Riata Lead Summit
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SJM Perspective

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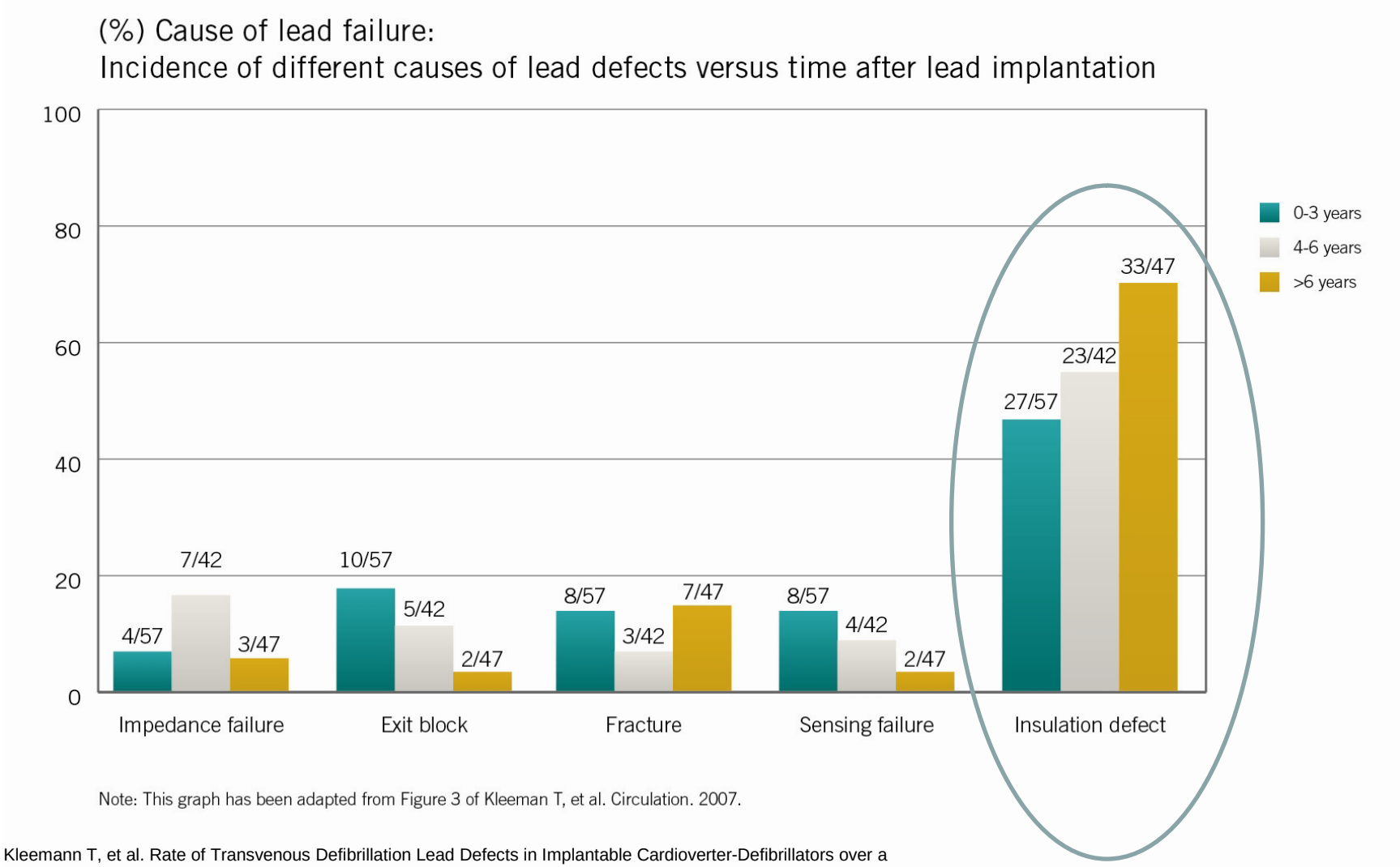
Presentation Outline

- Background, Characterization of Externalized Conductors
- Modeling and Testing
- Diagnostics and Therapeutics
- Recommendations
- SJM Prospective Study
- Optim Leads

Insulation Failure
Most Common Industry-Wide Lead Failure



Kleemann T, et al. Rate of Transvenous Defibrillation Lead Defects in Implantable Cardioverter-Defibrillators over a Period > 10 years. *Circulation. 2007;115:2474-2480.*

Timeline

- June 2001: Riata® Silicone leads approved
- Dec 2010: SJM communicated to physicians on Riata Silicone lead performance and completed phase-out
  - Reviewed by FDA and not considered a recall
- 2011: Acquired and analyzed additional data, meetings with MAB and clinicians, and designed clinical trial
- Nov 2011: SJM issued a physician advisory on Riata Silicone leads
  - Approximately 79,000 remaining in US
- Dec 2011: SJM News Release, FDA classifies as Class I Recall
- Dec 21st, 2011: HRS Webinar

