CIED (CARDIOVASCULAR ELECTRONIC DEVICES) FOR NORA

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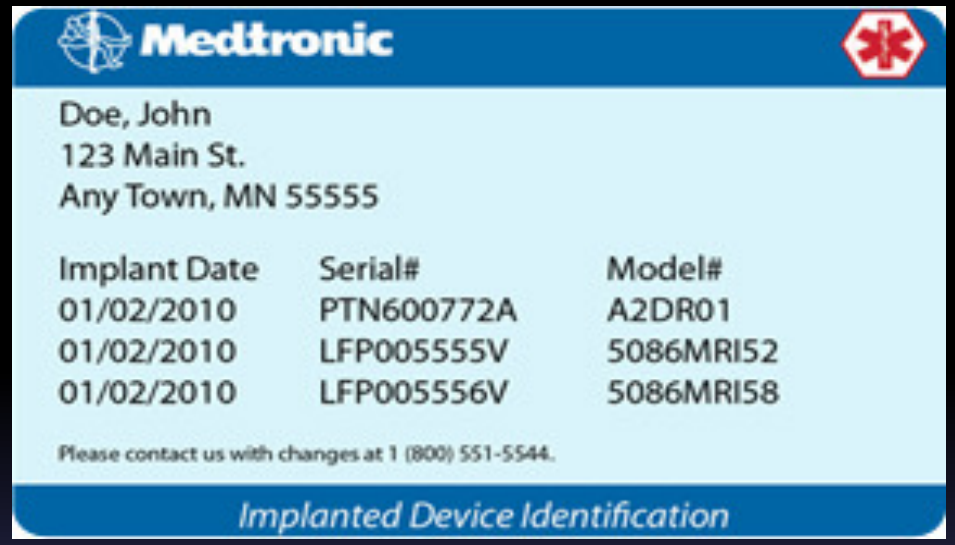
Healthy Hearts Don't Get CIEDs

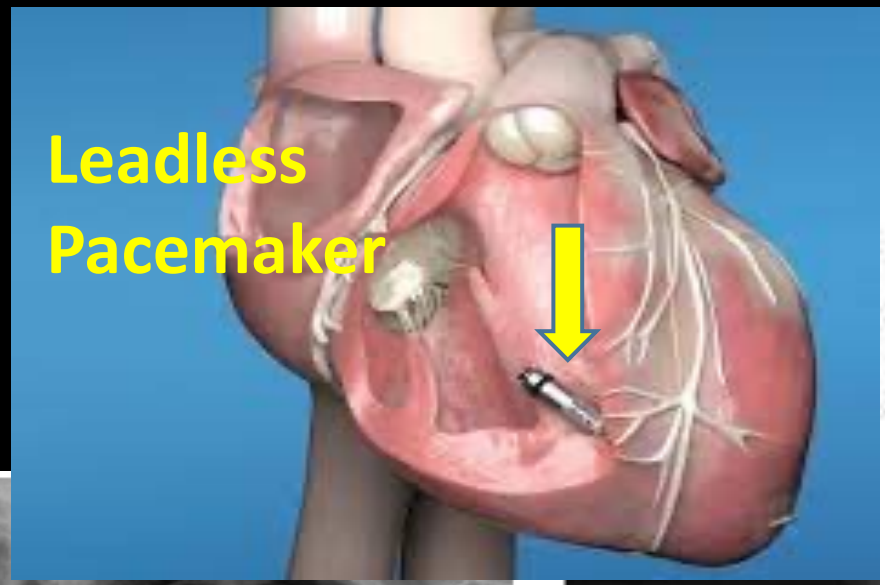
- Tachy-brady syndrome
- Sick sinus syndrome
- Some post-transplant patients
- 2nd degree Mobitz 2 or 3rd degree (complete) heart block
- Neurogenic syncope
- Ventricular tachycardia/fibrillation
- EF $\leq$ 35%
- Hypertrophy cardiomyopathy (HCM)
- Heart transplant wait-list patients
- Long Q-T syndrome
- Brugada syndrome (RBBB with ST segment elevation V1-V3)
- Arrhythmogenic right ventricular dysplasia

