

Special article

Spanish Catheter Ablation Registry. 17th Official Report of the Spanish Society of Cardiology Working Group on Electrophysiology and Arrhythmias (2017)



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ABSTRACT

Introduction and objectives: This report describes the findings of the 2017 Spanish Catheter Ablation Registry.

Methods: Data collection was retrospective. A standardized questionnaire was completed by each of the participating centers.

Results: A total of 15 284 ablation procedures were performed by 98 institutions (the highest number of ablations and institutions historically reported in this registry), with a mean of 156 ± 126 and a median of 136 procedures per center. For the first time, the most frequently treated ablation target was atrial fibrillation ($n = 3457$; 22.6%), followed by cavotricuspid isthmus ($n = 3449$; 22.5%) and atrioventricular nodal re-entrant tachycardia ($n = 3429$; 22.4%). The overall success rate was 87%. The rate of major complications was 2.6%, and the mortality rate was 0.09%. The percentage of procedures performed without fluoroscopic support increased to 6% of all ablations, and 2.3% of all ablations were performed in pediatric patients.

Conclusions: The Spanish Ablation Catheter Registry systematically and uninterruptedly collects data on the ablation procedures performed in Spain, revealing that both the number of ablations and the number of centers performing them has progressively increased, while maintaining a high success rate and a low percentage of complications.

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Registro Español de Ablación con Catéter. XVII Informe Oficial de la Sección de Electrofisiología y Arritmias de la Sociedad Española de Cardiología (2017)

RESUMEN

Introducción y objetivos: Se describen los resultados del Registro Español de Ablación con Catéter correspondientes al año 2017.

Métodos: La recogida de datos se llevó a cabo de forma retrospectiva con la cumplimentación de un formulario de recogida de datos de cada uno de los centros participantes.

Resultados: El número total de procedimientos de ablación fue de 15.284 realizados en 98 centros (mayor número de centros y de procedimientos de ablación comunicados históricamente en este registro) con una media de 156 ± 126 y una mediana de 136 procedimientos. El sustrato abordado con más frecuencia ha sido por primera vez en el registro la fibrilación auricular ($n = 3.457$; 22,6%), seguida del istmo cavotricuspidé ($n = 3.449$; 22,5%) y la taquicardia intranodular ($n = 3.429$; 22,4%). La tasa total de éxito fue del 87%; la de complicaciones mayores, del 2,6% y la mortalidad, del 0,09%. Se ha producido un aumento de los procedimientos realizados sin apoyo de fluoroscopia hasta suponer un 6% del total de las ablaciones. Un 2,3% de las ablaciones se realizó en pacientes pediátricos.

Conclusiones: El Registro Español de Ablación con Catéter recoge sistemática e ininterrumpidamente los procedimientos de ablación realizados en España, y esto nos ha permitido observar un aumento progresivo del número de ablaciones y de centros que las realizan manteniendo una tasa de éxito elevada y unos porcentajes de complicaciones bajos.

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Palabras clave:

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Abbreviations

- AF: atrial fibrillation
- AVNRT: atrioventricular nodal reentrant tachycardia
- CTI: cavotricuspid isthmus
- FAT: focal atrial tachycardia
- IVT: idiopathic ventricular tachycardia
- MAT: macroreentrant atrial tachycardia
- VT-AMI: ventricular tachycardia associated with acute myocardial infarction
- VT-NAMI: ventricular tachycardia not associated with acute myocardial infarction

INTRODUCTION

The purpose of the present article is to report the findings of the Spanish Catheter Ablation Registry, the Official Report of the Working Group on Electrophysiology and Arrhythmias of the Spanish Society of Cardiology for 2017, which marks the 17th year of uninterrupted activity by this group.^{1–16} The registry is a voluntary nationwide record, published annually, that includes data from most arrhythmia units operating in Spain, making it one of the few large-scale, observational registries focusing on catheter ablation.

The objectives of the registry are to observe and describe developments in the interventional treatment of cardiac arrhythmias in Spain and to provide reliable information on the type of activity performed and the facilities available in Spanish arrhythmia units.

METHODS

Data were retrospectively collected using a standardized data collection form sent to all interventional electrophysiology laboratories in January 2018; the form was also available on the website of the Working Group on Electrophysiology and Arrhythmias.¹⁷ All of the compiled data remained anonymous, even to the registry coordinators, with the secretariat of the Spanish Society of Cardiology removing any identifying information from the data.

The information collected concerned the technical and human resources available in the arrhythmias units, the procedures performed, and their results and complications.

We analyzed the same 10 arrhythmias and arrhythmogenic substrates examined in previous registries: atrioventricular nodal reentrant tachycardia (AVNRT), accessory pathways, atrioventricular node ablation, focal atrial tachycardia (FAT), cavotricuspid isthmus (CTI), macroreentrant atrial tachycardia (MAT), atrial fibrillation (AF), idiopathic ventricular tachycardia (IVT), ventricular tachycardia associated with myocardial infarction (VT-AMI), and ventricular tachycardia not associated with myocardial infarction (VT-NAMI). Variables common to all conditions were analyzed: number of patients and procedures, success rate, type of ablation catheter used, and procedure-related complications (number and type), including periprocedural death. The numbers of procedures performed with a navigation system and those performed without fluoroscopy were also recorded for all substrates, as well as the number of patients younger than 15 years of age (pediatric). In addition, a number of ablation target-specific variables were analyzed: location and type of accessory pathway, location and mechanism of atrial tachycardias, type of AF ablation and approach, and ventricular tachycardia substrate.

As in previous years, the success rate refers only to the immediate postprocedural data (acute success rate). As for complications, only those occurring during the hospital stay following the procedure were reported.

RESULTS

All previous records have been broken in the 2017 registry, in terms of both the number of centers—98 (15.3% more than last year) (Appendix 1 and Appendix 2)—and the number of procedures that, with a total of 15 284, represents an increase of 11.8% vs 2016 (Figure 1).

The increase in the number of centers was regardless of their source of funding: public centers (68% of the total) increased by 12% and private centers by 20% (Figure 2). The participating hospital centers were still mostly teaching (72.4%) and tertiary (77.5%) centers. Patients were attended in cardiology departments in 97% of cases, and 67% of the centers had cardiac surgery units.

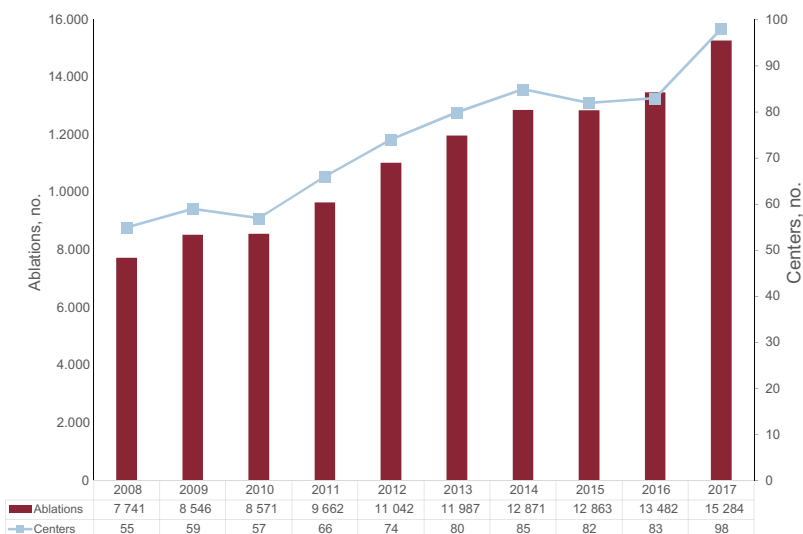


Figure 1. Data analyzed.

