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Review

ED evaluation and management of implantable cardiac defibrillator electrical shocks

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ABSTRACT

Patients with implantable cardiac defibrillators not infrequently present to the emergency department after experiencing an implantable cardiac defibrillator shock. This review considers the management of such patients in the emergency department, including appropriate, inappropriate, and phantom shocks as well as electrical storm.

1. Introduction

At its simplest, the primary components of an implantable cardiac defibrillator (ICD) are its leads and the pulse generator, which contains the battery and essential circuitry. A single-chamber ICD consists of a defibrillation lead in the right ventricle, whereas a dual-chamber ICD consists of leads in the right atrium and the right ventricle. Some patients may also have a pacing lead in the left ventricle for treatment of heart failure; this form of electrical therapy is known as *cardiac resynchronization therapy*. Lastly, the ICD can also have a pacemaker function with lead placement dependent upon the chambers paced. The device is usually implanted in the left infraclavicular region, but if not seen there, it may be in the right infraclavicular area or in the abdominal wall. Most devices are easily palpable even if they are not noticeable visually [1–4].

The primary indications for ICD implantation are ventricular tachycardia (VT) or ventricular fibrillation (VF) resulting in cardiac arrest or syncope, sustained VT in a patient with structural heart disease, and end-stage cardiomyopathy with low ejection fraction, among other clinical situations. Fig. 1 depicts Class I and IIa indications for ICD placement [5]. There are many complications associated with ICD implantation such as wound hematoma, infection of the site or leads, and upper extremity deep venous thrombosis [2,3,5].

Our focus in this review is the management of the patient presenting after an ICD shock.

2. ICD function

The ICD can perform as a pacemaker for bradycardia. It can also sense cardiac electrical activity, recognize malignant rhythms such as VT and VF, and terminate these dysrhythmias by either antitachycardia pacing (ATP) or electrical shock. ATP involves a burst of 6-10 paced impulses at a rate faster than the VT rate. ATP use was less common in the past because of concern that ATP could increase the VT rate rather than terminating the dysrhythmia; several studies have demonstrated a low risk of rate acceleration. In addition to its efficacy, ATP is preferred to electrical shock because the latter causes significant patient discomfort and decreases battery life [1,3–9].

Ventricular rate and elapsed time at the accelerated rate are the 2 primary determinants for shock delivery. Each ICD is individually programmed for detection of dysrhythmias. For example, in a patient with structural heart disease, slow VT may be defined as a heart rate of approximately 150-180 beats per minute and rapid VT as 180-200 beats per minute; rates greater than 200 beats per minute are considered "VF-like." In a younger patient, the detection zones may be set at higher heart rates because of the possibility of more rapid forms of sinus tachycardia during periods of exertion and other high-adrenergic states. The sequence of treatment (ATP, low-energy shock, high-energy shock) is also individualized. As an example, a device may be programmed to attempt 2 ATP trials before shocking a rapid VT rhythm to terminate the dysrhythmia quickly and relatively painlessly. Moreover, spontaneous termination of ventricular dysrhythmias can occur, so the device may be programmed to wait for a period of seconds before delivering therapy. Electrical discharges, or shocks, are usually delivered at a maximal intensity of 40-42 J. Although these shocks use significantly less energy than an external defibrillator, they are still painful to the conscious patient [1,3,4,9–11].

3. ICD shock: appropriate versus inappropriate

Although the reported incidence in various studies differs, appropriate ICD shocks represent approximately 50%-75% of ICD discharges;

