

## INTERVENTIONAL ELECTROPHYSIOLOGY IN BULGARIA IN 2024: DATA FROM THE ELECTRONIC REGISTRY BG-EPHY

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<sup>3</sup>Appendix 1 (<https://10.3897/bgcardio.31.e152746.suppl.1>)

## ИНТЕРВЕНЦИОНАЛНАТА ЕЛЕКТРОФИЗИОЛОГИЯ В БЪЛГАРИЯ ПРЕЗ 2024 ГОДИНА: ДАННИ ОТ ЕЛЕКТРОННИЯ РЕГИСТЪР BG-EPHY

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### Abstract.

This study presents data from the national electronic registry BG-EPHY on electrophysiologic (EP) studies and catheter ablations in 2024. Material and methods: Full one-year sample of the BG-EPHY registry was analysed retrospectively. Sex and age distribution of the patients, number of ablations, use of electroanatomic mapping (EAM), ablation energy source, distribution of different types of arrhythmias, acute procedural success, complications, recurrences and redo procedures are presented. Results: In 2024 ten EP centers performed 2624 ablations in 1714 men (65.3%) and 910 women, incl. 16 ablations in pediatric patients (0.61%). EAM was used in 1506 procedures (57.4%), irrigated-tip catheter – in 1535 (58.5%), cryocatheter – in 507 (19.3%), and intracardiac echocardiography – in 203 (7.7%). The most frequently performed primary ablation was pulmonary vein isolation (51.9%), followed by ablation for typical atrial flutter (15.1%) and AV nodal reentrant tachycardia (13.5%). The acute success was over 99%, while intraprocedural complications were less than 1.5%. Redo procedures for recurrence of the index arrhythmia were done in 190 patients (7.24%), with atrial fibrillation and atrial flutters accounting for the largest numbers (n = 147). Conclusion: The national registry of electrophysiology collects systematically and continuously data on all ablations of cardiac arrhythmias performed in the country. In 2024, the number of ablations increased compared to 2023, but at a slower pace. Distribution of EP procedure types was similar to previous years. Acute success was very high, while intraprocedural complications were rare.

### Key words:

invasive electrophysiology; catheter ablation; electroanatomic mapping; cryoablation; national registry.

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### Резюме.

Обзорът представя данни от Националния електронен регистър BG-EPHY за електрофизиологичните изследвания и катетърни аблации през 2024 г. Материал и методи: Едногодишна извадка от регистъра BG-EPHY е проучена ретроспективно. Представени са разпределение на пациентите по пол и възраст, брой процедури, честота на използване на електроанатомичен мепинг (EAM), иригирана аблация и криоаблация, честота на електрофизиологичните диагнози, непосредствен успех, интрапроцедурни усложнения, рецидиви и повторни процедури. Резултати: През 2024 г. в десет електрофизиологични центъра са извършени 2624 аблации при 1714 мъже (65.3%) и 910 жени, вкл. 16 пациенти на възраст < 18 год. (0.61%). При 1506 аблации (57.4%) е използван EAM, иригиран катетър – в 1535 (58.5%), криокатетър – в 507 (19.3%), интракардиална ехография – в 203 (7.7%). Най-често е правена изолация на белодробни вени (51.9%), следвана от аблация на типично предсърдно трептене (15.1%) и AV нодална риентри тахикардия (13.5%). Непосредственият успех е над 99%, а интрапроцедурните усложнения – под 1.5%. Повторни процедури поради рецидив на индексната аритмия са извършени при 190 пациенти (7.24%), най-често заради предсърдно мъждене и трептене (n = 147). Заключение: Националният регистър по електрофизиология събира системно и непрекъснато данни за аблациите на сърдечни аритмии, извършвани в страната. През 2024 г. броят на аблациите нараства спрямо 2023 г., но с по-бавно темпо. Структурата на дейността се запазва спрямо предходните години. Непосредственият процедурен успех е много висок, а интрапроцедурните усложнения – много редки.

