Insertable/Implantable cardiac monitor
(Reveal LINQ ICM system)
TRURHYTHM™ DETECTION INSIDE
ACCURACY EVOLUTION

Reveal™ XT
With FullView™ Software

NEW Pause algorithm
with diminishing R-wave analysis

NEW AF algorithm
and improved noise discrimination

AF
Industry’s first AF detection algorithm

Reveal LINQ™

NEW simplified insertion and
tight pocket for better signal quality

AF
NEW AF algorithm
identifies p-waves for greater accuracy

Streamlined episode review
for clinic efficiency

NEW algorithms with
- Smart filtering
- Self-learning intelligence

2007
2011
2014
2017
M/73, Referred for abnormal ECG
Burned-out phase of apical hypertrophic cardiomyopathy
## Ventricular Ectopy

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total VE Beats</td>
<td>1055 (1.2%)</td>
</tr>
<tr>
<td>Vent Runs</td>
<td>0</td>
</tr>
<tr>
<td>Beats</td>
<td>0</td>
</tr>
<tr>
<td>Longest</td>
<td>0</td>
</tr>
<tr>
<td>Fastest</td>
<td>0 BPM</td>
</tr>
<tr>
<td>Triplets</td>
<td>1 Event</td>
</tr>
<tr>
<td>Couplets</td>
<td>10 Events</td>
</tr>
<tr>
<td>Single/Interp PVC</td>
<td>473/537</td>
</tr>
<tr>
<td>R on T</td>
<td>2</td>
</tr>
<tr>
<td>Single/Late VE's</td>
<td>20/0</td>
</tr>
<tr>
<td>Bi/Trigeminy</td>
<td>0/0 Beats</td>
</tr>
</tbody>
</table>
Admitted for syncope

환자: 아침식사 후 의자에 앉아서 식구들과 대화를 하다가 갑자기 1분 정도 의식을 잃었다. 대변을 했다.
이식형 사건기록기 급여기준

1. 재발성 실신. 구조적 심장질환을 가진 환자의 경우에는 실신이 1회 발생한 경우에도 인정.

2. 재발성 두근거림(palpitations)

3. 심방세동이 의심되는 원인불명의 재발성 뇌졸중

고시 제2016-118호, `16.7.1. 시행
Reveal LINQ™ ICM system

- Longevity: 3 years
- ECG data storage: 59 min (automatic: 27 min, patient: 30 min)
- MR conditional at 1.5 & 3.0T
- Minimally invasive simple procedure
Best location:
45 degrees to sternum over 4th intercostal space, 2 cm from left edge of sternum.

97% of physicians found the insertion tool simple and intuitive.\(^6\)

Requires minimal procedure time and clinical resources.
Implantable cardiac monitor
(Reveal LINQ™, Medtronic)

R wave amplitude ≥ 0.5 mV
Readmitted for aborted SCD
# Episode List

**Device:** REVEAL LINQ LNQ11  
**Serial Number:** RLA933226S  
**Date of Visit:** 05-Jan-2017 08:39:54  
**Patient:** YUN  
**ID:**  
**Physician:** Prof. PARK J S

**Arrhythmia Episode List:** 28-Dec-2016 13:59:16 to 05-Jan-2017 08:39:54

All collected episodes.

<table>
<thead>
<tr>
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<th>Type</th>
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<td>07:20</td>
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<tr>
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</tbody>
</table>

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**Last Programmer Session:** 28-Dec-2016

**Last Medtronic CareLink Monitor Session:** 16-Dec-2016

(Data prior to last session has not been interrogated.)
Device Status (Implanted: 16-Dec-2016)

Battery Status: Good

Episodes (19)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Count</th>
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</thead>
<tbody>
<tr>
<td>Symptom</td>
<td>2</td>
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<tr>
<td>Tachy</td>
<td>9</td>
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<tr>
<td>Pause</td>
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<tr>
<td>Brady</td>
<td>8</td>
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<tr>
<td>AT/AF</td>
<td></td>
</tr>
<tr>
<td>AT</td>
<td>0</td>
</tr>
<tr>
<td>AF</td>
<td>0</td>
</tr>
<tr>
<td>% of Time AT/AF</td>
<td>0.0 %</td>
</tr>
</tbody>
</table>

Cardiac Compass Trends (Dec-2016 to Jan-2017)

OBSERVATIONS (2)
- Symptom (Patient Activated) episode #2 occurred within 20 minutes of automatic detection(s), on 01-Jan-2017.
- Device and programmer time differ more than 1 hour.
Tachy Episode #1

Device: REVEAL LINQ LNQ11
Serial Number: RLA933226S
Patient: YUN
ID: 
Date of Visit: 05-Jan-2017 08:39:54
Physician: Prof. PARK J S

Episode #1: 01-Jan-2017 17:07:25

Episode Summary

Type: Tachy
Duration: 25 min
Max V. Rate: 353 bpm (170 ms)
Median V. Rate: 231 bpm (260 ms)
Average V. Rate: 231 bpm (260 ms)
Activity Level: Inactive

Symptom (Patient Activated) occurred during episode.
Noise detected during episode.

