

# 1 Prevention of venous thromboembolism after right heart- 2 sided electrophysiological procedures: results of an EHRA 3 survey

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15 **Abstract**

16 **Introduction:** Limited data are available regarding venous thromboembolism (VTE), specifically  
17 deep vein thrombosis (DVT) and pulmonary embolism (PE), following right-sided ablations and  
18 electrophysiological (EP) studies. Compared to left-sided procedures, no guidelines on  
19 antithrombotic management strategies for the prevention of DVT and PE are available. The main  
20 purpose of the present European Heart Rhythm Association (EHRA) survey is to report the current  
21 management of right-sided EP procedures, focusing on anticoagulation and prevention of VTE.

22 **Methods and Results:** An online survey was conducted using the EHRA infrastructure. A total of  
23 244 participants answered a 19-items questionnaire on the periprocedural management of EP  
24 studies and right-sided catheter ablations.

25 The right femoral vein is the most common access for EP studies and right-sided procedures. An  
26 ultrasound-guided approach is employed by more than 2/3 of respondents. Intravenous heparin is  
27 not commonly given by the majority of participants. About 1/3 of participants (34%) routinely  
28 prescribe VTE prophylaxis during (mostly aspirin and low molecular weight heparin) and 1/4 of  
29 respondents (25%) commonly prescribe VTE prophylaxis after discharge (mostly aspirin). Of note,

1 respectively 13% and 9% of participants observed at least one DVT and one PE related to right-  
2 sided ablation or EP study within the last year in their center.

3 **Conclusions:** The present survey shows that only a minority of operators routinely gives  
4 intraprocedural intravenous heparin and prescribes VTE prophylaxis after right-sided EP  
5 procedures. Compared to left-sided procedures like AF ablation, there are no consistent systematic  
6 antithrombotic management strategies.

7  
8 **Keywords:** catheter ablation; electrophysiological study; right-sided ablations; anticoagulation.

### 9 10 **Condensed Abstract**

11 The European Heart Rhythm Association (EHRA) investigated with an online survey the current  
12 peri-procedural management of electrophysiological studies and right-sided ablations in terms of  
13 anticoagulation and venous thromboembolism prevention.

### 14 15 **What's new?**

- 16 - The echo-guided is currently adopted in a routine way by only one third of respondents  
17 (37%);
- 18 - The “heparin bridging” in patients on VKA is still adopted by a significant amount of  
19 physicians (29%);
- 20 - Intravenous heparin is adopted by a smaller but not negligible amount of European  
21 electrophysiologists during EP studies (28%) and right-sided ablation (37%);
- 22 - VTE prophylaxis is – on average- adopted by 1 operator out of 4 after the discharge (25%),  
23 and the type of VTE prophylaxis is heterogeneous;
- 24 - Among operators who prescribe VTE prophylaxis, the majority (71%) give aspirin;
- 25 - No significant differences were found in anticoagulation strategies neither between Northern  
26 and Southern Europe nor between fully trained EPS and senior/junior EP fellows

## 1 **Introduction**

2 Femoral venous access is commonly used for all right-sided ablation procedures and for diagnostic  
3 electrophysiological (EP) studies. Limited data are available about venous thromboembolism  
4 (VTE), specifically deep venous thrombosis (DVT) and pulmonary embolism (PE), following right-  
5 sided ablations and EP studies<sup>1-13</sup>. In left-sided ablation procedures, especially pulmonary vein  
6 isolation, the peri-procedural approach is well standardized and homogenous throughout most of the  
7 centers and guidelines exist<sup>14-15</sup>. Conversely, for right-sided procedures there is no clear guidance  
8 from guidelines and no broadly accepted or standardized approach/workflow. Symptomatic DVT  
9 and PE following right-sided EP procedures are globally reported in 0.5-0.8% of patients<sup>1</sup>.  
10 Although venous thromboembolism is considered a rare event, it might potentially lead to severe  
11 consequences. The main purpose of this European Heart Rhythm Association (EHRA) survey was  
12 to investigate the management of right-sided ablations, especially in terms of anticoagulation and  
13 prevention of VTE, among cardiac electrophysiologists.

## 14 **Methods**

15 This physician-based survey was promoted and disseminated by EHRA. An online questionnaire,  
16 consisting of 19 multiple-choice questions, was developed, amended and validated by the Scientific  
17 Initiative Committee (SIC).

18 The questionnaire was distributed through official EHRA channels (EHRA newsletters, Scientific  
19 Research Network members, and national electrophysiology working groups) and social media  
20 platforms. It was active between 18 October and 21 November 2022. All cardiologists working in  
21 the field of Electrophysiology, from junior cardiac electrophysiology fellows to senior fellows until  
22 to fully trained cardiac electrophysiologists, were deemed to be eligible to participate in the survey.

23 In detail, the questionnaire was created by the promotor and then shared with the members of the  
24 working group; then, the questionnaire was shared, discussed and debated with all members of the  
25 SIC Committee. The specific queries included in the questionnaire are shown in Supplementary  
26 material online.

1 Results were collected anonymously in compliance with the European General Data Protection  
2 Regulation (GDPR) 2016/679.

3 Data were analyzed using descriptive statistical methods. Categorical variables are presented  
4 numerically with absolute percentages (%).

### 5 **Descriptive statistics**

6 Continuous variables are expressed as mean  $\pm$  SD or median and range as appropriate. Categorical  
7 variables are expressed as absolute and relative frequencies. Comparisons of continuous variables  
8 were done with a Student's t-test or the Mann-Whitney U-test as appropriate. The Chi-square test or  
9 the Fisher's exact test was used to compare categorical variables as appropriate. A 2-tailed  
10 probability value of  $<0.05$  was deemed significant. Statistical analyses were conducted using the  
11 SPSS software (SPSS v20, Chicago, IL, USA).