<b>Ключови думи:</b>	инвазивна електрофизиология; катетърна аблация; електроанатомичен мепинг; криоаблация; национален регистър.
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## INTRODUCTION

Starting in 2021, the national electronic registry BG-EPHY publishes annually summarized data on the catheter ablations of cardiac arrhythmias in all electrophysiological (EP) centers in Bulgaria. Four reports covering five consecutive years have been published so far [1-4]. The registry provides complete and accurate information on catheter ablations and EP studies performed in the EP centers staffed with certified electrophysiologists operating in accordance with the requirements of the National Health Insurance Fund (NHIF), and allows to trace the annual dynamics of the type and number of EP procedures on a national scale.

The purpose of this fifth consecutive report is to present the number and type of EP interventions performed in Bulgaria in 2024 and to compare the main indicators with the previous year.

## MATERIAL AND METHODS

Details on the registry have been described previously [1, 2]. The registry encompasses all invasive EP procedures (diagnostic studies and ablations), performed according to the requirements of NHIF. Demographic indicators, preliminary clinical-electrocardiographic diagnosis, number and type of the ablation catheters used, use of electroanatomic mapping (EAM), dose-area product, EP diagnosis, acute ablation result, intraprocedural complications and text summary of the procedure are mandatory. Eleven EP diagnoses can be selected alone or in combination of up to three.

For the purposes of this report an anonymized full data extraction was done for all EP procedures performed within the time frame January 1<sup>st</sup> – December 31<sup>st</sup> 2024.

We studied sex and age distribution of the patients, overall number of procedures, diagnostic EP procedures, ablations (overall and according to the ablation energy used), use of EAM, high-density mapping diagnostic catheters and intracardiac echography, different types of arrhythmias (EP diagnoses), ablated arrhythmias (by EP diagnoses), acute success, recurrences and redo ablations, intraprocedural complications. The change in individual indicators compared to the previous year is presented.

The statistical analysis was carried out with jamovi v.2.6 (The jamovi project 2024) [5, 6]. Descriptive sta-

tistics were used. Distribution of data was assessed by the Shapiro-Wilk test and continuous data were presented as median (interquartile range IQR 25-75%, min-max). Proportions were presented as percentages.

## RESULTS

Data for a total of 2730 EP procedures performed at 10 EP centers between January 1<sup>st</sup> and December 31<sup>st</sup> 2024 were available for analysis. One of the centers started operations in 2024, while another one ceased to operate. Nine of the centers were equipped with at least one system for three-dimensional electroanatomic mapping and with a cryoablation console. Five of the centers had also intracardiac ultrasound console.

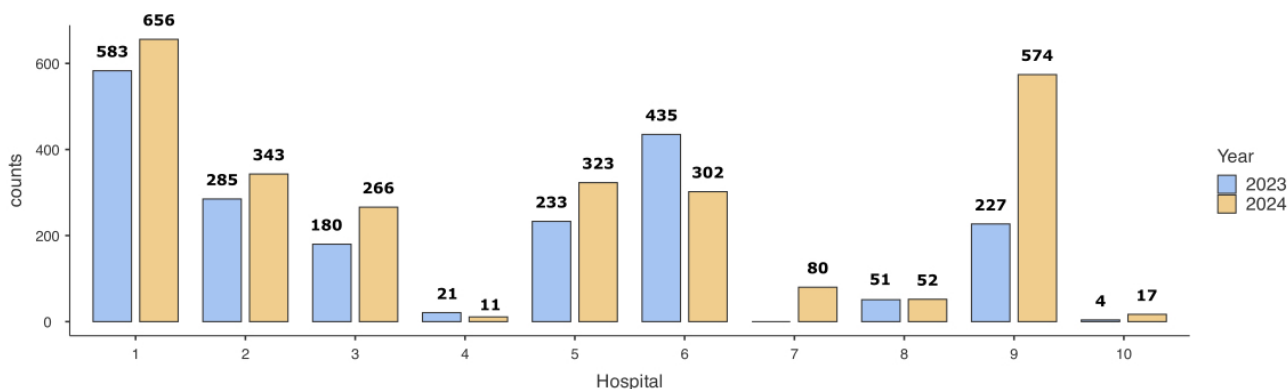
Of all EP procedures, 106 (3.9%) were only diagnostic EP studies, performed in 56 males and 50 females. The most common finding was “negative study” (n = 37), followed by “conduction disorder” (n = 19), “atrial fibrillation” (n = 13), and dual AV nodal physiology/AV nodal reentrant tachycardia (AVNRT) (n = 13).

