Pacemakers And ICDs

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Disclosures

- No conflicts of interest

Pacemakers/ICDs

- Electrical therapy used to treat:
  - Bradyarrhythmias
  - Tachyarrhythmias
- USA implantations from 1990 to 2002
  - 2.25 million **pacemakers**
  - 416000 ICDs
- USA
  - 255,000/year pacemakers
  - 133,00/year ICDs

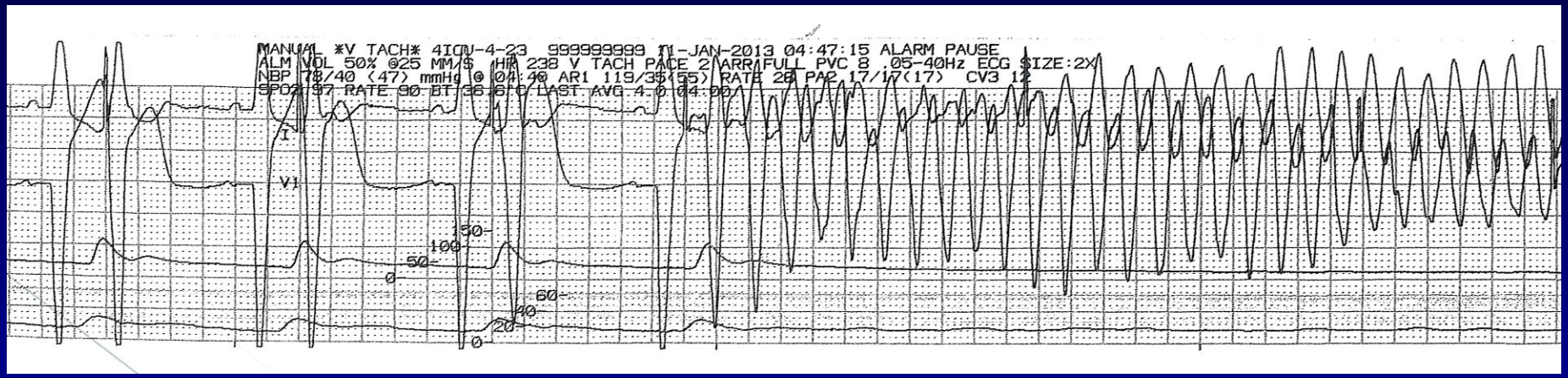
Pacer Codes

I Chamber paced	II Chamber sensed	III Mode of response
V - ventricle	V - ventricle	I - inhibited
A - atrium	A - atrium	T - triggered
D - dual	D - dual	D - dual
	0 - none	0 - none

Pacemaker - Patient competition

- Interpolated beats could compromise cardiac output
- Ventricular fibrillation from R-on-T

R-on-T


MANUAL *V TACH* 4ICU-4-23 999999999 11-JAN-2013 04:47:15 ALARM PAUSE
ALM VOL 50% @25 MM/S HR 238 V TACH PACE 2 ARR FULL PVC 8 .05-40Hz ECG SIZE:2X
NBP 78/40 (47) mmHg @ 04:40 AR1 119/35(155) RATE 28 PA2 17/17(17) CV3 12
SPO2 97 RATE 90 BT 36.6 C LAST AVG 4.0 04:00
I
V1
150
100
50
0
60
40
20
0

Pacer Codes

I Chamber paced	II Chamber sensed	III Mode of response
V - ventricle	V - ventricle	I - inhibited
A - atrium	A - atrium	T - triggered
D - dual	D - dual	D - dual
	0 - none	0 - none

Atrial tracking

- Requires dual chamber leads
- If the atria speed up, ventricles are paced at the faster rate
- Maintains AV synchrony
- Higher cardiac output when needed

- VAT
- DDD

Pacemaker Function Codes

- What does each mode do?
- Will it keep you alive if there is sinus node block?
- Will it treat A-V node block?
- Does competition occur?
- Does it track the atrial rate?

Mode	Treats sinus node disease?	Treats AV node disease?	? No compn	Atrial kick?	Tracks the atrial rate?	Pacemaker math	Use?
VOO	✓	✓	✗	✗	✗		
VVI	✓	✓	✓	✗	✗		
AOO	✓	✗	✗	✓	✗		
AAI	✓	✗	✓	✓	✗		
DOO	✓	✓	✗	✓	✗	AOO VOO DOO	
VAT	✓	✓	✗	✓/✗	✓		
DDD	✓	✓	✓	✓	✓	AAI VVI VAT DDD	

DDD - Universal Mode

- Dual chamber pacing
- Atrial kick adds to ventricular filling
- Only paces as needed: A and V
- Allows atrial tracking
- Not indicated in AF

Demand Modes

- Inhibited modes
- Back up modes
- Pace when needed
- Inhibit when not needed
- Avoid competition

- VVI
- AAI
- DDD

Asynchronous Modes

- Never inhibited by artifact or electrocautery
- Emergency pacing mode
- Cause competition

- A00
- V00
- D00

Rate

- Lower rate
  - Back up rate
- Upper rate
  - Highest rate ventricles will be paced in response to an atrial rhythm
  - Maximum atrial tracking
  - Wenkebach

Rate Adaptive Pacing

- Changes the rate of the pacer in response to the metabolic demand
- Physiological variables
  - Body motion or activity
  - Body chemistry changes
    - Minute ventilation
    - Respiratory rate
    - Central venous SO2
    - Central venous pH
  - Central venous temperature
  - Electrical changes in the heart

Rate Adaptive Methods

- Vibration sensor
  - Piezo-electric crystal
  - Deforms with movement
  - High sensitivity, low specificity
- Trans-thoracic bio-impedence
  - Measures depth and rate of respiration
  - Lower sensitivity, high specificity
- Vibration *and* minute ventilation
  - High sensitivity and specificity

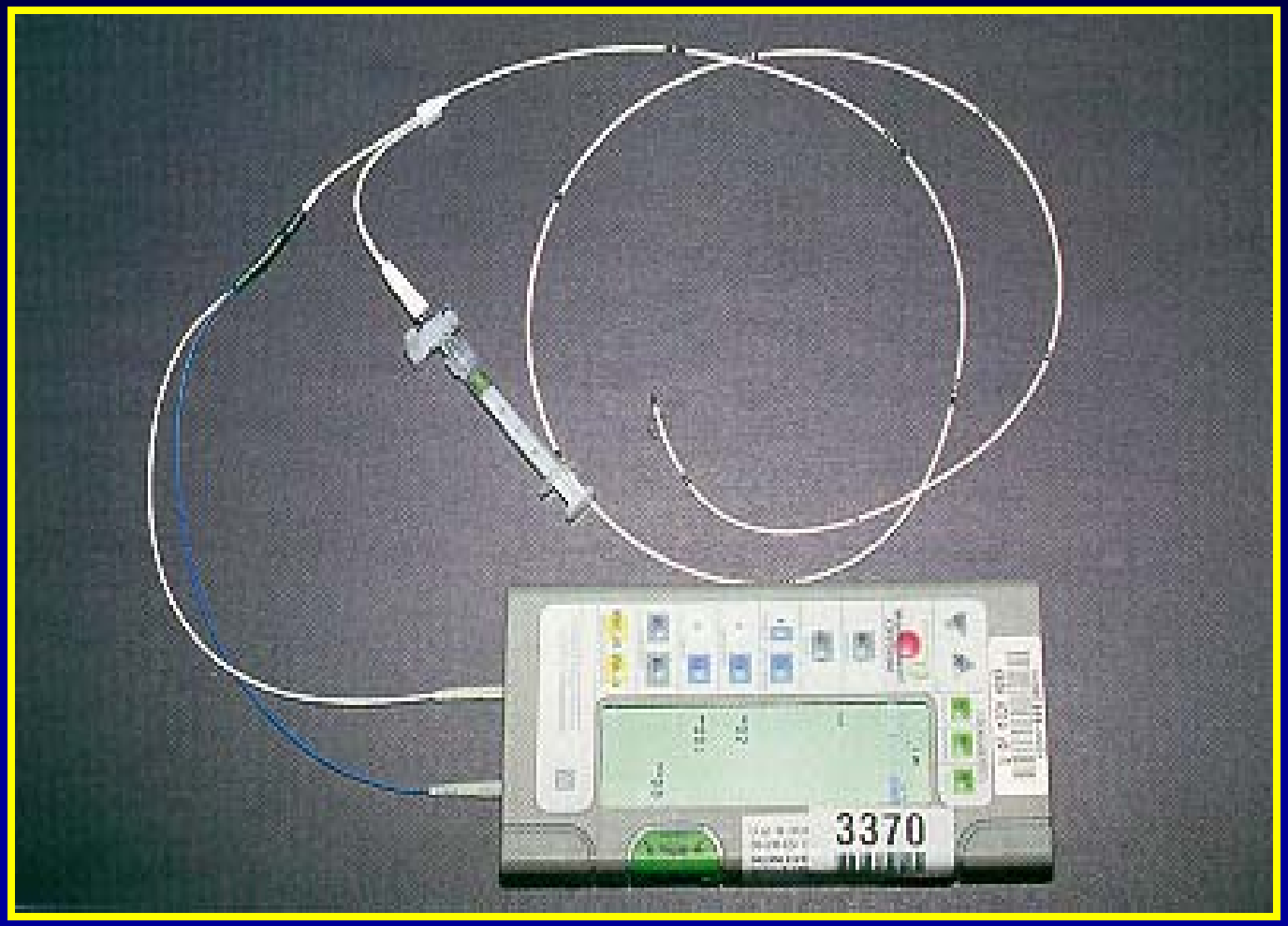
Temporary Perioperative Pacing

- Any indication for permanent pacing
- Cardiac surgery
- Bifascicular block with 1st degree block?

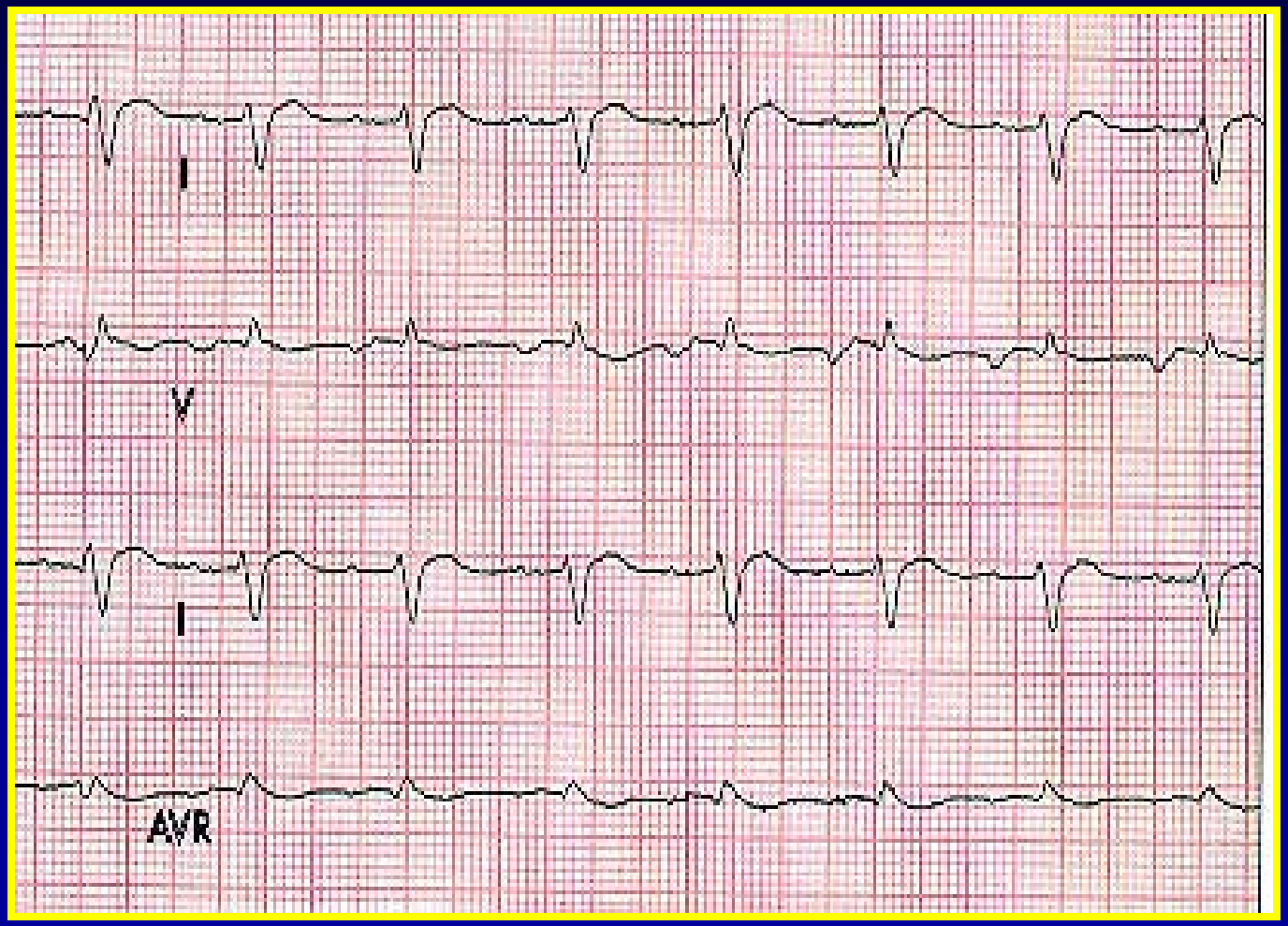
Temporary Pacing Techniques

- Transvenous
  - Ordinary pacing catheter
  - Pace-port pulmonary artery catheter
  - Balloon directed catheter
- Epicardial
- Trans-cutaneous
- Trans-oesophageal

