WELCOME

From the Wild West to the Next Frontier

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Disclosures

Consultant for Biosense Webster

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Question 1

What is the current state of pacing?

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Response

A. Pacing is a mature technology with little or no chance of improvement
B. Pacing is an exciting subject with innovations on the horizon
C. Pacing is gradually evolving

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3 Problems with Cardiac Devices

- Leads
  - leadless pacemakers, transthoracic pacing
- Batteries
  - batteryless pacemakers or biological pacemakers
- Dyssynchrony caused by RV pacing resulting in heart failure associated with pacing
  - Optimize LV pacing via the CS
  - Utilize HIS bundle for intrinsic (native) activation
- Device Management for safety

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Leadless pacing

- Most of the complications from pacing arise from the leads and pocket
  - Hematoma, infection, erosion, pneumothorax, fracture, threshold rise
- Micra MDT, Nanostim SJM
  - Leadless devices
  - Venous access from the groin
  - Active fixation battery, lead and computer all in one.

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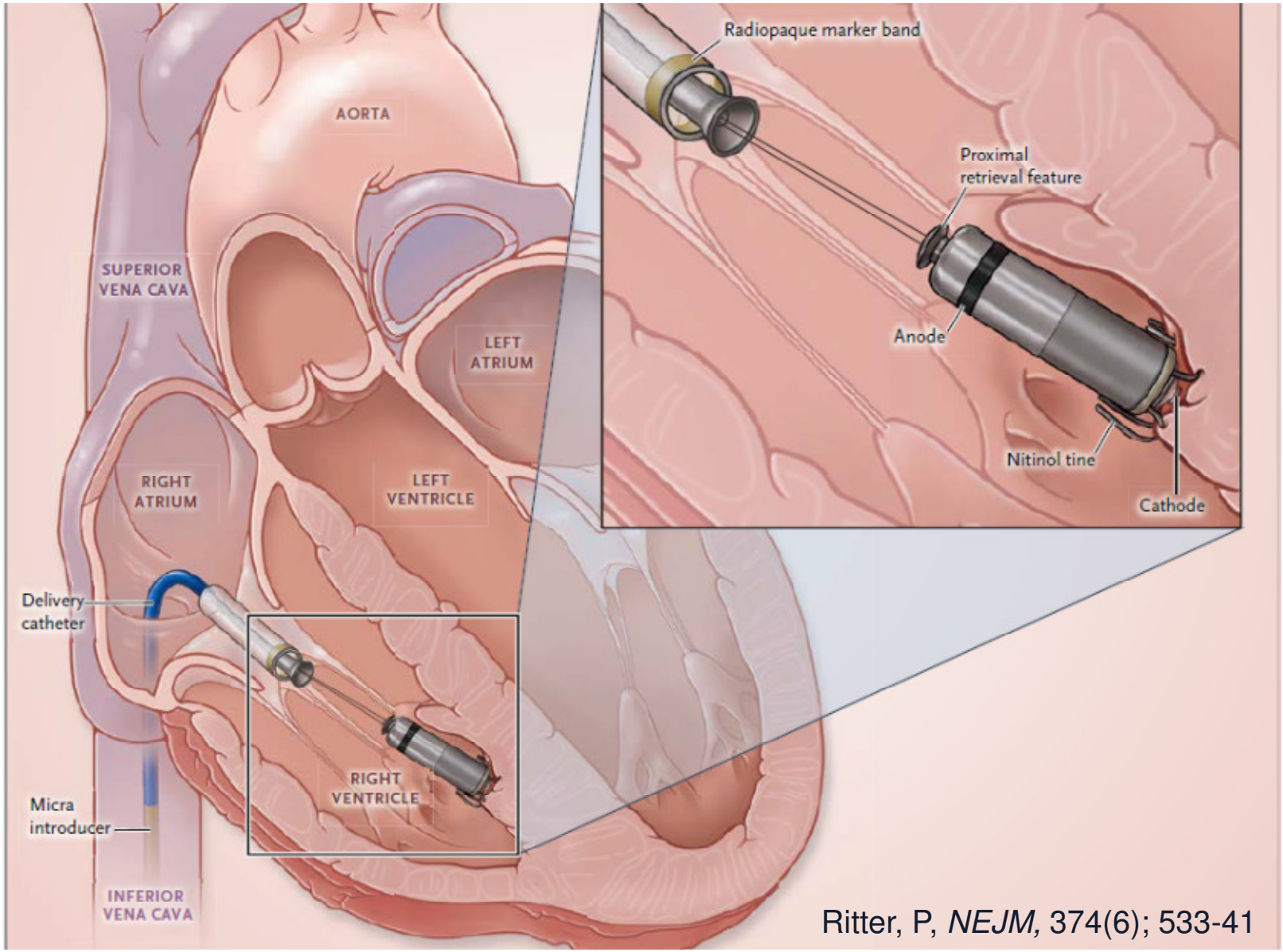

