CMR Imaging Of Patients With CIED

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Learning Objectives

- Identify the different manufacturers and types of CIEDs
- Explain what the four letters of the NBG code represent
- Describe the factors of Ohm's Law
- Differentiate capture threshold, sensing, and lead impedance
- Identify the steps in preparing patients with CIED for CMR
- Explain the potential hazards for scanning patients with CIED

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Introduction

CARDIOLOGY SURESCAN™ MRI TECHNOLOGY OVERVIEW

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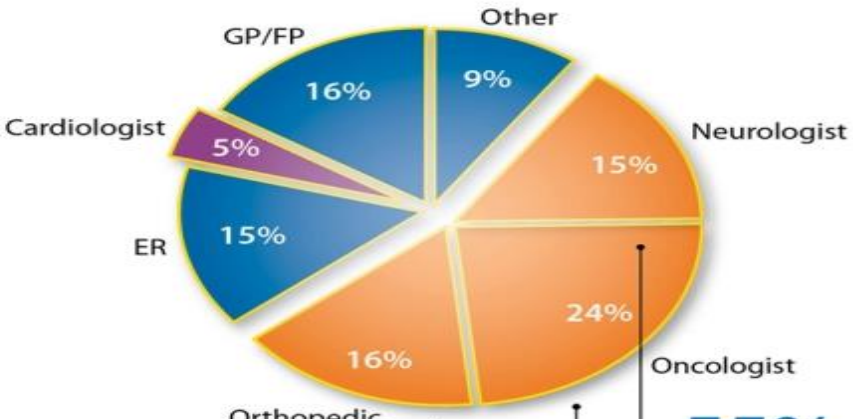
THE CARDIOLOGIST HAS LIMITED VISIBILITY TO MRI UTILIZATION

MRI is predominantly used to diagnose back and joint pain, stroke symptoms and cancer.[1,2]



[1] RSNA research, radiologists. December 2008.
[2] IMV MRI 2010 Benchmark Report.

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CIED Manufacturers

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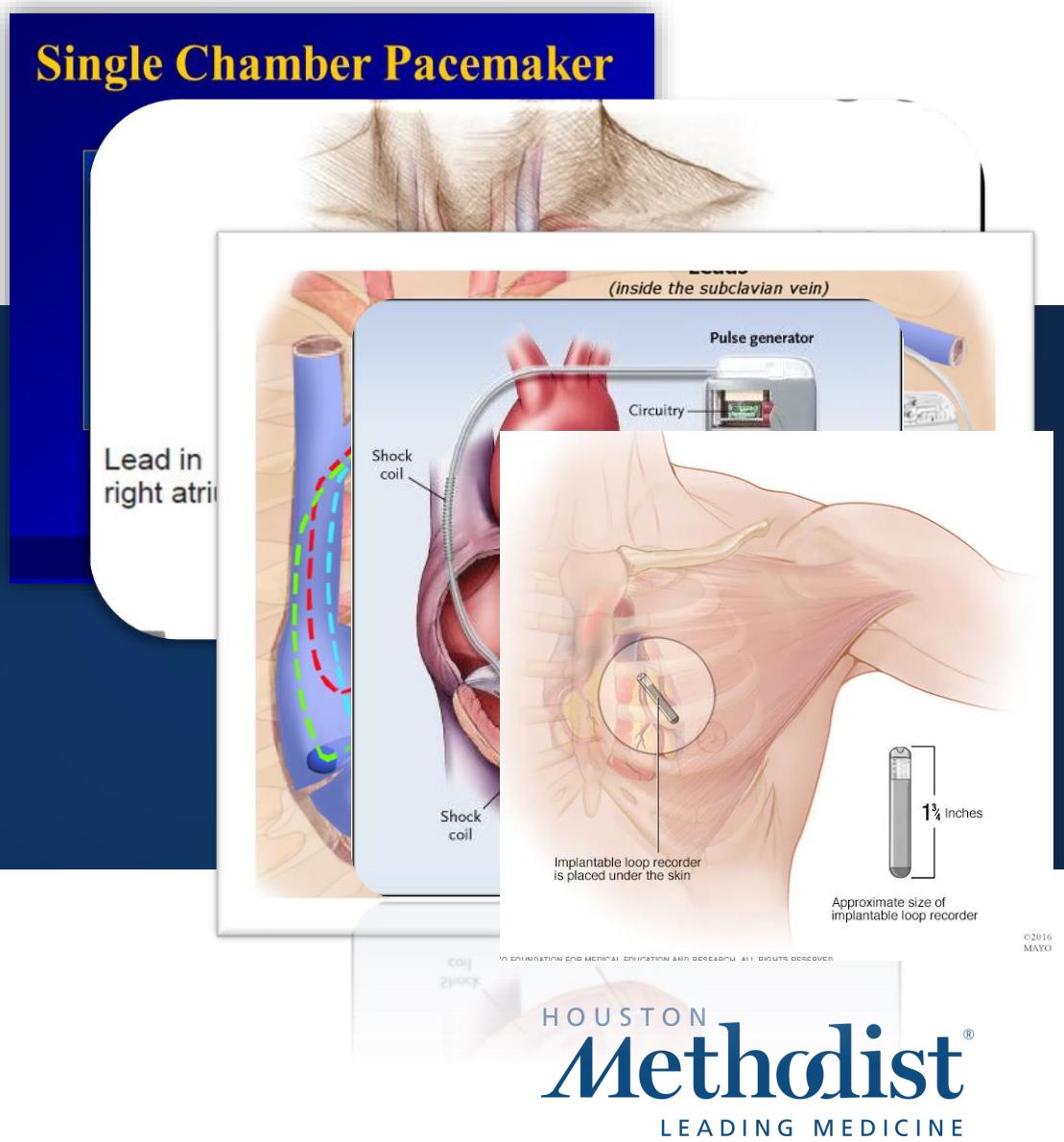
Types of CIEDs

