

# Length of hospital stay for elective electrophysiological procedures: a survey from the European Heart Rhythm Association

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## Aims

Electrophysiological (EP) operations that have traditionally involved long hospital lengths of stay (LOS) are now being undertaken as day case procedures. The coronavirus disease-19 pandemic served as an impetus for many centres to shorten LOS for EP procedures. This survey explores LOS for elective EP procedures in the modern era.

## Methods and results

An online survey consisting of 27 multiple-choice questions was completed by 245 respondents from 35 countries. With respect to *de novo* cardiac implantable electronic device (CIED) implantations, day case procedures were reported for 79.5% of implantable loop recorders, 13.3% of pacemakers (PMs), 10.4% of implantable cardioverter defibrillators (ICDs), and 10.2% of cardiac resynchronization therapy (CRT) devices. With respect to CIED generator replacements, day case procedures were reported for 61.7% of PMs, 49.2% of ICDs, and 48.2% of CRT devices. With regard to ablations, day case procedures were reported for 5.7% of atrial fibrillation (AF) ablations, 10.7% of left-sided ablations, and 17.5% of right-sided ablations. A LOS  $\geq$  2 days for CIED implantation was reported for 47.7% of PM, 54.5% of ICDs, and 56.9% of CRT devices and for 54.5% of AF ablations, 42.2% of right-sided ablations, and 46.1% of left-sided ablations. Reimbursement (43–56%) and bed availability (20–47%) were reported to have no consistent impact on the organization of elective procedures.

## Conclusion

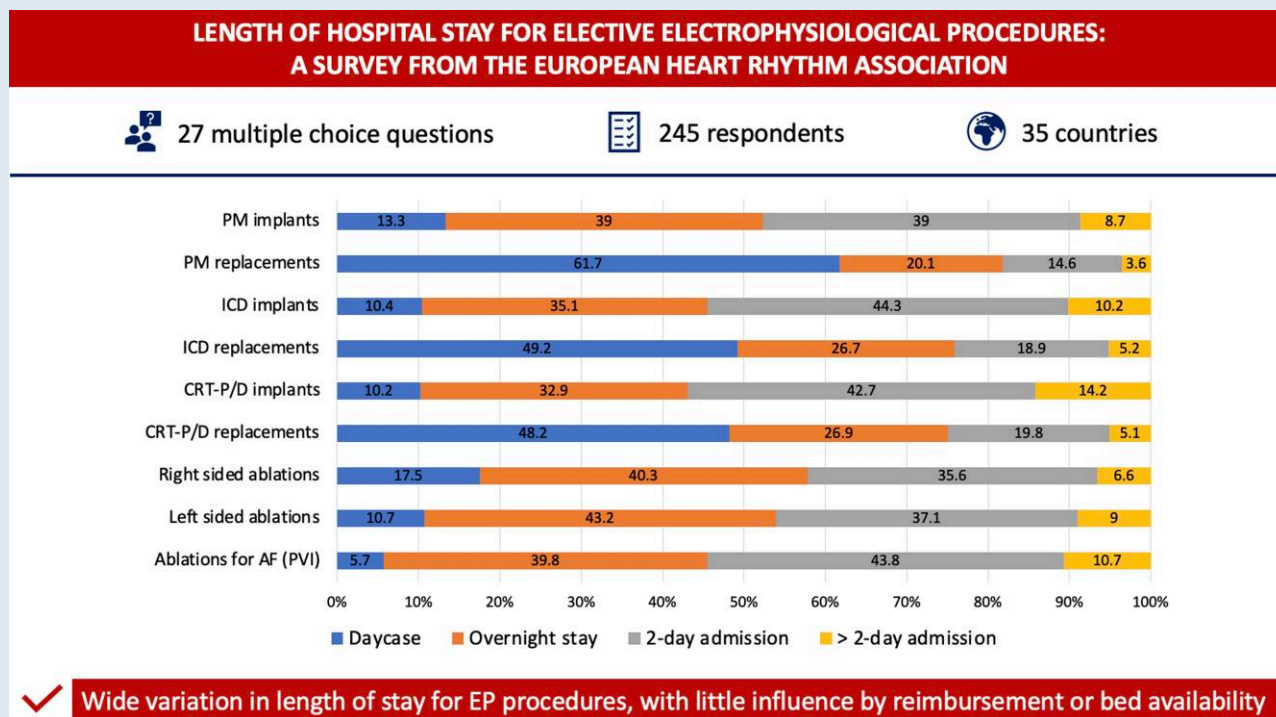
There is a wide variation in the LOS for elective EP procedures. The LOS for some procedures appears disproportionate to their complexity. Neither reimbursement nor bed availability consistently influenced LOS.