Ritter, P, *NEJM,* 374(6); 533-41

Micra Results

- 724 patients with class I or II indications for ventricular pacing (VVIR)
  - 99.2% were successfully implanted
- 6 month- 96% patients were free of complications
- Compared with 2667 historical controls
  - Fewer complications- hospitalizations, revisions
  - Similar anticipated battery life based on thresholds
  - No embolization, rare retrieval (n=1)

Ritter, P, *NEJM,* 374(6); 533-41

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Future directions

- Atrial and ventricular dual chamber device with blue tooth device- device communication.
- Intracardiac portion of s-ICD- ATP and back up pacing
- Limitations
  - Thresholds
  - Battery changes

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Batteryless Pacing

- Cardiac and pulmonary motion represent unlimited supply of energy for pacing.
- Harvesting cellular resources to accomplish this goal
- Nanowire with a pizo-electric crystal which when moved generates 1-2 V and up to 100mA.
- Device testing currently in animals.

Friedman, P et al, *JACC,* 69(2):2011-35, Jan 2017

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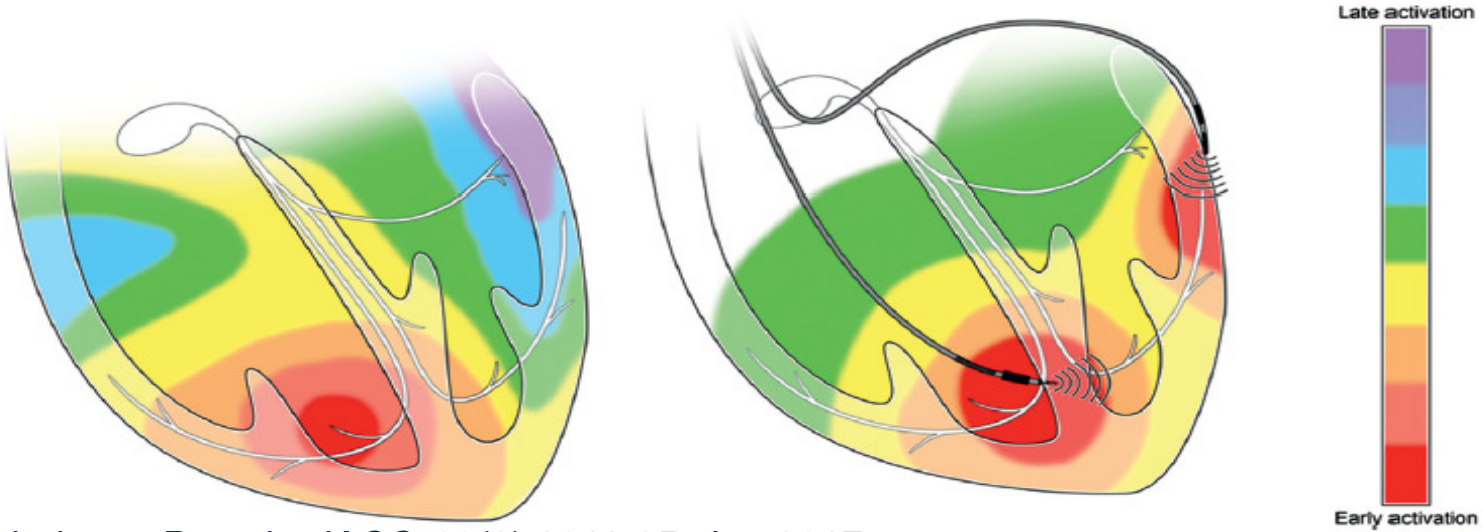
Cardiac Resynchronization

