

# Device Interrogation- Pacemakers, ICD and Loop Recorders

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# Disclosures

Consultant: Medtronic, St. Jude Medical

Do all Cardiac Implantable Electronic Devices deliver therapy?

A. Yes

B. No

# Answer

A. Yes

B. No

Only Pacemakers, ICDs and CRTs provide device based therapies. Implantable Loop Recorders ( ILR) are purely diagnostic devices.

# Cardiac Implantable Electronic Devices

## Pacemaker



- Battery
- Capacitor
- Low Voltage
- High Voltage
- Asystole
- Heart Failure
- Brady Detections
- Brady Therapies
- AT/AF Detections
- AT/AF Therapies
- VT/VF Detections
- VT/VF Therapies

# Cardiac Implantable Electronic Devices

## ICD



- ✓ Battery
- ✓ Capacitor
- ✓ Low Voltage
- ✓ High Voltage
- ✓ Asystole
- ✓ Heart Failure
- ✓ Brady Detections
- ✓ Brady Therapies
- ✓ AT/AF Detections
- ✓ AT/AF Therapies
- ✓ VT/VF Detections
- ✓ VT/VF Therapies

# Cardiac Implantable Electronic Devices

## ILR



- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Battery  | <input checked="" type="checkbox"/> Brady Detections |
| <input type="checkbox"/> Capacitor           | <input type="checkbox"/> Brady Therapies             |
| <input type="checkbox"/> Low Voltage         | <input checked="" type="checkbox"/> AT/AF Detections |
| <input type="checkbox"/> High Voltage        | <input type="checkbox"/> AT/AF Therapies             |
| <input checked="" type="checkbox"/> Asystole | <input checked="" type="checkbox"/> VT/VF Detections |
| <input type="checkbox"/> Heart Failure       | <input type="checkbox"/> VT/VF Therapies             |

# Cardiac Implantable Electronic Devices

## Trends

### ICDs: Expanding Indications for implantation

*2006 ACC/AHA/ESC Guidelines for Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death. Circulation. 2006;114:1088-1132*

*2008 ACC/AHA/HRS Guidelines for Device-Based Therapy. Circulation. 2008;117:2820-2840*

*2013 ACC/AHA Guideline for the Management of Heart Failure. Circulation. 2013;128:e240-e327*

*2013 ACC/AHA Guideline for the Management of ST-Elevation Myocardial Infarction. Circulation. 2013;127:e362-e425*

*2014 HRS/ACC/AHA Expert Consensus Statement on the Use of Implantable Cardioverter-Defibrillator Therapy in Patients Who Are Not Included or Not Well Represented in Clinical Trials  
Circulation. 2014;130:94-125*





# Increasing co- morbid conditions

## Charleston Co morbidity Index

	1993	2009
CCI >2		
VVI	14.1%	45%
DDD	13.5%	42.4%

Is it necessary to interrogate every CIED you encounter?

A) Yes

B) No

# Device Interrogation

Determine clinical effectiveness

Confirm appropriate function

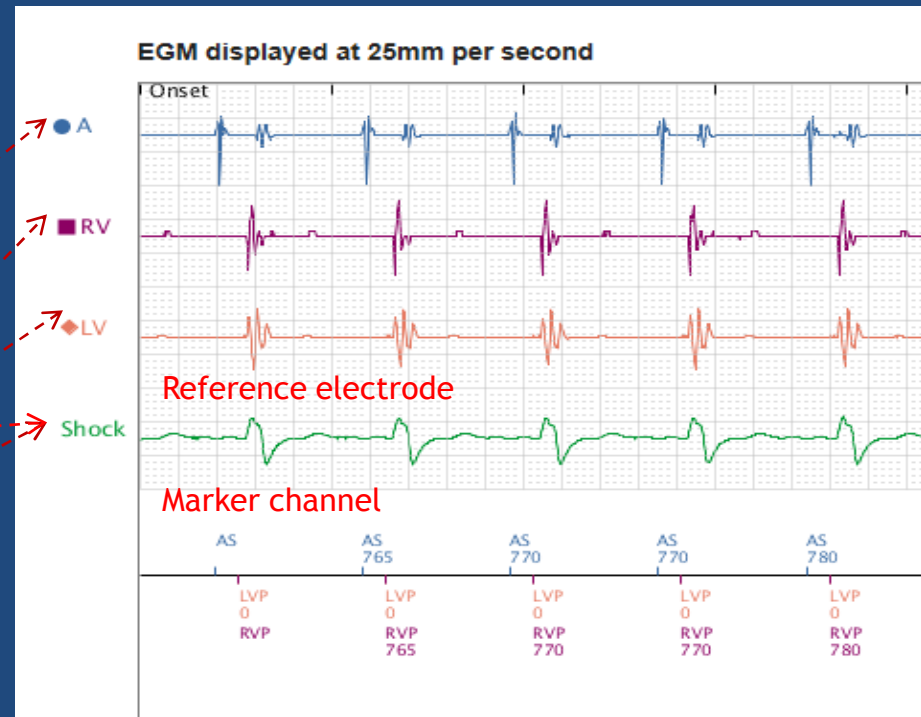
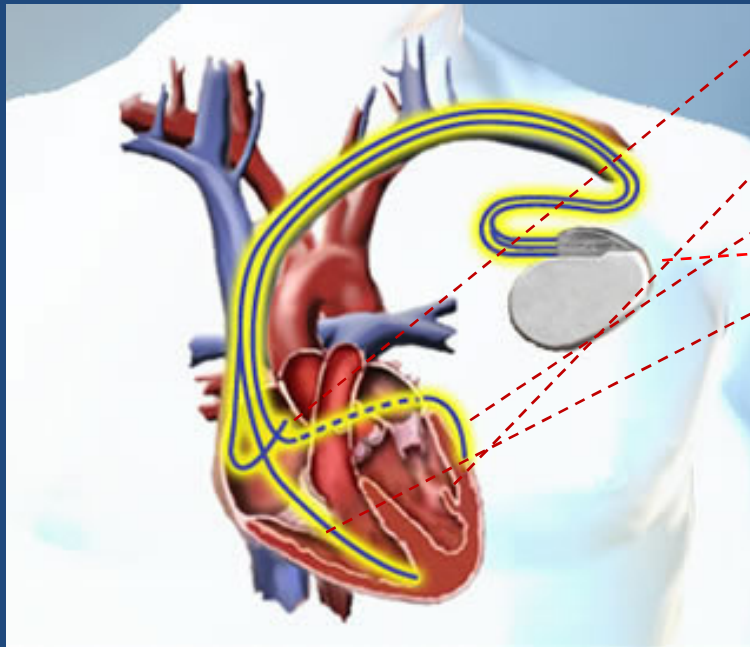
Evaluate impact on co-morbid conditions