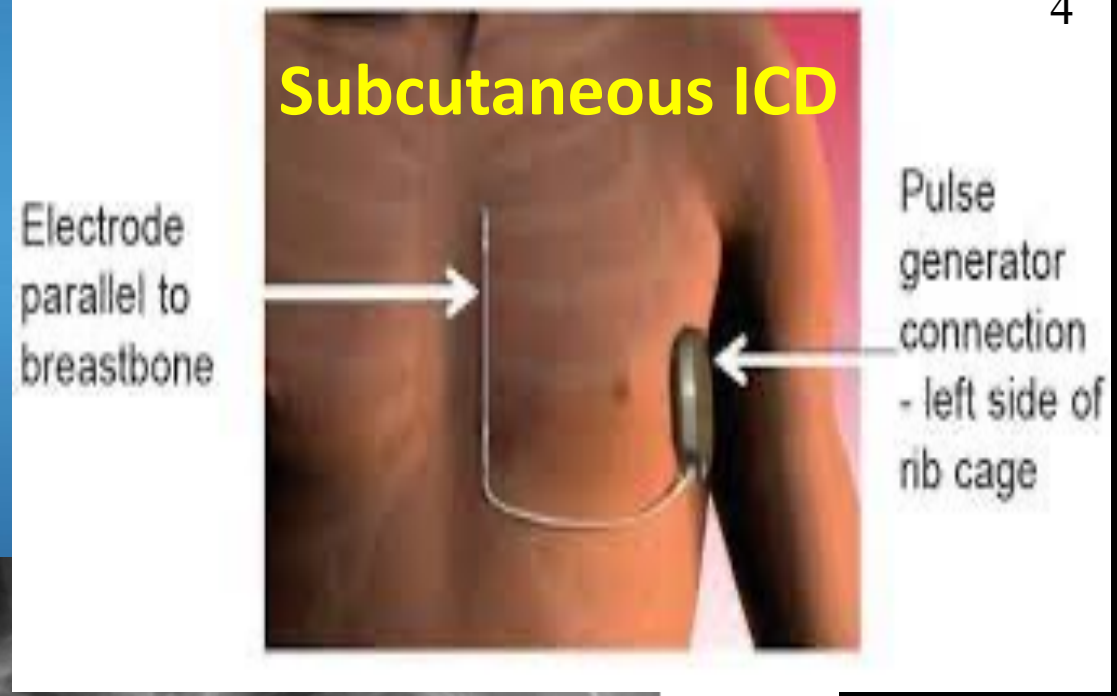
Plan ahead

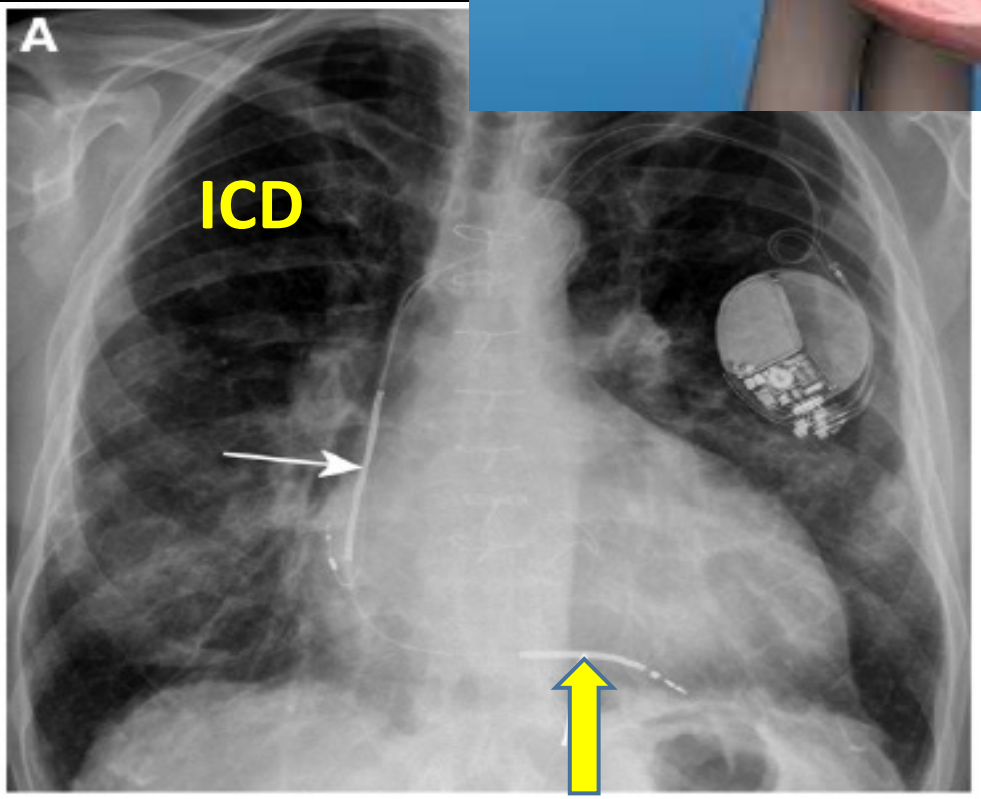
- Most patients have identification card
- Most information from EMR or a phone call
- Radiographs
- Type of CIED
- Manufacturer
- Model
- Primary indication for placement
- Pacing-dependency
- **Effects of a magnet**
- Proper functioning of the CIED
  - Recommended interrogations q12 months for pacemaker, q6 months for ICD