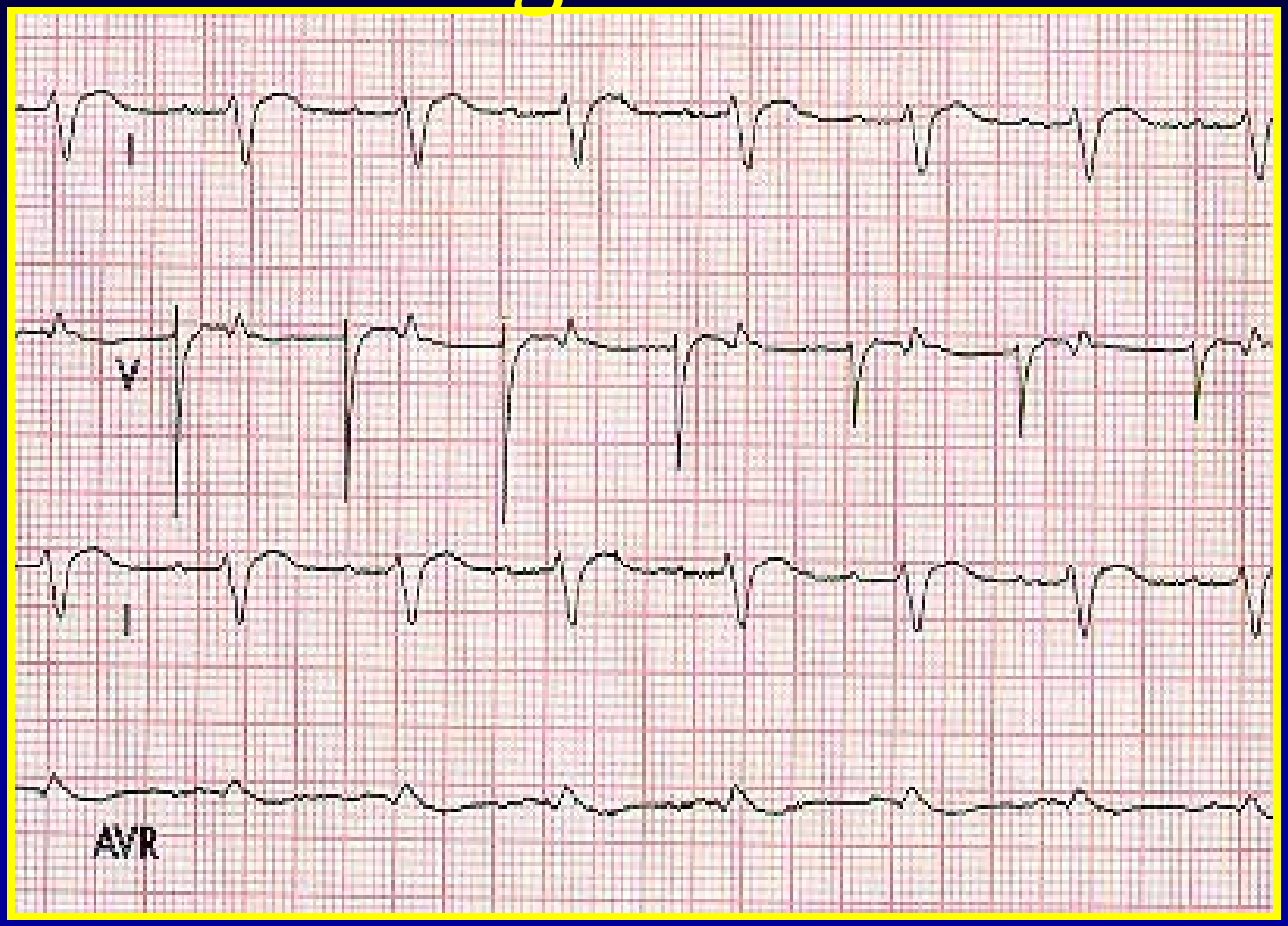
Balloon Directed Pacing Wire



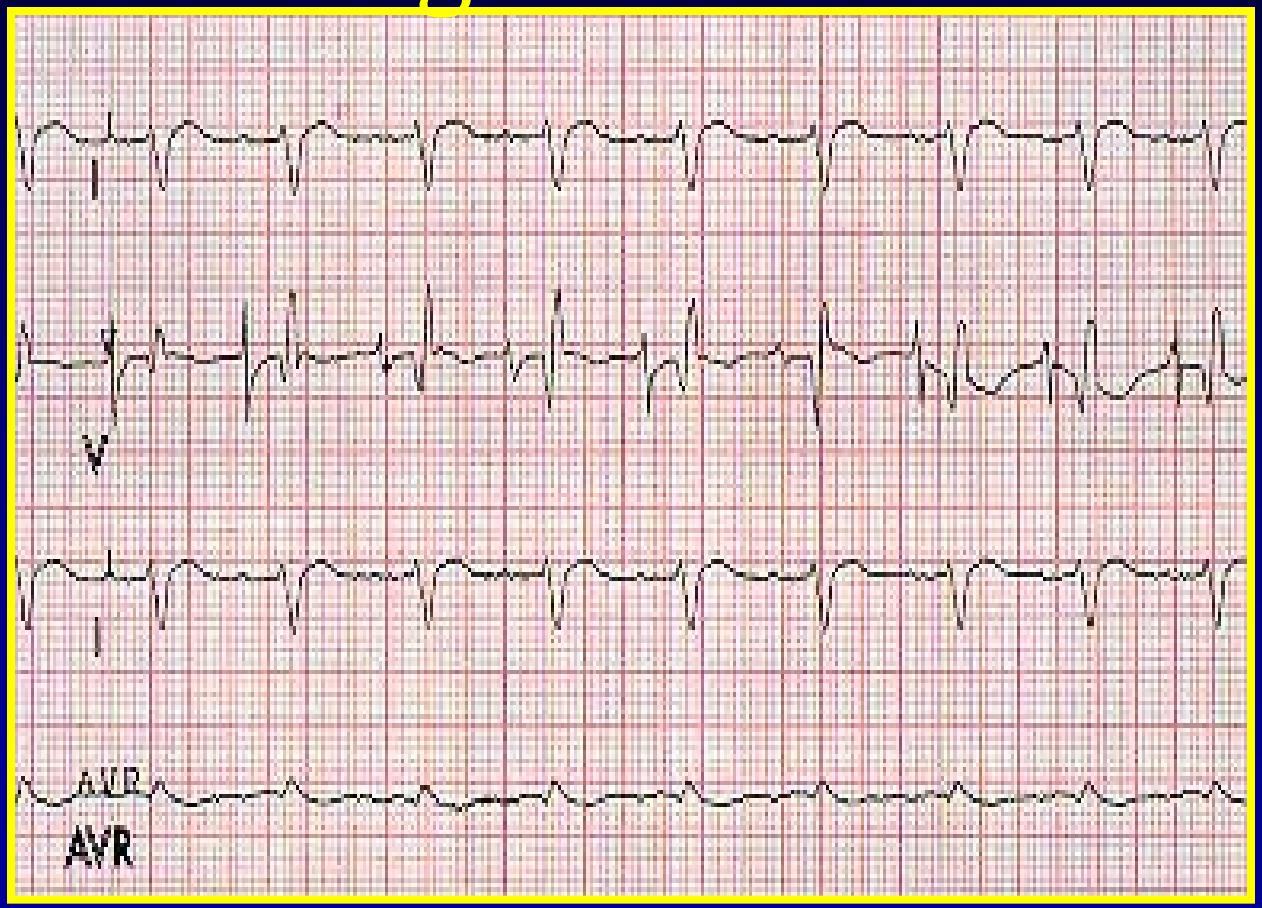
Floating a Pacing Wire
1: SVC



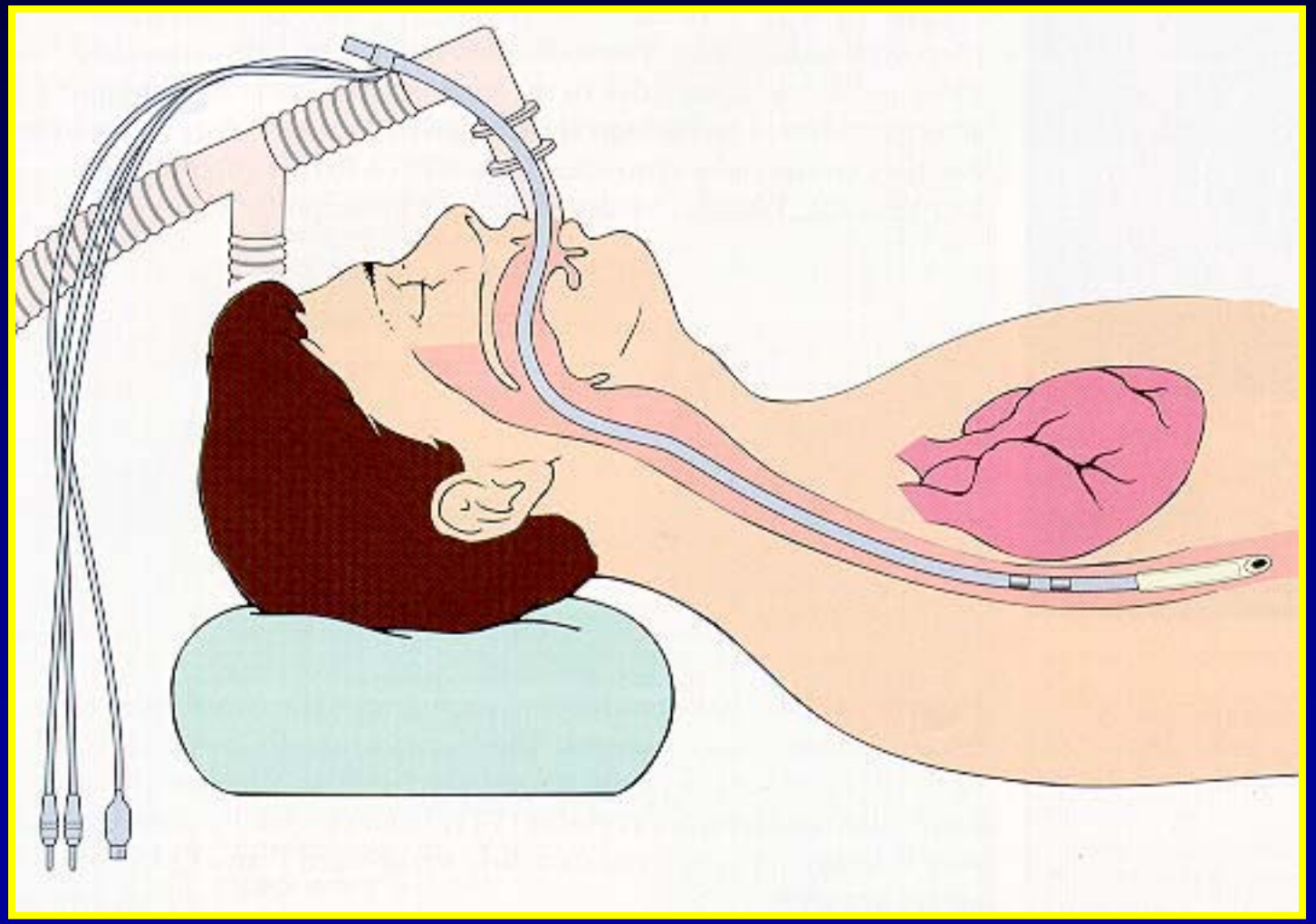
Floating a Pacing Wire
2: Right Atrium



Floating a Pacing Wire
3: Right Ventricle

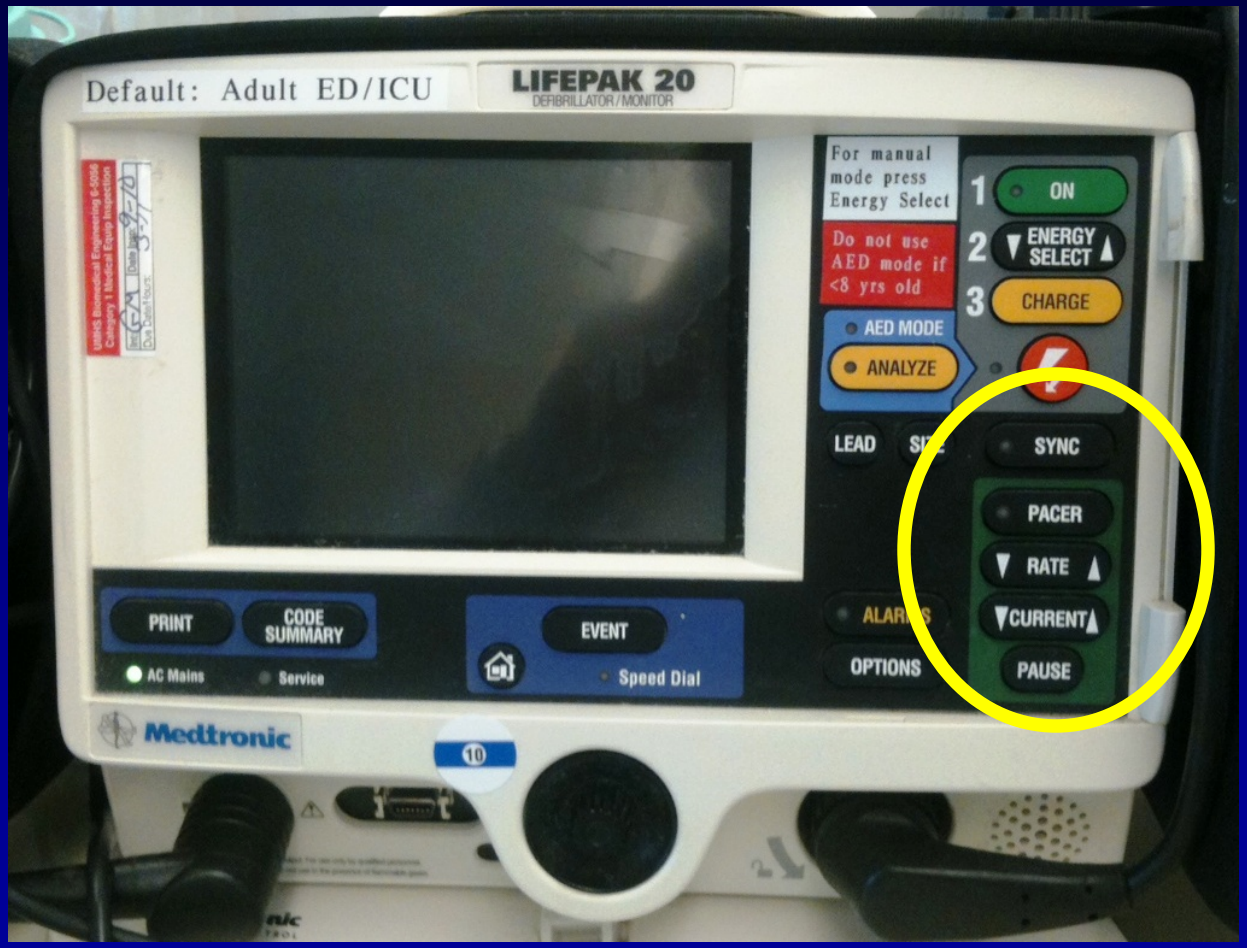


Trans-esophageal Atrial Pacing



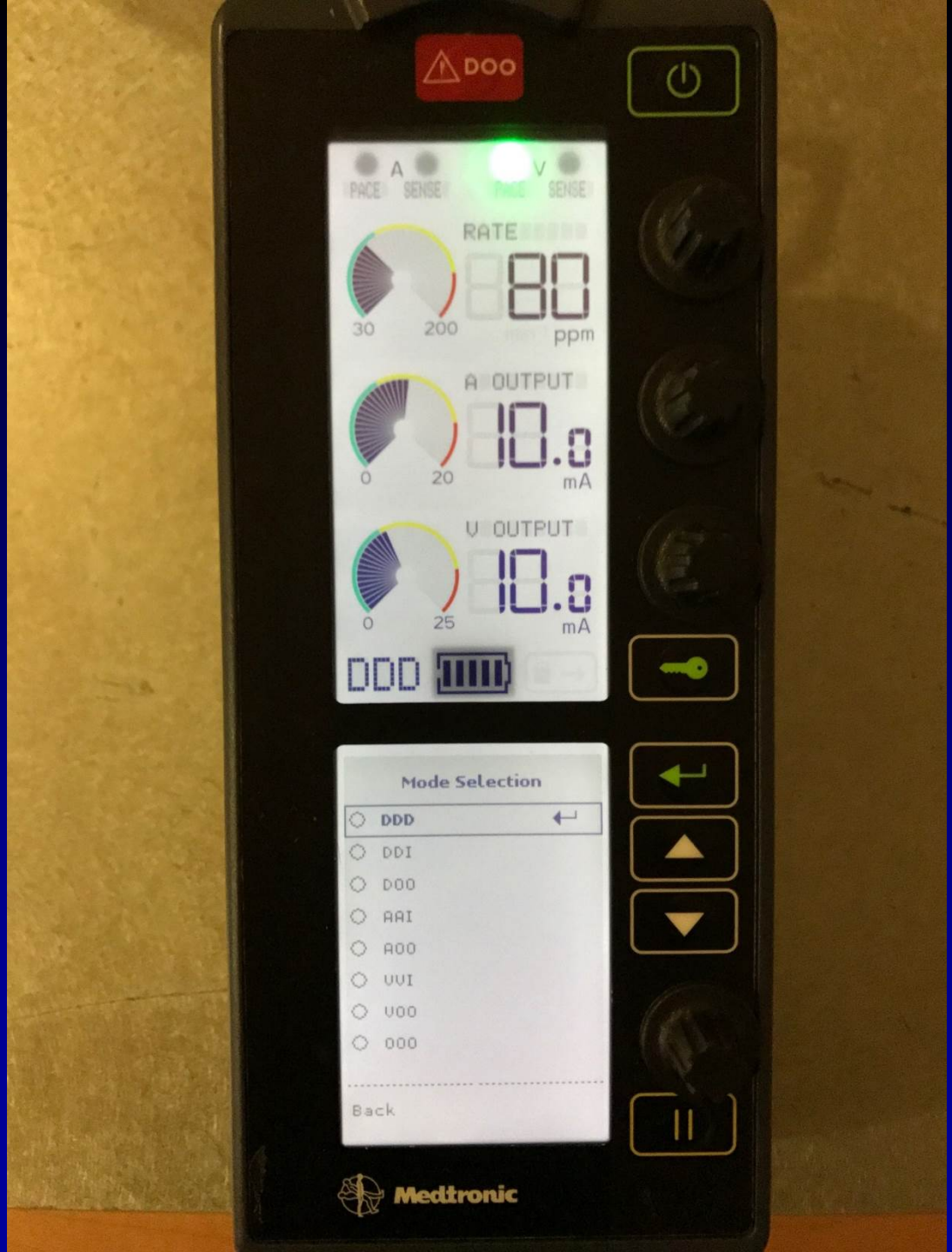
Trans-cutaneous Pacing

Transcutaneous Pacing Control



Transcutaneous Pacing Control

Temporary External Pacer


DOO
A
PACE
SENSE
V
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A OUTPUT
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mA
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V OUTPUT
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mA
