Infection and mortality after implantation of a subcutaneous ICD after transvenous ICD extraction

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BACKGROUND The subcutaneous implantable cardioverter-defibrillator (S-ICD) provides an alternative to the transvenous implantable cardioverter-defibrillator (TV-ICD). Patients undergoing TV-ICD explantation may be eligible for reimplantation with an S-ICD; however, information on safety outcomes in this complex population is limited.

OBJECTIVE This analysis was designed to provide outcome and safety data from S-ICD patients who received their device after TV-ICD explantation.

METHODS Patients in the S-ICD IDE Study and EFFORTLESS Registry with a prior TV-ICD explantation, as well as those with no prior implantable cardioverter-defibrillator (ICD), were included. Patients were divided into 3 groups: those implanted with the S-ICD after TV-ICD extraction for system-related infection (n = 75); those implanted after TV-ICD extraction for reasons other than system-related infection (n = 44); and patients with no prior ICD (de novo implantations, n = 747).

RESULTS Mean follow-up duration was 651 days, and all-cause mortality was low (3.2%). Patients previously explanted for TV-ICD infection were older (55.5 ± 14.6, 47.8 ± 14.3 and 49.9 ± 17.3 years in the infection, noninfection, and de novo cohorts, respectively; $P = .01$), were more likely to have received the ICD for secondary prevention (42.7%, 37.2% and 25.6%; $P < 0.0001$) and had higher percentages of comorbidities, including atrial fibrillation, congestive heart failure, diabetes mellitus, and hypertension, in line with the highest mortality rate (6.7%). Major infection after S-ICD implantation was low in all groups, with no evidence that patients implanted with the S-ICD after TV-ICD explantation for infection were more likely to experience a subsequent reinfection.

CONCLUSION The S-ICD is a suitable alternative for TV-ICD patients whose devices are explanted for any reason. Postimplantation risk of infection remains low even in patients whose devices were explanted for prior TV-ICD infection.

KEYWORDS Death; sudden; Subcutaneous ICD; Infection; Safety

ABBREVIATIONS **ICD** = implantable cardioverter-defibrillator; **NCDR** = National Cardiovascular Data Registry; **S-ICD** = subcutaneous implantable cardioverter defibrillator; **TV-ICD** = transvenous implantable cardioverter defibrillator

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Introduction

The number of patients implanted with an implantable cardioverter-defibrillator (ICD) for either a secondary[1,2] or a primary prevention indication[3,4] has increased substantially over the past 2 decades.[5] As implantation numbers continue to increase because of the recognized mortality benefit of

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these devices, so does the incidence of both device and lead extraction for reasons such as end of life,[6] infection,[7,8] and device malfunction or manufacturer advisory.[9,10] Data from the National Cardiovascular Data Registry (NCDR) ICD Registry show that between April 2010 and June 30, 2011, of 174,499 hospital visits, 47% were repeat procedures for reasons such as device upgrade, battery end of life, and systemic infection,[11] and it is known that complication rates are higher with reimplantations, particularly if a lead implantation or revision is involved.[11,12] In addition, morbidity and mortality are particularly high in patients with an infected transvenous ICD (TV-ICD) system, especially when a systemic infection or endocarditis is present,[13] and the risk of reinfection after system reimplantation is also of concern.[14]

The subcutaneous ICD (S-ICD) was developed to provide an alternative to the TV-ICD, because it is implanted without any transvenous or epicardial leads. Studies demonstrating the safety and effectiveness of the S-ICD have been published,[15,16] and the S-ICD appears to be a good alternative for a variety of patients eligible for a TV-ICD system.[17] In this retrospective analysis, we evaluated the outcomes of patients undergoing S-ICD implantation after extraction of a TV-ICD system for any reason. Mortality rates and intraoperative and postoperative complication rates were examined and compared with those of patients receiving an S-ICD as their initial ICD implant (de novo implants).

Methods

Patient population

Patients included in the pivotal safety and efficacy study (S-ICD System IDE Clinical Investigation) and the EFFORTLESS S-ICD Registry (Evaluation of Factors Impacting Clinical Outcome and Cost-Effectiveness of the S-ICD) were assessed for this analysis. The design and methodology for each study have been published in detail elsewhere.[15,18] The main trial results of the IDE were published in 2013,[15] whereas a preliminary report on overall performance of the S-ICD system in EFFORTLESS was published in 2014.[16] Recently, the initial safety and efficacy results from the pooled dataset with 2-year follow-up were also reported.[19] Briefly, the IDE study was a prospective, nonrandomized study designed to evaluate the safety and efficacy of the S-ICD system for US Food and Drug Administration approval. A total of 330 patients were enrolled, of whom 314 received an S-ICD implantation. Mean follow-up duration was 661 days, with a range of 17 to 1012 days. In contrast, the ongoing EFFORTLESS Registry has enrolled 1000 patients and is a standard-of-care post-market evaluation documenting the long-term clinical outcome of S-ICD patients followed up for 5 years in 9 countries. At the time of the present analysis, data were available from the first 581 patients who received S-ICDs. Thirteen patients were common between the 2 studies. Sixteen patients available at the time of analysis were not included because of lack of information on prior TV-ICD implantation status, which left an analysis cohort of 866 patients. The poolability of study data, event definitions, and event adjudications have been described previously.[15,16,19] Ethical approval was obtained at all centers for the purpose of each study, and all patients provided informed consent according to national and institutional regulations.

Three separate groups were analyzed, which consisted of (1) repeat procedures in which the S-ICD implant was to replace a previous TV-ICD extracted for infection; (2) repeat procedures in which the S-ICD implant was to replace a previous TV-ICD extracted for reasons other than infection; and (3) S-ICD patients whose devices were implanted as an initial procedure, or de novo implants. All groups were evaluated for all-cause mortality; infection rates after S-ICD implantation, and other procedural and device-related complications.

Clinical complications

All clinical events collected in both studies were independently monitored. Events were documented and then subclassified into complications or observations. Complications were those that required a prolonged hospitalization or a need for reintervention. All deaths were automatically classified as complications independent of underlying cause. Complications were additionally classified as to whether there was a relation to the S-ICD system or the implantation procedure. An implantation-related complication was defined as any complication that was directly or indirectly caused by the implantation procedure. A device-related complication was defined as any event related to the implanted S-ICD system, including lead-, tunneling tool–, and generator-related complications. In the event that a clear relationship could not be documented but could not be ruled out, a conservative classification of the complication as being related to the S-ICD system or procedure was adopted.

Statistical and data analysis

Baseline demographics and clinical variables, including medical history, risk factors, comorbidities, and New York Heart Association functional class for heart failure, are presented as available. Continuous variables are summarized as means with standard deviations or as medians and ranges where appropriate. Continuous data were compared by the Student t test. Categorical variables are summarized as frequencies and percentages and were compared with χ^2 test. Complication-free rates were analyzed with the Kaplan-Meier methodology. All statistical analyses were performed with SAS Enterprise Guide, version 5.1 (SAS 9.3).

Results

A total of 866 patients from 31 clinical centers were included in the analysis. Follow-up data for complications and mortality were available for all patients. For the ongoing EFFORTLESS Registry, the data reflect information available as of November 18, 2013; for the IDE Study, the data