### 13 **Results**

14 From 18 October to 21 November 2022, a total of 244 respondents from 33 European countries  
15 (Armenia, Austria, Belgium, Belarus, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark,  
16 Estonia, France, Georgia, Germany, Greece, Hungary, Iceland, Italy, Latvia, Malta, The  
17 Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain,  
18 Sweden, Switzerland, Turkey, Ukraine, United Kingdom) participated in the survey (Figure 1).  
19 Respondents from Italy and Germany most frequently participated in the survey (respectively 24%  
20 and 16% of the overall participants) followed by respondents from Spain (6%), Croatia (5%),  
21 Belgium (4%), Greece (4%) and United Kingdom (4%). The average age of the responders was  $43 \pm$   
22 9 years. The majority of respondents were male (78%).

23 The majority of participants worked in university hospitals (56%). The remaining participants  
24 worked in specialized public cardiology centers (19%), public community hospitals (14%) and  
25 private hospitals/clinics (11%). Most of the survey respondents were fully trained cardiac  
26 electrophysiologists (73%), followed by junior cardiac electrophysiology fellows (18%) and senior

1 cardiac electrophysiology fellows (9%). The mean number of years of training among participants  
2 was  $11\pm 8$  years (median 10 years, interquartile range 5 to 15 years).

3 The mean volume of right-sided EP procedures performed at the centers of the participants was  
4  $166\pm 110$ /year (median 115/year and interquartile range 100 to 215/year). In details, only 4% of the  
5 participants performed less than 50 right-sided procedures per year at their centers; 20% of the  
6 respondents worked in centers performing 50-100 right-sided procedures per year; 32% of the  
7 physicians declared to perform between 100 and 150 procedures per year and 10% stated to perform  
8 between 150 and 200 procedures. The remaining 34% of participants were active in centers  
9 performing more than 200 right-sided EP procedures per year.

10 Fifty-four percent of respondents stated that, in their centers, they kept a systematic, institutional  
11 reporting system used for the collection and assessment of EP procedure-related complications. The  
12 median response rate for each question was 80.3% [IR 76.2%; 82.3%].

### 13 **Venous access and procedural approach**

14 Most of the respondents declared to use 2 or 3 catheters (respectively, 46% and 44%) for  
15 performing EP studies and predominantly 3 catheters for AVNRT, right accessory pathway, and  
16 right AT ablation (respectively 55%, 57% and 56% of all participants). Two catheters are most  
17 commonly used for right atrial flutter and right ventricular tachycardia/extrasystole ablations  
18 (respectively used by 54% and 51% of the overall respondents); a single catheter approach is mostly  
19 used for AV node ablation by 67% of the interviewed sample.

20 Eighty-one percent of the respondents stated to use only the right groin as venous access (left groin:  
21 0.5%; both right and left groins: 18.5%). The femoral venous access is always obtained by  
22 ultrasound-guided approach by 37% of respondents while, on the contrary, 28% of respondents  
23 never use an ultrasound-guided technique for femoral venous puncture. Around one third of  
24 participants (35%) declared to use an ultrasound-guided approach for femoral venous puncture only  
25 in selected cases or patients. Most of respondents (84%) never intubate the coronary sinus from the  
26 superior jugular/subclavian vein approach while a small minority (3%) does it in all procedures; of

1 note, 13% of participants cannulate the coronary sinus using a jugular approach only in selected  
2 cases, such as accessory pathway ablations (6%), inability to get a femoral access (4%), atrial  
3 fibrillation ablation (1%), and AVNRT ablation (1%).

#### 4 **Anticoagulation management before EP studies and right-sided ablation procedures**

5 Direct oral anticoagulation (DOAC) is commonly interrupted before EP studies and right-sided  
6 ablation procedures by 44% of respondents (Figure 2). Among these, 74% stop DOAC therapy  
7 within 24 hours before the procedure, 25% stop DOAC therapy 24-48 hours before the procedure  
8 and 1% suspend the DOAC therapy more than 48 hours before the procedure (Figure 2). Among  
9 respondents who commonly stop DOAC therapy, the majority (68%) resumes DOAC therapy on  
10 the day of the procedure and 29% on the following day (Figure 2).

11 On the other side, vitamin K antagonists (VKA) are interrupted before EP studies and right-sided  
12 ablation procedures by 34% of respondents (Figure 3). Among the latter, 37% stop VKA therapy  
13 within 24 hours from the procedure, 44% 24-48 hours before the procedure and 19% suspend VKAs  
14 for more than 48 hours before the procedure (Figure 3). Of note, the heparin bridging therapy is  
15 adopted by 29% of respondents who stop VKAs before the procedure (Figure 3).

#### 16 **Anticoagulation management during EP studies and right-sided ablation procedures**

17 The majority of respondents (72%) never administer intravenous (i.v.) heparin during EP studies  
18 (Figure 4); 16% administer a fixed dose of i.v. heparin, 9% a weight-adjusted dose of i.v. heparin  
19 and the remaining 3% an ACT-directed dose of i.v. heparin. Similarly, most of the respondents  
20 (63%) do not administer i.v. heparin during right-sided supraventricular tachycardia ablations  
21 (Figure 4); the remaining physicians use a fixed dose of i.v. heparin (26%), a weight-adjusted dose  
22 of i.v. heparin (9%) or ACT-directed dose of i.v. heparin (2%).

23 Of note, the majority of participants (69%) irrigates long sheath introducers during EP studies and  
24 right-sided ablation procedures; among them, 80% irrigate with heparin saline solution and the  
25 remaining 20% use a normal saline infusion.

26

## 1 **Femoral venous access and post-procedural management**

2 After the procedures, bed rest is recommended for less than 4 hours by 12% of respondents, for 4-6  
3 hours by 70% of respondents, and for more than 6 hours by 18% of respondents. Participants were  
4 also asked about the type of venous access site closure and management: manual compression was  
5 declared as the most common way to achieve the venous access closure (59%); Z-suture was  
6 preferred by 39% of respondents. Vascular closure devices (Perclose Proglide™ and Angio-Seal)  
7 are used by 2% of participants. Among respondents who apply Z-suture in the femoral venous  
8 access, 7% of them remove it within 4 hours, 14% of them 4-6 hours later, 9% of them cut the  
9 suture 6 hours later on the same day and, most of them (70%), remove the Z-suture the day after or  
10 even later.

