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CLINICAL RESEARCH

Access to and clinical use of cardiac implantable electronic devices and interventional electrophysiological procedures in the European Society of Cardiology Countries: 2016 Report from the European Heart Rhythm Association

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Aims The aim of this analysis was to provide comprehensive information on the access to and use of cardiac implantable electronic device (CIED) and catheter ablation therapy in the European Society of Cardiology (ESC) area.

Methods and results The European Heart Rhythm Association (EHRA) has been collecting descriptive and quantitative data on invasive arrhythmia therapies since 2008. This year 50 of the 56 ESC member countries provided data for the EHRA White Book. Up-to-date information on procedure rates for the last 5 years together with information on demographics, economy, vital statistics, local healthcare systems, and training activities is presented for each country and the 5 geographical ESC regions. Our analysis indicated that considerable heterogeneity in the access to arrhythmia therapies still exists across the ESC area. In 2015, the CIED implantation rates per million population were highest in the Western followed by the Southern and Northern European countries. The catheter ablation activity was largest in the Western followed by the Northern and Southern areas. Overall, the procedure rates were 3–10 times higher in the European than in the non-European ESC countries. Economic resources were not the only driver for utilization of arrhythmia therapies as in some Eastern European countries with relative low gross domestic product the procedure rates exceeded the average values.

Conclusion These data will help the healthcare professionals and stakeholders to identify and to understand in more depth the trends, disparities, and gaps in cardiac arrhythmia care and thereby promote harmonization of cardiac arrhythmias therapies in the ESC area.

Keywords Pacemaker • Implantable cardioverter-defibrillator (ICD) • Cardiac resynchronization pacemaker (CRT-P) • Cardiac resynchronization defibrillator (CRT-D) • Catheter ablation • Atrial fibrillation ablation

Introduction

The European Heart Rhythm Association (EHRA) White Book is the key source for information on invasive electrophysiological procedure (EP) rates in the European Society of Cardiology (ESC) member countries. European Heart Rhythm Association has collected comprehensive information concerning the rates of invasive electrophysiology procedures alongside information on demographics, economy, vital statistics and healthcare resources, and reimbursements policies together with the National Cardiac Societies

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What's new?

- New data on use of cardiac table electronic devices and invasive electrophysiology procedures in Europe is presented in detail.
- The use of CIED and invasive EP procedures is highest in Western and Nothern Europe.
- Key areas of growth are in ablation of ventricular arrhythmias in patients with structural heart disease and in the use of left atrial appendage closure devices.
- For the first time, data are presented on leadless pacemakers and subcutaneous implantable defibrillators.
- The data will help better understand the disparities in the use of arrhythmia treatments in the ESC area.

and Working Groups since 2008.[1] This year 50 of the 56 ESC member countries provided data for the EHRA White Book 2016.[2] These data have formed the backbone for the 'ICD for life'[3] and many other strategic initiatives of the EHRA.

Like in the past,[4–7] the objective of this analysis is to provide up-to-date information on the rates of cardiac implantable electronic device (CIED) and catheter ablation procedures in the ESC countries over the past 5 years. In order to allow each country to view its data in a larger context and to facilitate detection of potential cross-national disparities and gaps in the invasive electrophysiology procedure rates, the statistics for the four geographical European ESC regions and for the non-European ESC countries are presented separately (*Figure 1*). In addition, we have provided descriptive and quantitative information on the demographics and economic aspects as well as on training of electrophysiologist in the constituent ESC countries.

The ability to see its own numbers in a European context provides each country robust means to demonstrate shortfalls in resource allocation, reimbursement, and training requirements to the national or local authorities. It is our hope that these data will help to design national and international strategic initiatives and awareness activities to acquire more resources for cardiac arrhythmia management and eventually to champion EHRA's mission '*To improve the quality of life of the population by reducing the impact of cardiac rhythm disturbances and reduce sudden cardiac death*'.

Demographics and general societal and economic aspects

In this section, we have provided an overview of the demographic and financial profiles of the 56 ESC countries. The ESC countries are a heterogeneous group of nations with varying political, financial, and demographic characteristics. Distribution of the population within these regions over the last 5 years is shown in *Table 1*.

Vital statistics and gross domestic product

Population and vital statistics and gross domestic product (GDP) in the 56 ESC countries are presented in *Table 2*. Total GDP ranged from 1.54 (San Marino) to 3371 (Germany) billion US dollars (USD). The GDP per capita was almost 100 times higher in Luxembourg (103 187 USD) than in Kyrgyzstan (1198 USD).

Medium- to high-quality data on cause of death are available in most ESC countries, although they are lacking in many other parts of the world. World Health Organisation (WHO) health statistics

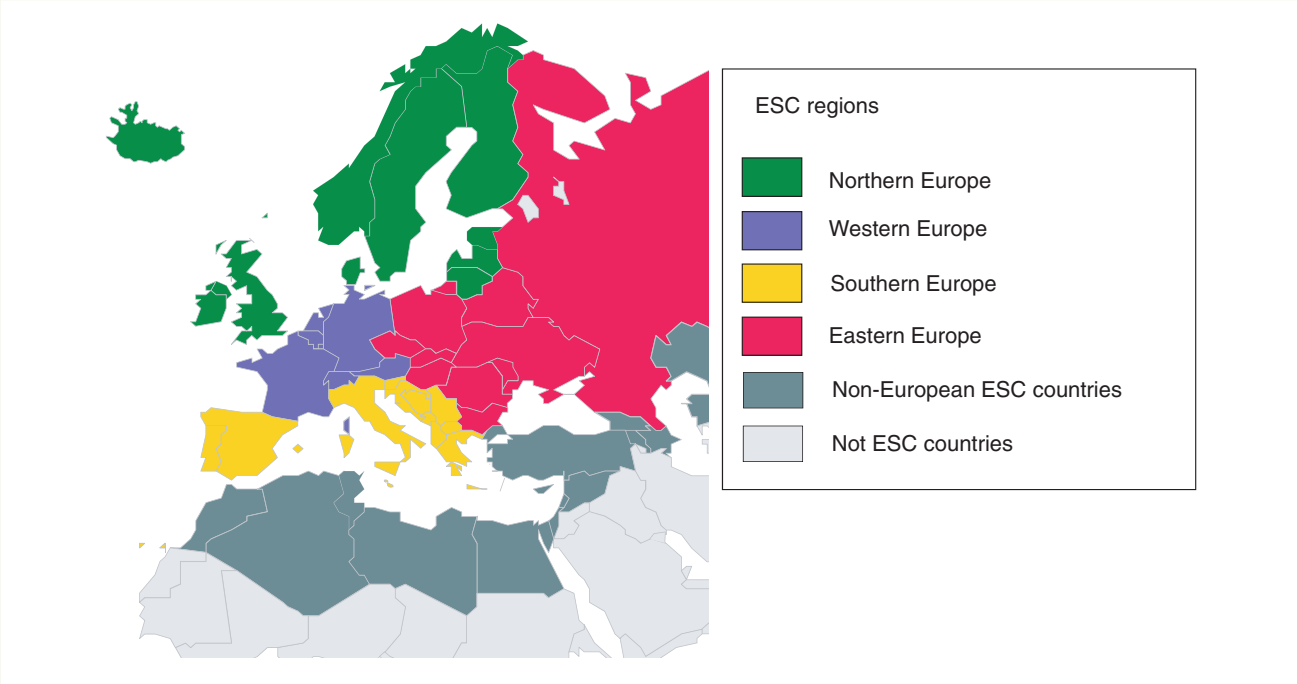

Figure 1 Geographic representation of the 56 ESC countries. The European regions were composed according to the UN Statistics Division (http://unstats.un.org/unsd/methods/m49/m49regin.htm).

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Table 1 Populations in the five geographical ESC regions in 2011–15

Region	Country	ISO code	2011	2012	2013	2014	2015
Northern Europe	Denmark	DK	5 529 888	5 543 453	5 556 452	5 569 077	5 581 503
	Estonia	EE	1 282 963	1 274 709	1 266 375	1 257 921	1 265 420
	Finland	FI	5 259 250	5 262 930	5 266 114	5 268 799	5 476 922
	Iceland	IS	311 058	313 183	315 281	317 351	331 918
	Ireland	IE	4 670 976	4 722 028	4 775 982	4 832 765	4 892 305
	Latvia	LV	2 204 708	2 191 580	2 178 443	2 165 165	1 986 705
	Lithuania	LT	3 535 547	3 525 761	3 515 858	3 505 738	2 884 433
	Norway	NO	4 691 849	5 000 000	5 085 582	5 147 792	5 207 689
	Sweden	SE	9 088 728	9 103 788	9 647 386	9 723 809	9 801 616
	UK	GB	62 698 362	63 047 162	63 395 574	63 742 977	64 088 222
Northern Europe total			**99 273 329**	**99 984 594**	**101 003 047**	**101 531 394**	**101 516 733**
Western Europe	Austria	AT	8 217 280	8 219 743	8 221 646	8 223 062	8 665 550
	Belgium	BE	10 431 477	10 438 353	10 444 268	10 449 361	11 323 973
	France	FR	65 102 719	65 630 692	65 951 611	66 259 012	66 553 766
	Germany	DE	81 471 834	81 305 856	81 147 265	80 996 685	80 854 408
	Luxembourg	LU	503 302	509 074	514 862	520 672	570 252
	The Netherlands	NL	16 653 734	16 730 632	16 805 037	16 877 351	16 947 904
	Switzerland	CH	7 639 961	7 925 517	7 996 026	8 061 516	8 121 830
Western Europe total			**190 020 307**	**190 759 867**	**191 080 715**	**191 387 659**	**193 037 683**
Eastern Europe	Belarus	BY	9 577 552	9 643 566	9 625 888	9 608 058	9 498 364
	Bulgaria	BG	7 093 635	7 037 935	6 981 642	6 924 716	7 186 893
	Czech Republic	CZ	10 190 213	10 177 300	10 609 762	10 627 448	10 644 842
	Hungary	HU	9 976 062	9 958 453	9 939 470	9 919 128	9 897 541
	Moldova	MD	3 694 121	3 656 843	3 619 925	3 583 288	3 546 847
	Poland	PL	38 441 588	38 415 284	38 383 809	38 346 279	38 562 189
	Romania	RO	21 904 551	21 848 504	21 790 479	21 729 871	21 666 350
	Russian Federation	RU	138 739 892	142 517 670	142 500 482	142 470 272	142 423 773
	Slovakia	SK	5 477 038	5 483 088	5 488 339	5 492 677	5 415 949
	Ukraine	UA	45 134 707	45 416 589	44 573 205	44 291 413	44 429 471
Eastern Europe total			**290 229 359**	**294 155 232**	**293 513 001**	**292 993 150**	**293 272 219**
Southern Europe	Albania	AL	2 994 667	3 002 859	3 011 405	3 020 209	3 029 278
	Bosnia and Herzegovina	BA	4 622 163	3 879 296	3 875 723	3 871 643	3 867 055
	Croatia	HR	4 483 804	4 480 043	4 475 611	4 470 534	4 464 844
	Greece	GR	10 760 136	10 767 827	10 772 967	10 775 557	10 775 643
	Italy	IT	61 016 804	61 261 254	61 482 297	61 680 122	61 855 120
	Kosovo	XK	1 825 632	1 836 529	1 847 708	1 859 203	1 870 981
	FYR Macedonia	MK	2 077 328	2 082 370	2 087 171	2 091 719	2 096 015
	Malta	MT	408 333	409 836	411 277	412 655	413 965
	Montenegro	ME	661 807	657 394	653 474	650 036	647 073
	Portugal	PT	10 760 305	10 781 459	10 799 270	10 813 834	10 825 309
	San Marino	SM	31 817	32 140	32 448	32 742	33 020
	Serbia	RS	7 310 555	7 276 604	7 243 007	7 209 764	7 176 794
	Slovenia	SI	2 000 092	1 996 617	1 992 690	1 988 292	1 983 412
	Spain	ES	46 754 784	47 042 984	47 370 542	47 737 941	48 146 134
Southern Europe total			**155 708 227**	**155 507 212**	**156 055 590**	**156 614 251**	**157 184 643**
Non-European ESC countries	Algeria	DZ	34 994 937	37 367 226	38 087 812	38 813 722	39 542 166
	Armenia	AM	2 967 975	2 970 495	3 064 267	3 060 927	3 056 382
	Azerbaijan	AZ	9 397 279	9 493 600	9 590 159	9 686 210	9 780 780
	Cyprus	CY	1 120 489	1 138 071	1 155 403	1 172 458	1 189 197
	Egypt	EG	82 079 636	83 688 164	85 294 388	86 895 099	88 487 396
	Georgia	GE	4 585 874	4 570 934	4 942 157	4 935 880	4 931 226

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Table 1 *Continued*

Region	Country	ISO code	2011	2012	2013	2014	2015
	Israel	IL	7 473 052	7 590 758	7 707 042	7 821 850	8 049 314
	Kazakhstan	KZ	17 304 513	17 736 896	17 736 896	17 948 816	18 157 122
	Kyrgyzstan	KGZ	5 450 776	5 496 737	5 548 042	5 604 212	5 664 939
	Lebanon	LB	4 143 101	4 140 289	4 131 583	4 136 895	6 184 701
	Libya	LY	6 597 960	5 613 380	6 002 347	6 244 174	6 411 776
	Morocco	MA	31 968 361	32 309 239	32 649 130	33 478 299	33 322 699
	Syria	SY	22 517 750	22 530 746	22 457 336	22 597 531	17 064 854
	Tunisia	TN	10 629 186	10 732 900	10 835 873	10 937 521	11 037 225
	Turkey	TR	78 785 548	79 749 461	80 694 485	81 619 392	79 414 269
Non-European ESC countries total			**320 016 437**	**325 128 896**	**329 896 920**	**334 952 986**	**332 294 046**
Total ESC countries			**1 055 247 659**	**1 065 535 801**	**1 071 549 273**	**1 077 479 440**	**1 077 305 324**

reveal several important differences in the vital statistics between the ESC countries.[8,9] As an example, the life expectancy at birth varied from 70.4 years (Kyrgyzstan and Moldova) to 83.2 years (San Marino). The death rate per 1000 population was lowest in Turkey (4.70%) and highest in Bulgaria (14.96%). It is noteworthy that in most countries with life expectancy over 80 years, the GDP per capita is also relatively high (*Table 2*).

Healthcare systems

The organization of healthcare across the ESC member countries varies markedly. Many countries provide national healthcare services with full coverage to the whole population, while in others healthcare services are primarily delivered by commercial health insurance companies (*Table 3*). The proportion of people with no health insurance was highest in the Eastern European and non-European ESC countries. In the Northern, Southern, and Western European ESC countries, patients do not need to provide any co-payment for invasive electrophysiology procedures, whereas in many Eastern European (e.g. Armenia, Bulgaria, and Georgia) and non-European ESC countries (e.g. Egypt and Morocco) a co-payment is necessary (*Table 3*).

The numbers of hospitals and hospital beds available for healthcare are shown in *Figure 2*. The numbers of hospitals and beds were not directly related to the financial profile of the countries or to healthcare expenditure. Rather, these data indicate that some countries have directed more resources towards hospital care than ambulatory and home care. For example, the number of beds per 100 000 inhabitants was 828 in Germany and only 259 in Sweden, despite the relatively high GDP and healthcare expenditure in both countries.

Healthcare expenditure

Healthcare expenditure has been escalating rapidly and nowadays represents the biggest government-spending item in many countries. In *Figure 3*, the healthcare expenditure is presented as percentage of the national GDP and in *Figure 4* as expenditure per capita. The mean healthcare expenditure in the ESC area as percentage of the GDP was 8.3%. It was highest in the Netherlands (12.9%) and lowest in Kazakhstan (4.3%).

The healthcare expenditure per capita was highest in Norway (9692 USD) and Switzerland (9208 USD) and lowest in Kyrgyzstan (85 USD). Hence, there was more than 100-fold difference between the lowest and highest healthcare expenditures per capita in the ESC area.[8,9] Given the trend towards a progressive aging of populations and unhealthy living style, there is pressure to increase the healthcare expenditure. Despite this, the mean healthcare expenditure per capita in the ESC area was slightly lower in 2013 (2733 USD) than in 2011 (2818 USD).

Certification of professional excellence

General information

In 2015, 47 countries (94% of the countries that responded to the EHRA White Book survey) provided data on certification of physicians and allied professionals in device therapy and invasive electrophysiology for the EHRA White Book 2016.[2] National certification programme for CIED therapy and invasive cardiac EPs for physicians was available in 23 (46%) and 22 (44%) of these countries, respectively. A certification programme was an obligatory practice requirement for CIED therapy in 11 countries and for EP in 12 countries (*Figures 5* and *6*).

A national certification for allied professionals was available in 17 countries and was required for practice in 11 countries (*Figure 7*). Training centres were accredited in only 17 (34%) countries, and certification of training centres was mandatory in order to train fellows in 13 countries (*Figure 8*). Several centres in various regions were available as training centres for the EHRA Training Fellowship Program and allowed many young physicians from emerging economies to be trained in high-volume centres abroad.

European Heart Rhythm Association certification

The EHRA certification programme is the first European certification of professional excellence in the field of CIED therapies and

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Table 2 Population, vital statistics, and GDP in the 56 ESC countries

Country	Population	Population growth rate (%)	Life expectancy at birth (years)	Death rate per 1000 population	GDP (×1000 billion USD)	GDP per capita (USD)	Total health expenditure as % of GDP
Albania[a]	3 029 278	0.30	78.1	5.68	11.59	4200	5.88
Algeria	39 542 166	1.86	76.6	N/A	175.08	4345	N/A
Armenia	3 056 382	−0.14	74.4	9.13	10.61	3547	4.52
Austria	8 665 550	0.58	81.4	9.16	372.61	43 547	11.03
Azerbaijan	9 780 780	0.97	72.2	5.88	63.98	6794	5.58
Belarus	9 498 364	−0.10	73.2	12.60	62.02	6583	6.07
Belgium	11 323 973	0.77	80.9	9.83	458.65	40 456	11.19
Bosnia and Herzegovina	3 867 055	−0.12	76.6	9.12	15.57	4030	9.63
Bulgaria	7 186 893	−0.57	74.4	14.96	47.17	6582	7.63
Croatia	4 464 844	−0.13	76.6	11.84	48.93	11 551	7.30
Cyprus	1 189 197	1.42	78.5	6.37	19.38	21 531	7.44
Czech Republic	10 644 842	0.16	78.5	10.39	182.46	17 330	7.24
Denmark	5 581 503	0.22	79.3	9.31	291.04	51 424	10.62
Egypt	88 487 396	1.82	73.7	N/A	N/A	N/A	N/A
Estonia	1 265 420	−0.56	76.5	11.35	22.93	17 425	5.72
Finland	5 476 922	0.41	80.8	9.46	230.69	42 159	9.40
France	66 553 766	0.44	81.8	8.49	2422.65	37 728	11.66
Georgia	4 931 226	−0.09	76.0	13.17	13.75	3720	9.43
Germany	80 854 408	−0.18	80.6	11.08	3371.00	41 267	11.30
Greece	10 775 643	0.00	80.4	10.52	192.98	17 657	9.82
Hungary	9 897 541	−0.22	75.7	12.81	118.49	12 021	8.05
Iceland	331 918	1.23	83.0	6.27	16.74	51 068	9.06
Ireland	4 892 305	1.22	80.7	6.36	227.50	48 940	8.92
Israel	8 049 314	1.61	82.3	5.15	298.87	35 702	7.24
Italy	61 855 120	0.28	82.1	10.30	1819.05	29 847	9.09
Kazakhstan	18 157 122	1.15	70.6	8.51	195.01	11 028	4.26
Kosovo	1 870 981	0.63	71.3	N/A	6.31	N/A	N/A
Kyrgyzstan	5 664 939	1.08	70.4	6.10	7.16	1198	6.67
Latvia	1 986 705	−1.05	74.2	14.28	27.82	13 729	5.72
Lebanon[a]	6 184 701	5.01	77.4	N/A	54.40	11 945	N/A
Libya[a]	6 411 776	2.65	76.3	N/A	29.72	4754	N/A
Lithuania	2 884 433	−1.04	74.7	13.70	41.78	14 318	6.24
Luxembourg	570 252	2.17	82.2	6.76	57.93	103 187	7.10
FYR Macedonia	2 096 015	0.21	76.0	9.30	10.09	4867	6.44
Malta	413 965	0.32	80.3	7.65	9.19	21 540	8.73
Moldova[a]	3 546 847	−1.02	70.4	10.70	6.19	1740	11.80
Montenegro	647 073	−0.46	78.4	9.29	3.99	6373	6.49
Morocco	33 322 699	1.01	76.7	6.34	103.08	3077	N/A
Netherlands	16 947 904	0.42	81.2	8.41	750.78	44 333	12.89
Norway	5 207 689	1.16	81.7	8.11	397.59	76 266	9.57
Poland	38 562 189	−0.08	77.4	10.06	481.24	12 662	6.66
Portugal	10 825 309	0.11	79.2	10.22	197.51	18 984	9.71
Romania	21 666 350	−0.29	74.9	11.99	174.92	8807	5.34
Russian Federation	142 423 773	−0.03	70.5	13.47	1235.86	8447	6.55
San Marino	33 020	0.85	83.2	7.34	1.54	49 139.01	6.49
Serbia	7 176 794	−0.46	75.3	14.00	36.56	5102	10.60
Slovakia	5 415 949	0.03	76.9	9.84	86.20	15 893	8.21
Slovenia	1 983 412	−0.25	78.0	9.08	42.74	20 712	9.16
Spain	48 146 134	0.85	81.6	8.38	1221.39	26 327	8.88
Sweden	9 801 616	0.80	82.0	9.43	483.72	48 966	9.71
Switzerland	8 121 830	0.75	82.5	8.03	676.98	82 178	11.47
Syria[a]	17 064 854	−5.07	74.7	N/A	N/A	N/A	N/A
Tunisia[a]	11 037 225	0.91	75.9	N/A	44.27	3985	N/A
Turkey	79 414 269	1.28	74.6	4.70	722.22	9290	5.59
Ukraine	44 429 471	−1.15	71.6	14.60	90.14	2109	7.77
UK	64 088 222	0.54	80.5	8.99	2864.90	44 118	9.12

[a]These six countries did not submit data for the EHRA White Book 2016.

