Europace (2014) **16**, 935–938
doi:10.1093/europace/euu143

Current implantable cardioverter-defibrillator programming in Europe: the results of the European Heart Rhythm Association survey

Alessandro Proclemer[1]*, Maria Grazia Bongiorni[2], Heidi Etsner[3], Derick Todd[4], Elena Sciaraffia[5], Carina Blomström-Lundqvist[5], and Scientific Initiatives Committee, European Heart Rhythm Association

[1]Division of Cardiology, University Hospital S. Maria della Misericordia, IRCAB Foundation Udine, Udine, Italy; [2]2nd Cardiology Department, University Hospital of Pisa, Pisa, Italy; [3]Medizinische Klinik, Ludwig-Maximilians-Universität, Campus Großhadern, München, Germany; [4]Manchester Heart Centre, Manchester, UK; and [5]Department of Cardiology, Institution of Medical Science, Uppsala University, Uppsala, Sweden

Received 30 April 2014; accepted after revision 8 May 2014

The purpose of this European Heart Rhythm Association (EHRA) survey was to examine the current practice on the choice of implantable cardioverter-defibrillator (ICD) type, use of defibrillation testing, and ICD programming for detection and therapy of ventricular arrhythmias. In accordance with recent guidelines and the results of observational studies, the majority of EHRA research network centres reported a high utilization rate of dual-chamber ICDs in the presence of symptomatic and asymptomatic sinus node dysfunction, biventricular ICD in high-degree atrioventricular block and QRS duration <120 ms, and a limited use of defibrillation testing either in primary and secondary prevention settings. Activation of the long ventricular tachycardia (VT) detection window, slow VT zone, antitachycardia pacing before shock for slow and fast VT, and atrial tachyarrhythmia discrimination were considered useful in ICD programming for the majority of patients.

Keywords Implantable cardioverter-defibrillator • ICD programming • Defibrillation testing • Ventricular tachycardia detection • Antitachycardia pacing • SVT discrimination algorithm • EHRA survey • EP Wire

Introduction

Several studies[1–4] have reported that implantable cardioverter-defibrillator (ICD) therapies, both appropriate and inappropriate, are associated with an increased risk of death and hospitalization for cardiac causes. High-energy ICD shocks can also induce anxiety, depression, and post-traumatic stress disorders.[5] In order to reduce these unfavourable outcomes, some non-randomized or randomized studies[6–14] have tested the best ICD programming strategies, including prolonged ventricular tachycardia (VT) detection intervals and extensive use of antitachycardia pacing (ATP) algorithms to interrupt VT episodes. This European Heart Rhythm Association (EHRA) survey investigated the choice of ICD type and ICD programming strategies employed by the centres participating in the EHRA research network.

Methods and results

Responses were received from 58 partners of the EHRA Research Network. There was a wide geographical distribution of respondents, with responses received from 19 countries (10 centres in Italy, 7 centres in Spain and UK, 6 centres in Belgium, 4 centres in France; 3 centres in Denmark, Germany and Sweden; 2 centres in Argentina, Bulgaria, Greece, and the Netherlands; and 1 centre in Austria, Georgia, Lithuania, Luxemburg, Norway, Poland, and Romania). The majority of centres declared a medium (200–399) or high ($\geq$400) volume of catheter ablations, a medium (100–199) or high (200 or more) number of ICD implantations, and a medium (200–399) or high (400 or more) number of pacemaker implantations in the last calendar year.

Selection of implantable cardioverter-defibrillator type and defibrillation testing

The indications for the type of ICD [single-chamber (VR-ICD), dual-chamber (DR-ICD), or cardiac resynchronization therapy plus ICD (CRT-ICD)] were scored on a scale of 1–9 to indicate if the indication was appropriate (7–9), partially appropriate (4–6), and less

* Corresponding author. *E-mail address*: proclemer.alessandro@aoud.sanita.fvg.it

appropriate or rarely used (1–3). In patients with symptomatic or asymptomatic sinus node dysfunction, implantation of DR-ICD was considered appropriate in 83 and 59% of the centres, partially appropriate in 4 and 28%, and rarely appropriate in 13 and 13% of the centres, respectively.

In patients with first-degree atrioventricular (AV) block or Mobitz type I AV block and QRS duration <120 ms who met the criteria for ICD implantation, CRT-ICD was considered appropriate in 17 and 37% of the centres, partially appropriate in 27 and 23%, and rarely appropriate in 56 and 40%, respectively.

In patients with advanced second-degree AV block or third-degree AV block who met the criteria for ICD implantation, CRT-ICD was considered appropriate in 69% of the centres, partially appropriate in 17%, and rarely appropriate in 14%.

The participating centres always considered performing defibrillation testing in 21% of all patients, in 13% of the patients only receiving an ICD for secondary prevention, and only for selected cases in 34%. Defibrillation testing was never utilized by the collaborating centres in 32% of their patients.