# Determine Clinical Effectiveness

Presenting rhythm

Settings ( parameters)

# Presenting Rhythm



# Settings (ICD)

## Parameter Summary

Mode	VVI	Lower Rate	60 bpm
<b>Detection</b>		<b>Rates</b>	<b>Therapies</b>
VF	On	>200 bpm	ATP During Charging, 35J x 6
FVT	OFF		All Rx Off
VT	On	167-200 bpm	Burst(3), 20J, 35J x 4

Enhancements On: VT Monitor, Wavelet, TWave, Noise




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# Settings (PM)

## Parameter Summary

Mode	AAI<=>DDD	Lower Rate	60 bpm	Paced AV	180 ms
Mode Switch	171 bpm	Upper Track	130 bpm	Sensed AV	150 ms
		Upper Sensor	130 bpm		
<b>Detection</b>		<b>Rates</b>		<b>Therapies</b>	
AT/AF	Monitor	>171 bpm		All Rx Off	
VT	Monitor	>150 bpm			

# Settings (ILR)

 Parameter Summary: 02-Sep-2015 11:13

	<i>Detection</i>	<i>Rate</i>	<i>Duration</i>
Symptom	On	---	Four 7.5 min Episodes
Tachy	On	150 bpm	16 beats
Brady	On	30 bpm	4 beats
Pause	On	---	3 seconds
AT/AF	AF Only	---	All Episodes



# Confirm Appropriate Function

Intrinsic Rhythm

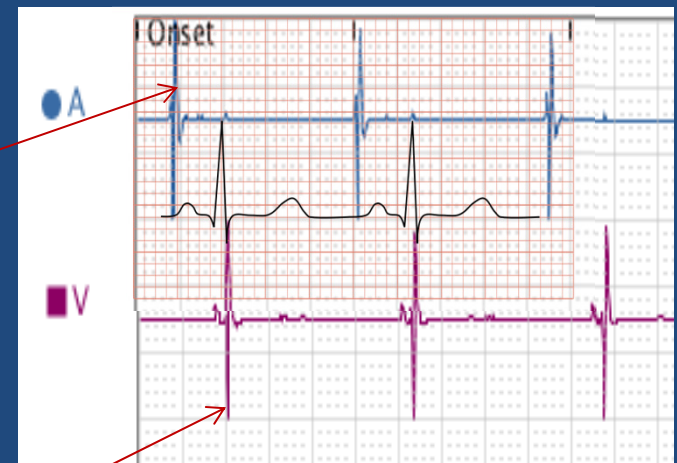
Lead integrity

Battery Status

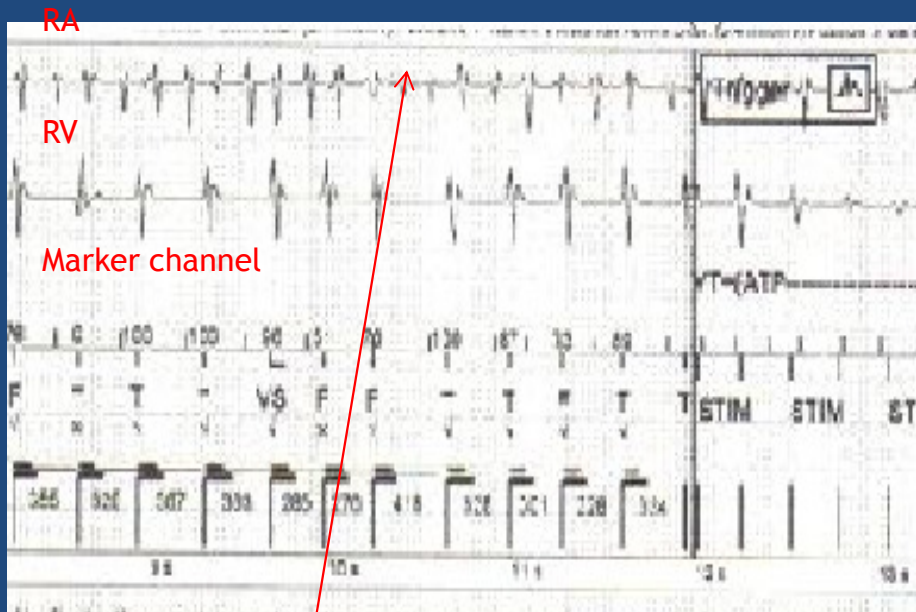
# Intrinsic amplitude (mV)

