Séminaire
Winter Arrhythmia
School
Annual Cardiac Arrhythmia Meeting
Division of Cardiology, University of Toronto

An Approach to the Cardiac Implantable Electronic Device Nearing End of Its Life

Michael Mohareb, MD, FRCPC

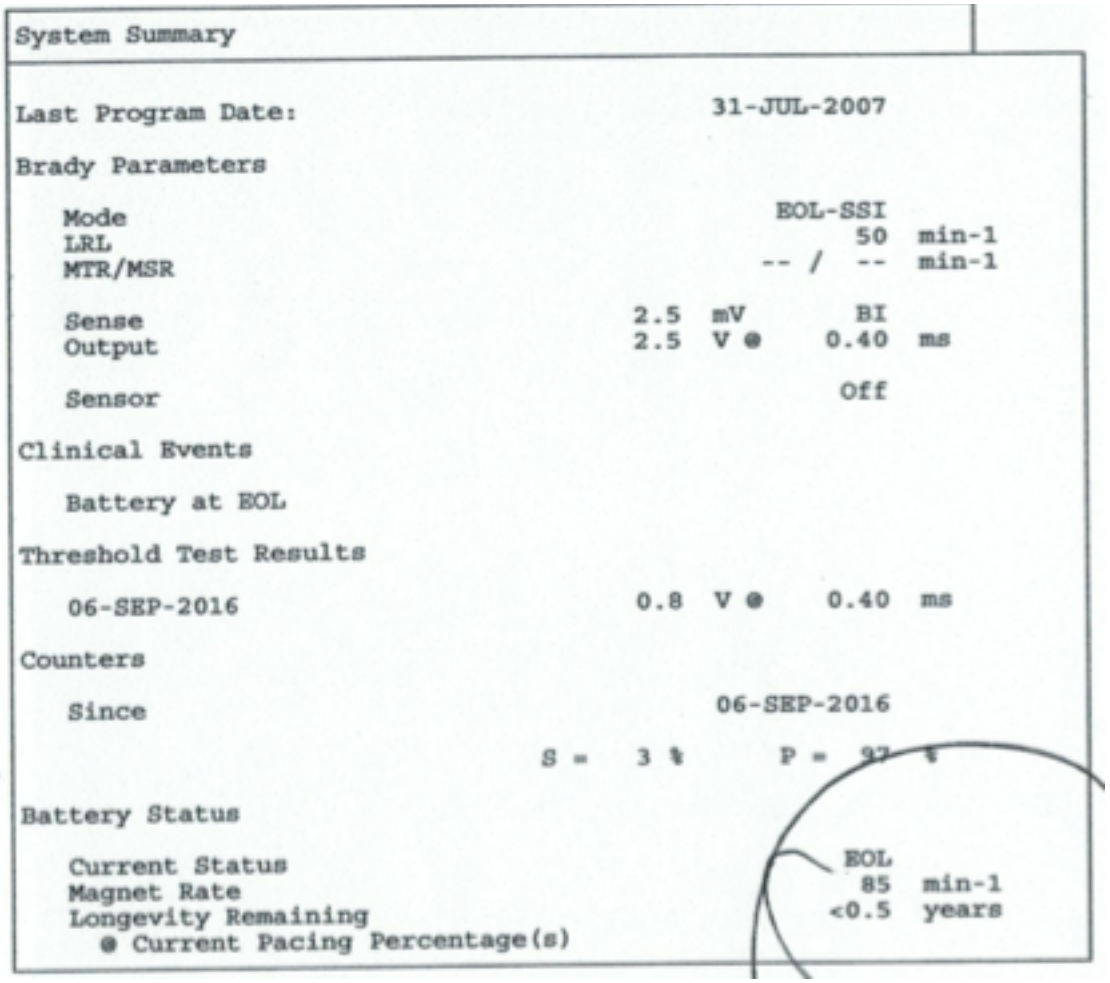
14th Annual
Collingwood, Ontario,
February 10 -12, 2017

Disclosures

- Inexperience
- Lack of confidence
- Inability to match clothes well
- Laugh at my own jokes

Case 1

- 97F admitted with Corynebacterium sepsis
- VVI PPM followed at a different centre
- In lieu of her regular appointment, while an inpatient, she is interrogated



System Summary

Last Program Date:			31-JUL-2007	
Brady Parameters				
Mode			EOL-SSI	
LRL			50	min-1
MTR/MSR			-- / --	min-1
Sense	2.5	mV	BI	
Output	2.5	V ●	0.40	ms
Sensor			Off	
Clinical Events				
Battery at EOL				
Threshold Test Results				
06-SEP-2016	0.8	V ●	0.40	ms
Counters				
Since			06-SEP-2016	
	S = 3 %		P = 97 %	
Battery Status				
Current Status			EOL	
Magnet Rate			85	min-1
Longevity Remaining			<0.5	years

● Current Pacing Percentage(s)

Case 1

- What do you recommend for this patient?
  A. Let her recover from her illness and follow up as an outpatient
  B. Replace her pack/generator while she is admitted
  C. Place a temporary transvenous pacemaker until she has finished her antibiotic therapy then replace
  D. You need more information

Case 2

- 65F seen in routine PPM clinic follow-up
- Had a DDD PPM implanted 8yrs previously for vasovagal syncope with pauses

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System Summary

Last Program Date:			23-JUL-2015	
Brady Parameters				
Mode			DDD	
LRL			50	min-1
MTR/MSR			130 / 130	min-1
A-Sense	0.75	mV	BI	
A-Output	2.8	V @	0.50	ms
V-Sense	AUTO	mV	BI	
V-Output	AUTO	V @	0.40	ms
Sensor			Off	
A-Tachy Response			On	
AV Delay (paced)	DYN		--	ms
Clinical Events				
Sudden Brady Response				
Threshold Test Results				
23-JUL-2015	A 1.1	V @	0.50	ms
06-JAN-2016	V 1.7	V @	0.40	ms
Counters				
Since			23-JUL-2015	
	AsVs = 99 %		AsVp = 1 %	
	ApVs = 0 %		ApVp = 0 %	
ATR Mode Switches			8	
ATR Mode Switch Time			0 %	
Battery Status				
Current Status			Good	
Magnet Rate			100	min-1
Longevity Remaining			1.5	years

@ Current Pacing Percentage(s)

AP 0%
VP 1%

Case 2

- What would you recommend for this patient?
  A. Go ahead with a DDD PPM pack change
  B. Tell her she obviously does not need her pacemaker and take the current device out (and cap the leads)
  C. Tell her she obviously does not need her pacemaker and leave the device in situ
  D. You need more information

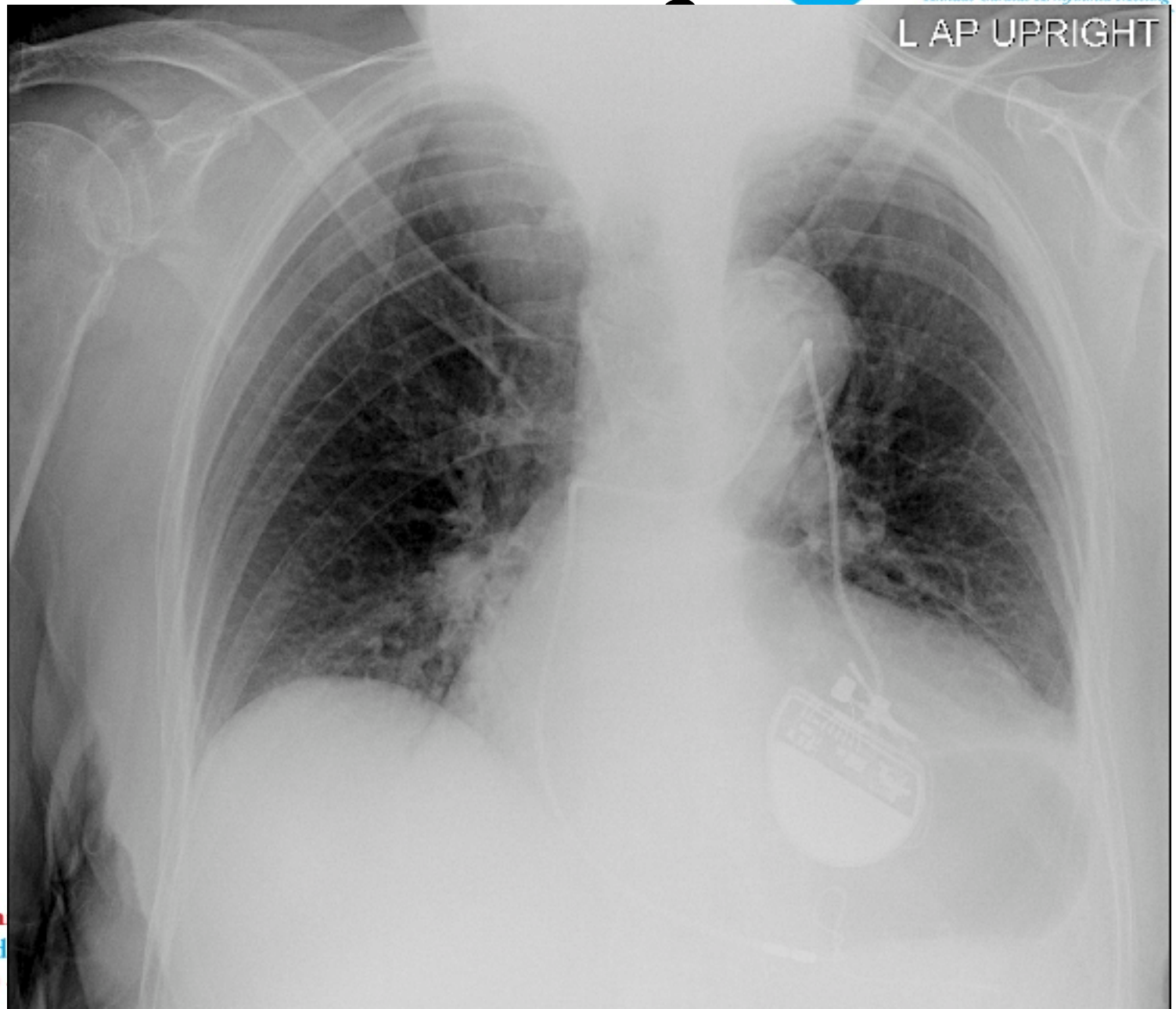
Case 3

- 85F with poor functional status is seen in routine pacemaker clinic follow-up
- She has a VVI PPM implanted 6yrs earlier
- Her other past medical history includes stroke, dementia (fully dependent)

Underlying Heart Rhythm: Complete Heart Block **Rate:** < 40 **bpm**
Dependancy: 4
Ventricular Capture Threshold: 0.70 V @ 0.40 ms
Ventricular Sensing Threshold: No R waves detected
Final Settings: 1.2 V (Auto) @ 0.40 ms @ 2.50 mV
Minimum Pacing Rate: 60 **ppm** **Maximum Sensor Rate:** 130 **ppm**
Nurse's Comments: Device has reached Elective Replacement Indicator (ERI). Magnet noted at 90 min-1, longevity recorded at 1.0 year.
Pre-op and OR date will be arranged by resource nurse.

