Navigating complexities in implantable cardioverter-defibrillator therapy: insights, challenges, and patient-centred approaches

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Chapter 4B

Causes of death in patients withdrawn from tachytherapy

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Abstract

Background

Implantable Cardioverter-defibrillators (ICDs) have proven effective in preventing sudden cardiac death. However, patients with active ICD devices face the risk of painful shocks during end-of-life care. Despite guidelines, there's variability in ICD-tachytherapy deactivation practices.

Objective

This study aimed to analyze ICD-tachytherapy deactivation trends over a decade and assess the mode of death among patients whose tachytherapy was deactivated.

Methods

The study included patients from the Leiden University Medical Center's ICD registry who died between 2006 and 2015. Data on deactivation, cause of death, and device status were collected. Trends in deactivation practices and causes of death were analyzed.

Results

Of 949 deceased patients, 321 (33.8%) had tachytherapy deactivated before death. The majority were male (75%) with a median age of 73 years. Terminal heart failure (38%) and malignancy (24%) were the primary causes of death among those with tachytherapy deactivated. Over time, there was a shift in causes of death, with increasing numbers of patients with non-cardiac terminal illnesses undergoing tachytherapy deactivation.

Discussion

The study highlights a growing awareness of ICD-tachytherapy implications for end-of-life care. Deactivation practices have diversified beyond cardiac care settings, emphasizing the importance of advanced care planning across medical disciplines.

Conclusion

Increasing awareness has led to improved tachytherapy withdrawal policies. Deactivation rates have risen, encompassing patients with non-cardiac terminal illnesses. Early discussions and open communication are crucial for avoiding unnecessary shocks and stress during patients' final moments.

Introduction

Large randomized trials have demonstrated the beneficial effect of Implantable Cardioverter-defibrillators (ICDs), initially in survivors of life-threatening ventricular arrhythmias (secondary prevention) and subsequently, also in patients at high risk of sudden cardiac death (primary prevention).(1-7) As expected, along with the adoption of the international guidelines incorporating these results, a progressive decrease in the annual number of people dying of sudden cardiac death was observed in developed countries such as the Netherlands.(8) While heart disease was the leading cause of death for decades, as of 2009, death by cancer has exceeded the number of cardiac deaths in the Netherlands. (9, 10) The majority of causes of death leave time for advance care planning. For ICD patients, this is important since, in case of an active ICD-device, they are at risk of painful tachytherapy shocks in the last hour of life and first moments of death, imposing great morbidity on patients and next-of-kin.(11) Attention has been drawn towards the subject by several reports on repetitive, unwanted and unnecessary shock therapy in dying patients(12-16). The International and national position papers (17, 18) and guidelines (19) have been published to provide physicians with recommendations on tachytherapy management in the ICD patients when the end of life is in sight. However, considering the implications of an ICD at the last moment of life, it is important not only for cardiac care givers, but for all medical disciplines to be aware of the possible deactivation of ICD-tachytherapy in the last moments of life.

The current study was performed to examine the practice of ICD-tachytherapy deactivation over the last 10 years, thereby assessing the mode of death amongst patients who have died after their ICD's tachytherapy was deactivated.

Methods

Study population

Since 1996, all patients who received an ICD or CRT-D at the Leiden University Medical Center (LUMC), the Netherlands, are registered in the departmental Cardiology Information System (EPD-Vision®; Leiden University Medical Center, Leiden, The Netherlands) and followed up on prospectively. This registry has been described in previous studies.(20-24) Characteristics at baseline, data of the implant procedure, and pacemaker/ICD data were recorded. Data of clinical follow-up visits and consultations are best available digitally from 2006 onwards. Eligibility implantation in this population was according to the prevailing

international guidelines.(7, 25-30) For the current analysis, patients deceased between January 1, 2006 and December 31, 2015 whilst still under follow-up for their ICD-care at the LUMC, were selected from our registry. Patients who emigrated or transmigrated and were referred to other centers, or when follow-up visits were not performed for >12 months, were considered incomplete. These patients were excluded from this study. The institutional review board of the LUMC waived the need for informed consent for this study.