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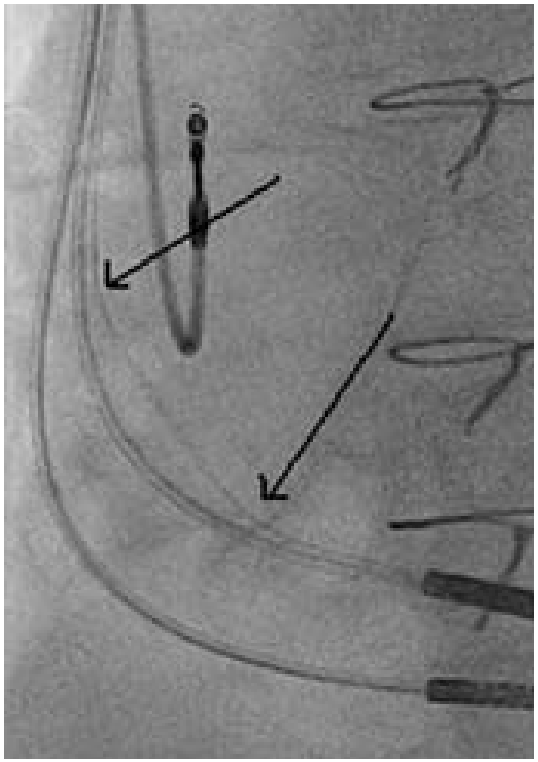
What are externalized conductors?

Definition:

The appearance by x-ray or fluoroscopy of conductors outside of the lead body due to an abrasion-related breach of the outer insulation



Clinical Presentation: Visual vs. Electrical

- Most externalized conductors present as an observation on X-ray or fluoroscopy without functional abnormalities
- Over 85% of externalized conductors in returned leads functioned normally due to their ETFE insulation
- There have been no reports of failure to pace or deliver a shock that have been attributable to the presence of an externalized conductor

Locations: 91% of all Externalized Conductors are between RV and SVC shock coils.

SJM ICD Lead Insulation Abrasion

Complaints Plus Returns Analysis Data

	Dec 2010 Communication (Data through October 2010)		Nov 2011 Communication (Data through Sep 2011)	
SJM Lead Family	**All Cause Abrasion**	**Externalized Conductors**	**All Cause Abrasion**	**Externalized Conductors**
Riata & Riata ST	0.47%	0.047%	0.63%	0.10%
Riata ST Optim & Durata	0.03%*	0.0%	0.04%	0.0%

**Data not provided in communication*

Externalized Conductors: 8F vs. 7F Silicone leads

	Shock Coil Configuration	Incidence Rate	Remaining Population
Riata 8F	Dual Coil	0.096%	48,000
	Single Coil	0.64%	2,000
Riata 7F	Dual Coil	0.024%	27,000
	Single Coil	0.081%	2,000

US data, leads from product returns and complaints (does not include visual observations of normally functioning leads, not reported as complaints).

- Riata 8F Silicone leads have a significantly higher rate of externalized conductors than Riata 7F Silicone leads (p=0.006)
- Riata 8F Single Coil leads have a significantly higher rate of externalized conductors than all other Riata Silicone lead models combined (p<0.001)

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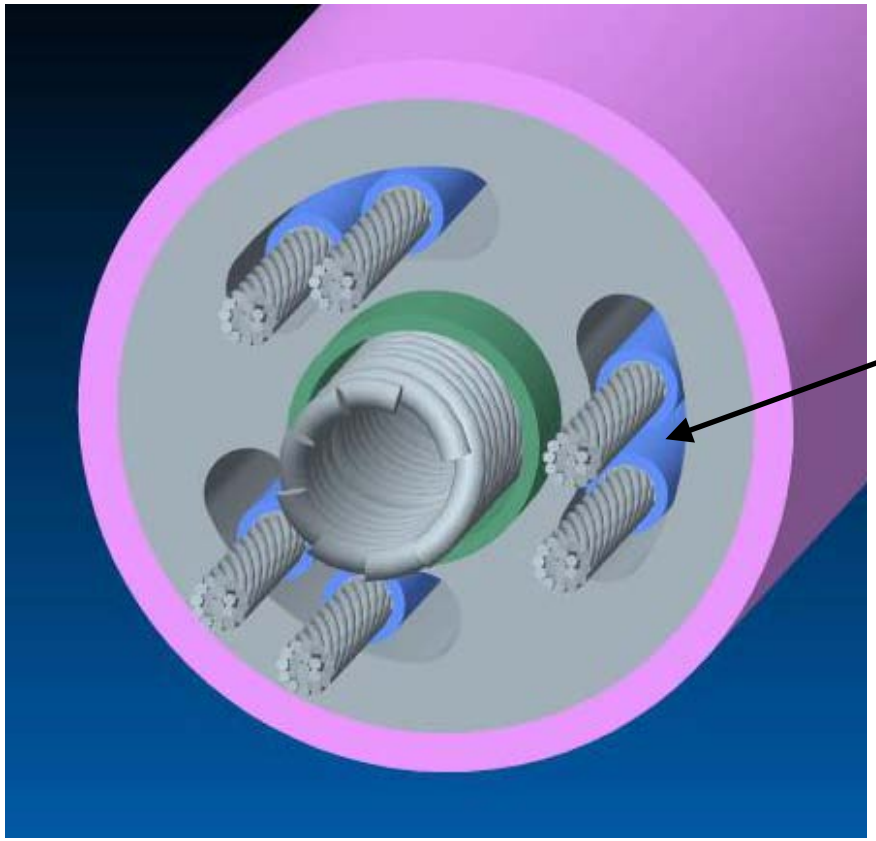
Modeling & Testing

ETFE Conductor Cable Insulation

- Ethylenetetrafluoroethylene (ETFE) insulation is a polymer coating applied to the outer surface of defibrillation lead conductor cables across industry.