11 Of note, compression dressings are routinely applied after the procedure by 25% of respondents.  
12 Among the latter, 14% remove the compression dressing within 4 hours, 24% keep the dressing for  
13 4 hours, 42% for 6 hours and 20% for more than 6 hours.

14 Finally, nearly half of respondents (46%) routinely remove the venous sheaths while aspirating  
15 blood with a syringe to pull out possible clots or thrombi.

16 Patients are commonly discharged at home on the day of the diagnostic EP study by 36% of  
17 respondents (53% of respondents never discharge the same day). The remaining 11% of them  
18 discharge the patient on the same day only if the procedure is performed in the morning. In case of  
19 AVNRT ablation, 74% of respondents never discharge patients on the same day; on the other hand,  
20 17% of physicians always discharge in the evening after the procedure and a further 9% of  
21 respondents discharge the patient on the same day only if the procedure is performed in the  
22 morning. Similarly, with right-sided accessory pathway ablation, 75% of respondents never  
23 discharge patients on the same day; on the contrary, 15% of respondents always discharge in the  
24 evening after the procedure and the remaining 10% discharge only if the procedure is performed in  
25 the morning.



1 In case of right atrial tachycardia and right atrial flutter ablations, 77% and 75%, respectively, of  
2 respondents never discharge patients on the same day. When ablation of premature ventricular  
3 contraction or ventricular tachycardia in the right ventricle are performed, 82% of respondents  
4 never discharge patients on the same day; conversely, only 7% of respondents always discharge in  
5 the evening after the procedure.

### 6 **VTE prevention strategies after EP studies and right-sided ablation procedures**

7 As shown in Figure 5A, medical prophylaxis for VTE following EP studies and right-sided  
8 ablations, during the hospital stay, is never done by 2/3 of physicians (67%); on the other hand,  
9 17% of respondents routinely prescribe low-molecular-weight heparin (LMWH) after the  
10 procedures and a further 14% routinely prescribe aspirin. After discharge, medical prophylaxis for  
11 VTE is never done by 76% of physicians; of note, 17% of respondents routinely prescribe aspirin  
12 after discharge and a small minority usually prescribes LMWH and oral anticoagulation  
13 (respectively, 4% and 3%) (Figure 5B).

14 Overall, 33% of the respondents routinely prescribe VTE prophylaxis early after the EP studies and  
15 right-sided ablations and 24% of the respondents commonly prescribe VTE prophylaxis after  
16 discharge. If a pharmacological prophylaxis for VTE is prescribed, the mean duration is for  $29 \pm 21$   
17 days (median 29.5 days, interquartile range 14 to 30 days). When aspirin is used as VTE  
18 prophylaxis, the mean duration of the therapy is for  $32 \pm 17$  days (median 30 days, IQR 27; 30);  
19 medical prophylaxis with LMWH is prescribed for a median duration of 6 days (IQR 3;75).

20 Most of the physicians (69%) do not change their strategy to prevent VTE based on the presence of  
21 specific risk factors. However, 31% of respondents report to change their strategy to prevent VTE  
22 according to specific risk factors; the latter ones are known, previous episodes of VTE (40%),  
23 concomitant therapy with oral contraceptives (16%), obesity (12%), smoking habit (5%), female  
24 gender (5%), known thrombophilic disease or hypercoagulable condition (5%).

1 Of note, 25 out of 184 respondents (13%) experienced within the last year at least one DVT related  
2 to right-sided ablation or EP study. In addition, 9% (n=16) of respondents also stated that they  
3 experienced within the last year at least one PE related to right-sided ablation or EP study.

4 The analysis of specific subgroups (Northern vs Southern Europe, fully trained EPs vs junior/senior  
5 fellows) did not show significant differences in terms of intra-procedural i.v. heparin and VTE  
6 prophylaxis. In particular, a virtual line was drawn throughout the Alps in order to divide Europe  
7 into Northern and Southern Europe. Between 129 respondents from Northern Europe and 115  
8 respondents from Southern Europe, no differences were found in terms of administration of i.v.  
9 heparin during EP studies (respectively, 33% vs 23%;  $p=0.1$ ) and right-sided ablations (39% vs  
10 34%,  $p=0.4$ ). No differences were also found in terms of VTE prophylaxis: 36% of participants  
11 from Northern Europe versus 31% of participants from Southern Europe routinely prescribe VTE  
12 prophylaxis after the procedure ( $p=0.4$ ). Similarly, VTE prophylaxis after discharge was commonly  
13 prescribed by 26% of respondents from Northern Europe compared with 23% of respondents from  
14 Southern Europe ( $p=0.6$ ). Between 178 fully trained EPs and 66 junior/senior fellows, no  
15 differences were found in terms of administration of i.v. heparin during EP studies (respectively,  
16 31% vs 23%;  $p=0.2$ ) and right-sided ablations (42% vs 29%,  $p=0.1$ ). No differences were also  
17 found in terms of VTE prophylaxis: 34% of fully trained EPs versus 30% of junior/senior EP  
18 fellows routinely prescribe VTE prophylaxis after the procedure ( $p=0.5$ ). Similarly, VTE  
19 prophylaxis after discharge was commonly prescribed by 25% of respondents from Northern  
20 Europe compared with 21% of respondents from Southern Europe ( $p=0.5$ ).

## 22 **Discussion**

23 The main findings of the present survey are listed in the Table 1.

24 In the last three decades, invasive EP studies and catheter ablation have become standard of care in  
25 the diagnosis and treatment of cardiac arrhythmias<sup>16-18</sup>. Although catheter ablation has a high yield-  
26 to-complication ratio, the occurrence of venous thromboembolic complications is not neglectable.

1 As reported by previous studies, the evidence of asymptomatic DVT following catheter ablation is  
2 high, ranging between 0 and 16%<sup>7</sup>. Nevertheless, the incidence of symptomatic DVT is much lower  
3 (0.5–0.8%)<sup>1,13,19</sup>. Three different mechanisms can be identified for the development of DVT/PE: 1)  
4 venous stasis and inflammation at the puncture site; 2) thrombosis due to radiofrequency ablation;  
5 3) groin bandage and immobility after procedures leading to venous stasis.

