The Bionic Patient: Cardiac Implantable Electronic Devices (CIED)

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Objectives

- Understand pacemaker coding scheme and synchronous versus asynchronous pacing
- Identify device type (pacer vs ICD) by appearance on CXR
- Describe cardiac resynchronization therapy (CRT)
- Describe recommended management strategies for patients presenting to the OR with CIED therapy

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Disclosures

- No financial conflicts of interest

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Pacemakers & ICDs

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Implantable Pacemaker

- Device capable of pacing the RA, RV, and/or LV
- Subcutaneous generator +/- lead(s)
- Indications:
  - Symptomatic bradycardia
  - Sinus node dysfunction
  - AV block
  - Fascicular block
  - Recurrent SVT
  - Recurrent asystole
  - HFrEF

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Leadless Pacemakers

- Implanted in RV via femoral venous access
- No leads, no generator → reduced risk of infection
- Originally could only pace & sense the RV
  - Micra AV now allows for AV synchrony
  - Uses accelerometer to detect atrial contraction
- Battery life 8-13 years
- No response to magnet application

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Pacemaker Coding Scheme

Position I: Pacing Chamber(s)	Position II: Sensing Chamber(s)	Position III: Response(s) to Sensing	Position IV: Programmability	Position V: Multisite pacing
O = None	O = None	O = None	O or no letter = none	O = None
A = Atrium	A = Atrium	I = Inhibited	R = rate modulation	A = Atrium
V = Ventricle	V = Ventricle	T = Triggered	CLS = Closed loop system	V = Ventricle
D = Dual (A+V)	D = Dual (A+V)	D = Dual (T + I)		D = Dual (A+V)

Most common mode for dual or triple chambers is DDDRO

Positions II and III are critical for telling you whether pacer is synchronous

Pacing Clin Electrophysiol. 2002 Feb;25(2):260-4.

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Rate Response Features

- Noted by an "R" or "CLS" in the 4th position (i.e. VVIR, DDD-CLS)
- Three types:
  - Accelerometer (all major manufacturers)
  - Minute ventilation (Boston Sci)
  - Closed loop system (Biotronik)
- Rest or sleep modes can result in bradycardia in evening (rare)
- ASA recommends disabling rate-responsive features in OR to avoid inappropriate activation (shivering, fasciculations, mechanical ventilation, etc)

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Asynchronous Modes (AOO, VOO, DOO)

- Used for two reasons:
  - Emergent pacing of symptomatic bradycardia, high-grade AV block/CHB, or asystole
  - High risk of EMI-induced PM inhibition in PM-dependent patient
- Complications: "R on T"

Heart Rhythm. 2012;9(6): 970-973.

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Cardiac Resynchronization Therapy (CRT)

- Multi-site pacing with pacing of both ventricles to appropriately time RV & LV ejection
- Used in pts with CHF (LVEF <35%) who meet criteria:
  - Sinus or AV node dysfunction
  - Intraventricular conduction delays (fibrosis, dilation) with prolonged QRS >130ms
- Benefits:
  - Improved CO
  - Reduced HF symptoms
  - Improved quality of life

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Cardiac Resynchronization Therapy (CRT)

Implications for perioperative care:

- High pacing burden but likely not PM dependent
  - Typical interrogation report may read: "DDDRD 60-120, As 98% Vp 98%"
  - EMI inhibition may drop SV/HR but will not cause CHB or asystole
- Often paired with ICD
  - CRT-P: pacemaker only
  - CRT-D: pacemaker/defibrillator

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Implantable Cardiac Defibrillator (ICD)

- Device capable of providing cardioversion, defibrillation, and pacing (including anti-tachycardiac pacing AKA overdrive pacing)
  - Senses atrial and/or ventricular rhythm
  - Analyzes rate & rhythm to determine what intervention, if any, is needed
- Indications for placement:
  - Primary prevention: LVEF <35% , HOCM, long QT
  - Secondary prevention: H/o cardiac arrest, VT, VF, syncope in setting of high-risk features (CAD, structural heart disease)
- Many configurations
  - May have RA lead
  - May be one lead of a multi-lead pacemaker

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Subcutaneous ICD

- Entire system subQ
  - Lead tunneled from xyphoid to manubriosternal junction
  - No contact w/cardiac structures = lower risk infection
- Cannot provide pacing
- Can be inhibited with magnet; 60s tone indicates suspension of therapy

J Cardiothorac Vasc Anesth. 2018;32(4):1871-1884.