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Table 3 Healthcare service and insurance systems in the 56 ESC countries

Country	Basic insurance availability	Uninsured citizens (% of population)	Distribution of insurance modality (%)			Possibility to subscribe to private health insurance plans	Co-payment necessary for therapies		
			Public insurance	Private insurance	Private co-payment		ICD	PM	Ablation
Albania[a]									
Algeria	Yes	30	100	0	0	Yes	No	Yes	No
Armenia	No	67	0	100	0	Yes	Yes	Yes	Yes
Austria	Yes	2	99	0	0	Yes	No	No	No
Azerbaijan	Yes	0	80	10	10	Yes	Yes	No	Yes
Belarus	Yes	0	100	N/A	N/A	Yes	No	No	No
Belgium	Yes	1	90	0	10	Yes	No	No	Yes
Bosnia and Herzegovina	No	25	75	N/A	25	No	Yes	Yes	N/A
Bulgaria	Yes	20	75	1	24	Yes	Yes	No	Yes
Croatia	Yes	10	90	5	5	Yes	No	No	No
Cyprus	No	15	85	15	0	Yes	No	No	No
Czech Republic	Yes	0.1	99.8	0.1	0.1	No	No	No	No
Denmark	Yes	0	100	0	0	Yes	No	No	No
Egypt	No	35	64	1	35	Yes	Yes	Yes	Yes
Estonia	Yes	N/A	N/A	N/A	N/A	N/A	No	No	No
Finland	Yes	0	75.6	3	21.4	Yes	No	No	No
France	Yes	0	100	N/A	N/A	Yes	No	No	No
Georgia	Yes	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes
Germany	Yes	1	87	13	N/A	Yes	No	No	No
Greece	Yes	25	90	10	0	Yes	N/A	N/A	N/A
Hungary	Yes	2	99	1	0	Yes	No	No	No
Iceland	Yes	0	100	0	0	No	No	No	No
Ireland	Yes	0	100	46	46	Yes	No	No	No
Israel	Yes	0	100	0	0	Yes	No	No	No
Italy	Yes	0	100	0	0	Yes	No	No	No
Kazakhstan	No	N/A	N/A	N/A	N/A	Yes	No	No	No
Kosovo	No	N/A	N/A	N/A	N/A	N/A	No	No	No
Kyrgyzstan	Yes	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes
Latvia	Yes	0	81	19	N/A	Yes	Yes	Yes	No
Lebanon[a]									
Libya[a]									
Lithuania	Yes	0	98	2	0	Yes	No	No	No
Luxembourg	Yes	0	100	N/A	N/A	Yes	No	No	No
FYR Macedonia	No	10	90	10	N/A	Yes	No	No	No
Malta	Yes	0	N/A	N/A	N/A	Yes	No	No	No
Moldova[a]									
Montenegro	Yes	1	99	N/A	1	No	No	No	No
Morocco	No	25	80	15	5	Yes	Yes	Yes	Yes
The Netherlands	Yes	0	0	100	0	Yes	No	No	No
Norway	Yes	0	99	0	1	Yes	No	No	No
Poland	Yes	N/A	90	0	10	Yes	No	No	No
Portugal	Yes	0	100	0	0	Yes	No	No	No
Romania	Yes	N/A	100	0	0	No	Yes	Yes	Yes
Russian Federation	Yes	N/A	90	7	3	Yes	No	Yes	No
San Marino	Yes	0	100	0	0	Yes	No	No	No
Serbia	Yes	0	100	0	0	Yes	No	No	No
Slovakia	Yes	0	75	25	0	No	No	No	No
Slovenia	Yes	1	4	0	96	N/A	No	No	No
Spain	Yes	1	79	5	16	Yes	No	No	No
Sweden	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Switzerland	Yes	N/A	0	100	0	Yes	No	No	No
Syria[a]									
Tunisia[a]									
Turkey	Yes	1	99	1	N/A	Yes	No	No	No
Ukraine	No	N/A	N/A	N/A	N/A	Yes	No	No	No
UK	No	95	95	0	5	Yes	No	No	No

[a]These six countries did not submit data for the EHRA White Book 2016.

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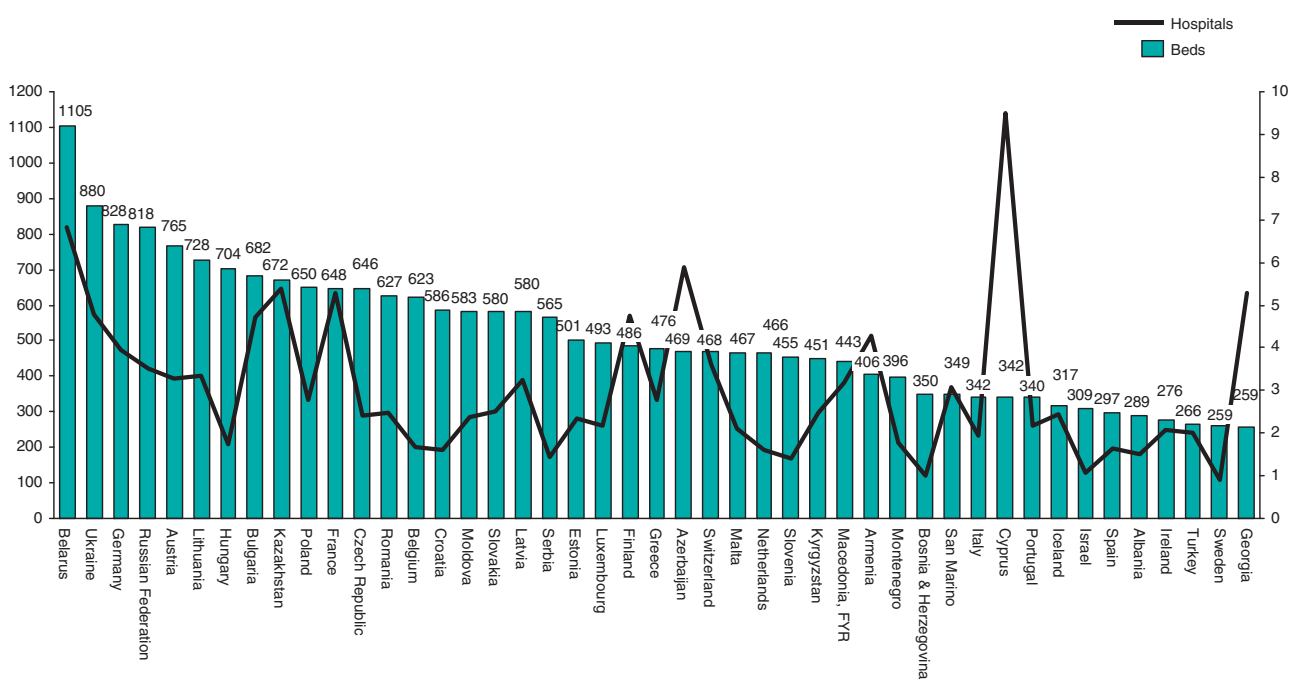

Figure 2 Hospitals and hospital beds per 100 000 inhabitants in the ESC countries.

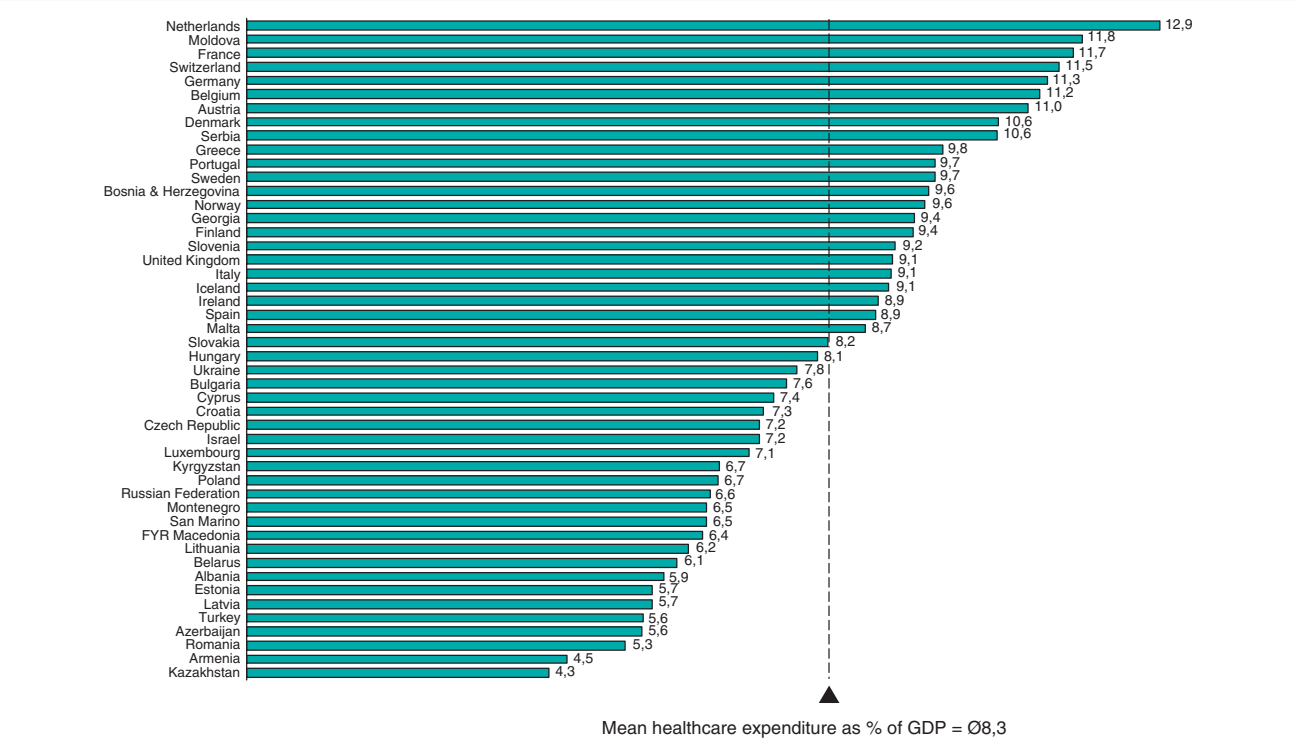

Figure 3 Healthcare expenditure as percentage of national GDP in the ESC countries in 2013. The mean healthcare expenditure as % of GDP is weighted by population.

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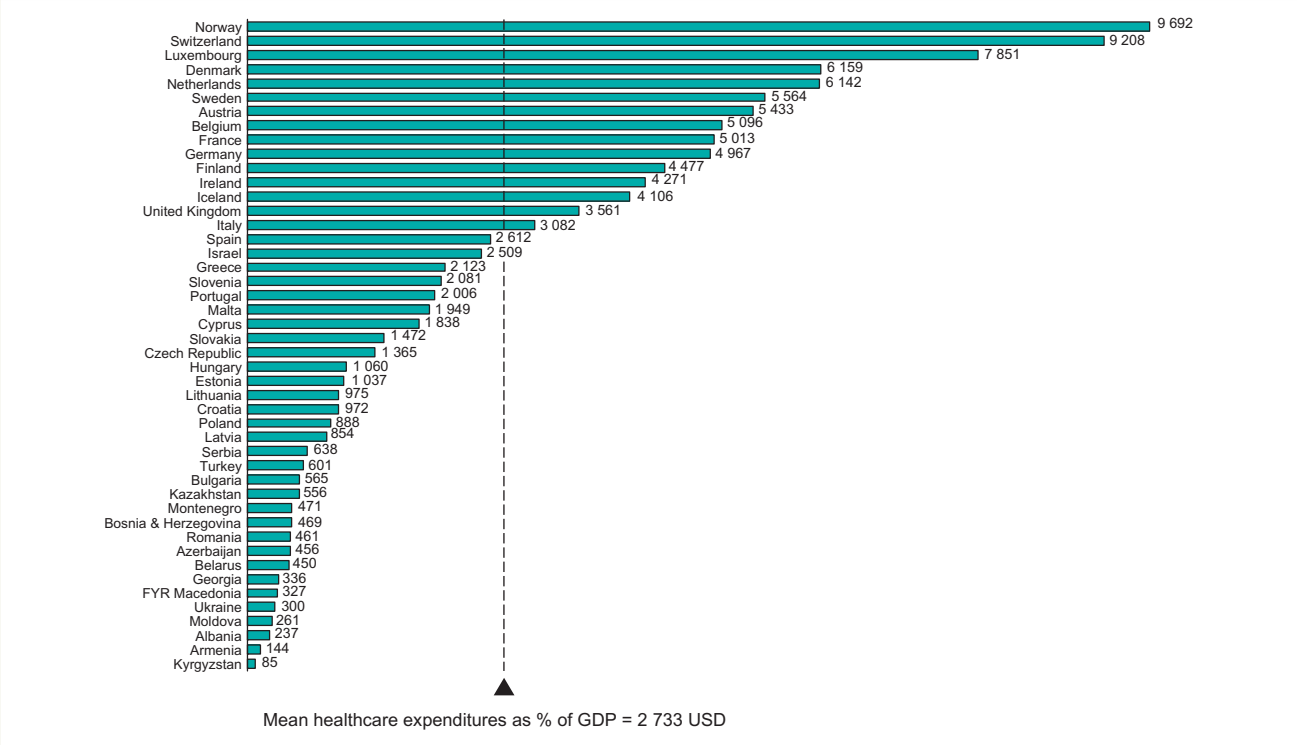

Figure 4 Healthcare expenditure per capita in the ESC countries in 2013. The mean number of expenditure is weighted by population. Mean healthcare expenditures as % of GDP = 2733 USD.

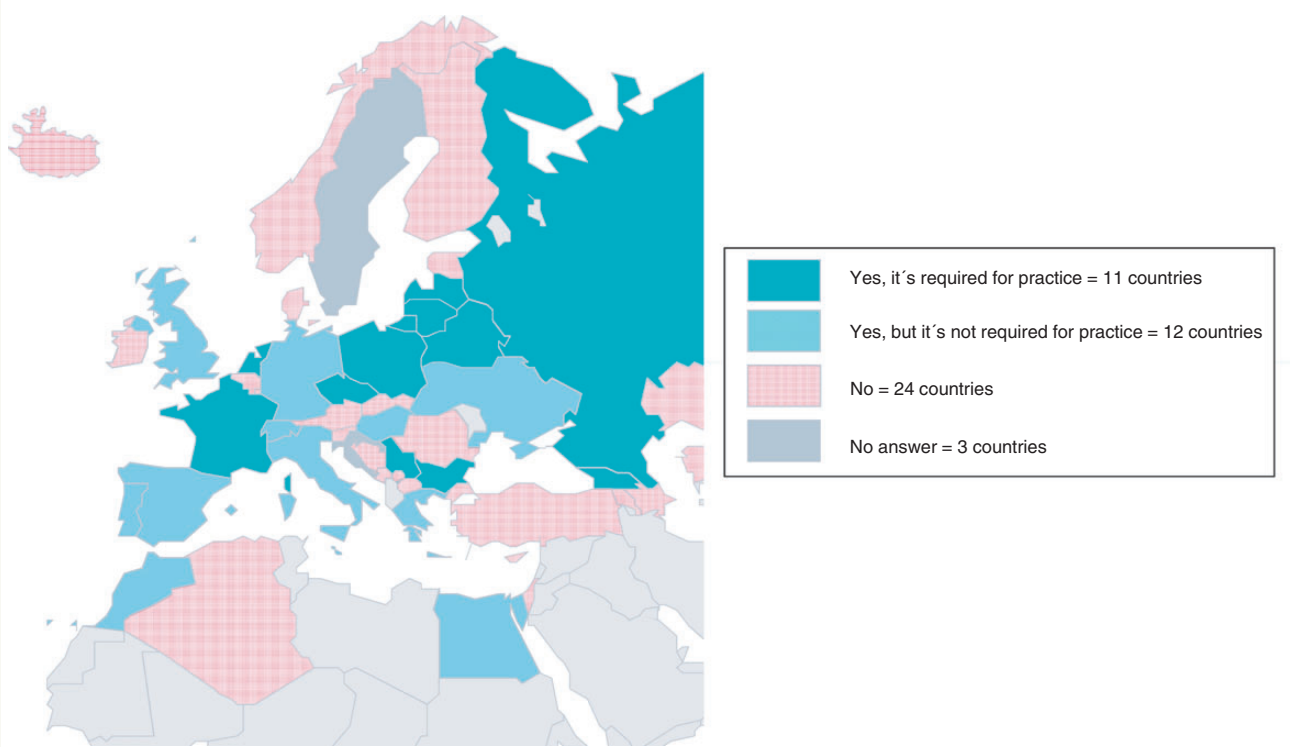

Figure 5 Certification for CIED therapy in the ESC countries in 2015.

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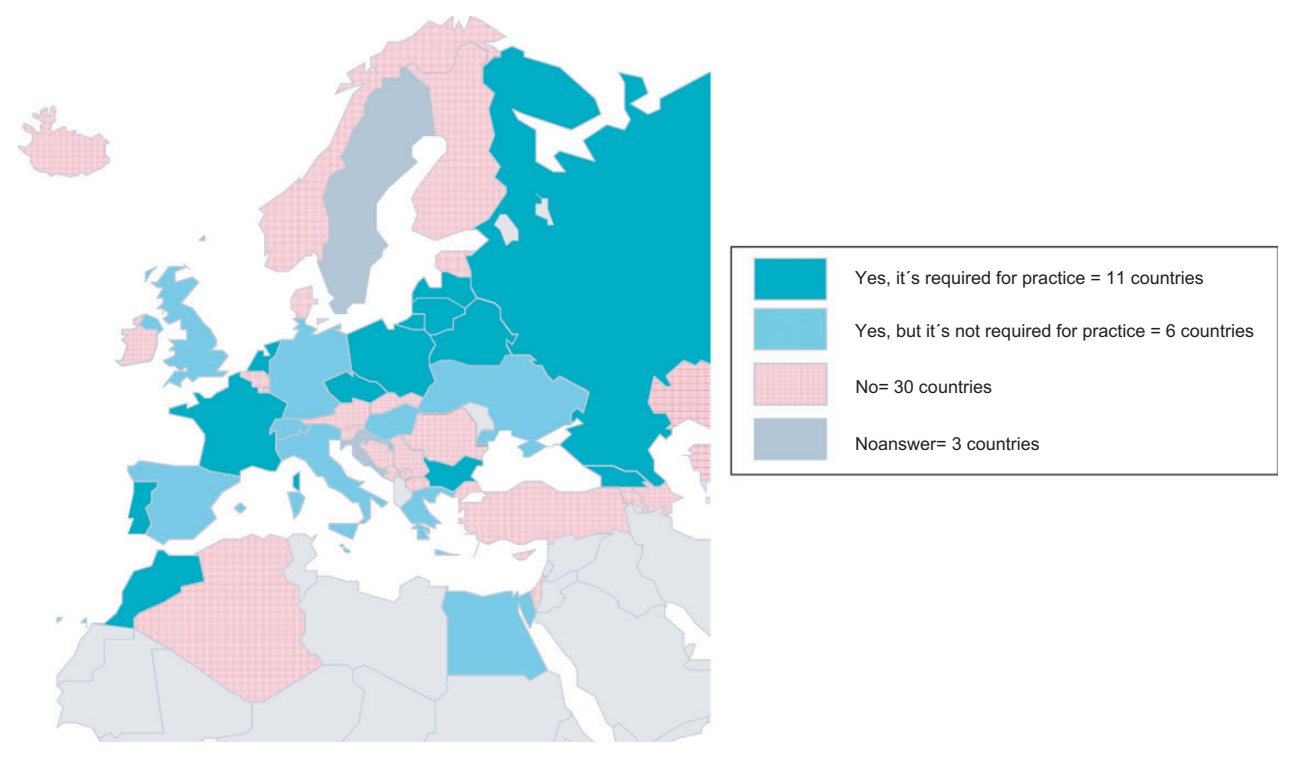

Figure 6 Certification for invasive electrophysiology in the ESC countries in 2015.

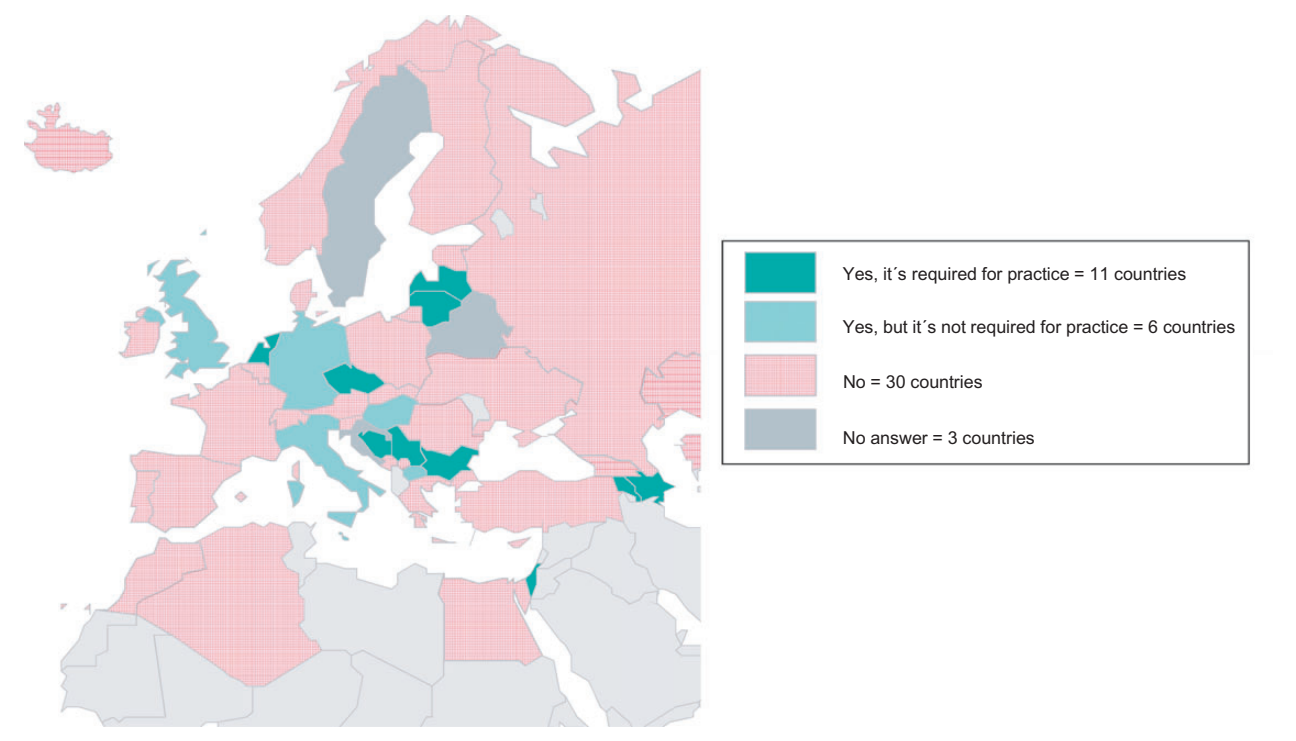

Figure 7 Certification for allied professionals in the ESC countries in 2015.

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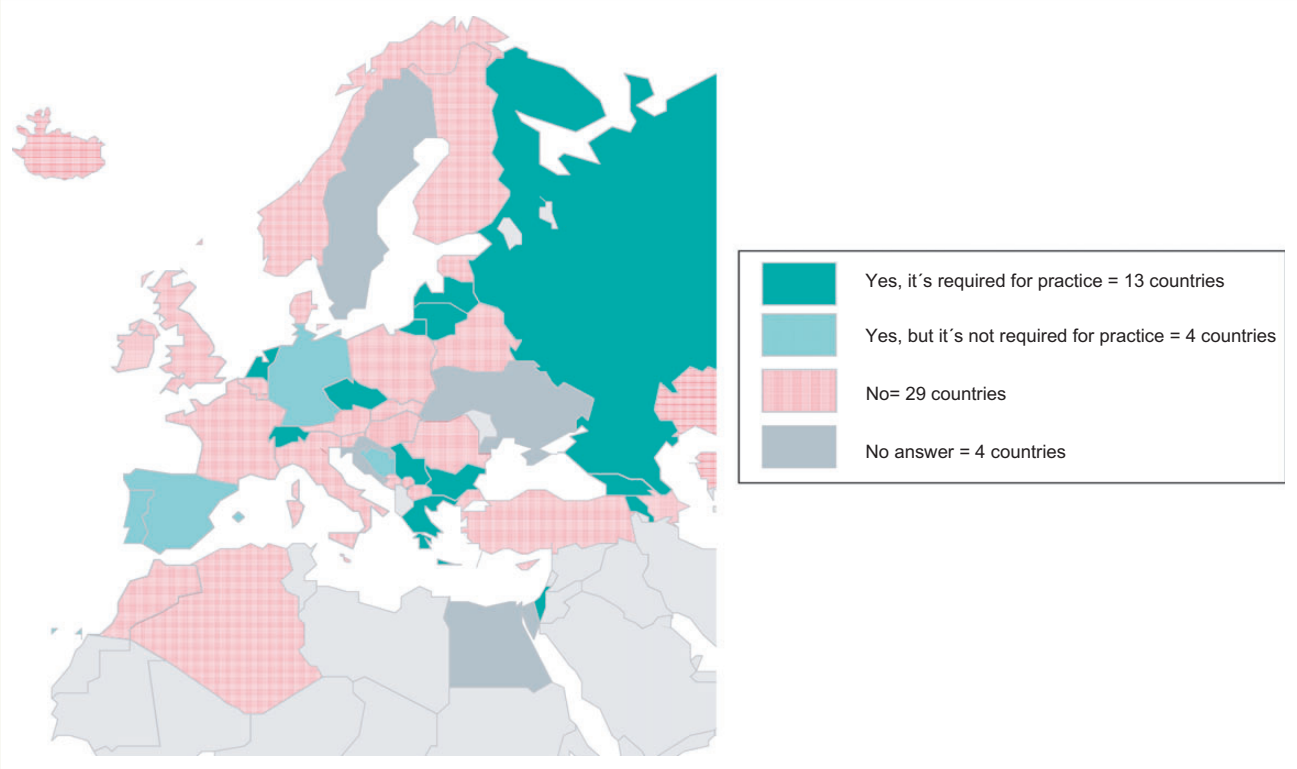

Figure 8 Certification for training centres in the ESC countries in 2015.