Can a lead with externalized conductors and intact ETFE coating function normally?

ETFE coated conductors, without Silicone insulation were subjected to industry standard verification and validations tests for leads.

- Wet Hypot Test – 5000V at 10 seconds in saline with and without 10 day saline soak (over 5X voltage severity than shocking); All have passed
- Cyclic Wet Hypot Test – 500 pulses at 1500V in saline soak with and without 10 day saline soak; All have passed

Can a lead with externalized conductors and breached ETFE coating sense, pace and provide high voltage therapy effectively?

Externalized Conductors with ETFE breaches (including sizes beyond what we have observed clinically – pin holes to 2 cm; 2X worst observed) were subjected to:

- Acute studies:
  - No effect on sensing.
  - No effect on delivered energy with multiple shocks.
  - No changes in capture thresholds and pacing impedance.
- Bench Testing: Saline Tank set up - Shocking at 40J (100 times), pacing at 2V, with pre-soaked cables; no changes in impedance or delivered energy.

Can ETFE withstand continuous flexing during exposure to body fluids and abrasion against other cardiac structures?

- ETFE coated cables were subjected to Wet Hypot test after completing 400 million cycles in flex tester (FDA validated development test to simulate cardiac flexing for 10 years)
  - All samples passed
- ETFE coated cables are undergoing 60 day soak in oxidative solution at elevated temperatures (ISO test)
  - Interim results at 20 days: All passed Wet Hypot test
- Externalized Riata cables have equivalent or higher time to failure on typical abrasion test relative to typical Brady leads with Silicone insulation on coil conductors
- Cables alone are 40 times more flexible than Riata and are more flexible than pacing leads on the market

Modeling and Testing – Key Takeaways

- ETFE coating on cables provides adequate dielectric strength for the lead to continue to function normally without the Silicone covering
- In studies and bench tests, externalized cables with compromised ETFE continued to pace, sense and shock effectively, even after multiple shocks
- ETFE coating is extremely resilient to cardiac motion, as confirmed by standardized 10 year simulated tests, and have strong abrasion resistance.
- ETFE coated cables are significantly more flexible than leads.
- ETFE coated cables have undergone the full suite of biocompatibility tests as is typical for other blood tissue contacting materials
- No insulation material is impervious. Scenarios where breached cables contact other surfaces have increased likelihood of an electrical anomaly

Data from Returns and Complaints in Leads with Externalized Conductors

- Electrical abnormalities from any cause were observed in 171 leads with externalized conductors*:
  - Noise and /or oversensing not resulting in inappropriate therapy (~38%)
  - Impedance Changes - pacing or defibrillation (~35%)
  - Inappropriate therapy (~33%)
  - Pacing threshold rise (~9%)
  - Failure to deliver HV therapy (~6%)
- Of 146 leads returned for analysis:
  - In 79% the ETFE was intact on the externalized conductors
  - The remaining 21% had breached ETFE:
    - Were equally distributed between RV coil and ring electrode conductors
    - 6% had no electrical abnormalities
    - 12% had electrical abnormalities where other failure modes were also observed along with externalized conductors
    - 3% (6) had electrical abnormalities where the externalized conductor was the only failure mode
- Therefore, over 85% of returned leads did not have electrical abnormalities as a result of externalized conductors
- There have been no reports of failure to pace or deliver a shock that have been attributable to the presence of an externalized conductor

*Some leads exhibited more than one electrical abnormality

Diagnostics and Therapeutics

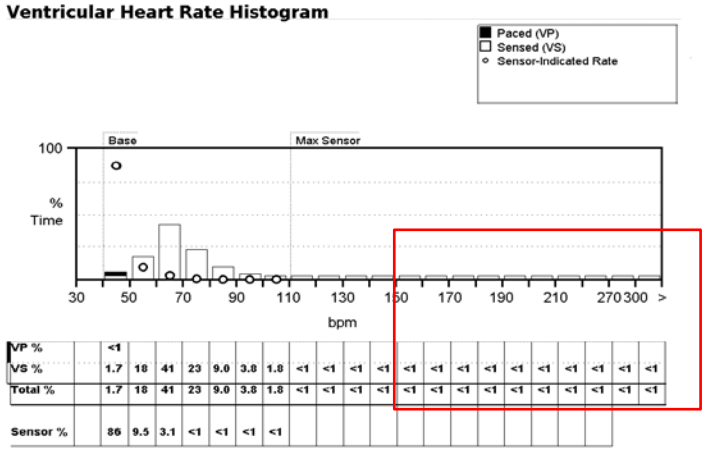
What does SJM offer in newer devices to detect each of these potential electrical anomalies automatically?

