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Implant and Midterm Outcomes of the Subcutaneous Implantable Cardioverter-Defibrillator Registry

The EFFORTLESS Study

Lucas Boersma, MD, PhD,[a,b] Craig Barr, MD,[c] Reinoud Knops, MD,[b] Dominic Theuns, PhD,[d] Lars Eckardt, MD,[e] Petr Neuzil, MD, PhD,[f] Marcoen Scholten, MD, PhD,[g] Margaret Hood, MBCHB,[h] Juergen Kuschyk, MD,[i,j] Paul Jones, MS,[k] Elizabeth Duffy, MS,[k] Michael Husby, MS, MPH,[k] Kenneth Stein, MD,[k] Pier D. Lambiase, MD, PhD,[l] on behalf of the EFFORTLESS Investigator Group

ABSTRACT

BACKGROUND The subcutaneous implantable cardioverter-defibrillator (S-ICD) was developed to defibrillate ventricular arrhythmias, avoiding drawbacks of transvenous leads. The global EFFORTLESS S-ICD (Evaluation oF FactORs ImpacTing CLinical Outcome and Cost EffectiveneSS of the S-ICD) registry is collecting outcomes in 985 patients during a 5-year follow-up.

OBJECTIVES The primary goal of the EFFORTLESS registry is to determine the safety of the S-ICD by evaluating complications and inappropriate shock rate.

METHODS This is the first report on the full patient cohort and study endpoints with follow-up ≥1 year. The predefined endpoints are 30- and 360-day complications, and shocks for atrial fibrillation or supraventricular tachycardia.

RESULTS Patients were followed for 3.1 ± 1.5 years and 82 completed the study protocol 5-year visit. Average age was 48 years, 28% were women, ejection fraction was 43 ± 18%, and 65% had a primary prevention indication. The S-ICD system and procedure complication rate was 4.1% at 30 days and 8.4% at 360 days. The 1-year complication rate trended toward improvement from the first to last quartile of enrollment (11.3% [quartile 1]) to 7.8% [quartile 2], 6.6% [quartile 3], and 7.4% [quartile 4]; quartile 1 vs. quartiles 2 to 4; $p = 0.06$). Few device extractions occurred due to need for antitachycardia ($n = 5$), or biventricular ($n = 4$) or bradycardia pacing ($n = 1$). Inappropriate shocks occurred in 8.1% at 1 year and 11.7% after 3.1 years. At implant, 99.5% of patients had a successful conversion of induced ventricular tachycardia or ventricular fibrillation. The 1- and 5-year rates of appropriate shock were 5.8% and 13.5%, respectively. Conversion success for discrete spontaneous episodes was 97.4% overall.

CONCLUSIONS This registry demonstrates that the S-ICD fulfills predefined endpoints for safety and efficacy. Midterm performance rates on complications, inappropriate shocks, and conversion efficacy were comparable to rates observed in transvenous implantable cardioverter-defibrillator studies. (Evaluation oF Factors ImpacTing CLinical Outcome and Cost EffectiveneSS of the S-ICD [The EFFORTLESS S-ICD Registry]; NCT01085435) (J Am Coll Cardiol 2017;70:830–41)

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From the [a]St. Antonius Ziekenhuis, Nieuwegein, the Netherlands; [b]Academic Medical Center, Amsterdam, the Netherlands; [c]Russells Hall Hospital, Dudley, United Kingdom; [d]Erasmus Medical Center, Rotterdam, the Netherlands; [e]Division of Electrophysiology, University Hospital, Münster, Germany; [f]Heart Center Homolka Hospital, Prague, Czech Republic; [g]Medisch Spectrum Twente, Enschede, the Netherlands; [h]Auckland City Hospital, Auckland, New Zealand; [i]First Department of Medicine, Medical Faculty Mannheim, Heidelberg University, Mannheim, Germany; [j]DZHK (German Center for Cardiovascular Research), Partner Site Heidelberg-Mannheim, Mannheim, Germany; [k]Boston Scientific, St. Paul, Minnesota; and the [l]Heart Hospital, London, United Kingdom. The EFFORTLESS registry is sponsored by Boston Scientific Corporation. Dr. Boersma has served as a consultant for and received speaking fees from the Cardiology Department for Medtronic, and Boston Scientific. Dr. Knops has received consulting fees from Medtronic and Boston Scientific; and research grants from Boston Scientific. Dr. Theuns has served as a consultant for and received research grant support from Boston Scientific. Dr. Eckardt has served on the speakers bureau for Boston Scientific.