There were 2624 catheter ablations, performed in 1714 men (65.3%) and 910 women. This number of ablations corresponded to an increase of 29.8%, compared to the previous year. Six of the ten centers performed 94% of all ablations (n = 2464). The number of ablations performed in the individual centers is shown on Fig. 1.

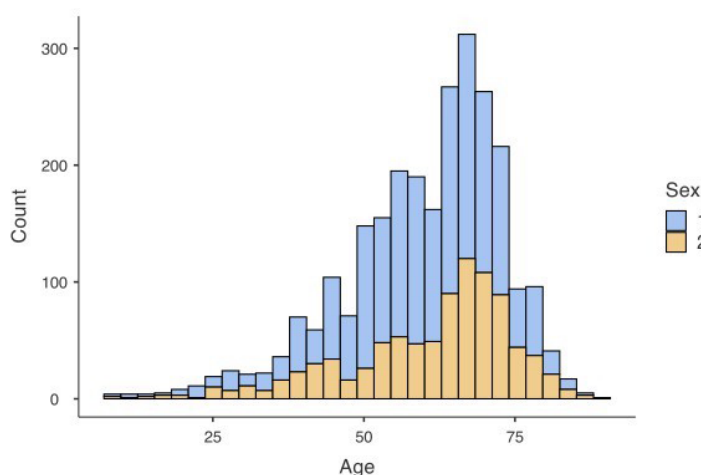
The median age of the patients was 62.5 years (IQR 53-69.3, 7-88 years). The median age of men was 61 years (IQR 52-68, 7-88 years), while in women it was 65 years (IQR 54-71, 8-87 years). Sixteen of the patients (0.61%) were under 18 years of age. The age and sex distribution of the patients is shown in Fig. 2.

Radiofrequency energy was used in 2111 ablations (80.4%), cryoenergy – in 501 ablations (19.1%), both radiofrequency and cryoenergy were used in 6 ablations, ethanol ablation was done in 4 cases. Two pulsed field ablations were done for the first time in Bulgaria. Percutaneous transpericardial approach was not reported in 2024. The numbers of different types of ablation consumables used in 2024 and 2023 and reimbursed by the NHIF is shown in Table 1.

A second EP substrate was found in 398 procedures. In 51 cases there were three EP substrates. The distribution of the main and additional EP diagnoses is shown in Tables 2 and 3, and is similar to previous year.



**Fig. 1.** Distribution of ablation procedures across participating centers in 2023 and 2024. Numbers above the bars show the number of ablations for the year. Center 7 started operations in 2024



**Fig. 2.** Age distribution of the patients. Each column equals 2.5-year age span. Sex 1 = male (blue); Sex 2 = female (ocher)

**Table 1. Ablation consumables reimbursed by the NHIF**

	2024, n (%)	2023, n (%)	Change (%)
Electroanatomic mapping patches	1506 (57.4)	941 (46.6)	+60
Irrigated ablation catheter	1535 (58.5)	1121 (55.5)	+36.9
Contact force catheter	973 (37.1)	NA	
Cryocatheter (incl. for focal ablation)	507 (19.3)	420 (20.8)	+20.7
High-density mapping catheter	963 (36.7)	190 (9.4)	+406.8
Intracardiac echography catheter	203 (7.7)	43 (2.1)	+372.1
Steerable introducer*	939 (35.8)	55 (2.7)	+1607.3

\*Steerable introducers for balloon cryoablation not included. The last column of this and all other tables shows the change of the absolute numbers