Data Collection

After implantation, technical follow-up was performed in all patients at regular intervals of 6 months and clinical follow-up at least once a year. Some patients had a cardiologist at an affiliated center as primary caregiver. All device related follow-up was however performed at the LUMC. Data on ICD interrogations and patient survival recorded in EPD-Vision were checked for delivery ICD-therapy and survival status. The survival status of patients was retrieved from municipal civil registries, enabling identification of also deaths occurring outside our center. Patient records were reviewed in order to identify date of death, cause of death, ICD-therapy status and type of device at time of death. In case of ICD-deactivation prior to death, initiator of the deactivation (i.e. physician, family doctor, patient or family) was noted, including location of the actual deactivation, e.g. hospital ward or patient's (nursing)home.

Logistics of deactivation

Depending on the timing and initiator of tachytherapy deactivation, tachytherapy deactivation was performed by ICD technician or knowledgeable physician, after consultation with the cardiologist in charge. In all cases, the patient and next a kin were informed prior to deactivation. The initiator of deactivation was recorded in the electronic patient file. When patients were unable to visit the hospital for the deactivation, a technician was sent out to perform the task on location. As a result, all deactivations were coordinated by the hospital and recorded in patient files accordingly.

Definition of clinical outcomes and assessment

Deactivation of an ICD-tachytherapy prior to death was defined as deactivation of tachytherapy because of the terminal nature of the patient's disease state or condition. Devices deactivated due to malfunction, improved left ventricle ejection fraction, battery depletion and the decision of not replacing the device, or a patient's specific request due to personal preferences other than life expectancy,

were viewed as tachytherapy withdrawal for other reasons than assessed in this study and excluded.

Appropriate therapy consists of both anti-tachycardia pacing (ATP) and shocks for ventricular tachycardia (VT) or ventricular fibrillation (VF). Appropriate shocks are shocks for VT or VF. Inappropriate therapy consists of both ATP and shocks for heart rhythms other than VT or VF. Inappropriate shocks are those delivered not for VT or VF.

Causes of death were categorized according to a modified Hinkle-Thaler Classification and categorized in three groups: cardiac death, non-cardiac death and sudden death.(31) Cause of death for patients dying while hospitalized was, in absence of an autopsy, based on hospital records. In all other cases without autopsy, the cause of death was determined by the expertise of the contacted general practitioners (i.e. family doctors).

For the purpose of this study, cardiac death was further categorized into tachyarrhythmic death, heart failure death and death due to other cardiac causes. The non-cardiac deaths were divided into death due to malignancy and death due to other non-cardiac causes. Patients who died in their sleep or died unexpectedly without worsening of their clinical situation, were categorized as sudden death cases. Patients who died suddenly but with clear alternative mode of death were categorized as non-sudden cases and allocated to the alternative mode of death's category. Death due to heart failure was defined as patients dying of terminal heart failure, progressive failure of cardiac pump function, or cardiac asthma under maximal inotropic drug support. All other causes were categorized as 'other non-cardiac causes'. In all cases, the mechanism underlying the immediate demise, was selected as the mode of death. In case of palliative sedation and euthanasia, mode of death was categorized according to the underlying illness, e.g. malignancy.

Statistical analysis

Based on their distributions, continuous variables are presented as mean ± standard deviation or median with interquartile ranges (25^{th}, 75^{th} percentile). Dichotomous and categorical data are expressed as numbers and percentages. Deceased patients were divided into two groups: patients with tachytherapy deactivated prior to death and patients with active tachytherapy functions during death.

RESULTS

Patients

A total of 3998 consecutive patients have been enrolled to the Leiden ICD registry between 1996 to December 2015. Of these patients, 1005 deceased between 2006 and 2015. Twenty-eight (2.8%) of these 1005 patients were lost to follow-up. In 28 (2.8%) patients, tachytherapy function of the device was readily deactivated for other reasons or explanted because of expiration of ICD-indication (e.g. heart transplantation or improvement of LVEF). Of the remaining of 949 deceased patients, 321 (33.8%) were withdrawn from tachytherapy prior to their death. Mean age at death was 73±9 years, 241 (75%) patients were male and 201 (63%) patients had a primary ICD-indication. Median time from first ICD-implantation to death was 4.6 (2.7, 7.5) years. Baseline characteristics at primary implantation are summarized in table 1. In table 2 patient characteristics at death are summarized.

