The implantable cardioverter-defibrillator (ICD) reduces mortality when used for primary or secondary prevention of sudden cardiac death in patients at high risk for life-threatening arrhythmias. In the era of single-chamber ICD, atrial fibrillation (AF) was the most common cause of inappropriate shocks, responsible for up to 62% of these. The issue still constitutes a major challenge, even after the advent of dual-chamber ICD and sophisticated detection criteria/algorithms.¹³

In the MADIIT II (Multicenter Automatic Defibrillator Implantation Trial II) study, which originally evaluated the effect of ICD on total mortality in patients with coronary artery disease and an ejection fraction ≤30%, during the 17.2-month follow-up of 719 patients, 169 (24%) received appropriate and 83 (11.5%) received inappropriate shocks.¹⁴ Inappropriate shocks may result in the induction of potentially fatal ventricular tachyarrhythmias. Appropriate shocks are associated with an increase in mortality, especially in patients with heart failure, although the need for appropriate shocks might only be an indicator of sicker patients. According to the sub-study of MADIIT II, a higher number of patients in the ICD group required hospitalization compared with the conventional therapy group (23% vs 17%, P=0.02).⁴ The reason for the frequent hospitalization in the ICD group is supposed to be prolongation of life by appropriate shocks. In the MADIIT II patients, the effect of damage to cardiac muscle and function by an ICD shock on heart failure hospitalization should be insignificant because inappropriate shocks were not associated with a significantly increased risk of a subsequent heart failure hospitalization. The sub-study of SCD-HeFT (the Sudden Cardiac Death in Heart Failure Trial) also reported that an appropriate shock, as compared with no appropriate shock, was associated with a significant increase in the subsequent risk of death from any cause in patients with heart failure (hazard ratio 5.68, P<0.001).⁵ But, in the SCD-HeFT, an inappropriate shock, as compared with no inappropriate shock, was associated with a significant increase in the risk of death in the risk of death (hazard ratio 1.98, P=0.002). Unlike MADIIT II, it is possible that a shock itself may increase the risk of death through damage to cardiac muscle and function. The other explanation is that an inappropriate shock might only be an indicator of sicker patients, because the prevalence of AF, a major cause of inappropriate shocks, increases with the severity of heart failure. Both of the sub-studies support the idea that reducing the occurrence of shocks is worthwhile.

In any case, it is essential for the patient’s comfort to minimize ICD shocks. In this issue of the Journal, Nagai et al⁷ report on the details of inappropriate shocks in their patients, focusing on the administration of amiodarone. Clinical data of 232 patients with structural heart disease and an ICD implanted at their hospital were systematically reviewed. Half of the patients were on amiodarone at the time of ICD implantation. Amiodarone was administered empirically by the referring physician or at the hospital to prevent the recurrence of ventricular arrhythmias. During a mean observation period of 29 months, inappropriate shocks occurred less frequently in the amiodarone group than in the non-amiodarone group (12% vs 27%, P=0.0068). Their analysis showed that amiodarone therapy and an absence of a history of spontaneous AF were independent predictors of a lower risk of inappropriate shocks. They suggest that amiodarone therapy may be effective for avoiding inappropriate shocks.

Should every patient who has an ICD receive an antiarrhythmic drugs, especially amiodarone, for prevention of any shocks? At this time, amiodarone therapy cannot be advocated for all patients and should be considered on an individual basis because of a high incidence of adverse effects and a lack of survival prolongation effect. Prospective controlled studies have to be performed to study the efficacy of amiodarone for avoidance of any ICD shocks and to reveal the best candidates for prophylactic use for amiodarone. Until then, routine use of amiodarone in ICD patients does not appear to be warranted. Here I would like to introduce some pharmacological and interventional measures that can confer an incremental benefit for the reduction of inappropriate shocks.

Several studies have shown that antitachycardia pacing successfully terminates approximately 90% of relatively slow (<200 beats/min) ventricular tachycardias (VTs), with an acceptable risk of VT acceleration. The programming of repetitive antitachycardia pacing can prolong the time to shock delivery and thus provide the opportunity for some supraventricular tachycardias (SVTs) self-terminate or to gain time for the ICD to discriminate SVT from VT. The number of intervals to detect should be optimized for the reduction of inappropriate shocks because of pseudo-regular AF.

