Pacemakers and Implantable Cardioverter-Defibrillators

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Practice Essentials

An implantable cardioverter-defibrillator (ICD) is a specialized device designed to directly treat a cardiac tachydysrhythmia. ICDs have revolutionized the treatment of patients at risk for sudden cardiac death due to ventricular tachyarrhythmias. A permanent pacemaker is an implanted device that provides electrical stimuli, thereby causing cardiac contraction when intrinsic myocardial electrical activity is inappropriately slow or absent.

Essential update: New technique can eliminate imaging artifacts caused by ICDs

Rashid and colleagues developed a modified wideband late gadolinium enhancement (LGE) magnetic resonance imaging technique that can overcome hyperintensity image artifacts caused by implanted cardiac devices. In their study of 12 patients with ICDs, use of the wideband LGE sequence eliminated the severe, uninterpretable hyperintensity artifacts in the left ventricular wall that occurred with conventional LGE technique, thereby enabling confident evaluation of myocardial viability.[1]

Indications for ICD placement

Indications for ICD implantation can be divided into 2 broad categories: secondary prophylaxis against sudden cardiac death and primary prophylaxis. For secondary prophylaxis, ICD placement is indicated as initial therapy in survivors of cardiac arrest due to VF or hemodynamically unstable VT. Published guidelines exclude cases in which there are "completely reversible causes,"[2] although this exclusion is somewhat controversial.

Currently, indications for primary prophylaxis account for most of ICD implants, even though the evidence for such implants is often less well established. Class I indications (ie, the benefit greatly outweighs the risk, and the treatment should be administered) are as follows:

- Structural heart disease, sustained VT
- Syncope of undetermined origin, inducible VT or VF at electrophysiologic study (EPS)
- Left ventricular ejection fraction (LVEF) < 35% due to prior MI, at least 40 days post-MI, NYHA class II or III
- LVEF ≤35%, NYHA class II or III
- LVEF ≤30% due to prior MI, at least 40 days post-MI
- LVEF < 40% due to prior MI, inducible VT or VF at EPS

Class IIa indications (ie, the benefit outweighs the risk and it is reasonable to administer the treatment) are as follows:

- Unexplained syncope, significant LV dysfunction, nonischemic cardiomyopathy

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- Sustained VT, normal or near-normal ventricular function
- Hypertrophic cardiomyopathy with 1 or more major risk factors
- Arrhythmogenic right ventricular dysplasia cardiomyopathy (ARVD/C) with 1 or more risk factors for sudden cardiac death (SCD)
- Long QT syndrome, syncope or VT while receiving beta-blockers
- Nonhospitalized patients awaiting heart transplant
- Brugada syndrome, syncope or VT
- Catecholaminergic polymorphic VT, syncope or VT while receiving beta-blockers
- Cardiac sarcoidosis, giant cell myocarditis, or Chagas disease

**Pacemaker indications**

Absolute indications for pacemaker placement include the following:

- Sick sinus syndrome
- Symptomatic sinus bradycardia
- Tachycardia-bradycardia syndrome
- Atrial fibrillation with sinus node dysfunction
- Complete atrioventricular block (third-degree block)
- Chronotropic incompetence (inability to increase the heart rate to match a level of exercise)
- Prolonged QT syndrome
- Cardiac resynchronization therapy with biventricular pacing

Relative indications include the following:

- Cardiomyopathy (hypertrophic or dilated)
- Severe refractory neurocardiogenic syncope

Temporary emergency pacing is indicated for therapy of significant and hemodynamically unstable bradydysrhythmias and for prevention of bradycardia-dependent malignant dysrhythmias.

**Magnet Inhibition**

Features of magnet inhibition are as follows:

- In most devices, placing a magnet over a permanent pacemaker temporarily "reprograms" the pacer into asynchronous mode; it does not turn the pacemaker off
- If the device company parameters are known, application of a magnet can determine whether the pacer's battery needs to be replaced
- Although many different branded pacemaker/ICD magnets are available, in general, any pacemaker/ICD magnet can be used to inhibit the device
- Magnet use inhibits further ICD discharge; it does not, however, inhibit pacing

Indications for ICD deactivation are as follows:

- End-of-life care (after a discussion with the patient and family)
- Inappropriate shocks
- During resuscitation
- With transcutaneous pacing (external pacing can cause an ICD to fire)
- During procedures such as central lines or surgery with electrocautery

**ICD complications and malfunctions**

Acute surgical complications include the following:

- Pain
- Bleeding
- Pneumothorax

- Hemothorax
- Cardiac perforation with or without pericardial effusion and tamponade (sometimes requiring urgent drainage)
- Pulseless electrical activity following intraoperative defibrillation threshold testing

Subacute ICD complications include the following:

- Pain
- Infection
- Pocket hematoma
- Wound dehiscence
- Lead dislodgment
- Deep venous thrombosis
- Upper extremity edema
- Degradation of lead function

Chronic complications include the following:

- Device-related pain
- Lead fracture
- Inappropriate shocks
- Erosion of device through skin
- Immunologic rejection – Rare

**Pacemaker complications and malfunctions**

Pacemaker complications include the following:

- Pneumothorax
- Pericarditis
- Infection
- Skin erosion
- Hematoma
- Lead dislodgment
- Venous thrombosis

Major pacemaker malfunctions include the following:

- Failure to output
- Failure to capture
- Failure to sense
- Pacemaker-mediated tachycardia
- Runaway pacemaker
- Pacemaker syndrome
- Twiddler’s syndrome
- Cardiac monitor pseudomalfunction
- Pacemaker pseudomalfunction

**Inpatient Care**

Reasons for admission may include the following:

- Device investigation: To determine if there is an eminent battery failure (multiple shocks will deplete battery life)
- Addition of antiarrhythmic medications
- Treatment of MI (which may be linked to the initial discharge)
- Treatment of patient discomfort
- Provision of psychological support: Up to 35% of people develop anxiety disorder following ICD
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