Mode of death

In the majority of the 321 patients withdrawn from tachytherapy, death was due to terminal heart failure or malignancy (38% and 24% respectively). Other frequent causes of death included terminal kidney insufficiency, infectious diseases and other non-cardiac causes. Sudden death occurred in only 3 (0.9%) patients with a deactivated device.

Terminal heart failure lead to the death of 186 (30%) patients not withdrawn from tachytherapy. In this latter group, 70 (11%) patients deceased from malignancies and sudden death was identified in 52 (8%) patients as the cause of death.

A gradual change over time in causes of death was observed. Initially, In 2006, all causes of death for patients withdrawn from tachytherapy were cardiac causes. The distribution shifted over time. In 2015 cardiac causes accounted for 64% of all deaths and malignancies alone for 24%. Initially, terminal heart failure patients were the only few patients composing the population in which tachytherapy was timely deactivated. However, a gradual emergence and increase of number of patients and other causes of death can be observed throughout the years, with an uprising of malignancies and other types of non-cardiac terminal illnesses (e.g. terminal kidney failure and refractory infectious diseases) (figure 1).

Tachytherapy withdrawal

In a total of 116 (36%) devices, tachytherapy was deactivated in the last 24 hours of patients' lives. Ninety-nine (31%) devices were deactivated at patients' homes

and nursing homes in case of patients' conditions impeding them from visiting the outpatient clinic in person. Median time from deactivation to death was 96 (24, 480) hours. Most frequently, tachytherapy deactivation was initially proposed by the attending physicians in the hospital (n=197, 61%) most often whilst the patient was in a hospitalized setting (n=177, 55%). In a minority of cases, patients were recognized to be moribund outside of clinical settings and tachytherapy withdrawal was requested by the patient or patient's family (n=59, 18%)(Table 3).

DISCUSSION

This study provides insight in the practice of tachytherapy withdrawal during the last phase of life in a large population throughout a recent decade. The most important findings is the diversification over time of the cause of death in patients with tachytherapy deactivation, indicating an increase of awareness of ICD tachytherapy implications for the last moments of life. Deactivating ICD-tachytherapy is no longer limited to the cardiac care ward. However, although the observed trends are favorable, patients in whom tachytherapy deactivation was not performed, remain to exist in all disciplines. This study's findings press the need for advanced care planning in order to avoid painful shocks and stress in the last moments of patients' lives.

Diversification in cause of death

Causes of death for patients included in the Leiden ICD registry have been previously described.(20) Most patients died from end-stage heart failure (32.6%) or other non-cardiac terminal illnesses such as neoplasms, end-stage renal failure, infectious causes or pulmonary diseases. The number of unknown causes of death is relatively low, with only 11.6% of our registered patients dying from unknown causes. When observed separately for patients withdrawn from tachytherapy prior to death, a diversification throughout the years can be noted. In 2006, the majority of the (few) patients undergoing tachytherapy deactivation were those with terminal heart failure. With the increased awareness of the issue over the recent years, numbers of patients diagnosed with also other terminal illnesses than cardiac causes have risen as well. In the recent years, withdrawal from tachytherapy is no longer limited to patients moribund from cardiac causes. Moreover, it is performed increasingly in patients with terminal malignant disease and other non-cardiac causes.

International scope

With elaborate numbers on end-of-life care practice in other countries being unavailable, it is difficult to put our findings in an international perspective. Colleagues from Northern Ireland observed that in ICD patients deceased in 2012-2013, end of life discussions were performed in up to 52% of their patients, resulting in a deactivation rate of 36.4% overall.(32) It would be interesting to assess the level of end of life discussions in other clinics and countries and deactivation rates throughout the years other than our own to provide more insight in the awareness on this topic internationally. Recent data for other centers over multiple years is unfortunately currently unavailable.