The β-blocker dosage should be maximized in order to

---

**Editorial**: Tactics for the Reduction of Inappropriate Implantable Cardioveter Defibrillator Shocks

Yuji Okuyama, MD, PhD

---

The opinions expressed in this article are not necessarily those of the editors or of the Japanese Circulation Society.

Received May 17, 2010; accepted May 17, 2010; released online June 15, 2010

Division of Cardiology, Osaka General Medical Center, Osaka, Japan

Mailing address: Yuji Okuyama, MD, PhD, Cardiology, Osaka General Medical Center, 3-1-56 Bandai-Higashi, Sumiyoshi-ku, Osaka 558-8558, Japan. E-mail: yujikokuyama@hotmail.com


All rights are reserved to the Japanese Circulation Society. For permissions, please e-mail: cj@j-circ.or.jp
decrease ventricular rates during SVT and thus minimize the odds of SVT rates falling within VT/ventricular fibrillation detection zones. Beta-blockers, together with angiotensin-converting enzyme inhibitors/angiotensin receptor blockers, are essential for most patients with structural heart disease and an ICD, because these drugs reverse the process of left ventricular remodeling, improve patient symptoms, prevent hospitalization, and prolong life.

Adjunctive antiarrhythmic agents are administered between 49% and 69% of patients with an ICD to prevent VT and SVT. The OPTIC (Optimal Pharmacological Therapy in Cardioverter Defibrillator Patients) study compared the efficacy of a β-blocker, sotalol, and amiodarone plus β-blocker. Amiodarone plus β-blocker was more effective than β-blocker alone (hazard ratio 0.27; P<0.001) or sotalol (hazard ratio 0.43; P=0.02) in preventing both appropriate and inappropriate shocks. Thus, when the use of antiarrhythmic agents is considered necessary, the first choice should be amiodarone. However, the increased likelihood of drug-related cardiac and non-cardiac adverse events should be taken into consideration. In the OPTIC study, adverse pulmonary, thyroid, and bradycardia events were more common with amiodarone treatment and the rate of discontinuation of amiodarone at 1 year was 18.2% (for sotalol, 23.5%; for β-blocker, 5.3%). Whenever an antiarrhythmic agent is administered, drug–device interactions must be considered. Amiodarone seems to increase the defibrillation threshold (DFT) in some (but not all) human studies. On the other hand, sotalol or β-blocker monotherapy has been associated with a decrease in the DFT. Beta-blockers should be administered to all patients without contraindications, as mentioned above. Sotalol can be a second choice when amiodarone is either ineffective or is discontinued because of adverse effects.

Catheter ablation constitutes a first-line approach for avoiding inappropriate shocks related to SVTs, especially typical atrial flutter (AFL), atrioventricular nodal reentry tachycardia and atrioventricular reentry tachycardia. Patients with a history of such SVTs should receive catheter ablation before or just around the time of ICD implantation. Pulmonary vein isolation (PVI) has become a valid and feasible first-line treatment option for patients with symptomatic AF. Recent studies suggest that PVI is also a feasible option for patients with AF and congestive heart failure. As far as I know, there is no prospective study investigating the preventive effect of PVI on inappropriate shocks because of AF in patients with an ICD. With the limitation that symptom improvement does not always translate into a cure of AF, PVI would be an attractive choice of therapy to avoid inappropriate shocks caused by AF. One concern is the high incidence of left AFL after PVI, because AFL with 1:1 atrioventricular conduction is one of the most troublesome rhythms for an ICD to discriminate from VT. In case of failure with all these measures, atrioventricular node ablation may be the last resort for prevention of inappropriate shocks because of AF.

Statins have been shown to reduce the occurrence of AF. Recently, Bhavnani et al reported that statin therapy was associated with a reduction in the prevalence of AF/AFL and inappropriate shocks in their ICD patients. The effect of statins on prevention of inappropriate shocks might be small and needs further investigation, but they could be a choice of additional drug therapy, because statins are associated with multiple benefits such as a reduced probability of VT/ventricular fibrillation recurrence.

In summary, optimized programming and drug therapies including β-blocker and angiotensin-converting enzyme inhibitors/angiotensin receptor blockers should be used in all patients with an ICD, and amiodarone or PVI could be taken into consideration when AF induces inappropriate shocks or severe symptoms.

References