6 The Multicenter European Radiofrequency Survey (MERFS)<sup>1</sup>, the largest cohort including 4398  
7 patients referred for catheter ablation of supraventricular or ventricular tachycardias, showed that  
8 DVTs were identified in 0.5% of and the risk of embolic events following right-sided procedures  
9 was extraordinarily uncommon (0.06%). However, the true rate of VTE is surely underestimated as  
10 a systematic search of thromboembolic complications is not routinely done after procedures; as a  
11 matter of fact, asymptomatic rate of VTE has been reported to be much higher<sup>11,12</sup>.

12 Chen et al<sup>11</sup> reported an incidence of 17.6% for the development of asymptomatic, non-occlusive  
13 DVTs after EP studies using multiple venous sheaths. Repeat ultrasonography at one week  
14 documented regression of the non-occlusive DVTs in 92% of cases. A similar incidence of  
15 asymptomatic thrombosis (20%) was reported by Tiroke et al<sup>12</sup> despite the use of i.v. heparin.

16 Currently, there are no guidelines or consensus documents about the management of EP studies and  
17 right-sided ablations in terms of anticoagulation and VTE prevention before, during and after the  
18 procedures. Of note, this survey shows that i.v. heparin is never administered by the majority of  
19 operators during EP studies or right-sided ablations (respectively 72% and 63% of participants). A  
20 Canadian survey recently reported similar findings<sup>5</sup>. Generally, most of centers do not administer  
21 intra-procedural i.v. heparin during EP studies or right-sided ablation procedures, probably because  
22 the thrombotic risk is deemed to be largely overcome by the hemorrhagic risk. However, although  
23 venous thromboembolic complications are infrequent, they might potentially be life-threatening  
24 such as in case of PE. As VTE prophylaxis after right-sided EP procedures, some operators  
25 prescribe aspirin (oral, 50–150 milligrams) for a period of 1–3 months following catheter ablation;  
26 on the other hand, some physicians commonly use heparin during the procedure and a few days

1 after to prevent venous thromboembolism<sup>7</sup>. Although a discrete amount of operators gives aspirin  
2 for VTE prevention after right-sided EP procedures, there is no clear evidence supporting aspirin  
3 for prevention of DVT and PE. Low molecular weight heparin represents the cornerstone for  
4 prevention of DVT and PE following major surgery and invasive procedures<sup>20</sup>.

5 However, a recent multicenter, randomized, noninferiority trial compared enoxaparin 30 mg twice  
6 daily with aspirin 81 mg twice daily, as thromboprophylaxis in 12'211 patients with either  
7 surgically treated extremity fractures or with any pelvic or acetabular fracture. This study showed  
8 that aspirin was noninferior to LMWH in preventing death and was associated with a low  
9 incidences of DVT and PE and low 90-day mortality<sup>21</sup>. On the other hand, a recent and large meta-  
10 analysis concluded that aspirin was inferior when compared with other anticoagulants in VTE-  
11 related orthopedic major surgery<sup>22</sup>. Therefore, the role of aspirin for VTE prevention after surgery  
12 and invasive procedures is controversial, and needs more evidence.

13 The present survey shows that systematic prophylaxis for VTE following EP studies and right-sided  
14 ablations is never done – during the hospital stay - by two-thirds of physicians (67%) and - after the  
15 discharge - prophylaxis for VTE is not considered by three-quarters (76%) of respondents. Nearly a  
16 fifth of the overall respondents (17%) routinely prescribes aspirin after the discharge. This EHRA  
17 survey confirms lack of systematic DVT prophylaxis following right sided EP procedures and  
18 ablations. Although the ultrasound-guided approach has been shown to significantly reduce groin  
19 complications compared with conventional “blind” puncture technique<sup>23-25</sup>, a considerable amount  
20 of electrophysiologists (28%) still never use echo-color-doppler to puncture femoral veins in EP  
21 studies and right-sided ablation and 35% use it only in selected cases.

22 In patients under direct oral anticoagulation before the procedure, this therapy is usually not  
23 interrupted by most of the operators (56%); in case of VKA, most of respondents did not suspend  
24 the therapy before the procedure (66%). Among one third of respondents who usually stop VKAs, a  
25 minority (29%) is still replacing oral anticoagulation with heparin before the procedure (the so-  
26 called “bridging heparin therapy”). However, bridging with LMWH has been clearly shown to be

1 associated with higher incidence of groin hematoma/bleeding compared to continuation of VKA in  
2 left-sided procedures and device implantation procedures<sup>26,27</sup>. With the current evidence of a lower  
3 hemorrhagic complication rate with uninterrupted VKA therapy, the bridging strategy should be  
4 clearly abandoned also in EP and right-sided ablation procedures.

5 A very interesting strategy is commonly adopted by one third of participants who tailor their  
6 behavior according to the presence of specific risk factors such as previous episodes of VTE,  
7 concomitant therapy with oral contraceptives, obesity, smoking habit, female gender, known  
8 hypercoagulable conditions. In addition, an accurate sheath management with frequent flushing or  
9 continuous irrigation, especially with heparin saline solution, might help to minimize the risk  
10 VTE<sup>10</sup>. In our survey, more than two thirds of participants (69%) commonly irrigate the femoral  
11 sheaths and, among them, 80% routinely use heparin saline solution.

12 In our survey only 25% of respondents regularly used compression dressings, with a variable  
13 duration of application that commonly does not exceed 6 hours (80% of respondents used to remove  
14 compression dressings no more than 6 hours later). There was relative homogeneity among the  
15 prescribed duration of bed rest after EP procedures, with most of physicians (82%) recommending 6  
16 hours or less. A potential preventive strategy to avoid thromboembolic complications is the “same-  
17 day discharge”<sup>28,29</sup>. The present survey showed that this strategy is predominantly used in case of  
18 diagnostic EP studies. As a matter of fact, an early mobilization and a quick resumption to the  
19 routine daily life may significantly reduce the blood flow stasis and potentially reduce procedure-  
20 related VTE complications.