- Single lead
- Dual Chamber
- Bi-Ventricular Leads
- ICD
- ILR



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S-ICD
Transcatheter/ Leadless Pacemaker

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NBG Code

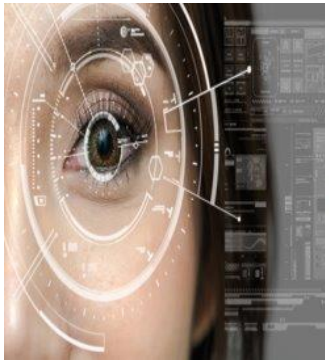
NBG = North American Society of Pacing and Electrophysiology (NASPE) Mode Code Committee + British Pacing and Electrophysiology Group (BPEG)

NBG CODE – THE USUAL PACING MODES

The NBG Code is the shorthand used to describe pacemaker operation.

The NBG code was developed by the North American Society of Pacing and Electrophysiology (NASPE) and the British Pacing and Electrophysiology Group (BPEG). The code can consist of up to 5 letters, although commonly only the first three or four letters are used.

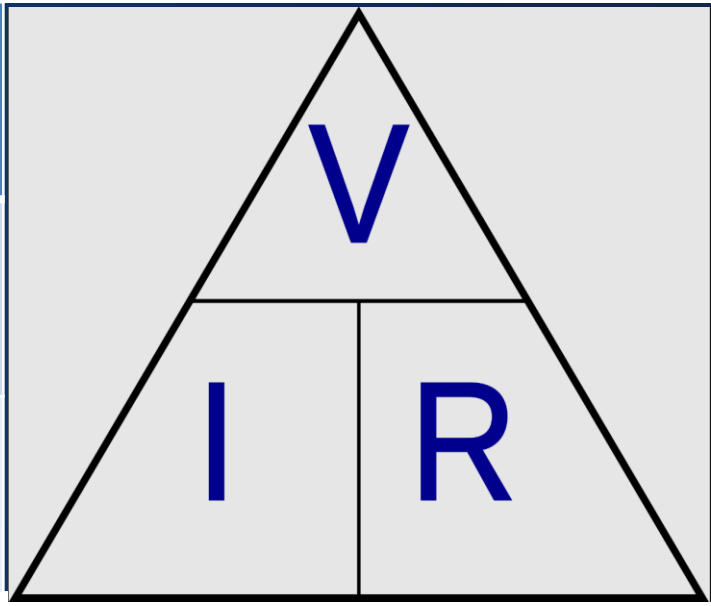
Chamber(s) Paced	Chamber(s) Sensed	Response to Sensing	Rate Modulation
O = None	**O** = None	**O** = None	**O** = None
A = Atrium	**A** = Atrium	**T** = Triggered	**R** = Rate modulation
V = Ventricle	**V** = Ventricle	**I** = Inhibited	
D = Dual (A + V) + V)	**D** = Dual (A + V)	**D** = Dual (T + I)	
S = Single (A or V)	**S** = Single (A or V)		



Electrical Concepts In Pacemakers

Voltage	Force that causes electrons to move through a circuit
Current	Flow of electrons through a completed circuit
Impedance	Opposition to current flow

Ohm's Law



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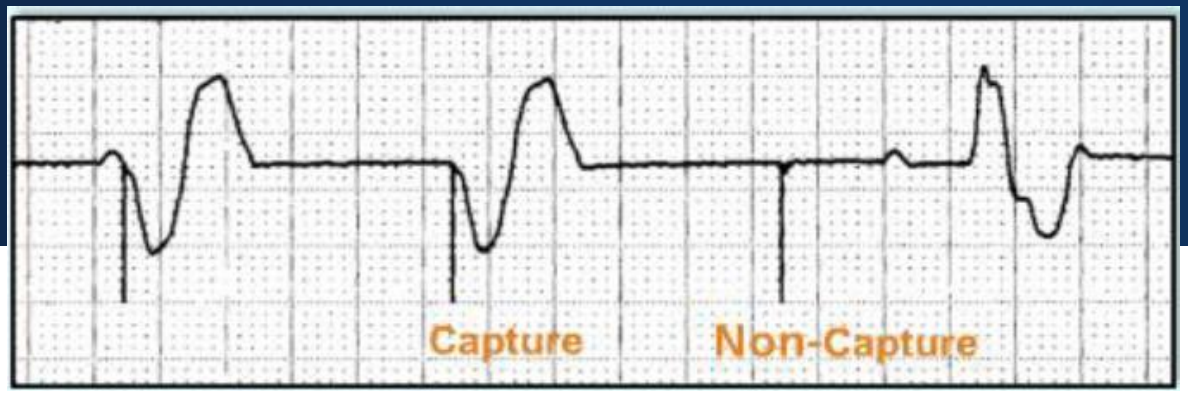
Capture Threshold

The minimum electrical stimulation, measured in volts (V), needed to consistently capture the heart outside of the heart's own refractory period



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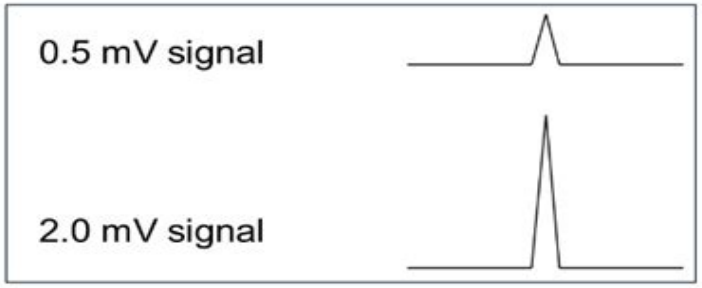
Sensing

SENSING

Sensing is the ability of the pacemaker to "see" when a natural (intrinsic) depolarization is occurring

- Pacemakers sense cardiac depolarization by measuring changes in electrical potential of myocardial cells between the anode and cathode



