

# Management of ventricular tachycardia in the ablation era: results of the European Heart Rhythm Association Survey

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Patients with sustained ventricular tachycardia (VT) are at risk of sudden death. Treatment options for VT include antiarrhythmic drug therapy, insertion of an implantable cardioverter-defibrillator, and catheter ablation. Evidence on indications for VT ablation, timing, ablation strategies, and periprocedural management is sparse. The aim of this European Heart Rhythm Association (EHRA) survey was to evaluate clinical practice regarding management of VT among the European countries. An electronic questionnaire was sent to members of the EHRA Electrophysiology Research Network. Responses were received from 88 centres in 12 countries. The results have shown that management of VTs is very heterogeneous across the participating centres. Indications, periprocedural management, and ablation strategies vary substantially. This EP Wire survey has revealed that catheter ablation is the first-line therapy for the treatment of recurrent monomorphic stable VT in patients without structural heart disease as well as in patients with ischaemic cardiomyopathy and impaired left ventricular ejection fraction in the majority of centres. Furthermore, in patients with ischaemic cardiomyopathy and the first episode of monomorphic VT, most centres (62.0%) performed catheter ablation. On the contrary, in patients with non-ischaemic cardiomyopathy, amiodarone (41.4%) and catheter ablation (37.1%) are used in a very similar proportion. Ablation strategies, endpoints, and post-ablation antithrombotic management vary substantially among European centres.

## Keywords

Ventricular tachycardia • Sudden cardiac death • Catheter ablation • Implantable cardioverter-defibrillator • Mapping • Inducibility • Ablation endpoints • EHRA survey • EP Wire

## Introduction

With about 17 million deaths annually, cardiovascular disease is still one of the major causes of death worldwide, of which 25% are estimated to be sudden cardiac in origin.<sup>1</sup> The major causes of sudden cardiac death (SCD) in younger patients are channelopathies, cardiomyopathies, myocarditis, and substance abuse, whereas in elderly patients, SCD more commonly occurs as a result of chronic degenerative disease, such as coronary artery

disease, valvular disease, and heart failure.<sup>2,3</sup> The primary cause of sudden cardiac death is ventricular tachycardia (VT). Treatment of VT includes antiarrhythmic drug therapy, implantation of an implantable cardioverter-defibrillator (ICD), and catheter ablation.<sup>4,5</sup> Treatment options depend on several factors, such as comorbidities, age, haemodynamic instability, presence and type of structural heart disease, and the number of VT episodes despite antiarrhythmic drug therapy.<sup>6</sup>

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Catheter ablation is the primary treatment option for idiopathic VT and has emerged as an important management strategy in reducing VT burden in patients with structural heart disease.<sup>4,7</sup> Data on the optimal periprocedural patient management, the timing, and the strategy of VT ablation are sparse and vary substantially among the European countries. The aim of this European Heart Rhythm Association (EHRA) survey was to provide an insight into the current practice in Europe, regarding the management of patients with VT.

## Methods

An online questionnaire was provided to the participating centres of the EHRA Electrophysiology Research Network, and responses from 88 centres in 12 countries were collected between 1 August 2017 and 31 August 2017. Of these, 76 completed the entire survey and were qualified for further analysis. In this survey, we asked questions about policies and indications for VT ablation. Percentages are expressed with the denominator indicating the number of centres that provided responses to each question.