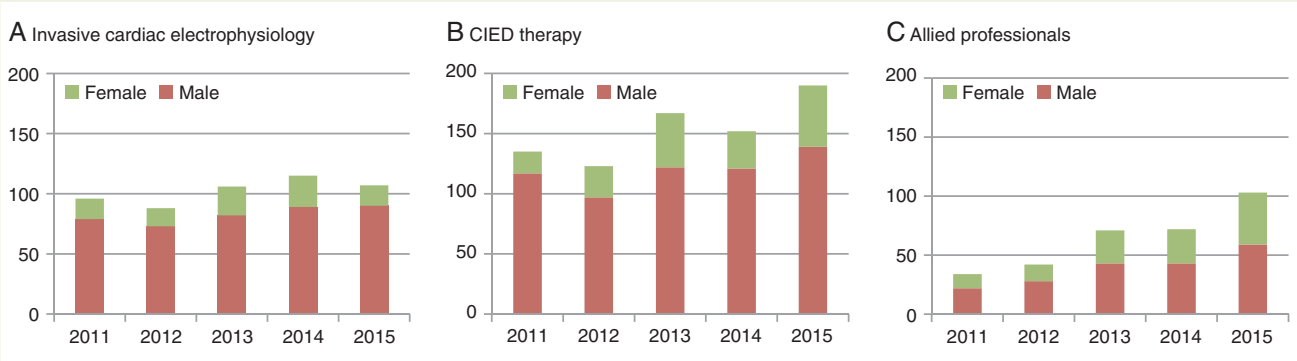

Figure 9 Number of participants in the EHRA examination during the last 5 years. CIED, cardiac implantable electronic device.

invasive electrophysiology. It plays an important role with regard to EHRA's goal to promote unified and clear standards for the training of cardiac rhythm management specialists and to assure high quality in arrhythmia care across the ESC area.

During the last 5 years, 1276 physicians (767 in CIED and 509 in EP) from 58 countries have participated in the EHRA examination. Over the years, most of them have submitted the case logbook within the required time and subsequently achieved full (Level 2) certification. In 2015, 294 physicians participated in the EHRA certification examination. The majority of them were male (78% in the invasive electrophysiology examination and 73% in the CIED programme). Over the years, the proportion of female candidates has increased from <10 to ~25% (*Figure 9*). Last year, the highest numbers of candidates participating in the CIED examination were from the Netherlands (31 candidates), Switzerland (23), and Italy (23). In the invasive electrophysiology examination, the highest numbers of participants were from Italy (13), Spain (12), and the Netherlands (12).

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Table 4 Pacemaker implantation facilities and implantation rates in 2015 in comparison with 4 previous years

Country	ISO code	National registry for PM implants	Number of PM implanting centres 2015		PM implantations 2015		Development potential—target number of PM implantations		PM implantations per mil inhabitants				
			Absolute number	Per mil inhabitants	Absolute number	Per mil inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	44	N/A
Algeria	DZ	No	19	0	2915	74	20 481	34 883	N/A	N/A	65	65	74
Armenia	AM	No	2	1	117	38	1583	2696	133	74	31	42	38
Austria	AT	Yes	57	7	7905	912	–	–	950	957	967	1006	912
Azerbaijan	AZ	No	8	1	395	40	5066	8628	15	N/A	14	19	40
Belarus	BY	No	10	1	3149	332	4920	8379	258	275	292	309	332
Belgium	BE	Yes	104	9	13 073	1154	–	–	N/A	1228	1218	1236	1154
Bosnia and Herzegovina	BA	No	6	2	854	221	2003	3411	138	234	224	215	221
Bulgaria	BG	Yes	19	3	3953	550	–	6340	385	448	503	538	550
Croatia	HR	No	17	4	2855	639	–	3939	565	561	540	582	639
Cyprus	CY	No	5	4	280	235	616	1049	223	211	216	213	235
Czech Republic	CZ	Yes	37	3	8969	843	–	9391	881	899	887	889	843
Denmark	DK	Yes	15	3	4818	863	–	4924	795	841	850	866	863
Egypt	EG	No	33	0	3552	40	45 833	78 061	N/A	30	33	38	40
Estonia	EE	No	5	4	1085	857	–	1116	766	748	912	838	857
Finland	FI	No	20	4	5821	1063	–	–	923	990	1020	1051	1063
France	FR	No	453	7	64 176	964	–	–	969	958	910	1011	964
Georgia	GE	No	15	3	817	166	2554	4350	84	102	125	123	166
Germany	DE	Yes	1135	14	106 700	1320	–	–	1313	1311	1152	1152	1320
Greece	GR	Yes	56	5	8800	817	–	9506	701	691	724	742	817
Hungary	HU	Yes	18	2	6432	650	–	8731	584	607	618	645	650
Iceland	IS	No	2	6	308	928	–	–	1006	967	996	939	928
Ireland	IE	Yes	17	3	2277	465	2534	4316	507	451	479	N/A	465
Israel	IL	No	20	2	4250	528	–	7101	500	558	515	537	528
Italy	IT	Yes	435	7	65 234	1055	–	–	1034	1001	1012	1029	1055
Kazakhstan	KZ	No	25	1	1801	99	9405	16 018	N/A	69	84	131	99
Kosovo	XK	No	3	2	122	65	969	1651	N/A	N/A	N/A	68	65
Kyrgyzstan	KGZ	N/A	2	0	126	22	2934	4997	N/A	N/A	N/A	22	22
Latvia	LV	Yes	3	2	1400	705	–	1753	550	548	591	571	705
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	218	218	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	No	5	2	2583	895	–	–	714	756	772	789	895
Luxembourg	LU	No	6	11	393	689	–	503	336	621	365	670	689

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Table 4 *Continued*

Country	ISO code	National registry for PM implants	Number of PM implanting centres 2015		PM implantations 2015		Development potential—target number of PM implantations		PM implantations per mil inhabitants				
			Absolute number	Per mil inhabitants	Absolute number	Per mil inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
FYR Macedonia	MK	No	3	1	470	224	1086	1849	174	166	154	170	224
Malta	MT	No	1	2	400	966	–	–	740	644	552	887	966
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	79	N/A	N/A
Montenegro	ME	No	1	2	247	382	335	571	264	218	312	280	382
Morocco	MA	Yes	11	0	1801	54	17 260	29 396	39	38	34	44	54
The Netherlands	NL	Yes	85	5	10 000	590	–	14 951	585	560	605	600	590
Norway	NO	Yes	23	4	4121	791	–	4594	675	691	680	755	791
Poland	PL	No	145	4	30 494	791	–	34 018	710	716	716	742	791
Portugal	PT	Yes	40	4	8769	810	–	9550	595	825	814	817	810
Romania	RO	No	24	1	3918	181	11 222	19 113	139	144	110	196	181
Russian Federation	RU	Yes	140	1	34 492	242	73 770	125 642	216	212	244	266	242
San Marino	SM	Yes	1	30	11	333	17	29	503	809	431	N/A	333
Serbia	RS	Yes	17	2	3724	519	–	6331	448	431	546	507	519
Slovakia	SK	Yes	14	3	3664	677	–	4778	617	567	630	606	677
Slovenia	SI	Yes	9	5	1235	623	–	1750	647	668	646	736	623
Spain	ES	Yes	230	5	33 373	693	–	42 473	734	738	749	761	693
Sweden[a]	SE	N/A	44	4	N/A	N/A	N/A	N/A	N/A	1041	995	969	N/A
Switzerland	CH	Yes	71	9	6401	788	–	7165	791	753	763	812	788
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	155	233	N/A	201	N/A
Turkey	TR	No	N/A	N/A	9200	116	41 134	70 057	N/A	N/A	N/A	89	116
Ukraine	UA	No	38	1	4851	109	23 013	39 194	112	121	148	119	109
UK	GB	Yes	211	3	46 110	719	–	56 537	610	615	702	708	719
Total ESC countries			**3660**	**3.85**	**528 441**	**518**			**649**	**648**	**632**	**660**	**680**

[a]These seven countries did not submit any data on PM implantations for the EHRA White Book 2016.

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Table 5 Specialty of physicians performing device implantations and LEs

Country	ISO code	Specialist performing PM implantations (%)			Specialist performing ICD implantations (%)			Specialist performing CRT implantations (%)			Specialist performing loop recorder implantations (%)			Specialist performing LEs (%)		
		Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	99	1	0	100	0	0	100	0	0	100	0	0	97	3	0
Armenia	AM	100	0	0	100	0	0	100	0	0	100	0	0	0	0	0
Austria	AT	50	50	0	10	90	0	50	50	0	80	20	0	10	90	0
Azerbaijan	AZ	90	10	0	100	0	0	100	0	0	100	0	0	100	0	0
Belarus	BY	0	100	0	0	100	0	0	100	0	0	100	0	0	100	0
Belgium	BE	N/A	N/A	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bosnia and Herzegovina	BA	85	15	0	85	15	0	100	0	0	100	0	0	N/A	N/A	N/A
Bulgaria	BG	90	10	0	100	0	0	100	0	0	100	0	0	100	0	0
Croatia	HR	90	10	0	95	5	0	100	0	0	100	0	0	100	0	0
Cyprus	CY	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Czech Republic	CZ	95	5	0	95	5	0	95	5	0	100	0	0	80	20	0
Denmark	DK	100	0	0	100	0	0	100	0	0	100	0	0	85	15	0
Egypt	EG	100	0	0	90	0	10	70	0	30	0	0	0	90	0	10
Estonia	EE	100	0	0	100	0	0	100	0	0	100	0	0	N/A	N/A	N/A
Finland	FI	95	5	0	95	5	0	100	0	0	100	0	0	100	0	0
France	FR	90	10	0	95	5	0	100	0	0	100	0	0	90	10	0
Georgia	GE	90	10	0	100	0	0	100	0	0	100	0	0	N/A	N/A	N/A
Germany	DE	60	28	12	67	21	12	68	20	12	92	2	6	17	83	0
Greece	GR	97	3	0	98	2	0	98	2	0	100	0	0	90	10	0
Hungary	HU	95	5	0	97	3	0	97	3	0	100	0	0	95	5	0
Iceland	IS	50	50	0	50	50	0	100	0	0	100	0	0	100	0	0
Ireland	IE	100	0	0	100	0	0	100	0	0	100	0	0	50	50	0
Israel	IL	98	2	0	100	0	0	100	0	0	100	0	0	99	1	0
Italy	IT	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Kazakhstan	KZ	N/A	N/A	0	N/A	N/A	N/A	N/A	N/A	N/A	100	0	0	100	0	0
Kosovo	XK	100	0	0	100	N/A	N/A	80	0	20	100	0	0	100	0	0
Kyrgyzstan	KGZ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Latvia	LV	70	30	0	70	30	0	70	30	0	70	30	0	0	100	0
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	99	1	0	100	0	0	100	0	0	100	0	0	95	5	0
Luxembourg	LU	85	15	0	98	2	0	90	10	0	100	0	0	0	100	0
FYR Macedonia	MK	100	0	0	100	0	0	100	0	0	100	0	0	50	50	0
Malta	MT	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0

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Table 5 *Continued*

Country	ISO code	Specialist performing PM implantations (%)			Specialist performing ICD implantations (%)			Specialist performing CRT implantations (%)			Specialist performing loop recorder implantations (%)			Specialist performing LEs (%)		
		Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	70	30	0	50	50	0	100	0	0	50	50	0	50	50	0
Morocco	MA	99	1	0	N/A	N/A	N/A	99	1	0	0	0	0	99	1	0
The Netherlands	NL	95	2	3	95	3	2	97	3	0	85	5	10	90	10	0
Norway	NO	99.7	0.3	0	100	0	0	100	0	0	100	0	0	100	0	0
Poland	PL	99	1	0	99	1	0	100	0	0	100	0	0	99	1	0
Portugal	PT	99	1	0	100	0	0	100	0	0	100	0	0	N/A	N/A	N/A
Romania	RO	99	1	0	100	0	0	100	0	0	100	0	0	100	0	0
Russian Federation	RU	80	18	2	70	30	0	40	60	0	N/A	N/A	N/A	N/A	N/A	N/A
San Marino	SM	100	0	0	100	0	0	100	0	0	100	0	0	0	0	0
Serbia	RS	98	2	0	100	0	0	100	0	0	100	0	0	100	0	0
Slovakia	SK	98	2	0	98	2	0	100	0	0	100	0	0	95	5	0
Slovenia	SI	20	80	0	N/A	N/A	N/A	100	0	0	50	50	0	0	100	0
Spain	ES	72	24	4	92	8	0	98	2	0	100	0	0	30	70	0
Sweden	SE	64	18	18	81	14	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Switzerland	CH	95	5	0	95	5	0	100	0	0	100	0	0	80	20	0
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Turkey	TR	95	5	0	97	3	0	99	1	0	100	0	0	75	25	0
Ukraine	UA	10.3	89.7	0	14.3	85.7	0	20	80	0	50	50	0	0	100	0
UK	GB	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0

[a]These six countries did not submit data for the EHRA White Book 2016.

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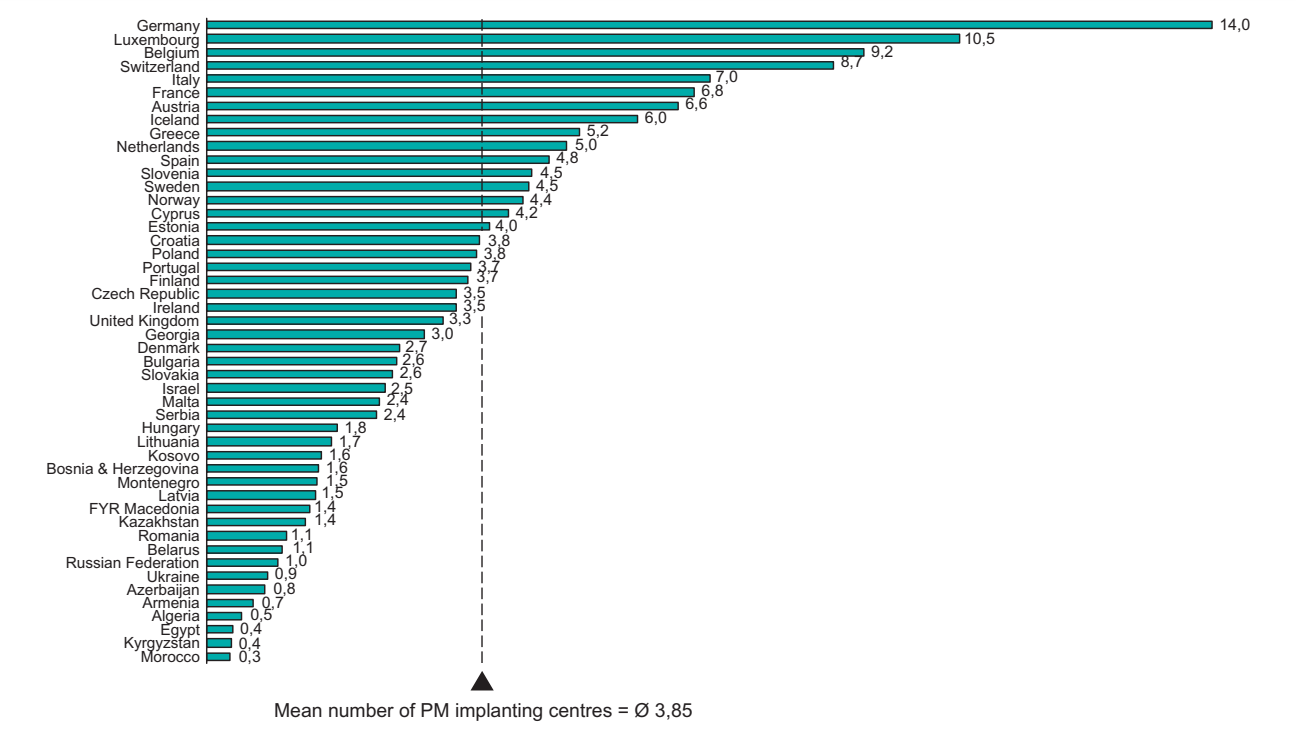

Figure 10 Number of PM implanting centres per million inhabitants in the ESC countries in 2015. The mean number of implantation centres is weighted by population.

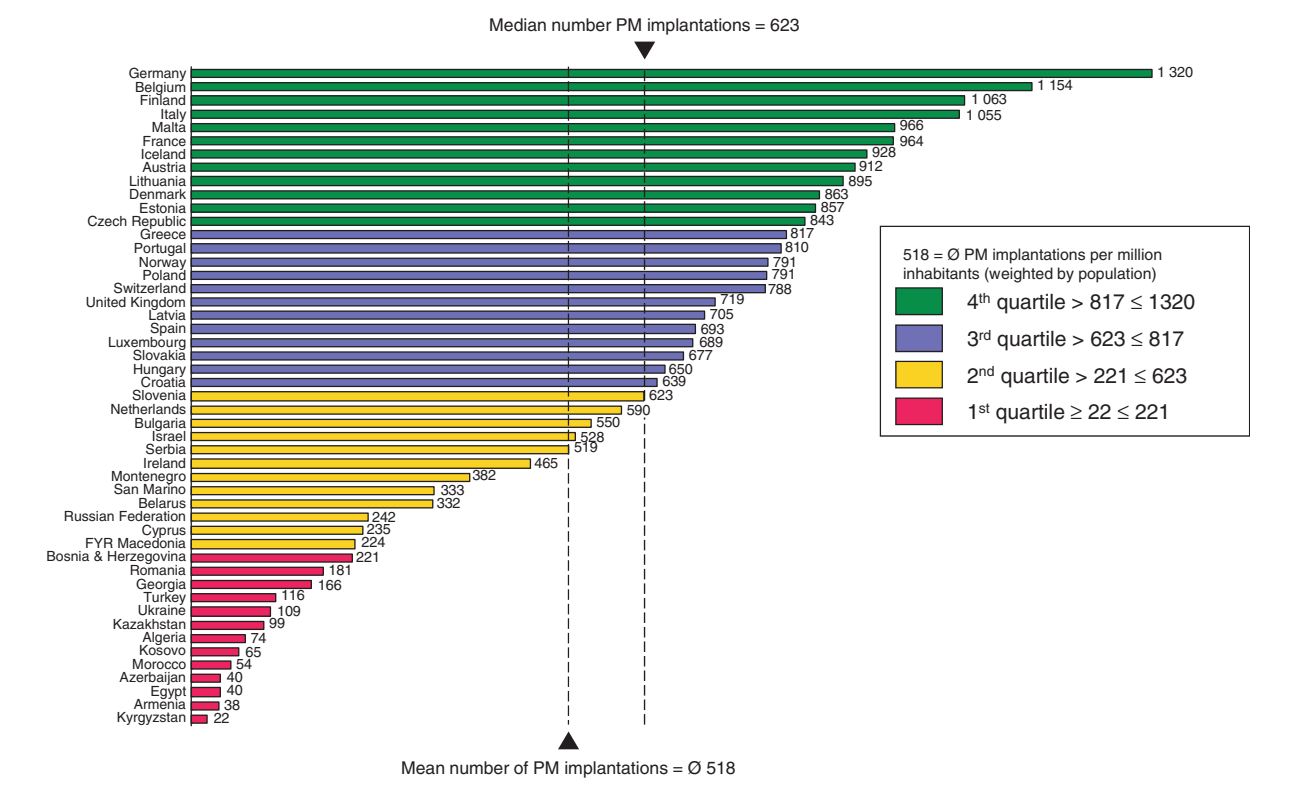

Figure 11 Pacemaker implantations per million inhabitants in the ESC countries in 2015. The mean number of implantations is weighted by population.

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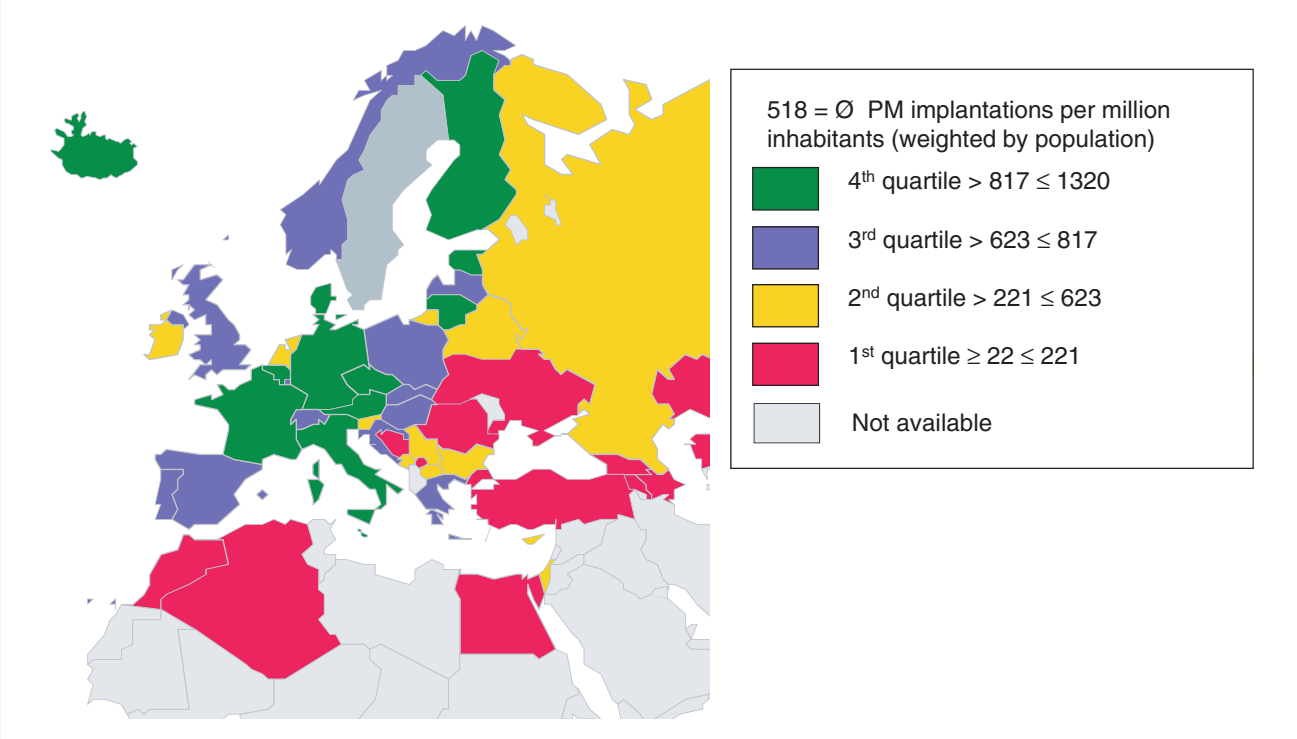

Figure 12 Pacemaker implantations per million inhabitants in the ESC countries in 2015. The mean number of implantations is weighted by population.