21 Of note, 13% of participants stated they had experienced at least one DVT related to right-sided  
22 ablation or EP study within the last year in their Centre. Likewise, 9% of respondents declared at  
23 least one PE related to right-sided ablation or EP study within the last year. This data might be  
24 strongly limited by a possible overestimation due to the possibility of more respondents coming  
25 from the same Centre.

26 By the way, our data confirm that the incidence of DVT/PE is rather low.

1 Larger, multicentric, prospective and randomized studies are needed to identify which, if any, of  
2 these post-procedural factors may affect the development of post-procedural VTE.

### 3 **Limitations**

4 The present survey has limitations attributed to target respondents and questionnaire design. The  
5 survey included a limited number of selected physicians and participation was completely  
6 voluntary, therefore being prone to selection bias. Moreover, junior EP fellows are included in the  
7 present survey (18% of all respondents); as they might tend to follow or reproduce their Center  
8 protocols or Senior colleagues' behaviour, this might represent a potential limitation.

9 Being a physician-based survey, physicians belonging to same EP centers might have answered  
10 leading to a possible overestimation of some periprocedural management strategies.

11 Italy and Germany represented about 40% of the 33 involved European countries.

12 Local vascular complications have not been collected by the questionnaire.

### 13 **Conclusions**

14 The present survey shows that only a minority of operators routinely gives intraprocedural  
15 intravenous heparin and prescribes VTE prophylaxis after right-sided EP procedures. Compared to  
16 left sided procedures like AF ablation, there are no consistent systematic antithrombotic  
17 management strategies. Thus, additional studies and guidelines or consensus statements are needed  
18 in order to standardize VTE prevention strategies throughout EP centers.

19

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2

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#### 15 **Figure legends**

16 **Figure 1:** geographical map showing the distribution of the main responders across Europe.

17 **Figure 2:** the picture illustrates the management of direct oral anticoagulants before EP studies and  
18 right-sided ablation procedures.

19 **Figure 3:** the picture illustrates the management of vitamin K antagonists before EP studies and  
20 right-sided ablation procedures.

21 **Figure 4: on the left** – the graphic shows how many physicians administer intravenous heparin  
22 during EP studies; **on the right** – the picture illustrates how many operators administer intravenous  
23 heparin during right-sided ablations.

24 **Figure 5: A** – the pie chart shows the proportion of physicians who gives VTE prophylaxis during  
25 the hospital stay and the type of medical prophylaxis; **B** – the pie chart illustrated the rate of

1 physicians who commonly prescribes VTE prophylaxis after the discharge and the type of medical  
2 prophylaxis.

3

4 **Graphical Abstract Legend:** EP: electrophysiological; ACT: activated clotting time; i.v.: intra-  
5 venous; VTE: venous thromboembolism; UF: unfractionated; lmwh: low molecular weight heparin.

6

7 **Table 1. Key messages**

The echo-guided approach for femoral venous access is routinely adopted in roughly one third of respondents
The right groin is usually chosen as the only access site
Intravenous heparin is adopted by, respectively, 28% and 37% of participants during EP studies and right-sided ablations
Before the procedure: in patients on VKA “heparin – bridging” is still standard of care in 29% and DOACs are interrupted by 44% of respondents
After the procedure/in-hospital: 33% of participants routinely prescribe VTE prophylaxis after the EP studies and right-sided ablations (mostly LMWH, 17%, and aspirin, 14%)
After hospital discharge: 25% of respondents commonly prescribe VTE prophylaxis even after the discharge (mostly aspirin) for a median duration of 30 days

8 *EP: electrophysiological; VKA: vitamin K antagonists; DOAC: direct oral anticoagulants; VTE: venous*  
9 *thromboembolisms; LMWH: low molecular weight heparin.*

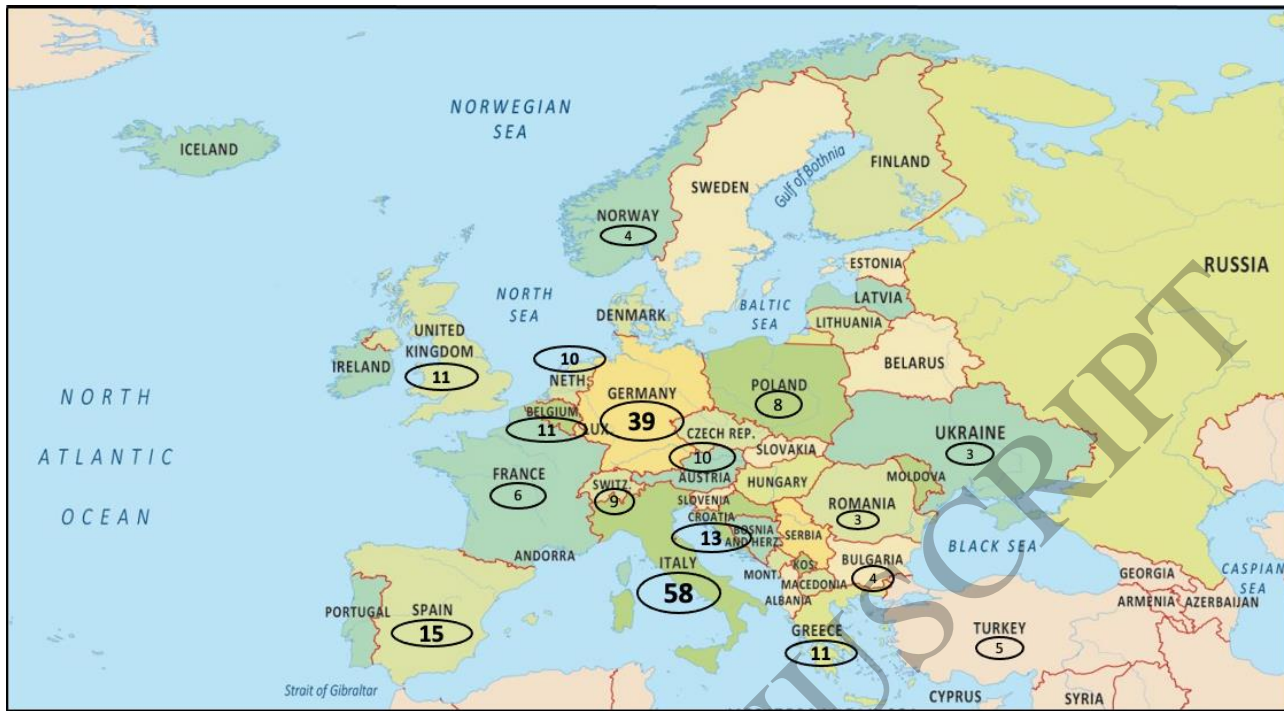


Figure 1  
296x163 mm (x DPI)

