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

(%) Cause of lead failure:
Incidence of different causes of lead defects versus time after lead implantation

Note: This graph has been adapted from Figure 3 of Kleemann T, et al. Circulation. 2007.

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
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

<table>
<thead>
<tr>
<th>SJM Lead Family</th>
<th>Dec 2010 Communication</th>
<th>Nov 2011 Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Data through October 2010)</td>
<td>(Data through Sep 2011)</td>
</tr>
<tr>
<td>SJM Lead Family</td>
<td>All Cause Abrasion</td>
<td>All Cause Abrasion</td>
</tr>
<tr>
<td></td>
<td>Externalized Conductors</td>
<td>Externalized Conductors</td>
</tr>
<tr>
<td>Riata &amp; Riata ST</td>
<td>0.47%</td>
<td>0.63%</td>
</tr>
<tr>
<td></td>
<td>0.047%</td>
<td>0.10%</td>
</tr>
<tr>
<td>Riata ST Optim &amp; Durata</td>
<td>0.03%*</td>
<td>0.04%</td>
</tr>
<tr>
<td></td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

*Data not provided in communication*
## Externalized Conductors: 8F vs. 7F Silicone leads

<table>
<thead>
<tr>
<th>Shock Coil Configuration</th>
<th>Incidence Rate</th>
<th>Remaining Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riata 8F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Coil</td>
<td>0.096%</td>
<td>48,000</td>
</tr>
<tr>
<td>Single Coil</td>
<td>0.64%</td>
<td>2,000</td>
</tr>
<tr>
<td>Riata 7F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Coil</td>
<td>0.024%</td>
<td>27,000</td>
</tr>
<tr>
<td>Single Coil</td>
<td>0.081%</td>
<td>2,000</td>
</tr>
</tbody>
</table>

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)
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

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St. Jude Medical™
More control. Less risk.
Device-Based Features Available to Assess Device/Lead Functionality by Family

<table>
<thead>
<tr>
<th>Device Family</th>
<th>Out-of-Clinic HV Lead Impedance</th>
<th>In-Clinic HV Lead Impedance</th>
<th>Post-Shock (In- or Out-of-Clinic) HV Lead Impedance</th>
<th>Out-of-Clinic Pacing Lead Impedance</th>
<th>Pacing Capture Trends</th>
<th>Vibratory Patient Notifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fortify/Unify</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (Daily)</td>
<td>Yes</td>
<td>Yes (HV &amp; LV)</td>
</tr>
<tr>
<td>Current/Promote</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (Daily)</td>
<td>Accel Family only</td>
<td>Yes (HV &amp; LV)</td>
</tr>
<tr>
<td>Epic II/Atlas II</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (Daily)</td>
<td>No</td>
<td>Yes (LV)</td>
</tr>
<tr>
<td>Epic/Atlas</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (Monthly)</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
## Device Comparison -

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

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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
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

**Enrollment**
- Medical History
- Lead Measurements
- Cinefluoroscopy (3 views)

**Externalized Conductors?**
Cinefluoroscopy adjudicated by independent physicians

**Follow-up (every 3 mths)**
- Lead Measurements
- AEs (if applicable)

**Standard Follow-up**
- Lead Measurements
- AEs (if applicable)

**24 months**
- Lead Measurements
- Cinefluoroscopy (3 views)
- AEs (if applicable)
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
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%
- 0.04%
Externalized Conductors:
- 0.10%
- 0.00%

Rates reflect all reported or confirmed cases

St. Jude Medical  
More control. Less risk.
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

- Riata 8F: 99.967%
- Optim: 99.993%
- p = 0.045

Internal Shorts Under the Shock Coil

- Riata 8F: 99.967%
- Optim: 99.995%
- p = 0.012

<table>
<thead>
<tr>
<th>Family</th>
<th>Worldwide Sales</th>
<th>All-Cause Internal Shorts</th>
<th>Internal Shorts Under Shock Coil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riata 8F</td>
<td>156,338</td>
<td>Qty: 103, Rate: 0.066%</td>
<td>Qty: 87, Rate: 0.056%</td>
</tr>
<tr>
<td>Optim (Riata ST Optim, Durata)</td>
<td>281,337</td>
<td>Qty: 10, Rate: 0.004%</td>
<td>Qty: 4, Rate: 0.001%</td>
</tr>
</tbody>
</table>

The diagrams show the percentage of all-cause internal shorts and internal shorts under the shock coil over a duration of 6 years. The p-values indicate statistical significance between the two groups.
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
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

<table>
<thead>
<tr>
<th>OPTIMUM, SCORE, and SJ4 PAS Registries</th>
<th>All Optim ICD Leads Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Externalized Conductors</td>
<td>0.00%</td>
</tr>
<tr>
<td>All Cause Insulation Abrasion</td>
<td>0.02%</td>
</tr>
<tr>
<td>All Cause Mechanical Failure</td>
<td>0.09%</td>
</tr>
</tbody>
</table>
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