A- EGM: measurement of intrinsic atrial signal

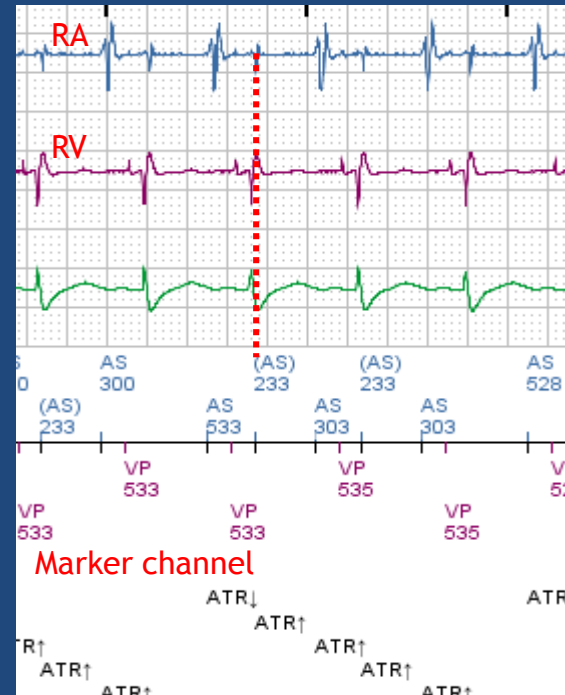
V-EGM: measurement of intrinsic ventricular signal