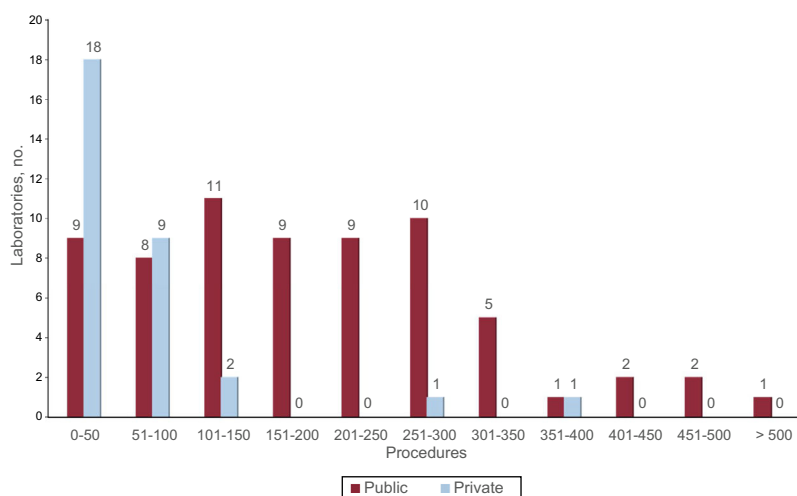


Figure 2. Number of electrophysiology laboratories participating in the registry by the number of ablation procedures performed in 2017.

Infrastructure and Resources

The technical and human resources available in the different participating centers, as well as the other activities performed, are detailed in [Table 1](#) and [Table 2](#).

Overall, 62% of the centers were equipped with at least 1 dedicated cardiac electrophysiology laboratory. In addition, 74.5% of the centers had 1 room; 23.5%, 2; and 2%, 3. On average, the laboratory was available on 3.2 ± 1.7 (median, 3.0) days a week.

In addition to electrophysiological procedures, a cardiac device was implanted in 98.9% of centers: pacemakers in 92% of centers, defibrillators in 90%, resynchronization devices in 92%, and subcutaneous Holter monitors in 95%.

At least 1 fixed C-arm fluoroscopy system was available in 70 laboratories (71.4%) and at least 1 portable C-arm fluoroscopy system was available in 47 (48%).

No nonfluoroscopic navigation systems were available in 14 centers (14.2%), 29.6% had at least 2 nonfluoroscopic navigation systems, and 11 centers (11.2%) had 3, figures similar to those of the previous registries. The availability of rotational angiography, an X-ray system with integrated fluoroscopy, continues to be stable, present in 24.5% of the laboratories.

Radiofrequency ablation was again the most common type of ablation available in the different centers; cryoablation showed a slight decrease vs 2016 (72.4% vs 74.7%) but an increase in absolute numbers (71 vs 62), continuing the growth seen in recent years.

In terms of personnel ([Table 2](#)), there was a slight increase in staff physicians per laboratory (average, 3.2) and 87% of laboratories had at least 1 full-time physician (average, 2.2).

The average number of nurses per center continues to be stable at 2.8 registered nurses; 82% of laboratories had 2 or more (range, 1–6). In addition, 26.5% of laboratories had at least 1 X-ray technician (range, 0–4). Furthermore, 33.7% of the laboratories had fellows, most 1 or 2 (range, 1–12). Finally, 79.6% of laboratories had anesthesia support during ablation procedures.

Overall Results

The number of centers participating in the registry (98 centers) is the highest since its creation and the tendency continues for a progressive increase in the number of ablations, which peaked this year (15 284) ([Figure 1](#)). The mean number of procedures per center was 156 ± 126 (median, 124.5; range, 2–568).

Twelve centers (11 public) reported more than 300 ablations and 5 centers (all public) reported more than 400 ablations ([Figure 2](#)).

The overall success rate was 87%, similar to the 86% rate of the previous registry. The success rates of all substrates since 2011 are shown in [Figure 3](#), although the success rate for AF is only from 2016, when the new data collection form was introduced.

The number of reported complications was 281 (2.6%), similar to previous years, but with a slight increase vs previous registries (2.3% in 2016 and 2% in 2015) ([Figure 4](#)).

The most common complications were vascular (32.4%), followed by pericardial effusion/cardiac tamponade (30.2%). There were 16 atrioventricular blocks (AVBs) (5.7% of total complications and 0.1% of total ablations).

Ten deaths (0.09%) were recorded in 2017. The ablation targets in 5 of them were VT-AMI and VT-NAMI, with 2 complicated tamponades and 3 electrical storms that resulted in electromechanical dissociation and death.

There were 2 deaths related to AF ablation caused by esophageal problems. In addition, another 3 deaths were described for CTI ablation, 2 due to vascular complications and 1 due to complicated cardiac tamponade.

For the first time, AF (22.6%) was the most frequently treated ablation target, followed by CTI (22.5%) and AVNRT (22.4%) ([Figure 5](#)).

The number of ablation procedures reported increased for all substrates vs the 2016 registry, except IVT ([Figure 5](#)).

The changes in the relative frequency of the different ablation targets since 2008 are shown in [Figure 6](#). The increase in AF continues with respect to the other ablation targets, as well as the decrease in accessory pathway ablation. The ablation of CTI and AVNRT has remained at a stable percentage in recent years, whereas VT ablation (of any cause, including ventricular extrasystole) increased this year to represent 16% of all substrates.

Information on the number of laboratories treating each of the different ablation targets is shown in [Figure 7](#). AVNRT was the most frequently treated substrate in the participating centers: 97 (99%), followed by CTI at 93 (95%). AF ablation was performed in 75.5% of the centers submitting their data to the registry, a slight increase from 2015 (73%) but a slight decrease from 2016 (78%).

The following sections summarize the data analysis for the different subgroups.