The Netherlands is a relatively small country in which deactivation at patient homes or nursing homes can be arranged on short notice. In larger countries however, this might be more complicated and take longer. In the latter case, there is a risk of being too late to withdraw tachytherapy in patients for whom this is requested in the last moments of life. Early discussions of the topic can therefore be even more valuable to clinics servicing large (rural) areas.

Clinical implications

This is large-scaled study evaluating the practice of tachytherapy withdrawal structurally over multiple years. This study confirms that there has been an increasing awareness for the risk of painful ICD shocks at the last moments of life for patients. The need for tachytherapy deactivation is not limited to patients dying under the care of a cardiologist. Considering the fact that many patients die at home or nursing homes, awareness amongst primary care providers on tachytherapy withdrawal remains necessary.

It is unclear what the exact burden of shocks in patients dying from other causes is. Similar to previous studies, we were unable to assess the true burden of shocks in the last moments of life (other than the estimated cumulative incidence of therapy in the last 30-days of life). Post-mortem read-outs of devices are not a standard part of clinical practice and data is frequently unavailable due patients dying outside the hospital. The only structural study in which devices of deceased patients at one Swedish center were explanted and structurally and consecutively, revealed that 35% of the patients experienced a ventricular tachycardia episode in the last hour of their lives.(11) Secondary prevention was however the case in 82% of the included patients. These results are therefore possibly not applicable to the currently investigated patients and the majority of patients in general clinical practice who mostly have an ICD as primary prevention.

Limitations

This study is an observational cohort study to assess the practice of tachytherapy withdrawal over the past decade in clinical practice. Patients were collected and enrolled to our ICD registry over a long period of time and evolvement of guidelines could have created a heterogeneous population influencing also the development over time. In addition, some patients can also have died whilst under the care of a different caregiver than our hospital with possible tachytherapy withdrawal without our knowledge, leading to an underestimation of tachytherapy deactivation rates. Even though the retrospective non-randomized nature of this study prevents the demonstration of a causal association, the trend over the years is clear and both the trend as the position papers and guideline are a result of an increasing awareness for the issue.

CONCLUSIONS

Increasing awareness of the issue of ICD and tachytherapy in end-of-life care has led to an improvement of tachytherapy withdrawal policies over the recent years. Deactivation numbers have gradually increased, also for patients dying from non-cardiac causes. Identification of a terminal stage of illness is complex and not possible in all patients. Early and open discussions on this issue with also non-moribund patients are an essential part of advanced care planning in order to avoid painful shocks and stress in the last moments of patients' lives.

Tables

Table 1: Baseline characteristics at ICD implantation.

Baseline characteristic	All patients (n=321)
Age at implant (y),	68 ± 9
Sex: male	241 (75)
ICD-indication: primary	201 (63)
CRT-D	159 (49.5)
BMI (kg/m^2)	26 ± 3.9
LVEF (%)	30 ± 12
Creatinin (mmol/L)	104 (86, 130)
Ischemic heart disease	221 (69)
Congenital heart disease	5 (1.6)
Hypertension	144 (45)
Diabetes mellitus	77 (24)
NYHA	
• I	78 (24)
• II	86 (27)
• III	134 (42)
• IV	15 (4.7)
• Unknown	8 (2.5)

Categorical variables are expressed by n (%), and continuous variables are expressed by mean ± standard deviation or median (interquartile range). ICD: Implantable cardioverter-defibrillator. CRT-D: Cardiac Resynchronization Therapy-defibrillator. BMI: body mass index. LVEF: left Ventricle Ejection Fraction. NYHA: New York Heart Association classification of dyspnoea.

Table 2. Patient characteristics at time of death.

Patient characteristic	ICD deactivated (n=321)
Age at death (y)	73 ± 9
Median ICD-therapy duration (y)	4.6 (2.7, 7.5)
CRT-D	307 (96)

Categorical variables are expressed by n (%), and continuous variables are expressed by mean ± SD or median (interquartile range). ICD: Implantable cardioverter-defibrillator. CRT-D: Cardiac Resynchronization Therapy-defibrillator.