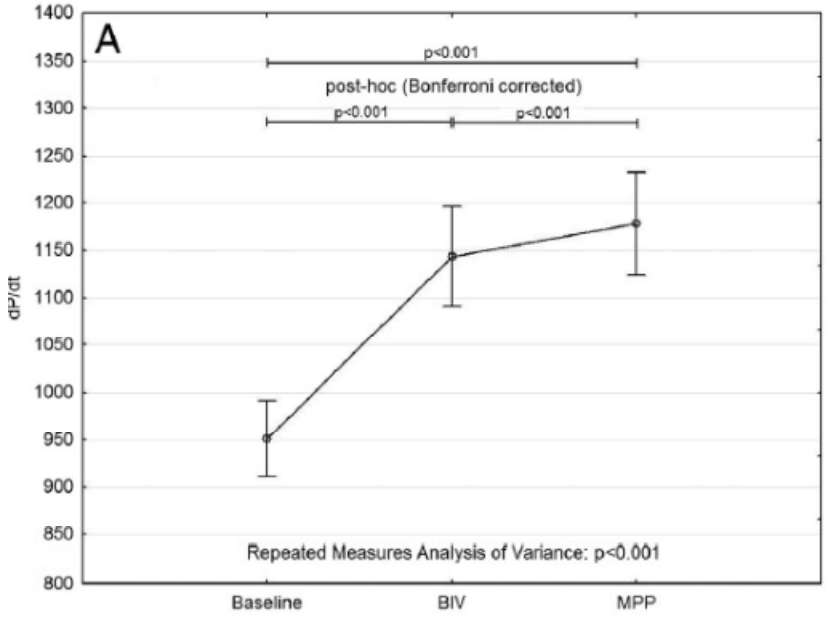
- Limitations:
  - Anatomy of the CS- dependent on branches
  - High LV thresholds (pacing from a vein)
  - Nonresponders



Friedman, P et al, *JACC,* 69(2):2011-35, Jan 2017

Multipoint pacing

- Quadripolar LV lead
- Paces LV1, LV2 and RV
- 90% patients have better LV performance with multipoint LV pacing
- Improves prior nonresponders
- Uses more energy from the battery.



Zanon, F et al, *Heart Rhythm* 12 (5):975-81, May 2015

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Adaptive CRT

- Device based algorithm for patients with LBBB
- Utilizes native RBB for RV activation and LV lead for LV activation
- Less energy expended for cardiac activation
- Results in higher % of responders

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HIS Bundle Pacing

- AVNode→ HIS bundle→ Left and Right Bundles→ Fascicular system
- 75% of AV block- intra-HIS or proximal disease
  - age-related
  - mechanical
  - auto-immune
- Distal disease- HIS pacing not possible
  - usually CAD and scar related