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## Graphical Abstract



## Keywords

Ablation • Arrhythmia • Implantable defibrillator • Electrophysiology • Pacemaker • EHRA Survey

## What's new?

- There are limited data in the literature on the length of stay for in-hospital elective electrophysiology procedures.
- Our survey highlights substantial variations in length of stay for most elective electrophysiology procedures.
- In a substantial proportion of cases, the length of stay appears disproportionately long for the procedure complexity and, perhaps, clinical need.

## Introduction

Major advances in the field of device therapy and ablation have been achieved over recent years. Such advances have transformed the management of patients with or at risk of cardiac arrhythmias and heart failure.<sup>1-8</sup> Improved detection and treatment of electrophysiological (EP) conditions have placed increasing demands on secondary care medicine.<sup>9-16</sup>

The quality of healthcare institutions is measured in terms of the timely delivery of equitable, safe, effective, and personalized treatment of as many patients as possible.<sup>17</sup> With regard to interventions, quality means short waiting times, preferential treatment of those who benefit the most, a high volume of procedures, a high procedural success rate, a low complication rate, and the minimum possible demands on hospital resources. A key factor in this mix is the length of hospital stay (LOS) for interventional procedures.

The coronavirus disease (COVID)-19 pandemic had a dramatic impact on healthcare provision in general, demanding a more efficient delivery of treatment, not least for patients with or at risk of cardiac arrhythmias or cardiac arrest.<sup>18-30</sup> During the pandemic, several groups reported

dramatic reductions in the LOS for interventional procedures, borne out of the need to minimize cross-infection and to maximize hospital bed occupancy and other healthcare resources. Despite considerable logistical and reimbursement pressures,<sup>31-34</sup> day case admissions for elective EP procedures became the standard for many centres especially during the pandemic.<sup>35,36</sup> It is against this background that the Committee on Health Economics of the European Heart Rhythm Association (EHRA) undertook a survey on current LOS for EP procedures.