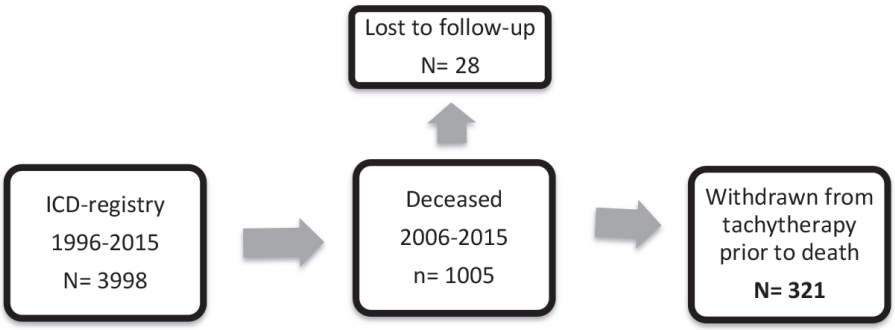
Table 3. Overall results of tachytherapy deactivation

	Therapy deactivated patients (n=321)
Tachytherapy deactivation in last 24hs of life	104 (32)
Location of deactivation	
- Hospital ward	58 (18)
- ICU/CCU	53 (17)
- Outpatient clinic	45 (14)
- (Nursing)home	99 (31)
- Other hospital	66 (21)
Initiator of deactivation	
- Hospital physician	197 (61)
- General Practitioner/primary care physician	65 (20)
- Patient and/or family	59 (18)

Variables are expressed by n (%). ICU: Intensive Care Unit. CCU: Cardiac Care Unit.

Figures

Flow-chart total number of patients included in study:



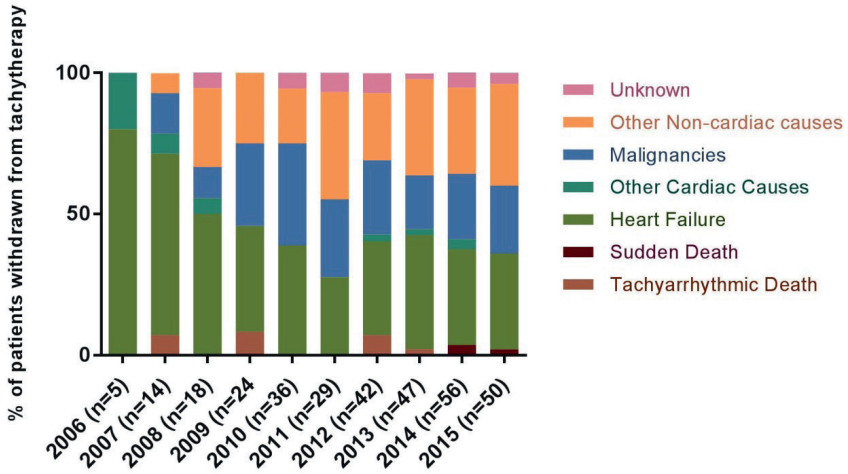


Figure. Distribution of mode of death over the studied decade. Total n=321.