# Atrial sensing

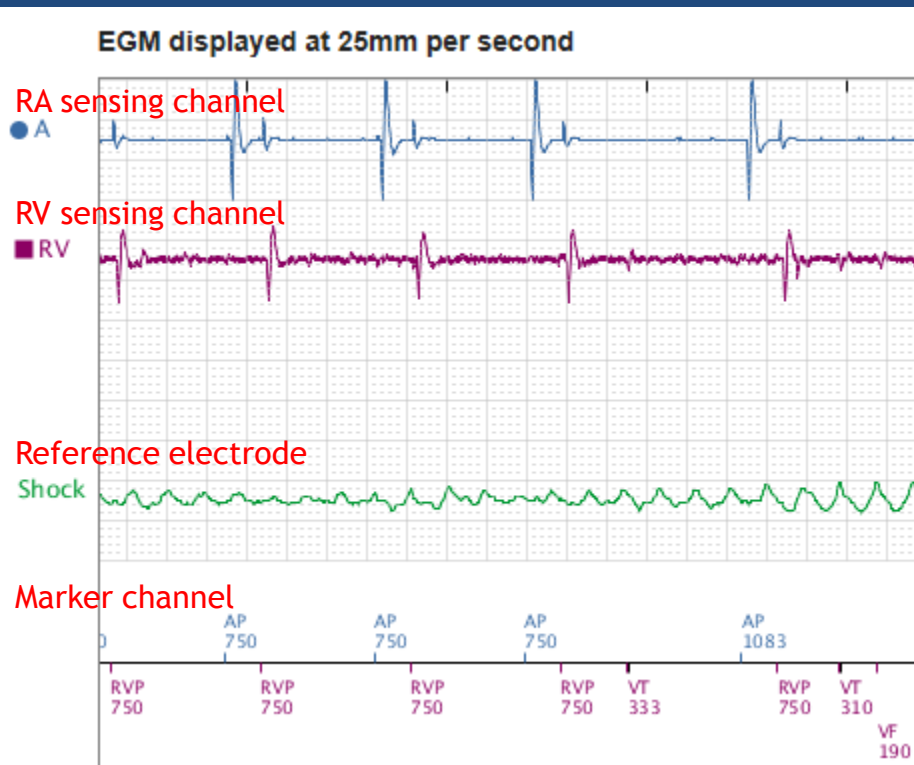


Atrial undersensing with inappropriate ATP

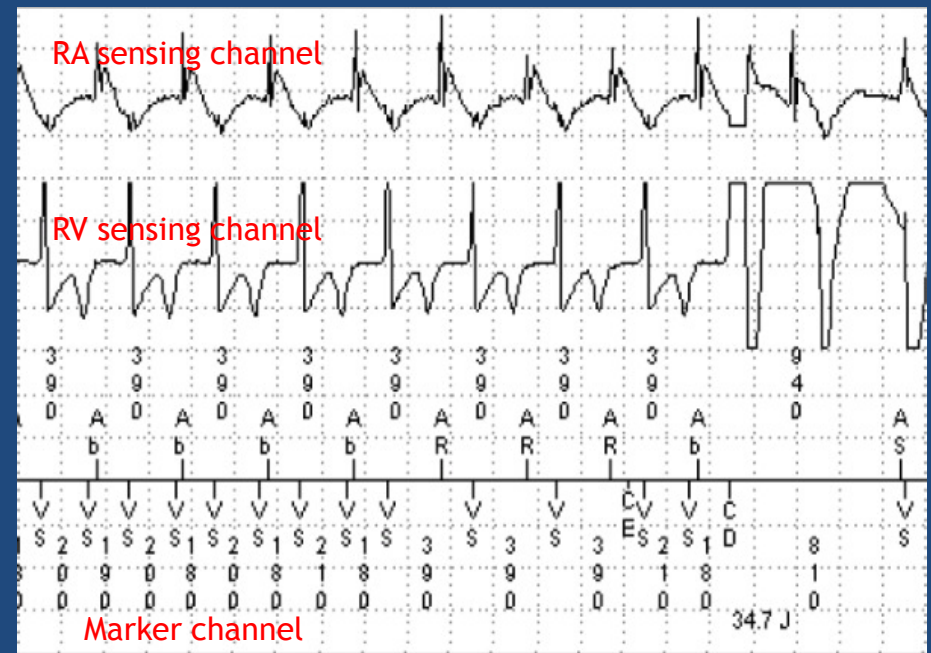


Atrial oversensing with inappropriate mode switch

# Ventricular sensing



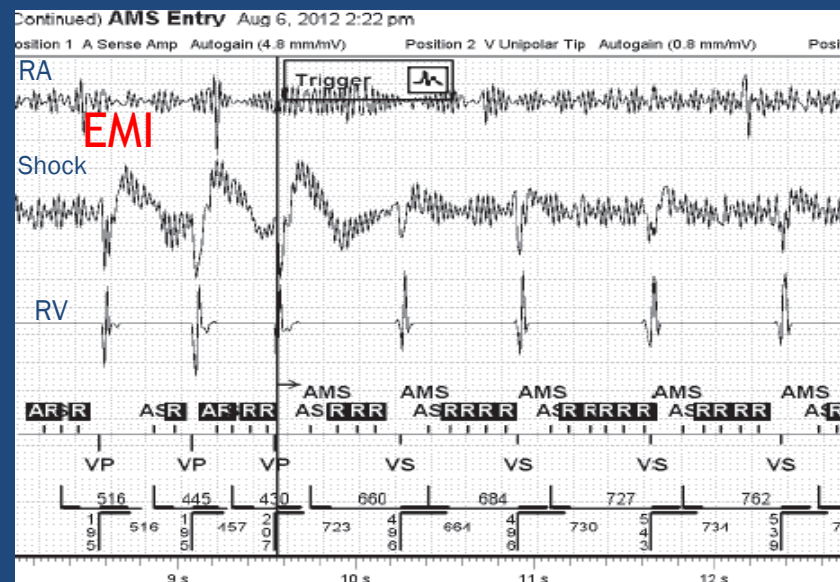
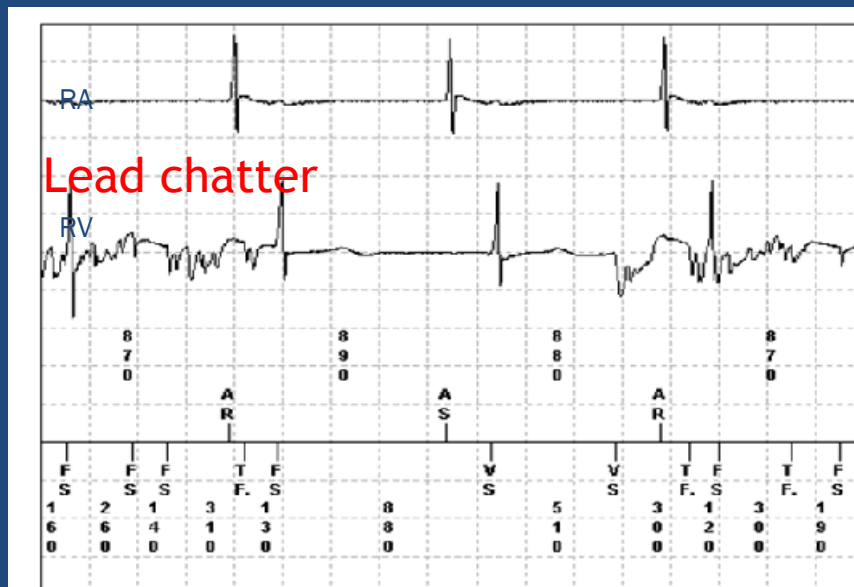
Undersensing of VF



Oversensing of T wave

# Lead assessment

Causes of lead noise:



# Voltage: battery status

## Battery

Longevity: 5.3-8.7 yrs



Implant Date:

May 12, 2016

Voltage

3.01 V

Magnet Rate

100.0 ppm

Battery Current

12 uA

Remaining Capacity to ERI

>95%



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# Impact on co-morbid conditions

Observations:

Arrhythmia burden

Percent paced

HF Metrics

# Observations:

## Arrhythmia burden: Atrial fibrillation

- Duration
- Average ventricular response

Paulus Kirchhof et al. Europace 2016;europace.euw295



# Observations:

## Arrhythmia burden: ICD shocks

- Discrimination
- Appropriate intervention

# Minimizing ICD Shocks

## Conventional programming

VF detection (200 bpm): 1 sec

VT detection (180 bpm): 2.5  
secs

ATP therapy: 188-200 bpm

SVT discrimination: 188-200

## Therapy reduction programming\*

VF detection (230 bpm): 60 sec

VT detection (200 bpm): 6-12  
secs

ATP therapy 188-230 bpm

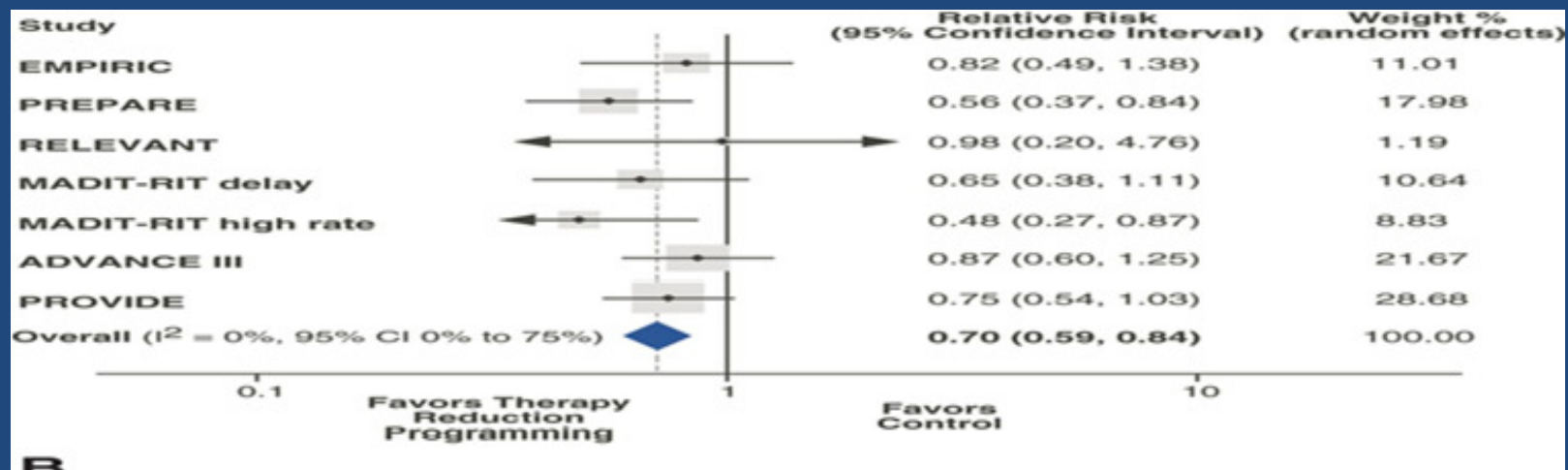
SVT discrimination: 188-230

\*in primary prevention

*2015 HRS/EHRA/APHRS/SOLAECE expert consensus statement on optimal implantable cardioverter-defibrillator programming and testing*

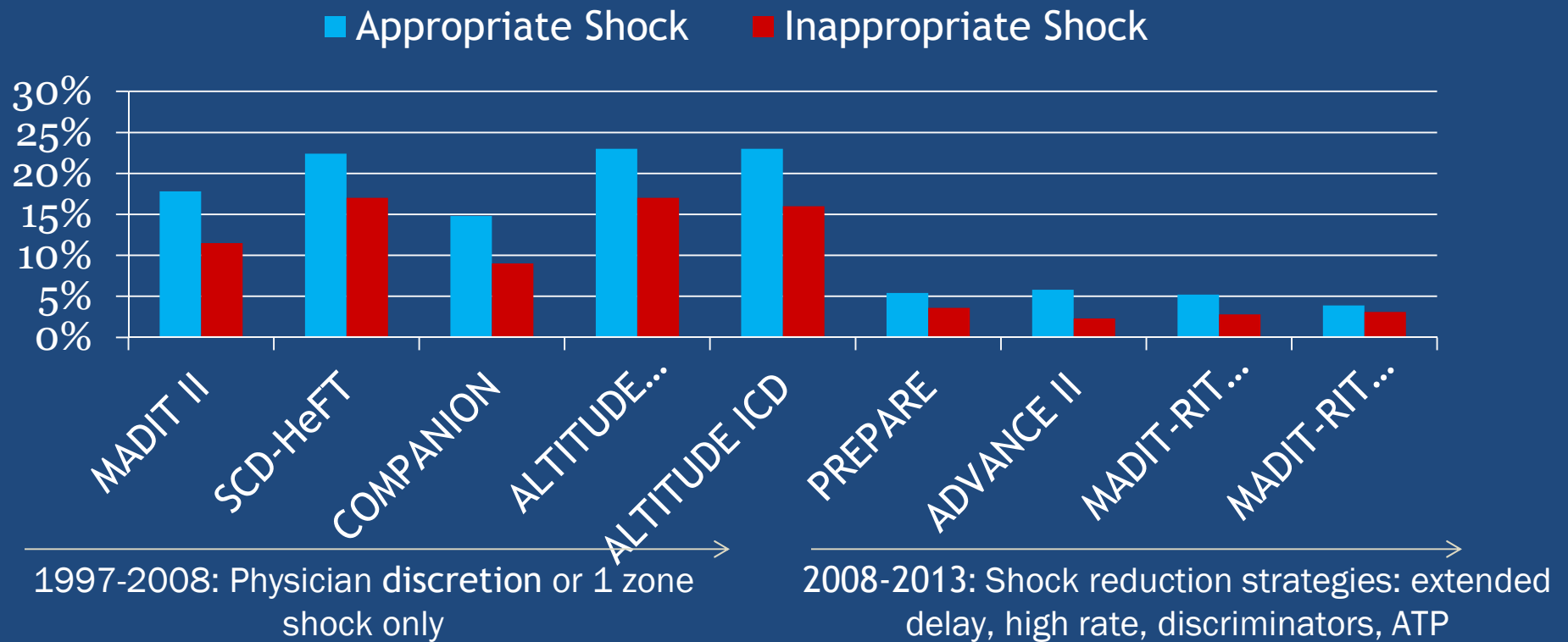


# Meta analysis on mortality risk, therapy reduction vs conventional programming



Therapy reduction programming was associated with 30% reduction on all cause mortality  $P = <0.001$

# INCIDENCE Appropriate and Inappropriate Shocks



Daubert JP, et al. *JACC* 2008; 51:1357-1365.  
 Bardy GH, et al. SCD-HeFT. *NEJM* 2005; 352:3:225-237.  
 Saxon, LA et al. *Circulation* 2006; 114; 2766-2772.  
 Saxon LA et al. *Circulation* 2010; 122:2359-2367.

Wilkoff B, et al. *JACC* 2008; 52:541-550  
 Gasparini, M, et al. *JAMA* 2013; 309: 1903-1911.  
 Moss, A, et al. *NEJM* 2012; 367:2275-2283



What is the most compelling reason to minimize ICD shocks?