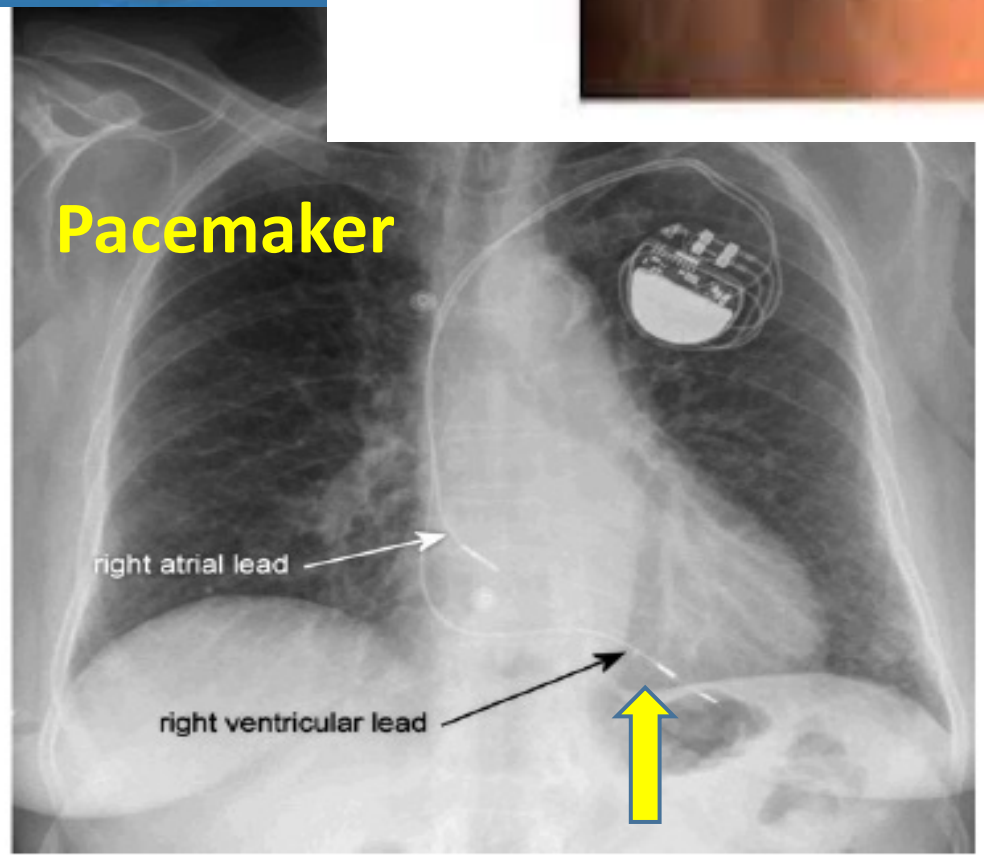


CIED


Leadless
Pacemaker


Subcutaneous ICD
Electrode parallel to breastbone
Pulse generator connection - left side of rib cage


A
ICD


Pacemaker
right atrial lead
right ventricular lead

Preoperative Preparations

- Procedure teams need to inform CIED team about procedure details, patient positioning and type of anticipated EMI
- CIED trained professionals should communicate specific programming, **response to a magnet**, pacemaker dependency, battery life, and history of serious arrhythmias
- CIED-trained clinicians can reprogram the CIED or oversee an industry employed professional
  - Industry professionals may not be aware of the medical history or have hospital privileges and may raise liability concerns

Anesthesiology 2015;123:1024-; Heart Rhythm 2011;8:1114-

Table 6. Magnet response: pacemakers

Pacemaker persists in asynchronous mode	
Boston Scientific (Guidant)	Asynchronous at 100 beats · min^{-1}, 90 beats · min^{-1}, or 85 beats · min^{-1}
Medtronic	Two beats at 100 beats · min^{-1}, 1 beat at 90 beats · min^{-1}, then 85 beats · min^{-1}
Sorin/ELA	Asynchronous at 98-82 beats · min^{-1} (depending on battery life)
St Jude Medical	Three beats at 100 beats · min^{-1} or 98 beats · min^{-1}, then 85 beats · min^{-1} until magnet removed
Pacemaker reverts to programmed mode	
Biotronik	Ten beats asynchronous at 90 beats · min^{-1} or 80 beats · min^{-1}, then subsequent at programmed rate less 11%
Intermedics (most models; now owned by Boston Scientific)	Transient magnet rate (sometimes 64 beats · min^{-1}) then reverts to programmed rate

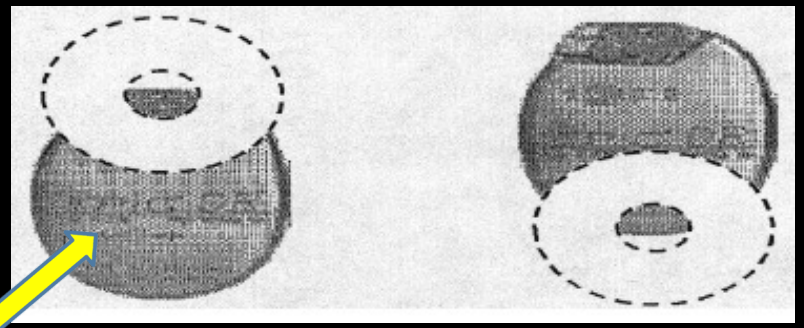
Responses may be different if battery generator replacement is indicated (ERI) or battery depleted (EOL).

- Magnets MAKE pacemakers pace (asynchronously)
- Pace at manufacturer's preset rates
- Magnet rates decrease if battery life is limited
- Biotronik has unique magnet responses
- **Magnets do not force pacing with ICDs!!**

88 yo with pacemaker for 3rd degree heart block for cholecystectomy. You decide to use a magnet.

- After magnet placed she complains of chest pain
- You notice her HR is 100
- Asynchronous “magnet” rates may be too fast
  - Typical manufacturer-programmed rates are 98-100 beats/minute
- **Solution: have pacemaker reprogrammed preoperatively to an appropriate rate**

Magnet Behavior With ICDs



- Magnets STOP ICDs from firing
  - Inhibit tachytherapies temporarily
- Magnets have reversible effects
- St. Jude ICDs magnet needs to be placed off center
- Magnets **DO NOT** change pacemaker function of ICDs
  - **If you need asynchronous pacing from ICD it MUST be reprogrammed**
    - **Pacer dependent patient when EMI anticipated**

Do you always need to reprogram pacemakers or use a magnet?