Table 1

General Characteristics, Technical Resources, and Activity (in Addition to Catheter Ablation) of the 98 Electrophysiology Laboratories in the 2017 Registry

General characteristics	
Teaching hospital	71 (72.4)
Tertiary	76 (77.5)
Health care system	
Public	67 (68.4)
Fully private	31 (31.6)
Responsible department: Cardiology	95 (97)
Cardiac surgery available	66 (67)
Anesthetist available	78 (79.6)
Technical resources	
Availability of the laboratory	
Exclusive use	59 (60.2)
Used for electrophysiology, d	3.3 ± 1.8
More than 1 electrophysiology laboratory	25 (25.5)
Fluoroscopy system	
Fixed C-arm	70 (71.4)
Portable C-arm	47 (47.9)
Rotational angiography	24 (24.5)
NFNS	
No navigator	14 (14.2)
Carto (Biosense Webster)	53 (54)
Ensite (Abbott)	58 (59.2)
Rhythmia (Boston Scientific)	15 (15.3)
Remote navigation	
Magnetic	2 (2)
Robotic	2 (2)
Other systems	
Intracardiac echocardiography	34 (34.7)
Cryoablation	71 (72.4)
Ultrasound ablation	2 (2)
Laser ablation	3 (3)
Activity performed	
Device implantation	
Pacemaker	90 (91.8)
ICD	88 (89.8)
Resynchronization device	90 (91.8)
Subcutaneous Holter monitor	93 (94.9)
Elective electrical cardioversion	
ECV	86 (87.7)
ICV	47 (48)
Renal denervation	
Atrial appendage closure	18 (18.3)

ECV, external cardioversion; ICD, implantable cardioverter-defibrillator; ICV, internal cardioversion; NFNS: nonfluoroscopic navigation system. Values represent No. (%) or mean ± standard deviation.

Atrioventricular Nodal Reentrant Tachycardia

AVNRT has ceased to be, probably definitively, the most treated substrate and now occupies third place, despite 371 more procedures than in the previous registry. A total of 3429 AVNRT ablation procedures (22.4% of the total) were performed in 97 hospitals.

The mean number of procedures was 34.9 ± 24.7 (range, 2–122), with a success rate of 98.6%; 77% of centers reported a 100% success rates. Twelve major complications were reported (0.3%): 4 AVBs

requiring pacemaker placement (0.12%), 3 vascular complications (0.09%), 2 pulmonary thromboembolisms, 1 stroke, and 1 pericardial effusion. The 4-mm tip radiofrequency ablation catheter was still the most used catheter (95.4% of procedures), followed by the irrigated tip catheter (2.2%). In addition, the cryoablation catheter was used in 1.8% and the 8-mm tip catheter in 0.4%. The use of navigation systems has doubled vs the previous year; they were used in 11.6% of procedures, with 298 of these (8.7% of the total) performed without fluoroscopy.

Cavotricuspid Isthmus

In all, 3449 CTI ablation procedures (22.6%) were performed in 94.9% of centers, with a mean number of 35.2 ± 29.3 (range, 2–123) procedures per center. Success was reported in 94% of procedures, with a 100% success rate in 60% of centers.

There were 23 major complications (0.7%), including 12 vascular complications (52.2%), 5 pericardial effusions (21.7%), 3 AVBs (13%), 1 stroke (4.3%), 1 myocardial infarction (4.3%), and 1 pericarditis without effusion (4.3%). Three deaths were reported, 1 of them due to embolism. The other 2 deaths were due to complications occurring during surgical treatment of the problem: mesenteric ischemia and death after pericardial window in a patient with tamponade, and twin-to-twin transfusion syndrome and multiorgan failure 3 days after the repair of a vascular tear of the left femoral artery. Left femoral access had been used as the approach to control the bleeding of a lesioned right femoral secondary branch injured during the ablation procedure.

Irrigated tip catheters were the most prevalent catheters, used in 2053 procedures (60.4%; 225 with contact forcesensing technology), followed by 8-mm tip catheters (34.9%) and 4-mm tip catheters (4.3%).

A navigation system was used in 26% of procedures and 14.1% of the total were performed without fluoroscopy.

Accessory Pathways

Accessory pathways were again the fourth most targeted substrate, treated in 91 centers, with a slight increase in absolute number after several years of decline. In total, 1902 procedures were performed (mean, 20.9 ± 17.2; range, 2–88). Success was achieved in 90% of procedures and 33 centers reported a 100% success rate.

Data were available on the conduction direction of 1784 of the accessory pathways, and bidirectional conduction was again the most frequent presentation in electrophysiology laboratories (820, 46%), followed by concealed pathways (632; 35.4%), whereas there were 332 exclusively anterograde conduction pathways (18.6%). Regarding their locations, left-sided accessory pathways continue to predominate (49.5%), followed by inferoseptal (27.8%), right ventricular free wall (12%), and para-Hisian (10.6%) pathways.

Nonfluoroscopic navigation systems were used in 16.2% and 5% of the total were performed without fluoroscopy.

Regarding the approach used in the ablation of left-sided pathways, the preference was for the retrograde aortic approach (68.3%); the remainder were transeptal (31.7%).

The success rate was 97.4% for left ventricular free wall procedures, 93.7% for inferoseptal, 91.8% for para-Hisian/antetroseptal, and 86.9% for right ventricular free wall.

There were 29 major complications (1.5%): 12 pericardial effusions, 10 vascular complications, 1 acute myocardial infarction, 1 systemic embolism, 1 AVB, 1 mitral insufficiency, 1 pulmonary thromboembolism, 1 hematoma, and 1 pericardial puncture during transeptal puncture without effusion.

Table 2

Changes in the Human Resources in the Electrophysiology Laboratories of Public Hospitals Participating in the Registry Since 2008

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Staff physicians	2.5	2.6	2.8	2.6	2.7	2.8	2.8	3.0	3.0	3.2
Full-time physicians	2.1	2.1	2.3	2.2	2.1	2.0	1.9	2.4	2.1	2.2
Residents/y	0.6	0.8	0.7	0.7	0.7	0.6	0.6	0.8	0.7	0.9
RN	2.2	2.2	2.4	2.3	2.3	2.2	2.3	2.7	2.7	2.8
RT	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3

RN, registered nurse; RT, radiologic technologist.

Most ablations (65.4%) were performed with 4-mm tip ablation catheters, although the use of irrigated tip catheters increased to 27.3%; of these, 39 had contact forcesensing technology. The other catheters used were cryoablation catheters (6.2%) and 8-mm tip catheters (1.3%).

Atrioventricular Node Ablation

The number remained stable with 700 ablations performed in 81 centers. Success was achieved in 96% of cases. Only 2 complications were reported (0.3%), 1 vascular and the other due to the onset of heart failure. Catheters other than the standard 4-mm tip catheter were used in 233 procedures (33.3%): 144 irrigated tip catheters and 88 8-mm tip catheters, with cryomodulation of the atrioventricular node attempted on 1 occasion.

Focal Atrial Tachycardia

In all, 429 FAT ablation procedures (3%) were performed in 78 centers, with a success rate of 86%. The available data on

location (412 procedures) showed that this substrate was located in the right atrium in 310 cases (with an 87.4% success rate) and in the left atrium in 131 (90.2% success rate). Complications developed in 6 cases (1.4%), 0.7% due to vascular complications, 0.2% due to AVBs, 0.2% due to pericardial effusions, and 0.2% due to pericarditis without effusion.

A total of 142 4-mm tip catheters and 13 8-mm tip catheters were used, but irrigated tip catheters predominated with a continual increase vs previous registries; in 2017, these catheters were used in 61.3% of procedures, with a high number of catheters with contact forcesensing technology (91 catheters).