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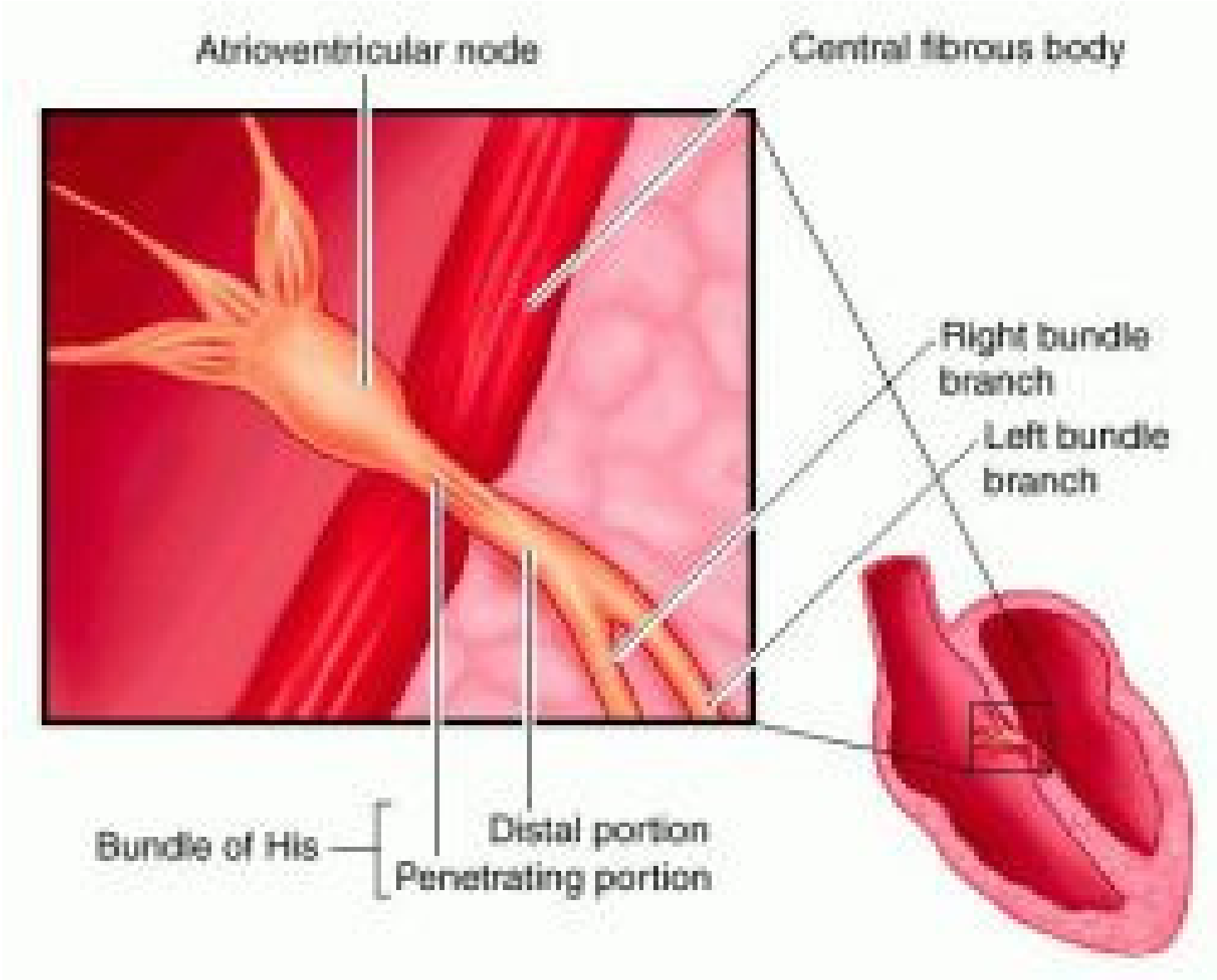
Atrioventricular node
Central fibrous body
Right bundle branch
Left bundle branch
Bundle of His
Distal portion
Penetrating portion

HIS Bundle Pacing

- Fixed curve catheter
- 4FR 3830 lead, select secure
- Unipolar recording to record HIS bundle
- Active fixation