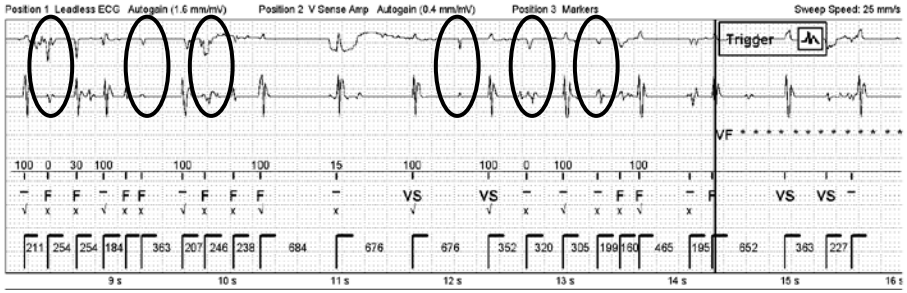
- Stored EGMS's for Noise / Oversensing, Noise Reversion Algorithm, and Ventricular Heart Rate Histogram detecting non-physiologic rates
  - Noise and /or oversensing ceasing prior to inappropriate therapy accounted for ~38% of electrical observations
- Automatic daily lead impedance trends for both pacing and defib with programmable thresholds and alerts to physicians and patients
  - Impedance changes accounted for ~35% of electrical observations
- Programming flexibility to avoid inappropriate therapy
  - Inappropriate therapy accounted for ~33% of electrical observations
- Pacing Capture Trends
  - Pacing threshold rise accounted for ~9% of electrical observations

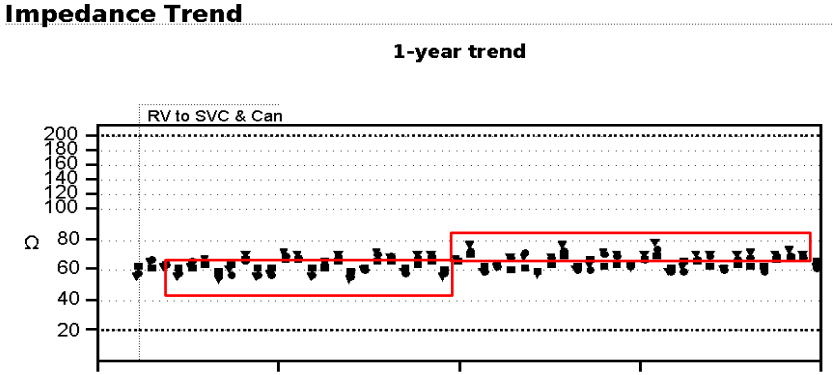
All detection methods can be viewed via Merlin.Net patient monitoring quickly and at a greater frequency than typical in clinic follow up

Clinical Presentation of Riata Lead Issues

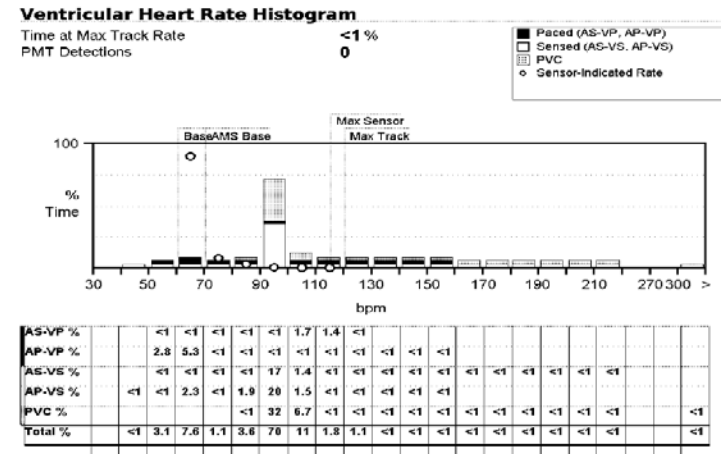
Externalized cable with a Lead to Can abrasion