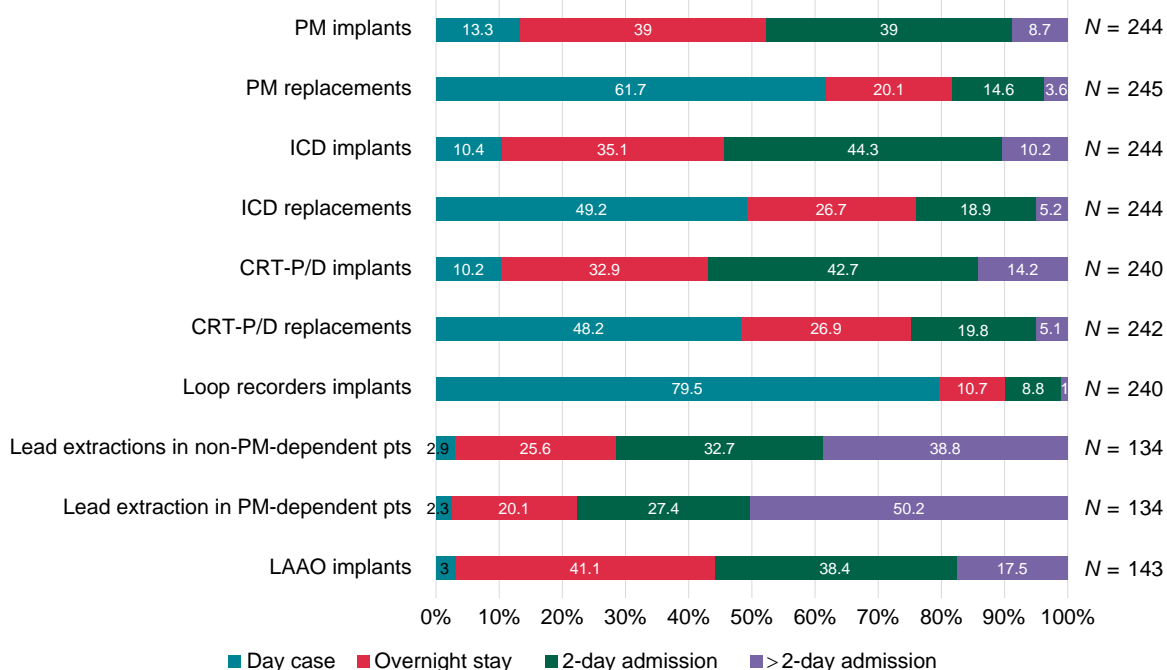
## Methods

Between 16 April 2023 and 7 May 2023, an online anonymous questionnaire was distributed to EHRA members, members of EP working groups, and healthcare professionals working in the field of cardiac arrhythmias using the EHRA infrastructure, website, social media platforms, and e-mail. Non-European countries were not excluded. A total of 2200 invitations were sent. The questionnaire consisted of 27 multiple-choice questions (see [Supplementary material online, Appendix S1](#)). The survey complied with the European General Data Protection Regulation.

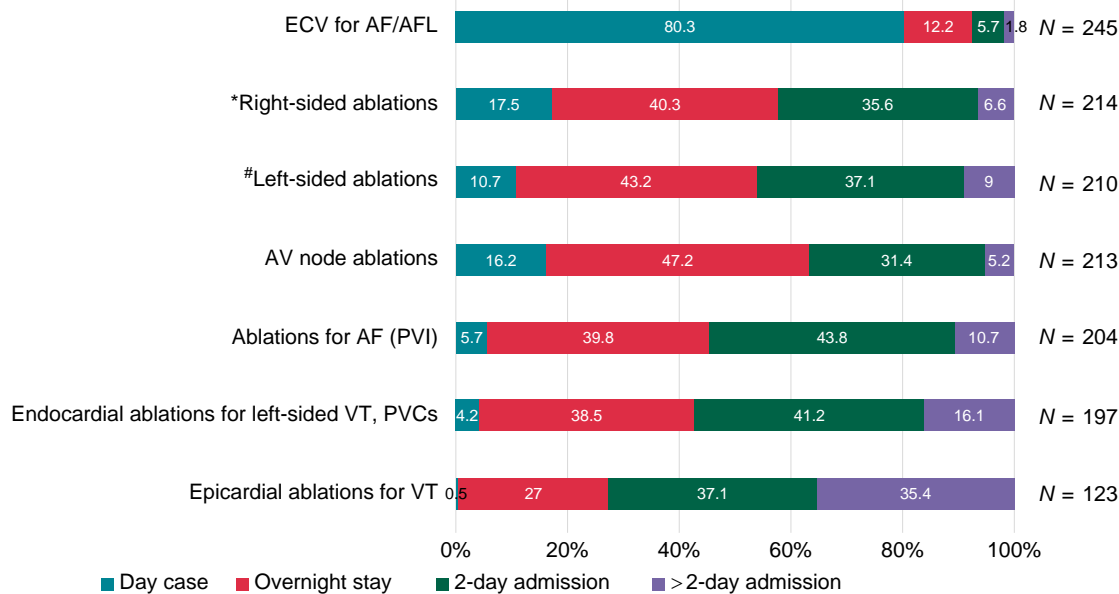
Continuous variables are presented as mean  $\pm$  standard deviation (SD). The present survey investigated several types of EP procedures, with different degrees of complexity. Therefore, a single centre may perform only some of those. For the purpose of the present analysis, missing data were excluded. Statistical analyses and graphics were performed using SPSS version 24 (IBM Corp.) and Microsoft Excel (version 16.71).