**Table 2. Main EP diagnoses in ablation procedures**

	2024, n (%)	2023, n (%)	Change (%)
Atrial fibrillation	1447 (55.1)	1015 (50.2)	+42.6
Atrial flutter – atypical	66 (2.5)	55 (2.7)	+20
Atrial flutter – typical	395 (15.1)	310 (15.3)	+36.6
AV nodal reentrant tachycardia	355 (13.5)	330 (16.3)	+27.4
Accessory pathways	92 (3.5)	90 (4.5)	+2.2
Conduction disorder	7 (0.3)	5 (0.2)	+40
Focal atrial tachycardia	73 (2.8)	70 (3.5)	+4.3
Incisional/macroeentrant atrial tachycardia	4 (0.15)	4 (0.2)	0
Sinus node disease	10 (0.4)	11 (0.5)	-9.1
Ventricular arrhythmia – idiopathic	142 (5.4)	106 (5.2)	+34
Scar-related ventricular tachycardia	28 (1.1)	25 (1.2)	+12

As in 2023 the most common secondary diagnoses were typical and atypical atrial flutter, atrial fibrillation, and AVNRT (Table 3).

Pulmonary vein isolation was the most commonly performed ablation, followed by cavotricuspid isthmus ablation, ablation of AVNRT, idiopathic ventricular arrhythmia, and accessory pathways (Table 4). The most common diagnosis in pediatric ablations was AVNRT (n = 7), followed by accessory pathway (n = 6), focal atrial tachycardia (n = 2), and idiopathic ventricular tachycardia (n = 1).

Ablation of a secondary arrhythmia substrate within the same procedure was performed in 278 cases (10.6%) – most often ablation of the cavotricuspid isthmus (Table 5). Ablation of a third arrhythmia substrate was undertaken in 26 procedures (1%).

Acute procedural success with respect to the main diagnosis was achieved in 2596 ablations (99.3%). In 2 cases (0.1%) the acute result of the ablation was not reported. In case of ablation of a second and third substrate acute success was achieved in 97.1% and 96.2% of the attempts, respectively.

In 2024 there were 338 repeat ablation procedures (12.9%) and in 190 of these cases (7.24%) it was a redo ablation for the index arrhythmia. The redo ablations in terms of absolute numbers were done most often for atrial fibrillation (n = 104), followed by typical atrial flutter (n = 23), atypical atrial flutter (n = 20), and idiopathic ventricular arrhythmias (n=13). However, in terms of proportion, recurrences were most common for atypical atrial flutter (32.8%), followed by scar-related ventricular tachycardia (17.9%), idiopathic ventricular arrhythmias (9.1%), atrial fibrillation (7.6%), accessory pathways (7.6%), focal atrial tachycardias (6.9%), typical atrial flutter (5.8%), and AVNRT (1.7%). It should be noted that part of the patients with redo procedures had their first ablation performed during the previous year or even earlier.

Intraprocedural complications were reported for 28 ablations and 3 diagnostic EP studies (1.2%) – phrenic nerve palsy during cryoisolation of pulmonary veins in 6 cases (1.2% of all cryoisolations); six pericardial effusions (incl. one pericardial tamponade necessitating pericardiocentesis); seven cases of conduction dis-

**Table 3. Secondary EP diagnoses**

	2024, n (%)	2023, n (%)	Change (%)
Atrial fibrillation	74 (2.8)	55 (2.7)	+34.5
Atrial flutter – atypical	79 (3)	50 (2.5)	+58
Atrial flutter – typical	114 (4.3)	133 (6.6)	-14.3
AV nodal reentrant tachycardia	37 (1.4)	47 (2.3)	-21.3
Accessory pathways	2 (0.1)	1 (0.05)	+100
Conduction disorder	25 (0.95)	29 (1.4)	-13.8
Focal atrial tachycardia	30 (1.1)	32 (1.6)	-6.2
Incisional/macroeentrant atrial tachycardia	2 (0.1)	3 (0.1)	-33.3
Sinus node disease	17 (0.65)	8 (0.4)	+112.5
Ventricular arrhythmia – idiopathic	11 (0.4)	1 (0.05)	+1000
Scar-related ventricular tachycardia	5 (0.2)	3 (0.1)	+66.7