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DDD
Mode Selection
DDD
DDI
DOO
AAI
AOO
VVI
VOO
OOO
Back
Medtronic


DOO
A
PACE
SENSE
V
PACE
SENSE
RATE
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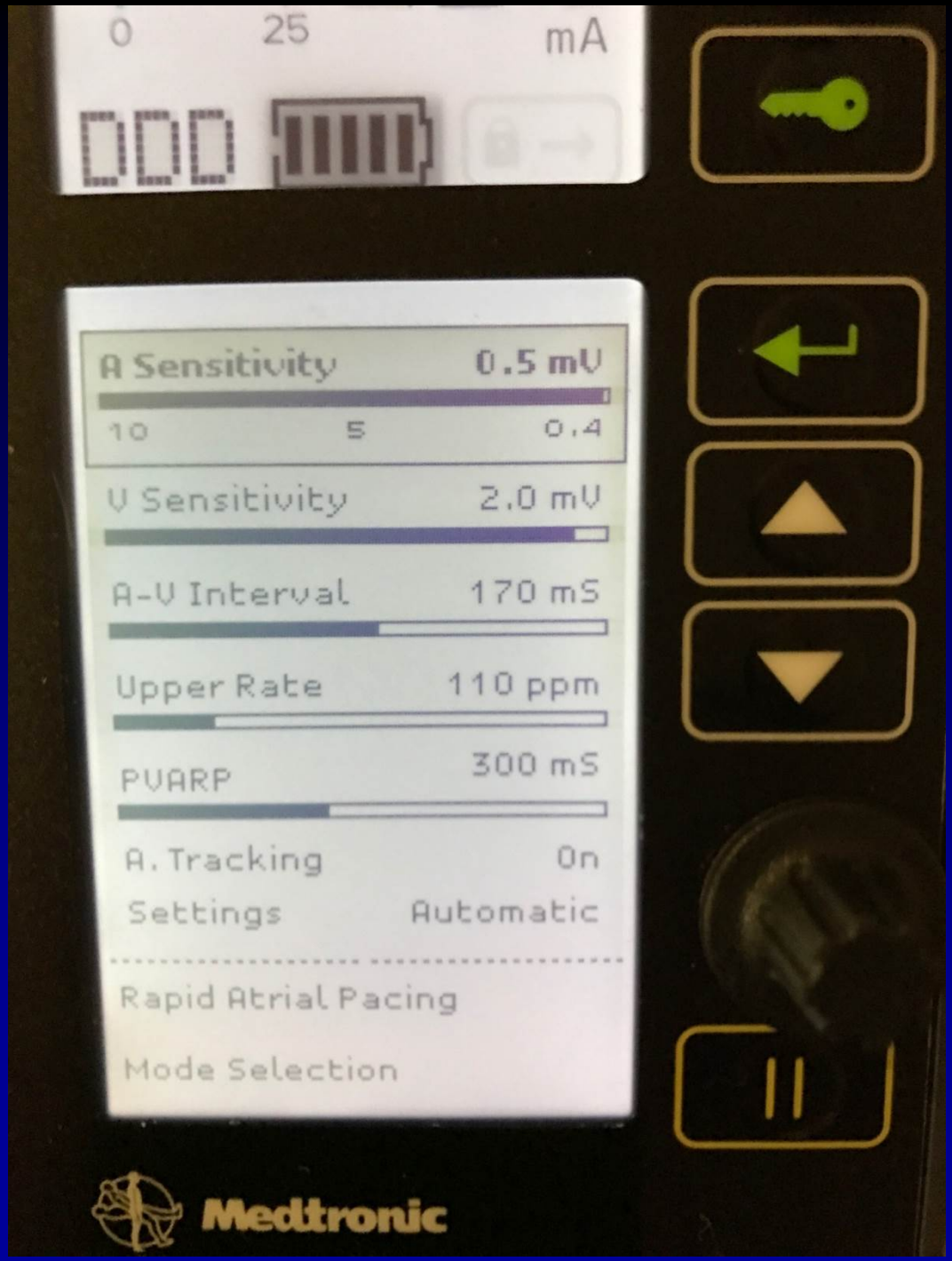
ppm
30
200
A OUTPUT
15.0
mA
0
20
V OUTPUT
15.0
mA
0
25
DDD
A Sensitivity 0.5 mV
10
5
0.4
V Sensitivity 2.0 mV
A-V Interval 170 mS
Upper Rate 110 ppm
PVARP 300 mS
A. Tracking On
Settings Automatic
Rapid Atrial Pacing
Mode Selection


0
25
mA
A Sensitivity
0.5 mV
10
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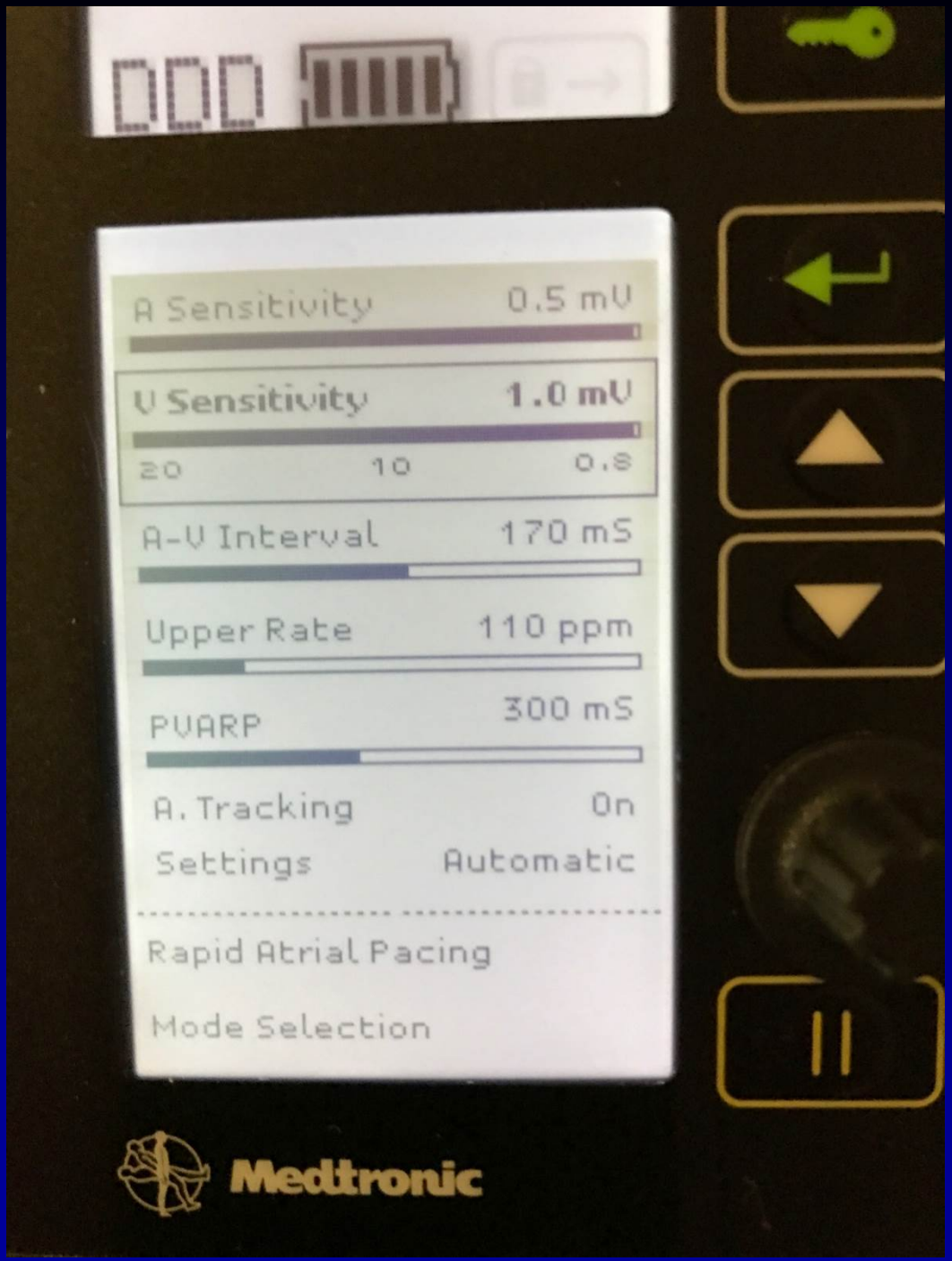
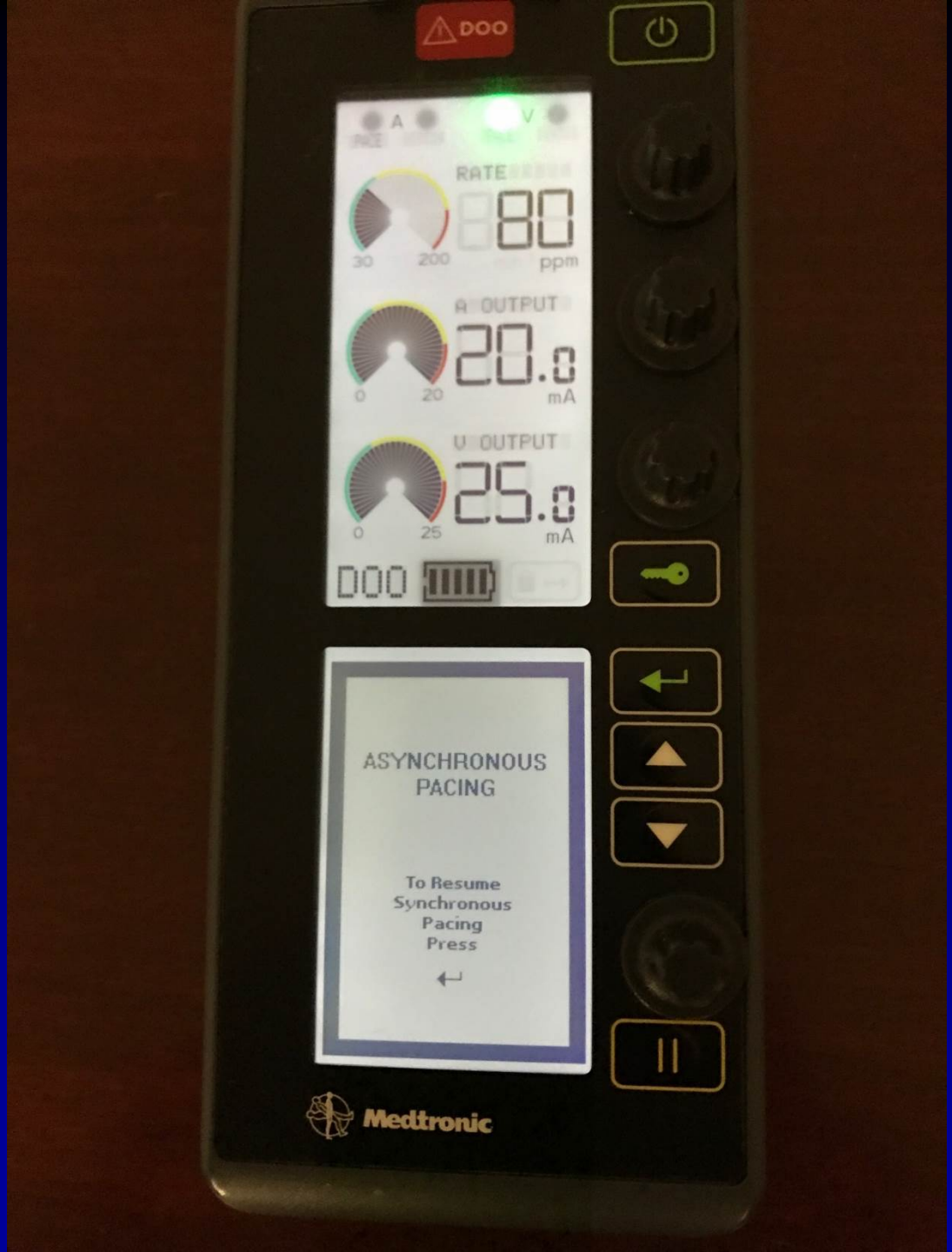
0.4
V Sensitivity
2.0 mV
A-V Interval
170 mS
Upper Rate
110 ppm
PVARP
300 mS
A. Tracking
On
Settings
Automatic
Rapid Atrial Pacing
Mode Selection
Medtronic