## Results

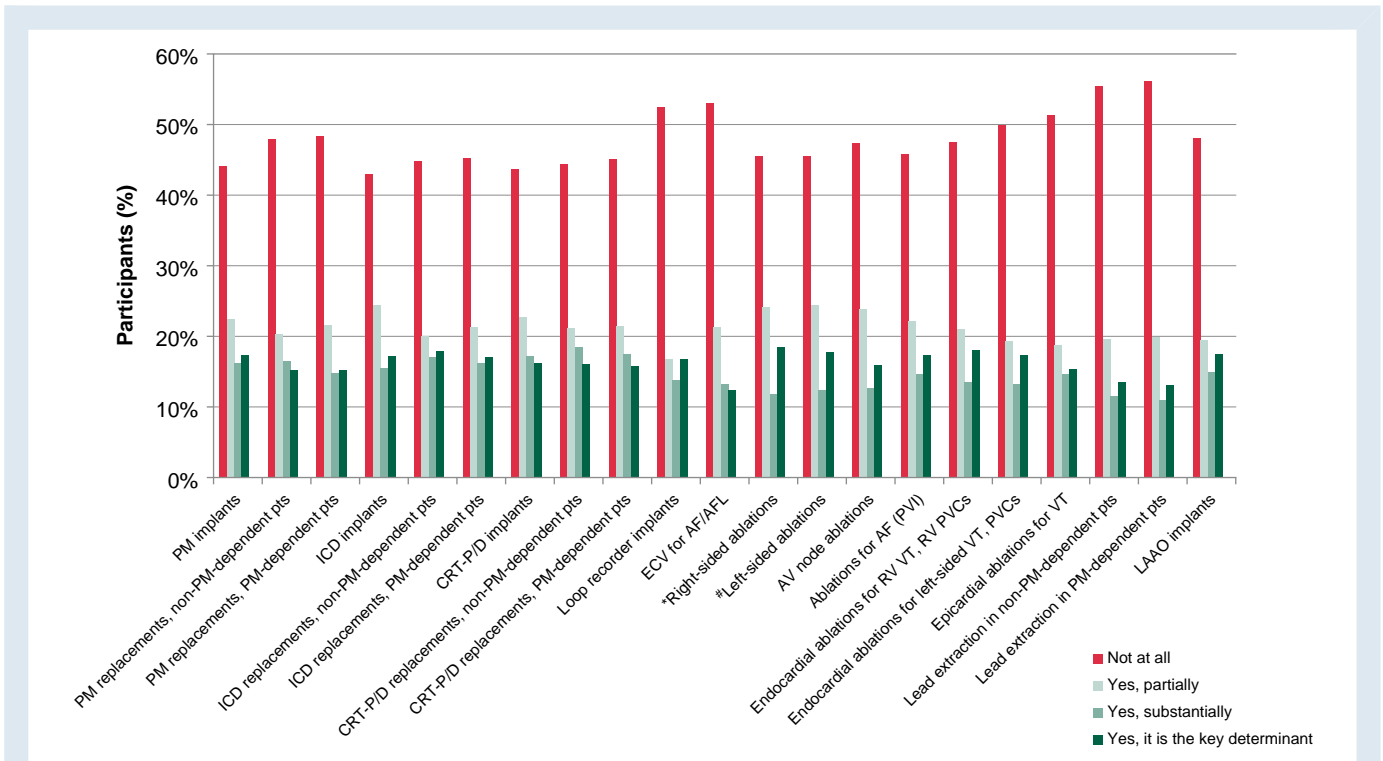
The survey was completed by 245 participants from 35 hospitals from various countries (see [Supplementary material online, Figure S1](#)). As shown in [Supplementary material online, Figure S2](#), participating centres



**Figure 1** Length of hospital stay for elective, device-related procedures. CRT-P/D, cardiac resynchronization therapy and pacing/defibrillation; ICD, implantable cardioverter defibrillator; LAAO, left atrial appendage occluder; PM, pacemaker.