- A. To prolong battery life
- B. To minimize pain
- C. To improve quality of life
- D. To improve survival

# Answer

- A. To prolong battery life
- B. To minimize pain
- C. To improve quality of life
- D. To improve survival**

Therapy reduction programming was associated with 30% reduction on all cause mortality  $P = <0.001$

Vern Hsen Tan et al. Circ Arrhythmia Electrophysiol. 2014;7:164-170



# Impact on co-morbid conditions

Observations:

Arrhythmia burden

Percent paced :

Minimizing Unnecessary RV Pacing

HF Metrics



### From: Dual-Chamber Pacing or Ventricular Backup Pacing in Patients With an Implantable Defibrillator: The Dual Chamber and VVI Implantable Defibrillator (DAVID) Trial

JAMA. 2002;288(24):3115-3123. doi:10.1001/jama.288.24.3115

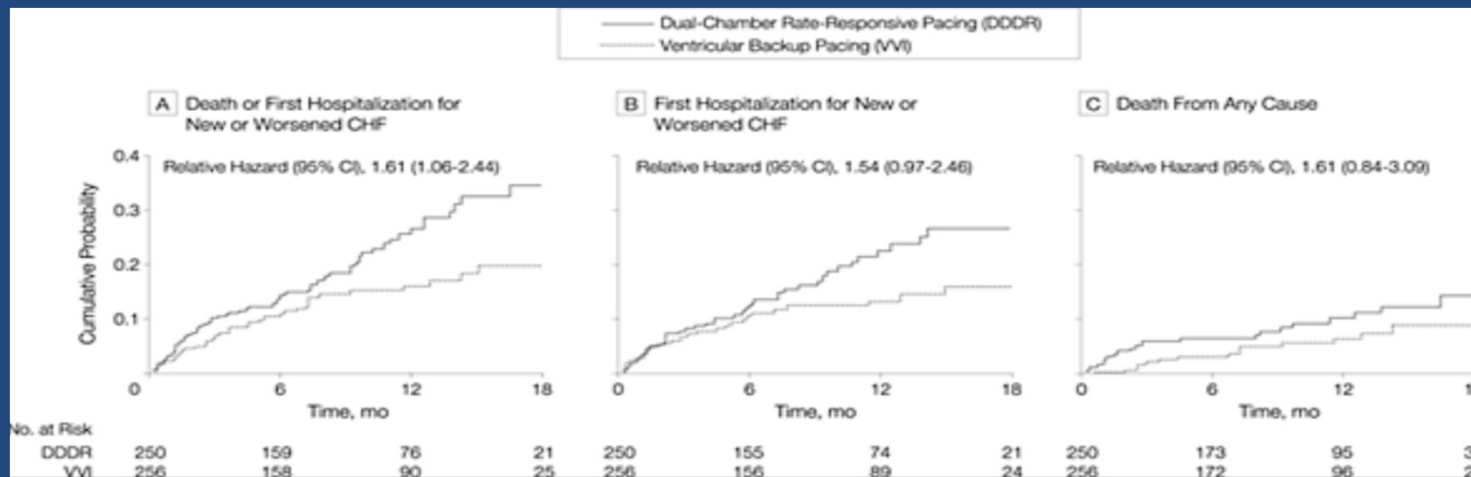


Figure Legend:

For all plots, time zero is the day of randomization. CI indicates confidence interval. A, Survival to death or first hospitalization for congestive heart failure (CHF). Unadjusted P = .02; adjusted for sequential monitoring, P = .03. B, Survival to first hospitalization for CHF. Patients are censored at death. Log-rank P = .07. C, Survival to death from any cause. Log-rank P = .15

Date of download: 9/3/2016

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# Observations: Percent paced

## Meta analysis of atrial based vs ventricular based pacing

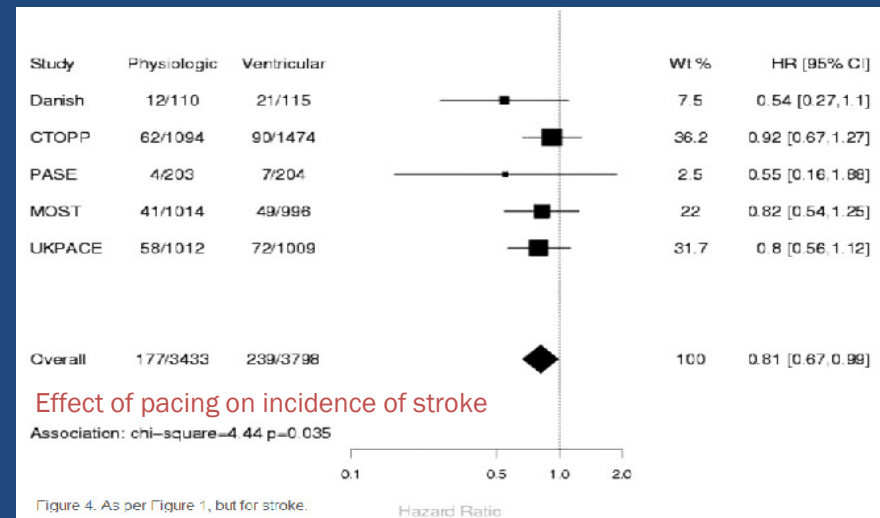
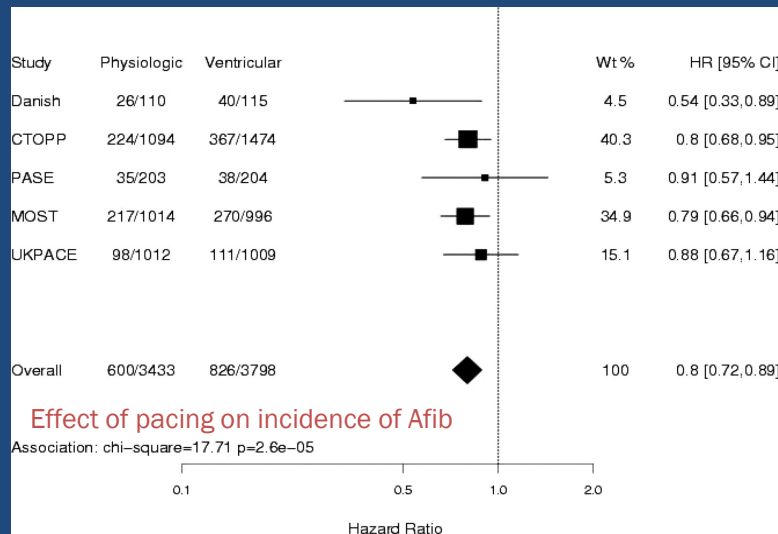


Figure 4. As per Figure 1, but for stroke.