The subcutaneous implantable cardioverter-defibrillator (S-ICD) was developed with the goal of providing a defibrillator system with no leads in or on the heart, thereby eliminating several important complications associated with transvenous leads, while maintaining reliable detection and defibrillation of life-threatening arrhythmias (1). Following the first human feasibility trials in 2002, S-ICD regulatory approval clinical trials began in 2008 and the S-ICD received the CE (Conformité Européene) mark in Europe in 2009 (2). Over the past 7 years, short-term follow-up data have been reported from the investigational device exemption (IDE) trial and an interim subset of less than one-half of the EFFORTLESS S-ICD (Evaluation oF Factors ImpacTing CLinical Outcome and Cost EffectiveneSS of the S-ICD) registry (3–5). These EFFORTLESS and IDE study patients were pooled for analysis of 889 patients (308 in the IDE trial, 568 in the EFFORTLESS registry, and 13 in both studies) followed for an average of 1.8 years and 1,571 patient-years (5).

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This paper provides the first report of the full EFFORTLESS cohort, which is the largest S-ICD database in the world with the longest follow-up so far. This includes nearly 1,000 patients followed for an average of 3.1 years (3,053 patient-years), enabling a comprehensive analysis of current important issues related to S-ICD performance. The primary goal of the EFFORTLESS registry is to demonstrate the safety of the S-ICD by evaluating complications and inappropriate shock rate (6). In addition, the following important outcomes for device performance and appropriate therapy were analyzed: 1) burden and predictors of monomorphic ventricular tachycardia (MVT); 2) incidence of recurrent MVT and impact of lack of availability of antitachycardia pacing (ATP); 3) differences in performance of the S-ICD in converting induced versus spontaneous episodes; and 4) reasons for device explant.

METHODS

The EFFORTLESS S-ICD registry is an observational, nonrandomized, standard-of-care registry enrolling up to 1,000 patients at 42 clinical centers in 10 countries. Details of the study design and endpoints were reported previously (6). Briefly, the objective of the EFFORTLESS registry is to demonstrate the early as well as mid- and long-term clinical outcomes of the S-ICD system (Cameron Health/Boston Scientific Inc., Minneapolis-St. Paul, Minnesota).

Patients eligible for implantation of an S-ICD system or with an S-ICD currently implanted at enrollment were eligible for inclusion. Exclusion criteria involved patients with spontaneous, incessant, or frequently recurring ventricular tachycardia (VT) amenable to ATP; patients with an indication for cardiac resynchronization therapy or symptomatic bradycardia, and patients with unipolar pacemakers or implanted systems that revert to unipolar pacing.

STUDY METHODS. Pre-specified endpoints were perioperative (30 days post-implantation) S-ICD complication rate, 360-day S-ICD complication rate, and the percentage of inappropriate shocks for atrial fibrillation (AF) or supraventricular tachycardia (SVT). The registry was conducted in accordance with the Declaration of Helsinki, ISO 14155:2009, and all applicable local and national regulations, and registered on ClinicalTrials.gov (NCT01085435). Patients were considered enrolled after providing written informed consent, in accordance with applicable local and national guidelines or ethics committee or internal review board requirements.

From August 2009 through December 2014, the registry enrolled 994 patients. Data were collected through the final 1-year follow-up visit for the last patient enrolled, which occurred in January 2016, thereby providing a minimum follow-up of 1 year in all eligible subjects who did not withdraw before 1 year. The database was locked in January 2016, following completion of data monitoring and resolution of data entry queries. The study protocol allowed for prospective and retrospective enrollments.

The study protocol did not require defibrillation threshold testing, but simply collected conversion testing data. Evaluable conversion tests were those

ABBREVIATIONS AND ACRONYMS

AF = atrial fibrillation
ATP = antitachycardia pacing
CI = confidence interval
HR = hazard ratio
ICD = implantable cardioverter-defibrillator
IDE = investigational device exemption
MVT = monomorphic ventricular tachycardia
PVT = polymorphic ventricular tachycardia
S-ICD = subcutaneous implantable cardioverter-defibrillator
SVT = supraventricular tachycardia
TV-ICD = transvenous implantable cardioverter-defibrillator
VF = ventricular fibrillation
VT = ventricular tachycardia

Dr. Hood has owned equity in Boston Scientific. Dr. Kuschyk has served as a consultant for Boston Scientific. Mr. Jones, Ms. Duffy, Mr. Husby, and Dr. Stein are employees of Boston Scientific. Dr. Lambiase has received speaker fees and research support from Boston Scientific, Medtronic, St. Jude Medical, and University College London Hospitals Biomedicine National Institute of Health Research. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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