- EMI above umbilicus:
  - Pacemaker-dependent patient with **pacemaker: R**eprogram or use magnet to provide asynchronous mode to avoid pacing inhibition
  - **Leadless pacemakers** in pacemaker-dependent patient: **Must** reprogram to provide asynchronous mode to avoid pacing inhibition
  - Most Biotronik pacemakers must be reprogrammed
- **Advantage of magnets: easily reversible**

Ann Card Anaesth 2020;23:493- ; Heart Rhythm 2011;8:1114-

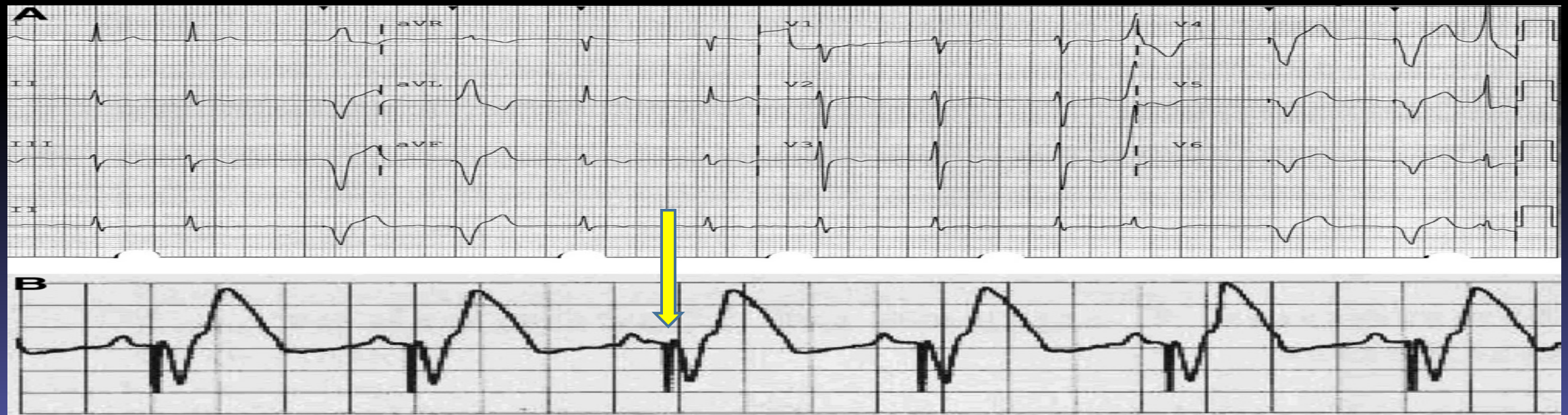
When do you reprogram an ICD or use a magnet?

- EMI above umbilicus:
  - Reprogram or use magnet to avoid inappropriate tachytherapies
  - Pacemaker-dependent patient with ICD: Must reprogram to provide asynchronous mode to avoid pacing inhibition
- EMI below umbilicus:
  - Reprogram or use magnet for **subcutaneous ICD regardless of** EMI location
- No EMI expected:
  - Use magnet in circumstances such as intracranial, intraspinal or intraocular surgeries when movement from a shock is undesirable
- **Advantage of magnets: easily reversible**

Heart Rhythm 2011;8:1114-

Monitoring Essentials

- Be sure ECG detects pacer discharges
- Disable "artifact filter" or change from monitor to diagnostic or pacer mode
  - Can falsely mark artifact as pacemaker spike
  - Failure to detect pacemaker spkes due to onitor filters
- Can overcount the HR due to counting pacer spikes and QRS



Electromechanical Interference (EMI)

- Monopolar electrosurgery most common cause of EMI
- Pacemakers over-sense EMI and are inhibited from pacing
- ICDs falsely detect arrhythmias and are triggered
- Avoid monopolar electrosurgical unit (ESU)
- Use bipolar ESU if possible
- Cutting mode has less EMI than coagulation mode
- ESU below umbilicus has low risk of EMI (except for subcutaneous ICDs

Dispersive electrode placement

- Place pad so current path does NOT CROSS the device
- May need to place pad on neck or shoulder for head, neck and upper torso surgeries