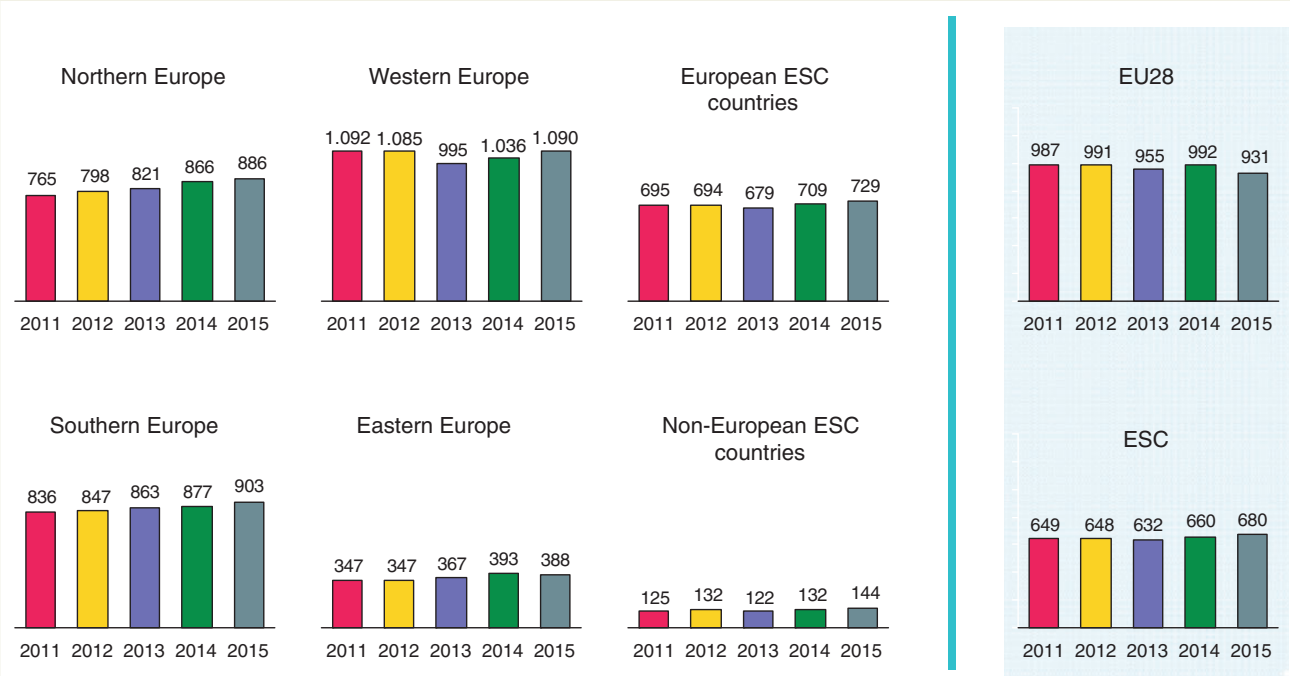

Figure 13 Pacemaker implantations per million inhabitants 2011–15 in the five geographical regions of the ESC and comparison with the total ESC area and the 28 member countries of the European Union (EU28).

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Figure 14 Pacemaker implantations per million inhabitants 2011–15 in Northern Europe. *No data available.

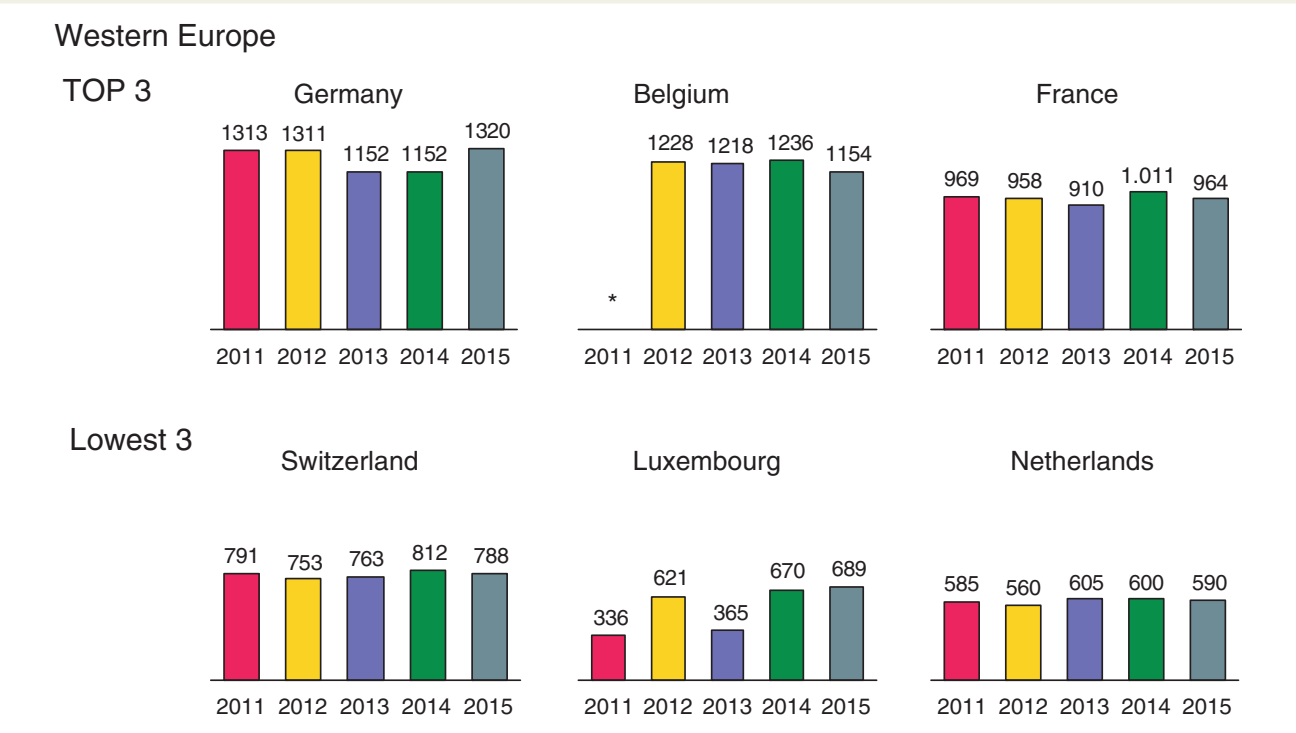

Figure 15 Pacemaker implantations per million inhabitants 2011–15 in Western Europe. *No data available.

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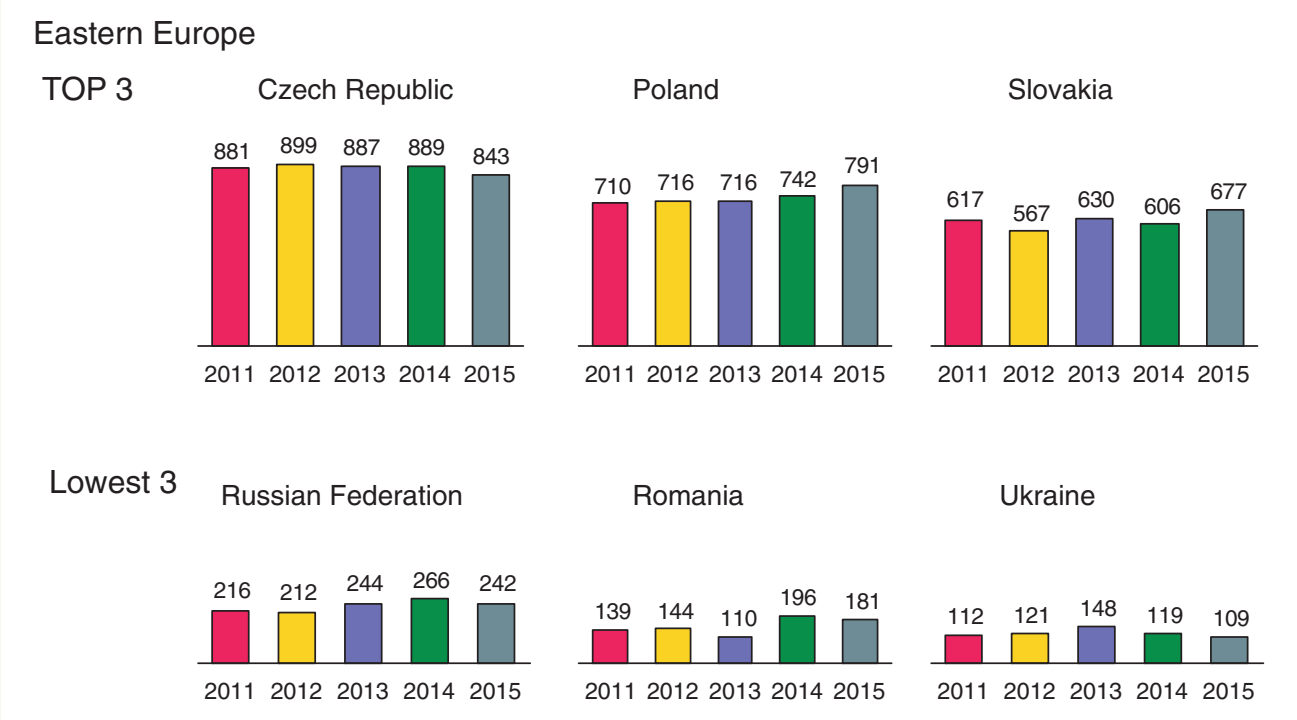

Figure 16 Pacemaker implantations per million inhabitants 2011–15 in Eastern Europe.

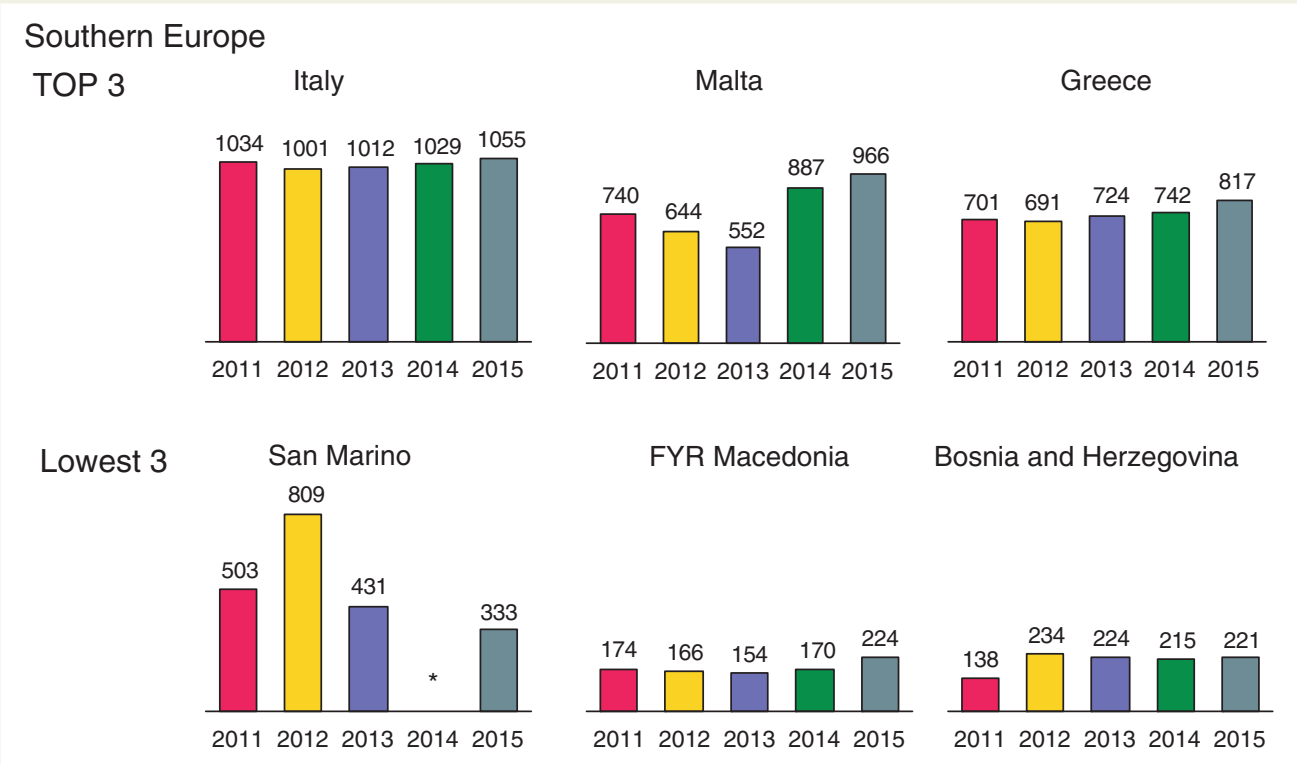

Figure 17 Pacemaker implantations per million inhabitants 2011–15 in Southern Europe. *No data available.

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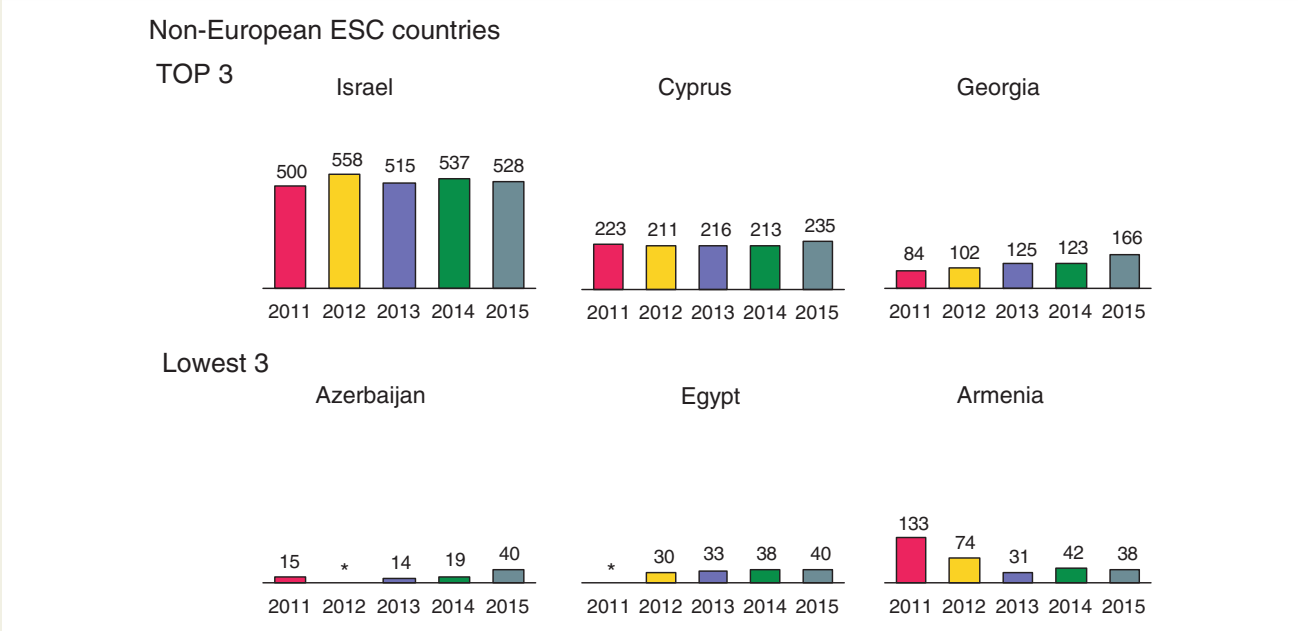

Figure 18 Pacemaker implantations per million inhabitants 2011–15 in the non-ESC countries. *No data available.

In 2015, the pass rate was 67% for physicians participating in the invasive electrophysiology examination and 62% for those participating in CIED examination. These numbers are markedly higher than in 2014 when the pass rate in the EP examination was 49% and in the CIED examination 51%.

The EHRA certification programme in cardiac device therapy for allied professionals was launched in 2011. Since then, 215 allied professionals from 14 countries have participated in the EHRA examination, and many of them have achieved full certification. Last year, the pass rate in the allied professional exam was 67%, which was lower than in 2014 (74%). Last year, most participants were from Italy (41). For allied professionals, the examination is currently available in six languages (English, Spanish, French, German, Italian, and Greek).

Pacemakers

General information

The 50 countries (89% of all ESC member countries) that submitted the requested data on pacemaker (PM) implantation for this year's edition of the EHRA White Book are listed in *Table 4*. Albania, Lebanon, Libya, Moldova, Syria, and Tunisia did not provide any PM data this year. A national registry for PM implantations was present in 23 countries, up 3 from the previous year (*Table 4*). The vast majority of implants were performed by cardiologists, and the remaining implantations were performed by physicians with various training backgrounds, including surgeons, anaesthesiologists, paediatricians, and internists. In three countries (Belarus, Slovenia, and Ukraine), the proportion of implanting cardiologists was <50% (*Table 5*).

Pacemaker facilities and procedure rate

It was reported that in 3660 centres, a total of 528 441 PMs were implanted in 2015 (*Table 4*), slightly up from the last year. The mean number of centres implanting PMs per million inhabitants was 3.85, slightly higher than the preceding year (*Figure 10*). The country with the highest density of implanting facilities, excluding San Marino, was Germany (14.0 per million inhabitants) followed by Luxembourg (10.5) and Belgium (9.2). Those with the lowest density were Egypt and Kyrgyzstan both with 0.4 per million and Morocco with 0.3 implanting centres per million inhabitants.

In 2015, the mean PM implantation rate in the participating ESC countries was 518 PM units per million inhabitants. The implantation rate was highest in Germany (1320), followed by Belgium (1154) and Finland (1063). The two countries with the lowest PM implantation rate were Armenia (38) and Kyrgyzstan (22). An overview of the PM implantation rate per million inhabitants for each country is shown in *Figures 11* and *12*. Across the 50 countries, heterogeneity was observed in the distribution of PM implantation rate per million inhabitants, as has been seen in the White Book PM data from previous years.

The number of PM implantations according to the five ESC regions and the trend in implantation rate in comparison with the 28 European Union member countries (EU28) and the whole ESC area from 2011 to 2015 are shown in *Figure 13*. Countries with the highest and lowest activities in each region as well as yearly trends are shown in *Figures 14–18*. The number of PM implantations per million inhabitants was highest in Western Europe and lowest in Eastern Europe and in the non-European ESC countries. The most active countries in each region were Germany (1320 per

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Table 6 Changes in the number of PM implantation centres in year 2014 vs. 2015

Country	ISO code	Number of PM implanting centres 2014		Number of PM implanting centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	4	1.32	N/A	N/A	N/A
Algeria	DZ	19	0.49	19	0.48	−1.8
Armenia	AM	3	0.98	2	0.65	−33.2
Austria	AT	57	6.93	57	6.58	−5.1
Azerbaijan	AZ	10	1.03	8	0.82	−20.8
Belarus	BY	10	1.04	10	1.05	1.2
Belgium	BE	104	9.95	104	9.18	−7.7
Bosnia and Herzegovina	BA	5	1.29	6	1.55	20.1
Bulgaria	BG	17	2.45	19	2.64	7.7
Croatia	HR	18	4.03	17	3.81	−5.4
Cyprus	CY	5	4.26	5	4.20	−1.4
Czech Republic	CZ	37	3.48	37	3.48	−0.2
Denmark	DK	11	1.98	15	2.69	36.1
Egypt	EG	33	0.38	33	0.37	−1.8
Estonia	EE	5	3.97	5	3.95	−0.6
Finland	FI	20	3.80	20	3.65	−3.8
France	FR	451	6.81	453	6.81	0.0
Georgia	GE	9	1.82	15	3.04	66.8
Germany	DE	980	12.10	1135	14.04	16.0
Greece	GR	56	5.20	56	5.20	0.0
Hungary	HU	18	1.81	18	1.82	0.2
Iceland	IS	2	6.30	2	6.03	−4.4
Ireland	IE	17	3.52	17	3.47	−1.2
Israel	IL	20	2.56	20	2.48	−2.8
Italy	IT	433	7.02	435	7.03	0.2
Kazakhstan	KZ	22	1.23	25	1.38	12.3
Kosovo	XK	2	1.08	3	1.60	49.1
Kyrgyzstan	KGZ	2	0.36	2	0.35	−1.1
Latvia	LV	3	1.39	3	1.51	9.0
Lebanon[a]	LB	15	3.63	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	4	1.14	5	1.73	51.9
Luxembourg	LU	5	9.60	6	10.52	9.6
FYR Macedonia	MK	3	1.43	3	1.43	−0.2
Malta	MT	1	2.42	1	2.42	−0.3
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	1	1.54	1	1.55	0.5
Morocco	MA	11	0.33	11	0.33	0.5
The Netherlands	NL	83	4.92	85	5.02	2.0
Norway	NO	23	4.47	23	4.42	−1.2
Poland	PL	150	3.91	145	3.76	−3.9
Portugal	PT	39	3.61	40	3.70	2.5
Romania	RO	24	1.10	24	1.11	0.3
Russian Federation	RU	140	0.98	140	0.98	0.0
San Marino	SM	N/A	N/A	1	30.28	N/A
Serbia	RS	17	2.36	17	2.37	0.5
Slovakia	SK	13	2.37	14	2.58	9.2
Slovenia	SI	7	3.52	9	4.54	28.9
Spain	ES	230	4.82	230	4.78	−0.8

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Table 6 *Continued*

Country	ISO code	Number of PM implanting centres 2014		Number of PM implanting centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Sweden	SE	45	4.63	44	4.49	−3.0
Switzerland	CH	76	9.43	71	8.74	−7.3
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	20	1.83	N/A	N/A	N/A
Turkey	TR	N/A	N/A	N/A	N/A	N/A
Ukraine	UA	36	0.81	38	0.86	5.2
UK	GB	207	3.25	211	3.29	1.4
Total ESC countries		**3523**	**3.69**	**3660**	**3.85**	**4.4**

[a]These six countries did not submit data for the EHRA White Book 2016.

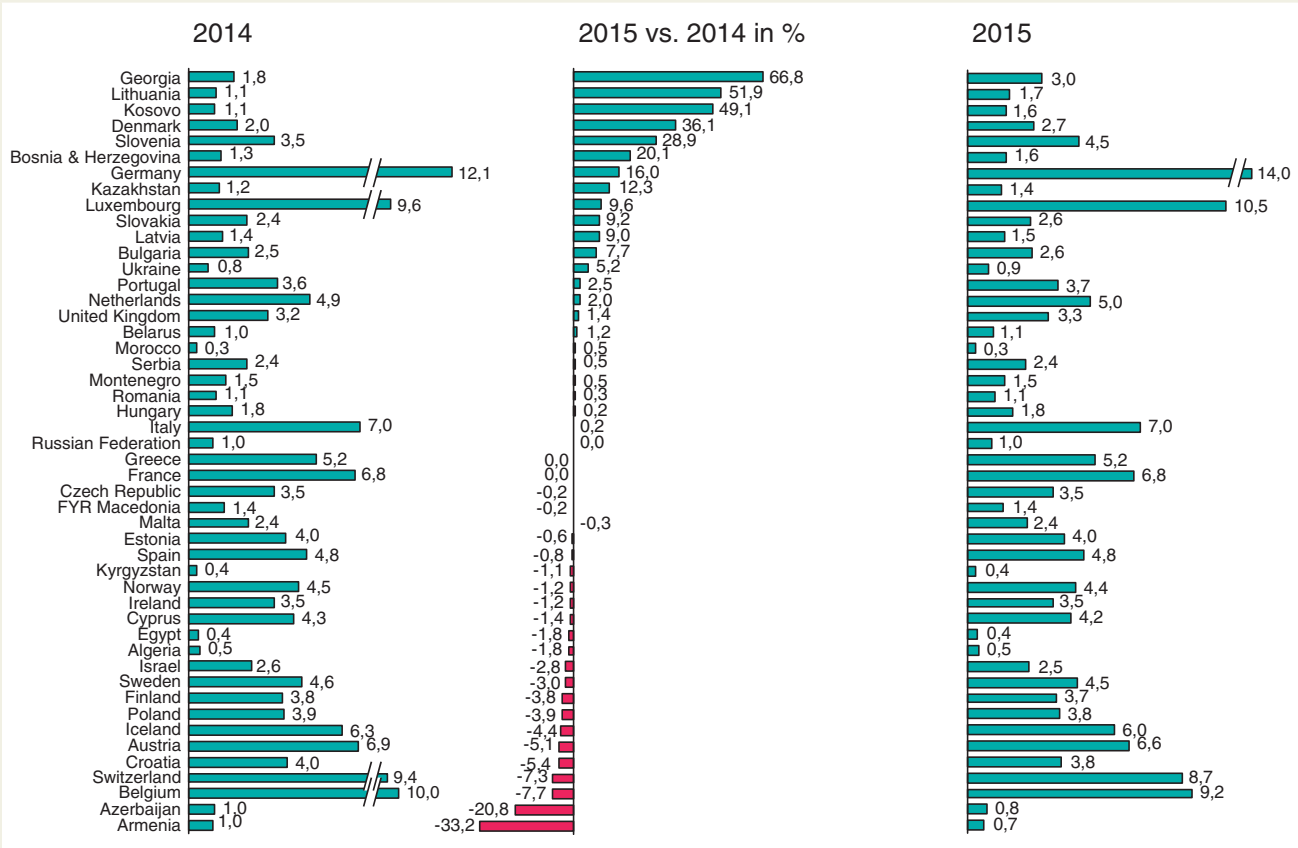

Figure 19 Change in the number of PM implanting centres per million inhabitants from 2014 to 2015.

million inhabitants), Finland (1063), Italy (1055), Czech Republic (843), and Israel (528).