## Results

### Hospital setting and ablation volume

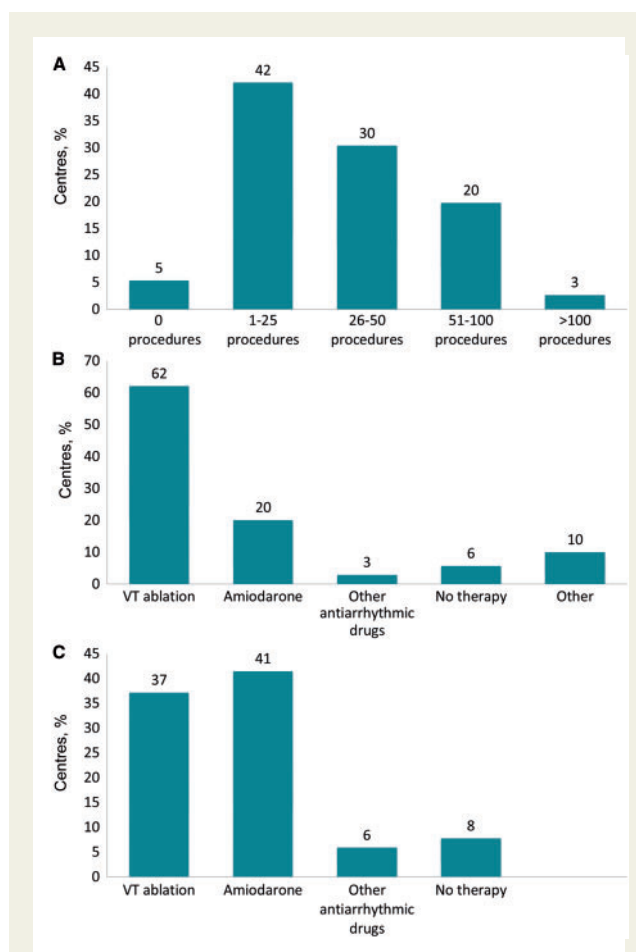
Of 88 centres that responded to the survey, 47 (53.4%) were University hospitals, 26 (29.6%) non-university public hospitals, 11 (12.5%) private hospitals, and 4 (4.6%) other types of hospitals. Of the 76 centres that completed the survey, 19 (25%) centres performed >500 catheter ablation procedures during the last calendar year, 18 (23.7%) performed 251–500 procedures, 22 (29.0%) 51–250 procedures, 13 (17.1%) 1–50 procedures, and 4 (5.3%) no procedure. Endocardial and epicardial ablation were performed in 39 (51.3%) centres, endocardial ablation in both ventricles but no epicardial ablation in 32 (42.1%) centres; VT ablation was not performed routinely in 5 (5.7%) centres. None of the responding centres performed right ventricular ablation only. In patients without structural heart disease, the VT ablation procedure volume was >100 in 2 (2.6%) centres, 51–100 in 15 (19.7%), 26–50 in 23 (30.3%), 1–25 in 32 (42.1%), and 0 in 4 (5.3%) centres (Figure 1A).

The number of ablation procedures for treatment of VT in patients with structural heart disease was >100 in 4 (5.3%) centres, 51–100 in 7 (9.2%), 26–50 in 24 (31.6%), 1–25 in 34 (44.7%) and 0 in 7 (9.2%).

### Ablation technique

Participants were asked regarding the standard pre-procedural imaging used. This included transoesophageal echocardiography (TOE) without magnetic resonance imaging (MRI) or computed tomography (CT) scan in 33.3%, MRI or CT but without TOE in 33.3%, and both TOE and MRI or CT in 8.7%. Other imaging modalities, for instance, transthoracic echocardiography only, were used in the remainder (24.6%).

In patients without structural heart disease, the standard catheter for VT ablation among the majority of operators (80.8%) was an irrigated tip catheter with (53.4%) or without (46.6%) contact force sensing. The majority of centres (90.4%) routinely use a 3D mapping system, with only 9.6% of the centres performing predominantly fluoroscopic procedures. In patients with structural heart disease, a



**Figure 1** (A) The number of ablation procedures for treatment of VT in patients without structural heart disease in 2016 per centre. (B) Preferred therapy in patients with ischaemic cardiomyopathy and impaired LVEF (35–50%), presenting with the first episode of haemodynamically stable sustained monomorphic VT despite beta-blockers and after exclusion of a reversible cause. (C) Preferred therapy in patients with non-ischaemic cardiomyopathy and impaired LVEF (35–50%), presenting with the first episode of haemodynamically stable sustained monomorphic VT despite beta-blockers and after exclusion of a reversible cause. LVEF, left ventricular ejection fraction; VT, ventricular tachycardia.

higher proportion of operators (95.8%) used an irrigated tip catheter with (70.8%) or without (29.2%) contact force sensing, in combination with a 3D mapping system (94.4%).

### Management of ventricular tachycardia in patients without structural heart disease

In patients without structural heart disease and preserved left ventricular ejection fraction (LVEF), presenting with recurrent episodes of haemodynamically stable VTs from the right ventricular outflow tract (RVOT), catheter ablation was the first-line treatment in the majority of centres (63.4%), with the remaining centres recommending antiarrhythmic drug therapy (predominantly beta-blockers) as

first-line therapy. Treatment of choice in patients without structural heart disease (non-RVOT VT) was catheter ablation in 43.7% and antiarrhythmic drug therapy (again, predominantly beta-blockers) in the remaining patients.