A navigation system was used in 56.6% of procedures; 7.2% of the total were performed without fluoroscopy.

Macroreentrant Atrial Tachycardia/Atypical Atrial Flutter

This ablation target was treated in 58 centers (59.2%), with 538 procedures (3.5% of the total) in 443 patients (mean, 5.4; range, 0-123). The number of procedures performed on this substrate has increased each year: 80 more cases and 4 more

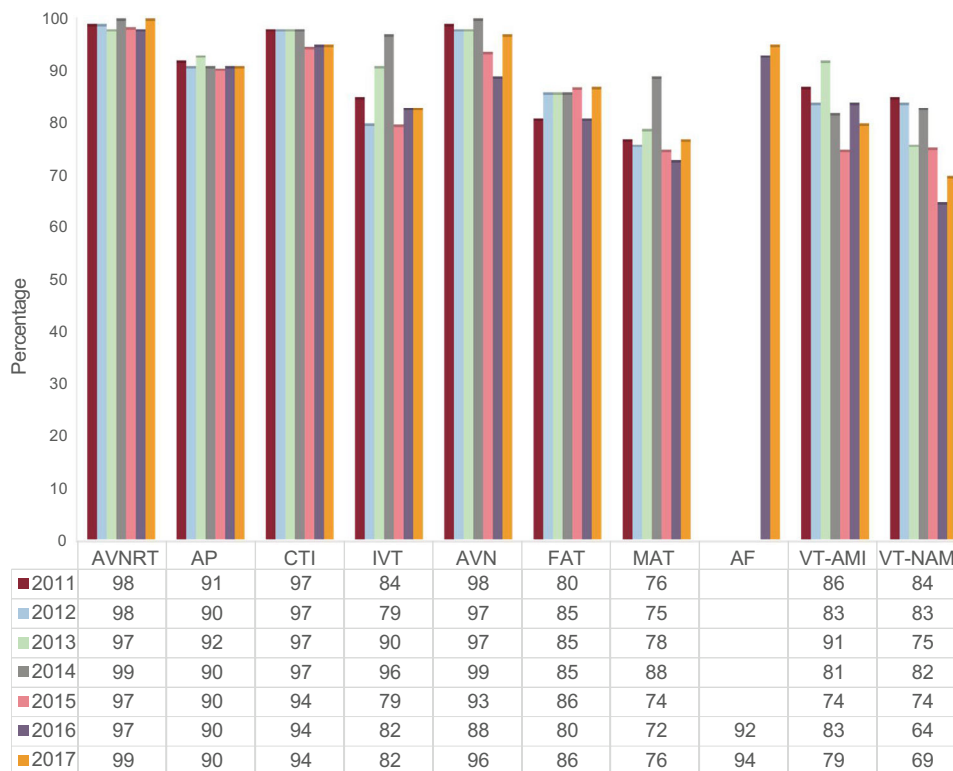


Figure 3. Changes in catheter ablation success rates since 2011 by the substrate treated. AF, atrial fibrillation; AP, accessory pathway; AVN, atrioventricular node; AVNRT, atrioventricular nodal reentrant tachycardia; CTI, cavotricuspid isthmus; FAT, focal atrial tachycardia; IVT, idiopathic ventricular tachycardia; MAT, macroreentrant atrial tachycardia; VT-AMI, ventricular tachycardia associated with acute myocardial infarction; VT-NAMI, ventricular tachycardia not associated with acute myocardial infarction.

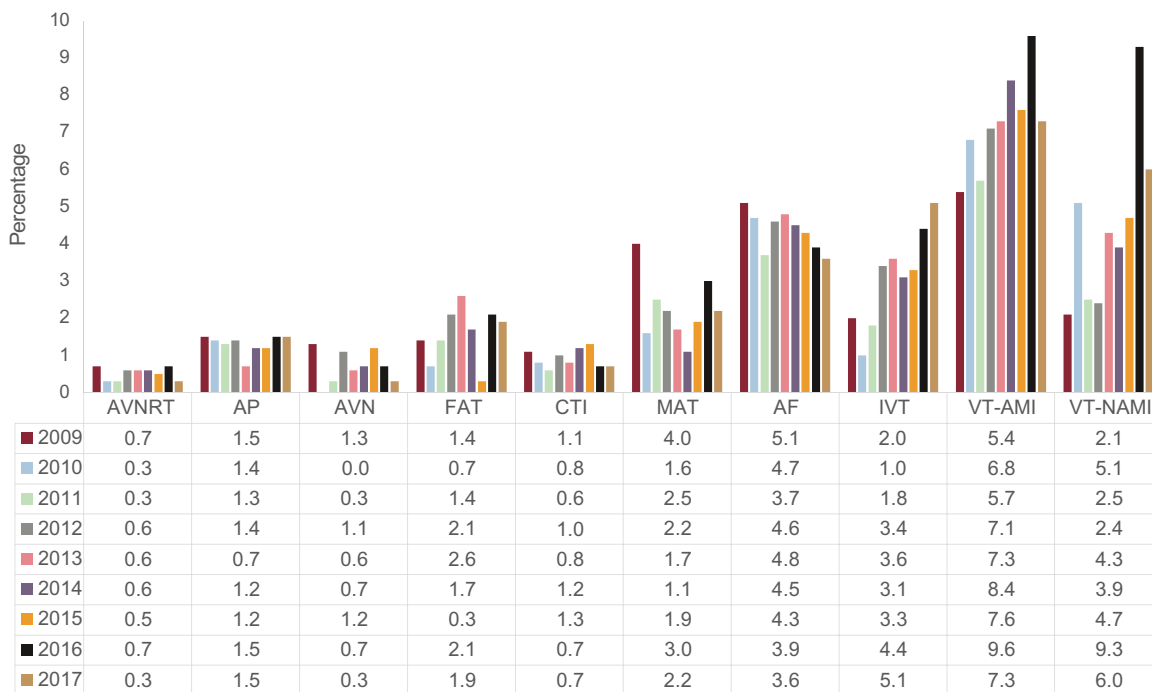


Figure 4. Percentage of catheter ablation-related complications since 2009 by the substrate treated. AF, atrial fibrillation; AP, accessory pathway; AVN, atrioventricular node; AVNRT, atrioventricular nodal reentrant tachycardia; CTI, cavotricuspid isthmus; FAT, focal atrial tachycardia; IVT, idiopathic ventricular tachycardia; MAT, macroreentrant atrial tachycardia; VT-AMI: ventricular tachycardia associated with acute myocardial infarction; VT-NAMI, ventricular tachycardia not associated with acute myocardial infarction.

centers vs the 2016 registry. The procedure was successful in 76% of cases. The left atrium was the most frequently treated location (234 procedures), with a 76.5% success rate; 134 procedures were performed in the right atrium, successfully in 93.3%. Regarding the

information available on the substrate underlying the MAT: 122 cases (40.9%) were secondary to AF ablation, 70 to congenital heart disease (23.5%), 45 to atriotomy (15.1%), and 61 to others (20.5%).