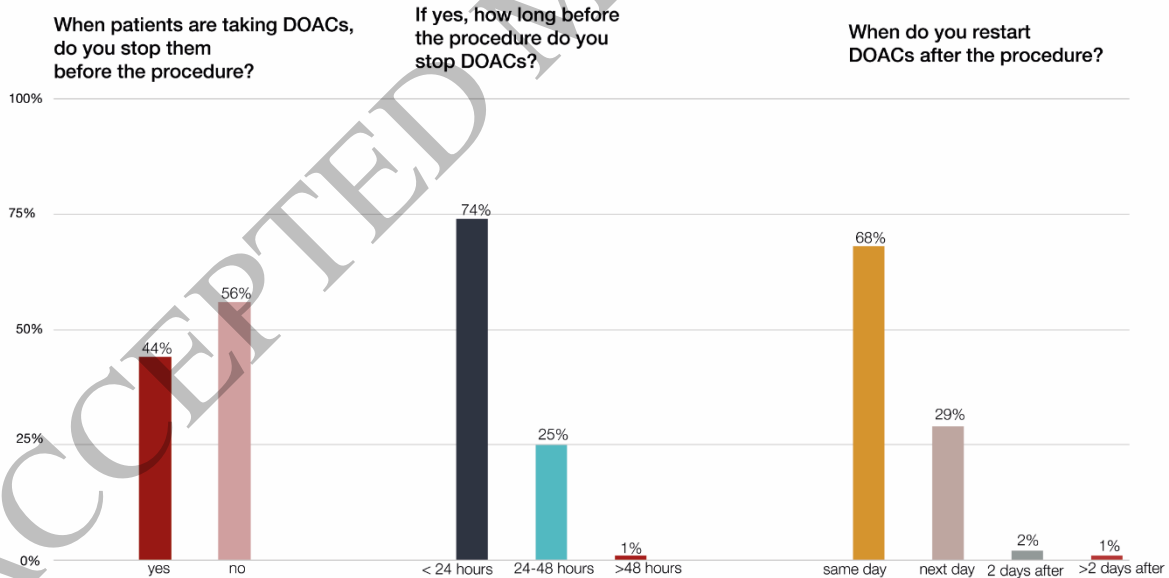


Figure 2  
210x119 mm (x DPI)

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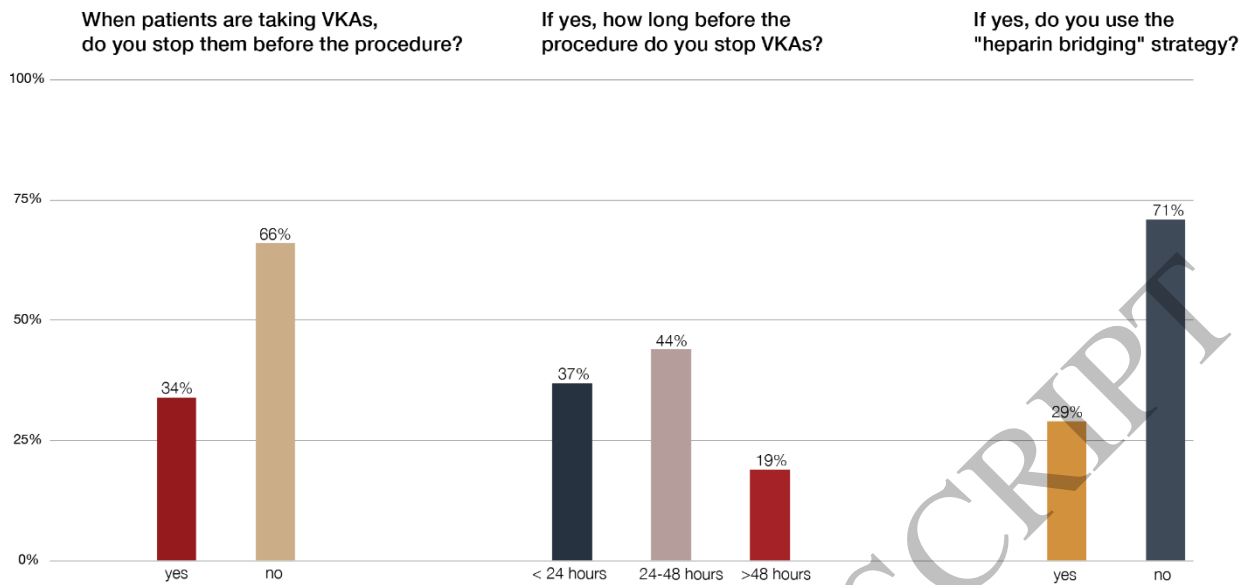


Figure 3  
200x92 mm ( x DPI)