Magnet rate, lead impedance and battery voltage were appropriate.
No R-waves sensed, stable thresholds on testing.
Diagnostics indicated pacing at 100% with limited rate distribution noted on the Histogram.

Arrhythmia logbook recorded 2 episodes, EGM's appear to have recorded noise on the lead,
Pacemaker incision site is satisfactory.
Device is visible and prominent beneath the skin, no erosion noted.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Case 3

- What would you recommend?
  A. Proceed with pack change and attempt a new RV lead
  B. Proceed with pack change only
  C. Recommend against any procedures in this woman
  D. You need more information

Case 4

- 84F with DDD PPM comes for routine visit
- Her medications include apixaban, HCTZ, candesartan, acetaminophen

Brady Parameters

Mode	Initial Value VVIR	Present Value VVIR	
Lower Rate Limit	60	60	min-1
Max Tracking Rate	--	--	min-1
Max Sensor Rate	130	130	min-1
AV Delay (paced)	--	--	ms
Atrial			
Pulse Width	--	--	ms
Amplitude	--	--	V
Sensitivity	--	--	mV
Refractory (PVARP)	--	--	ms
Ventricular			
Pulse Width	0.60	0.60	ms
Amplitude	3.0	3.0	V
Sensitivity	1.0	1.0	mV
Refractory	250	250	ms

AV Delay

	Initial Value	Present Value	
Dynamic AV Delay	--	--	
Maximum Delay	--	--	ms
Minimum Delay	--	--	ms
Sensed AV Offset	--	--	ms

Sensor(s)

	Initial Value	Present Value	
Accelerometer	On	On	
Activity Threshold	Medium	Medium	
Reaction Time	20	20	sec
Response Factor	8	8	
Recovery Time	5	5	min

Measured Data- Lead Impedance

	Atrial		Ventricular	
	Previous	Present	Previous	Present
Date of last test	11-JAN-2017		11-JAN-2017	
Impedance	680		820	
Amplitude	3.5		3.0	
Pulse Width	0.60		0.60	
Current	5		4	
Lead Config. (paced)	Bipolar		Bipolar	
Energy	10.8		6.6	

Measured Data- Intrinsic Amplitude

	Previous	Present	
Date of last test	11-JAN-2017		
Chamber Tested	Atrium		
Measured Amplitude	2.4		mV
Lead Configuration (sensed)	Bipolar		

Measured Data- Intrinsic Amplitude

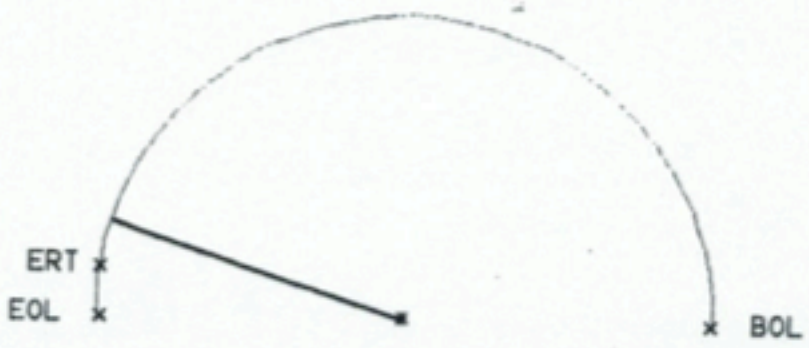
	Previous	Present	
Date of last test	11-JAN-2017		
Chamber Tested	Ventricle		
Measured Amplitude	4.4		mV
Lead Configuration (sensed)	Bipolar		

Counters

Date of Last Reset	11-JAN-2017	
		Since Last Reset
Paced and Sensed		
A-sensed / V-sensed	50 %	1.3M
A-sensed / V-paced	50 %	1.4M
A-paced / V-sensed	0 %	0
A-paced / V-paced	0 %	0
Atrial		
Paced	0 %	0
Sensed	0 %	0
Ventricular		
Paced	50 %	1.4M
Sensed	50 %	1.3M
A-Tachy Response		0
Mode Switches	0 %	0.0 min
Total Time		0.0 min
Maximum Time		0.0 min
Average Time		
Ectopic Beats		
PACs		0
Single or Double PVCs		0
Three or More PVCs		0
Atrial Tachy Detections		0
Ventricular Tachy Detections		0
Rate Hysteresis		
Searches		0
Successful Searches		0
Pacemaker Wenckebach Counters		0

Battery Status

	Previous	Present	
Date of last test	11-JAN-2017		
Battery Status	Good	Good	
Magnet Rate	90	90	
Longevity Remaining @ Current Pacing Percentage(s)		<0.5	min- year



BOL- Beginning of life
ERT- Elective Replacement Time
EOL- End of Life

Case 4

- What would you recommend?
  A. Proceed with DDD PPM pack change
  B. Other

Case 5

- 66M with DDD PPM for complete AV block approaching ERI
- Dependent on RV
- Has been getting recent syncopal episodes

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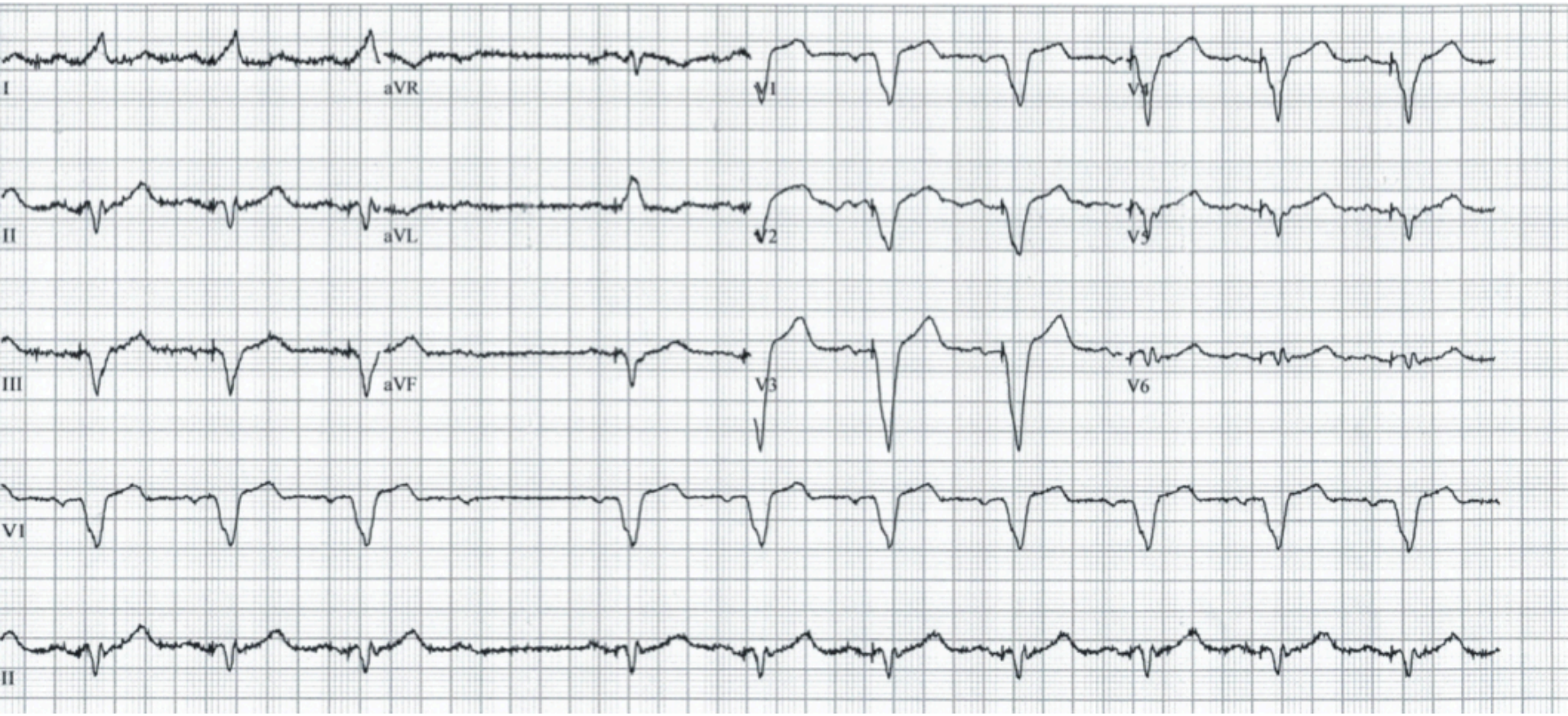