**Figure 2** Length of hospital stay for elective electrical cardioversions and ablations. AF, atrial fibrillation; AFL, atrial flutter; AV, atrioventricular; ECV, electrical cardioversion; PVCs, premature ventricular complexes; PVI, pulmonary vein isolation; VT, ventricular tachycardia. \*Atrioventricular nodal re-entrant tachycardia, AFL, focal right atrial tachycardia, etc. #Atrioventricular re-entrant tachycardia, focal left atrial tachycardia, etc.



**Figure 3** Effect of reimbursement on the scheduling of elective electrophysiological procedures. AF, atrial fibrillation; AFL, atrial flutter; AV, atrioventricular; CRT-P/D, cardiac resynchronization therapy and pacing/defibrillation; ECV, electrical cardioversion; ICD, implantable cardioverter defibrillator; LAAO, left atrial appendage occluder; PM, pacemaker; PVCs, premature ventricular complexes; PVI, pulmonary vein isolation; RV, right ventricular; VT, ventricular tachycardia. \*Atrioventricular nodal re-entrant tachycardia, AFL, focal right atrial tachycardia, etc. #Atrioventricular re-entrant tachycardia, focal left atrial tachycardia, etc.

included academic public hospitals (49.2%) general public hospitals (30.6%), specialized public hospitals (5.8%), private general hospitals (5.4%), specialized private hospitals (4.5%), and academic private hospitals (4.5%). The volume of yearly activity for respondents' centres is highlighted in [Supplementary material online, Figure S3](#). Reported pacemaker (PM) procedure volumes (number per year) per centre were as follows: >250 in 63.1%; between 101 and 250 in 33.2%; and ≤100 in 3.7%. Implantable cardioverter defibrillator (ICD)/cardiac resynchronization therapy (CRT) device procedure volumes (number per year) per centre were as follows: >250 in 15.8%; between 101 and 250 in 49.2%; and ≤100 in 35%. Ablation procedure volumes (number per year) per centre were as follows: >400 in 32.3%; between 301 and 400 in 14.5%; between 151 and 300 in 35.9%; and ≤150 in 17.3%.

## Practice for elective procedures after the coronavirus disease-19 pandemic

Between 64% and 78% of participants reported that the organization of elective pacing and EP procedures had not changed after the COVID-19 pandemic; between 17% and 29% reported a partial change, and between 4% and 11% reported a complete change (see [Supplementary material online, Figure S4](#)).

### Cardiac implantable device implantation

As shown in [Figure 1](#), day case procedures were most frequently reported for PM replacements (61.7%), ICD replacements (49.2%), CRT device replacements (48.2%), and implantable loop recorder (ILR) implantations (79.5%). Overnight stays were most frequently reported for left atrial appendage occluder (LAAO) implantation (41.1%).