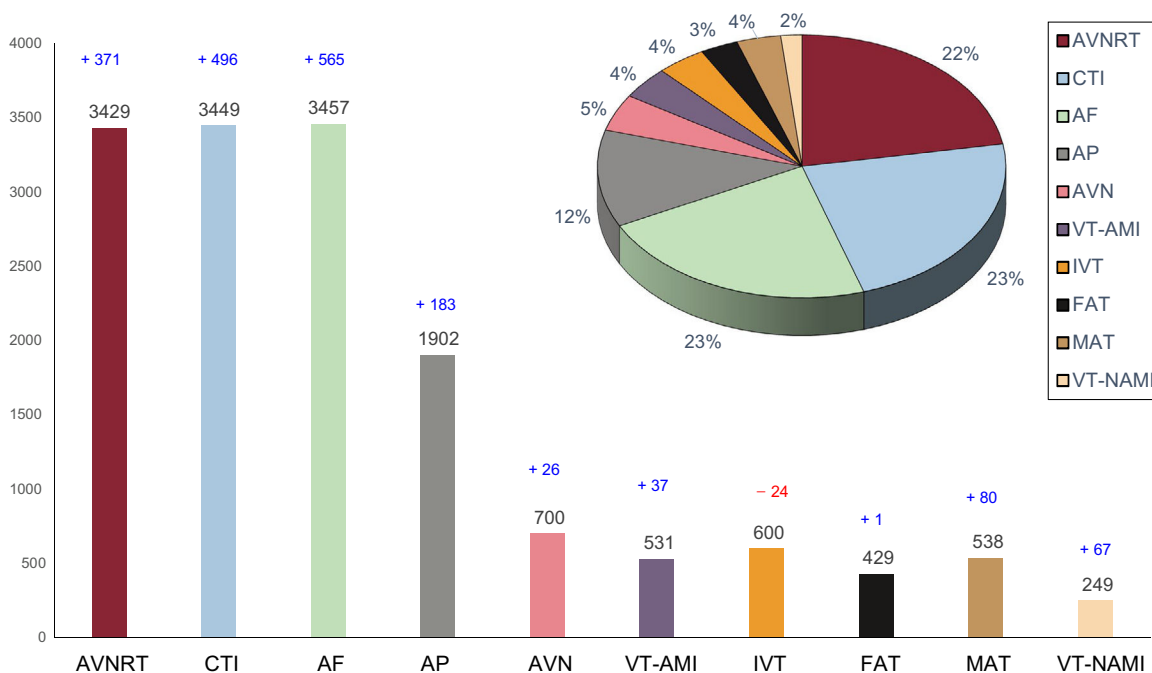


Figure 5. Relative frequency of the different ablation targets treated by catheter ablation in Spain in 2017 (15 284 procedures). The change in the number of cases compared with the previous registry (13 482 procedures) is also shown for each ablation target, expressed as number of cases. AF, atrial fibrillation; AP, accessory pathway; AVN, atrioventricular node; AVNRT, atrioventricular nodal reentrant tachycardia; CTI, cavotricuspid isthmus; FAT, focal atrial tachycardia; IVT, idiopathic ventricular tachycardia; MAT, macroreentrant atrial tachycardia; VT-AMI, ventricular tachycardia associated with acute myocardial infarction; VT-NAMI, ventricular tachycardia not associated with acute myocardial infarction.

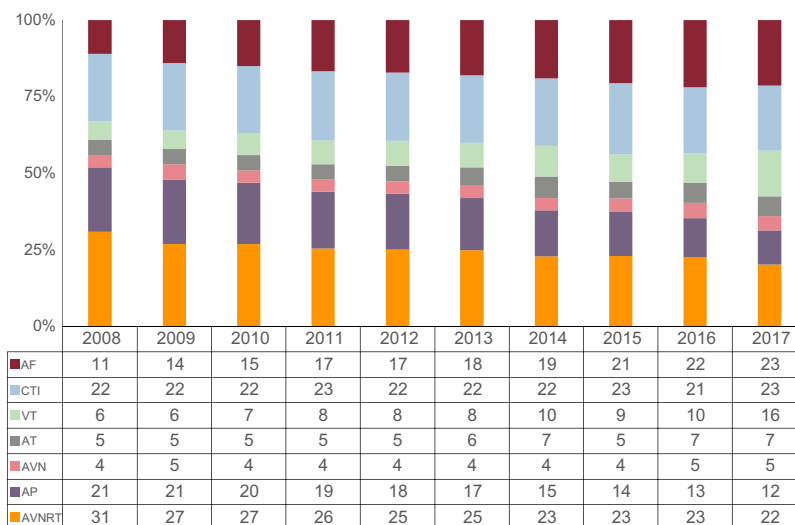


Figure 6. Changes in the relative frequency of different ablation targets treated since 2007. AF, atrial fibrillation; AP, accessory pathway; AT, atrial tachycardia (focal and atypical flutter); AVN, atrioventricular node; AVNRT, atrioventricular nodal reentrant tachycardia; CTI, cavotricuspid isthmus; VT, ventricular tachycardia.

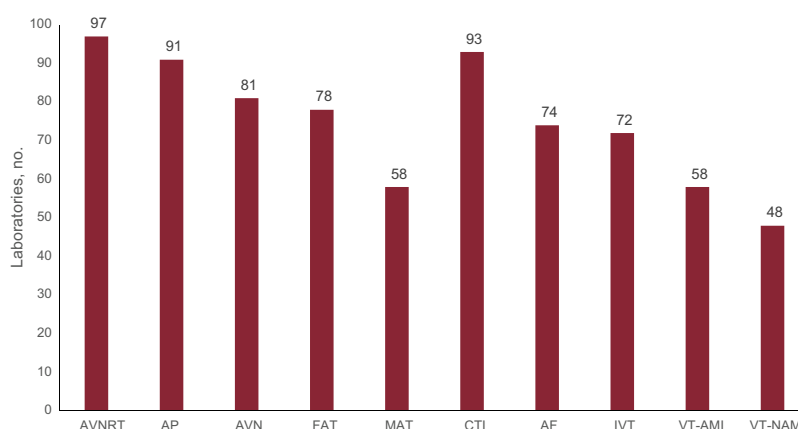


Figure 7. Number of electrophysiology laboratories treating each of the different ablation targets. AF, atrial fibrillation; AP, accessory pathway; AVN, atrioventricular node; AVNRT, atrioventricular nodal reentrant tachycardia; CTI, cavotricuspid isthmus; FAT, focal atrial tachycardia; IVT, idiopathic ventricular tachycardia; MAT, macroreentrant atrial tachycardia; VT-AMI, ventricular tachycardia associated with acute myocardial infarction; VT-NAMI, ventricular tachycardia not associated with acute myocardial infarction.

The most used catheters were conventional irrigated tip catheters (38.9%) and irrigated tip catheters with contact for sensing technology (37.4%); the other types were rarely used. A navigation system was used in 51.5% of procedures; of these, 3.5% of the total were performed without the use of fluoroscopy.