A Sensitivity 0.5 mV
V Sensitivity 1.0 mV
20 10 0.8
A-V Interval 170 mS
Upper Rate 110 ppm
PVARP 300 mS
A. Tracking On
Settings Automatic
Rapid Atrial Pacing
Mode Selection
Medtronic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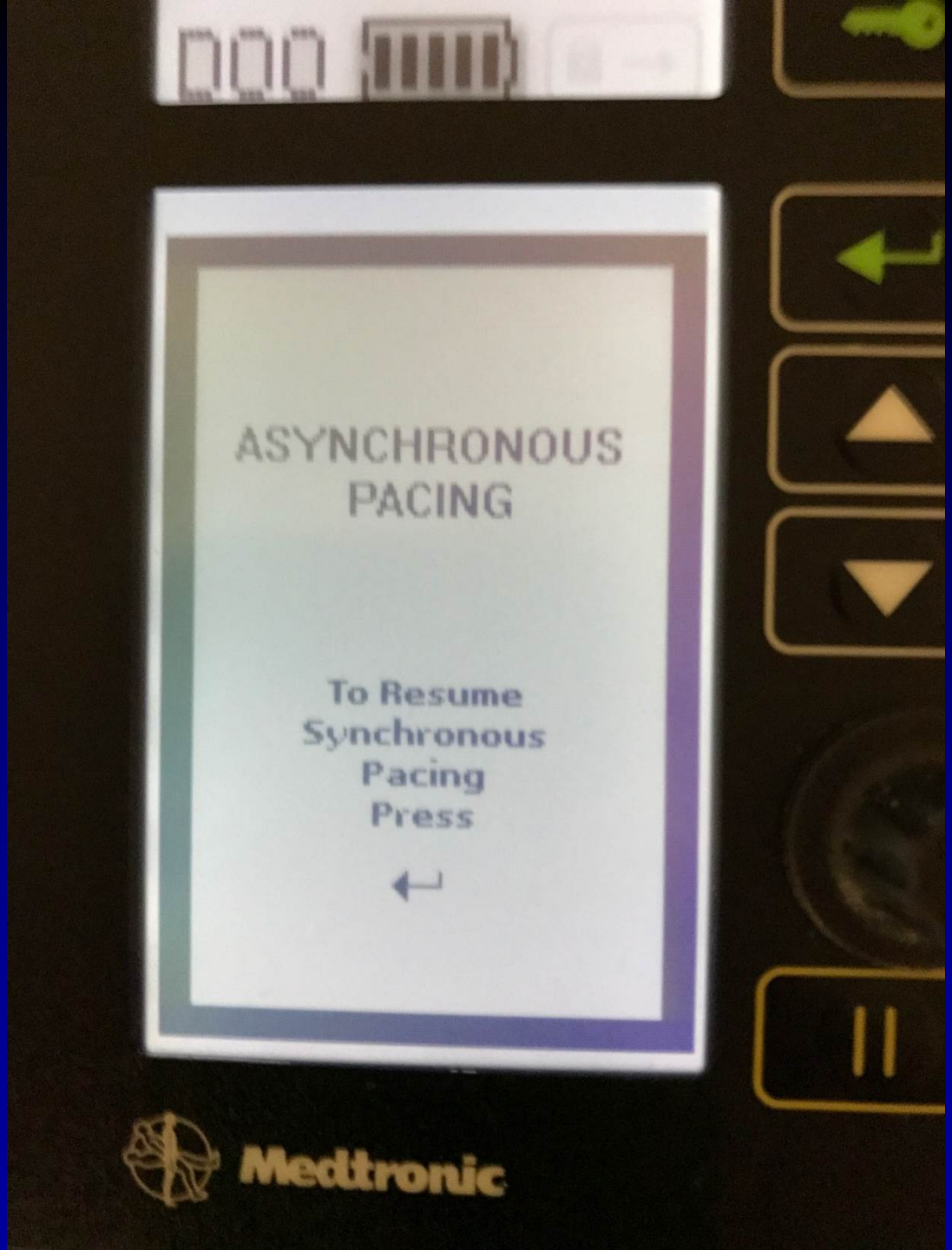
DOO
ASYNCHRONOUS
PACING
To Resume
Synchronous
Pacing
Press
Medtronic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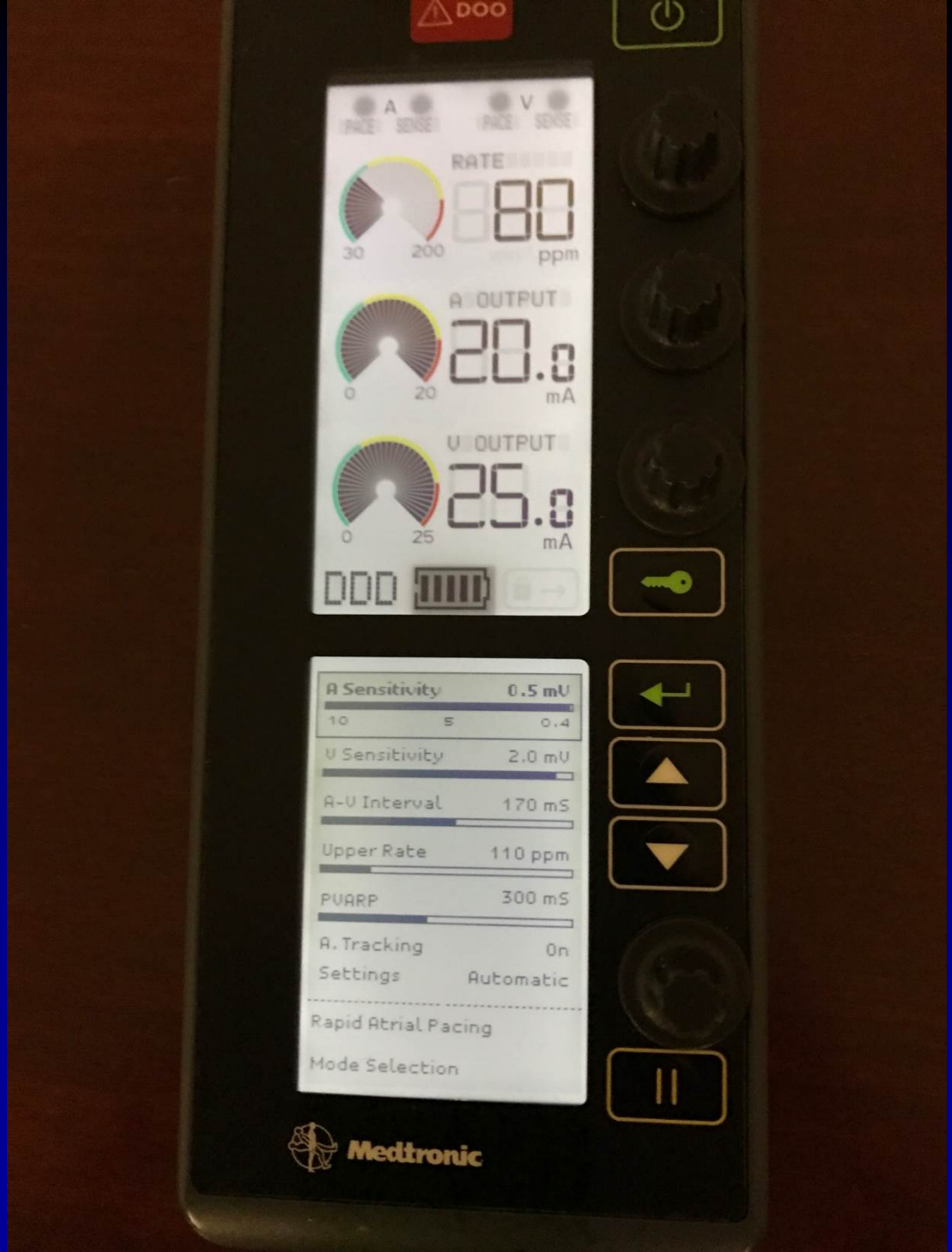
PACING
To Resume
Synchronous
Pacing
Press
Medtronic


DOO
A PACE SENSE
V PACE SENSE
RATE
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DDD
A Sensitivity 0.5 mV
10
5
0.4
V Sensitivity 2.0 mV
A-V Interval 170 mS
Upper Rate 110 ppm
PVARP 300 mS
A. Tracking On
Settings Automatic
Rapid Atrial Pacing
Mode Selection
Medtronic

Perioperative Concerns

- History
  - Indication for pacemaker
  - Return of symptoms?
- Evaluation
  - ECG
  - Listen with AM radio - tuned to 550Hz
  - Slow the heart by vagal manoeuvres
    - Could be dangerous
  - Pacing system analyser

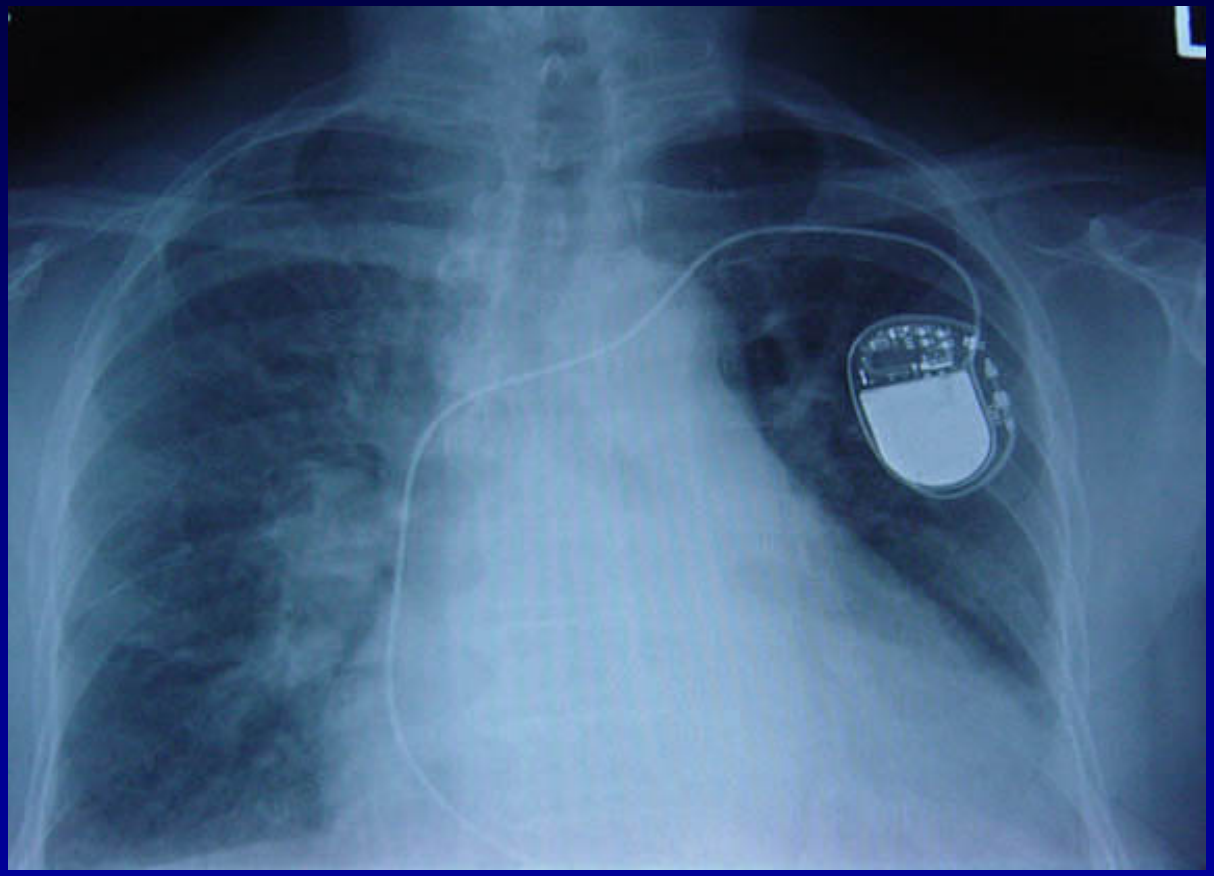
Pacemaker Interrogation

- Required if the pacer has not been interrogated in the past year
- Checks the mode of the pacer
- Assesses battery level
- Test for pacemaker malfunction
- ERI
  - Elective Replacement Indicator
  - Triggered at regular follow up interrogation
  - Indicates need to replace the battery or device