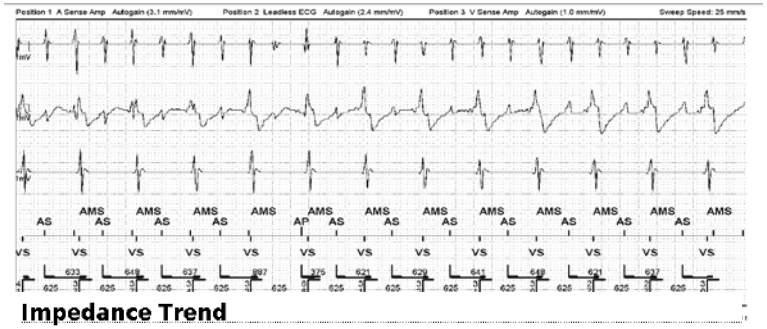


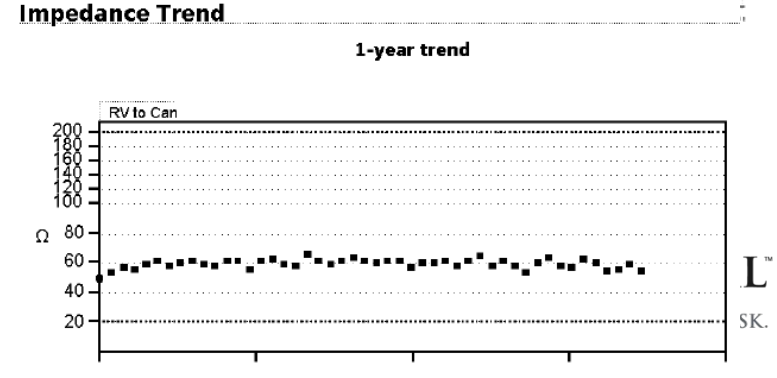




Externalized cable with no electrical anomaly

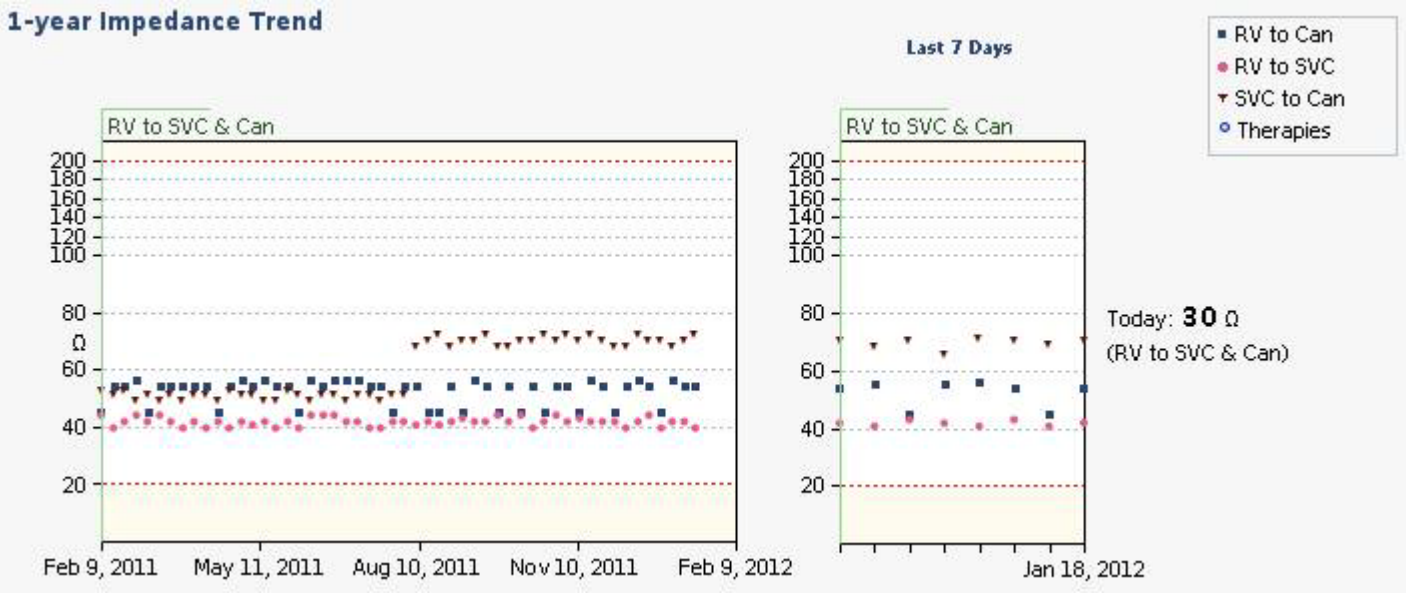






Features To Detect Pacing/High Voltage Lead Impedance (PLI/HVLI) Changes

- PLI/HVLI constantly monitored and can trigger alert through Merlin.net® PCN
- St. Jude Medical devices measure impedance for all high voltage vectors independently in addition to providing system impedance
  - RV→can, SVC→can and RV→SVC
- System Impedance alone can be misleading
- Capability to program SVC coil off
- Upper and lower limits can be programmed* to detect smaller variations



HVLI: Adjustable upper (40-125 Ω) and lower (20-80 Ω) limits
PLI: Adjustable upper (750-3,000 Ω) and lower (100-500 Ω) limits

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

Device-Based Features Available to Assess Device/Lead Functionality by Family

Device Family	Out-of-Clinic HV Lead Impedance	In-Clinic HV Lead Impedance	Post-Shock (In- or Out-of-Clinic) HV Lead Impedance	Out-of-Clinic Pacing Lead Impedance	Pacing Capture Trends	Vibratory Patient Notifier
Fortify/ Unify	Yes	Yes	Yes	Yes (Daily)	Yes	Yes (HV & LV)
Current/ Promote	Yes	Yes	Yes	Yes (Daily)	Accel Family only	Yes (HV & LV)
Epic II/ Atlas II	No	Yes	Yes	Yes (Daily)	No	Yes (LV)
Epic/Atlas	No	Yes	Yes	Yes (Monthly)	No	No

Device Comparison -

	SJM (Fortify/Unify)	MDT (Protecta)	BSX (Cognis/Teligen)
Impedance	Daily PLI and HVLI	Daily PLI and HVLI	Daily PLI and HVLI
PLI	Daily Measurements with Programmable Alerts	Daily Measurements with Programmable Alerts	Daily Measurements with Programmable Alerts
HVLI	Daily measurements of all independent HV vectors including RVC, SVC, and Can with programmable alerts	Daily Measurements of System Impedance with programmable alerts	Daily Measurements of System Impedance with programmable alerts
EGM Storage	45 min	28.5 min	17 min
Noise/Oversensing	Noise Reversion	RV Lead Noise Discrimination, LIA	Noise Response
Pacing Thresholds	Daily	Daily	Not Available
Diagnostics	Heart Rate Histogram	Rate Histogram Report	Heart Rate Histogram
Patient Alerting	Vibratory	Auditory	Auditory
Patient Monitoring	Remote Monitoring with Programmable Alerts	Remote Monitoring with Programmable Alerts	Remote Monitoring with Programmable Alerts

Recommendations

Riata Silicone Lead Patient Management Recommendations

- St. Jude Medical MAB
  - Normal follow up as per HRS/EHRA consensus
  - Remote monitoring strongly encouraged
  - No prophylactic screening x-ray or fluoroscopy
  - No explantation of normally functioning leads with or without externalized conductors
  - No expert consensus regarding fluoroscopy at the time of pulse generator replacement
- HRS Webinar (Dec 21, 2011) participants recommendations were similar