The change in the number of implanting centres from 2014 to 2015 is shown in *Table 6* and *Figure 19*, and the change in the number of PM implantations per million inhabitants during the same period is presented in *Table 7* and *Figure 20*. The increase in the number of PM implantations was highest in those countries with rather small implantation numbers, Azerbaijan, Montenegro, and Georgia, but interestingly there was an almost 15% increase in PM implantation rates in Germany, the country with the highest implant rates in Europe. On the other hand, there was an almost 10% drop in the number of devices implanted in neighbouring Austria. The changes in the *de novo* PM implantation rate are shown separately in *Figure 21* and for PM generator replacements in *Figure 22*. The relationship between

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Table 7 Changes in PM implantations in year 2014 vs. 2015

Country	ISO code	Number of PM implantations 2014		Number of PM implantations 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	134	44	N/A	N/A	N/A
Algeria	DZ	2508	65	2915	74	14.1
Armenia	AM	129	42	117	38	−9.2
Austria	AT	8272	1006	7905	912	−9.3
Azerbaijan	AZ	184	19	395	40	112.6
Belarus	BY	2970	309	3149	332	7.3
Belgium	BE	12 912	1236	13 073	1154	−6.6
Bosnia and Herzegovina	BA	831	215	854	221	2.9
Bulgaria	BG	3726	538	3953	550	2.2
Croatia	HR	2601	582	2855	639	9.9
Cyprus	CY	250	213	280	235	10.4
Czech Republic	CZ	9447	889	8969	843	−5.2
Denmark	DK	4823	866	4818	863	−0.3
Egypt	EG	3320	38	3552	40	5.1
Estonia	EE	1054	838	1085	857	2.3
Finland	FI	5536	1051	5821	1063	1.2
France	FR	67 000	1011	64 176	964	−4.6
Georgia	GE	608	123	817	166	34.5
Germany	DE	93 315	1152	106 700	1320	14.5
Greece	GR	8000	742	8800	817	10.0
Hungary	HU	6393	645	6432	650	0.8
Iceland	IS	298	939	308	928	−1.2
Ireland	IE	N/A	N/A	2277	465	N/A
Israel	IL	4200	537	4250	528	−1.7
Italy	IT	63 442	1029	65 234	1055	2.5
Kazakhstan	KZ	2355	131	1801	99	−24.4
Kosovo	XK	127	68	122	65	−4.5
Kyrgyzstan	KGZ	126	22	126	22	−1.1
Latvia	LV	1236	571	1400	705	23.4
Lebanon[a]	LB	900	218	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	2767	789	2583	895	13.5
Luxembourg	LU	349	670	393	689	2.8
FYR Macedonia	MK	356	170	470	224	31.8
Malta	MT	366	887	400	966	8.9
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	182	280	247	382	36.3
Morocco	MA	1465	44	1801	54	23.5
The Netherlands	NL	10 132	600	10 000	590	−1.7
Norway	NO	3887	755	4121	791	4.8
Poland	PL	28 470	742	30 494	791	6.5
Portugal	PT	8830	817	8769	810	−0.8
Romania	RO	4258	196	3918	181	−7.7
Russian Federation	RU	37 832	266	34 492	242	−8.8
San Marino	SM	N/A	N/A	11	333	N/A
Serbia	RS	3657	507	3724	519	2.3
Slovakia	SK	3326	606	3664	677	11.7
Slovenia	SI	1464	736	1235	623	−15.4

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Table 7 *Continued*

Country	ISO code	Number of PM implantations 2014		Number of PM implantations 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Spain	ES	36 322	761	33 373	693	−8.9
Sweden	SE	9421	969	N/A	N/A	N/A
Switzerland	CH	6543	812	6401	788	−2.9
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	2200	201	N/A	N/A	N/A
Turkey	TR	7300	89	9200	116	29.5
Ukraine	UA	5258	119	4851	109	−8.0
UK	GB	45 131	708	46 110	719	1.6
Total ESC countries		**526 213**	**508**	**528 441**	**518**	**2.1**

[a]These six countries did not submit data for the EHRA White Book 2016.

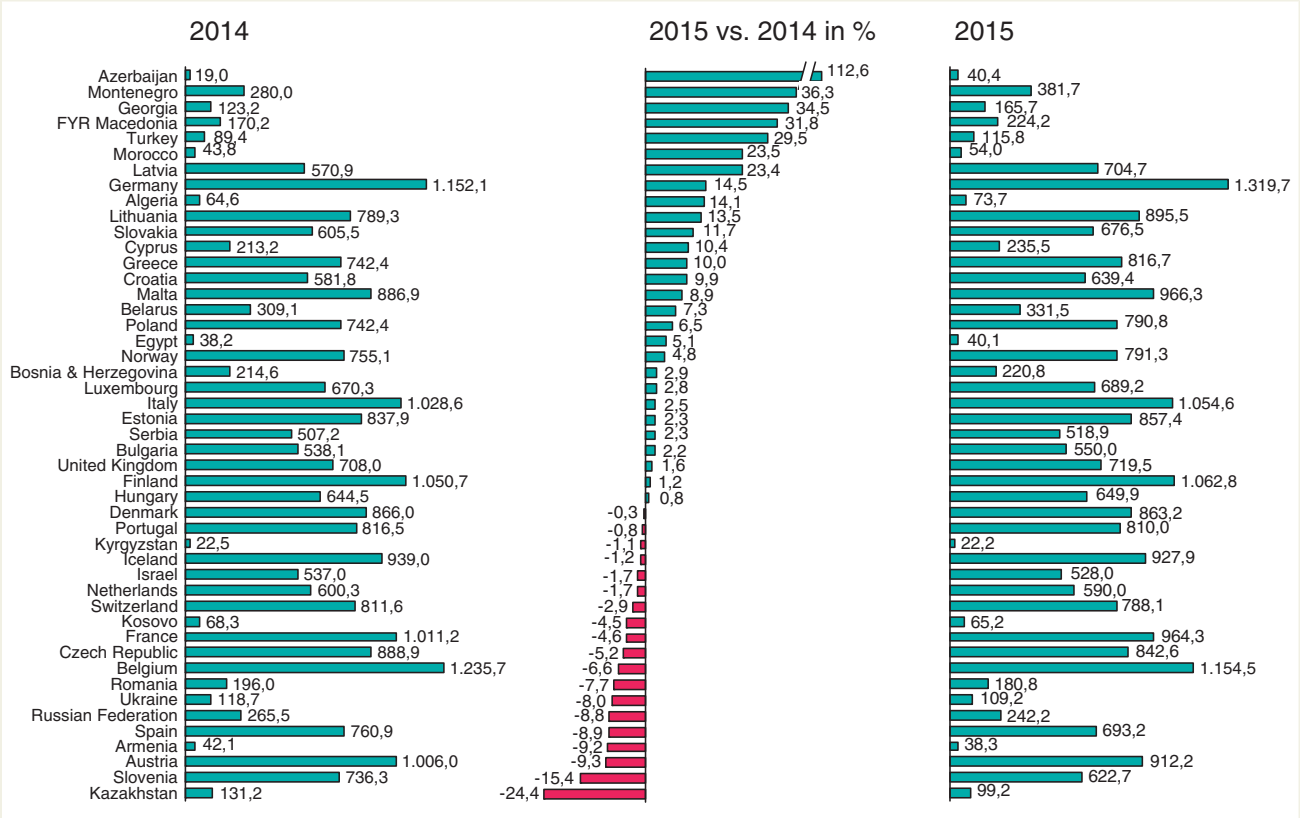

Figure 20 Change in the number of PM implantations per million inhabitants from 2014 to 2015.

the mean annual PM implantation rate per million inhabitants and the number of PM implanting centres per million inhabitants in the 56 ESC countries and in the EU28 is shown in *Figure 23*.

Leadless pacing

Leadless pacing is a new therapeutic modality[10,11] which has just been introduced in most ESC countries. This is the first time that data on leadless PM implantations have been collected for the EHRA White Book. According to the EHRA White Book survey, a total of 244 leadless PMs were implanted in 9 countries in 2015. No leadless PMs were implanted in 23 countries, and data on these devices were not available from 24 ESC countries. The most active countries in the ESC area with regard to leadless PM implantations were France, the Netherlands, and Hungary, but the implantation rates were rather low also in these early adopters (*Figure 24*).

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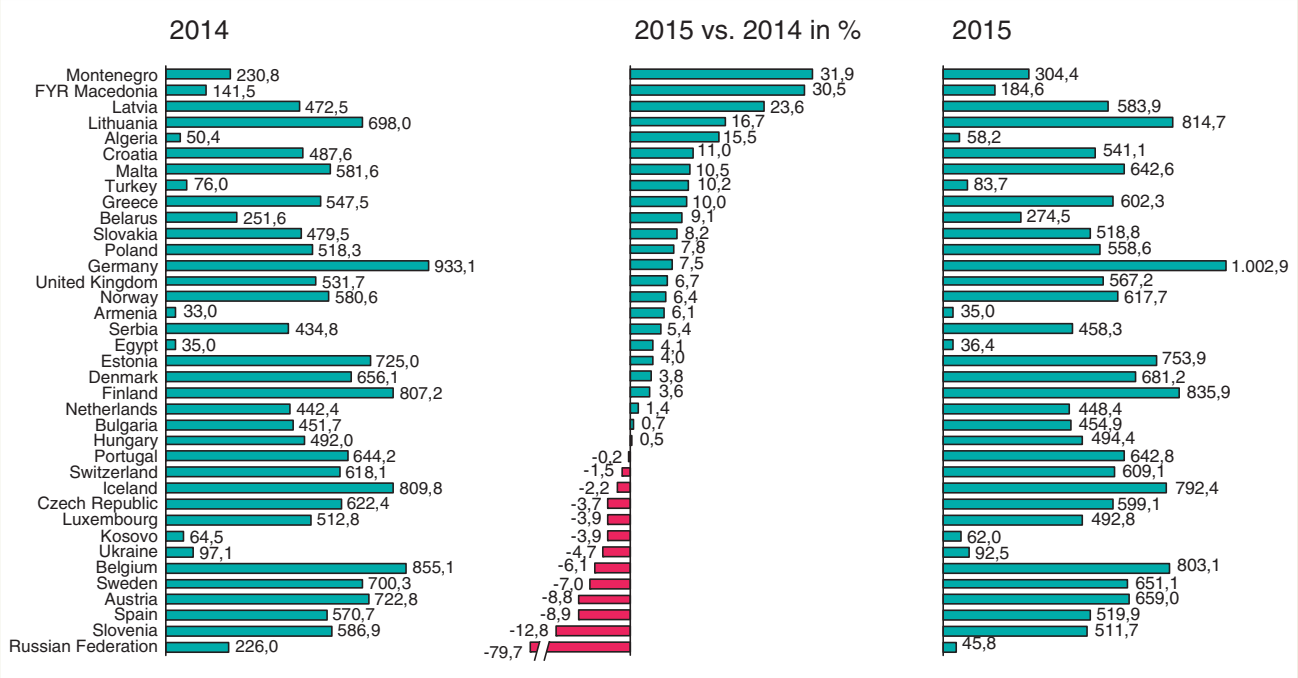

Figure 21 Change in the number of new PM implantations per million inhabitants from 2014 to 2015.

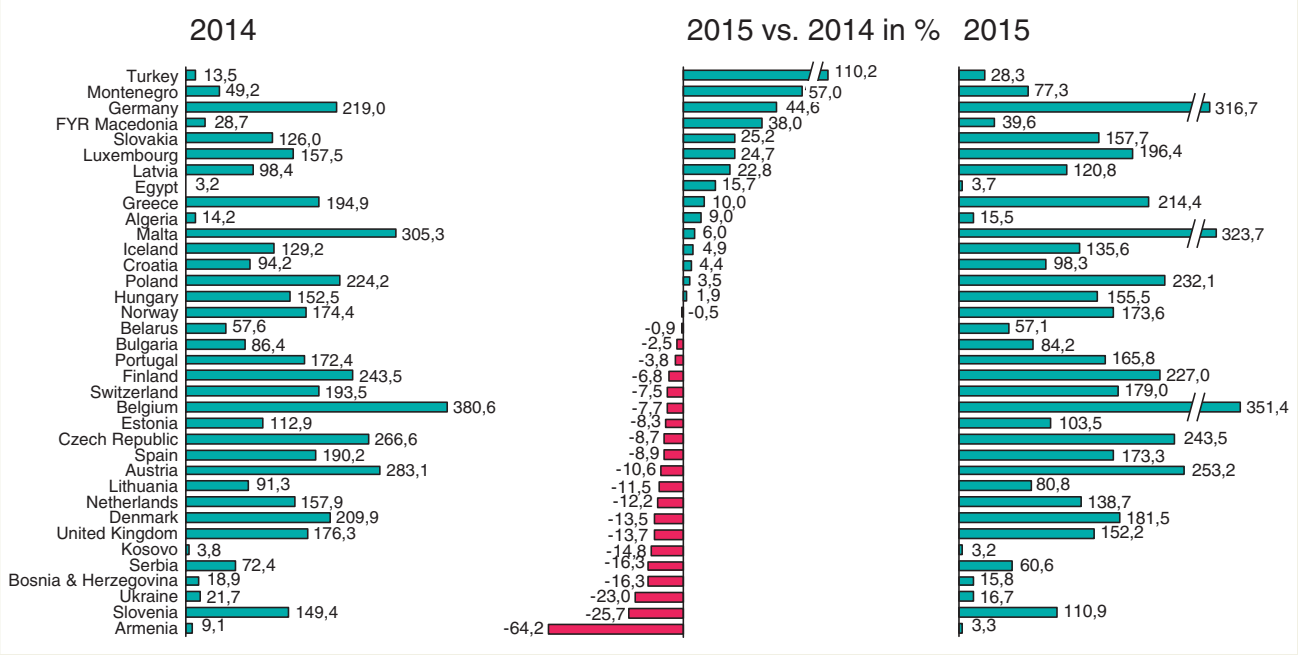

Figure 22 Change in the number of PM replacements per million inhabitants from 2014 to 2015.

Implantable cardioverter-defibrillators

General information

The 50 countries (89%) that submitted data for the EHRA White Book on implantable cardioverter-defibrillators (ICDs) in 2015 are listed in *Table 8*. Albania, Lebanon, Libya, Moldova, Syria, and Tunisia did not provide data on ICD implantations, while Sweden provided only limited data. In 25 countries, a national registry for ICD implantations was in use. The vast majority of implants were performed by cardiologists, and the remaining implantations were performed by physicians having various other training backgrounds, mainly surgical. However, in some countries (Austria, Belarus, and

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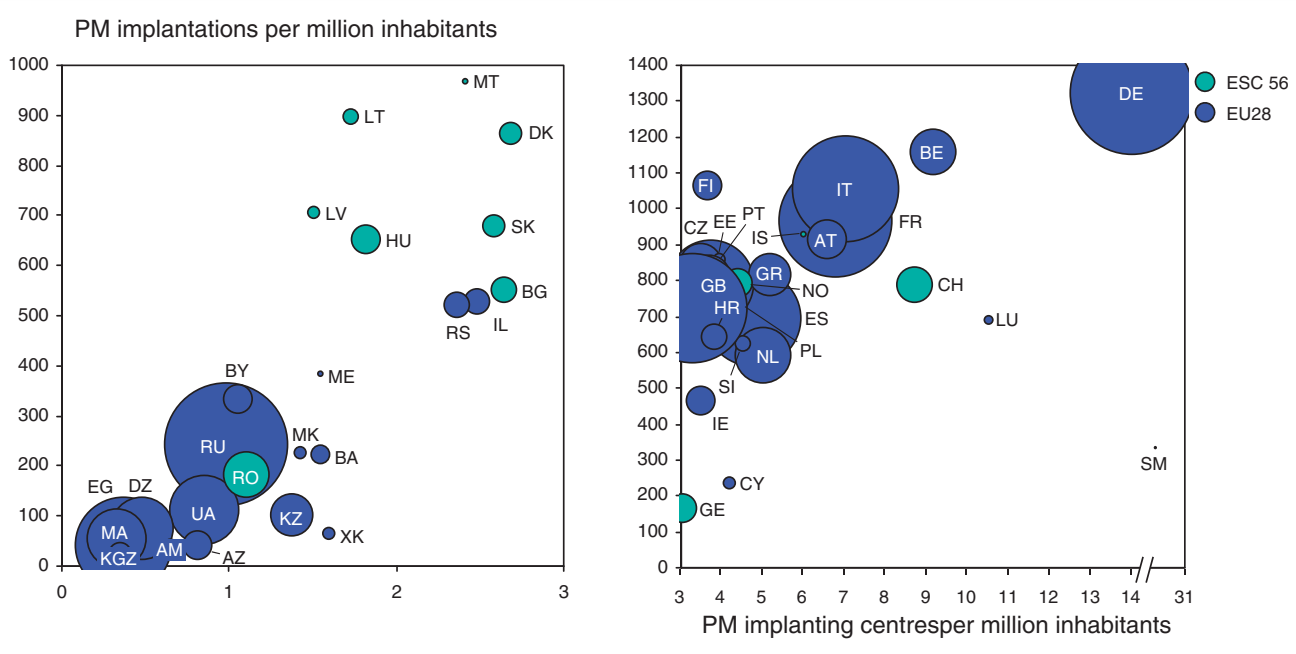

Figure 23 Pacemaker implantation centres and rates in the ESC and European Union (EU28) member countries in 2015. Bubble size is related to population in the country. The ISO codes of the countries are explained in *Table 1*.

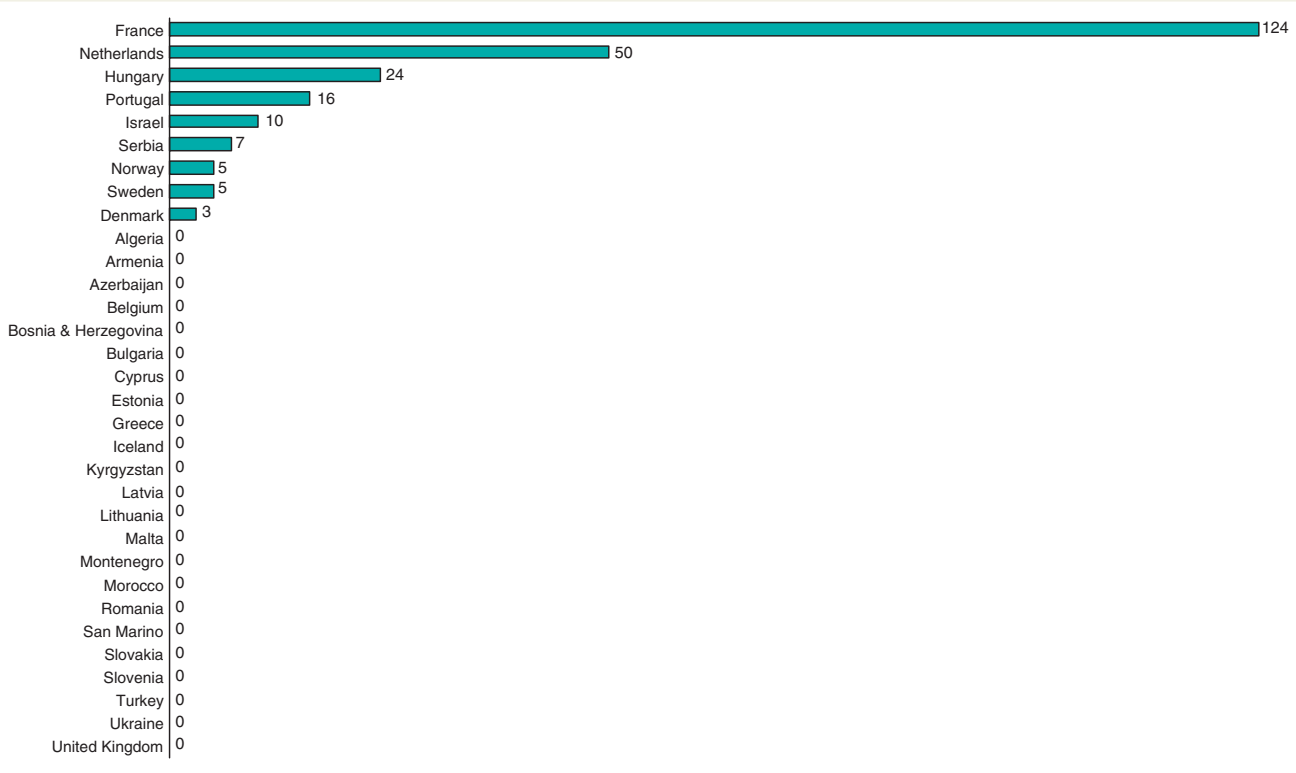

Figure 24 Number of leadless PM implantations in 2015.