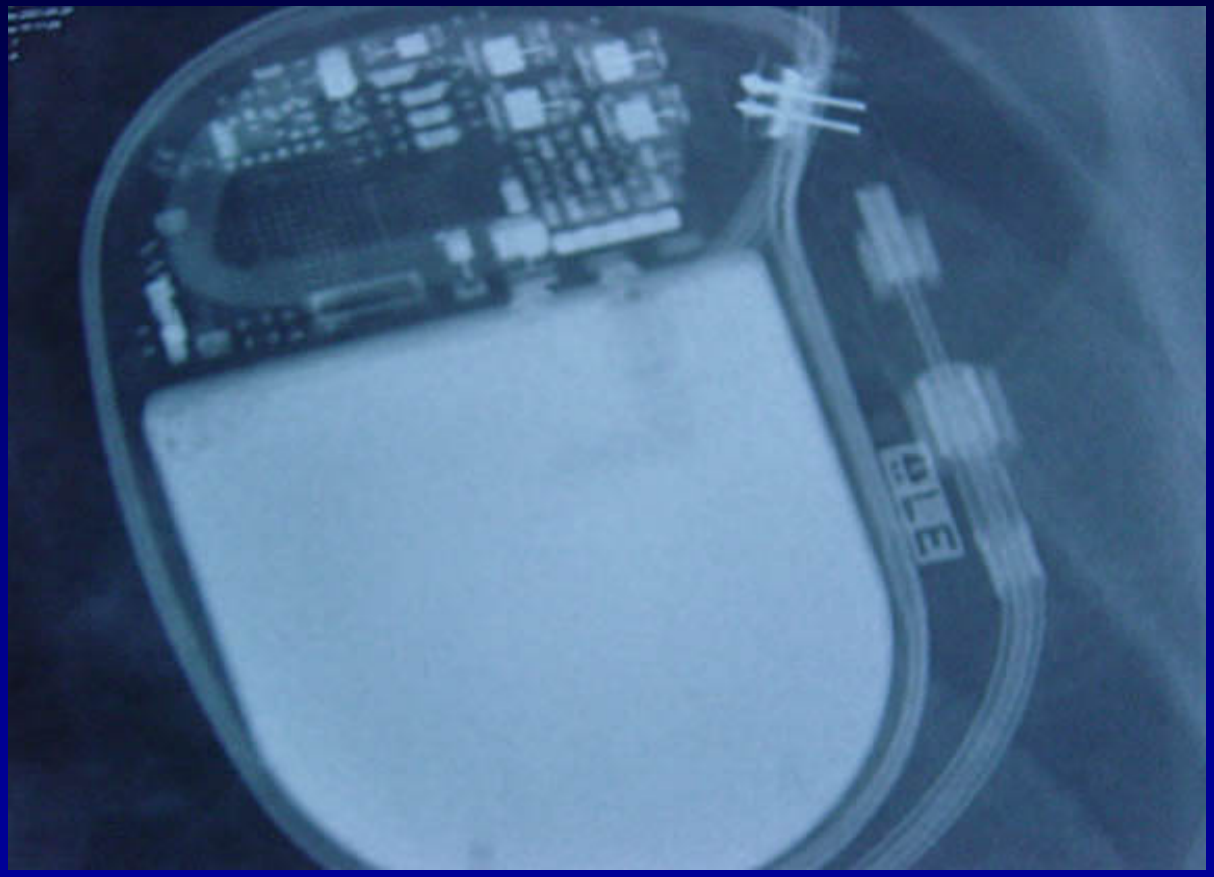
Make and Type of Pacer?