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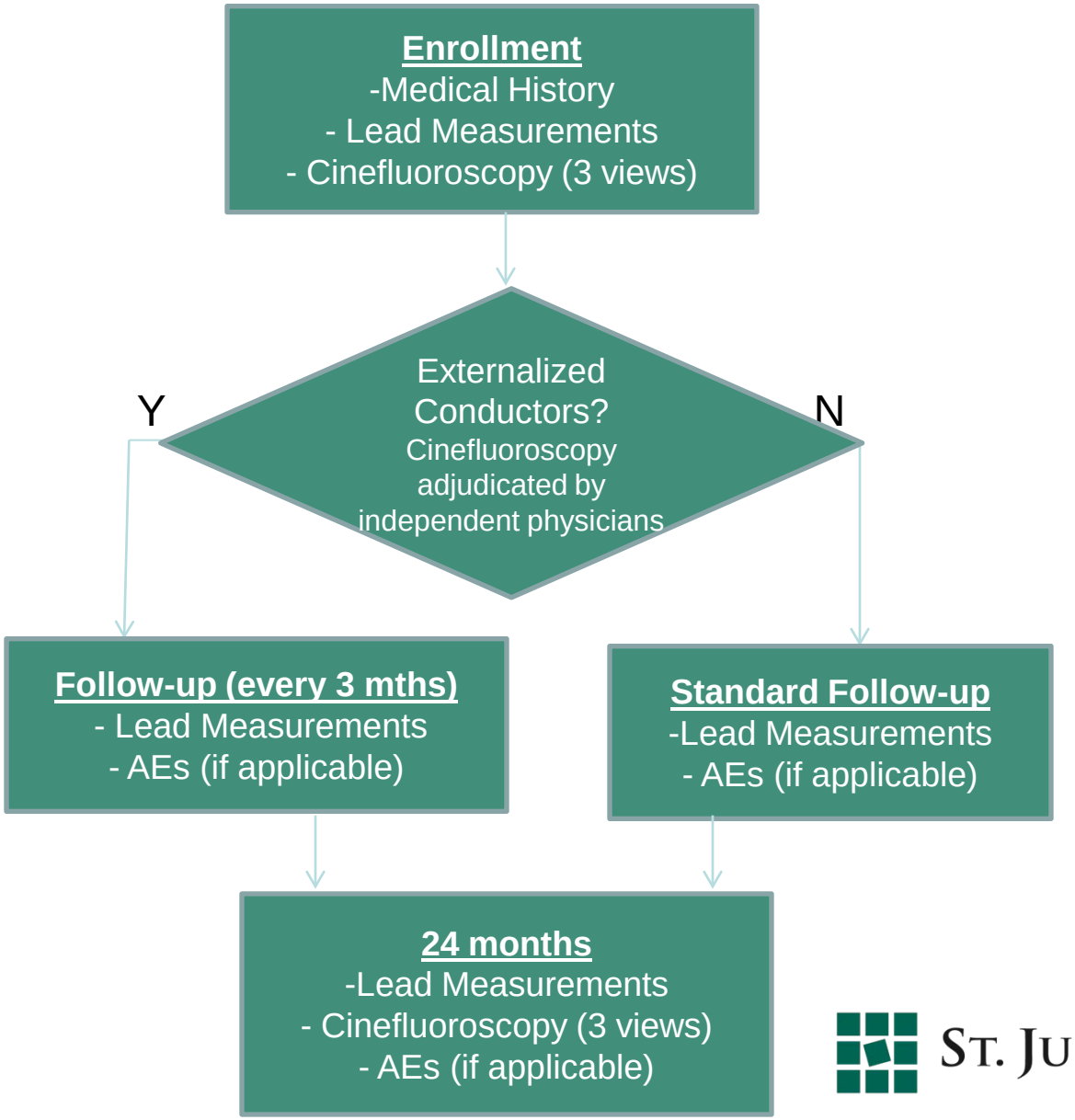
Prospective Multi Center Riata Study

Riata Lead Evaluation Study

- Prospective, Multicenter Study
- N >500 patients
- Over 15 centers (USA, Canada & Japan)
- Objectives:
  - To determine the rate of externalized conductors in the Riata®/ Riata® ST silicone endocardial leads
  - To determine the survival from electrical malfunction in patients with leads that have externalized conductors

Study Design



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Optim Leads

Optim® Insulated Leads: Riata ST Optim and Durata

- Optim material development began in the 1990's
- July 2006: Optim 7F Defibrillation Leads approved
- ~280,000 Optim defibrillation leads implanted (~250,000 Durata leads)
- Over 5 years of clinical experience
  - Although external abrasions have occurred rarely, externalized conductors have not occurred

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Significant Design Improvements from Riata silicone to Optim insulated leads

Riata® (8F)
Riata ST (7F)

Silicone Insulation

Design changes that most impact abrasion and externalized conductors

- Conductor cables closer to center of lead body reducing tension on conductor cables
- 50% increase in overall wall thickness
- Optim insulation added to silicone – 50X more abrasion resistant
- Flat wire shock coils with Silicone backfill to mitigate internal abrasion