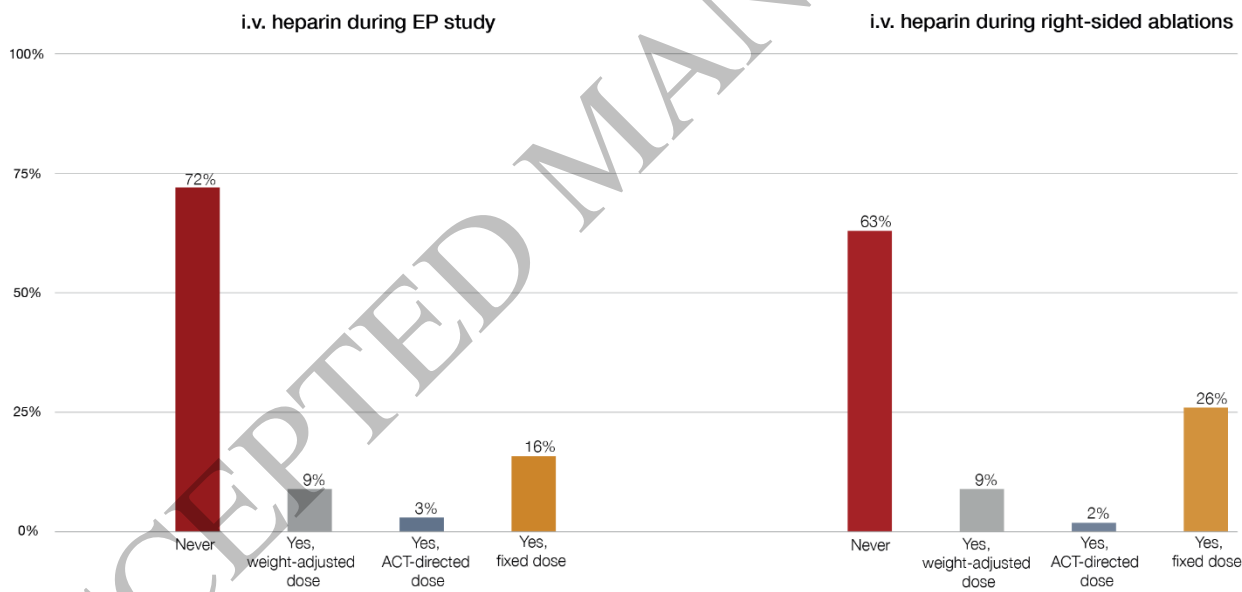


Figure 4  
202x94 mm ( x DPI)

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### VTE prophylaxis during the hospital stay

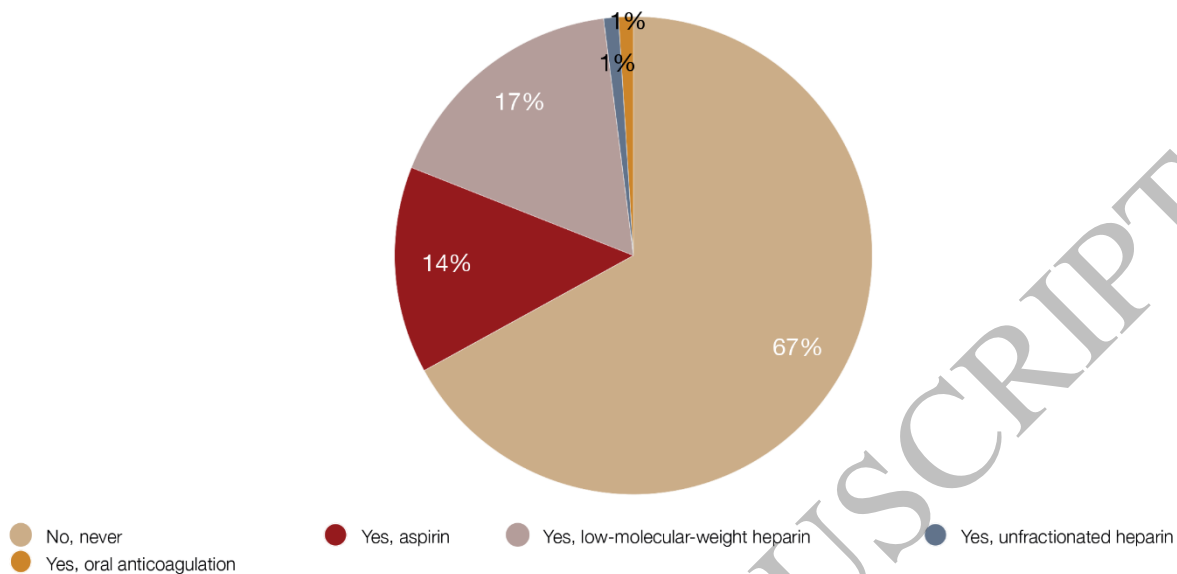


Figure 5A  
200x106 mm ( x DPI)