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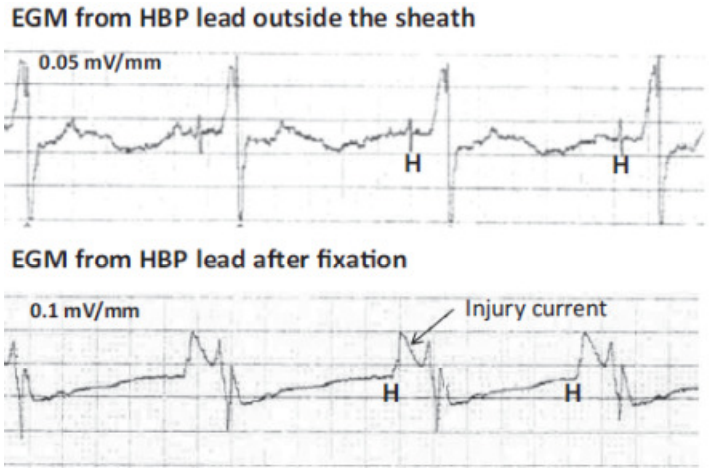
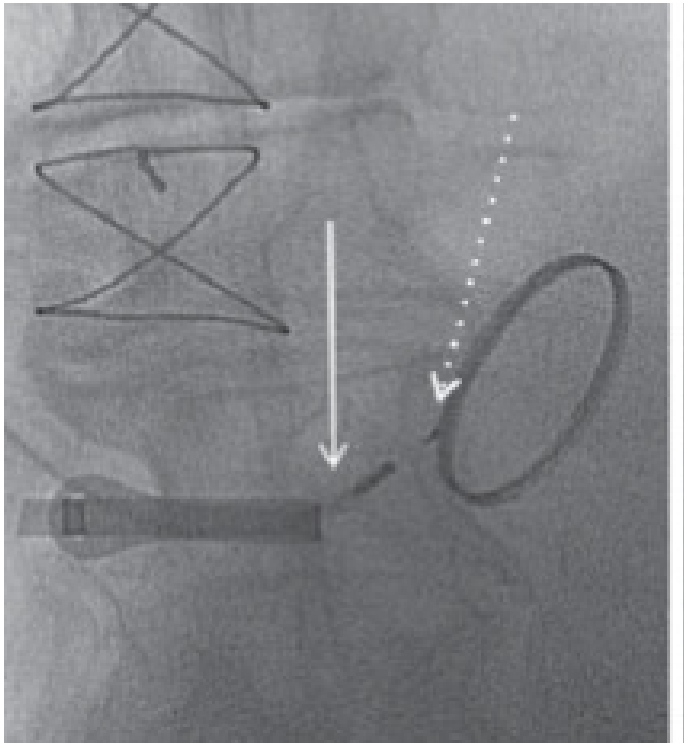
EGMs, Xray





Dandamudi, G et al, *PACE* 39 (2016): 1298-1304

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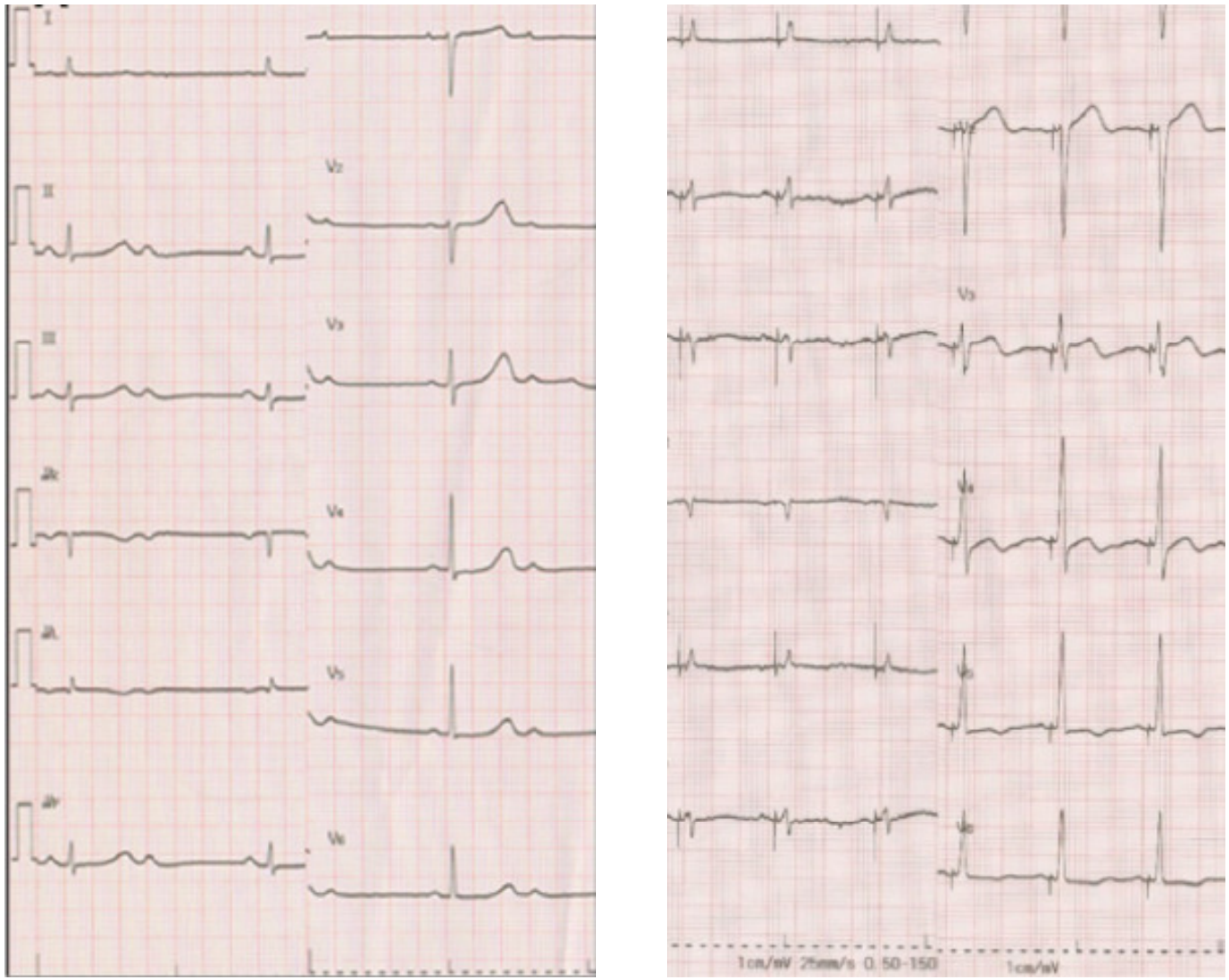