Durata®

Optim Insulation

Improved Abrasion Resistance & Protection Against Externalized Conductors

All Cause Abrasion:
0.63%

Externalized Conductors:
0.10%

All Cause Abrasion:
0.04%

Externalized Conductors:
0.00%

Rates reflect all reported or confirmed cases

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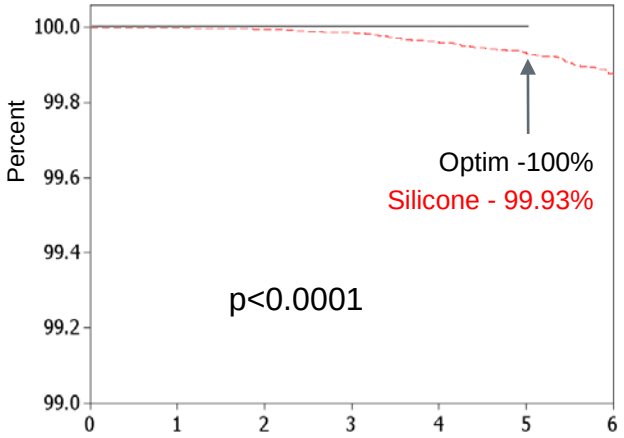
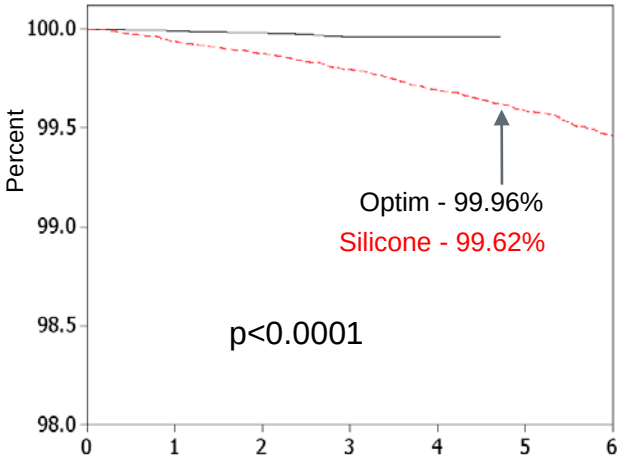
Performance Improvements Due To Optim® Insulation and Design Changes in Riata ST Optim and Durata

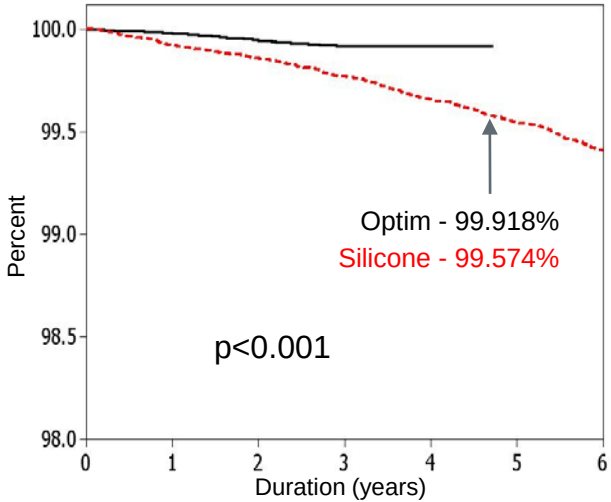
Freedom from Externalized Conductors:
Optim insulation: No Reports of Externalized Conductors



Freedom from All-Cause Abrasion:
Optim insulation: Significant Reduction in All-Cause Abrasions



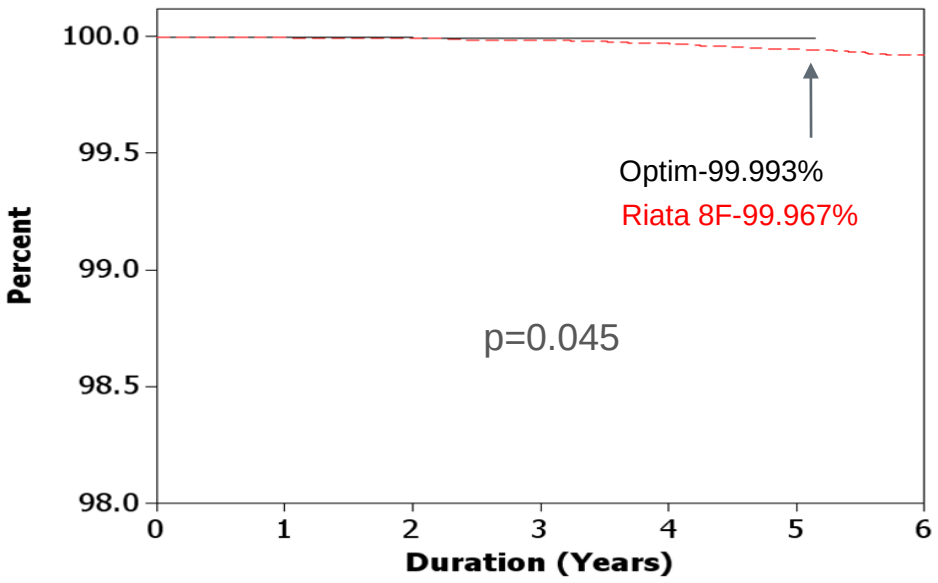
Freedom from All-Cause Mechanical Failures:
Optim insulation: Significantly Higher Overall Lead Survival Rate