Healey, et al. *Circulation*. 2006;114:11-17.

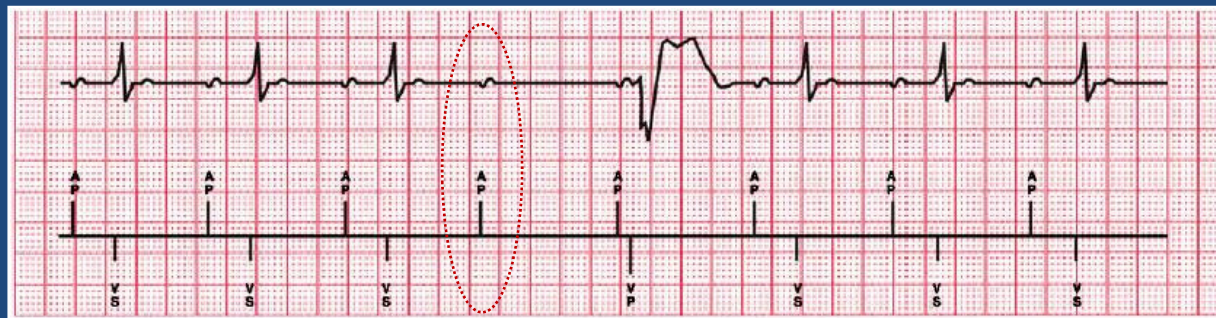
Physiologic (atrial based) pacing showed a significant reduction on Afib incidence and a moderate reduction on stroke risk



# Observations:

## Percent paced

- Minimizing RV pacing



Loss of  
conduction



Back-up  
V-pace

Courtesy of Medtronic Inc

What negative outcomes can result from unnecessary RV pacing ?

- A. May worsen heart failure in LV systolic dysfunction
- B. Increases incidence of Afib
- C. Shortens patient survival by 10 years
- D. Both A and B
- E. Both A and C

## Answer

- A. May worsen heart failure in LV systolic dysfunction
- B. Increases incidence of Afib
- C. Shortens patient survival by 10 years
- D. Both A and B**
- E. Both A and C

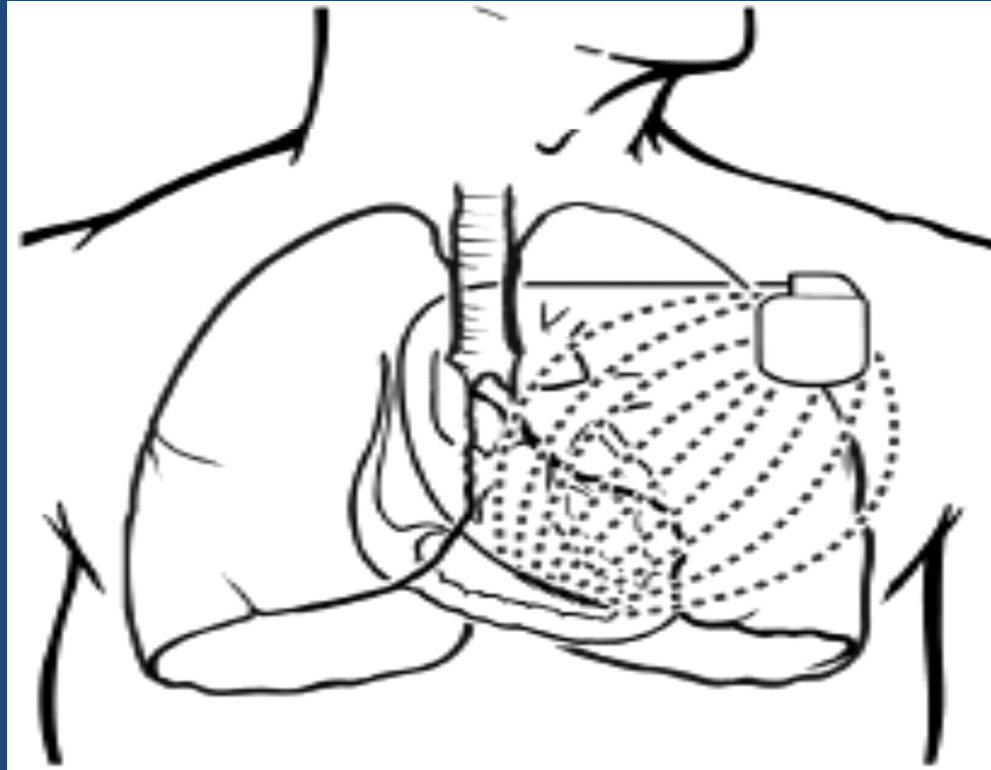
Unnecessary RV pacing is associated with higher incidence of Afib and ventricular dyssynchrony.