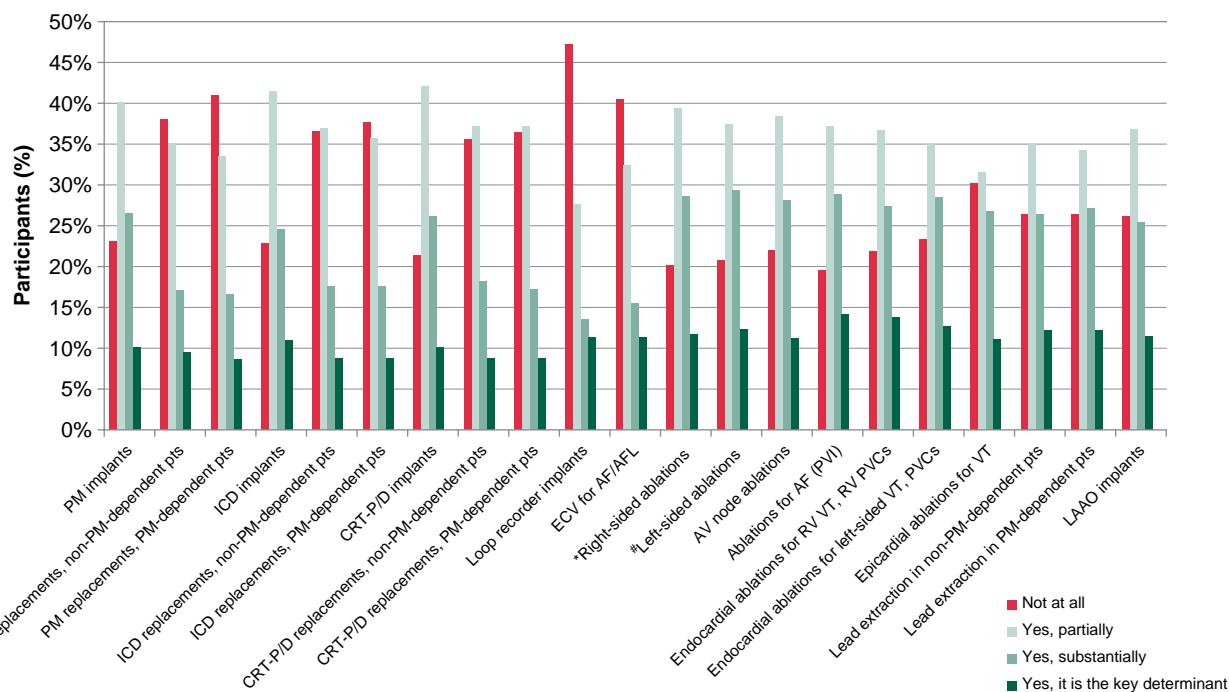
A 2-day admission was most frequently reported for ICD (44.3%) and CRT-pacing (P) or CRT-defibrillation (D) (42.7%) implantations. A >2-day stay was most frequently reported for lead extraction in non-PM-dependent patients (38.8%) and PM-dependent patients (50.2%) ([Figure 1](#)).

### Ablations

With regard to right-sided ablations, left-sided ablations, and atrioventricular (AV) node ablations, the minority (17.5%, 10.7%, and 16.2%, respectively) were undertaken as a day case ([Figure 2](#)). Overnight stays were reported in 40.3%, 43.2%, and 47.2% of cases, respectively. Most atrial fibrillation (AF) ablations (54.5%) involved a ≥2-day stay. For left-sided, endocardial ventricular tachycardia (VT)/premature ventricular complex (PVC) ablations and epicardial VT ablations, a 2-day admission was reported in 41.2% and 37.1%, respectively ([Figure 2](#)).

### Reimbursement

Between 43% and 56% of participants reported that reimbursement had no consistent impact on different elective procedures ([Figure 3](#)). A partial influence was reported by 17–24%; a 'substantial influence' by 11–19% and 12–18% reported that it was a key determinant. When considering only respondents reporting no impact of reimbursement practices on elective EP procedures, the reported percentage of procedures performed as day case increased for PM replacements, ICD replacements, CRT device replacements, ILR implants, and right-sided ablations. For other procedures, data did not change significantly as compared with the general assessment including all respondents (see [Supplementary material online, Figures S5 and S6](#)).



**Figure 4** Effect of bed availability on the scheduling of elective electrophysiological procedures. AF, atrial fibrillation; AFL, atrial flutter; AV, atrioventricular; CRT-P/D, cardiac resynchronization therapy and pacing/defibrillation; ECV, electrical cardioversion; ICD, implantable cardioverter defibrillator; LAAO, left atrial appendage occluder; PM, pacemaker; PVCs, premature ventricular complexes; PVI, pulmonary vein isolation; RV, right ventricular; VT, ventricular tachycardia. \*Atrioventricular nodal re-entrant tachycardia, AFL, focal right atrial tachycardia, etc. #Atrioventricular re-entrant tachycardia, focal left atrial tachycardia, etc.