**Table 4. Ablations by main EP diagnoses**

	2024, n (%)	2023, n (%)	Change (%)
Atrial fibrillation (PVI)	1363 (51.9)	937 (46.4)	+45.5
Atrial flutter – atypical	61 (2.3)	54 (2.7)	+13
Atrial flutter – typical	396 (15.1)	308 (15.2)	+28.6
AV nodal reentrant tachycardia	355 (13.5)	330 (16.3)	+7.6
Accessory pathways	92 (3.5)	90 (4.5)	+2.2
AV junction	86 (3.3)	81 (4)	+6.2
Focal atrial tachycardia	72 (2.7)	70 (3.5)	+2.9
Incisional/macroeentrant atrial tachycardia	4 (0.2)	4 (0.2)	0
Cardioneuroablation	25 (0.9)	16 (0.8)	+56.2
Ventricular arrhythmia – idiopathic	142 (5.4)	106 (5.2)	+34
Scar-related ventricular tachycardia	28 (1.1)	25 (1.2)	+12

PVI – pulmonary vein isolation

**Table 5. Ablations by secondary EP diagnoses**

	2024, n (%)	2023, n (%)	Промяна (%)
Atrial fibrillation (PVI)	28 (1.1)	30 (1.5)	-6.7
Atrial flutter – atypical	50 (1.9)	26 (1.3)	+92.3
Atrial flutter – typical	112 (4.3)	130 (6.4)	-13.9
AV nodal reentrant tachycardia	12 (0.5)	10 (0.5)	+20
Accessory pathways	1 (0.05)	2 (0.1)	-50
Conduction disorder	0	1 (0.05)	
Focal atrial tachycardia	17 (0.65)	22 (1.1)	-22.7
Incisional/macroeentrant atrial tachycardia	2 (0.08)	2 (0.1)	0
Cardioneuroablation	45 (1.7)	10 (0.5)	+350
Ventricular arrhythmia – idiopathic	8 (0.3)	1 (0.05)	+700
Scar-related ventricular tachycardia	2 (0.08)	1 (0.05)	+100

turbances – 5 cases of transient complete AV block, 1 case of AV block Wenckebach type, one LBBB; four vascular complications (inguinal hematomas); three cases of severe vasovagal reactions; one case of post cardioversion prolonged sinus arrest; one case of thrombosis of the left anterior descending artery; one transient ischemic attack; one case of catheter fracture.

## DISCUSSION

The main finding in this fifth annual report is that the numbers of the ablations for cardiac arrhythmias in Bulgaria continued to grow in 2024, but at a much slower pace compared to the previous year, when the increase was 47.5%. This growth was mostly due to increased number of ablations for atrial fibrillation, and at a smaller scale – for typical atrial flutter, idiopathic ventricular arrhythmias and AV nodal reentrant tachycardia. The most important factor contributing to the increase is probably the reimbursement by the NHIF for complex ablations, which made them more accessible to patients. Increased awareness of cardiologists of the European Society of Cardiology (ESC) guidelines on atrial fibrillation is also a possible factor.

Correspondingly, the use of consumables for high-density mapping and ablation, and for cryoablation also increased compared to the previous year (Table 1). Last year EAM procedures were 57% of all catheter ablations. According to other European registries, the usual proportion of EAM in complex ablations is slightly above 50% [7-9], and it is likely to increase further with the purpose to reduce the radiation dose even in non-complex ablations [7, 9, 10]. Interestingly, radiofrequency ablations still continue to account for approximately 80% of all procedures and, despite the reimbursement, the increase of cryoablations is relatively modest. The reason is probably the necessity for copayment by the patients in part of the centers performing cryoablations. The use of high-density map-

ping and intracardiac ultrasound catheters increased substantially, approximately fourfold. The most striking increase, however, is seen in the use of steerable introducers, which are relatively inexpensive compared to the other consumables in Table 1.

The structure of the leading electrophysiological diagnoses is very close to that of 2023 and quite similar to other registries [7, 9, 11] – atrial fibrillation prevails, followed by typical atrial flutter and AVNRT. The number of ablations according to the primary diagnosis corresponded to its frequency. Of note, cardioneuroablations increased substantially, although still primarily as a concomitant ablation and probably mostly as non-targeted effect reported in the registry [12].