Makishima, N, *J of Arr* 32 (2016): 499-501

Pros/Cons

- Pros
  - Provides equal or improved LV function in pacing induced or LBBB relate cardiomyopathy
  - Simpler procedure, more reproducible
- Cons
  - Slightly higher than normal thresholds
  - Lower than normal sensing
  - Lumenless lead
  - Higher rates of revision

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NMHI HIS Bundle Experience

- 22 devices (>3 months post implant)
- 2 not using the HIS lead because of high thresholds
- 2 revisions
- Average threshold 1.5@1.0ms
- 6 leads with back up pacing
- 16 without

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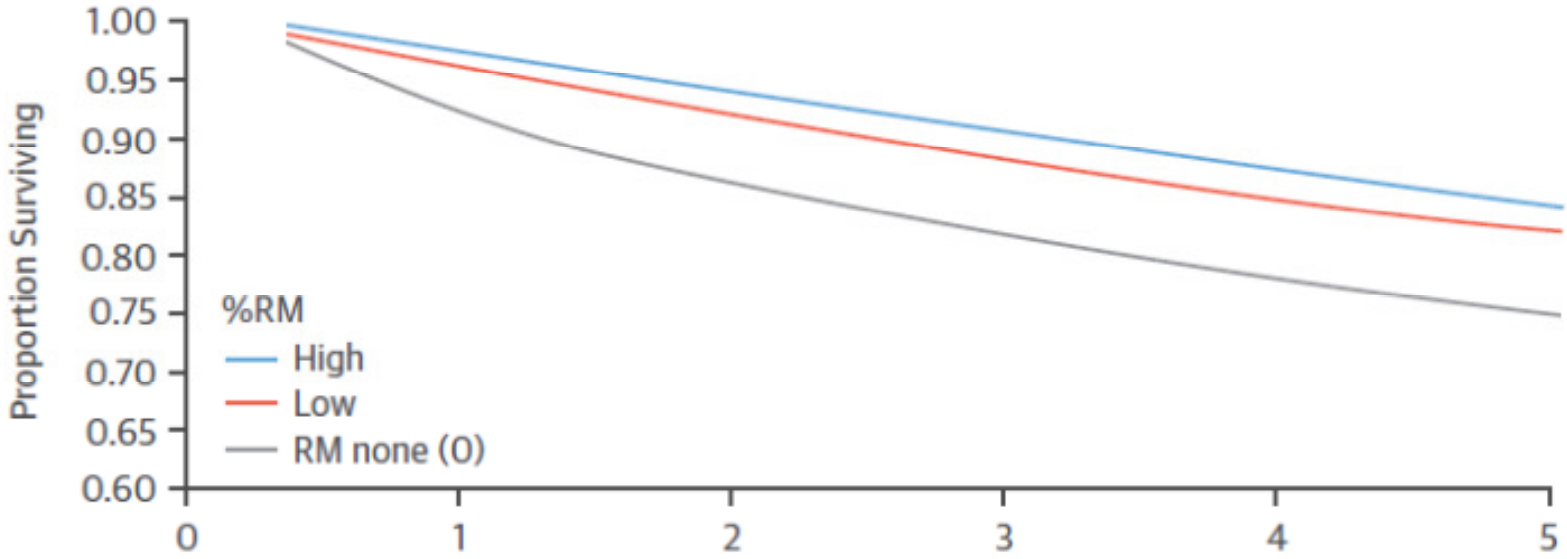
Remote Device Management