### VTE prophylaxis after the discharge

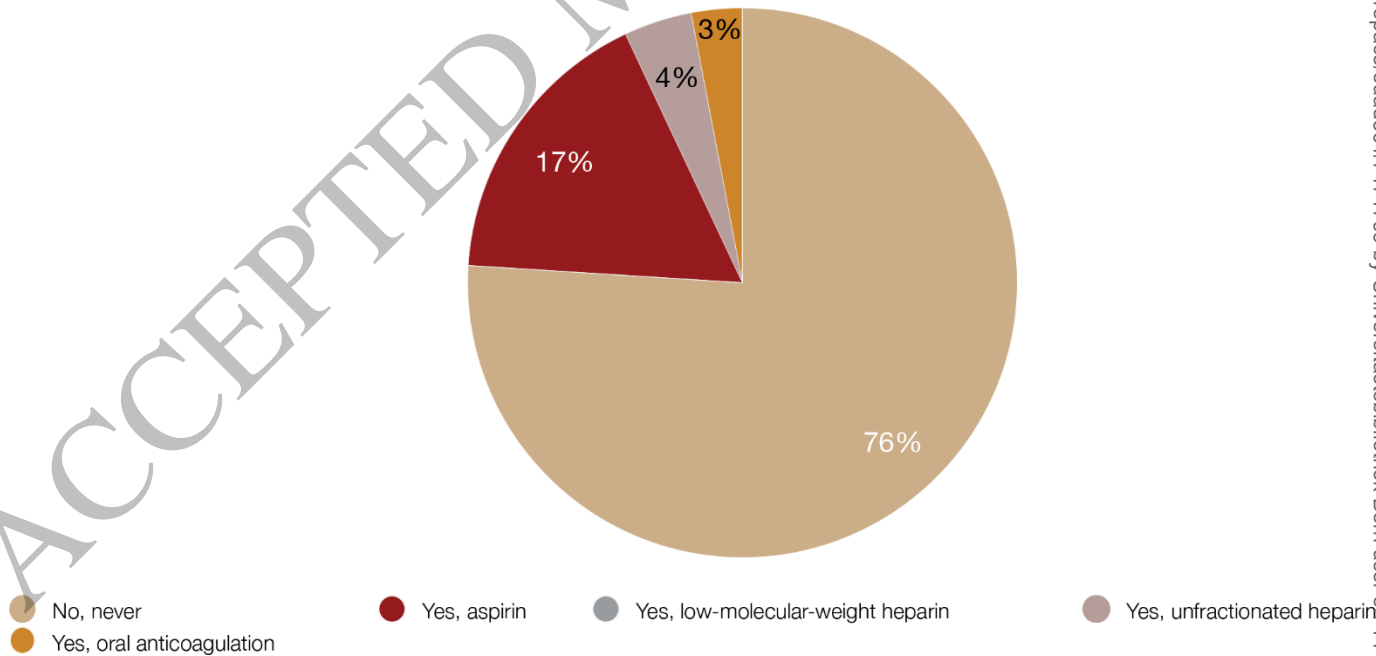


Figure 5B  
188x102 mm ( x DPI)

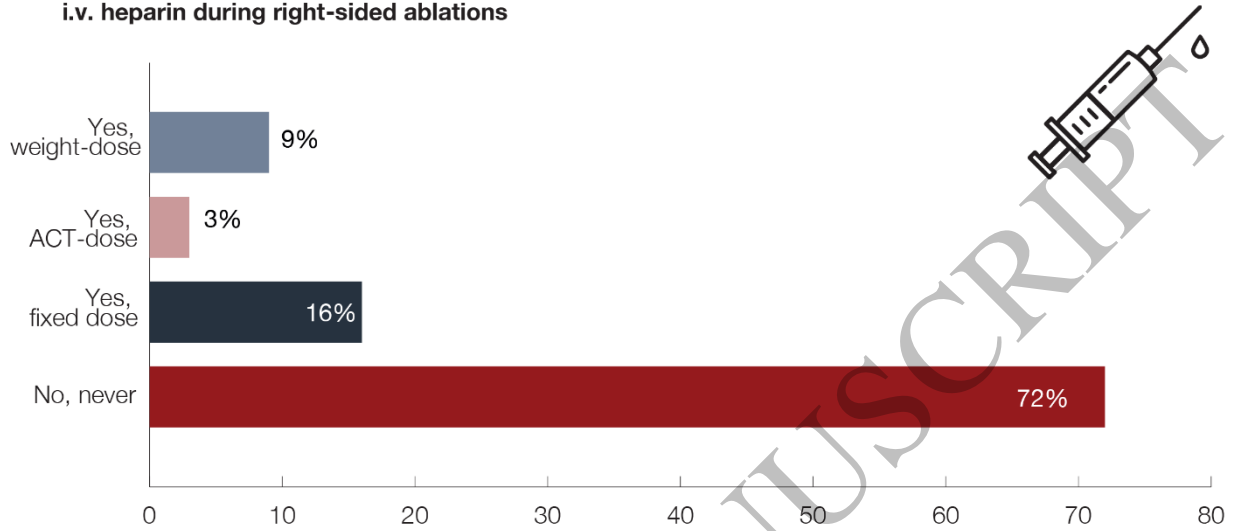
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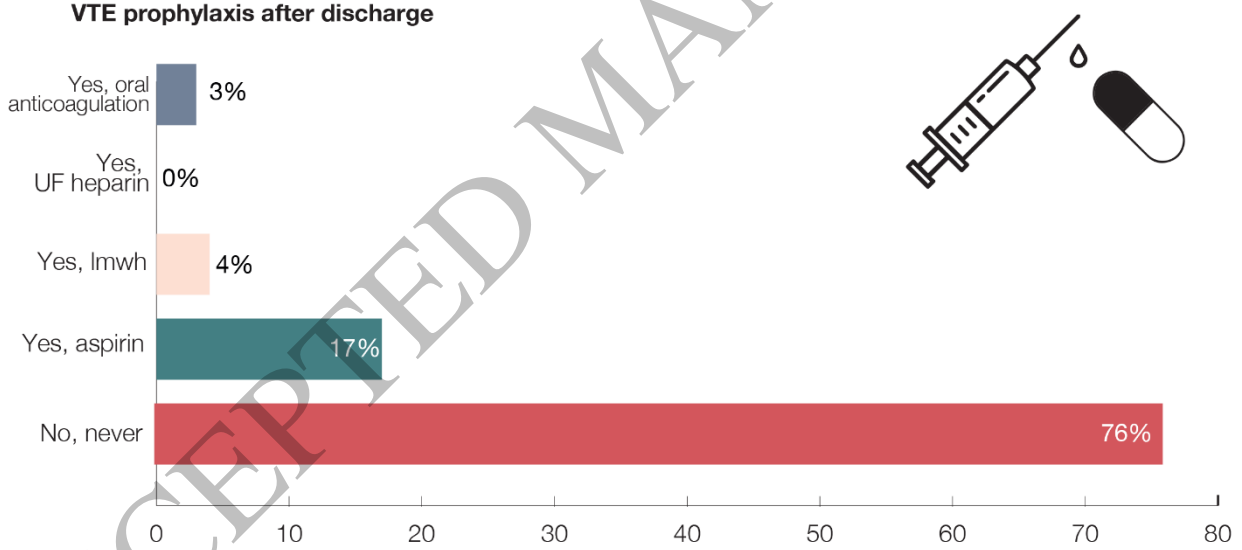
### Venous Thromboembolism in right-sided EP procedures

9% of respondents experienced at least one pulmonary embolism related to right-sided EP procedures in the last year

#### i.v. heparin during right-sided ablations



#### VTE prophylaxis after discharge



Graphical Abstract  
209x219 mm (x DPI)

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