- Pacemaker Passport
- Medical documentation
- X-ray signs

Single Lead Pacer

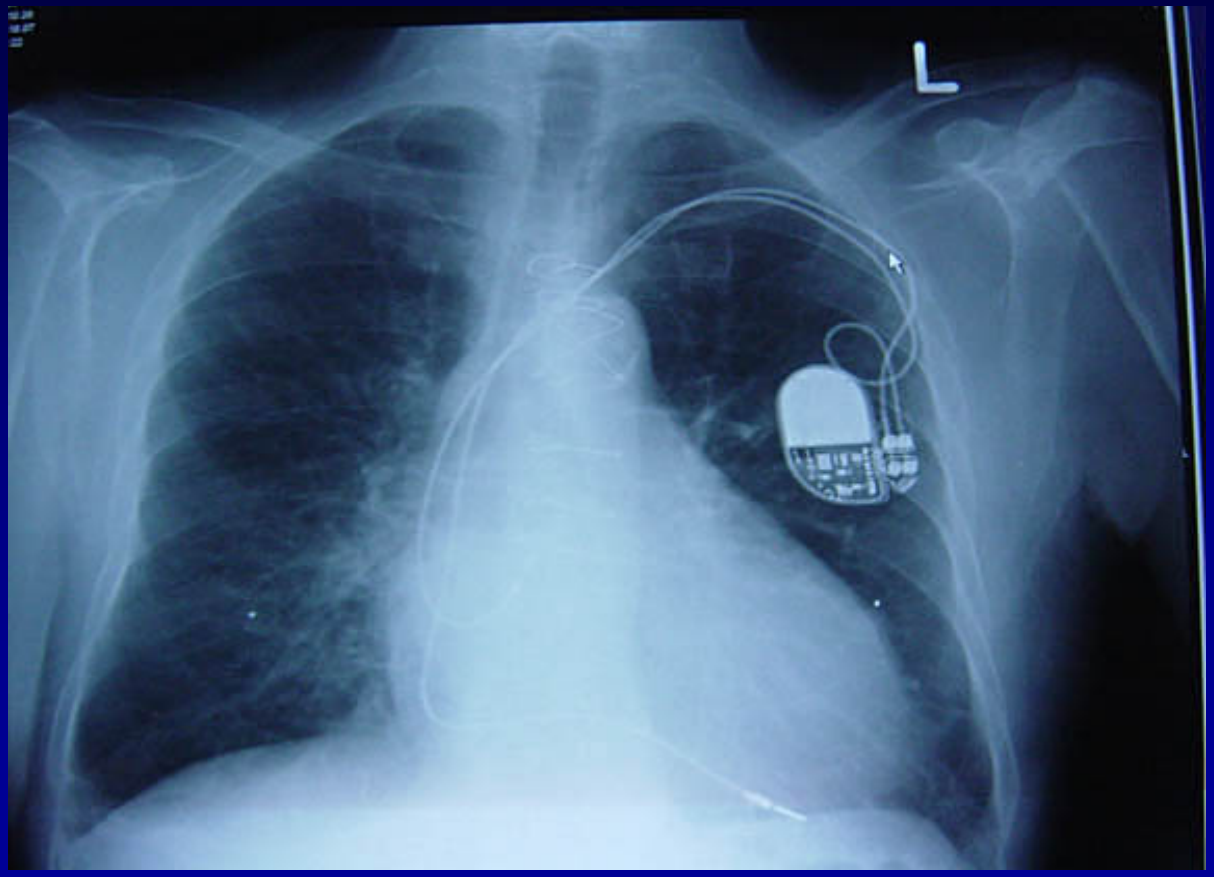


Single Lead Pacer

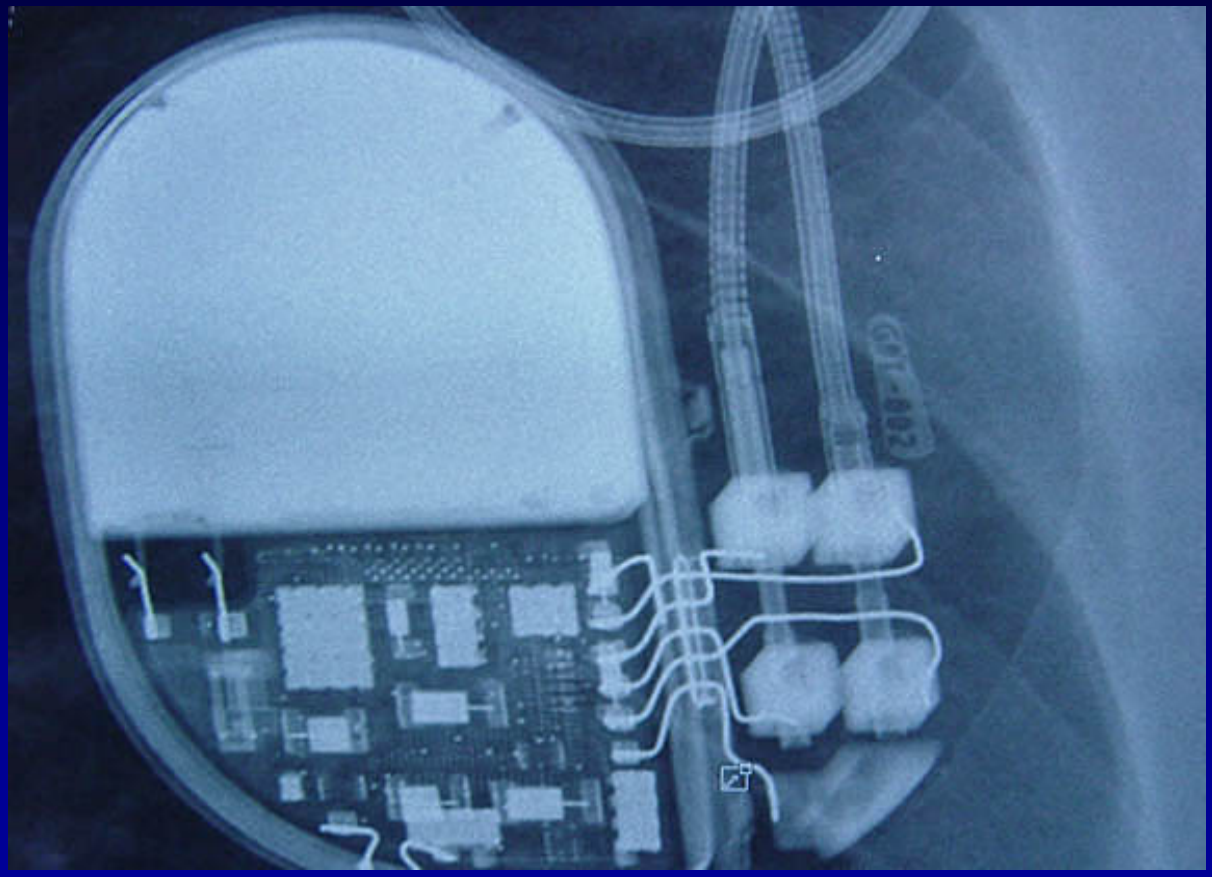


Biotronik - Triplos LV-T

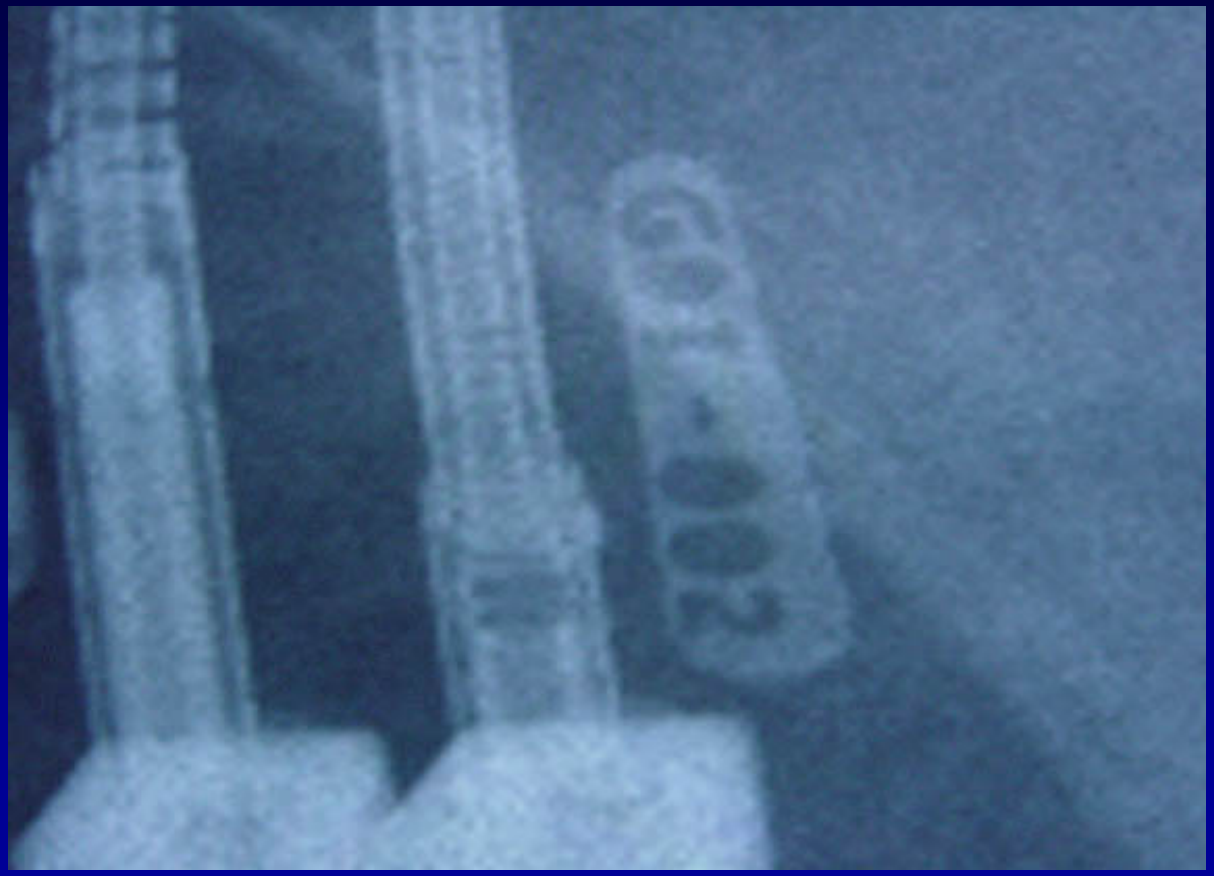
Dual Chamber Pacer



Dual Chamber Pacer

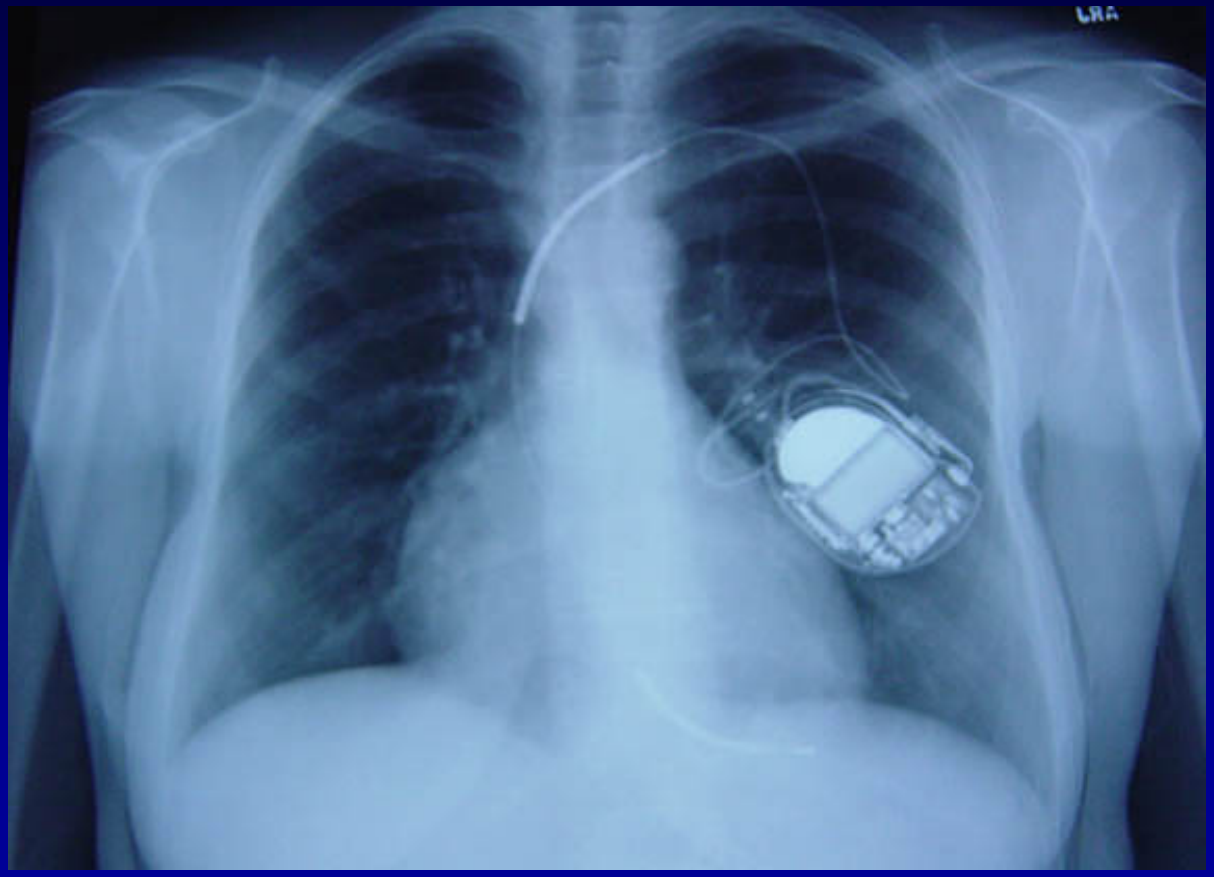


Dual Chamber Pacer

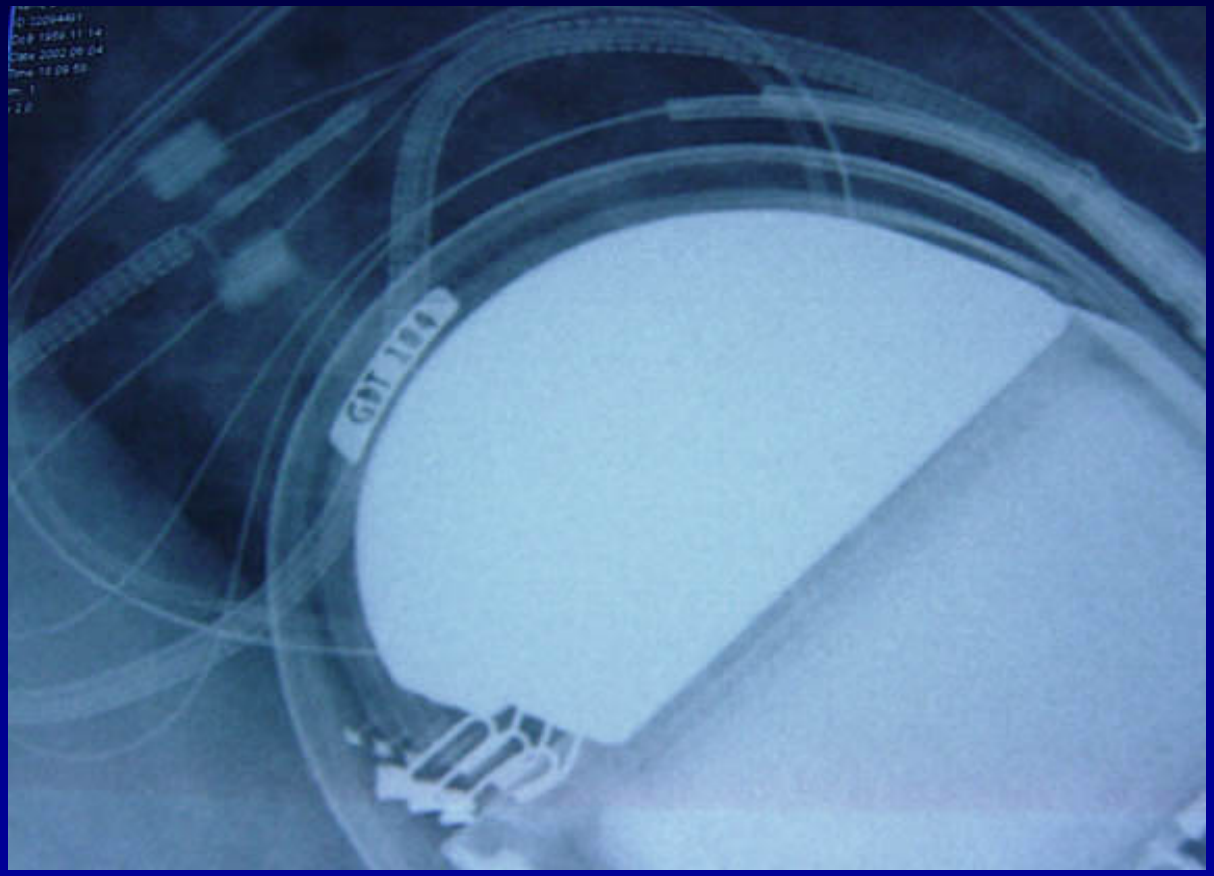


Guidant - Discovery II SR

Single Lead ICD