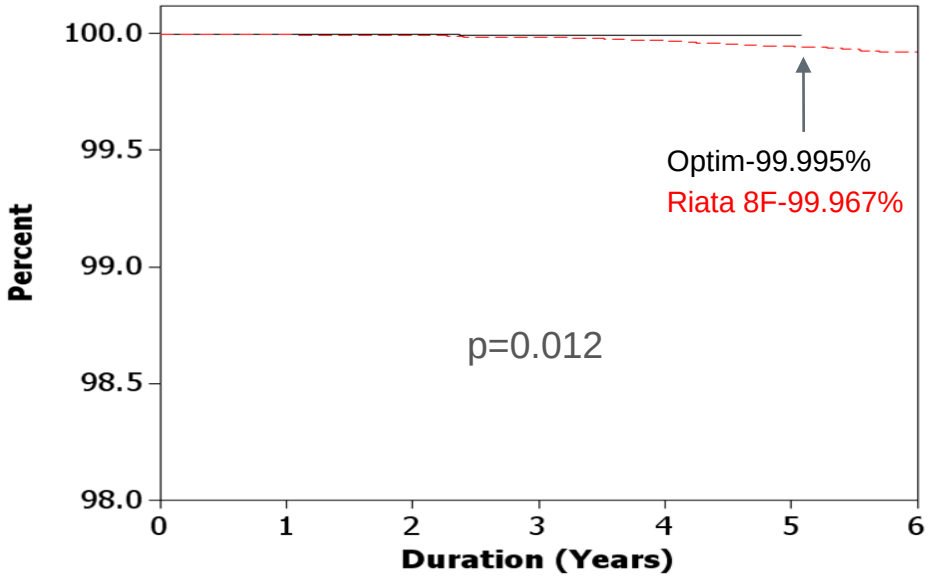
Data from Returns and Complaints

Rates of Internal Shorts and Internal Shorts Under Shock Coil

All-Cause Internal Shorts



Internal Shorts Under the Shock Coil



		All-Cause Internal Shorts		Internal Shorts Under Shock Coil	
Family	**Worldwide Sales**	**Qty**	**Rate**	**Qty**	**Rate**
Riata 8F	156,338	103	0.066%	87	0.056%
Optim (Riata ST Optim, Durata)	281,337	10	0.004%	4	0.001%

Proven Performance of Riata ST Optim and Durata 7F Optim Leads in SJM Registries

- OPTIMUM Registry (Aug 2006 -)
  - Prospective, multi-center, active follow-up registry
  - A total of 21,357 Optim leads were implanted in 14,014 pts at 224 sites
  - The all-cause abrasion free survival rate of high voltage Optim insulated leads was 99.97% in 5996 Durata and Riata ST Optim leads during 62 months of follow-up
  - **No cases of externalized conductors**
- SCORE Registry (Sep 2007 -)
  - No insulation failures in 3,143 Durata and Riata ST Optim leads with over 30 months of follow-up
  - **No cases of externalized conductors**
- SJ4 Post Approval Study (June 2009 -)
  - Prospective, multicenter study at 58 sites
  - No insulation failures in 1697 Durata DF4 leads with 2 years of follow-up
  - **No cases of externalized conductors**

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Combined Prospective, Active Registry Data: Riata ST Optim and Durata

- Large patient cohort representing true commercial experience
  - 10,836 patients
  - 292 clinical sites
  - 571 implanters
- Follow-up to date over 5 years with over 24,000 patient-years

OPTIMUM, SCORE, and SJ4 PAS Registries	All Optim ICD Leads Incidence (%)
Externalized Conductors	0.00%
All Cause Insulation Abrasion	0.02%
All Cause Mechanical Failure	0.09%

Optim ICD Lead Data Evaluation

- Independent third party evaluation:
  - Population Health Research Institute, McMasters University, Hamilton, Ontario
  - Committee Chair: Professor John Cairns MD, University of British Columbia
- Riata ST Optim/ Durata data
  - Optimum registry, Score registry and SJ4 PAS
- To assess freedom from
  - Externalized cables
  - All-cause insulation abrasion
  - Mechanical failures
- To assess future performance

Summary

- St. Jude communicated in Dec 2010 and Nov 2011 that Optim abrasion resistance was superior to silicone
- ETFE has been intact on 79% of returned leads with externalized conductors and over 85% of returned leads did not have electrical abnormalities as a result of externalized conductors
- There have been no reports of failure to pace or deliver a shock that have been attributable to the presence of an externalized conductor
- Bench Tests demonstrate that externalized conductors can deliver pacing and defibrillation therapy even when ETFE has been breached
- MAB and HRS panel encouraged remote monitoring, did not recommend prophylactic x-ray screening or removal of leads without electrical abnormalities, recognized the need for individualized patient management, and the need for more data

Summary (cont.)

- St. Jude Medical is conducting a prospective clinical trial to identify the rate of externalized conductors and the survival from malfunction of leads with externalized conductors
- Data from 10,836 Riata ST Optim and Durata leads in prospective, active registries (OPTIMUM, SCORE, and the SJ4 PAS) demonstrate very low rates of abrasion, all-cause mechanical failure and no externalized conductors
- St. Jude Medical is engaging an independent third party (PHRI at McMasters University) to evaluate the current and future performance of Optim-insulated leads
- Following today's meeting, this presentation can be viewed at: www.riatacommunication.com