Implantable cardioverter-defibrillator programming

Implantable cardioverter-defibrillator programming optimization was performed at the time of ICD implant in 51% of the patients, at pre-hospital discharge in 29%, and at first ambulatory follow-up visit in the remaining 20%. Of note, 26 centres (45%) reported that >70% of their patients underwent device optimization at ICD implant.

Among patients who received an ICD for primary prevention, a standard device programming was applied in 59%, while tailored ICD programming was considered in the remaining 41%. In particular, 29 centres used conventional ICD programming in >70% of patients.

The slow VT window was activated in a 'monitor only' mode in 67% of the patients, with 'ATP only' in 4%, with 'ATP and shock' in 12%, and was not activated in 17%. In patients with 'active ATP' in the VT zone, one or two ATP sequences were programmed in 18 and 32% of patients, respectively, and three or more ATP sequences in 50%.

According to the inclusion criteria and results of Multicenter Automatic Defibrillator Implantation Trial—Reduce Inappropriate Therapy (MADIT-RIT)[8] and ADVANCE (Prospective multicenter randomized trial of fast VT termination by prolonged vs. conventional antitachyarrhythmia burst pacing in ICD patients-Atp DeliVery for pAiNless ICD thErapy) III[7] trials, a long detection (>2.5 s or 30/40 intervals) or high rate (>200 bpm) VT detection windows were programmed in the setting of primary or secondary prevention in 45 centres (78%).

In patients treated with an ICD for secondary prevention, the number of detection and therapy windows was mainly based on the rate and tolerance of VT in 35% of the cases, on the number of clinical VTs in 24%, on concomitant antiarrhythmic drug use in 4%, and on the basis of all variables in 37%. The slow VT window was activated for detection and therapy only in patients with a previous history of VT in 42% of cases, independently of the index arrhythmia [VT or ventricular fibrillation (VF)] in 26%, and in 'monitor only' function in 32% of the remaining patients.

In both the primary and secondary prevention settings, ATP before shock for fast VT according to PainFREE Rx (Pacing Fast Ventricular Tachycardia Reduces Shock Therapies) II Trial[10] was activated up to 300 ms VT cycle in 16% of cases, up to 240 ms in 60% of cases, and for <240 ms VT cycle in 24% of cases (*Figure 1A*).Shock energy in the VT zone was programmed at maximum level energy in 67% of patients, on the basis of electrophysiological evaluation in 12%, and based on local protocols in 21% (*Figure 1B*).

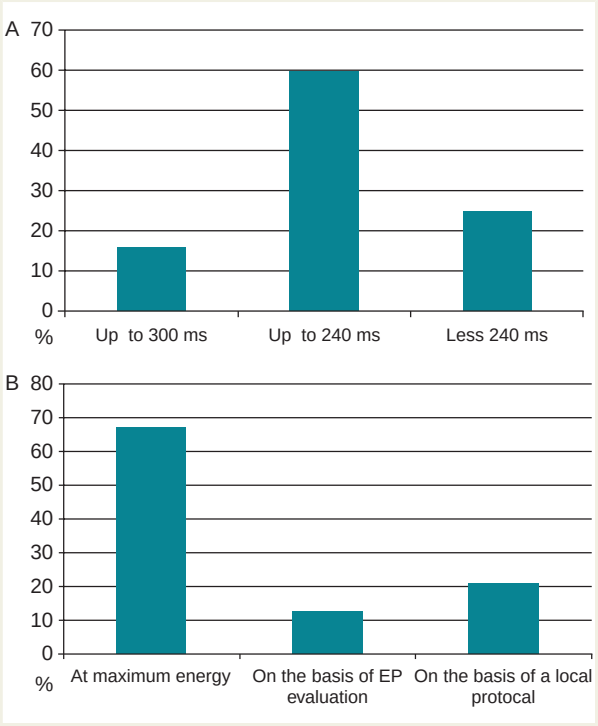

Figure 1 (*A*) Antitachycardia pacing activation for fast VT windows according to PainFREE Rx II Trial in the collaborating centres. (*B*) Classes of ICD shock energy in the VT zone in the collaborating centres.

The supraventricular tachyarrhythmia (SVT) discriminators were 'turned on' at the time of first ICD programming in 79% of cases. When programmed 'on', the algorithms were activated at nominal settings in 54% of patients, or at a tailored value in 46%. The 'EGM discriminator' was activated in 73% of patients. At the time of ICD replacement, device programming was updated in any case in 25% of the patients, only if cardiovascular history was changed in 40%, and was never modified in the remaining 35%.

Discussion

Implantable cardioverter-defibrillator type and defibrillation testing

In accordance with the European Society of Cardiology (ESC) guidelines on cardiac pacing,[15] this survey of 58 collaborating centres of the EHRA research network reported a high utilization of DR-ICD in the presence of symptomatic sinus node dysfunction and a slightly lower use in patients with asymptomatic sinus bradycardia. In the absence of randomized trials, the current ESC guidelines[15] and Heart Rhythm

Society/American College of Cardiology (HRS-ACCF) consensus statement[16] do not specify whether the single or dual-chamber ICD should be used in patients who do not have indications to pacing.