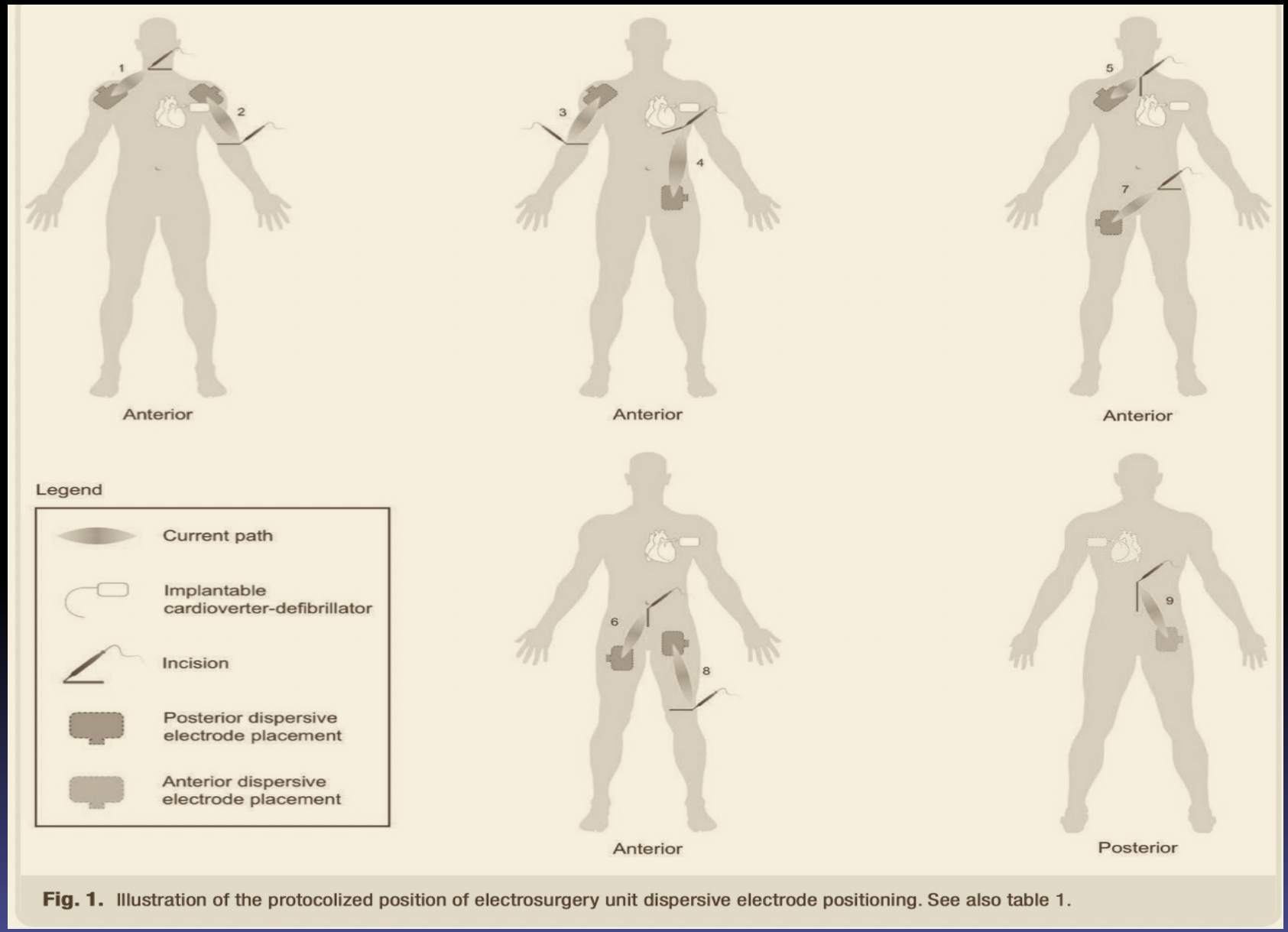


Fig. 1. Illustration of the protocolized position of electrosurgery unit dispersive electrode positioning. See also table 1.

Anesthesiology 2019;130:530-

Underbody dispersive electrode

- ✓Large surface are results in CIED interference even with EMI below umbilicus
- ✓Must always reprogram or use magnet