A second arrhythmia was diagnosed in approximately 15% of the procedures, most commonly typical atrial flutter. Ablation of the second arrhythmogenic substrate was done in 69.8% of the cases. A third substrate was found very rarely and ablation in these cases was performed also rarely. Acute success continued to be reported in over 98% of procedures, similarly to other registry reports [9, 11].

The number of intraprocedural complications in 2024 remained very low and quite comparable to that reported in other registries [9, 11, 13]. Their type is common for EP procedures [13]. Importantly, the rate of phrenic nerve palsy decreased substantially despite the growing number of pulmonary vein cryoisolations.

In the previous registry report, we compared our data to the aggregated data for the ESC member countries [4]. In the last ESC statistical report on cardiovascular diseases the median annual number of ablations in ESC countries in 2023 was 279.0 (IQR 123.9–493.9) per 1 million population and the median number of ablations in high-income ESC countries was 417.4 (IQR 279.0–709.7) per 1 million [14]. In 2023 Bulgaria moved to the group of high-income countries [15]. With a population of about 6.45 million [16] and 406.8 ablations per 1 million in 2024, Bulgaria is almost at the medi-

an for the high-income group and well above the ESC median. With 1.55 hospitals per million people undertaking catheter ablation procedures, Bulgaria is already above the ESC median of 1.5 per 1 million [14]. It is worth emphasizing that the European median takes into account all hospitals performing ablations and/or device implants. As there are 21 more hospitals in Bulgaria performing only device implantations, calculating the median as per the European atlas would give a median for Bulgaria of 4.8 hospitals per 1 million people, a number strikingly above the ESC 75th percentile even for high-income countries only [high-income ESC median 1.9 (IQR 1.1-2.6)] [14].

As in the previous year, the majority of the ablations was carried out mainly in already existing and established centers – 94% of all ablations were performed in 6 already established centers (Fig. 1). A small number of procedures is known to be associated with an increased risk of complications, especially in complex ablations [17].

So far, there are only scarce data on the longer-term procedural success achieved in Bulgarian centers and these are mostly single center reports [18-21]. For the first time since the initial yearly registry report, we tried to find out the one-year rate of recurrences stratified by the type of arrhythmia, and of redo ablations. Almost half of the repeat procedures were done for a newly diagnosed arrhythmia. The remaining 56% were redo procedures for recurrence of the index arrhythmia. The highest recurrence rate was seen after ablation of atypical atrial flutters and scar-related ventricular tachycardias. The proportions are similar to the numbers reported in other registries, except for atrial fibrillation, where the recurrence rate is unusually low [11, 13]. Unfortunately, the registry does not allow to draw a more detailed picture, presuming that there are patients without extended follow-up or with asymptomatic recurrences, not all patients with recurrence opt for a second procedure, and that both the index and the redo procedure may have had place within the previous year. Nevertheless, this is the first time that we demonstrate the longer-term efficacy of ablation in the most common types of arrhythmias on a national scale.

To our knowledge, despite the instruction of the NHIF and the Bulgarian Medical Association, issued in November 2023, that changed the requirement for mandatory completion of the registry to only a recommended one, the EP centers continued to input data on all procedures performed. That said, the registry is still a reliable tool, but nevertheless, this unnecessary instruction is still a threat to the completeness and the national coverage of the registry data.

### Limitations

A potential limitation inherent to all registries is the impossibility to validate the correct input of source

data. The registry reports only the intraprocedural complications. Therefore, the incidence of complications is likely to be underestimated. Despite these limitations the registry is a valuable tool to assess the type and number of ablations performed in all EP centers nationwide.

### CONCLUSION

The national EP registry BG-EPHY collects systematically and continuously data on ablations of cardiac arrhythmias performed in the country. In 2024 there was additional, albeit smaller-scale, increase in the number of catheter ablations, while the type of ablations remained the same compared to the previous year.

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*No conflict of interest was declared*

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