References

1. Bardy GH, Lee KL, Mark DB, Poole JE, Packer DL, Boineau R, et al. Amiodarone or an implantable cardioverter-defibrillator for congestive heart failure. The New England journal of medicine. 2005;352(3):225-37.
2. Investigators TAvID. A Comparison of Antiarrhythmic-Drug Therapy with Implantable Defibrillators in Patients Resuscitated from Near-Fatal Ventricular Arrhythmias. The New England journal of medicine. 1997;337(22):1576-83.
3. Kuck KH, Cappato R, Siebels J, Ruppel R. Randomized comparison of antiarrhythmic drug therapy with implantable defibrillators in patients resuscitated from cardiac arrest : the Cardiac Arrest Study Hamburg (CASH). Circulation. 2000;102(7):748-54.
4. Moss AJ, Hall WJ, Cannom DS, Daubert JP, Higgins SL, Klein H, et al. Improved survival with an implanted defibrillator in patients with coronary disease at high risk for ventricular arrhythmia. Multicenter Automatic Defibrillator Implantation Trial Investigators. The New England journal of medicine. 1996;335(26):1933-40.
5. Moss AJ, Zareba W, Hall WJ, Klein H, Wilber DJ, Cannom DS, et al. Prophylactic implantation of a defibrillator in patients with myocardial infarction and reduced ejection fraction. The New England journal of medicine. 2002;346(12):877-83.
6. Kadish A, Dyer A, Daubert JP, Quigg R, Estes NA, Anderson KP, et al. Prophylactic defibrillator implantation in patients with nonischemic dilated cardiomyopathy. The New England journal of medicine. 2004;350(21):2151-8.
7. Epstein AE, DiMarco JP, Ellenbogen KA, Estes NA, 3rd, Freedman RA, Gettes LS, et al. ACC/AHA/HRS 2008 Guidelines for Device-Based Therapy of Cardiac Rhythm Abnormalities: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the ACC/AHA/NASPE 2002 Guideline Update for Implantation of Cardiac Pacemakers and Antiarrhythmia Devices): developed in collaboration with the American Association for Thoracic Surgery and Society of Thoracic Surgeons. Circulation. 2008;117(21):e350-408.
8. Centraal Bureau voor de Statistiek (2016, March 4th). CBS StatLine - Overledenen; doodsoorzaak (uitgebreide lijst), leeftijd, geslacht [Dataset]. Last visit 15-06-2016, van http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=7233&D1=680&D2=0&D3=0&D4=a&HDR=G2,G1, G3&STB=T&VW=T.
9. Leening MJ, Siregar S, Vaartjes I, Bots ML, Versteegh MI, van Geuns RJ, et al. Heart disease in the Netherlands: a quantitative update. Netherlands heart journal : monthly journal of the Netherlands Society of Cardiology and the Netherlands Heart Foundation. 2014;22(1):3-10.
10. Centraal Bureau voor de Statistiek (2016, March 4th). CBS StatLine - Overledenen; belangrijke doodsoorzaken (korte lijst), leeftijd, geslacht [Dataset]. Last visit 15-06-2016, van http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=7052_95&D1=a&D2=0&D3=0&D4=0,10,20,30,40,50,60,(l-1)-l&HDR=G1,G2,G3&STB=T&VW=T
11. Kinch Westerdahl A, Sjoblom J, Mattiasson AC, Rosenqvist M, Frykman V. Implantable cardioverter-defibrillator therapy before death: high risk for painful shocks at end of life. Circulation. 2014;129(4):422-9.

12. Kirk TW. Implantable cardioverter-defibrillators and hospice care. IEEE engineering in medicine and biology magazine : the quarterly magazine of the Engineering in Medicine & Biology Society. 2007;26(4):82-4.
13. Grassman D. EOL considerations in defibrillator deactivation. The American journal of hospice & palliative care. 2005;22(3):179; author reply -80.
14. Butler K, Puri S. Deathbed shock: Causes and cures. JAMA Internal Medicine. 2014;174(1):88-9.
15. Bogan C, Kieran T, O'Brien T, Fahy G. Deactivation of an implantable cardioverter defibrillator in a dying patient. Irish medical journal. 2006;99(5):155-6.
16. Kirk TW. Deactivation of automatic implantable cardioverter-defibrillators in hospice and home care patients at the end of life. Home healthcare nurse. 2008;26(7):431-7.
17. Lampert R, Hayes DL, Annas GJ, Farley MA, Goldstein NE, Hamilton RM, et al. HRS Expert Consensus Statement on the Management of Cardiovascular Implantable Electronic Devices (CIEDs) in patients nearing end of life or requesting withdrawal of therapy. Heart rhythm. 2010;7(7):1008-26.
18. Padeletti L, Arnar DO, Boncinelli L, Brachman J, Camm JA, Daubert JC, et al. EHRA Expert Consensus Statement on the management of cardiovascular implantable electronic devices in patients nearing end of life or requesting withdrawal of therapy. Europace : European pacing, arrhythmias, and cardiac electrophysiology : journal of the working groups on cardiac pacing, arrhythmias, and cardiac cellular electrophysiology of the European Society of Cardiology. 2010;12(10):1480-9.
19. van Erven L. ICD/Pacemakers in de laatste levensfase. 2013.
20. Thijssen J, van Rees JB, Venlet J, Borleffs CJ, Hoke U, Putter H, et al. The mode of death in implantable cardioverter-defibrillator and cardiac resynchronization therapy with defibrillator patients: results from routine clinical practice. Heart rhythm : the official journal of the Heart Rhythm Society. 2012;9(10):1605-12.
21. van der Heijden AC, van Erven L, Schalij MJ, Borleffs CJ. Primary prevention implantable cardioverter-defibrillator implantation in elderly patients: is it justified to withhold treatment? Expert review of cardiovascular therapy. 2014;12(7):787-9.
22. van der Heijden AC, Borleffs CJ, Buiten MS, Thijssen J, van Rees JB, Cannegieter SC, et al. The clinical course of patients with implantable cardioverter-defibrillators: Extended experience on clinical outcome, device replacements, and device-related complications. Heart rhythm : the official journal of the Heart Rhythm Society. 2015;12(6):1169-76.
23. Borleffs CJ, van Erven L, van Bommel RJ, van der Velde ET, van der Wall EE, Bax JJ, et al. Risk of failure of transvenous implantable cardioverter-defibrillator leads. Circulation Arrhythmia and electrophysiology. 2009;2(4):411-6.
24. Borleffs CJ, Thijssen J, de Bie MK, van Rees JB, van Welsenes GH, van Erven L, et al. Recurrent implantable cardioverter-defibrillator replacement is associated with an increasing risk of pocket-related complications. Pacing and clinical electrophysiology : PACE. 2010;33(8):1013-9.
25. Dickstein K, Cohen-Solal A, Filippatos G, McMurray JJ, Ponikowski P, Poole-Wilson PA, et al. ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2008: the Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2008 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association of the ESC (HFA) and endorsed by the European Society of Intensive Care Medicine (ESICM). European heart journal. 2008;29(19):2388-442.