A recent large retrospective cohort study of 32 034 patients enrolled in the NCDR registry between 2006 and 2009, has shown that among patients who received an ICD for primary prevention without indications to pacing, the use of DR-ICD was higher and was associated with a similar 1-year mortality and hospitalization rates, but with a higher risk of complications compared with VR-ICD.[17] In clinical practice, the decision to implant DR-ICD rather than VR-ICD should include several clinical considerations such as the potential need for pacing due to conduction system disease, unfavourable impact of drugs on sinus or AV conduction, possible prevention of VT/VF with atrial pacing in specific syndromes, or the need for SVT discrimination.

In patients with advanced second- or third-degree AV block who met the criteria for ICD implantation, CRT-ICD was considered highly appropriate independently of the baseline QRS duration in the majority of the collaborating centres to the present survey. This indication is highly supported by the ESC guidelines[15] due to the high possibility that patients with moderate-to-severe left ventricular dysfunction may benefit from CRT instead of conventional right ventricular apical pacing, particularly when the percentage of pacing is >40%.

The defibrillation threshold testing was generally performed in <30% of patients. There is an on-going debate whether intraoperative defibrillation testing at the time of ICD insertion is needed.[18] A recent survey of new ICD implants demonstrated that the event rates were similar and extremely low in patients who had and those who did not have defibrillation testing.[19] Similar results were observed in patients with stable, optimally treated heart failure during ICD implantation for primary prevention of sudden death.[20] In this study, first shock efficacy for VT/VF was high independently of baseline defibrillation threshold testing results and this test did not predict long-term mortality or shock efficacy.

Implantable cardioverter-defibrillator programming

In agreement with the previous studies,[6–14] the collaborating centres of the EHRA research network reported activation of a long VT detection window, slow VT zone, ATP before shock, and SVT discriminators in the majority of their patients.

Previous non-randomized studies[6,10,12] have demonstrated that ATP is effective in limiting the number of shocks for rapid VT in patients with ischaemic and non-ischaemic cardiomyopathy. In the RELEVANT (Role of long dEtection window programming in patients with LEft VentriculAr dysfunction, Non-ischaemic eTiology in primary prevention treated with a biventricular ICD) study,[6] which included only patients with non-ischaemic cardiomyopathy treated with CRT-ICD, a significant reduction in all-cause hospitalization was observed in the long detection group while the incidence of syncope was low.

The MADIT-RIT randomized study[8] showed that new ICD programming modalities that permitted self-termination of non-sustained VT/VF episodes were associated with a significant reduction in inappropriate therapies. In the long duration group, VT detection included three zones: 170–199 bpm for 60 s with Rhythm ID, 200–249 bpm for 12 s with Rhythm ID, >250 bpm for 2.5 s. In the standard group, the VT detection was programmed in two zones: 170–199 bpm for 2.5 s and >200 bpm for 1 s. In the high-rate group, the VT detection was >200 bpm for 2.5 s. The MADIT-RIT trial enrolled only primary prevention ICD patients in sinus rhythm in whom DR-ICD or CRT-ICD has been implanted. The trial reported reduced mortality rate both in the high-rate group and in the delayed therapy group.[21]

The ADVANCE III randomized trial[7] has demonstrated that the use of a long detection interval (30 out of 40 intervals) with ATP during charging significantly reduces the rate of appropriate therapies (ATPs and shocks) and inappropriate shocks in comparison with the standard detection interval (18 out of 24). The trial included both primary and secondary prevention ICD patients, with or without atrial fibrillation, in whom VR-DR and CRT-ICD devices have been implanted.

The PROVIDE (Programming Implantable Cardioverter Defibrillators in Patients with Primary Prevention Indication to Prolong Time to First Shock) randomized study[22] has shown that in a large cohort of patients, a combination of programmed parameters including higher detection rate, longer detection intervals, empiric ATP and optimized SVT discriminators was associated with a significant reduction of ICD shock therapy with reduction in all-cause mortality and without increasing arrhythmic syncope.

Conclusion

This EHRA EP Wire survey demonstrates that, in agreement with the recent guidelines and large observational studies the majority of the European centres—participants of the EHRA research network report a high utilization of DR-ICD in the presence of sinus node dysfunction, of CRT-ICD in the case of high-degree AV block, and a limited use of defibrillation testing either in primary and secondary prevention settings. Specific ICD programming features such as activation of the long VT detection window, slow VT zone, ATP before shock, and SVT discriminators are considered useful in the majority of patients.

Conflicts of interest: none declared.

Acknowledgements

The production of this EP wire document is under the responsibility of the Scientific Initiative Committee of the European Heart Rhythm Association: Carina Blomström-Lundqvist (chairman), Maria Grazia Bongiorni (co-chair), Jian Chen, Nikolaos Dagres, Heidi Estner, Antonio Hernandez-Madrid, Melece Hocini, Torben Bjerregaard Larsen, Laurent Pison, Tatjana Potpara, Alessandro Proclemer, Elena Sciraffia, Derick Todd. The authors acknowledge the EHRA Research Network centres participating in this EP Wire. A list of the Research Network can be found on the EHRA website.

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