Parameter Settings V. Interval (Rate) Duration
Tachy 380 ms (158 bpm) 16 beats

Sensing
Sensitivity: 0.035 mV (35 μV)
Blank after Sense: 150 ms
Tachy Episode #1

Device: REVEAL LINQ LNQ11
Serial Number: RLA933226S
Date of Visit: 05-Jan-2017 08:39:54

Patient: YUN
ID:
Episode #1 Chart speed: 25.0 mm/sec

ECG Reveal
(0.1 mV)

Markers

Interval (ms)

ECG suspended for 25 min

"Tachy Detected"
# Tachy Episode #1

**Device:** REVEAL LINQ LNQ11  
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**Patient:** YUN  
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**Physician:** Prof. PARK J S

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\[ Tachy = 380 \text{ ms} \]
SYMPTOM Episode #2

Device: REVEAL LINQ LNQ11
Serial Number: RLA933226S
Date of Visit: 05-Jan-2017 08:39:54

Patient: YUN
ID:
Episode #2  Chart speed: 25.0 mm/sec

ECG Reveal
(0.1 mV)

Markers

Interval (ms)

SYMPTOM
### Episode List

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Last Programmer Session 28-Dec-2016  
---

Last Medtronic CareLink Monitor Session 16-Dec-2016  
---

(Data prior to last session has not been interrogated.)
Episode #6: 02-Jan-2017 16:30:24

**Episode Summary**

Type: Brady  
Duration: 6 sec  
Min V. Rate: 66 bpm (910 ms)  
Median V. Rate: 66 bpm (910 ms)  
Average V. Rate: 33 bpm (1810 ms)  
Activity Level: Inactive

**Parameter Settings**

<table>
<thead>
<tr>
<th>Type</th>
<th>V. Interval (Rate)</th>
<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>Brady</td>
<td>1500 ms (40 bpm)</td>
<td>4 beats</td>
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</tbody>
</table>

**Sensing**

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Blank after Sense</th>
</tr>
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<tbody>
<tr>
<td>0.035 mV (35 μV)</td>
<td>150 ms</td>
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</tbody>
</table>
False positive bradycardia episode due to VPC undersensing
Inappropriate brady/pause sensing
TRURHYTHM™ INTELLIGENT DETECTION
NEW ALGORITHMS

SMART FILTERING

NEW second sensing filter analyzes rhythms for possible undersensing in Brady and Pause

SELF-LEARNING

Exclusive fifth-generation atrial fibrillation algorithm learns and adapts to patient’s rhythm over time
Reveal LINQ with TruRhythm™

<table>
<thead>
<tr>
<th></th>
<th>REDUCTION IN FALSE DETECTIONS</th>
<th>RELATIVE SENSITIVITY¹</th>
</tr>
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<tbody>
<tr>
<td>BRADY</td>
<td>↓ 95%</td>
<td>98.3%†</td>
</tr>
<tr>
<td>PAUSE</td>
<td>↓ 47%</td>
<td>99.4%†</td>
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<tr>
<td>AF</td>
<td>↓ 49%</td>
<td>99.1%†</td>
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AF episode duration sensitivity used is ≥2 mins.
TRURHYTHM™ DETECTION INSIDE
ACCURACY EVOLUTION

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With FullView™ Software

NEW Pause algorithm with diminishing R-wave analysis
NEW AF algorithm and improved noise discrimination

2007

Reveal LINQ™

NEW simplified insertion and tight pocket for better signal quality
NEW AF algorithm identifies p-waves for greater accuracy

2014

TruRhythm™ Detection

Streamlined episode review for clinic efficiency
NEW algorithms with
- Smart filtering
- Self-learning intelligence

2017

AF

Industry’s first AF detection algorithm
AF

2011
DETECTOR PRINCIPLE: LORENZ PLOT

Sarkar et al.
AF detection concept

Reveal LINQ™ ICM system

- P-sense algorithm
- Self learning intelligence (TruRhythm™)
  → AF detection threshold adjustment
Reveal LINQ with TruRhythm™

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<th>Reduction in False Detections</th>
<th>Relative Sensitivity</th>
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AF episode duration sensitivity used is ≥2 mins.
PROVEN ACCURACY
DURATION-BASED PERFORMANCE METRICS

Reveal LINQ AF monitoring
Duration-based performance metrics

98.4% SENSITIVITY
99.5% SPECIFICITY
97.2% PPV
99.7% NPV
99.4% ACCURACY

Comparison of AF burden detected by ICM and Holter

$r = 0.995$
CRYSTAL-AF study results

Hazard ratio, 8.8 (95% CI, 3.5 - 22.2)
P < 0.001 by log-rank test

Atrial Fibrillation Detected (% of patients)

Months since randomization

# at risk
Control 220 194 167 114 72 36 7
ICM 221 191 173 102 57 29 8

6.4X more AF detected at 6 months: 8.9% in ICM group vs. 1.4% in control
7.3X more AF detected at 12 months: 12.4% in ICM group vs. 2.0% in control
8.8X more AF detected at 36 months: 30% in ICM group vs. 3.0% in control

Reveal ICM
Control
2016 ESC Guidelines for the Management of Atrial Fibrillation

Guidelines developed by the Task Force for the management of atrial fibrillation of the European Society of Cardiology (ESC)

Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC.

Endorsed by the European Stroke Organisation (ESO)

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Class</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>In stroke patients, additional ECG monitoring by long-term non-invasive ECG monitors or <strong>implanted loop recorders</strong> should be considered to document silent atrial fibrillation.</td>
<td>IIA</td>
<td>B</td>
</tr>
</tbody>
</table>
Potential indications of ICM

1. Palpitation
2. Syncope
3. Cryptogenic stroke
4. AF management
5. Risk stratification for arrhythmic death
경청해 주셔서 감사합니다.

동아대학교병원 순환기내과 박종성