## Management of ventricular tachycardia in patients with structural heart disease

In patients with ischaemic cardiomyopathy and impaired LVEF presenting with the first episode of haemodynamically stable sustained monomorphic VT despite beta-blocker therapy and after exclusion of a reversible cause, the preferred intervention was VT ablation in 62.0% of the responding centres. Amiodarone was typically used as first-line treatment in 19.7%, with other antiarrhythmic drugs being preferred in 2 centres (2.8%) (Figure 1B). Only 5.6% of the responders did not specify standard treatment irrespective of whether an ICD had been implanted or not.

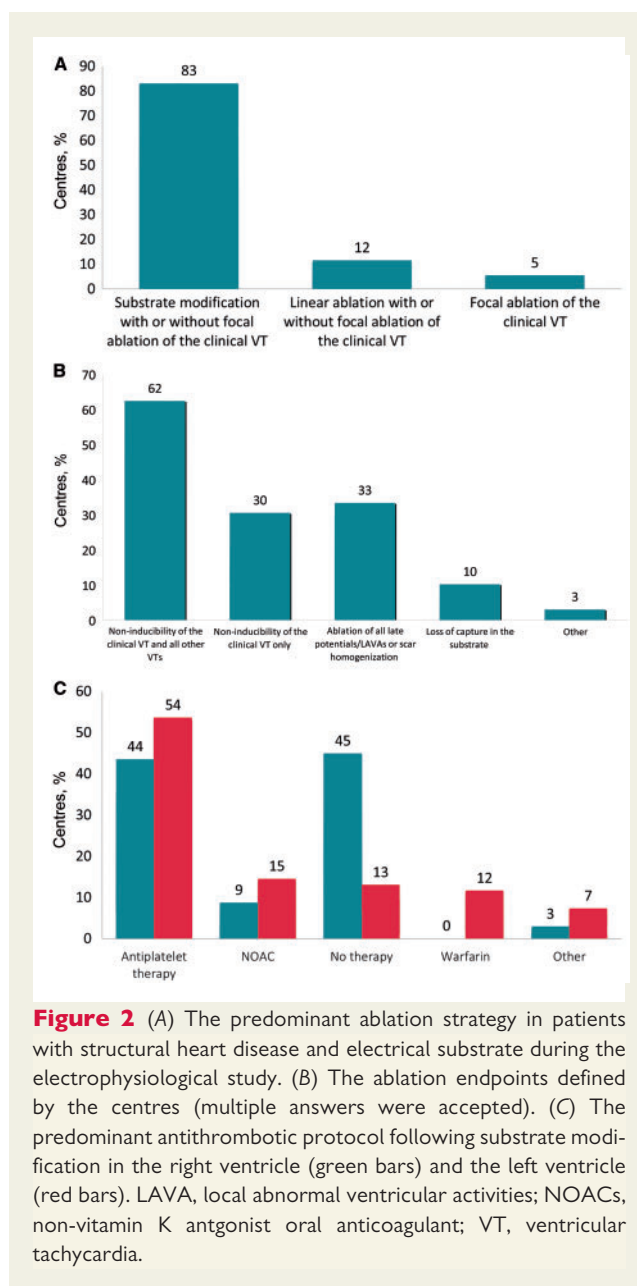
The typical post-ablation strategy in a younger patient (<65 years) in this clinical scenario was examined. Following successful ablation, where VT was rendered non-inducible at the end of the procedure, a typical post-ablation strategy was for an ICD to be implanted prior to discharge in 52.9%, discharge of the patient with a LifeVest for  $\geq 3$  months and potential ICD implantation after >3 months in 21.4%, discharge without ICD/loop recorder or a LifeVest in 18.6%, and implantation of an implantable loop recorder in the remaining 7.1% of the centres.

In a similar patient, but with a non-ischaemic aetiology, the preferred initial strategy was catheter ablation in 37.1%, amiodarone in 41.4%, no therapy in 15.7%, and other Class I/III antiarrhythmic drugs in 5.8% of the centres (Figure 1C). Following apparently successful ablation, the typical strategy in these non-ischaemic patients would be ICD implantation prior to discharge in 40.0%, discharge without an ICD or a LifeVest in 27.1%, discharge with a LifeVest in 25.7%, and loop recorder implantation in the remaining 7.2% of the patients.