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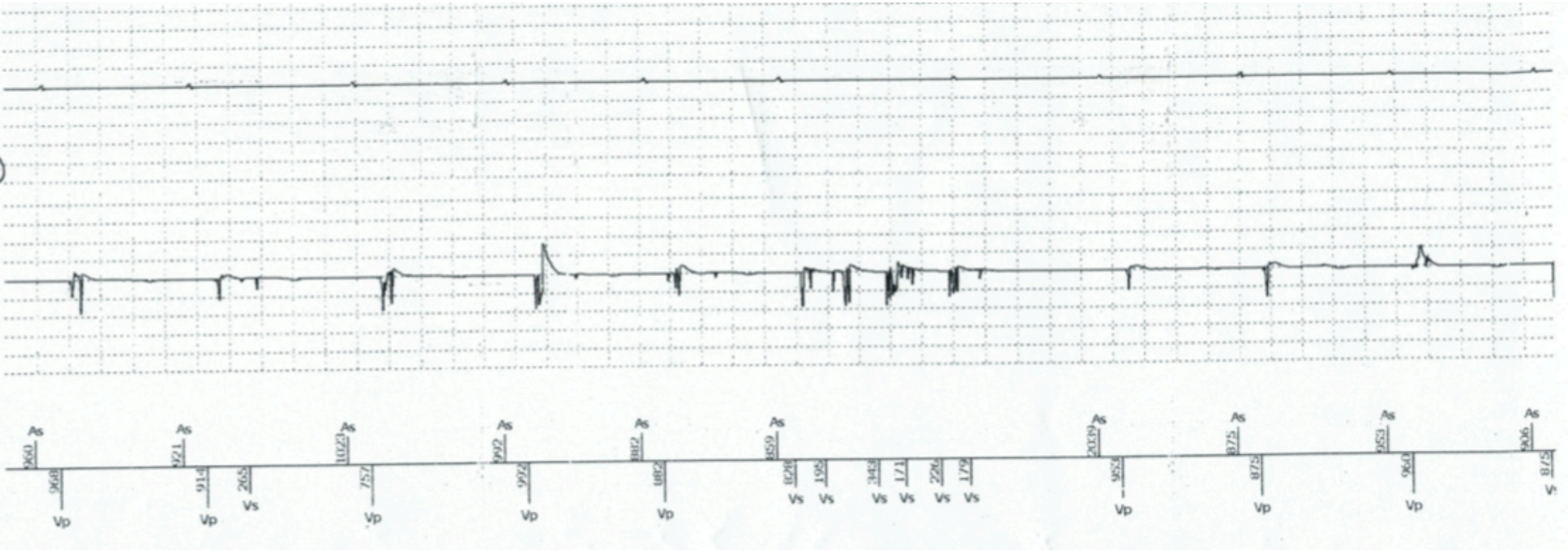
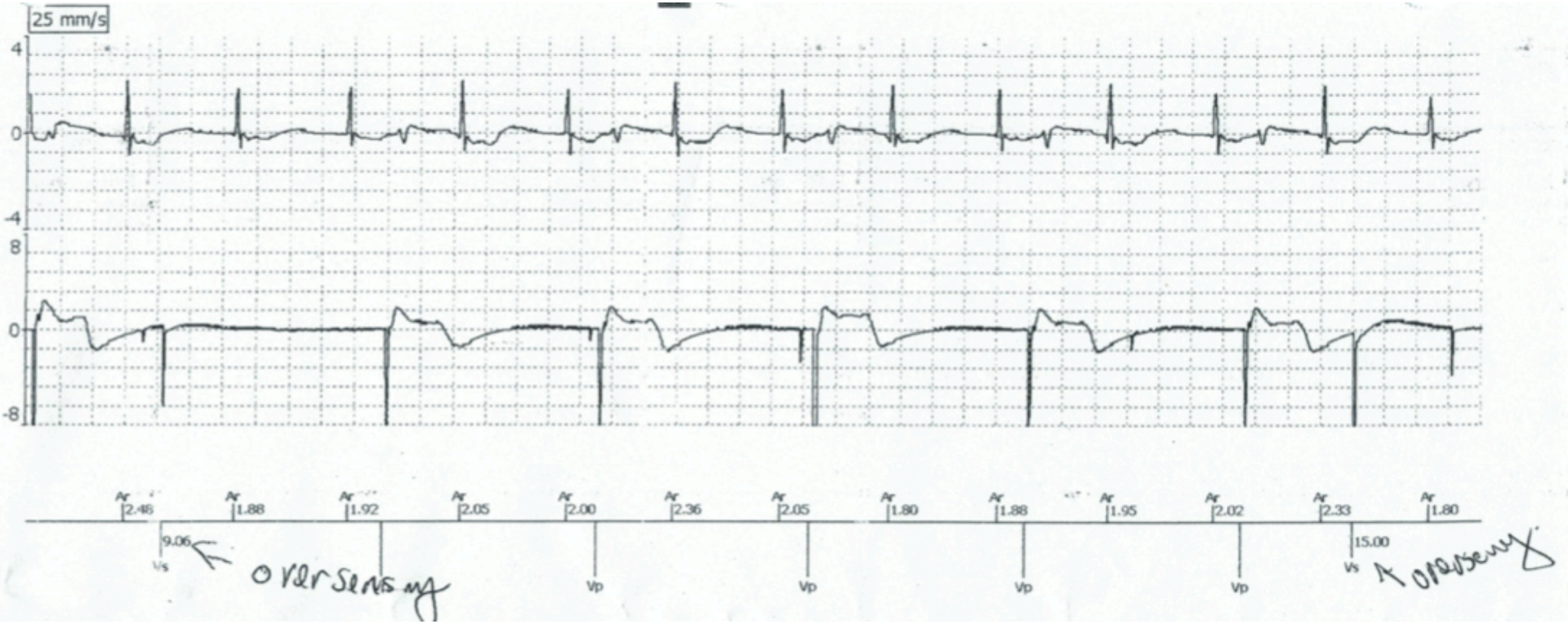

As
Vp
Vs


25 mm/s
4
0
-4
8
0
-8
Ar 2.46
Ar 1.88
Ar 1.92
Ar 2.05
Ar 2.00
Ar 2.36
Ar 2.05
Ar 1.80
Ar 1.88
Ar 1.95
Ar 2.02
Ar 2.33
Ar 1.80
9.06
Vs
oversensing
Vp
Vp
Vp
Vp
15.00
Vs
undersensing

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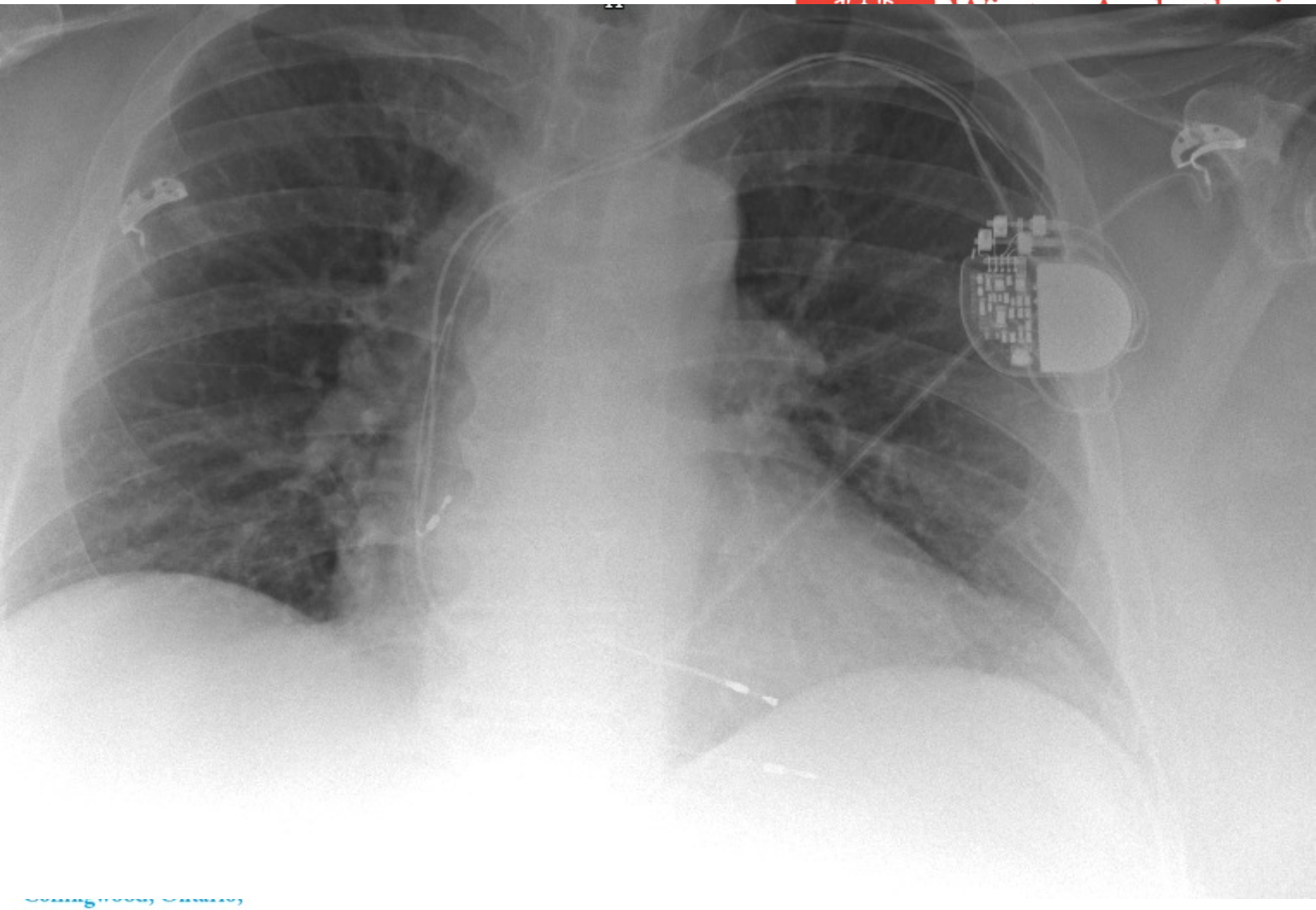

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Case 5

- What would you recommend?
  A. Proceed with DDD PPM pack change and new RV lead and cap the old RV lead
  B. Proceed with lead extraction, new device and RV lead
  C. Proceed with new DDD PPM on the right side

Case 6

- 65M with DDD PPM for complete AV block tripped ERI last month
- Dependent on the RV
- At implant, had normal LV function
- 2 years ago had angiogram because of LV dysfunction (LVEF 40%), no HF

Case 6

- What would you recommend?
  A. Proceed with DDD PPM pack change
  B. Proceed with CRT-D upgrade by adding RV and LV leads
  C. Proceed with CRT-P upgrade by adding LV lead
  D. You need more information

Terminology

- ERI = elective replacement indicator
- ERN = elective replacement near
- ERT = estimated replacement time
- RRT = recommended replacement time
- EOL = end of life