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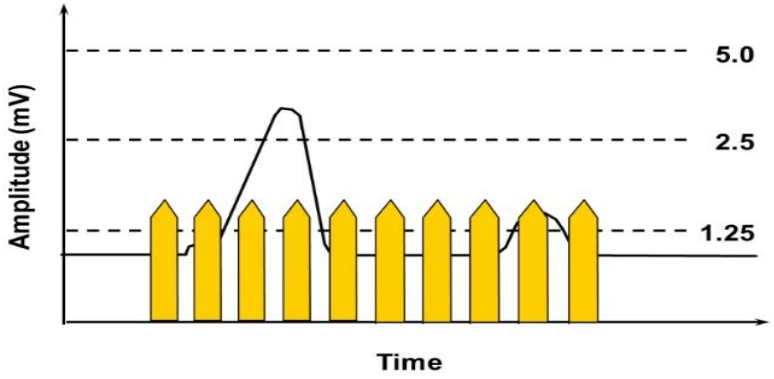
ADEQUATE SENSITIVITY



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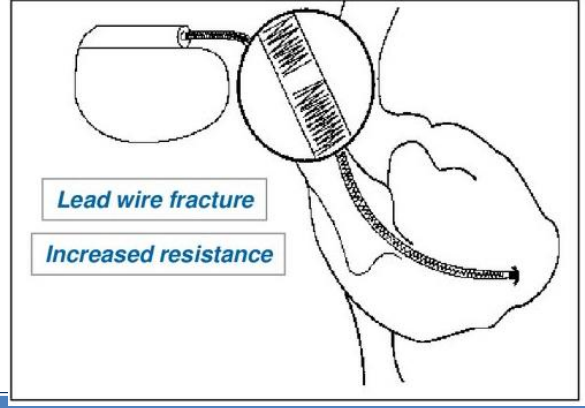
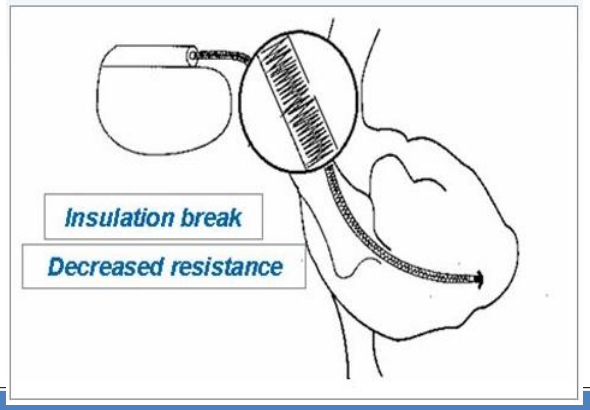
Lead Impedance





	Pacemaker	ICD
Normal Value For Lead Impedance	200-2000 Ohms (Varies with each manufacturer)	20-200 Ohms
Possible Lead Insulation Break	< 200 Ohms	< 20 Ohms
Possible Lead Fracture	> 2000 Ohms	> 200 Ohms

Greater than 30% change in lead impedance trend should be a hard stop

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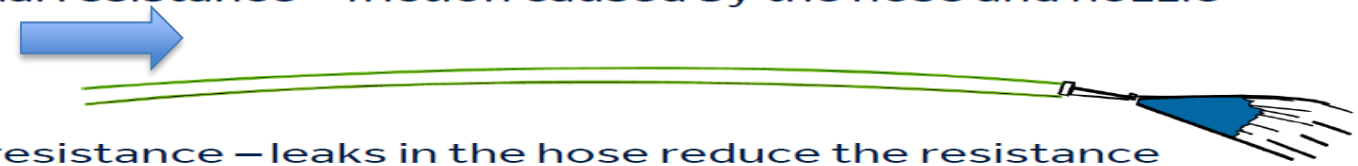
LEAD IMPEDANCE VALUES
ELECTRICAL ANALOGIES

- Normal resistance – friction caused by the hose and nozzle



- Low resistance – leaks in the hose reduce the resistance
  - Similar to a pacemaker lead with an insulation breach which results in low resistance and high current drain; may cause premature battery depletion.