Anesthesiology 2019;130:530-

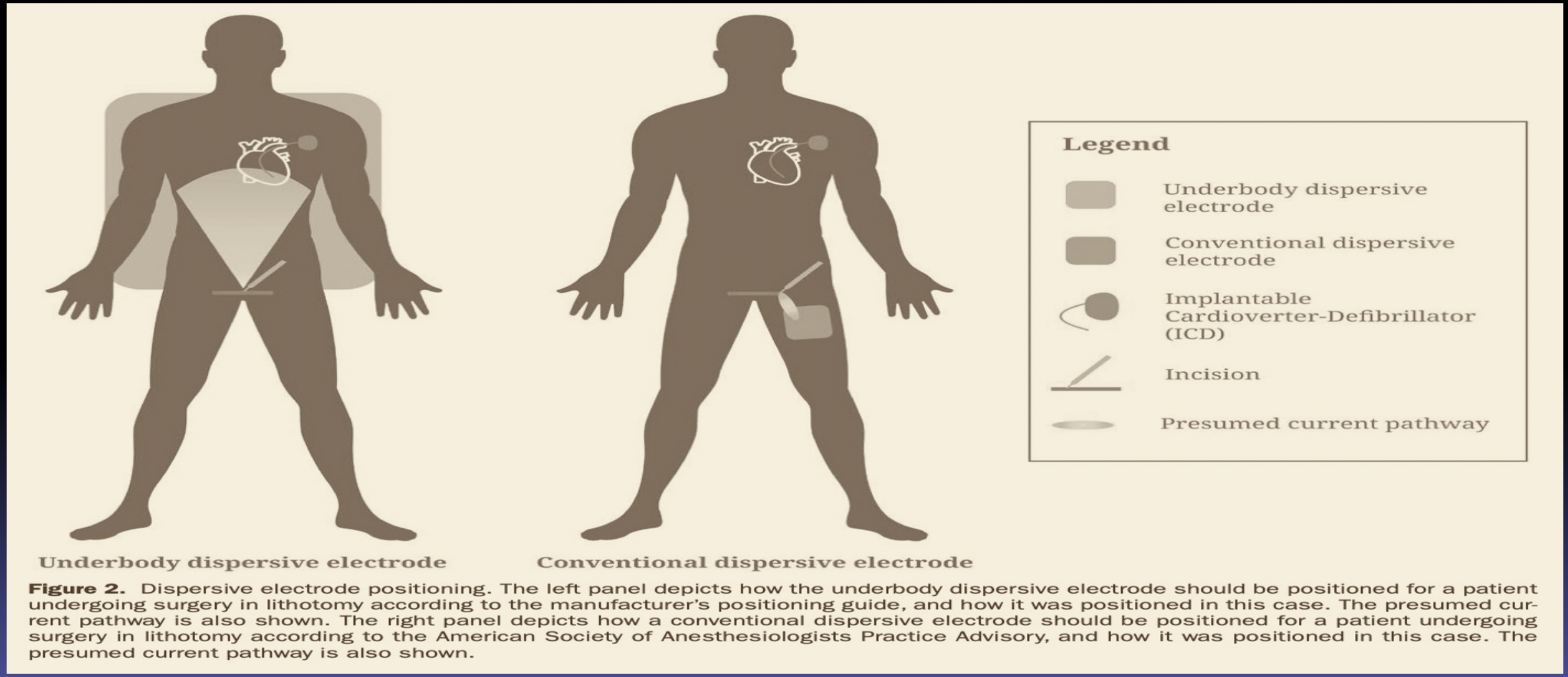
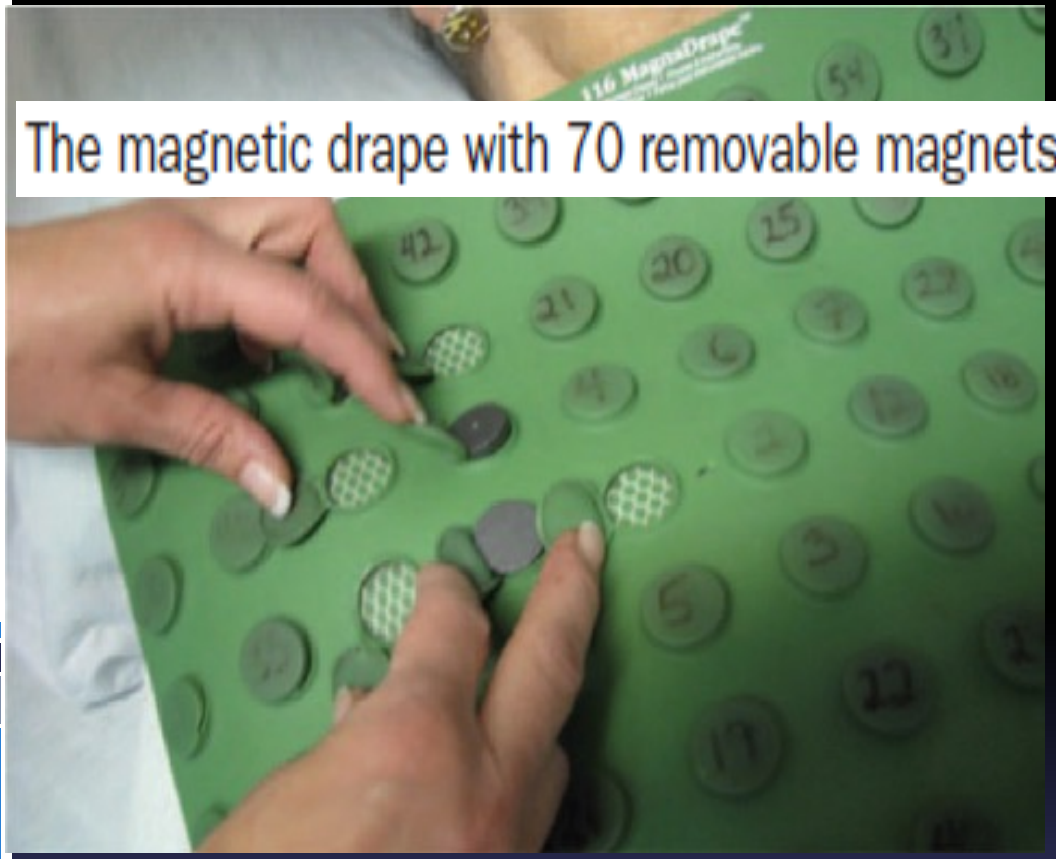


Figure 2. Dispersive electrode positioning. The left panel depicts how the underbody dispersive electrode should be positioned for a patient undergoing surgery in lithotomy according to the manufacturer's positioning guide, and how it was positioned in this case. The presumed current pathway is also shown. The right panel depicts how a conventional dispersive electrode should be positioned for a patient undergoing surgery in lithotomy according to the American Society of Anesthesiologists Practice Advisory, and how it was positioned in this case. The presumed current pathway is also shown.

Magnetic drapes that hold metal instruments interfere with CIEDs



The magnetic drape with 70 removable magnets.