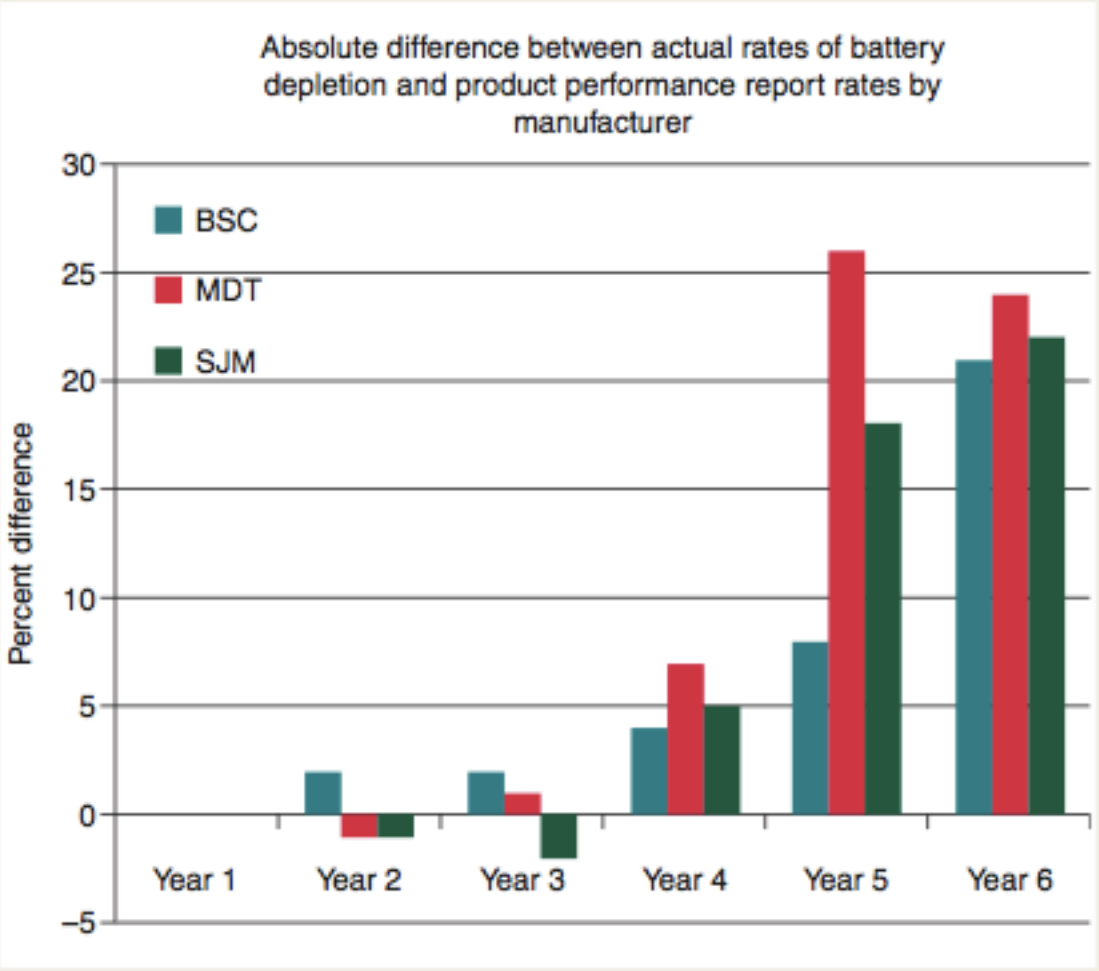

Figure 2 Bar graph showing the absolute difference in battery longevity between the measured longevity according to our data and the product performance report estimated longevity as published by each device manufacturer for each year after device implantation. Note the an increase in absolute overestimation by the product performance report particularly past 4 years from implantation.

ClinicoEconomics and Outcomes Research

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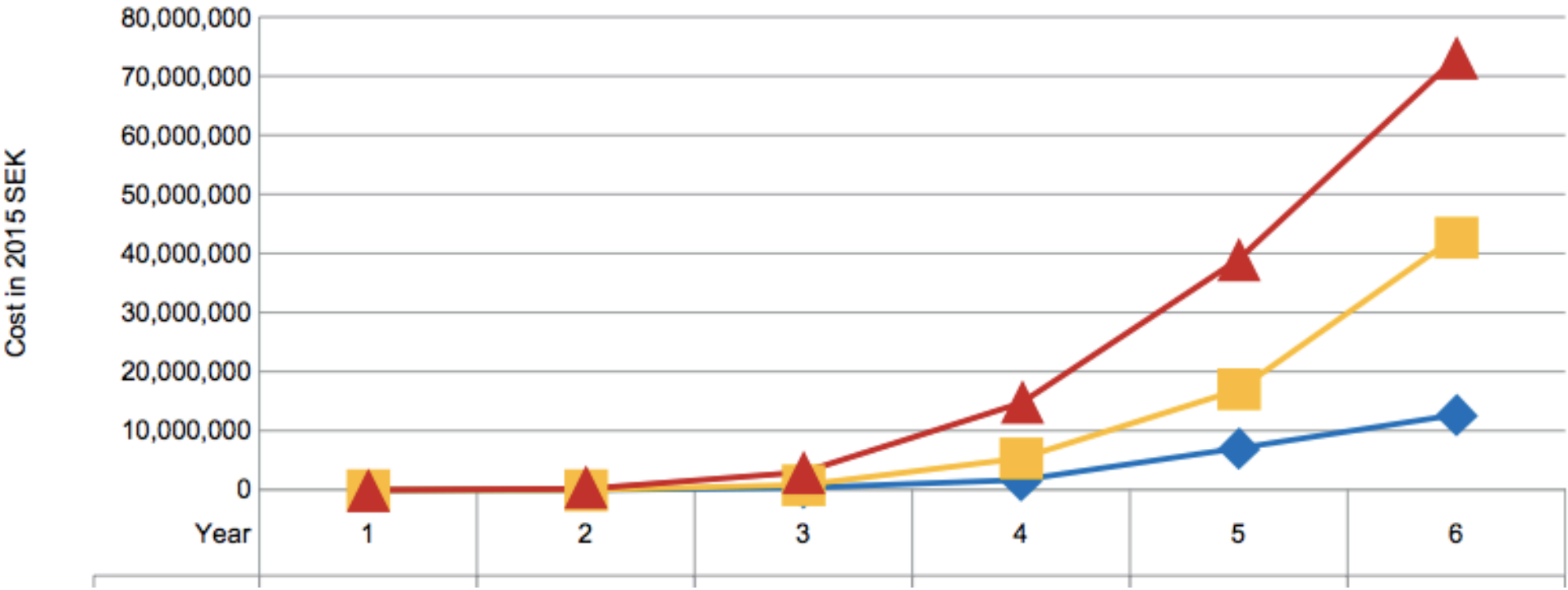
ORIGINAL RESEARCH

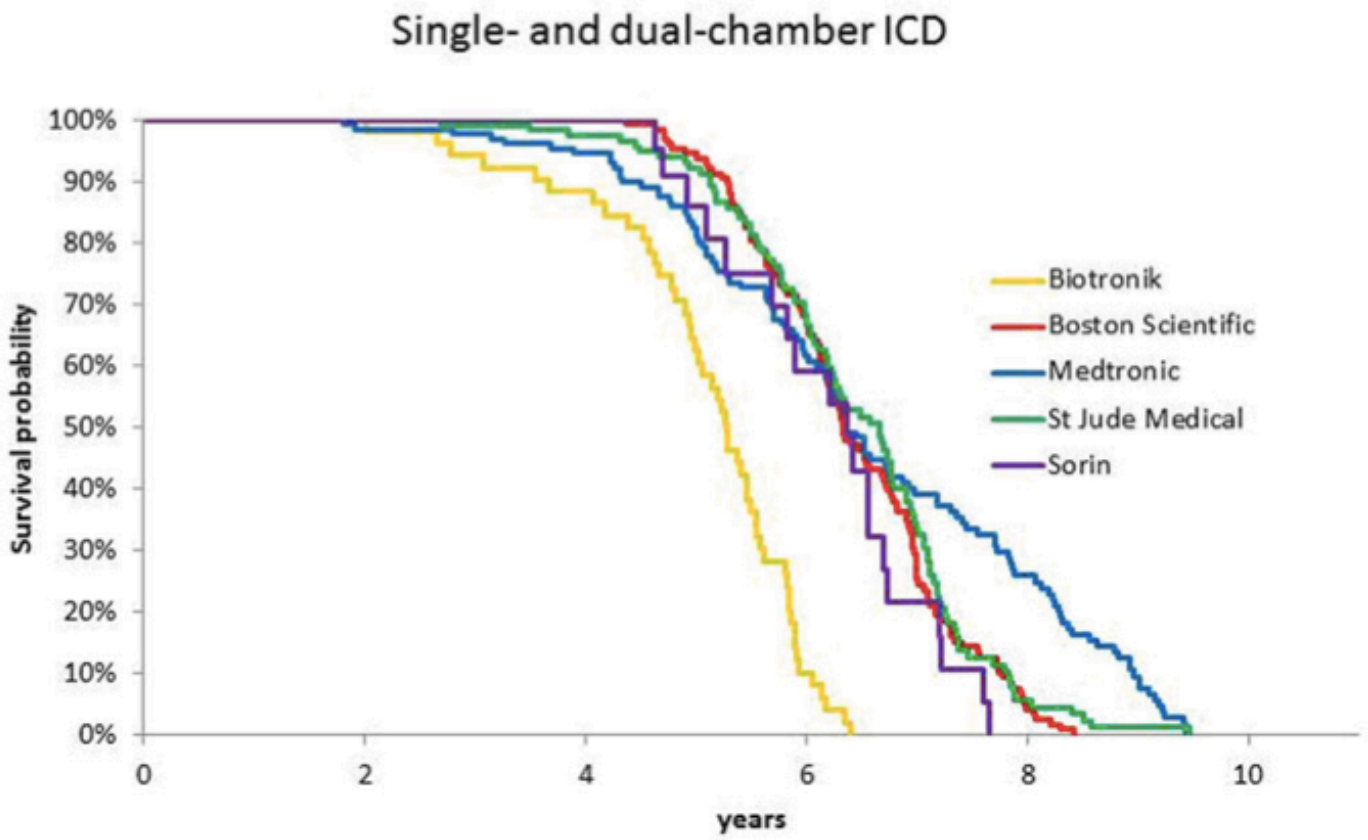
Economic impact of longer battery life of cardiac resynchronization therapy defibrillators in Sweden

Event-free battery survival (ie, percentage of devices with functional batteries and not requiring replacement)[22]			
Year 1	100.000	100.000	100.000
Year 2	100.000	100.000	99.727
Year 3	99.180	98.361	94.812
Year 4	97.246	90.687	77.596
Year 5	88.048	75.410	51.639
Year 6	87.978	40.816	31.694


Cost in 2015 SEK
80,000,000
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
Year
1
2
3
4
5
6

Device Longevity in a Contemporary Cohort of ICD/CRT-D Patients Undergoing Device Replacement

FRANCESCO ZANON, M.D., F.E.S.C., F.H.R.S.,* CRISTIAN MARTIGNANI, M.D.,† ERNESTO AMMENDOLA, M.D.,‡ ENDRJ MENARDI, M.D.,§ MARIA LUCIA NARDUCCI, M.D., PH.D.,¶ PAOLO DE FILIPPO, M.D.,# MATTEO SANTAMARIA, M.D.,‖ ANDREA CAMPANA, M.D.,** GIUSEPPE STABILE, M.D.,†† DOMENICO ROSARIO POTENZA, M.D.,‡‡ GIANNI PASTORE, M.D.,* MATTEO IORI, M.D.,§§ CONCETTO LA ROSA, M.D.,¶¶ and MAURO BIFFI, M.D.†