26. Dickstein K, Vardas PE, Auricchio A, Daubert JC, Linde C, McMurray J, et al. 2010 Focused Update of ESC Guidelines on device therapy in heart failure: an update of the 2008 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure and the 2007 ESC guidelines for cardiac and resynchronization therapy. Developed with the special contribution of the Heart Failure Association and the European Heart Rhythm Association. European heart journal. 2010;31(21):2677-87.

27. Gregoratos G, Abrams J, Epstein AE, Freedman RA, Hayes DL, Hlatky MA, et al. ACC/AHA/NASPE 2002 guideline update for implantation of cardiac pacemakers and antiarrhythmia devices: summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/NASPE Committee to Update the 1998 Pacemaker Guidelines). Circulation. 2002;106(16):2145-61.

28. Priori SG, Aliot E, Blomstrom-Lundqvist C, Bossaert L, Breithardt G, Brugada P, et al. Update of the guidelines on sudden cardiac death of the European Society of Cardiology. European heart journal. 2003;24(1):13-5.

29. Strickberger SA, Conti J, Daoud EG, Havranek E, Mehra MR, Pina IL, et al. Patient selection for cardiac resynchronization therapy: from the Council on Clinical Cardiology Subcommittee on Electrocardiography and Arrhythmias and the Quality of Care and Outcomes Research Interdisciplinary Working Group, in collaboration with the Heart Rhythm Society. Circulation. 2005;111(16):2146-50.

30. Zipes DP, Camm AJ, Borggrefe M, Buxton AE, Chaitman B, Fromer M, et al. ACC/AHA/ESC 2006 Guidelines for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death: a report of the American College of Cardiology/American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (writing committee to develop Guidelines for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death): developed in collaboration with the European Heart Rhythm Association and the Heart Rhythm Society. Circulation. 2006;114(10):e385-484.

31. Hinkle LE, Jr., Thaler HT. Clinical classification of cardiac deaths. Circulation. 1982;65(3):457-64.

32. Hill L, McIlfatrick S, Taylor BJ, Dixon L, Cole BR, Moser DK, et al. Implantable cardioverter defibrillator (ICD) deactivation discussions: Reality versus recommendations. European journal of cardiovascular nursing : journal of the Working Group on Cardiovascular Nursing of the European Society of Cardiology. 2016;15(1):20-9.