## Bed availability

Bed availability was reported to have no consistent influence on the organization of the following elective procedures: replacements for non-PM-dependent patients (38% of participants), replacements for PM-dependent patients (41%), ICD replacements for PM-dependent patients (37.8%), ILR implantations (47.2%), and electrical cardioversion for AF/atrial flutter (AFL) (40.5%). A partial influence was reported for the following procedures: PM implantations (40.1%), ICD implantations (41.5%), ICD replacements for non-PM-dependent patients (37%), CRT and pacing/defibrillation (CRT-P/D) implantations (42.1%), CRT-P/D replacements for non-PM-dependent patients (37.3%), CRT-P/D replacements for PM-dependent patients (37.3%), right-sided ablations (39.4%), left-sided ablations (37.4%), AV node ablations (38.5%), ablations for AF (37.3%), ablations for right ventricular outflow tract VT or RV PVCs with endocardial approach (36.8%), ablation for left-sided VT or PVCs with endocardial approach (35.2%), ablation for VT with epicardial approach (31.7%), lead extraction in non-PM-dependent patients (35%), lead extraction in PM-dependent patients (34.3%), and implantation of LAAO (36.9%) (Figure 4). When considering only respondents reporting no impact of bed availability on elective EP procedures, the reported percentage of procedures performed as day case increased for PM implants, PM replacements, ICD replacements, CRT device replacements, ILR implants, elective cardioversions for AF, right-sided ablations, and AV node ablations. For other procedures, data did not change significantly as compared with the general assessment including all respondents (see [Supplementary material online, Figures S7 and S8](#)).

## Discussion

This is the first survey to explore organizational practices across a broad range of EP procedures in different European countries.

Several salient findings have emerged. First, the majority of cardiac implantable electronic device (CIED) generator changes and ILR implantations were undertaken as a day case. Second, less than 14% of *de novo* CIED implantations were undertaken as a day case. Most involved overnight or longer stays. Third, a substantial proportion of right-sided ablations and AF ablations involved a  $\geq 2$ -day stay. Fourth, the COVID-19 pandemic appeared not to have changed the organization of EP procedures in most centres. Last, reimbursement and bed availability were reported to have influenced the organization of elective EP procedures.

## Cardiac implantable electronic device generator replacement

Whilst nearly two-thirds of PM generator replacements were undertaken as a day case admission, more than half of ICD and CRT device replacements involved a hospital stay of  $\geq 1$  day. Although some generator replacement procedures are technically complex, the majority should take less than 1 h and post-operative care should perhaps not exceed 2–3 h. Admittedly, we have not quantified procedure timings, actual LOS, nor indeed the logistics of patient movement through hospitals. There may well be very justifiable explanations for a non-day case procedure. For example, some patients undergoing procedures in an afternoon or evening may not be able to go home the same day, particularly if they are elderly or frail.

## Cardiac implantable electronic device implantation

With respect to *de novo* CIED implantations, <14% were undertaken as a day case procedure. In this respect, we should consider that some

centres routinely use general anaesthesia, which may lead to longer LOS than a day case. In addition, a post-operative chest X-ray is routine in most centres and this too may prolong LOS. These factors, however, do not apply to ILR implantations, which in this survey exceeded an overnight stay in >20% of cases.

## Ablation

Reportedly, up to 54.5% of AF ablations were performed as a  $\geq 2$ -day admission. These figures are at odds with those reported by high-volume centres participating in randomized controlled trials. They are also at odds with 'real-world' experience of day case AF ablation, reported to have a low complication rate.<sup>37–43</sup> In this respect, we should consider that AF ablation has growing indications<sup>44–46</sup> and that recent technological advances have helped to dramatically reduce procedure times.<sup>3,47–52</sup> Whether such reductions in procedure times have led to commensurate reductions in LOS is unknown.