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BOL Beginning of Life	GOOD	100 ppm	▪ Expected battery status at implant. ▪ All device features are available.	▪ Normal implant and pre-discharge monitoring.
Gauge points between BOL and ERT	GOOD	100 ppm	▪ Corresponds to a battery status gauge that is greater than ERT. ▪ All device features are available.	▪ Normal follow-up schedule per individual clinic guidelines.
	GOOD	90 ppm ERN	▪ Elective Replacement Near ▪ ERN is not a permanent/latching indicator, and will not appear on the battery status line (GOOD will appear). A Magnet Rate of 90ppm may revert to 100ppm with decreased pacing demands or programming changes. ▪ All device features remain available.	▪ Approximately one year or less remaining to ERT. ▪ Intensified follow-up is recommended.
ERT Elective Replacement Time	ERT	85 ppm	▪ Mode will change to a non-adaptive-rate mode (i.e., DDDR to DDD, VVIR to VVI). ▪ The following features will be disabled: • Sensors • Trending • Event Markers • EP Test • Stored and Real-time EGMs • Beat-to-beat Autocapture* • Activity Log • Commanded Autothreshold ▪ The ERT indicator is a permanent state. Even with decreased pacing demands or programming changes, the device will not revert to ERN or GOOD.	▪ Schedule replacement. ***NOTE:*** *Unlike Boston Scientific defibrillators, Boston Scientific pacemakers do not include a beeper to indicate replacement time.*
EOL End of Life	EOL	≤ 85 ppm	▪ **Three months after ERT, as the battery continues to deplete, the device will reach EOL.** ▪ EOL is a permanent state. Even with decreased pacing demands or programming changes, the device will not revert back to ERT, ERN or GOOD. ▪ Dual-chamber pacemakers will change modes to single-chamber operation (DDD and VDD to VVI). ▪ The lower rate limit will be lowered to 50 ppm and as the battery continues to deplete, the pacing amplitude will decrease. ▪ Telemetry is not guaranteed. ▪ The following additional features will be disabled: • Dual-chamber • Rate Smoothing • Threshold Test • Histograms • Lead impedance measurements • P & R wave measurements • Arrhythmia logbook • Event Counters • Temporary parameters • Quick Check	▪ Three months after ERT, the device will reach EOL. ▪ Schedule replacement immediately, as pacing capture and telemetry are no longer guaranteed.

20mos, <8 - 32mos

50% up to 20mos

vast majority more at least 8mos

minority more than 32mos

ended interval nths)	Battery impedance displayed at last follow-up (kOhms)												
	1.0 kΩ	1.5 kΩ	2.0 kΩ	2.5 kΩ	3.0 kΩ	3.5 kΩ	4.0 kΩ	4.5 kΩ	5.0 kΩ	5.5 kΩ	6.0 kΩ	6.5 kΩ	7.0 k
34 M	12 M	12 M	12 M	12 M	12 M	NA	NA	NA	NA	NA	NA	NA	NA
33 M	12 M	12 M	12 M	12 M	12 M	NA	NA	NA	NA	NA	NA	NA	NA
32 M	12 M	12 M	12 M	12 M	12 M	NA	NA	NA	NA	NA	NA	NA	NA
31 M	12 M	12 M	12 M	12 M	12 M	NA	NA	NA	NA	NA	NA	NA	NA
30 M	12 M	12 M	12 M	12 M	12 M	NA	NA	NA	NA	NA	NA	NA	NA
29 M	12 M	12 M	12 M	12 M	12 M	NA	NA	NA	NA	NA	NA	NA	NA
28 M	12 M	12 M	12 M	12 M	12 M	NA	NA	NA	NA	NA	NA	NA	NA
27 M	12 M	12 M	12 M	9 M	9 M	NA	NA	NA	NA	NA	NA	NA	NA
26 M	12 M	12 M	9 M	9 M	9 M	12 M	NA	NA	NA	NA	NA	NA	NA
25 M	12 M	12 M	9 M	9 M	9 M	9 M	NA	NA	NA	NA	NA	NA	NA
24 M	12 M	12 M	9 M	9 M	9 M	9 M	NA	NA	NA	NA	NA	NA	NA
23 M	12 M	9 M	9 M	9 M	9 M	9 M	NA	NA	NA	NA	NA	NA	NA
22 M	12 M	9 M	9 M	9 M	9 M	9 M	NA	NA	NA	NA	NA	NA	NA
21 M	12 M	9 M	9 M	6 M	9 M	9 M	NA	NA	NA	NA	NA	NA	NA
20 M	9 M	9 M	6 M	6 M	6 M	9 M	NA	NA	NA	NA	NA	NA	NA
19 M	9 M	9 M	6 M	6 M	6 M	6 M	9 M	NA	NA	NA	NA	NA	NA
18 M	9 M	9 M	6 M	6 M	6 M	6 M	9 M	NA	NA	NA	NA	NA	NA
17 M	9 M	6 M	6 M	6 M	6 M	6 M	6 M	NA	NA	NA	NA	NA	NA
16 M	9 M	6 M	6 M	6 M	6 M	6 M	6 M	NA	NA	NA	NA	NA	NA
15 M	6 M	6 M	6 M	6 M	6 M	6 M	6 M	NA	NA	NA	NA	NA	NA
14 M	6 M	6 M	6 M	3 M	3 M	6 M	6 M	6 M	NA	NA	NA	NA	NA
13 M	6 M	6 M	3 M	3 M	3 M	3 M	6 M	6 M	NA	NA	NA	NA	NA
12 M	6 M	3 M	3 M	3 M	3 M	3 M	6 M	6 M	NA	NA	NA	NA	NA
11 M	6 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	6 M	NA	NA	NA	NA
10 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	NA	NA	NA	NA
9 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	NA	NA	NA	NA
8 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	3 M	NA	NA	NA
7 M	3 M	3 M	ASAP	ASAP	ASAP	ASAP	3 M	3 M	3 M	3 M	NA	NA	NA
6 M	3 M	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	3 M	3 M	3 M	ASAP	NA	NA
5 M	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	NA
4 M	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP	ASAP

This table should be used for

Longevity estimates are ESTIMATES

Longevity estimates are ESTIMATES

- Patient usage (dependency, shocks)
- Programming features
- Lead characteristics (threshold and impedance)
- Probability

Approach

- PPM vs ICD

- History
- Examination
- Device
- Investigations

History

- Symptoms
  - symptoms of too slow
  - symptoms of too fast
  - symptoms of heart failure
  - symptoms of the device
- Allergies
- Past Medical History
- Medications
  - oral anticoagulation
  - dual antiplatelet agents

Examination

- Site

- Signs of heart failure

Device

1. Prior Implant (access, submuscular, complic)
2. Battery Longevity
3. Do the leads work?
   - threshold, sensing, impedance

   bipolar vs unipolar configuration
4. Does the patient work?
   - %pacing and dependency (-> is a spectrum)
   - histogram
   - new important episodes

Investigations

- ECG -> always a good idea

- Preprocedure bloodwork
  - creatinine is often the new INR

Major Decisions

1. Does the patient still need a device?
2. Does the patient need the same device?
   - consider upgrade to CRT if
     - LV dysfunction
     - high degree of pacing or underlying LBBB
     - NYHA >= 2
   - consider upgrade to ICD if
     - LVEF <=35%
     - sustained VT

Decision Aides

- ECHO
- MUGA
- 6 Minute Walk Test

Major Decisions

3. Does the patient need <u>new leads</u>?

ALWAYS A BALANCE

BENEFITS	RISKS
-old lead drains battery?	-new lead same/worse?
-requires AV synchrony?	-PNX/perf/dislodg?
-lower inf risk concurrently?	-slightly higher inf risk?

-are the old leads on advisory?

Risk of infection

- No Device
- New Device
- Pack Change
- Upgrade or Revision

HIGHER RISK

Major Decisions

4. Does the patient need <u>fewer</u> leads?

   -capping an RA lead

   -capping an LV lead

   -downgrading from ICD to PPM

   end of life, LV recovery, changing evidence

5. Does the patient need a <u>new site</u>?

   ie: pocket revision, submuscular implant

Major Decisions

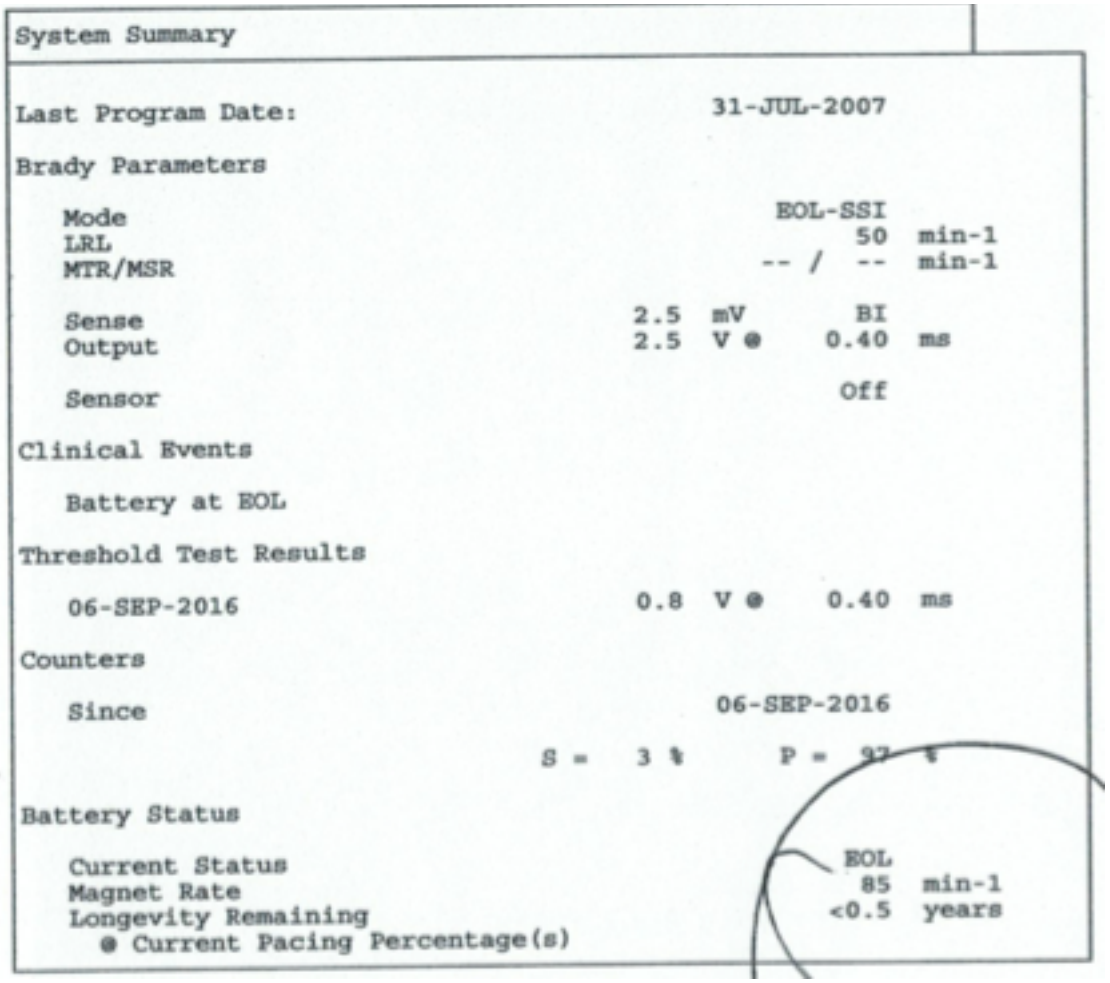
6. Timing?
   - longevity
   - dependency
   - travel
   - recent/upcoming medical issues