Friedman, P et al, *JACC,* 69(2):2011-35, Jan 2017

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NMHI Experience

- 2487 patients followed in our device clinic
- 70% of pacers and 80% of ICDs enrolled in remote monitoring.
- Compared 1400 patients from 2010 to 2014 enrolled in remote monitoring to a national pool from the Merlin (SJM) database.

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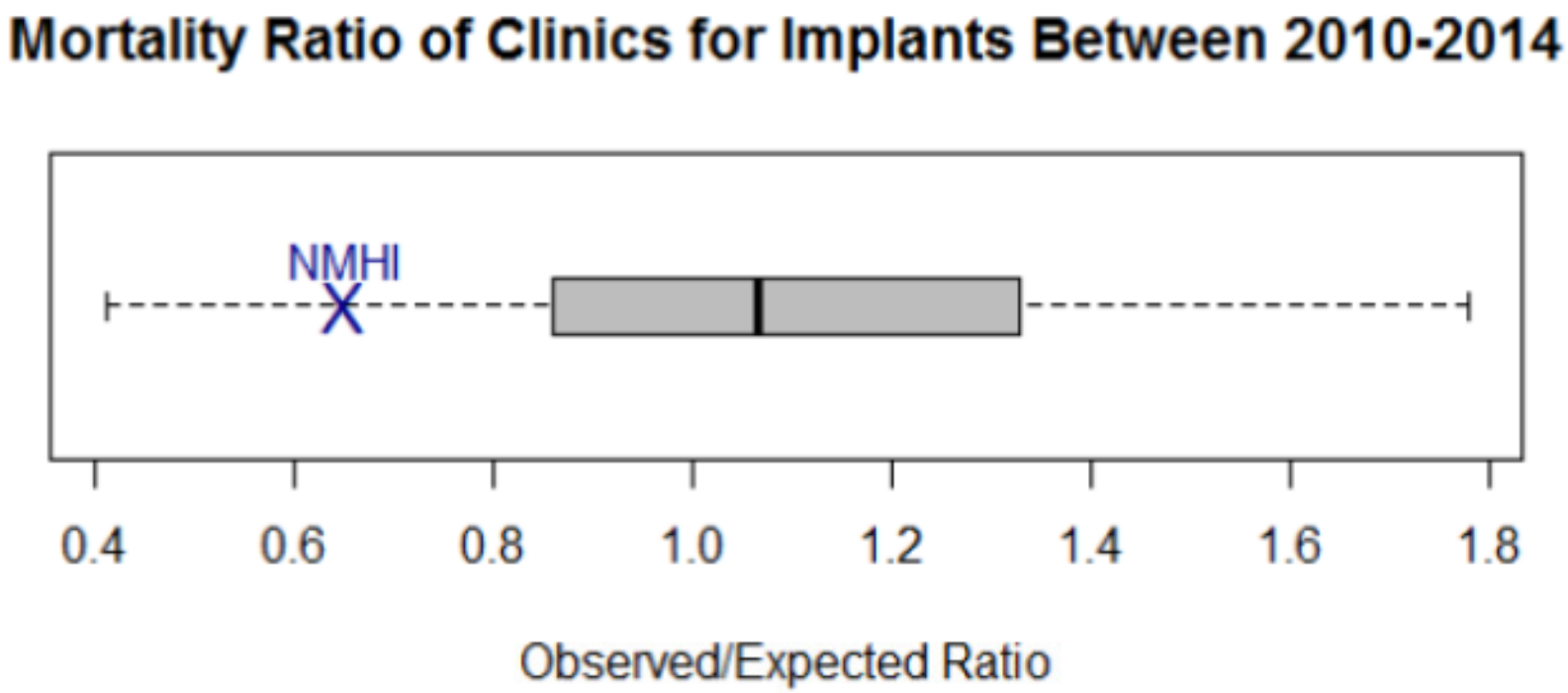
Overall Survival