## Other procedures

Whilst 80.3% of elective cardioversions for AF or AFL were performed as a day case, almost 20% involved an admission for  $\geq 1$  nights. This is perhaps surprising, given the proven feasibility<sup>53,54</sup> and safety<sup>55,56</sup> of day case cardioversion. With regard to lead extractions, the overwhelming majority were performed during a hospital stay  $\geq 2$  days. In this respect, day case lead extraction has been reported for selected patients<sup>57,58</sup> but most would accept that this relatively high risk procedure requires an extended stay.<sup>59</sup>

## Context

A high proportion of participants to this survey were from high-volume centres, a factor of proven association with higher success rates and lower complication rates, for both pacing and ablation procedures.<sup>1,2,60–64</sup> This may explain the trend<sup>65</sup> towards a very short hospital stay in cardiac pacing implantations<sup>66–68</sup> or replacements.<sup>69</sup> However, even in such centres, LOS for simple procedures, such as device replacements and loop recorder implantations, is in some cases surprisingly long. In this respect, it is noteworthy that the logistics and reimbursement of elective interventions vary across different healthcare systems, and organization of care and reimbursement policies may show an important heterogeneity.<sup>31,70–78</sup> Rather than prioritizing reimbursement, which may be at the root of the observed variation in LOS, it may be better to focus on patient values, system performance, and outcomes.<sup>34,53</sup> The fact that a substantial proportion of participants were from Italy raises the possibility that our findings may not be generalizable. However, because of the nature of our data, namely the results of a survey, we cannot draw any comparisons between countries.

## Limitations

Selection bias and potential inaccuracy of self-reported data are important limitations of this survey, which was not designed to compare different countries but to give an overall picture of what is current practice across countries. We hope that this may promote further analysis from administrative data sets and, hopefully, prospective audits in different countries, as has already been done for device replacements in Italy<sup>69</sup> and other EP procedures in the USA.<sup>37,56,57</sup> However, when analysing data on LOS from real-world practice, it is important to distinguish hospital stay for elective procedures, as analysed in this survey, from hospital stay for acute or chronic conditions requiring EP procedures during the course of the hospitalization, with hospital stay being dependent on much more complex and not standardized factors. Finally, as only 225 out of 2200 invitations were replied, our findings may have some limitations in being a reflection of all centres.

## Conclusions

There is a wide variation in LOS for elective EP procedures. In a substantial proportion of cases, the LOS appears disproportionately long for the procedure complexity and, perhaps, clinical need. Further studies are required to address the reported influence of reimbursement practices, bed availability, and other factors on LOS for EP procedures.

## Supplementary material

Supplementary material is available at *Europace* online.

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**Conflict of interest:** G.B. reported small speaker fees from Bayer, Boehringer Ingelheim, Boston, Daiichi Sankyo, Microport, Janssen, and Sanofi outside of the submitted work. R.C.-A. reported small educational speakers fees from Abbott and Boston Scientific. J.C. reports lecture fees/honoraria, educational grants Boston Scientific, Medtronic, and Biosense Webster outside of the submitted work. M.M.Z. reports lecture fees/honoraria, educational grants, and travel support by Medtronic, Boston Scientific, Bayer Vital, ZOLL CMS, and Pfizer. D.D. received modest lecture honorary fees from Abbott, Astra Zeneca, Biotronik, Boehringer Ingelheim, Boston Scientific, Bristol Myers Squibb, CVRx, Medtronic, Microport, Pfizer, and Zoll. M.M.F. reports speaker/consultation fees from Medtronic, Abbott, and ZOLL. The other authors did not report conflicts of interest to disclose outside of the submitted work.

## Data availability

Data are derived from an anonymous survey and will be available only upon reasonable request to the authors.

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