All responses (100%) indicated that the appropriate treatment for a patient with ischaemic cardiomyopathy presenting with recurrent appropriate ICD shocks despite long treatment with amiodarone would be VT ablation; this was recommended in 89.8% of patients with non-ischaemic cardiomyopathy. The remainder would typically treat the latter group of patients by discontinuation of amiodarone and therapy with a different Class I/III drug in 4.4%, increasing the dose of amiodarone in 2.9% and additional prescription of a Class I drug such as mexiletin in the remainder.

The most widely used ablation strategy in patients with structural heart disease and electrical substrate during the electrophysiological study (e.g. low voltage and pathological electrograms) was substrate modification (e.g. elimination of late potentials and dechannelling) with or without focal ablation of the clinical VT (83.1%), followed by linear ablation with or without focal ablation of the clinical VT (11.5%) and focal ablation of the clinical VT in the remaining 5.4% of the centres (Figure 2A).

Clinically useful ablation endpoints were reported as: non-inducibility of any VT, including the clinical VT (62.3%), non-inducibility of the clinical VT only (30.4%), ablation of all late potentials/LAVAs or scar homogenization in 33.3%, loss of capture in the substrate in 10.1% or other in 2.9% (Figure 2B).



**Figure 2** (A) The predominant ablation strategy in patients with structural heart disease and electrical substrate during the electrophysiological study. (B) The ablation endpoints defined by the centres (multiple answers were accepted). (C) The predominant antithrombotic protocol following substrate modification in the right ventricle (green bars) and the left ventricle (red bars). LAVA, local abnormal ventricular activities; NOACs, non-vitamin K antagonist oral anticoagulant; VT, ventricular tachycardia.

## Antithrombotic prophylaxis after ablation

Following substrate ablation within the right ventricle only, there was an approximately equal split between centres that recommended antiplatelet therapy (43.9%) and those who did not mandate anticoagulation or antiplatelet therapy (44.9%). Non-vitamin K antagonist oral anticoagulants (NOACs) were suggested in 8.7%. However, if substrate modification had taken place within the left ventricle, around half of the centres (53.6%) recommended antiplatelet therapy as thromboprophylaxis, with other strategies being employed in the remainder (NOACs: 14.5%; no therapy: 13.0%; vitamin K antagonists: 11.6%, and other strategies in 7, 3%) (Figure 2C).

## Discussion

This prospective, international, multicentre patient survey conducted in 88 centres in 12 countries provided important insights into the contemporary management of VTs. The survey revealed that (i) in 2016, the vast majority of ablation centres performed <50 VT ablation procedures in patients with and without structural heart disease and (ii) the management of VTs, ablation strategies, endpoints, and post-ablation antithrombotic management differs substantially among centres.

### Hospital setting and ablation volume

Although VT ablation, particularly in patients with structural heart disease, is one of the most challenging procedures in interventional electrophysiology, requiring a long learning curve, most ablation centres perform <50 VT ablations annually in patients with and without structural heart disease. This may affect outcomes, since in less complex atrial fibrillation ablation procedures, there was a significant association observed between operator and hospital volume and adverse outcomes.<sup>8</sup>

### Management of ventricular tachycardia in structural normal hearts

In patients without structural heart disease, presenting with recurrent RVOT VTs, the first-line treatment was ablation in the majority of centres, whereas in patients with non-RVOT VTs, the treatment of choice was antiarrhythmic drug therapy followed by ablation. This is in line with the current ESC guidelines for the management of patients with VT and the prevention of sudden cardiac death. The ESC guidelines state that in patients with symptomatic left ventricular outflow tract/aortic cusp/epicardial VT, treatment with sodium channel blocker is recommended and ablation should be considered if performed by an experienced operator after failure of  $\geq 1$  sodium channel blockers or in patients refusing long-term antiarrhythmic drug therapy.<sup>4</sup> Interestingly, in our survey, beta-blockers, and not a sodium channel blocker, were therapy of choice in the majority of centres. Furthermore, it is compelling that in 44% of the centres, VT ablation was the first-line treatment of choice in patients with non-RVOT VTs, although this is a Class I indication in the 2015 ESC guidelines only for patients treated by experienced operators.<sup>2</sup> However, as the number of these patients undergoing ablation is increasing, the operator experience for this type of procedure is also increasing. Since VT ablation in structurally normal hearts is usually similar to ablation of premature ventricular contractions, the real operator experience may be underestimated in that context.