Perioperative Issues

- Anticoagulation management
- Needs a temporary pacemaker?
- Follow-up afterwards (especially if upgraded)

Case 1

- 97F admitted with Corynebacterium sepsis
- VVI PPM followed at a different centre
- In lieu of her regular appointment, while an inpatient, she is interrogated



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  A. Let her recover from her illness and follow up as an outpatient
  B. Replace her pack/generator while she is admitted
  C. Place a temporary transvenous pacemaker until she has finished her antibiotic therapy then replace
  D. You need more information

Case 2

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- Had a DDD PPM implanted 8yrs previously for vasovagal syncope with pauses

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	ApVs = 0 %		ApVp = 0 %	
ATR Mode Switches			8	
ATR Mode Switch Time			0 %	
Battery Status				
Current Status			Good	
Magnet Rate			100	min-1
Longevity Remaining			1.5	years

@ Current Pacing Percentage(s)

AP 0%
VP 1%

Case 2

- What would you recommend for this patient?
  A. Go ahead with a DDD PPM pack change
  B. Tell her she obviously does not need her pacemaker and take the current device out (and cap the leads)
  C. Tell her she obviously does not need her pacemaker and leave the device in situ
  D. You need more information

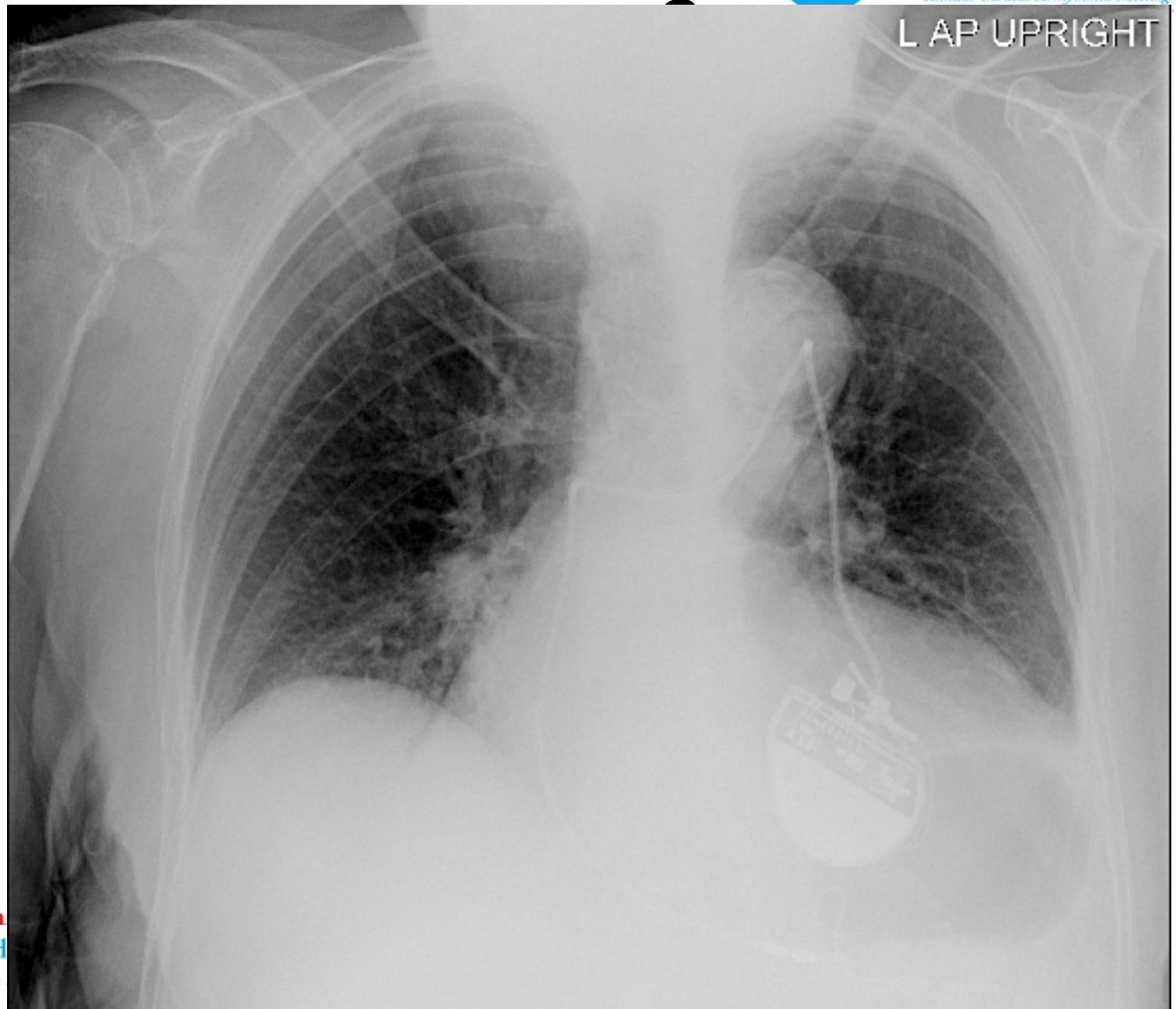
Case 3

- 85F with poor functional status is seen in routine pacemaker clinic follow-up
- She has a VVI PPM implanted 6yrs earlier
- Her other past medical history includes stroke, dementia (fully dependent)

Underlying Heart Rhythm: Complete Heart Block **Rate:** < 40 **bpm**
Dependancy: 4
Ventricular Capture Threshold: 0.70 V @ 0.40 ms
Ventricular Sensing Threshold: No R waves detected
Final Settings: 1.2 V (Auto) @ 0.40 ms @ 2.50 mV
Minimum Pacing Rate: 60 **ppm** **Maximum Sensor Rate:** 130 **ppm**
Nurse's Comments: Device has reached Elective Replacement Indicator (ERI). Magnet noted at 90 min-1, longevity recorded at 1.0 year.
Pre-op and OR date will be arranged by resource nurse.

Magnet rate, lead impedance and battery voltage were appropriate.
No R-waves sensed, stable thresholds on testing.
Diagnostics indicated pacing at 100% with limited rate distribution noted on the Histogram.

Arrhythmia logbook recorded 2 episodes, EGM's appear to have recorded noise on the lead,
Pacemaker incision site is satisfactory.
Device is visible and prominent beneath the skin, no erosion noted.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Case 3

- What would you recommend?
  A. Proceed with pack change and attempt a new RV lead
  B. Proceed with pack change only
  C. Recommend against any procedures in this woman
  D. You need more information

Case 4

- 84F with DDD PPM comes for routine visit
- Her medications include apixaban, HCTZ, candesartan, acetaminophen

Brady Parameters

Mode	Initial Value VVIR	Present Value VVIR	
Lower Rate Limit	60	60	min-1
Max Tracking Rate	--	--	min-1
Max Sensor Rate	130	130	min-1
AV Delay (paced)	--	--	ms
Atrial			
Pulse Width	--	--	ms
Amplitude	--	--	V
Sensitivity	--	--	mV
Refractory (PVARP)	--	--	ms
Ventricular			
Pulse Width	0.60	0.60	ms
Amplitude	3.0	3.0	V
Sensitivity	1.0	1.0	mV
Refractory	250	250	ms

AV Delay

	Initial Value	Present Value	
Dynamic AV Delay	--	--	
Maximum Delay	--	--	ms
Minimum Delay	--	--	ms
Sensed AV Offset	--	--	ms

Sensor(s)

	Initial Value	Present Value	
Accelerometer	On	On	
Activity Threshold	Medium	Medium	
Reaction Time	20	20	sec
Response Factor	8	8	
Recovery Time	5	5	min

Measured Data- Lead Impedance

	Atrial		Ventricular	
	Previous	Present	Previous	Present
Date of last test	11-JAN-2017		11-JAN-2017	
Impedance	680		820	
Amplitude	3.5		3.0	
Pulse Width	0.60		0.60	
Current	5		4	
Lead Config. (paced)	Bipolar		Bipolar	
Energy	10.8		6.6	

Measured Data- Intrinsic Amplitude

	Previous	Present	
Date of last test	11-JAN-2017		
Chamber Tested	Atrium		
Measured Amplitude	2.4		mV
Lead Configuration (sensed)	Bipolar		

Measured Data- Intrinsic Amplitude

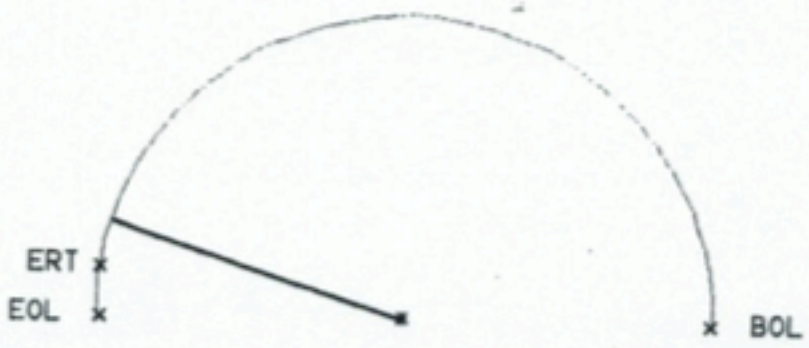
	Previous	Present	
Date of last test	11-JAN-2017		
Chamber Tested	Ventricle		
Measured Amplitude	4.4		mV
Lead Configuration (sensed)	Bipolar		