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Table 8 Implantable cardioverter-defibrillator implantation facilities and rates in 2015 and comparison with 4 previous years

Country	ISO code	National registry for ICD implants	Number of ICD implanting centres 2015		ICD implantations 2015		Development potential—target number of ICD implantations		ICD implantations per mil inhabitants				
			Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A
Algeria	DZ	No	9	0.23	91	2	4030	6992	N/A	N/A	1	2	2
Armenia	AM	No	3	0.98	21	7	311	540	12	N/A	9	8	7
Austria	AT	Yes	21	2.42	1393	161	–	1532	220	145	158	166	161
Azerbaijan	AZ	No	7	0.72	21	2	997	1729	2	N/A	1	2	2
Belarus	BY	No	10	1.05	133	14	968	1680	14	12	16	18	14
Belgium	BE	Yes	23	2.03	1531	135	–	2002	197	210	163	154	135
Bosnia and Herzegovina	BA	No	6	1.55	87	22	394	684	13	14	17	14	22
Bulgaria	BG	Yes	10	1.39	51	7	732	1271	8	7	5	7	7
Croatia	HR	No	11	2.46	388	87	455	789	19	26	35	39	87
Cyprus	CY	No	4	3.36	75	63	121	210	58	46	52	62	63
Czech Republic	CZ	Yes	18	1.69	2039	192	–	–	270	277	301	201	192
Denmark	DK	Yes	6	1.07	1208	216	–	–	198	218	231	217	216
Egypt	EG	No	17	0.19	253	3	9018	15 647	N/A	2	2	3	3
Estonia	EE	No	2	1.58	91	72	129	224	45	79	82	76	72
Finland	FI	No	18	3.29	1198	219	–	–	134	166	194	220	219
France	FR	No	161	2.42	7825	118	–	11 768	102	106	N/A	207	118
Georgia	GE	No	12	2.43	140	28	503	872	5	12	12	21	28
Germany	DE	No	745	9.21	28 914	358	–	–	326	326	336	295	358
Greece	GR	Yes	24	2.23	1188	110	–	1905	83	87	97	100	110
Hungary	HU	Yes	13	1.31	986	100	1009	1750	80	85	95	96	100
Iceland	IS	No	1	3.01	59	178	–	–	113	134	171	186	178
Ireland	IE	Yes	17	3.47	740	151	–	865	140	144	153	N/A	151
Israel	IL	Yes	20	2.48	1300	162	–	1423	156	137	166	215	162
Italy	IT	Yes	396	6.40	14 709	238	–	–	196	196	204	223	238
Kazakhstan	KZ	No	19	1.05	527	29	1850	3211	N/A	7	12	22	29
Kosovo	XK	No	1	0.53	12	6	191	331	N/A	N/A	N/A	2	6
Kyrgyzstan	KGZ	N/A	2	0.35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Latvia	LV	Yes	3	1.51	90	45	202	351	29	32	40	35	45
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	73	73	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	No	3	1.04	123	43	294	510	33	42	35	38	43
Luxembourg	LU	Yes	1	1.75	65	114	–	101	99	149	138	119	114
FYR Macedonia	MK	No	3	1.43	29	14	214	371	13	7	6	5	14
Malta	MT	No	1	2.42	35	85	42	73	71	132	163	87	85

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Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A
Montenegro	ME	No	1	1.55	53	82	66	114	47	44	58	63	82
Morocco	MA	N/A	6	0.18	57	2	3396	5892	1	1	1	1	2
The Netherlands	NL	Yes	29	1.71	3500	207	–	–	155	160	244	212	207
Norway	NO	Yes	11	2.11	1214	233	–	–	184	199	214	220	233
Poland	PL	No	122	3.16	8526	221	–	–	157	182	234	219	221
Portugal	PT	Yes	29	2.68	1224	113	–	1914	95	92	N/A	N/A	113
Romania	RO	No	16	0.74	300	14	2208	3831	8	8	9	15	14
Russian Federation	RU	Yes	48	0.34	1553	11	14 515	25 184	10	11	13	12	11
San Marino	SM	Yes	1	30.28	8	242	–	–	597	404	616	N/A	242
Serbia	RS	Yes	11	1.53	437	61	731	1269	44	38	62	63	61
Slovakia	SK	Yes	4	0.74	665	123	–	958	100	105	108	120	123
Slovenia	SI	Yes	3	1.51	228	115	–	351	72	61	71	88	115
Spain	ES	Yes	180	3.74	5348	111	–	8513	74	73	82	81	111
Sweden	SE	N/A	30	3.06	N/A	N/A	N/A	N/A	N/A	193	198	216	N/A
Switzerland	CH	Yes	49	6.03	1830	225	–	–	142	195	201	166	225
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	9	N/A	13	N/A
Turkey[a]	TR	No	N/A	N/A	6381	80	8093	14 042	N/A	N/A	N/A	77	80
Ukraine	UA	No	14	0.32	52	1	4528	7856	1	1	2	1	1
UK	GB	Yes	125	1.95	6701	105	–	11 332	86	91	92	102	105
Total ESC countries			**2266**	**2.38**	**103 399**	**102**			**102**	**106**	**108**	**118**	**113**

[a]These six countries did not submit any data on ICD implantations for the EHRA White Book 2016.

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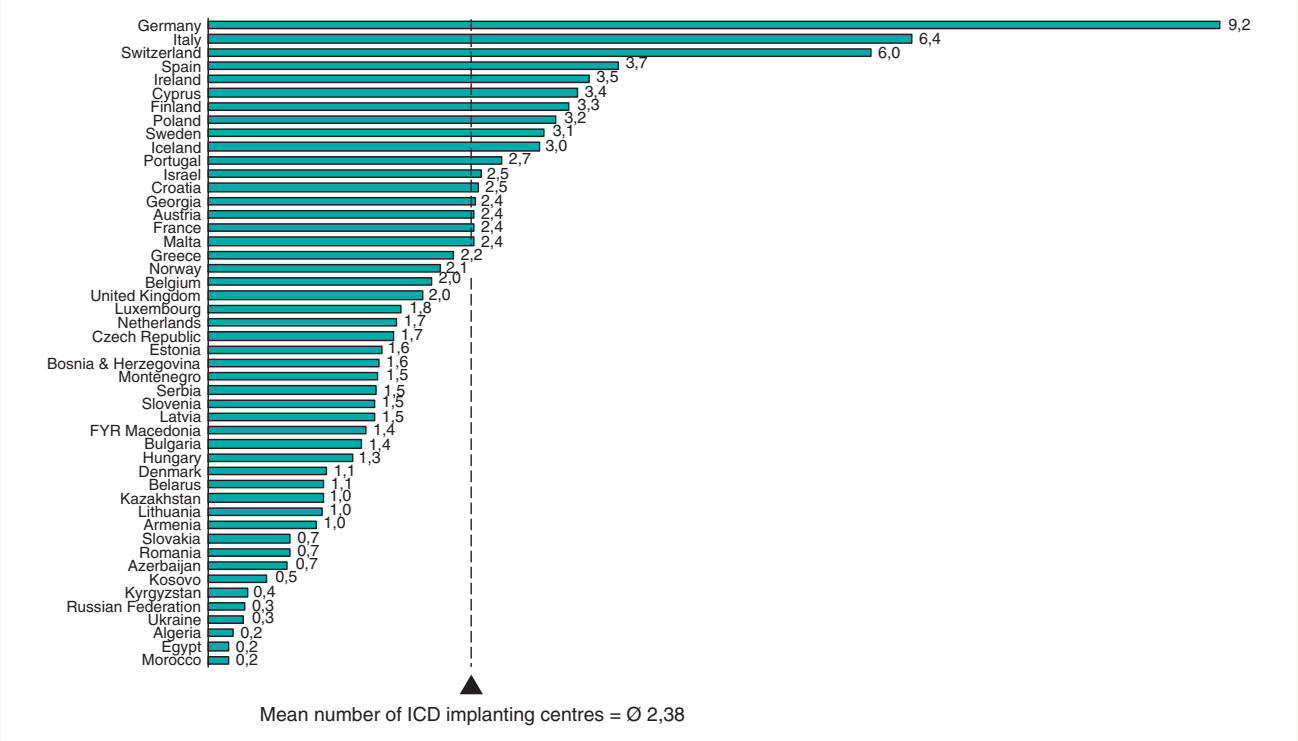

Figure 25 Implantable cardioverter-defibrillator implanting centres per million inhabitants in 2015. The mean number of implantation centres is weighted by population.

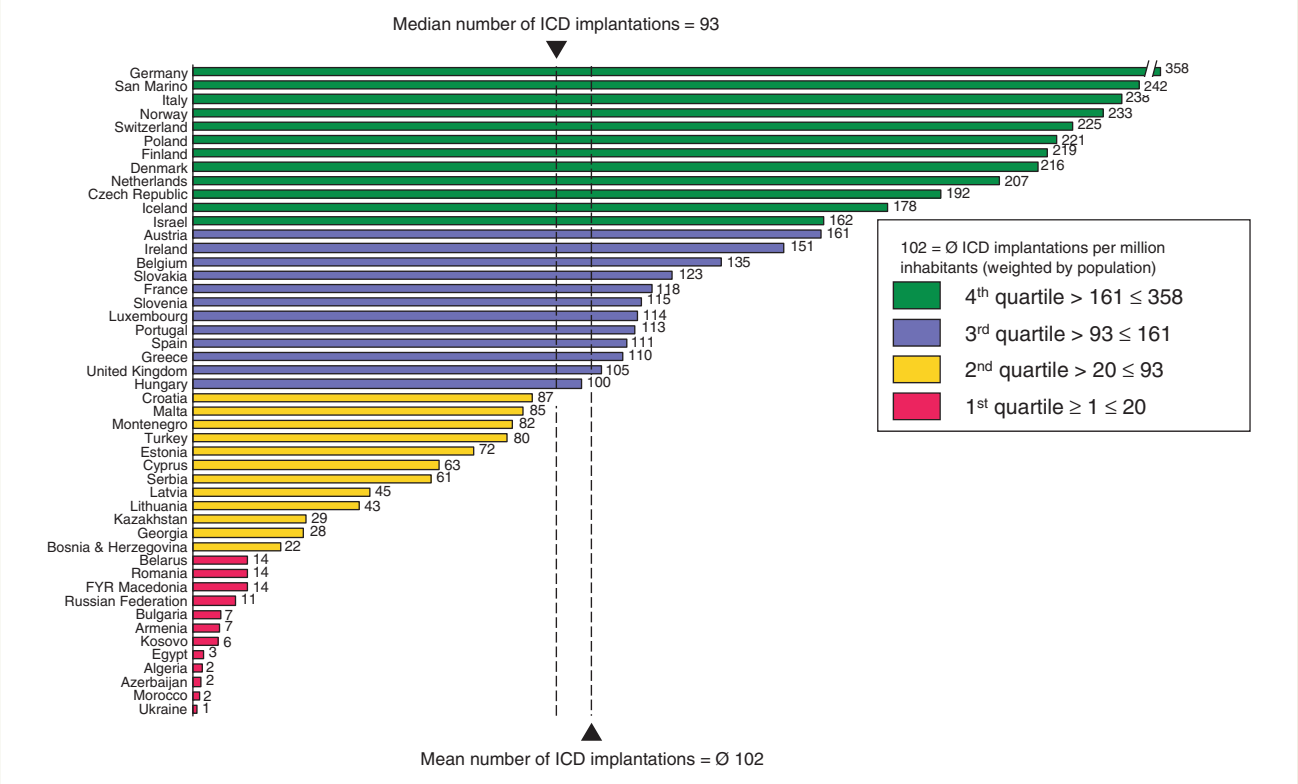

Figure 26 Implantable cardioverter-defibrillator implantations per million inhabitants in 2015. The mean number of implantations is weighted by population.

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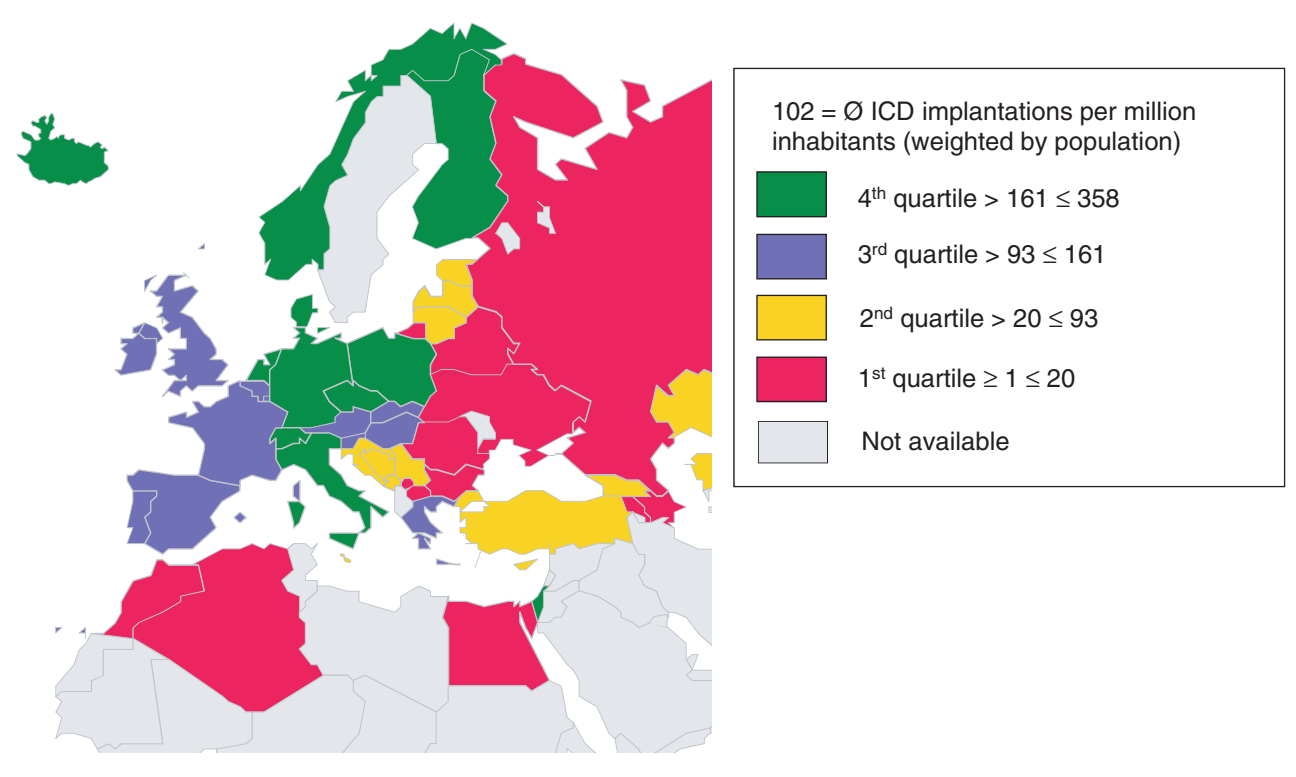

Figure 27 Implantable cardioverter-defibrillator implantations in the ESC countries in 2015.

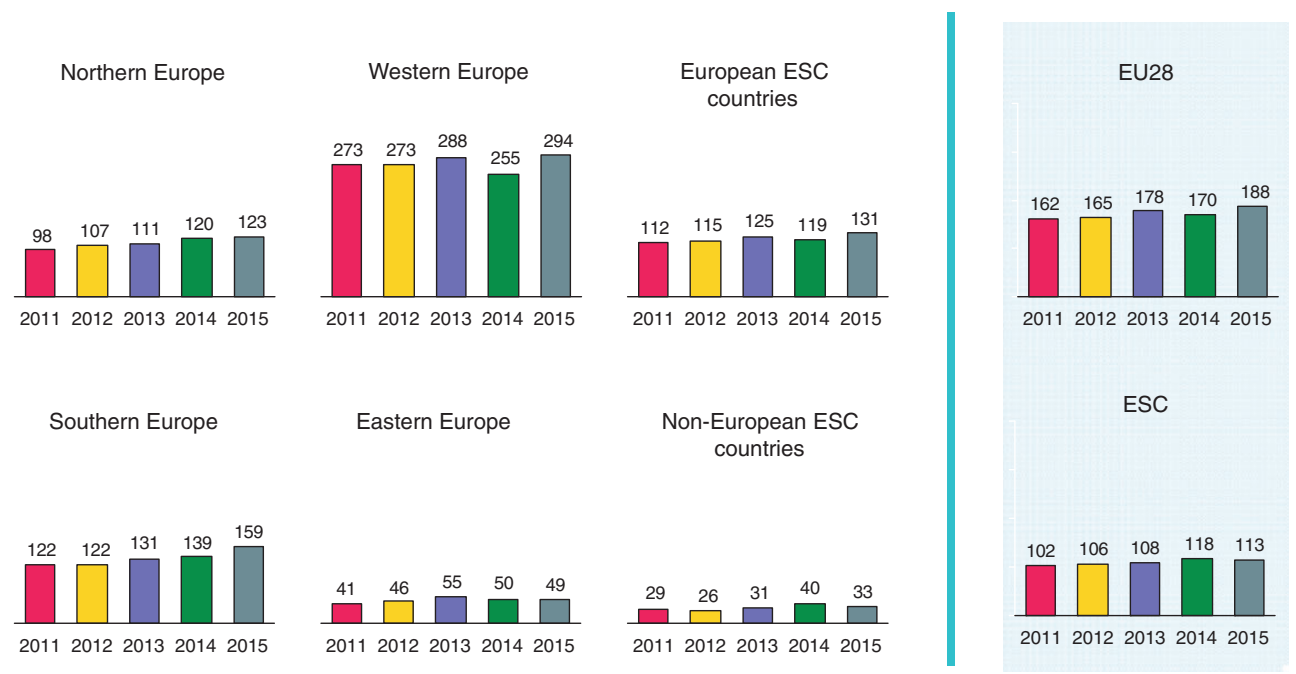

Figure 28 Implantable cardioverter-defibrillator implantations per million inhabitants 2011–15 in the five geographical regions of the ESC and comparison with the total ESC area and the 28 member countries of the European Union (EU28).

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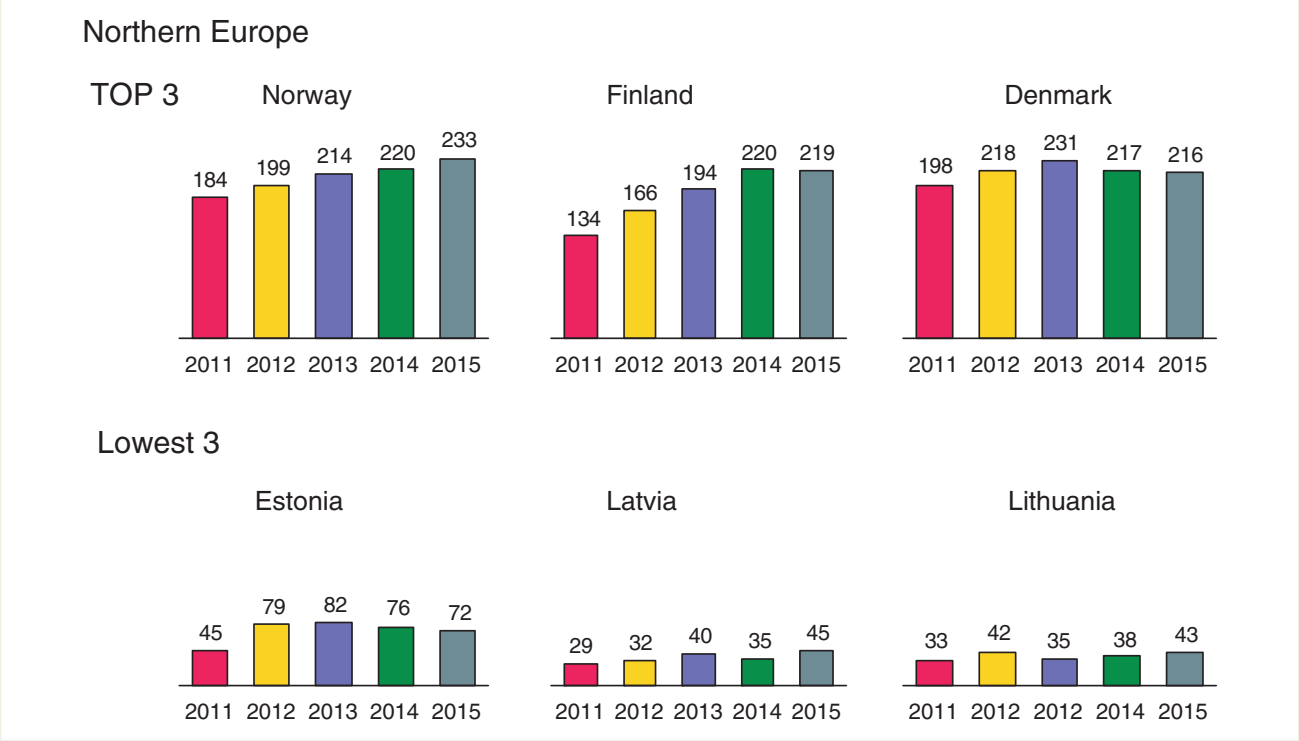

Figure 29 Implantable cardioverter-defibrillator implantations per million inhabitants 2011–15 in Northern Europe.

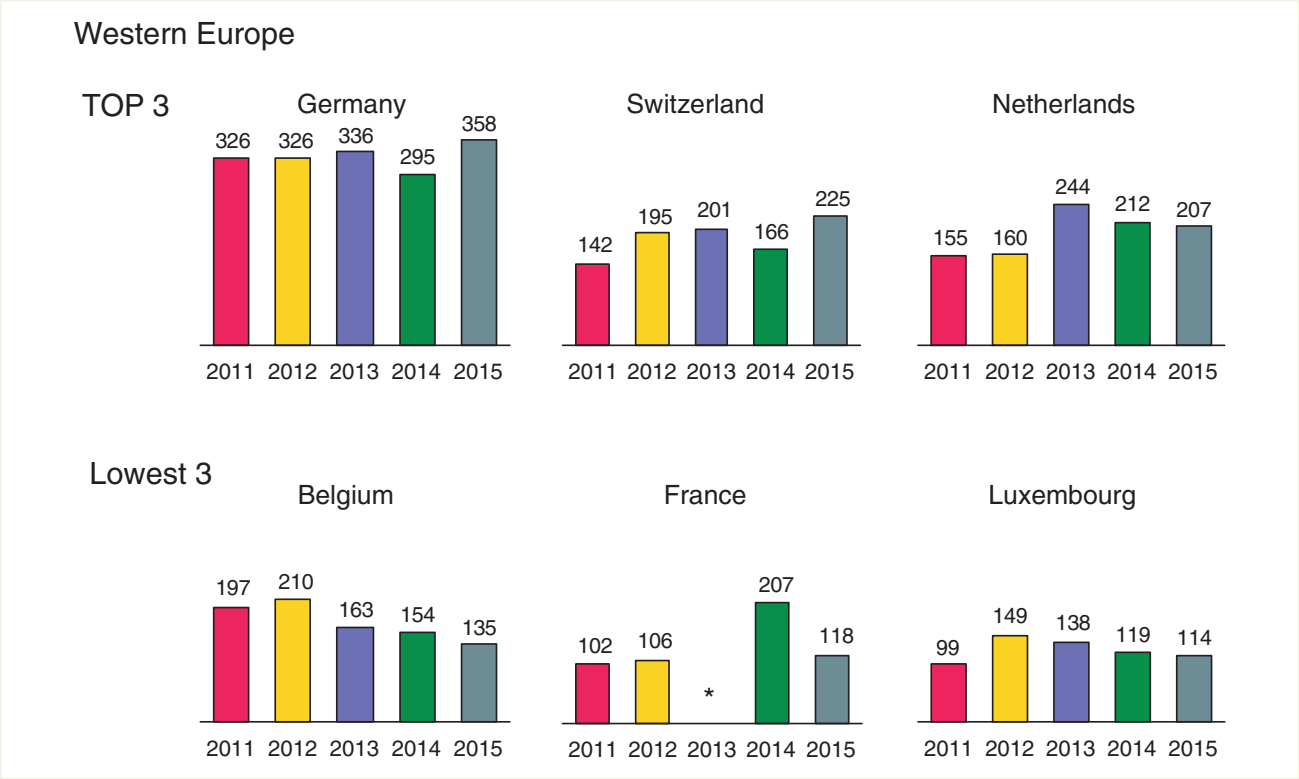

Figure 30 Implantable cardioverter-defibrillator implantations per million inhabitants 2011–15 in Western Europe. *No data available.

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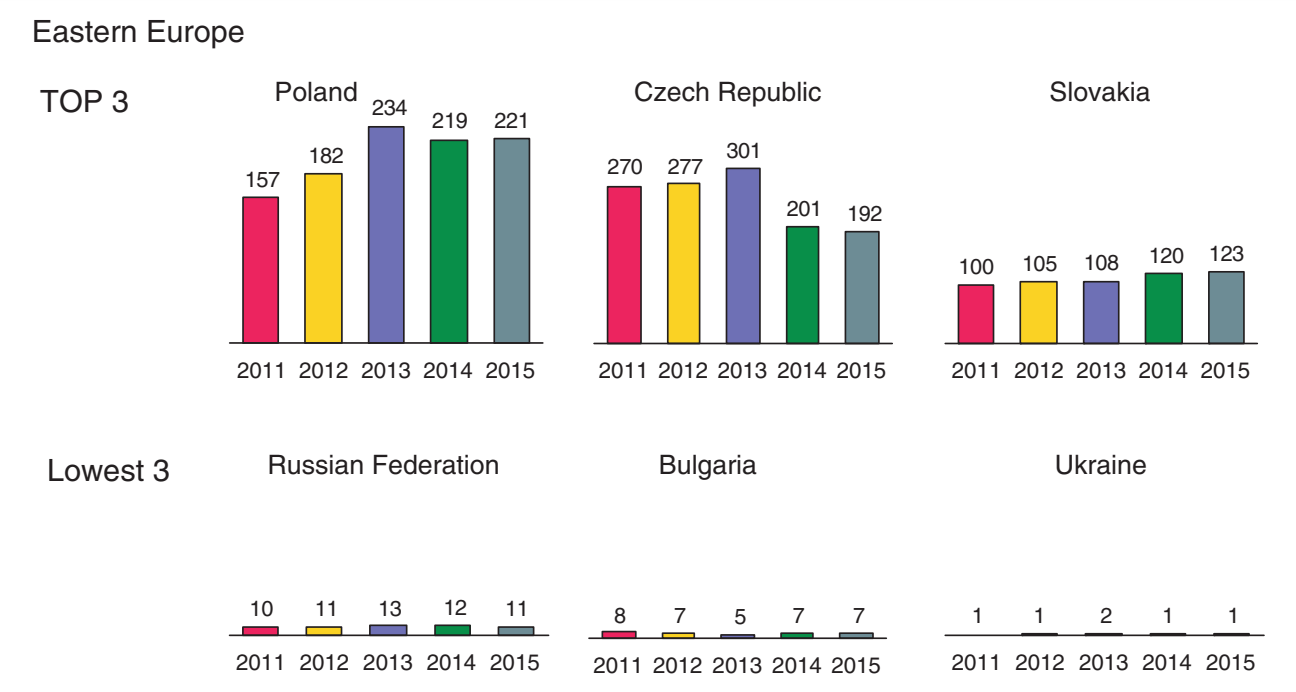

Figure 31 Implantable cardioverter-defibrillator implantations per million inhabitants 2011–15 in Eastern Europe.