There were 12 nonfatal complications (2.2%): 7 femoral vascular complications, 3 pericardial effusions, and 1 ABV.

Atrial Fibrillation

For the first year, AF was the most targeted substrate, with 3457 procedures (22.6%) in 3105 patients, spread over 74 centers (75.5%). These data reflect the recent trend for a progressive increase and represent an increase of 504 ablations and 9 centers treating this ablation target vs the previous registry (2016). The mean number of procedures per center was 32.3 (range, 0–199), with a success rate of 93.8%.

More than 50 procedures were performed in 23 centers (31% of the total); of these, 8 centers performed more than 100 procedures

(10.8%). According to the type of AF and the available data, paroxysmal AF was the most treated ablation target, with a total of 1912 procedures. The participating centers reported 787 procedures for persistent AF and 120 procedures for long-standing (> 1 year) persistent AF.

Electrical isolation of the pulmonary veins was the most common procedure, performed in 2877 cases (95.6%), with a success rate of 97%, as well as reduction of the antral electrogram in 4%, successful in 100%; placement of left atrial lines in 3.4%, successful in 95.7%; complex fractionated electrogram ablation in 0.5%, successful in 94.4%; superior vena cava isolation in 3.8%, successful in 97.7%; and other objectives in 14 procedures (including 3 magnetic resonance-guided scar ablations and 2 atrial appendage isolations performed with posterior box isolation).

The most widely used technique for AF ablation procedures continues to be point-to-point radiofrequency ablation, with 2171 procedures (62.9%). Cryoablation was in second place with 1235 procedures (35.8%), representing a 5% increase vs the previous registry. Other procedures represented a minority, such as multielectrode radiofrequency catheter ablation (0.9%) and laser ablation (0.4%).

The most commonly used catheter in point-to-point ablation was the irrigated tip ablation catheter and contact force sensor (72.3% in this type of procedure). The remainder comprised conventional irrigated tip catheters, 1.2% of them with microelectrodes.

There was another increase in the use of steerable sheaths, with 26.9% of all procedures in 31 centers vs 23.3% in the previous registry. The use of intracardiac echocardiography continues to be negligible: 304 procedures (8.8%).

Three-dimensional navigation was used for this ablation target in 61.8% of the procedures. Several centers reported the use of "minimal fluoroscopy" and have even described procedures performed completely without fluoroscopy.

A total of 124 complications were recorded (3.6%, slightly lower than the 3.9% of the previous year) subdivided as follows: vascular complications (39; 1.1%), pericardial effusion/cardiac tamponade (37; 1.1%), stroke (11; 0.3%), phrenic nerve palsy (19; 0.5%), and infarction/angina (3; 0.1%). Additionally reported were 2 air embolisms (with ST-segment elevation), 2 cases of pulmonary vein stenosis requiring stent dilatation or placement, 2 atrioesophageal fistulas 1 left atrial appendage perforation (requiring surgery), 1 atrial free wall perforation during transseptal puncture (which also required surgery), 1 hemoptysis, 1 fistula between the coronary cusp and right atrium, 1 coronary spasm with secondary ventricular fibrillation, 1 esophageal perforation during transesophageal echocardiography, 1 angioplasty guidewire fracture in the left atrium during transseptal puncture, recovered with a loop, and 1 esophageal hematoma with internal hemorrhage resulting in death. Of the 2 cases of fistula, 1 died due to massive digestive bleeding during transesophageal echocardiography a few days after the procedure; the other patient underwent surgical repair, but experienced severe neurological sequelae.

Idiopathic Ventricular Tachycardia

In total, 600 IVT ablation procedures (3.9%) were performed in 548 patients and 72 centers (mean, 6.1; range, 0-24). A successful outcome was achieved in 81.5% (81.1% in 2016). The type of ventricular tachycardia (VT) targeted was known for 95%: 292 of the right ventricular outflow tract, 107 of the left ventricular outflow tract, 52 originating from the aortic root/aortic cusps, 41 fascicular tachycardias, and 24 originating from the coronary/pericardial sinus. Other origins described in lesser proportion were the papillary muscles, lateral mitral ring, and ventricular free wall. The most successful ablation tachycardias were those originating from the right ventricular outflow tract and fascicular tachycardias (92.5% and 90.2%, respectively), with a lower success rate in those originating from the aortic root/coronary cusps, left ventricular outflow tract, and epicardial/coronary sinus (78.8%, 76.6%, and 50%).

Irrigated tip catheters were used in 88.6% of the cases reported: conventional in 46% and contact forcesensing in 42.6%. The 4-mm tip catheter was used in 8.3% and the use of other types of catheter was negligible. Fluoroscopy was not used in 3.5% of the procedures.

There were 18 complications (3%): 9 effusions/tamponades, 5 vascular complications, 2 acute coronary syndromes, 1 AVB, and 1 coronary spasm.

Ventricular Tachycardia Associated With Myocardial Infarction

The total number of VT-AMI ablation procedures slightly increased, reaching 531 procedures (3.5%) in 438 patients (mean, 5.4; range, 0-33).

The type of ablation performed was reported for 89.8% of the cases: 101 with a "standard" approach and 376 with a substrate

approach (a slight increase vs the previous year). The overall success rate was 78.7% (slightly lower than that reported in 2016 and 2015: 83.1% and 80.0%, respectively).

A high number of cases are still performed with an exclusively endocardial approach (89.9%). Consequently, the number of procedures with an epicardial or combined (endocardial and epicardial) approach continues to fall, with 43 procedures with a combined approach (8.9%) and 6 with a combined epicardial approach (1.2%). The rate of procedures with an exclusively epicardial approach continues to decline (8.7% in 2015, 4.9% in 2016, and 1.2% in the current registry) and there was a slight uptick in procedures with a combined approach (from 7.6% in 2016 to 8.9% in 2017).

Regarding the endocardial approach, retroaortic access continues to predominate and was used in 261 procedures (59.9%).

An irrigated tip ablation catheter was the most popular choice for VT-AMI ablations (93.7%), of which 66.5% were contact forcesensing catheters. Steerable sheaths were used in 24.3%.

The following complications (44; 7.3%) were reported: 14 pericardial effusions (2.3%), 11 vascular complications (1.8%), 10 heart failure events (1.7%), 3 AVBs (0.4%), 2 embolic episodes (0.4%), and 1 pleural cavity puncture during an attempted epicardial approach (0.2%). Three deaths (0.5%) were reported: in 1 case, tamponade occurred due to coronary sinus perforation, prolonged cardiopulmonary resuscitation, and surgery with sternotomy; the patient died at 48 hours due to cardiogenic shock. The second patient experienced electromechanical dissociation secondary to rapid VT induction after ablation completion. Finally, the third patient had refractory heart failure after 2 failed attempted incessant VT ablation procedures.