- High resistance – a knot results in low total current flow
  - Similar to a pacemaker lead with a lead conductor break – impedance will be high with little or no current reaching the myocardium.

CMR Checklist

STEPS FOR AN MRI SCAN[a] CARDIOLOGY DEPARTMENT

Please refer to the Abbott MRI Ready Systems Manual at https://medical.abbott/manuals

MRI SYSTEM CONDITIONS	YES	NO
Patient has a complete MRI Ready System with MR Conditional pulse generator and lead(s).	☐	☐
Confirmed the absence of lead extenders, lead adapters, and broken or abandoned leads.	☐	☐
Lead impedance measurements are within the programmed lead impedance limits.	☐	☐
Pulse generator is implanted in the left or right pectoral region.	☐	☐
Pulse generator has sufficient battery (not at end-of-life EOL).	☐	☐

PRE MRI SCAN DEVICE SETTINGS	YES	NO
Confirm pacing capture thresholds are stable.	☐	☐
Confirm capture threshold ≤ 2.5 V at a pulse width of 0.5 ms for RA and RV lead(s).	☐	☐
Confirm capture threshold of ≤ 2.0V at a pulse width of 0.5 ms for the LV lead.	☐	☐
Confirmed MRI Settings status and the programmed MRI Mode setting. Please select a pacing rate to avoid competitive pacing: ☐ DOO (Bipolar) Pacing rate_____bpm ☐ AOO (Bipolar) Pacing rate_____bpm ☐ VOO (Bipolar) Pacing rate_____bpm ☐ Pacing Off		
For pacemakers ONLY: if the SJM MRI Activator™ handheld device is used,[b] verify that it has been enabled using the Merlin™ Patient Care System (PCS) programmer.	☐	☐
Print an MRI summary report of the patient's MRI Settings and permanently programmed parameters. **For Gallant™ and Entrant™ ICDs & CRT-Ds ONLY:** If MRI Timeout is programmed, ensure that there is adequate time to complete the MRI scan before MRI Timeout expires.	☐	☐

POST MRI SCAN DEVICE SETTINGS	YES	NO
Disable the pulse generator MRI Settings, restoring the permanently programmed settings.	☐	☐
Confirm the permanently programmed settings are appropriate.	☐	☐
Check the pacing capture thresholds after the scan to ensure that the pacing parameters are programmed adequately for the patient based on the threshold.	☐	☐

This document is intended to be used as a guide for health care facilities.