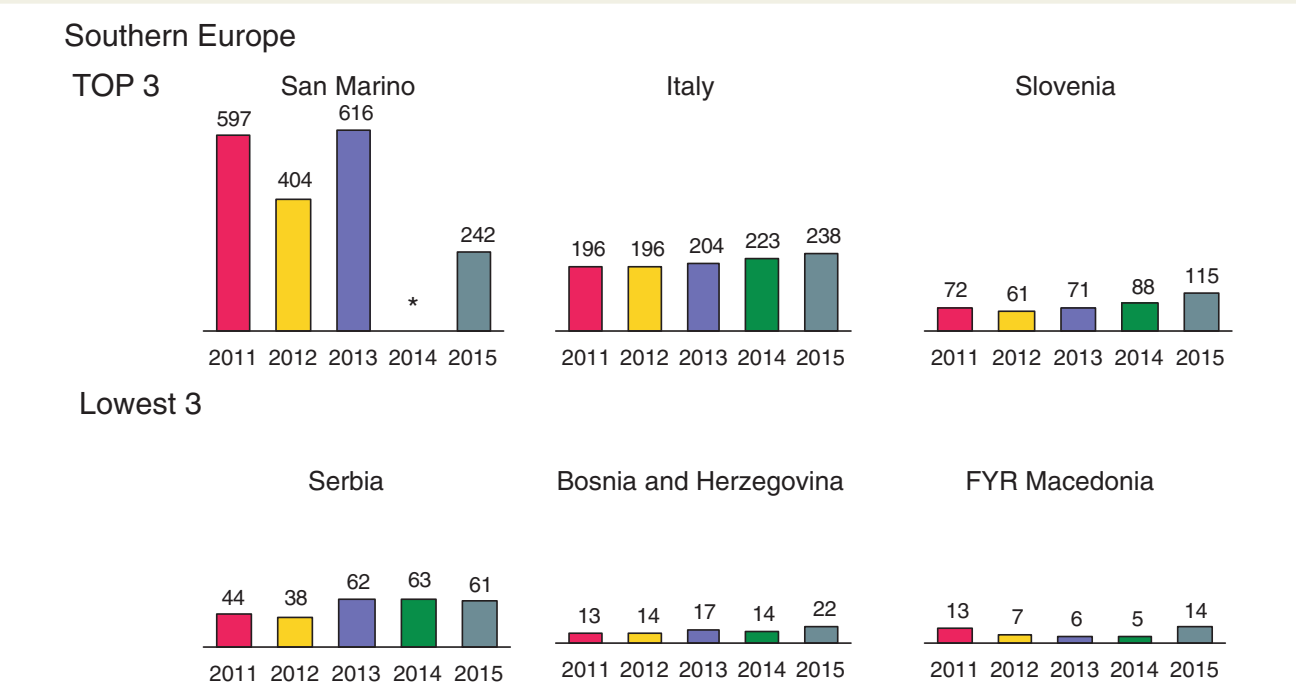

Figure 32 Implantable cardioverter-defibrillator implantations per million inhabitants 2011–15 in Southern Europe. *No data available.

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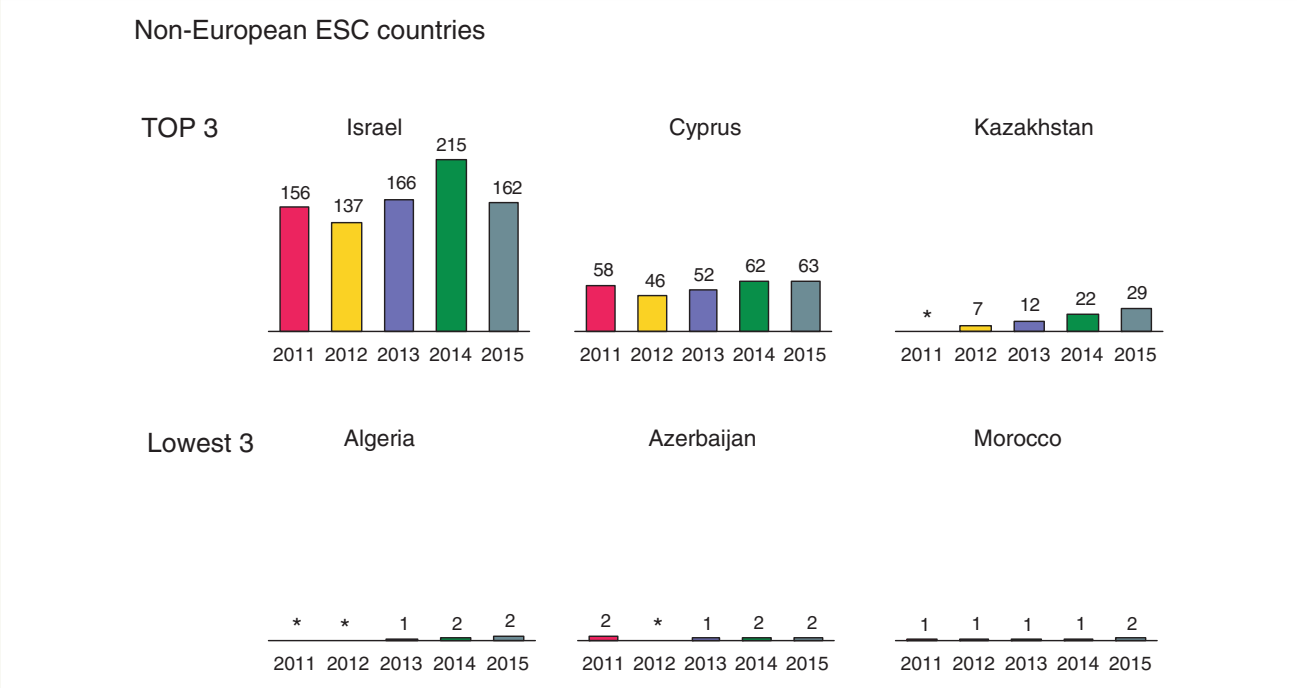

Figure 33 Implantable cardioverter-defibrillator implantations per million inhabitants 2011–15 in the non-European ESC countries. *No data available.

Ukraine), the proportion of implanting cardiologists was <50% (*Table 5*).

Implantable cardioverter-defibrillator facilities and procedure rates

It was reported that in 2266 national centres, a total of 103 399 ICDs were implanted in 2015 (*Table 8*), an almost 2% increase from 2014. *Table 8* also shows a comparison with the previous 4 years in each country. As shown in *Figure 25*, the mean number of implanting centres in the ESC area was 2.38 per country. In the ESC area, the mean number of ICD implantations per million inhabitants in 2015 was 102. In *Figures 26* and *27*, the ESC countries are grouped into quartiles according to the number of ICD implantations per million inhabitants. Germany (358 per million inhabitants) had by far the highest implant rate followed by San Marino (242), Italy (238), and Norway (233). The lowest reported implant rate was in Ukraine (one per million inhabitants).

The number of ICD implantations according to the five ESC regions and the trend from 2011 to 2015, compared with the EU28 and the whole ESC area, is shown in *Figure 28*. In Western Europe (294), the number of ICD implantations per million inhabitants was almost twice higher than in any other ESC region. Implantable cardioverter-defibrillator implantation rate also exceeds 100 per million population in the Southern (159), Northern (123), and European regions. The top and bottom three countries within the five ESC regions are shown in *Figures 29–33*. The most active countries in each region were Germany (358 per million inhabitants) in the west, Norway (233) in the north, Poland (221) in the east, San Marino (242) and Italy (238) in the south, and Israel (162) in the non-European ESC region.

The changes in the number of implanting centres from 2014 to 2015 are shown in *Table 9* and *Figure 34*, and the change in the number of ICD implantations per million inhabitants during the same period is presented in *Table 10* and *Figure 35*. These numbers are divided into *de novo* implantations and ICD generator replacements in *Figures 36* and *37*.

The relationship between the annual ICD implantation rate per million inhabitants and the number of ICD implanting centres per million inhabitants in the EU28 countries and the ESC area is shown in *Figure 38*.

Subcutaneous implantable cardioverter-defibrillator implantations

Subcutaneous ICD (S-ICD) is a novel therapeutic modality for prevention of sudden cardiac death. The device is implanted entirely under the skin avoiding the need for intravascular leads. It is best suited for patients with no need for pacing and increased risk for transvenous lead complications.[12,13]

This is the first time that data on S-ICD implantations have been collected for the EHRA White Book. As with the other new therapies and procedures, the response rate for this question in the EHRA White Book survey was markedly lower than that of the conventional arrhythmia treatments. A total of 1049 S-ICDs were implanted in 13 countries in 2015. No S-ICDs were implanted in 24 countries, and 19 countries reported no data on these devices. The most active countries with regard to the S-ICD implantations were Italy with 561 implantations followed by the UK (196 implantations) and the Netherlands (150 implantations) (*Figure 39*).

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Table 9 Changes in the number of ICD implantation centres in year 2014 vs. 2015

Country	ISO code	Number of ICD implanting centres 2014		Number of ICD implanting centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	2	0.66	N/A	N/A	N/A
Algeria	DZ	8	0.21	9	0.23	10.4
Armenia	AM	3	0.98	3	0.98	0.1
Austria	AT	21	2.55	21	2.42	−5.1
Azerbaijan	AZ	7	0.72	7	0.72	−1.0
Belarus	BY	10	1.04	10	1.05	1.2
Belgium	BE	23	2.20	23	2.03	−7.7
Bosnia and Herzegovina	BA	5	1.29	6	1.55	20.1
Bulgaria	BG	9	1.30	10	1.39	7.1
Croatia	HR	12	2.68	11	2.46	−8.2
Cyprus	CY	4	3.41	4	3.36	−1.4
Czech Republic	CZ	17	1.60	18	1.69	5.7
Denmark	DK	6	1.08	6	1.07	−0.2
Egypt	EG	16	0.18	17	0.19	4.3
Estonia	EE	2	1.59	2	1.58	−0.6
Finland	FI	19	3.61	18	3.29	−8.9
France	FR	162	2.44	161	2.42	−1.1
Georgia	GE	8	1.62	12	2.43	50.1
Germany	DE	670	8.27	745	9.21	11.4
Greece	GR	24	2.23	24	2.23	0.0
Hungary	HU	13	1.31	13	1.31	0.2
Iceland	IS	1	3.15	1	3.01	−4.4
Ireland	IE	17	3.52	17	3.47	−1.2
Israel	IL	20	2.56	20	2.48	−2.8
Italy	IT	397	6.44	396	6.40	−0.5
Kazakhstan	KZ	15	0.84	19	1.05	25.2
Kosovo	XK	1	0.54	1	0.53	−0.6
Kyrgyzstan	KGZ	0	0.00	2	0.35	N/A
Latvia	LV	3	1.39	3	1.51	9.0
Lebanon[a]	LB	15	3.63	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	3	0.86	3	1.04	21.5
Luxembourg	LU	1	1.92	1	1.75	−8.7
FYR Macedonia	MK	2	0.96	3	1.43	49.7
Malta	MT	1	2.42	1	2.42	−0.3
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	1	1.54	1	1.55	0.5
Morocco	MA	7	0.21	6	0.18	−13.9
The Netherlands	NL	28	1.66	29	1.71	3.1
Norway	NO	11	2.14	11	2.11	−1.2
Poland	PL	120	3.13	122	3.16	1.1
Portugal	PT	31	2.87	29	2.68	−6.6
Romania	RO	15	0.69	16	0.74	7.0
Russian Federation	RU	55	0.39	48	0.34	−12.7
San Marino	SM	N/A	N/A	1	30.28	N/A
Serbia	RS	10	1.39	11	1.53	10.5
Slovakia	SK	4	0.73	4	0.74	1.4

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Table 9 *Continued*

Country	ISO code	Number of ICD implanting centres 2014		Number of ICD implanting centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Slovenia	SI	2	1.01	3	1.51	50.4
Spain	ES	112	2.35	180	3.74	59.4
Sweden	SE	35	3.60	30	3.06	−15.0
Switzerland	CH	52	6.45	49	6.03	−6.5
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	8	0.73	N/A	N/A	N/A
Turkey	TR	N/A	N/A	N/A	N/A	N/A
Ukraine	UA	8	0.18	14	0.32	74.5
UK	GB	126	1.98	125	1.95	−1.3
Total ESC countries		**2142**	**2.24**	**2266**	**2.38**	**6.3**

[a]These six countries did not submit data for the EHRA White Book 2016.

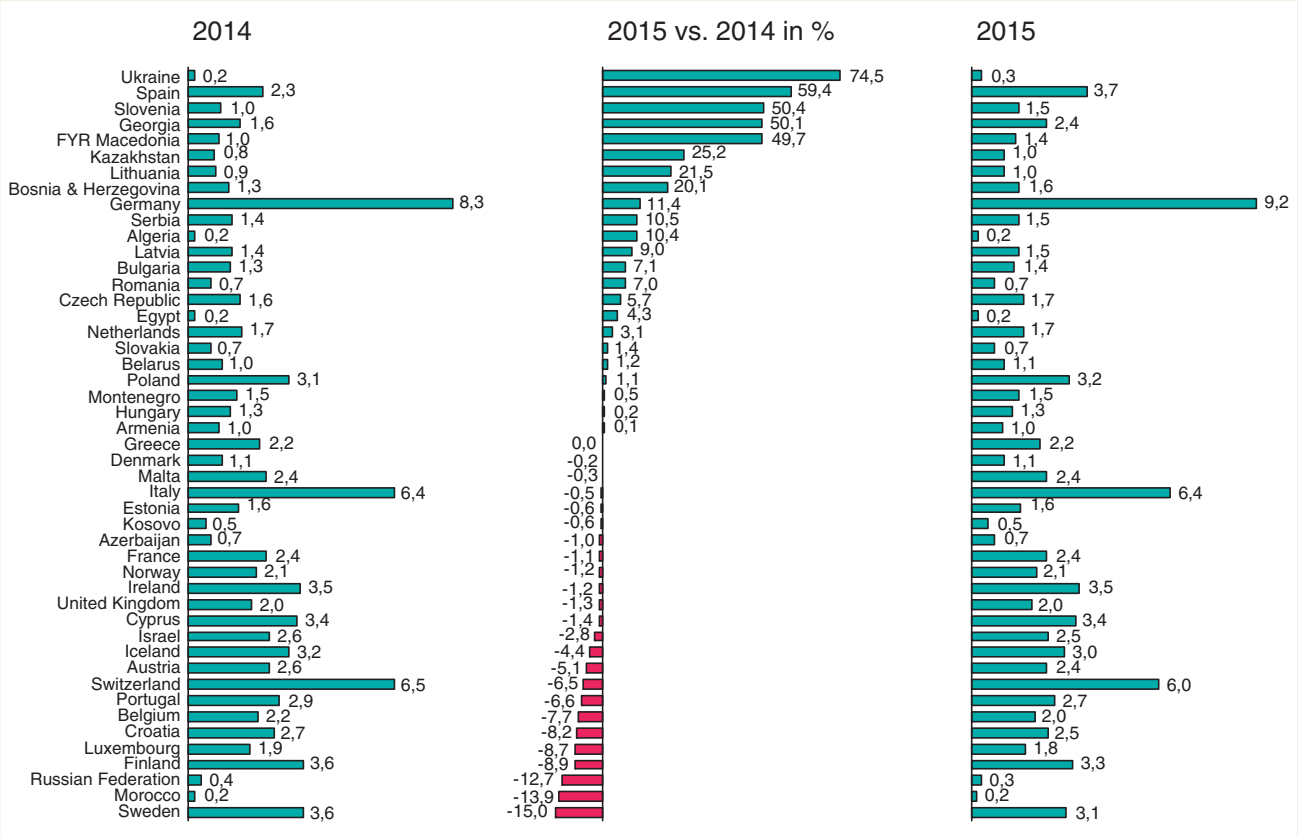

Figure 34 Change in the number of ICD implanting centres per million inhabitants from 2014 to 2015.

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Table 10 Changes in the number of ICD implantations in year 2015 vs. 2014

Country	ISO code	Number of ICD implants 2014		Number of ICD implants 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	4	1.32	N/A	N/A	N/A
Algeria	DZ	60	1.55	91	2.30	48.9
Armenia	AM	25	8.17	21	6.87	−15.9
Austria	AT	1362	165.63	1393	160.75	−2.9
Azerbaijan	AZ	20	2.06	21	2.15	4.0
Belarus	BY	172	17.90	133	14.00	−21.8
Belgium	BE	1611	154.17	1531	135.20	−12.3
Bosnia and Herzegovina	BA	55	14.21	87	22.50	58.4
Bulgaria	BG	47	6.79	51	7.10	4.6
Croatia	HR	173	38.70	388	86.90	124.6
Cyprus	CY	73	62.26	75	63.07	1.3
Czech Republic	CZ	2138	201.18	2039	191.55	−4.8
Denmark	DK	1208	216.91	1208	216.43	−0.2
Egypt	EG	236	2.72	253	2.86	5.3
Estonia	EE	96	76.32	91	71.91	−5.8
Finland	FI	1161	220.35	1198	218.74	−0.7
France	FR	13 700	206.76	7825	117.57	−43.1
Georgia	GE	104	21.07	140	28.39	34.7
Germany	DE	23 898	295.05	28 914	357.61	21.2
Greece	GR	1080	100.23	1188	110.25	10.0
Hungary	HU	956	96.38	986	99.62	3.4
Iceland	IS	59	185.91	59	177.75	−4.4
Ireland	IE	N/A	N/A	740	151.26	N/A
Israel	IL	1685	215.42	1300	161.50	−25.0
Italy	IT	13 729	222.58	14 709	237.80	6.8
Kazakhstan	KZ	402	22.40	527	29.02	29.6
Kosovo	XK	3	1.61	12	6.41	297.5
Kyrgyzstan[a]	KGZ	0	0.00	N/A	N/A	N/A
Latvia	LV	75	34.64	90	45.30	30.8
Lebanon[a]	LB	300	72.52	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	134	38.22	123	42.64	11.6
Luxembourg	LU	62	119.08	65	113.98	−4.3
FYR Macedonia	MK	11	5.26	29	13.84	163.1
Malta	MT	36	87.24	35	84.55	−3.1
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	41	63.07	53	81.91	29.9
Morocco	MA	27	0.81	57	1.71	112.1
The Netherlands	NL	3577	211.94	3500	206.52	−2.6
Norway	NO	1134	220.29	1214	233.12	5.8
Poland	PL	8399	219.03	8526	221.10	0.9
Portugal	PT	N/A	N/A	1224	113.07	N/A
Romania	RO	332	15.28	300	13.85	−9.4
Russian Federation	RU	1769	12.42	1553	10.90	−12.2
San Marino	SM	N/A	N/A	8	242.28	N/A
Serbia	RS	457	63.39	437	60.89	−3.9
Slovakia	SK	658	119.80	665	122.79	2.5
Slovenia	SI	174	87.51	228	114.95	31.4
Spain	ES	3869	81.05	5348	111.08	37.1
Sweden[a]	SE	2097	215.66	N/A	N/A	N/A
Switzerland	CH	1341	166.35	1830	225.32	35.5
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	140	12.80	N/A	N/A	N/A
Turkey	TR	6300	77.19	6381	80.35	4.1
Ukraine	UA	57	1.29	52	1.17	−9.1
UK	GB	6474	101.56	6701	104.56	2.9
Total ESC countries		**101 521**	**99**	**103 399**	**102**	**2.1**

[a]These eight countries did not submit data for ICD implantations for the EHRA White Book 2016.

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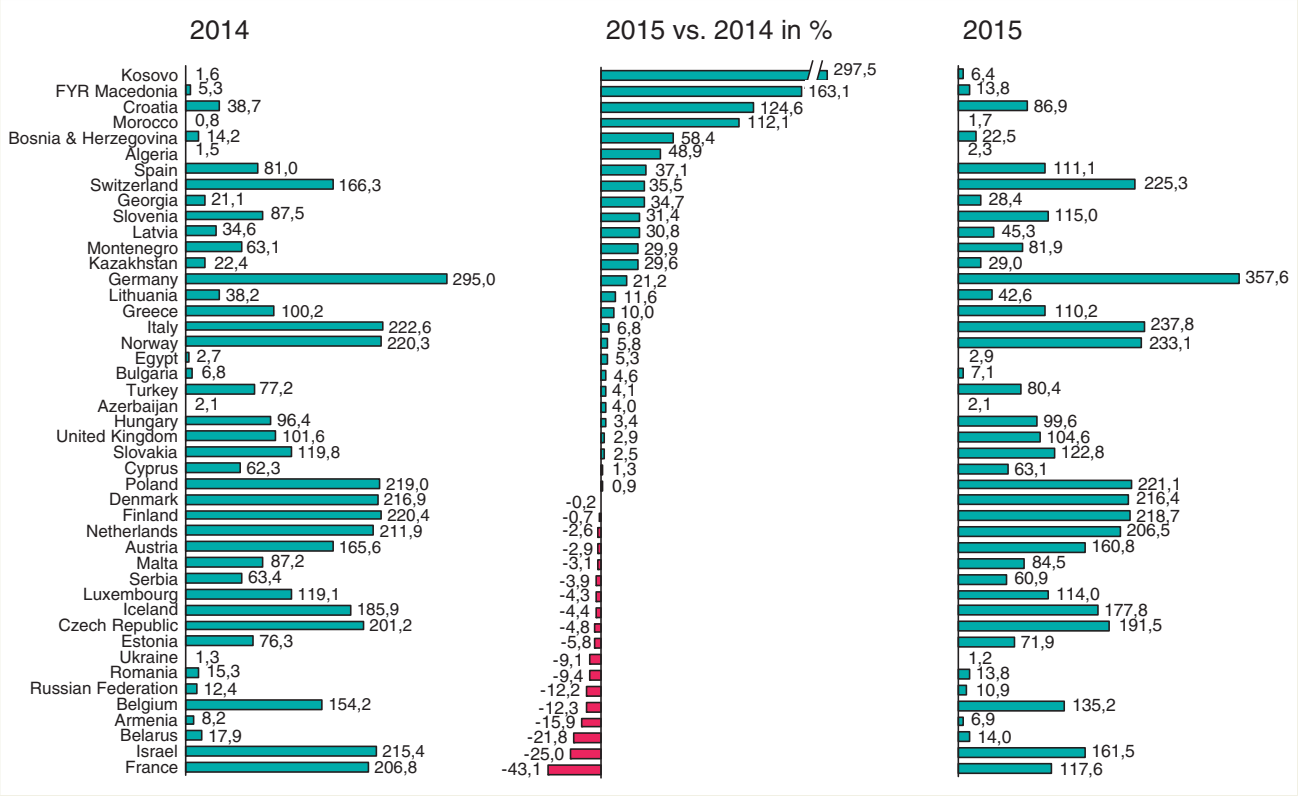

Figure 35 Change in the number of ICD implantations per million inhabitants from 2014 to 2015.