Counters

Date of Last Reset	11-JAN-2017	
		Since Last Reset
Paced and Sensed		
A-sensed / V-sensed	50 %	1.3M
A-sensed / V-paced	50 %	1.4M
A-paced / V-sensed	0 %	0
A-paced / V-paced	0 %	0
Atrial		
Paced	0 %	0
Sensed	0 %	0
Ventricular		
Paced	50 %	1.4M
Sensed	50 %	1.3M
A-Tachy Response		0
Mode Switches	0 %	0.0 min
Total Time		0.0 min
Maximum Time		0.0 min
Average Time		
Ectopic Beats		
PACs		0
Single or Double PVCs		0
Three or More PVCs		0
Atrial Tachy Detections		0
Ventricular Tachy Detections		0
Rate Hysteresis		
Searches		0
Successful Searches		0
Pacemaker Wenckebach Counters		0

Battery Status

	Previous	Present	
Date of last test	11-JAN-2017		
Battery Status	Good	Good	
Magnet Rate	90	90	
Longevity Remaining @ Current Pacing Percentage(s)		<0.5	min- year



BOL- Beginning of life
ERT- Elective Replacement Time
EOL- End of Life

Case 4

- What would you recommend?
  A. Proceed with DDD PPM pack change
  B. Other

Case 5

- 66M with DDD PPM for complete AV block approaching ERI
- Dependent on RV
- Has been getting recent syncopal episodes

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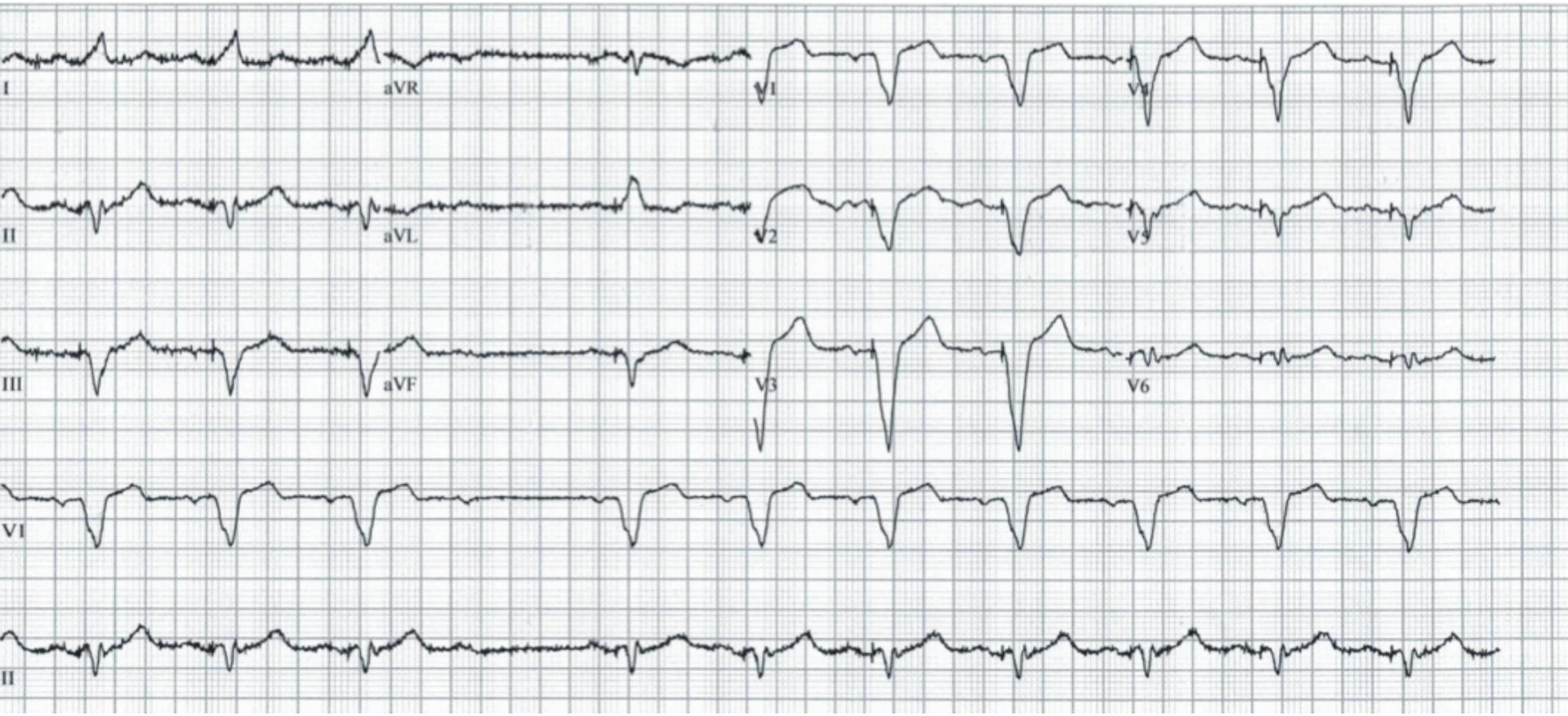

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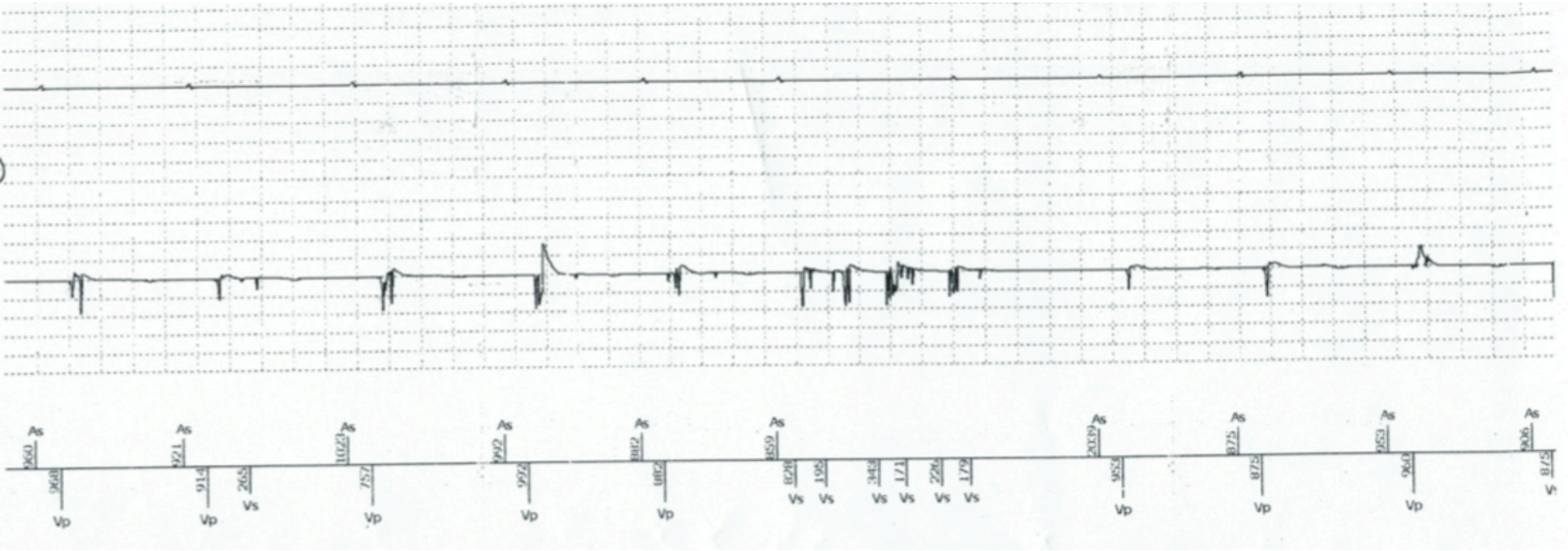
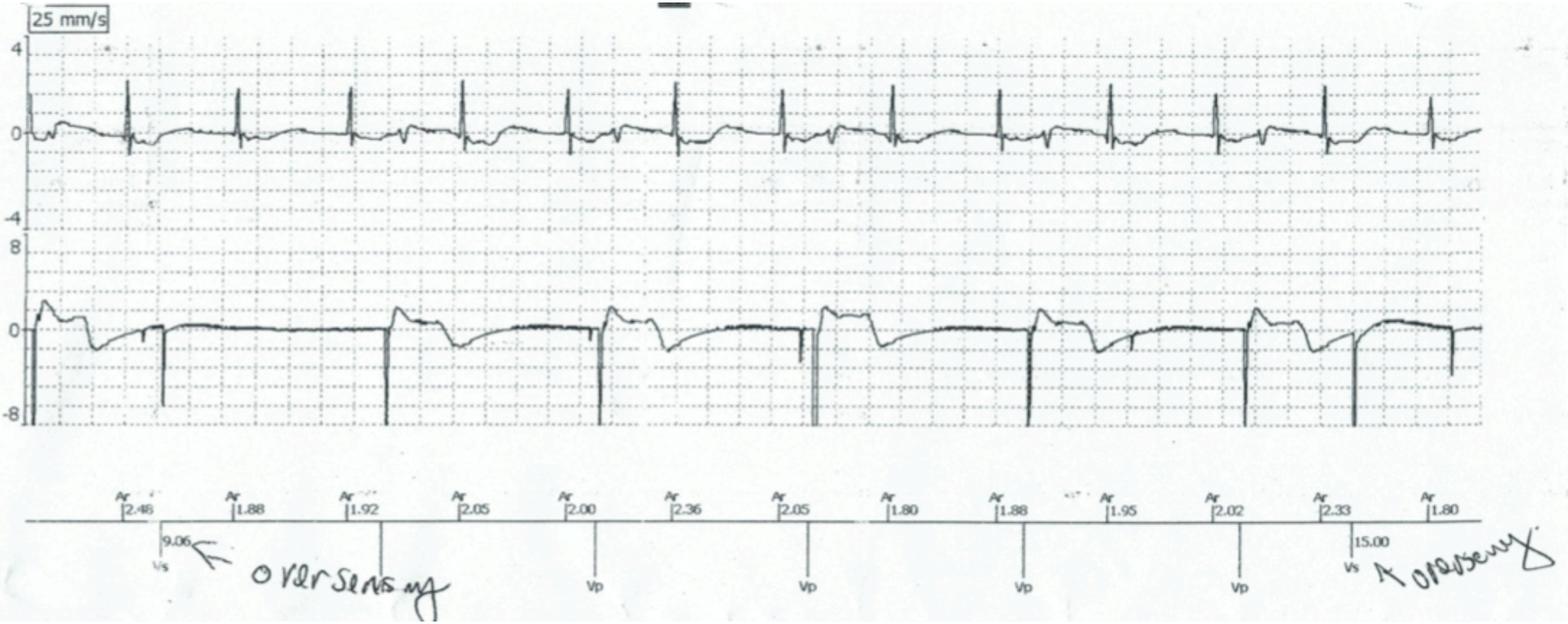