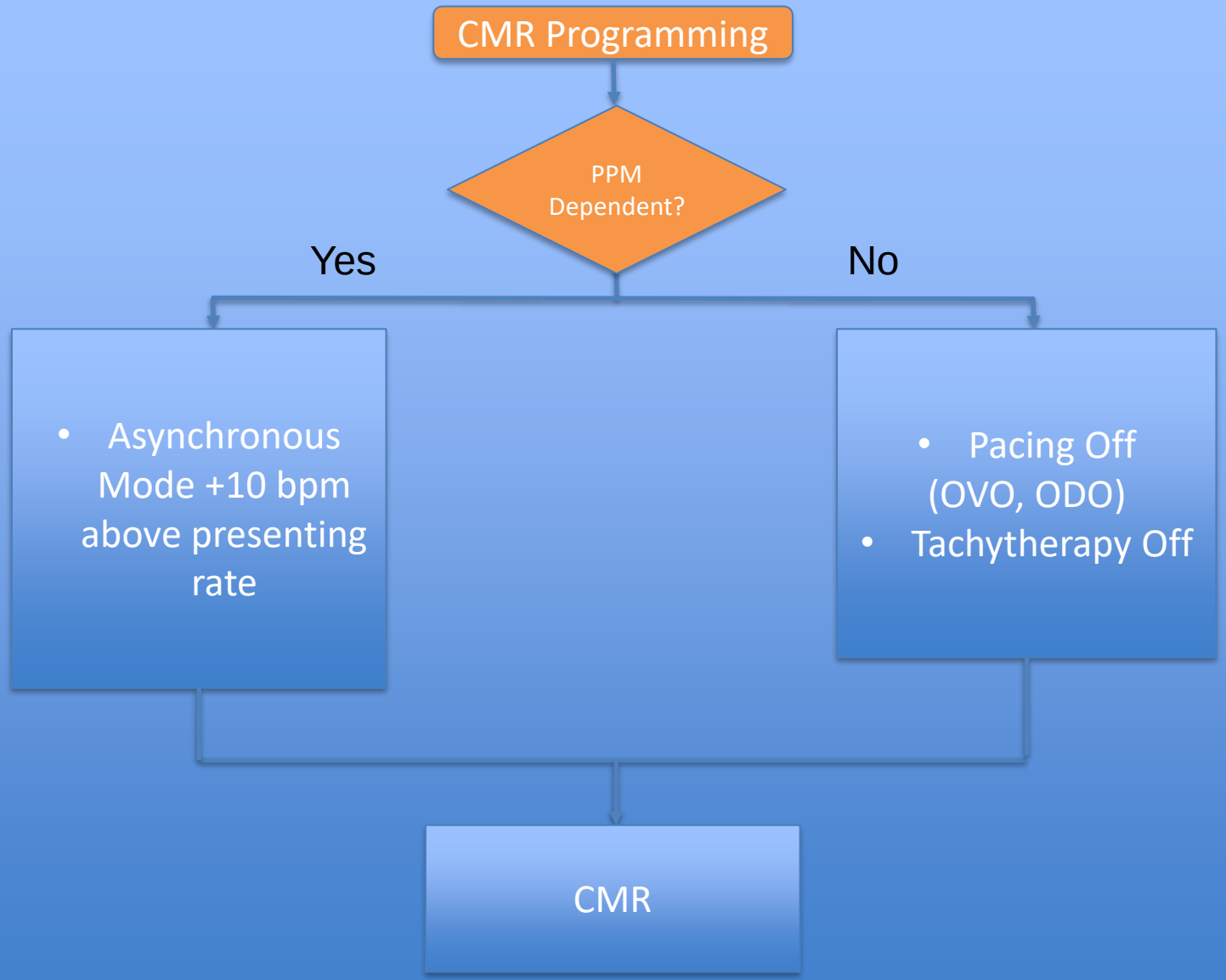
Physician Name: _____

Physician Signature: _____

Date: _____

Abbott

CMR Programming Algorithm



Potential Hazards

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HAZARDS RELATED TO THE MAGNETIC FIELDS

	Static	Gradient	RF
Unintended stimulation Arrhythmia induction, asystole		■	■
Force & torque Patient discomfort, dislodgement	■		
Vibration Patient discomfort, device damage	■	■	
Case heating Patient discomfort, necrosis		■	■
Device interactions Therapy delivery, device reset/damage	■	■	■
Lead electrode heating Therapy delivery, sensing			■

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Patient Monitoring

- RN (ACLS Certified) must be present throughout the procedure
- Supervising cardiology fellow must be in the vicinity
- Pacemaker RN/ Tech
- IV Access
- Monitor vital signs every 5-10 mins (BP, HR, O2 sat, EKG)
- Monitor patient for heating sensation, palpitations, SOB, and signs and symptoms of pacemaker syndrome
- Crash cart

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POST CMR

- Program device to its original setting
- Sensing, lead impedance, and threshold tests
- Save/ print report

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Summary

- Types of CIED: Single/ dual chamber PPM, CRT-P/D, AICD, ILR, transcatheter PPM
- Manufacturers: MDT, BSC, Abbott, BTK
- NBG Code: Chamber(s) paced, sensed, response to sensing, and rate response
- Ohm's law: Voltage = Current * Impedance
- Capture threshold, sensing, and lead impedance
- CMR Safety Screening
- Potential Hazards
- Patient Monitoring and Post CMR

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References

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