### Management of ventricular tachycardia in structural heart disease

In patients with impaired LVEF presenting with the first episode of stable monomorphic VT, the typical therapy was VT ablation for patients with ischaemic cardiomyopathy and amiodarone for patients with non-ischaemic cardiomyopathy.<sup>2</sup> Interestingly, only 6% of the centres have opted for the 'watch-and-wait' approach after the first episode of VT, especially when it is terminated with antitachycardia pacing. This approach might be explained by a selection bias since predominantly cardiologists from ablation centres responded to this

survey. However, in patients with ischaemic cardiomyopathy, this approach is in line with the current ESC guidelines which state that amiodarone or catheter ablation should be considered after a first episode of sustained VT in patients with an ICD. In patients with ischaemic cardiomyopathy, there are increasing data supporting an early ablative strategy after the first episode of VT. Both the VTACH (Substrate Modification in Stable Ventricular Tachycardia in Addition to ICD Therapy) as well as the SMASH-VT (Substrate Mapping and Ablation in Sinus Rhythm to Halt Ventricular Tachycardia) trials demonstrated, that VT ablation after the first VT episode resulted in a significantly lower number of ICD interventions compared with ICD only therapy.<sup>9,10</sup> However, although in the SMS (Substrate Modification Study) study, catheter ablation resulted in a significant reduction of ICD interventions, it did not meet the primary endpoint of time to first VT/ventricular fibrillation recurrence.<sup>11</sup> In addition, Sapp et al.<sup>7</sup> demonstrated that catheter ablation was superior in terms of death, VT storm, or appropriate ICD shocks compared with an escalation of antiarrhythmic drug therapy in patients with ischaemic cardiomyopathy and an ICD who had VT despite antiarrhythmic drug therapy. Data from further studies such as the ongoing BERLIN VT (Preventive Ablation of Ventricular tachycardia in Patients with Myocardial Infarction) study will evaluate whether an early ablative strategy is superior when compared with a strategy after the third appropriate shock (ClinicalTrials.gov Identifier: NCT02501005). In patients with non-ischaemic cardiomyopathy, the guidelines are less clear since there is a lack of randomized controlled trials.

It is striking that more than 20% of centres will discharge patients with VT and LVEF 35–50%, after a successful VT ablation, with a wearable cardioverter defibrillator (LifeVest). Neither the current ESC guidelines 2015<sup>2</sup> nor a recent EHRA review on indications for the use of the LifeVest<sup>12</sup> supports this approach.

The rationale for this strategy is that the LifeVest is a treatment option for patients at temporarily high risk for SCD. It is still controversial whether the patients are only temporarily at high risk for SCD post-VT ablation. In a recent retrospective non-randomized study by Maury et al.,<sup>13</sup> patients with well-tolerated sustained monomorphic VT, structural heart disease, and LVEF > 30% undergoing primary VT ablation without ICD implantation had a very low rate of arrhythmic death and recurrences were generally non-fatal.<sup>13</sup> This study supports a rather conservative approach of VT ablation only in selected patients.

The ablation technology in the majority of centres was the combination of a 3D mapping system with contact force sensing irrigated tip catheter. In contrast to the technology, the ablation strategy, procedural endpoints and post-ablation management differed significantly between centres. Although the predominant ablative strategy was substrate modification using a non-linear approach, other concepts such as focal ablation, linear ablation are currently standard approaches in several centres. For selected patients, novel ablative strategies, such as substrate isolation, are under evaluation.<sup>14</sup>

Ablation endpoints are even more heterogeneous between centres and may reflect the lack of scientific data, supporting an optimal endpoint. These findings are in line with the current guidelines stating that the best ablative strategy is unknown, and there is no consensus with respect to the ideal procedural endpoint.<sup>2</sup> They also state that while elimination of all clinical VTs should be attempted, non-inducibility of any VT after ablation may be the preferred procedural endpoint.



The predominant antithrombotic protocol post-substrate modification in the right ventricle and left ventricle was very heterogeneous between centres. This may reflect the lack of evidence from randomized controlled trials. In a current EHRA consensus document, the authors state that after right ventricular ablation, there is no proven benefit of administering post-interventional aspirin or oral anticoagulation unless it is required for another reason.<sup>15</sup> They also state that after left ventricular ablation, oral anticoagulation or aspirin for 4–12 weeks may be considered.

## Conclusions

Management of VTs, ablation strategies, endpoints, and post-ablation antithrombotic management vary substantially among the European centres. At most centres, the primary approach is in line with the current guidelines. Heterogeneity in patient management also reflects the lack of scientific data in this field.

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