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AHA / ACC Indications	Class
Structural heart disease, sustained VT	Class I
Syncope of undetermined origin, inducible VT or VF at EPS	Class I
LVEF < 35% due to prior MI, at least 40 days post-MI, NYHA Class II or III	Class I
LVEF ≤35%, NYHA Class II or III	Class I
LVEF ≤30% due to prior MI, at least 40 days post-MI	Class I
LVEF < 40% due to prior MI, inducible VT or VF at EPS	Class I
Unexplained syncope, significant LV dysfunction, nonischemic CM	Class IIa
Sustained VT, normal or near-normal ventricular function	Class IIa
Hypertrophic CM with 1 or more major risk factors	Class IIa
Arrhythmogenic right ventricular dysplasia/cardiomyopathy (ARVD/C) with 1 or more risk factors for sudden cardiac death (SCD)	Class IIa
Long QT syndrome, syncope or VT while receiving beta blockers	Class IIa
Nonhospitalized patients awaiting heart transplant	Class IIa
Brugada syndrome, syncope	Class IIa
Brugada syndrome, VT	Class IIa
Catecholaminergic polymorphic VT, syncope or VT while receiving beta blockers	Class IIa
Cardiac sarcoidosis, giant cell myocarditis, or Chagas disease	Class IIa

Fig. 1. Brief indications for ICD placement [45].

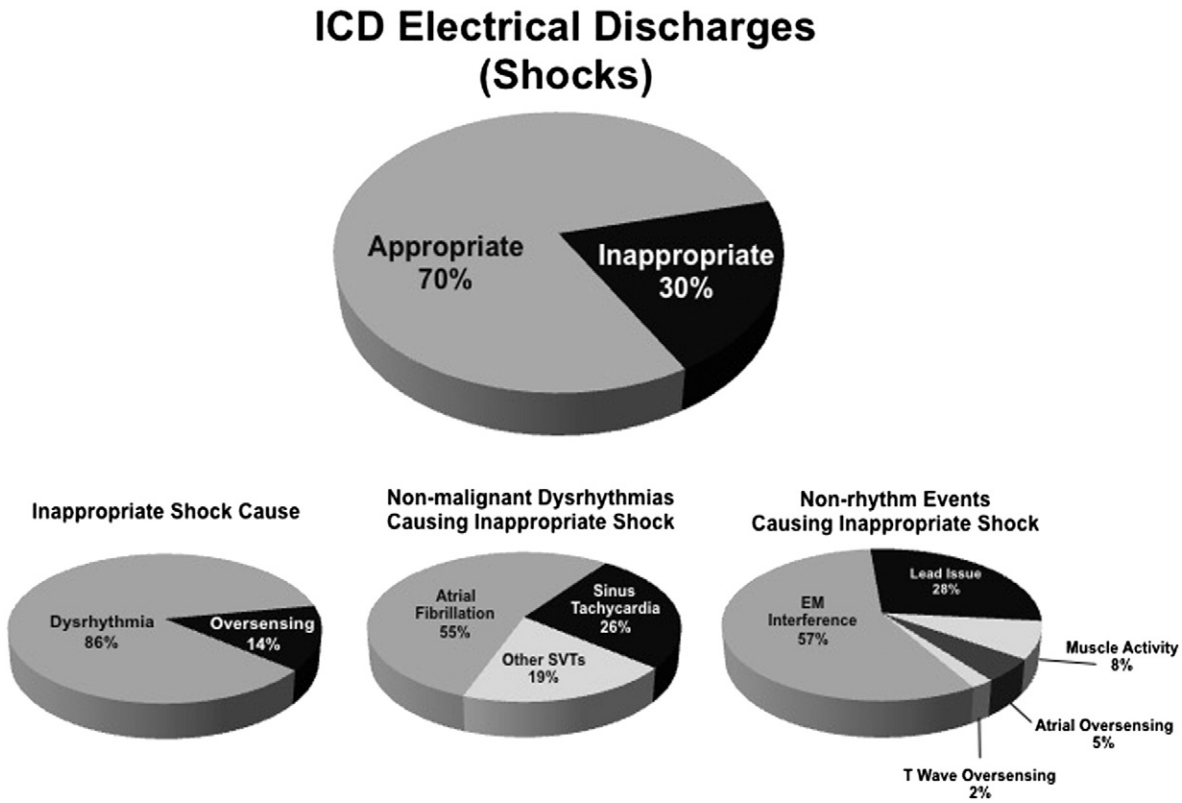

Fig. 2. ICD electrical discharges (shocks). Appropriate and inappropriate shocks with a description of inappropriate shock subtypes. [46,47].