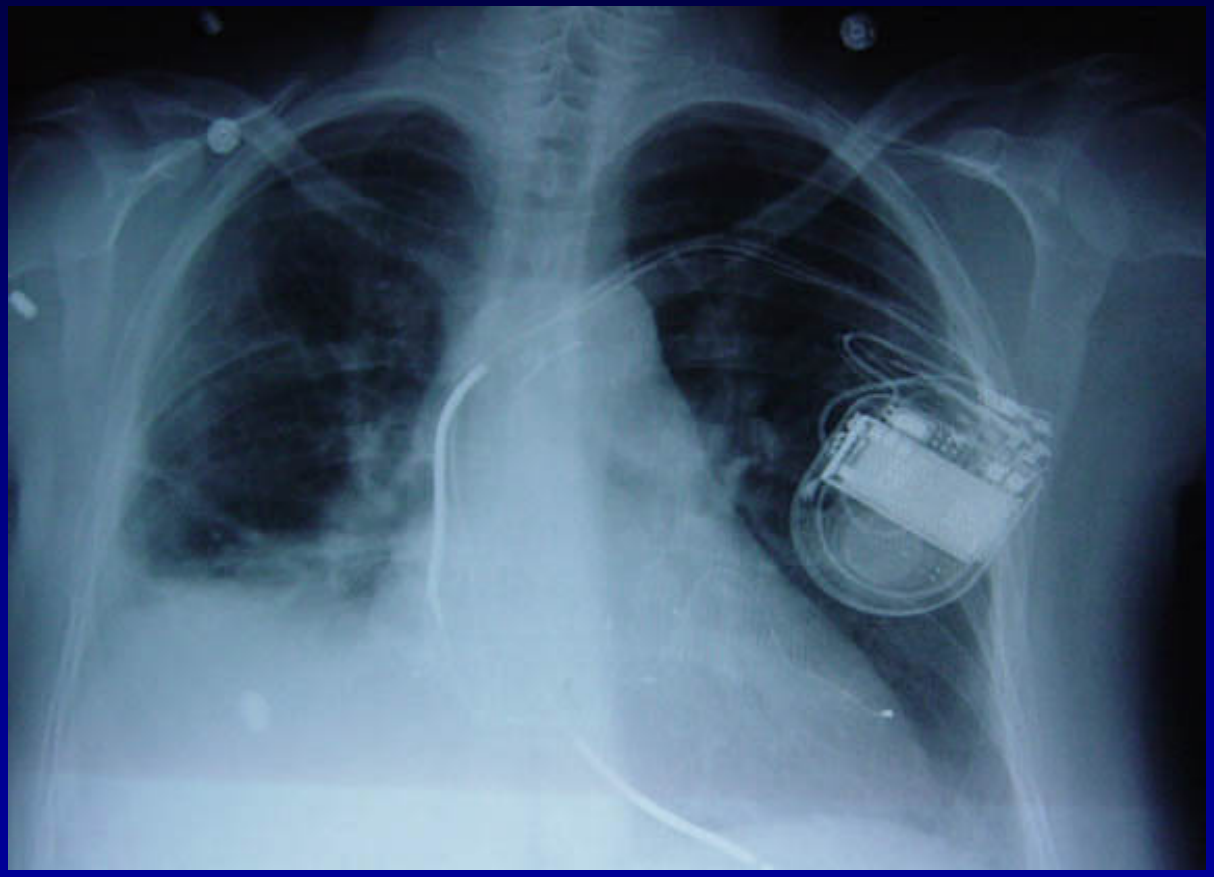


Single Lead ICD

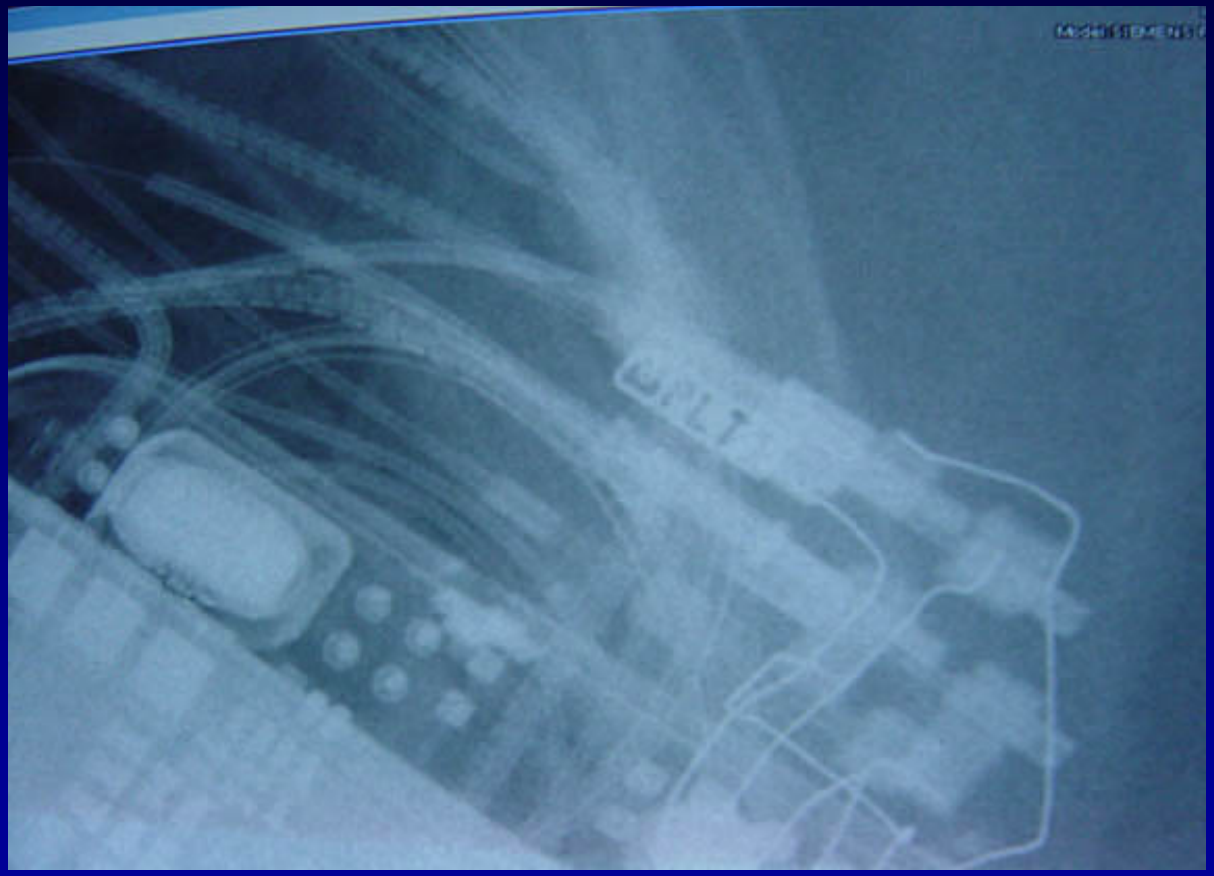


Guidant - Ventak Prizm

Dual Lead ICD

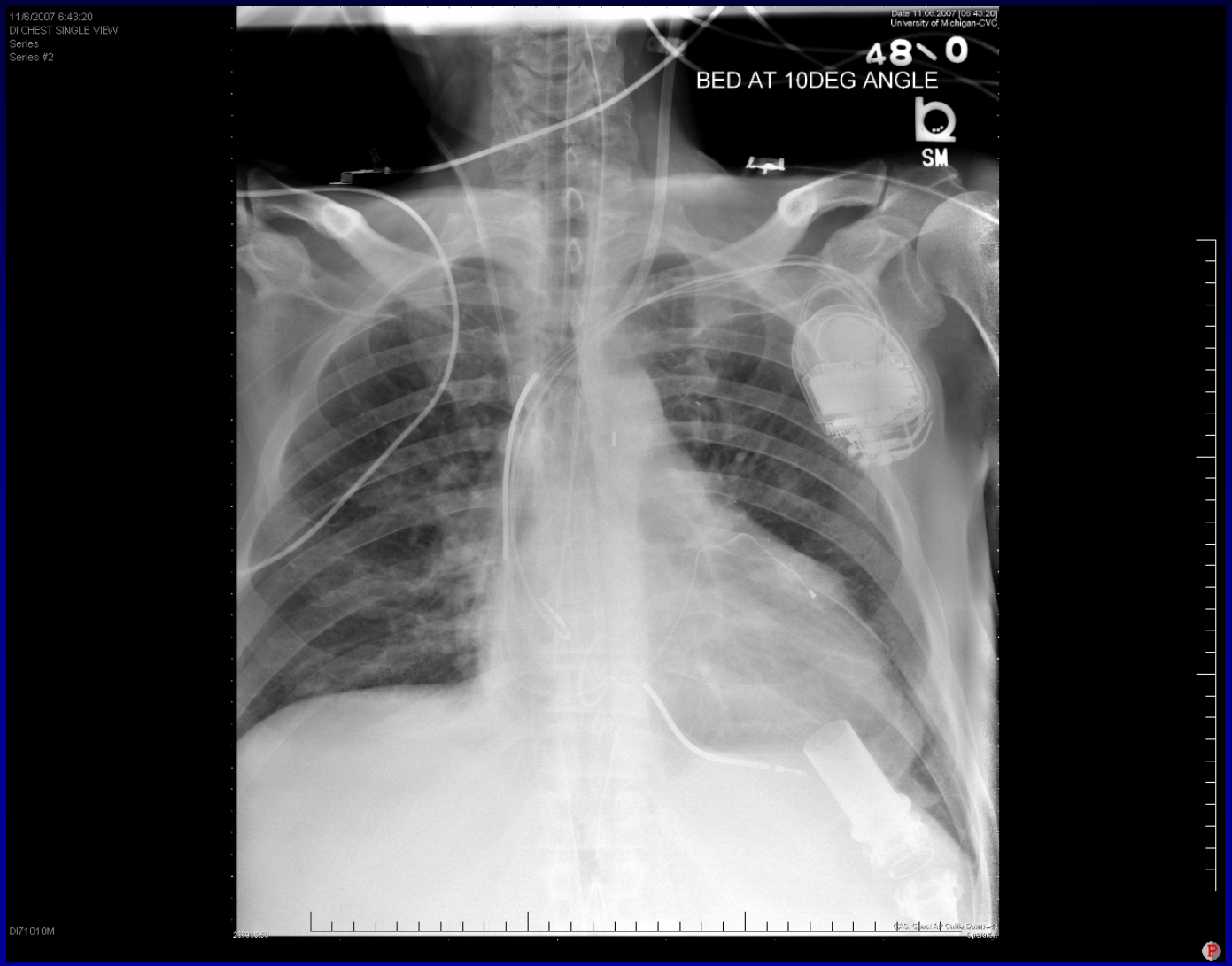


Dual Lead ICD

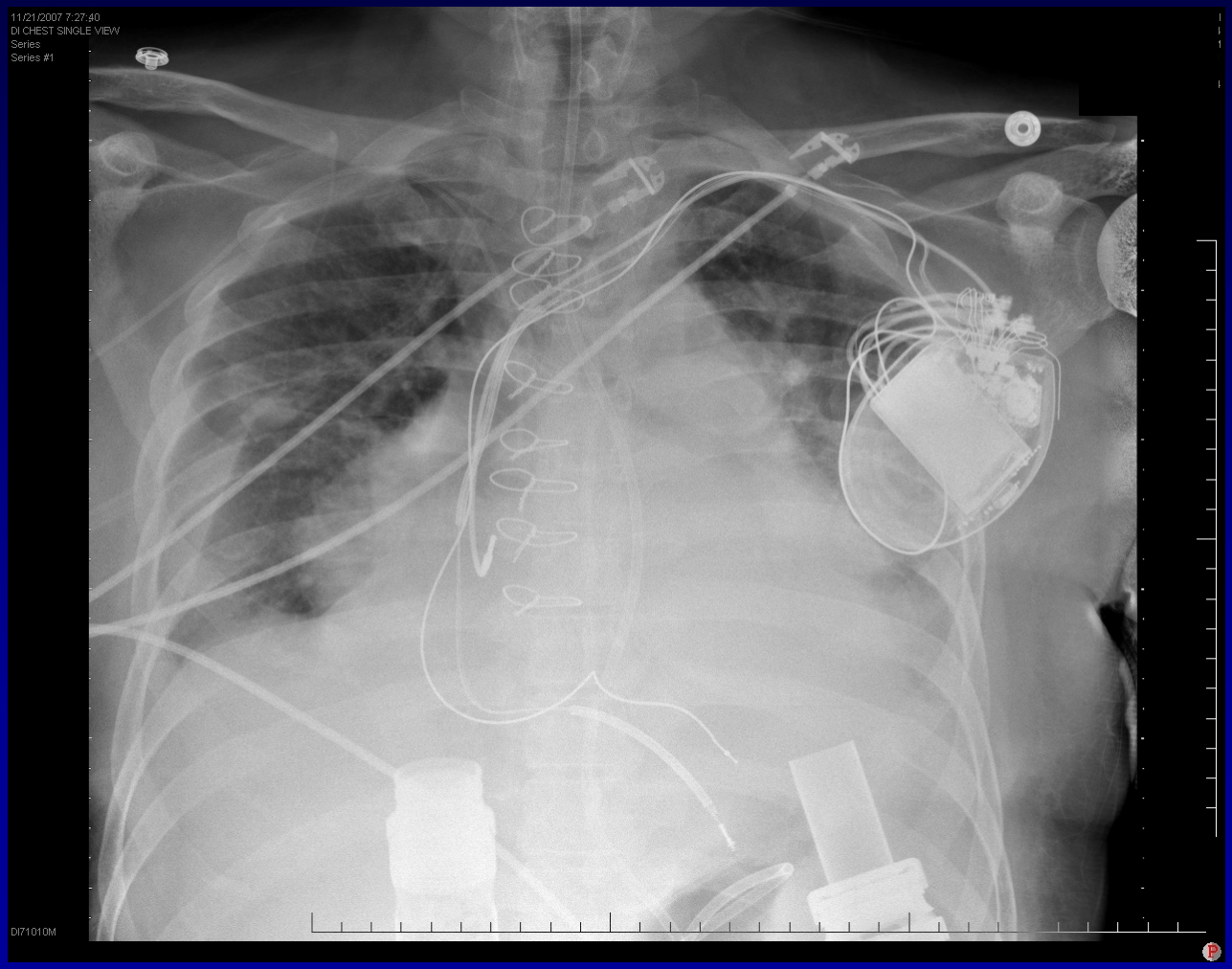


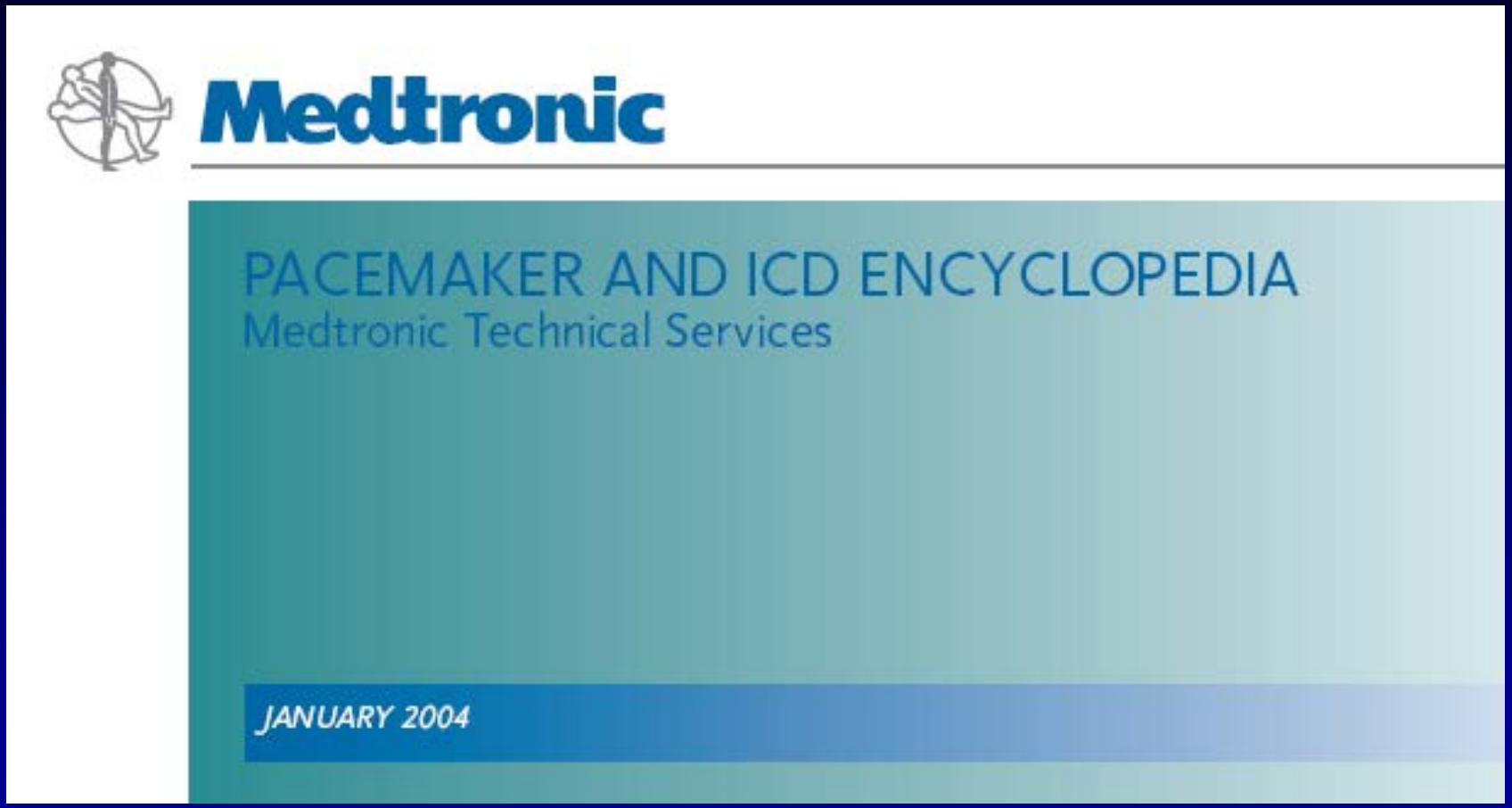
Medtronik - Insync Marquis

Bi-Ventricular Pacer ICD



Bi-Ventricular Pacer ICD





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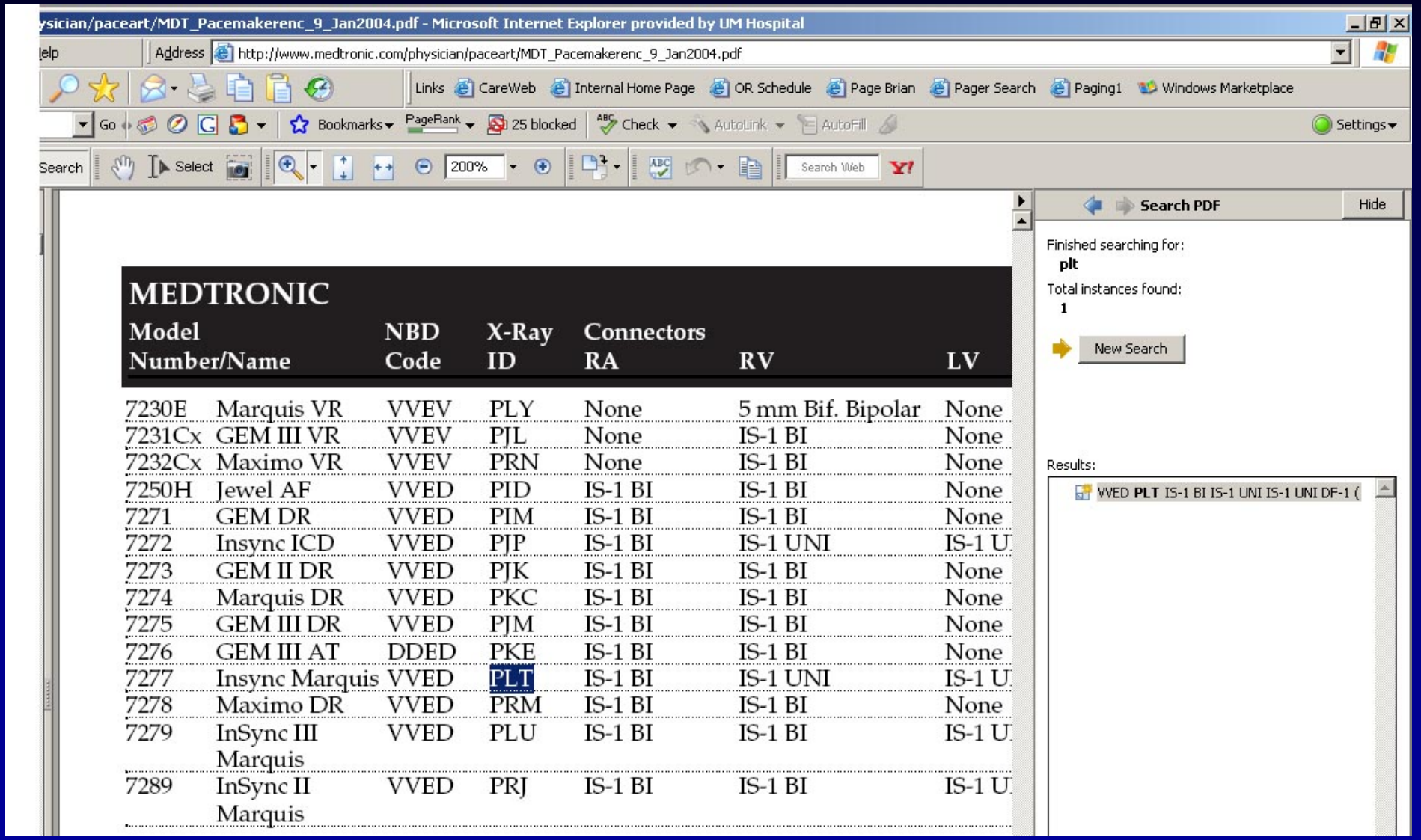