Ventricular Tachycardia Not Associated With Myocardial Infarction

A total of 249 VT-NAMI ablation procedures were performed (1.6%) in 48 laboratories (52.2%) (mean, 2.5; range, 0-37). The type of VT substrate was specified in 212 cases: 105 in nonischemic dilated cardiomyopathy (68.6% success rate), 34 in arrhythmogenic cardiomyopathy (82.4% success rate), 37 in congenital heart diseases (86.5% success rate), 10 bundle branch reentrant VTs (100% success rate), and 15 reported as being of "another type" (80% success rate), which included 6 cases of valvular heart disease, 2 after myocarditis, 1 in Chagas disease, and 1 in Brugada syndrome.

Regarding the approach used for these ablation targets, there was greater use of the epicardial or combined (endocardial and epicardial) approach vs VT-AMI procedures, similar to the previous registry. In total, 21 procedures were exclusively performed with an epicardial approach (8.4%) and 42 with a combined endocardial and epicardial approach (16.9%).

The most used catheter type was the irrigated tip (93.4%), with contact forcesensing technology used in most (53.7%).

There were 15 complications (6%), divided into 3 effusions/tamponades (1.2%), 3 heart failure events (1.2%), 2 AVBs (0.8%), 1 peripheral embolism (0.4%), 1 myocardial infarction (0.4%), and 3 "others" (1.2%): 1 pulmonary thromboembolism, 1 arrhythmic storm during ablation, and 1 pneumothorax. Two deaths were reported: an intraprocedural arrhythmic storm and an electromechanical dissociation in a patient with dilated cardiomyopathy.

Zero-fluoroscopy Ablation

The use of nonfluoroscopic navigation systems was reported in 5388 procedures (35%). Such navigation systems were most commonly used for point-by-point pulmonary vein isolation (61.8% of the procedures).

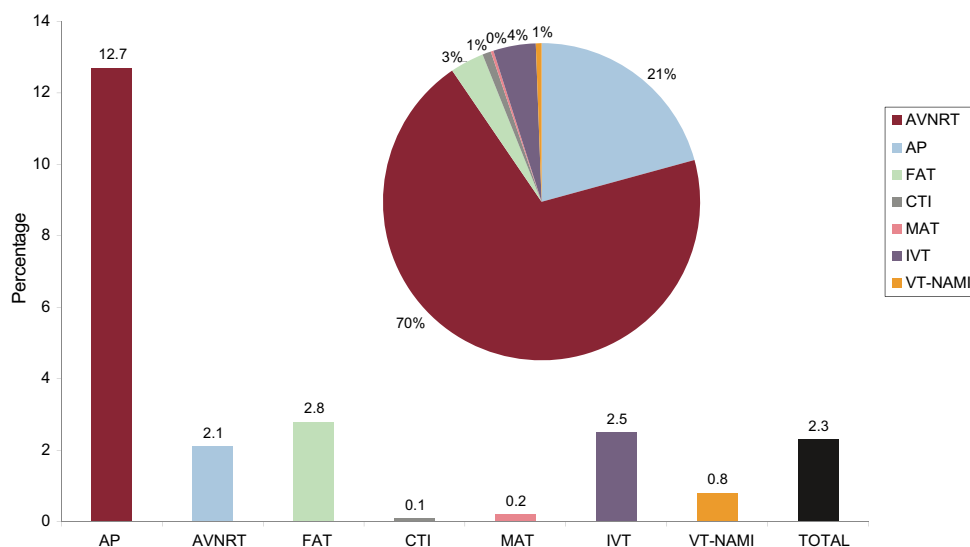


Figure 8. Pediatric ablation procedures. The bar chart shows the proportion of pediatric procedures for each ablation target and the total number of procedures in the registry while the pie chart shows the proportion of each substrate ablated with respect to the total number of pediatric procedures. AP, pathways pathway; AVNRT, atrioventricular nodal reentrant tachycardia; CTI, cavotricuspid isthmus; FAT, focal atrial tachycardia; IVT, idiopathic ventricular tachycardia; MAT, macroreentrant atrial tachycardia; VT-NAMI, ventricular tachycardia not associated with acute myocardial infarction.

Although its use has been mostly complementary to fluoroscopy, the percentage of zero-fluoroscopy procedures has continued to increase, reaching 6% (3.5% in 2016).^{18,19}

As in the previous registry, the ablation target most commonly treated without fluoroscopy has been the CTI (14.1% of all CTI ablations). At the other extreme, TV-AMI was not ablated at any time without fluoroscopy.

Ablations in Pediatric Patients

The registry recorded 347 ablation procedures (2.3% of the total number) in 34 centers; the most frequent ablation target was the accessory pathways (69.7%), representing 12.7% of the total number of ablations performed of this target. The data on the other procedures are shown in Figure 8.

DISCUSSION

The 2017 ablation registry has broken all historical records in both the number of procedures and the number of centers submitting information. Despite the marked increase in the number of procedures in virtually all ablation targets, the average per center has slightly decreased (156 ± 126 vs 162.4 ± 116 in 2016), mainly due to the higher number of centers performing less than 150 ablations/y (16 centers) vs the previous registry.

As for the frequency of ablation targets, the AF becomes the most commonly treated for the first time while the percentages of all other targets remain similar to those of previous years.

Although point-to-point ablation still predominates, the popularity of cryoablation continues for pulmonary vein ablation procedures and now accounts for 36% of these procedures (30% in 2016).

Regarding success, complication, and mortality rates, the figures continue to be stable in terms of the percentage vs previous registries, which implies that the data have not been affected by the number of lower-volume centers communicating their results.

AF is the condition with the highest number of complications, with 2 deaths in this registry. The ablation targets with the highest

percentage of complications were VT-AMI (7.3%) and VT-NAMI (6%), and they also have a higher percentage of mortality, which is related to the worse situation of patients prior to the procedure.

Three deaths were also described for “simpler” ablation targets, such as CTI ablation, a reminder that all procedures are susceptible to complications.

The number of zero-fluoroscopy procedures continues to increase, with practically double the percentage from the 2016 registry. The approach is more frequent for “simpler” ablation targets, although more complex procedures have been performed with “minimal” fluoroscopy or even, in some isolated cases, with a total absence of fluoroscopy, such as AF ablation.

Similar figures are maintained for pediatric ablation, with low percentages of the total number of procedures (2.3%), distributed among 36% of the centers.

CONCLUSIONS

The Spanish Catheter Ablation Registry continues to systematically record the ablation procedures performed in Spain and its track record and consistency make it the only such registry of its kind. The numbers of procedures and centers reached a historic peak this year, with very high success rates and low percentages of complications. The high participation means that the registry continues to represent the current situation of this procedure in Spain.

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CONFLICTS OF INTEREST

None declared.