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CIED in the OR

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Trusted Evidence: Discovery to Practice®
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Practice Advisory for the Perioperative Management of Patients with Cardiac Implantable Electronic Devices: Pacemakers and Implantable Cardioverter–Defibrillators 2020: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Management of Patients with Cardiac Implantable Electronic Devices*

British Journal of Anaesthesia
Volume 107, Supplement 1, December 2011, Pages i16–i26

Cardiovascular

Perioperative management of patients with cardiac implantable electronic devices

M.E. Stone [1,2], M. B. Salter [1], A. Fischer [2]

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- Type of device: PM, ICD, both?
- Is patient dependent on pacemaker?
- Use of EMI devices (cautery, ESWL) or MRI
  - Distance from CIED to EMI (<15 cm or above umbilicus is cutoff)
- Is pacemaker or ICD pocket going to be in the sterile field?
- Is this an emergency?

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Magnets

- What do magnets do?
  - Disable anti-tachy therapy functions on ICD (includes combo ICD/pacemakers)

  -or-
  - *(Usually)* place PM into asynchronous mode
- Caveat #1: some St Jude & Boston Sci devices have "magnet unresponsive" modes that can be turned on
- Caveat #2: If patient has combo ICD and pacemaker *and is pacer dependent* you should *reprogram* device (unless absolutely no EMI or very far from CIED)

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Preop prep:

- Determine device type, **recent interrogation report**
  - **Underlying rhythm?**
  - **Pacemaker dependent?**
  - Unknown? CXR; Pacemaker ID app
- Ensure external defibrillator & temporary pacing readily available

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Preop prep:

- If EMI use above umbilicus is likely
  - **Reprogram to asynchronous** (PM-dependent) and/or **disable anti-tachycardia therapies** (ICD)
  - **Magnet cannot do both** → A PM-dependent patient w/ICD requires formal reprogramming
  - Disable rate-responsive modes
- Is bipolar cautery or ultrasonic scalpel use possible?

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Intraop management:

- ASA monitors (ECG, continuous SpO_2) sufficient
- EMI current grounding pad placed to direct current away from pulse generator
- Bipolar cautery used when possible

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Intraop management special situations:

- Lithotripsy: beam away from generator
- RF ablation: keep catheter away from generator/leads; direct RF current away from generator
- MRI: interrogate & suspend AT functions; place asynchronous if PM dependent; CIED programmer available throughout scan and reinterrogates/resets at end
- ECT: place in asynchronous mode if PM dependent; suspend AT; be prepared to treat ventricular arrhythmias

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If defibrillation required periop:

- If magnet-disabled: stop all EMI, remove magnet, *wait for device therapy*
  - Can take up to 30 seconds for a device to detect VT/VF and charge to generate shock
  - Antitachycardia pacing may precede shock in VT
  - Prepare external defib pads, ACLS/CPR while waiting
- If reprogrammed-disabled: proceed with external defib/CV
- Never apply pad over pulse generator or electrode

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Post op management:

- Continuous monitoring until reprogrammed and/or interrogated
  - After magnet use alone, interrogation usually not needed
- Restore to original settings
  - Patient should not be discharged from monitored environment until original settings restored

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Post op management:

- Post-op interrogation recommended when:
  - Emergent surgery occurred with EMI use and no preop evaluation performed
  - Significant EMI used close to CIED
  - Anti-tachycardiac therapy occurred
  - Concern for CIED malfunction or inappropriate settings
  - Suspicion that magnet disabled device

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See article for algorithim for management of CIED in the OR

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Other Assorted CIED

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CardioMEMS

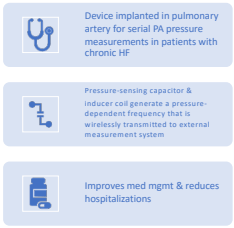

Image at: https://www.businesswire.com/news/home/20160404005737/en/St.-Jude-Medical-CardioMEMS-HF-System-Prompts-Changes-That-Improve-Heart-Failure-Management-and-Reduce-Hospitalizations

J Am Coll Cardiol HF. 2016 May, 4 (5) 333–344

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CardioMEMS

Periop implications:

- Patient has heart failure
- No live data available
- PAC insertion under fluoroscopy (preferably not at all) due to risk of dislodging device

Image at: https://www.businesswire.com/news/home/20160404005737/en/St.-Jude-Medical-CardioMEMS-HF-System-Prompts-Changes-That-Improve-Heart-Failure-Management-and-Reduce-Hospitalizations

J Am Coll Cardiol HF. 2016 May, 4 (5) 333–344

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Implantable Loop Recorder

- Used to monitor heart rhythm continuously (up to 3 years)
- Longer duration than ECG or Holter monitor, captures events in patients with:
  - Infrequent arrhythmias
  - Unexplained stroke
  - Unexplained syncope
- Subcutaneous implant
- Typically MRI safe; not affected by EMI

Case courtesy of Dr Vikas Shah, Radiopaedia.org, rID: 40632

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References

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