As
Vp
Vs


25 mm/s
4
0
-4
8
0
-8
Ar 2.46
Ar 1.88
Ar 1.92
Ar 2.05
Ar 2.00
Ar 2.36
Ar 2.05
Ar 1.80
Ar 1.88
Ar 1.95
Ar 2.02
Ar 2.33
Ar 1.80
9.06
Vs
oversensing
Vp
Vp
Vp
Vp
15.00
Vs
undersensing

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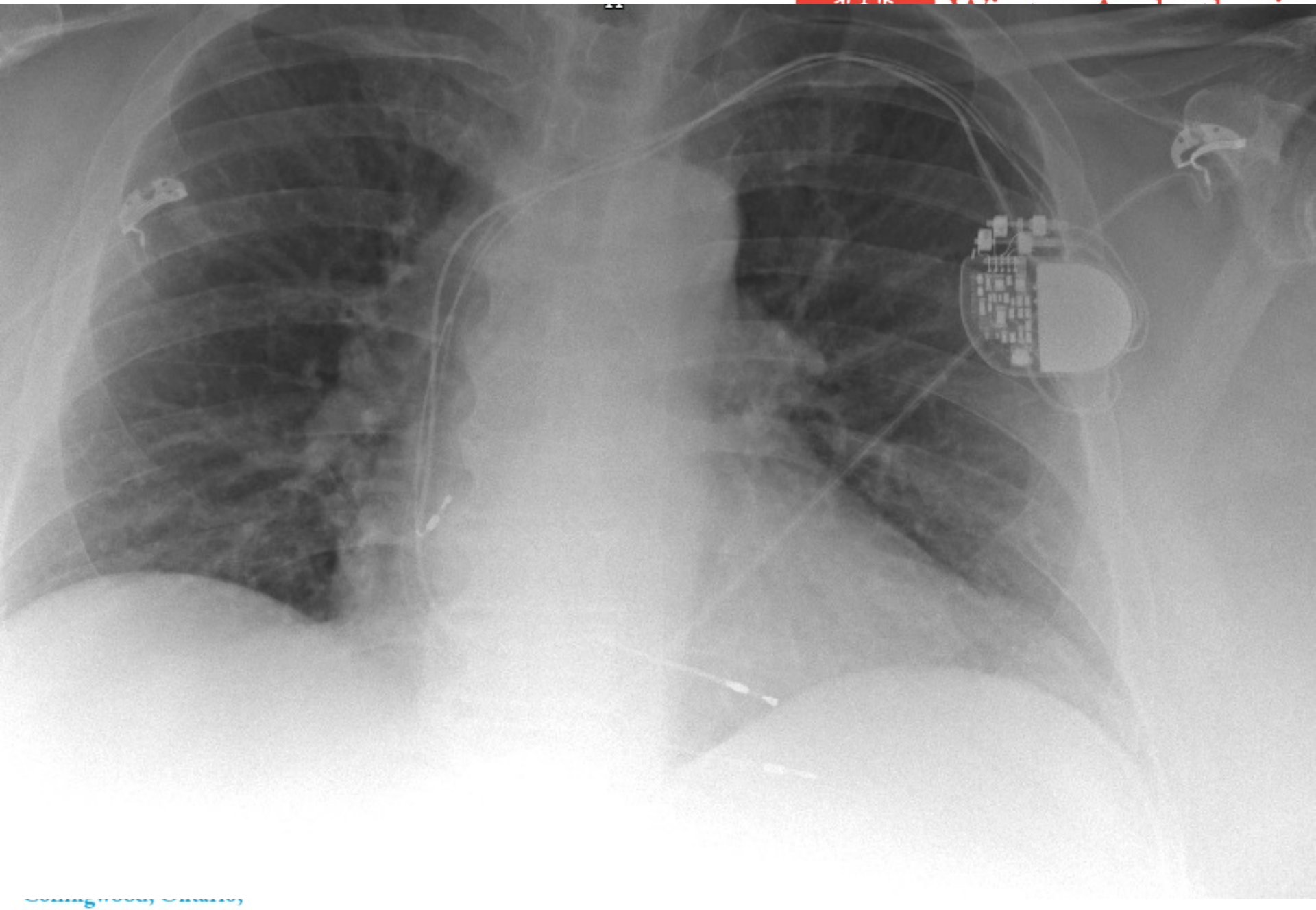

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Case 5

- What would you recommend?
  A. Proceed with DDD PPM pack change and new RV lead and cap the old RV lead
  B. Proceed with lead extraction, new device and RV lead
  C. Proceed with new DDD PPM on the right side

Transvenous Lead Extraction: Heart Rhythm Society Expert Consensus on Facilities, Training, Indications, and Patient Management

This document was endorsed by the American Heart Association (AHA).

Bruce L. Wilkoff, MD, FHRS,* Charles J. Love, MD, FHRS,† Charles L. Byrd, MD,‡
Maria Grazia Bongiorni, MD,§ Roger G. Carrillo, MD, FHRS,‖ George H. Crossley, III, MD, FHRS,¶
Laurence M. Epstein, MD,# Richard A. Friedman, MD, MBA, FHRS,** ‖‖
Charles E. H. Kennergren, MD, PhD, FHRS,†† Przemyslaw Mitkowski, MD,‡‡
Raymond H. M. Schaerf, MD, FHRS,§§ Oussama M. Wazni, MD*

Class IIa

1. Lead removal is reasonable in patients with leads that due to their design or their failure pose a threat to the patient, that is not immediate or imminent if left in place. (e.g. Telectronics ACCUFIX without protrusion) *(Level of evidence C)*
2. Lead removal is reasonable in patients if a CIED implantation would require more than 4 leads on one side or more than 5 leads through the SVC. *(Level of evidence C)*
3. Lead removal is reasonable in patients that require specific imaging techniques (e.g. MRI) and can not be imaged due to the presence of the CIED system for which there is no other available imaging alternative for the diagnosis. *(Level of evidence: C)*

Case 6

- 65M with DDD PPM for complete AV block tripped ERI last month
- Dependent on the RV
- At implant, had normal LV function
- 2 years ago had angiogram because of LV dysfunction (LVEF 40%), no HF

Case 6

- What would you recommend?
  A. Proceed with DDD PPM pack change
  B. Proceed with CRT-D upgrade by adding RV and LV leads
  C. Proceed with CRT-P upgrade by adding LV lead
  D. You need more information

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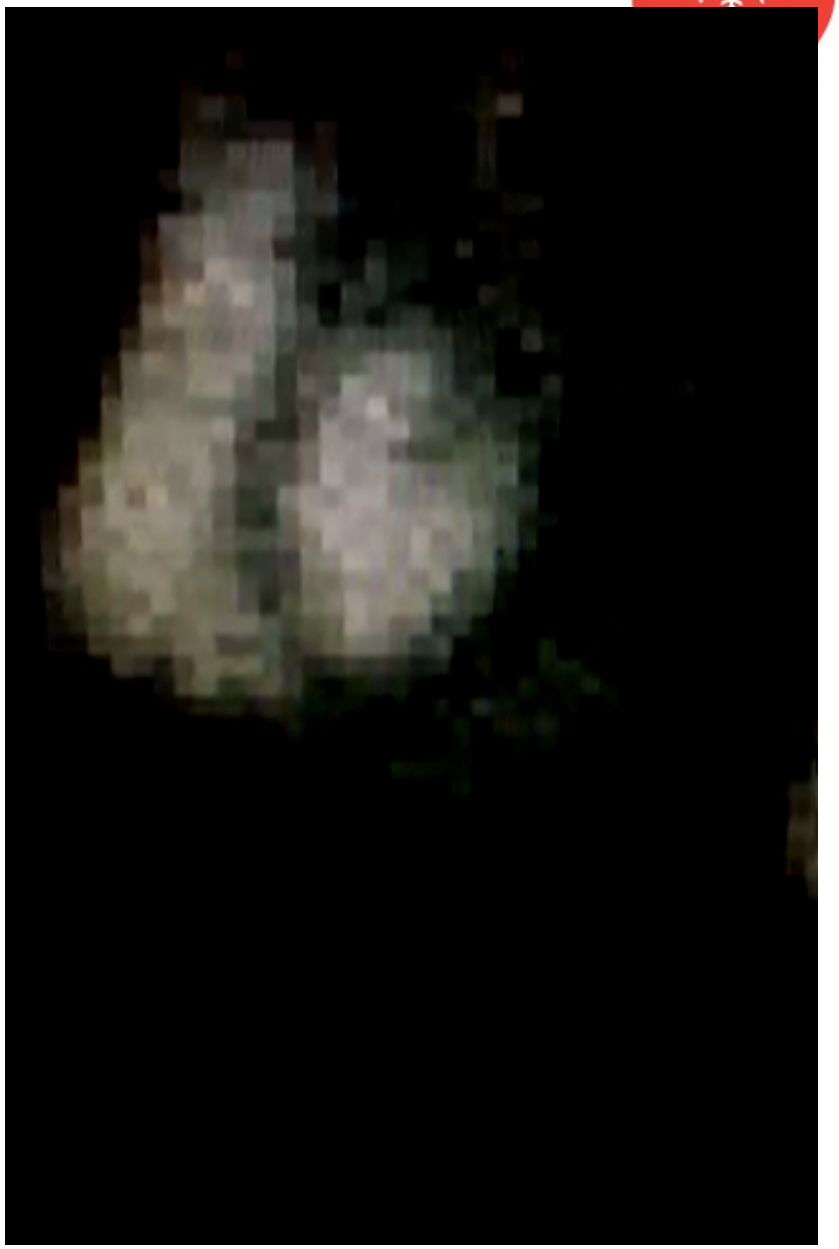

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Conclusions

- Device longevity is an estimate only
- Battery replacement is an opportunity to reevaluate the patient, the device, and anticipate problems
- No decision is without uncertainty and risk