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APPENDIX 2. ELECTROPHYSIOLOGY LABORATORIES PARTICIPATING IN THE 2017 SPANISH CATHETER ABLATION REGISTRY BY AUTONOMOUS COMMUNITY AND PROVINCE

<i>Andalusia</i>	
Cádiz	Hospital Universitario Puerta del Mar (Lucas Cano-Calabria)
Granada	Complejo Hospitalario Universitario de Granada, Hospital Inmaculada (Miguel Álvarez-López)
Huelva	Hospital Juan Ramón Jiménez, Hospital Costa de la Luz (Pablo Moriña)
Córdoba	Hospital Reina Sofía (Francisco Mazuelos)
Málaga	Hospital Clínico Universitario Virgen de la Victoria, Hospital El Ángel, Vithas Parque San Antonio, Vithas Xanit Internacional, Hospital Quirón Málaga, Hospital Quirón Salud Marbella, Vithas Internacional Benalmádena (Alberto Barrera-Cordero)
Sevilla	Hospital Virgen Macarena (Rocío Cózar); Hospital Nisa Aljarafe (Ernesto Díaz-Infante); Hospital Universitario Virgen del Rocío (Alonso Pedrote); Hospital Universitario Virgen de Valme (Ricardo Pavón Jiménez); Hospital Quirón Sevilla, Hospital Infanta Luisa (Juan Manuel Fernández-Gómez)
<i>Aragon</i>	
Zaragoza	Hospital Universitario Miguel Servet, Hospital Quirón Salud Zaragoza (Antonio Asso); Hospital Clínico Universitario Lozano Blesa (Gonzalo Rodrigo-Trallero)
<i>Principality of Asturias</i>	
Hospital de Cabueñes (Mar González-Vasserot); Hospital Central de Asturias (José Manuel Rubín)	
<i>Balearic Islands</i>	
Hospital Son Llàtzer (Santiago Magnani); Hospital Universitario Son Espases (María del Carmen Expósito-Pineda); Clínica Rotger, Quirón Palmaplanas (Nelson Alvaralenga); Grupo Juaneda (Ivo Roca)	
<i>Canary Islands</i>	
Las Palmas	Hospital Santa Catalina (Juan Carlos Rodríguez-Pérez); Hospital Universitario Dr. Negrín (Eduardo Caballero-Dorta); Hospital Perpetuo Socorro (Pablo Ruiz Hernández); Hospital Insular de Gran Canaria (Federico Segura)
Santa Cruz de Tenerife	Hospital Universitario Nuestra Señora de la Candelaria (Luis Álvarez Acosta); Hospital San Juan de Dios (Julio Hernández-Afonso)
<i>Cantabria</i>	
Hospital Marqués de Valdecilla (Felipe Rodríguez-Entem)	
<i>Castile-La Mancha</i>	
Toledo	Hospital Virgen de la Salud (Miguel Ángel Arias); Hospital Nuestra Señora del Prado (Alfonso Macías)
Ciudad Real	Hospital General Universitario de Ciudad Real (Javier Jiménez-Díaz)
Albacete	Complejo Hospitalario Universitario de Albacete (Víctor Manuel Hidalgo Olivares)
<i>Castile and León</i>	
Burgos	Hospital Universitario de Burgos (Ricardo Salgado-Aranda) Hospital Universitario de León (María Luisa Fidalgo)
Salamanca	Hospital Universitario de Salamanca (Javier Jiménez-Candil)
Valladolid	Hospital Clínico Universitario Valladolid (Jerónimo Rubio-Sanz)
<i>Catalonia</i>	
Barcelona	Hospital Universitario de Bellvitge (Ignasi Anguera); Hospital Clínic (Lluís Mont); Clínica Teknon (Enrique Rodríguez-Font); Hospital Germans Trias i Pujol (Axel Sarrias); Hospital Vall d'Hebron (Nuria Rivas-Gándara); Clínica Corachán Barcelona (José M. Guerra-Ramos); Clínica Sagrada Família, Hospital Quirón Dexeus (Ángel Moya-i-Mitjans); Hospital Mútua de Terrassa (Sonia Ibars); Hospital Sant Joan de Déu (Georgia Sarquella-Brugada); Hospital del Mar (Jesús Jiménez); Hospital Universitario de Sabadell (Jordi Punti-Sala); Hospital de la Santa Creu y Sant Pau (Concepción Alonso)
Tarragona	Hospital Juan XXIII (Sandra Cabrera)
Lleida	Hospital Arnau de Vilanova (Miguel Jauregui)
Girona	Clínica Girona (Josep Brugada)

APPENDIX 2. (Continued)

<i>Valencian Community</i>	
Alicante	Hospital Universitario de San Juan de Alicante (José Moreno-Arribas); Hospital General Universitario de Alicante (José Luis Ibáñez-Criado); CardioRitmo-Levante (Alicia Ibáñez-Criado)
Castellón	Hospital General Universitario de Castellón (Josep Navarro Manchón)
Valencia	Hospital La Fe (Joaquín Osca); Hospital General Universitario de Valencia (Aurelio Quesada); Hospital Clínico de Valencia (Ángel Martínez-Brotos); Hospital de Manises (Pau Alonso-Fernández); Hospital Universitario de la Ribera (Santiago Heras-Herreros); Hospital Dr. Peset (Claudia Cabadés)
<i>Extremadura</i>	
Badajoz	Hospital Infanta Cristina (Manuel Doblado)
Cáceres	Hospital San Pedro de Alcántara (Rosa Porro-Fernández)
<i>Galicia</i>	
A Coruña	Complejo Hospitalario Universitario de A Coruña (Luisa Pérez-Álvarez); Hospital Clínico Universitario de Santiago de Compostela (José Luis Martínez-Sande)
Pontevedra	Hospital Álvaro Cunqueiro (Pilar Cabanas-Grandío)
Lugo	Hospital Lucus Augusti (Juliana Elices)
<i>Community of Madrid</i>	
	Hospital Universitario Ramón y Cajal (Javier Moreno-Planas); Hospital Universitario 12 de Octubre (Adolfo Fontenla); Hospital Sanitas La Moraleja (Roberto Matía-Francés); Hospital Universitario de Getafe (Agustín Pastor); HM Hospitales (Jesús Almendral); Hospital Puerta de Hierro (Víctor Castro-Urda); Hospital La Paz (Rafael Peinado); Hospital Infantil La Paz (Marta Ortega-Molina); Hospital Clínico San Carlos (Nicasio Pérez-Castellano); Fundación Hospital de Alcorcón (Elena Esteban-Paul); Fundación Jiménez Díaz (José Manuel Rubio-Campal); Hospital Severo Ochoa (Ángel Grande); Hospital La Luz (Juan Benezet-Mazuecos); Hospital de Móstoles-Rey Juan Carlos (Federico Gómez-Pulido); Hospital Universitario de Torrejón (Carla Lázaro Rivera)
<i>Region of Murcia</i>	
	Hospital Virgen de la Arrixaca (Arcadio García-Alberola); Hospital Santa Lucía (Ignacio Gil-Ortega)
<i>Chartered Community of Navarre</i>	
	Complejo Hospitalario de Navarra (Javier Martínez-Basterra); Clínica Universidad de Navarra (Gabriel Ballesteros)
<i>Basque Country</i>	
Vizcaya	Hospital de Cruces (Andrés Bodegas-Cañas); Hospital de Basurto (María Fe Arcocha-Torres)
Álava	Hospital Txagorritxu (Javier Pindado)
<i>La Rioja</i>	
	Hospital Viamed Los Manzanos (F. Javier García-Fernández)

The physician in charge of the registry in each center is indicated in parentheses.

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