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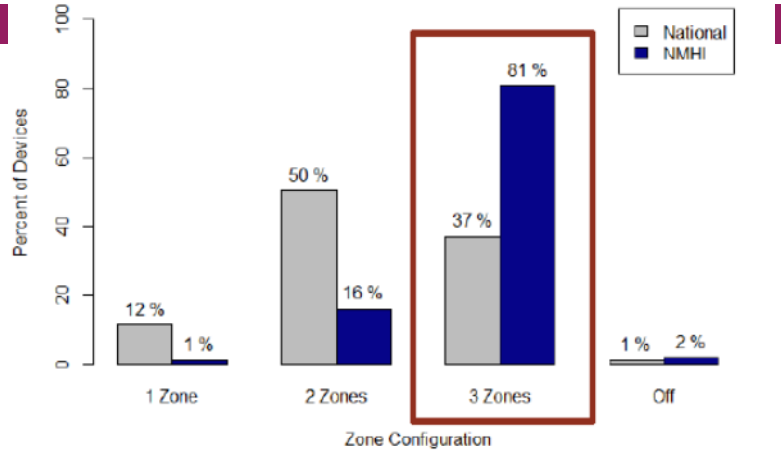
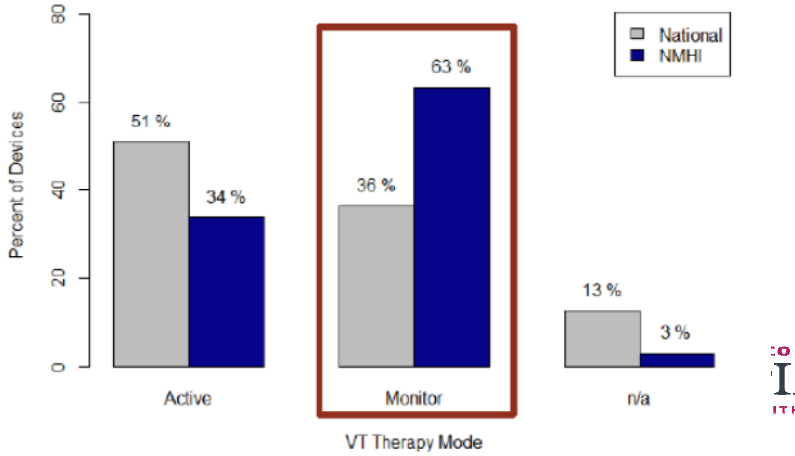
Device Longevity

Device Type	Clinic Longevity	National Average	Increase	p-value
CRT-D	6.8 +/- 1.1 years	6.1 years	13%	p < 0.001
ICD-DR	7.9 +/- 0.9 years	7.5 years	5%	p < 0.001
ICD-VR	9.1 +/- 0.8 years	8.7 years	4%	p < 0.001
CRT-P	8.1 +/- 1.9 years	6.8 years	19%	p < 0.001
Pacer-DR	10.1 +/- 1.7 years	9.0 years	12%	p < 0.001
Pacer-SR	11.7 +/- 1.6 years	10.6 years	10%	p < 0.001

Guideline Based Programming

- Guidelines recommend three zones
- Guidelines recommend a monitor zone





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