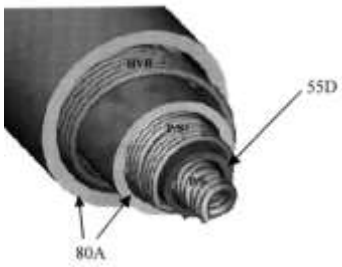


A) **Parylene Coating** on ICD can with Elipse PG
B) **Additional Optim layer** from proximal end to SVC coil with **Optisure Lead**
C) Dynamic Tx provides shock vector switching with detection of insulation breach

HV Component Failure by Lead Model

- Evolution to cable design associated with improved lead performance

Medtronic Transvene



Ellenbogen et al. JACC Jan 1, 2003

www.bostonscientific.com

Follow Up Considerations - Summary

- Programming
  - Set an unused EGM channel to RV Coil to SVC Coil (not a nominal setting) to monitor for noise
  - Turn on EGM for Noise Reversion (nominally off)
  - Options to set HVLI alert to tighter range (15 ohms outside established range)
  - Increase the number of VF intervals and VF Detection Rate based on the specific patient
- Diagnostic inspection
  - Look for counts in high rate bins (>240 bpm)
  - Check presenting rhythm / EGMs for noise or deviations on vectors that include RV Coil, SVC Coil, RV Ring
  - Check HVLI on all vectors for variation of > 25% since last follow-up
  - Examine real time electrogram on pacing and shocking components

ST. JUDE MEDICAL

St. Jude Medical. Riata Lead Summit 1/12

High Voltage ICD Lead Failure Summary

- Underappreciated and potentially fatal
- Can present with no change in painless HV impedance or any other parameters measured in ICD follow up
- Presentation varied and at times very complex
- Existing means of detection are inadequate
- **Do we need to change our follow up strategies?**