Impact of early complications on outcomes in patients with implantable cardioverter-defibrillator for primary prevention

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BACKGROUND The lifesaving benefit of implantable cardioverter-defibrillators (ICDs) has been demonstrated. Their use has increased considerably in the past decade, but related complications have become a major concern.

OBJECTIVE The purpose of this study was to assess the incidence and effect on outcomes of early ($\leq$30 days) complications after ICD implantation for primary prevention in a large French population.

METHODS We analyzed data from 5539 patients from the multicenter French DAI-PP (Défibrillateur Automatique Implantable–Prévention Primaire) registry (2002−2012) who had coronary artery disease or dilated cardiomyopathy and were implanted with an ICD for primary prevention.

RESULTS Overall, early complications occurred in 707 patients (13.5%), mainly related to lead dislodgment or hematoma (57%). Independent factors associated with occurrence of early complications were severe renal impairment (odds ratio [OR] 1.66, 95% confidence interval [CI] 1.17–2.37, $P = .02$), age $\geq$75 years (OR 1.01, 95% CI 1.00–1.02, $P = .03$), cardiac resynchronization therapy (OR 1.58, 95% CI 1.16-2.17, $P = .01$), and anticoagulant therapy (OR 1.28, 95% CI 1.02-1.61, $P = .03$). During a mean $\pm$ SD follow-up of 3.1 $\pm$ 2.3 years, 824 (15.8%) patients experienced $\geq$1 late complication (>30 days), and 782 (14.9%) patients died. After adjustment, early complications remained associated with occurrence of late complications (OR 2.15, 95% CI 1.73-2.66, $P < .0001$) and mortality (OR 1.70, 95% CI 1.34-2.17, $P = .003$).

CONCLUSION Early complications are common after ICD implantation for primary prevention, occurring in 1 in 7 patients, and are associated with an increased risk of late complications and overall mortality. Further studies are needed to investigate the underlying mechanisms of such associations.

KEYWORDS Implantable cardiac-defibrillator; Complication; Primary prevention; Mortality; Morbidity; Sudden death

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Introduction

The beneficial effect of an implantable cardioverter-defibrillator (ICD) on primary prevention of sudden cardiac death in patients with severe left ventricular systolic dysfunction has been well demonstrated.[1–5] However, ICD implantation has the potential for complications, with a higher rate observed in daily clinical practice than is usually reported in randomized trials.[6] To date, the extent to which early complications (ECs) are associated with morbidity and mortality in daily practice has been addressed only in limited populations.[7–9]

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In this analysis, we aimed to assess the incidence and prognosis of ECs after implantation of ICDs for primary prevention in a large French population from the DAI-PP (Défibrillateur Automatique Implantable–Prévention Primaire) registry (NCT 01992458).

Methods

Population

The DAI-PP registry enrolled all patients with coronary artery disease or dilated cardiomyopathy implanted with an ICD for primary prevention between 2002 and 2012 in 12 French centers. The registry was funded by private (Association de Rythmologie Toulousaine–Clinique Pasteur) and public sources, including the French Institute of Health and Medical Research (INSERM) and the French Society of Cardiology. The overall DAI-PP registry was coordinated by the Clinique Pasteur, Toulouse, and the Paris Cardiovascular Research Centre, European Georges Pompidou Hospital, Paris (see online supplementary material). The DAI-PP registry complied with the principles outlined in the Declaration of Helsinki. The data file was approved and authorized by the French data protection committee (Commission Nationale Informatique et Liberté, CNIL #913203) and by the local ethics committee of each hospital.

To be included in the registry, ICD recipients had to be at least 18 years old at the time of the implant procedure. All patients with ischemic or nonischemic cardiomyopathy who were implanted with an ICD (single, double, or triple chamber) in the setting of primary prevention were enrolled in the DAI-PP follow-up program. Indications for ICD were as established by the treating physicians, but to meet the "primary prevention" requirement the patient had to have no history of sudden cardiac arrest or documented ventricular tachycardia/fibrillation. Ischemic cardiomyopathy was defined as the presence of myocardial dysfunction resulting from previous myocardial infarction or history of coronary artery disease with or without revascularization (angioplasty or bypass surgery at least 3 months before implant). All other patients were classified as having nonischemic cardiomyopathy.

Patients who had received an ICD for secondary prevention and primary prevention patients without structural heart disease (eg, Brugada syndrome, long QT syndrome) or with structural heart disease other than ischemic or nonischemic cardiomyopathy (eg, valvular heart disease, hypertrophic cardiomyopathy, noncompaction cardiomyopathy, arrhythmogenic right ventricular dysplasia) were excluded.

Characteristics at implantation

All variables at ICD implantation were defined and categorized according to the literature or common practice. In addition to age, sex, and New York Heart Association (NYHA) functional status, we recorded the cause of the underlying heart disease (ischemic cardiopathy or dilated cardiomyopathy), level of renal function according to the Cockroft–Gault formula (categorized as creatinine clearance $\geq$60, 30–60, or $<$30 mL/min), QRS duration, and left ventricular ejection fraction (EF). Atrial fibrillation (AF) was defined as history of AF, documented on ECG or Holter monitoring. Information on nonsustained ventricular tachycardia recorded on Holter monitoring and electrophysiologic testing was collected and classified as positive or negative. Data on coexisting medical conditions (cancer, chronic obstructive pulmonary disease, chronic renal failure, chronic liver disease, history of transient ischemic attack, and others including diabetes mellitus) were systematically collected.

The type of implanted ICD device (single [VVI] or dual [DDD] chamber, associated or not with cardiac resynchronization therapy [CRT-D], without reference to manufacturing companies) was recorded, and device programming was left at the discretion of the treating physician. Information on medications at hospital discharge included beta-blockers, amiodarone, class IC antiarrhythmics, sotalol, digoxin, calcium channel blockers, angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers, diuretics, antiplatelets, and vitamin K antagonists.

Follow-up and outcomes, including cause-of-death analysis

We calculated the incidence of ECs and assessed patient- and device-related factors that were associated with EC occurrence. The association of ECs with outcomes, including late complications and death, was also evaluated.

ECs were defined as those that appeared during the first 30 days after device implantation and included lead dislodgment, bleeding or hematoma, sepsis, cardiac tamponade, pneumothorax, and death. They included perioperative events but also any significant event that occurred after hospital discharge within the 30 days after implantation. ICD-related fatal or nonfatal adverse events included infections, lead dislodgment or dysfunction, and inappropriate therapy due to supraventricular tachycardia, lead dysfunction, double counting, or noise. Complications that occurred after the first month postimplant were defined as late complications. Follow-up information was obtained from appointments held every 4–6 months for device evaluation.[10] Device interrogation printouts were checked by the local investigator for appropriate and inappropriate ICD therapy.

Late complications included inappropriate shock (classified as due to supraventricular tachycardia, lead dislodgment, double counting, and noise), infection, lead dislodgment, lead dysfunction, and ICD-related specific mortality. Vital status was obtained from the hospital or general practitioner, and controlled by the National Institute of Statistics Economical Studies (INSEE). Causes of death were obtained from the investigators or the French Center on Medical Causes of Death (CépiDc–INSERM). Information on causes of death was reviewed by 2 investigators and classified as sudden death, other cardiovascular death, noncardiovascular death, ICD-related mortality, or unknown (when the quality of information did not allow the investigators to appropriately identify the cause). ICD-related mortality was defined as any death due to complication related to the presence of