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# HEART FAILURE METRICS

# Intrathoracic impedance measurement by implantable system



Cheuk-Man Yu et al. *Circulation*. 2005;112:841-848



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# Combined Diagnostic Criteria

HF Device Diagnostic Parameter	Algorithm
AF duration	AF $\geq 6$ h on at least 1 day in patients without persistent AF (7 consecutive days with $\geq 23$ h AF)
Ventricular rate during AF	AF = 24 h and the average ventricular rate during AF $\geq 90$ beats/min on at least 1 day
Fluid index (OptiVol)	High fluid index on at least 1 day; thresholds included $\geq 60$ , $\geq 80$ , and $\geq 100$
Patient activity	Average patient activity $< 1$ h over 1 week (nonoverlapping weekly windows)
Night heart rate	Average night heart rate $> 85$ beats/min for 7 consecutive days (nonoverlapping weekly windows)
HRV	HRV $< 60$ ms everyday for 1 week (minimum 5 measured days) (nonoverlapping weekly windows)
% of pacing CRT	Ventricular pacing $< 90\%$ for 5 of 7 days (nonoverlapping weekly windows)
ICD shock for potentially lethal VT/VF	$\geq 1$ shocks during the evaluation period

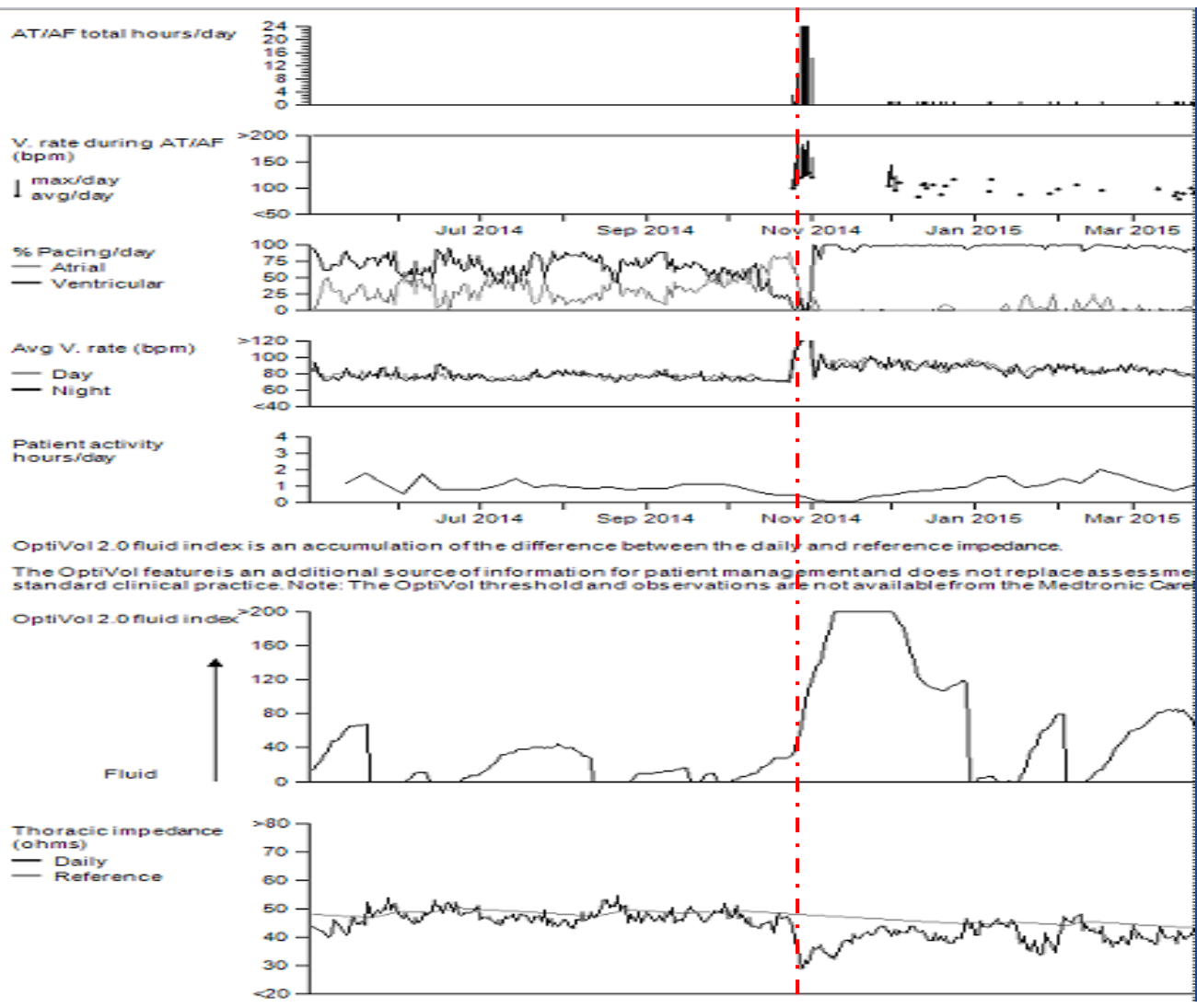
High risk of HF hospitalization:  
Optivol  $> 100$   
Criteria  $\geq 2$

PARTNERS-HF trial: data from 694 CRT-D pts followed for 11.7 2 months

Chart adapted from

Whellan DJ et al PARTNERS HF Trial JACC Volume 55, Issue 17, April 2010





Afib > 6 hours

VR during AF > 90bpm

Loss of CRT due to MS

Night HR > 85bpm x 1 week

Activity level < 1 hr x 1 week

Optivol > 100

Sudden drop in intrathoracic impedance





# Evaluation (final):

Appropriate?

Normal function?

# And let's not forget the patient

## Pocket appearance



Good



Bad



Ugly

# MNEMONIC

## P.S. I LOVE the patient

*Presenting rhythm*

*Settings*

*Intrinsic amplitude*

*Lead measurements*

*Observations*

*Voltage (battery function)*

*Evaluation*

*the patient*



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# Take away points

Device interrogation provides a myriad of data

A clinician's focus

- clinical effectiveness

- appropriate function

- Impact on co-morbid conditions



*Thank you!*



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