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Address http://www.medtronic.com/physician/paceart/MDT_Pacemakerenc_9_Jan2004.pdf

Links CareWeb Internal Home Page OR Schedule Page Brian Pager Search Paging1 Windows Marketplace

Bookmarks PageRank 25 blocked Check AutoLink AutoFill Settings

Search Select 200% Search Web

Search PDF Hide

Finished searching for:
plt

Total instances found:
1

New Search

Results:

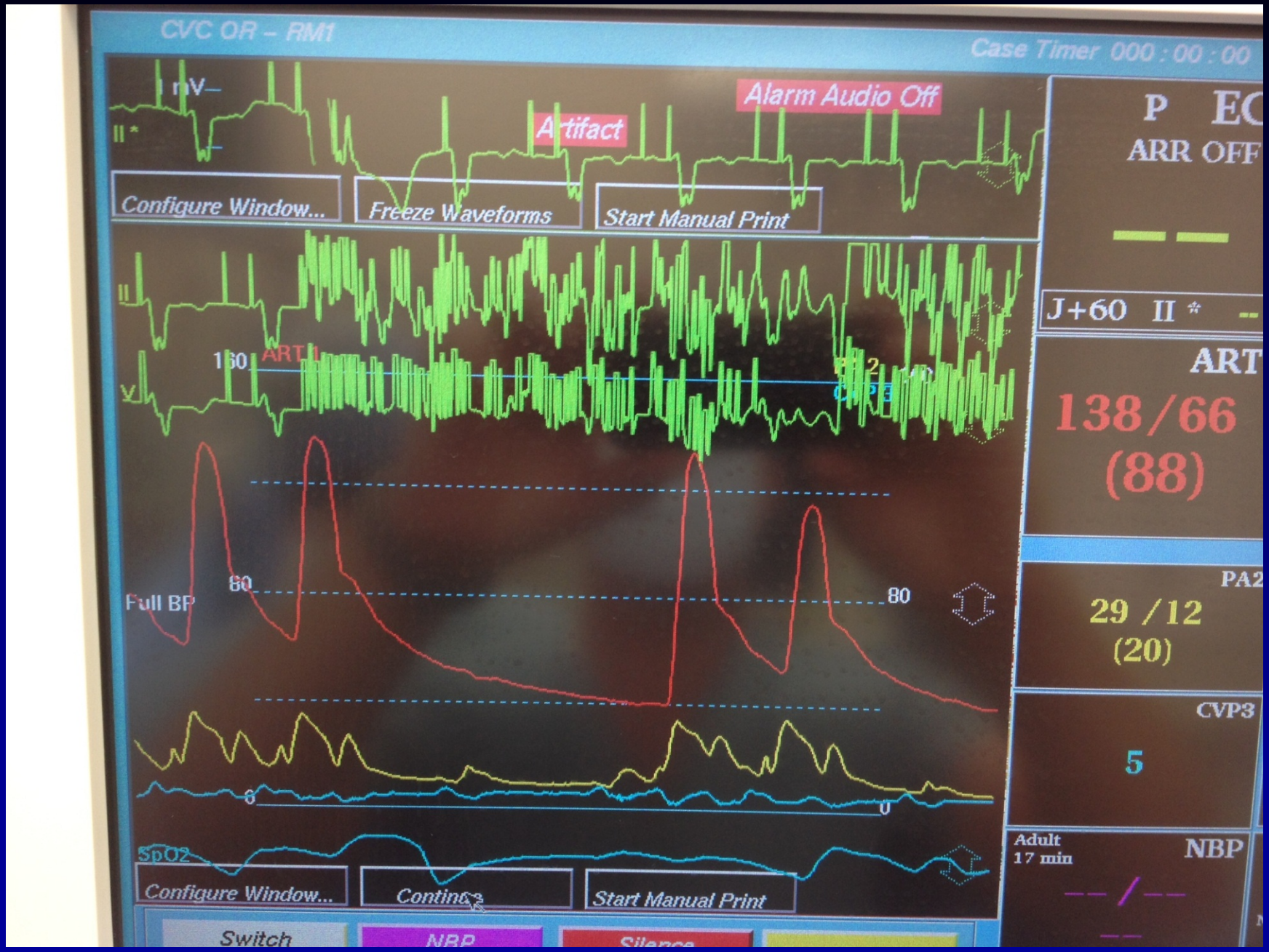
VVED **PLT** IS-1 BI IS-1 UNI IS-1 UNI DF-1 (

MEDTRONIC

Model Number/Name		NBD Code	X-Ray ID	Connectors RA	RV	LV
7230E	Marquis VR	VVEV	PLY	None	5 mm Bif. Bipolar	None
7231Cx	GEM III VR	VVEV	PJL	None	IS-1 BI	None
7232Cx	Maximo VR	VVEV	PRN	None	IS-1 BI	None
7250H	Jewel AF	VVED	PID	IS-1 BI	IS-1 BI	None
7271	GEM DR	VVED	PIM	IS-1 BI	IS-1 BI	None
7272	Insync ICD	VVED	PJP	IS-1 BI	IS-1 UNI	IS-1 U
7273	GEM II DR	VVED	PJK	IS-1 BI	IS-1 BI	None
7274	Marquis DR	VVED	PKC	IS-1 BI	IS-1 BI	None
7275	GEM III DR	VVED	PJM	IS-1 BI	IS-1 BI	None
7276	GEM III AT	DDED	PKE	IS-1 BI	IS-1 BI	None
7277	Insync Marquis	VVED	PLT	IS-1 BI	IS-1 UNI	IS-1 U
7278	Maximo DR	VVED	PRM	IS-1 BI	IS-1 BI	None
7279	InSync III Marquis	VVED	PLU	IS-1 BI	IS-1 BI	IS-1 U
7289	InSync II Marquis	VVED	PRJ	IS-1 BI	IS-1 BI	IS-1 U

Electromagnetic Interference

- EMI converts pacers to asynchronous mode
- *Intermittent* interference,
  eg electrocautery, does not convert to asynchronous mode
- Cautery can inhibit the pacer


CVC OR – RM1
Case Timer 000 : 00 : 00
Alarm Audio Off
Artifact
Configure Window...
Freeze Waveforms
Start Manual Print
ARR OFF
J+60 II *
ART
138/66
(88)
ART1
160
Full BP
80
80
PA2
29 /12
(20)
CVP3
5
6
0
SpO2
Configure Window...
Start Manual Print
Adult
17 min
NBP
Switch
NBP

Reprogramming Pacemakers for Surgery

- Usually not required
- Consider in pacer dependent pt with cautery close to the device
- Consider turning off rate adaptive pacing to avoid tachycardia
- Programmer or magnet should be available

Magnet

- Converts to asynchronous mode
- Avoids inhibition from electro-cautery
- May cause competition
- Rate may indicate battery depletion
- Random phantom reprogramming
  - –magnet and electrocautery combination

Random Phantom Reprogramming

- May occur when a magnet is used in the presence of EMI
- Electro-cautery is a form of EMI
- May occur with cautery alone close to the device
- Rate, mode, output may all be changed to bizarre values
- Less likely with modern pacemakers
  - digital programming signal rather than an analogue

Management of Random Phantom Reprogramming

- Leave the magnet in place
- Interrogate ASAP post-op
- Reprogram if required

Recommendations for Cautery

- Grounding plate away from the unit
- Keep output low
- Use short bursts
- Monitor the pulse
- Have atropine and isoproterenol available
- Convert to asynchronous mode
  - Magnet
  - Pacing system analyser / Reprogramming head for multiprogrammable units

Anaesthetic/ICU Management with Pacemakers

- Avoid electrolyte imbalances
- Aim for PaCO2 close to normal
- Inhibition may occur due to fasciculations with sux
- Most anaesthetic techniques do not affect pacing
- Deep ventilation may cause loss of contact of the electrode with the myocardium

Microshock

- Pacing leads provide a direct electrical pathway to the heart
- Ventricular fibrillation may be induced by a small electrical shock from static
- The leads should be electrically isolated when not in use
- External electrodes should be handled wearing insulating gloves

Implantable Cardiac Defibrillators

- eg. AICD
- Have pacing capability
- Defibrillation *must* be turned off before surgery above the umbilicus
  - Magnet *may* work
- The pacer can not be set to asynchronous mode

Table 3. **Trials Comparing Implantable Cardioverter-Defibrillators with Conventional Therapy for Primary Prevention of Sudden Cardiac Death***

Study Characteristic	MADIT (1990–1996)	MUSTT (1993–1999)†
Protocol	ICD vs. conventional therapy (mainly amiodarone)	Electrophysiologically guided therapy (ICD or drug therapy) vs. no electrophysiologically guided therapy
Sample size, *n*	ICD: 95 Conventional therapy: 101	Guided ICD: 161 Guided drug therapy: 190 No guided therapy: 353
Inclusion criteria	Previous Q-wave myocardial infarction, EF ≤ 0.35, asymptomatic nonsustained VT, and inducible VT not	Coronary artery disease, EF ≤ 0.40, asymptomatic nonsustained VT, and inducible VT
Reduction in mortality with ICD therapy	54% at 27 months	74% at 60 months

*EF = ejection fraction; ICD = implantable cardioverter-defibrillator; MADIT = Multicenter Automatic Defibrillator Implantation Trial; MUSTT = Multicenter Unsustained Tachycardia Trial; VT = ventricular tachycardia.
† Preliminary results as of March 1999.

Multicenter Automatic Defibrillator Implantation Trial (MADIT)
Multicenter Unsustained Tachycardia Trial (MUSTT)

ICD Response to Magnet

- **Medtronic**
  - The magnet does not alter pacing for bradycardia
  - The magnet temporarily suspends monitoring and therapy for as long as the magnet is on
- **St. Jude Medical**
  - The magnet does not alter pacing for bradycardia
  - The ICD must be programmed to be receptive to the magnet (default)

ICD Response to Magnet

- **Ventritex**
  - The magnet temporarily suspends monitoring and therapy for as long as the magnet is on
- **Sulzer Intermedics**
  - The magnet does not alter pacing for bradycardia
  - Pacing and shock therapy are terminated for as long as the magnet is in position
- **Biotronik**
  - The magnet will initiate a test of the pulse width of the impulse used for bradycardia related pacing

ICD Response to Magnet

- **Guidant/CPI**
  - The ICD must be programmed to be receptive to the magnet
  - If the ICD is programmed to “off”, then the magnet will switch the ICD between “off” and “monitor + therapy”
  - If the ICD is programmed to “monitor only”, then the magnet will switch the ICD to “monitor + therapy”
  - Continuously holding the magnet over the ICD will keep the ICD in the “monitor only” mode

ICD Response to Magnet

- **Boston Scientific**
  - If the ICD is programmed “off” and takes a catastrophic hit, eg cautery over the device I goes to “Safety mode” (VVI 72 bpm with 165bpm VF zone with shock therapy) Patient and/or surgeon may be shocked
  - If programmed to “Electro-cautery mode” the safety architecture will prevent reversion to “Safety mode”
    - Recommended mode for surgery
    - Provides asynchronous pacing
    - Pacing can be disabled before programming Electro-cautery mode
    - VVI, AAI or DDD cannot be used

Does your patient have an ICD or Pacemaker?

Yes a **pacemaker**
OR
Yes an **ICD** and the procedure is **below** the **umbilicus** as determined by the Surgeon, Proceduralist or Designee

No Intervention Required
*If the CIED is close to the surgical field or there are clinical concerns or questions, the Anesthesia Provider, Surgeon, Proceduralist or Designee may place an order for ICD / Pacemaker procedural management and page the CVC/UH Device Nurse **#2263**

Does your patient have an ICD or Pacemaker?

Yes an **ICD** and the procedure is **at or above** the **umbilicus** as determined by the Surgeon, Proceduralist or Designee.

Anesthesia Provider, Surgeon, Proceduralist or Designee may place an order for ICD / Pacemaker procedural management and page the CVC / UH Device Nurse **#2263**

CIED (Device) Nurse assesses patient and makes decision about Intervention needed (Magnet or Non-Magnet)

Magnet

Intervention Needed:
Magnet compatible Device and patient position amenable to magnet placement

CIED (Device) Nurse and Anesthesia Provider or Procedure Nurse discuss magnet placement

CIED (Device) Nurse writes note with recommendation including discharge instructions and completes order in the electronic medical record

Anesthesia Provider places magnet at case start and removes at case end

Does your patient have an ICD or Pacemaker?

Yes an **ICD** and the procedure is **at or above** the **umbilicus** as determined by the Surgeon, Proceduralist or Designee.

Anesthesia Provider, Surgeon, Proceduralist or Designee may place an order for ICD / Pacemaker procedural management and page the CVC / UH Device Nurse **#2263**

CIED (Device) Nurse assesses patient and makes decision about Intervention needed (Magnet or Non-Magnet)

Non-Magnet

Intervention Needed:
Not magnet compatible or patient position not amenable to magnet placement necessitating tachycardia therapies to be disabled

CIED (Device) Nurse places pink armband, disables tachycardia therapies and ensure external defibrillator patches are in place.

Patient transported to OR / Procedure with **defibrillator patches in place**

Patient transported to PACU with **defibrillator patches in place**. PACU Nurse or Recovery Nurse or PACU Anesthesia Provider pages CIED (Device) Nurse **#2263** for post-op evaluation

CIED (Device) Nurse enables tachycardia therapies and interrogates to assure proper device funtion and programing. Patches may safely be removed by recovery staff.

CIED (Device) Nurse removes pink armband, completes order and writes note in electronic medical record

Intra-operative Management of an ICD

- Have a magnet available
- Defibrillation function of the ICD must be turned OFF (or temporarily suspended)
  - If the operation is above the umbilicus
- If time, contact EP prior to the operation to be advised a whether magnet will work or if reprogramming is needed

Intra-operative Management of an ICD

- If no time to consult EP preop, then tape a magnet over the device and leave it in place
- Tachy therapy will be temporarily suspended while the magnet is in place
- Brady therapy will not be affected
- Therapy mode may NOT resume after removing the magnet from Guidant devices

Intra and Post-operative Management of an ICD

- Monitor ECG continuously while the ICD is turned off
- Alternative means for cardioversion/defibrillation needed
- Apply patches for external defibrillation during surgery
- Ensure that the external patches are as far away as possible from the device

Pacemakers

- Understand the modes
- Know when and how to use temporary pacing
- Know what to do with permanent pacers / ICDs in the OR/ICU