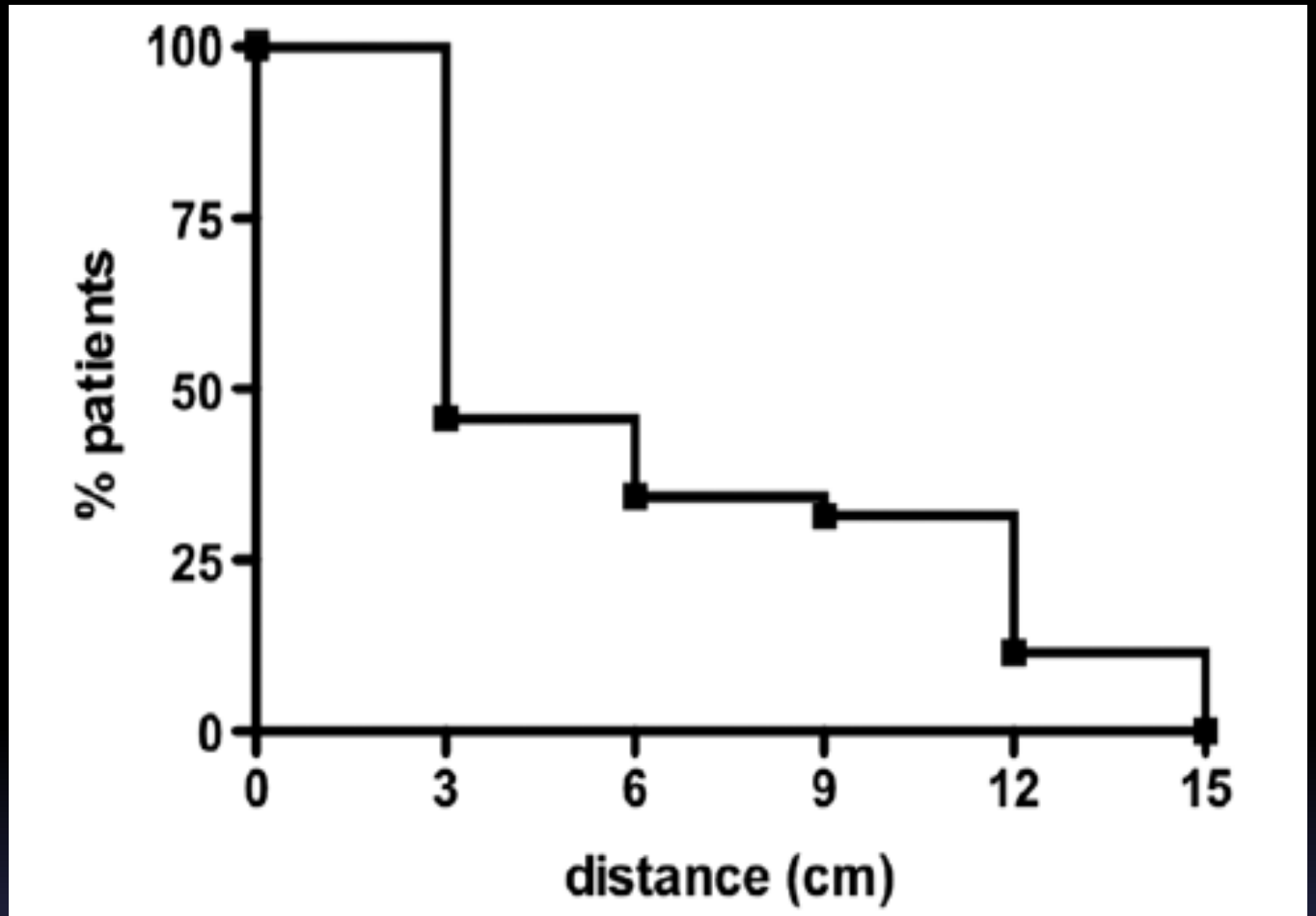


Figure 2. Percentage of patients (n = 35) with unfolded drape whose pacemakers ceased to have magnetic interference as the drape was moved caudally.

No interference if CIED 15 cm from magnetic drapes

Anesth Analg 2013;116:555-

Intraoperative Practices

- Need equipment for backup pacing and/or defibrillation
- Prophylactic pad placement if external defibrillation not an option

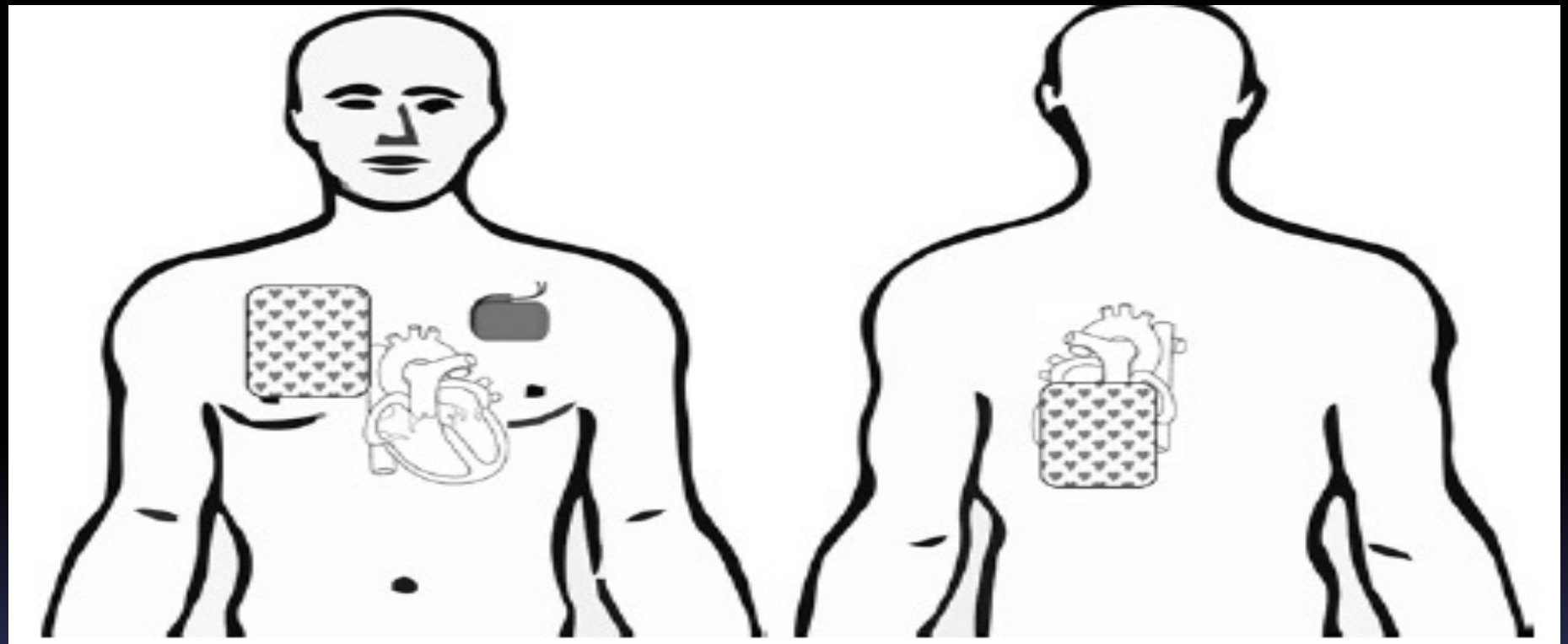


Figure 3. Placement of transcutaneous pads to facilitate intraoperative external pacing, cardioversion, or defibrillation. Care should be taken to ensure pads are not within 4 to 5 cm of the implanted pacemaker or defibrillator.

EMI other than ESU

- Central line insertion
- Radiofrequency ablation
- Therapeutic, but not diagnostic radiation
- ECT
- GI procedures using ESU
- TENS units
- Bone saws (rate responsive devices)
- Mechanical ventilators (rate responsive devices)
- MRIs can damage CIEDs

Anesthesiology 2001;94:710-

Rate Responsive Pacemakers

- Increases HR with increased O_2 demand (exercise or stress)
- Sensors detect patient "exercise" (vibration, respiration, movement)
- Activation in OR from prep, moving patient, ventilators, some monitors
- Maximum rates up to 180 beats/min
- Increased paced rates may cause ischemia
- Inappropriate treatments and harm

"Ventilators can cause inappropriate minute ventilation (MV) sensor-driven rates. Program MV sensor OFF during mechanical ventilation"

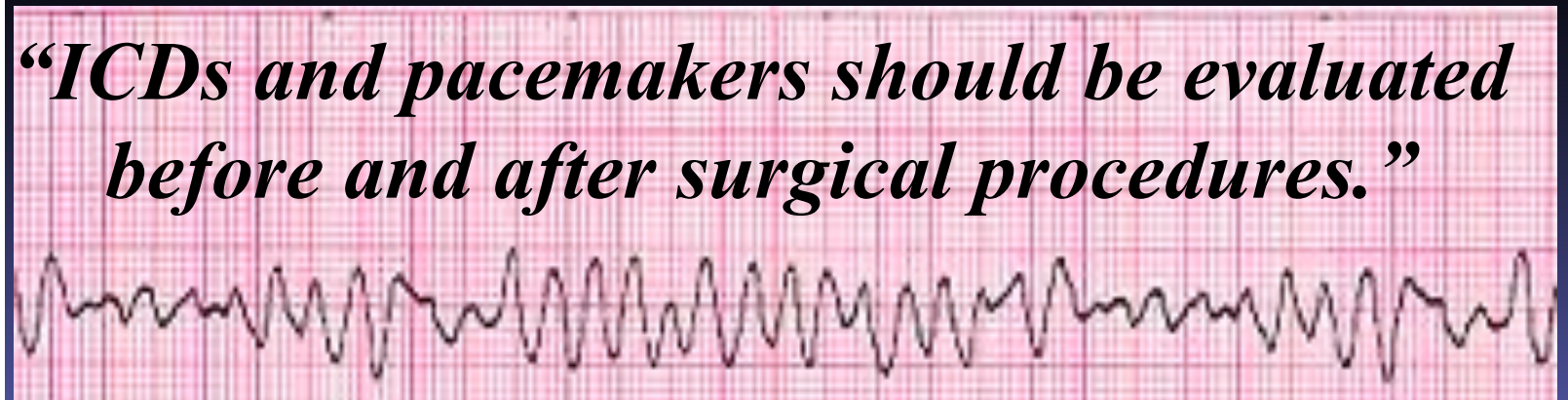
Guidant Information for Use

"…several reported incidents where minute ventilation rate-adaptive pacemakers paced at maximum rates when patients connected to monitoring and diagnostic equipment."

Anesthesiology 2001;94:710-

Failure to Reactivate Tachytherapies

- Continuously monitored with ECG while ICD disabled
- Devices must be reprogrammed to recommended settings before patients leaves monitored settings
- Sudden deaths reported to registries after failure to reactivate tachytherapies
- Patients should be encouraged to send remote transmissions to EP after discharge



Mayo Clin Proc 2002;77:885-
Heart Rhythm 2004;1:399-

The Heart Rhythm Society (HRS)/American Society of Anesthesiologists (ASA) Expert Consensus Statement on the Perioperative Management of Patients with Implantable Defibrillators, Pacemakers and Arrhythmia Monitors: Facilities and Patient Management: Executive Summary

This document was developed as a joint project with the American Society of Anesthesiologists (ASA), and in collaboration with the American Heart Association (AHA), and the Society of Thoracic Surgeons (STS)

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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**

Heart Rhythm 2011;8:1114-; Anesthesiology 2020; 132:225–