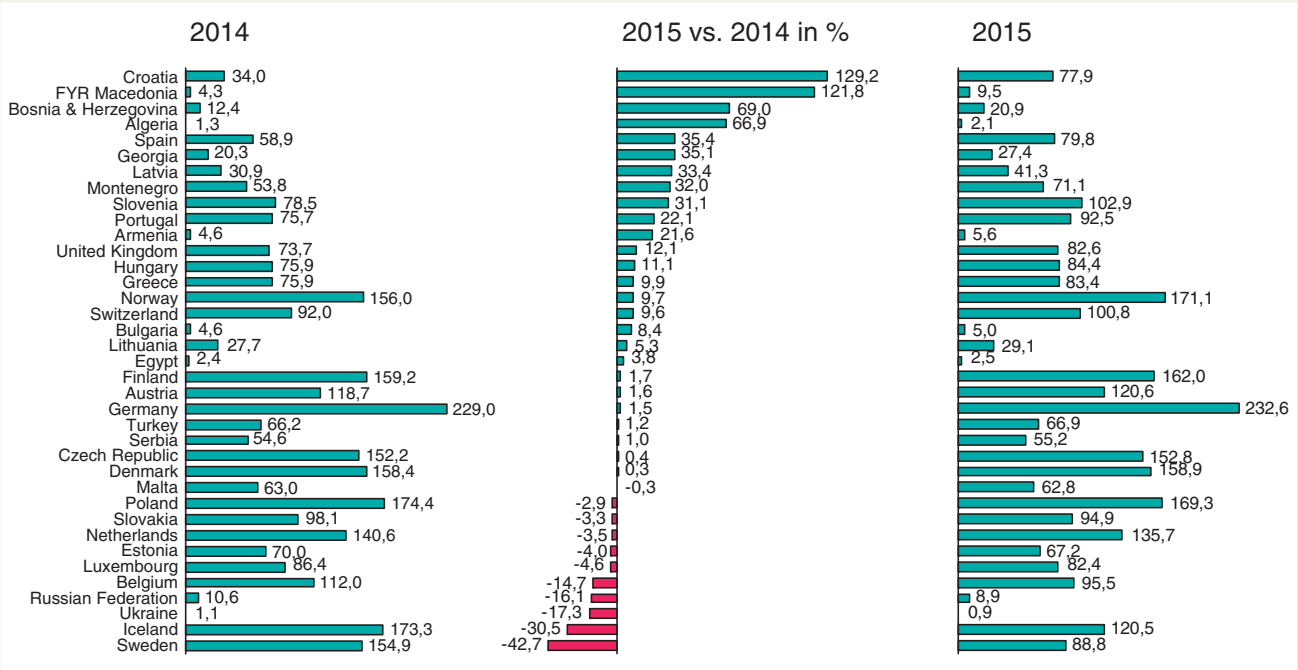

Figure 36 Change in the number of new ICD implantations per million inhabitants from 2014 to 2015.

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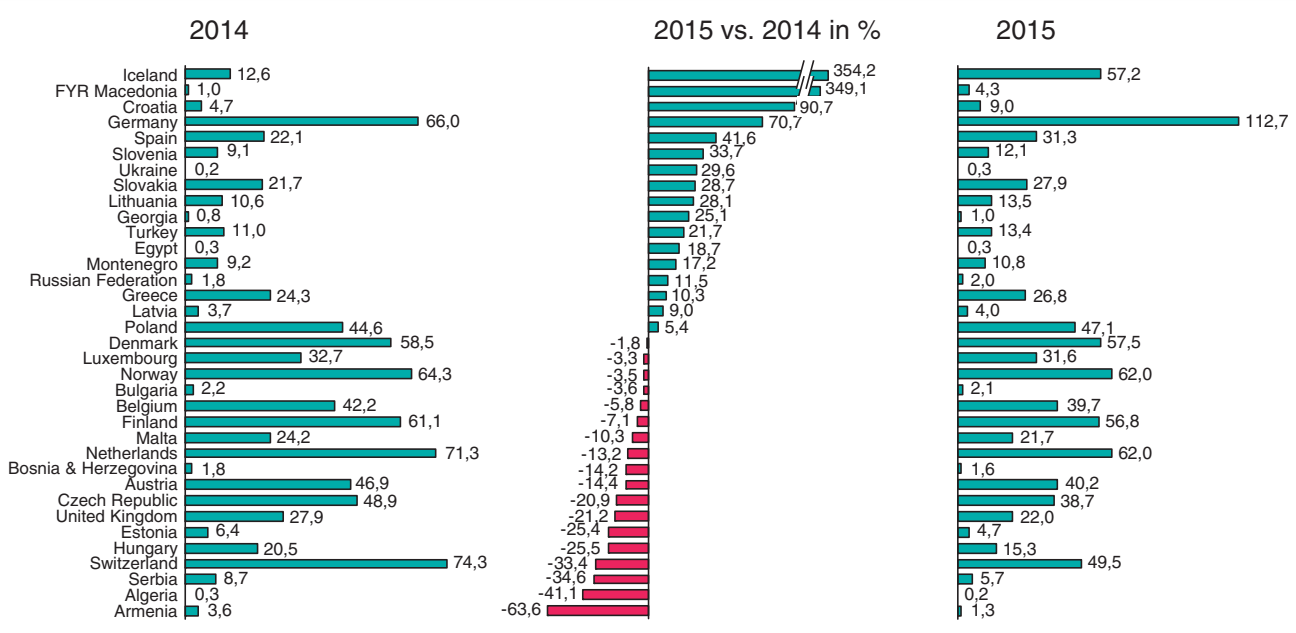

Figure 37 Change in the number of ICD replacements per million inhabitants from 2014 to 2015.

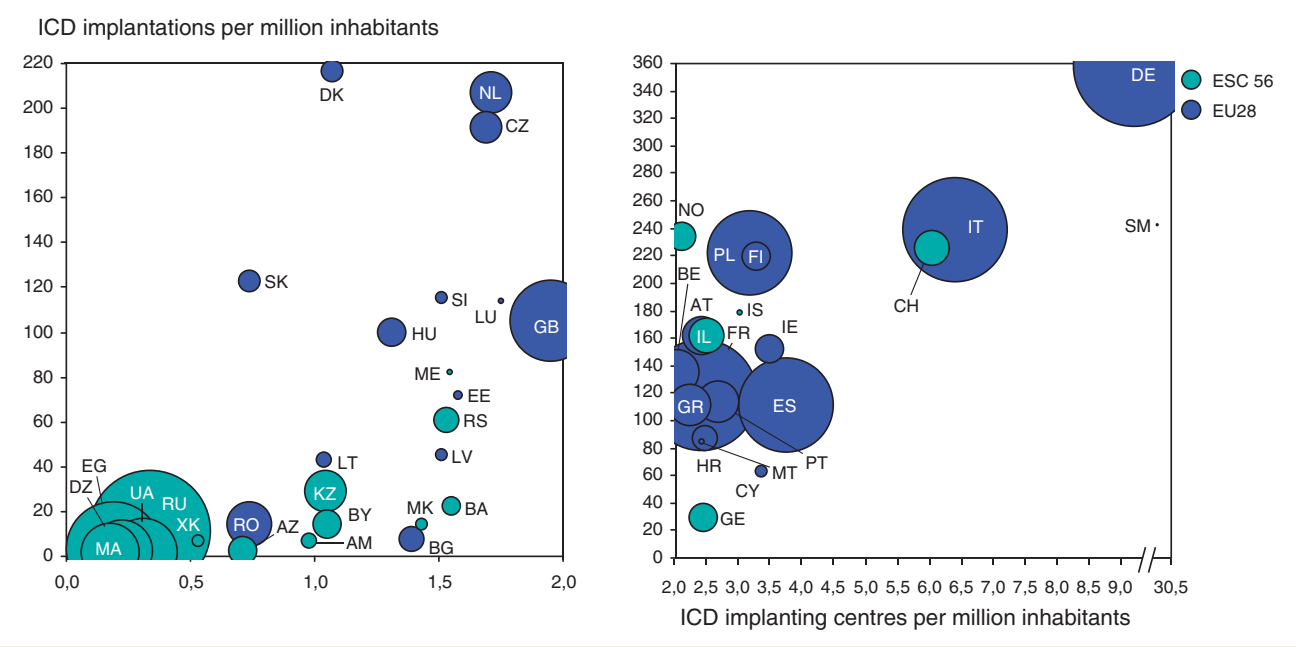

Figure 38 Implantable cardioverter-defibrillator implantation centres and rates in the ESC and European Union (EU28) member countries in 2015. Bubble size is related to population in the country. The ISO codes of the countries are explained in *Table 1*.

Cardiac resynchronization therapy devices

General information

The 49 (87.5%) countries that submitted data on cardiac resynchronization therapy (CRT) for the EHRA White Book 2016 are listed in *Table 11*. Albania, Kyrgyzstan, Lebanon, Libya, Moldova, Syria, and Tunisia did not report any data related to CRT. The vast majority of implants were performed by cardiologists (*Table 5*), and the remaining implantations were performed by physicians having various other training backgrounds, mainly surgeons. In Belarus, however, all CRT implantations were done by surgeons, and the majority of CRT

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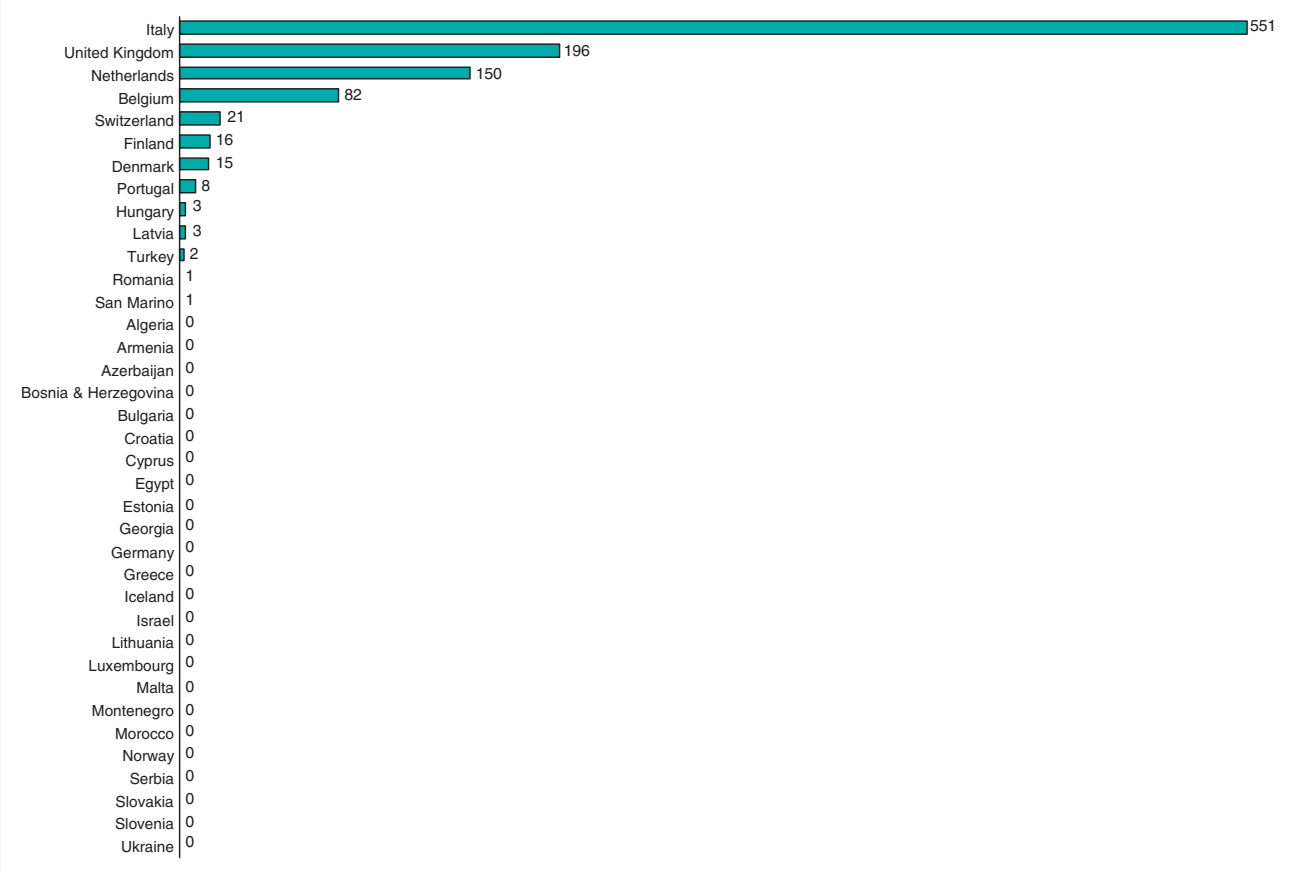

Figure 39 Number of S-ICD implantation in 2015.

implantations in the Ukraine and Russia were likewise done by others than cardiologists (*Table 5*).

Cardiac resynchronization therapy facilities and procedure rates

It was reported that in 2015 a total of 84 205 CRT devices were implanted in 1527 national centres (*Table 11*). There was an increase in both absolute numbers of implants and the rate of implants per million inhabitants compared with 2014, but a fall in the number of implanting centres (*Table 11*). The number of CRT implanting centres per million inhabitants in the ESC countries is shown in *Figure 40*. The mean number of implanting centres was 1.68 per country, which is a decrease from the previous year. The mean number of CRT devices implanted in 2015 was 82. Germany (261 implants per million), Italy (207), and Czech Republic (183) had the highest number of implants of all CRT devices. Implantation rates with the countries divided into quartiles are shown as a bar graph in *Figure 41* and as a geographical map in *Figure 42*.

Figures 43 and *44* show the corresponding numbers for CRT PMs (CRT-P) and CRT defibrillators (CRT-D). The ratio of CRT-D/CRT-P implants was 2.77 with a mean of 61 CRT-Ds and 22 CRT-Ps per million inhabitants. The ratio between CRT-D and CRT-P is slightly higher than the last year representing a continuation in the trend that the growth in CRT-D use is more than that in CRT-P use, while there is nevertheless an increase in the use of both types. Denmark had the highest rate of CRT-P implantations followed by the UK (*Figure 43*), while CRT-D implantation rate was highest in Germany followed by Italy and Israel (*Figure 44*).

The use of CRT devices within the five geographical ESC regions is shown in *Figure 45*, and further data from within each region are shown in *Figures 46–50*. The most active countries within each region were Germany (261 per million inhabitants), Denmark (176), Czech Republic (183), Italy (207), and Israel (180).

The changes in the number of implanting centres per million inhabitants between 2014 and 2015 are shown in *Table 12* and *Figure 51*. The changes between 2014 and 2015 for the number of total CRT implantations are shown in *Table 13* and *Figure 52*, and the changes according to CRT device type are shown in *Figures 53* and *54*.

The relationship between the annual CRT implantation rate and the number of CRT implanting centres per million population in the EU28 countries and the ESC area is shown in *Figure 55*.

Lead extraction

General information

This was the fourth year that information on lead extractions (LEs) was included in the EHRA White Book. The number of countries submitting data on LE procedures is not as high as for PMs and

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Table 11 Cardiac resynchronization therapy device (CRT-P and CRT-D) implantation facilities and rates in the ESC countries in 2015 and comparison with 4 previous years

Country	ISO code	Number of CRT implanting centres 2015		CRT implantations 2015		Total CRT implantations 2015		Development potential—target number of CRT implantations		CRT implantations per million inhabitants				
		Absolute number	Per million inhabitants	CRT-P implantations Absolute number	CRT-D implantations Absolute number	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A
Algeria	DZ	8	0.20	53	55	108	3	3250	5810	N/A	N/A	2	1	3
Armenia	AM	2	0.65	1	9	10	3	251	449	3	6	3	1	3
Austria	AT	18	2.08	470	894	1364	157	–	–	117	107	143	150	157
Azerbaijan	AZ	2	0.20	0	24	24	2	804	1437	2	N/A	2	2	2
Belarus	BY	6	0.63	N/A	N/A	100	11	781	1396	5	4	6	5	11
Belgium	BE	40	3.53	528	957	1485	131	–	1664	58	82	117	127	131
Bosnia and Herzegovina	BA	2	0.52	11	6	17	4	318	568	6	5	6	6	4
Bulgaria	BG	9	1.25	253	43	296	41	591	1056	12	28	37	44	41
Croatia	HR	8	1.79	125	136	261	58	367	656	12	13	18	28	58
Cyprus	CY	4	3.36	N/A	N/A	30	25	98	175	21	25	22	25	25
Czech Republic	CZ	18	1.69	465	1487	1952	183	–	–	143	127	162	176	183
Denmark	DK	5	0.90	441	544	985	176	–	–	158	170	180	173	176
Egypt	EG	17	0.19	429	116	545	6	7274	13 001	N/A	4	5	6	6
Estonia	EE	2	1.58	49	24	73	58	104	186	58	53	55	41	58
Finland	FI	15	2.74	184	343	527	96	–	805	62	72	83	100	96
France	FR	174	2.61	3888	6544	10 432	157	–	–	123	131	N/A	144	157
Georgia	GE	10	2.03	10	52	62	13	405	725	3	7	8	11	13
Germany	DE	250	3.09	3305	17 834	21 139	261	–	–	202	221	109	128	261
Greece	GR	16	1.48	88	550	638	59	886	1583	37	45	46	54	59
Hungary	HU	14	1.41	496	595	1091	110	–	1454	81	89	99	95	110
Iceland	IS	1	3.01	13	8	21	63	27	49	48	32	44	82	63
Ireland	IE	17	3.47	88	231	319	65	402	719	57	61	79	N/A	65
Israel	IL	20	2.48	115	1337	1452	180	–	–	97	118	158	170	180
Italy	IT	380	6.14	2153	10 662	12 815	207	–	–	203	194	198	200	207
Kazakhstan	KZ	18	0.99	0	314	314	17	1493	2668	N/A	9	12	15	17
Kosovo	XK	1	0.53	N/A	4	4	2	154	275	N/A	N/A	N/A	0	2
Kyrgyzstan[a]	KGZ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A
Latvia	LV	2	1.01	22	85	107	54	163	292	24	35	29	48	54
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	39	N/A

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Table 11 *Continued*

Country	ISO code	Number of CRT implanting centres 2015		CRT implantations 2015		Total CRT implantations 2015		Development potential—target number of CRT implantations		CRT implantations per million inhabitants				
		Absolute number	Per million inhabitants	CRT-P implantations Absolute number	CRT-D implantations Absolute number	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	3	1.04	150	45	195	68	237	424	31	39	47	55	68
Luxembourg	LU	1	1.75	8	26	34	60	47	84	40	59	43	65	60
FYR Macedonia	MK	3	1.43	26	12	38	18	172	308	13	5	8	13	18
Malta	MT	1	2.42	10	31	41	99	–	61	56	83	39	116	99
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A
Montenegro	ME	1	1.55	14	5	19	29	53	95	21	29	15	34	29
Morocco	MA	6	0.18	42	42	84	3	2739	4896	N/A	2	2	2	3
The Netherlands	NL	29	1.71	400	1600	2000	118	–	2490	130	124	123	114	118
Norway	NO	9	1.73	214	348	562	108	–	765	88	77	84	100	108
Poland	PL	N/A	N/A	645	3319	3964	103	–	5666	66	73	78	97	103
Portugal	PT	26	2.40	210	562	772	71	890	1591	41	52	N/A	64	71
Romania	RO	12	0.55	156	120	276	13	1781	3183	10	7	9	13	13
Russian Federation	RU	37	0.26	340	666	1006	7	11 708	20 926	6	6	7	6	7
San Marino	SM	1	30.28	0	2	2	61	3	5	94	62	0	N/A	61
Serbia	RS	6	0.84	234	79	313	44	590	1054	40	42	45	45	44
Slovakia	SK	4	0.74	209	379	588	109	–	796	60	61	82	96	109
Slovenia	SI	2	1.01	47	117	164	83	–	291	45	70	66	75	83
Spain	ES	130	2.70	910	1818	2728	57	3958	7074	56	53	54	62	57
Sweden	SE	25	2.55	440	594	1034	105	–	1440	N/A	49	100	88	105
Switzerland	CH	36	4.43	395	738	1133	140	–	1193	74	66	60	72	140
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	23	N/A	16	N/A
Turkey	TR	N/A	N/A	230	2580	2810	35	6528	11 668	N/A	N/A	N/A	30	35
Ukraine	UA	10	0.23	60	13	73	2	3652	6528	1	1	2	2	2
UK	GB	126	1.97	4160	6038	10 198	159	–	–	105	110	122	149	159
Total ESC countries		**1527**	**1.68**	**22 087**	**61 988**	**84 205**	**82**			**80**	**83**	**79**	**96**	**102**

[a]These seven countries did not submit any data on CRT implantations for the EHRA White Book 2016.

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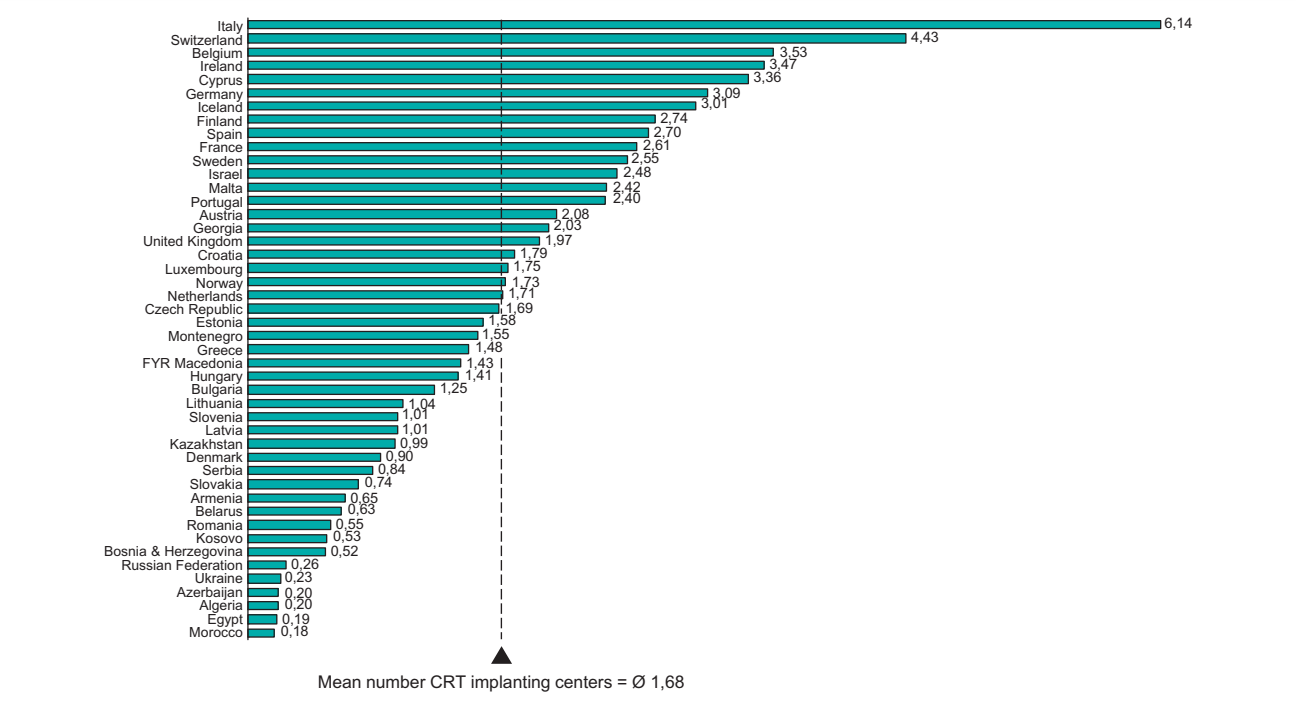

Figure 40 Cardiac resynchronization therapy device implanting centres per million inhabitants in 2015. The mean number of CRT implantation centres is weighted by population.

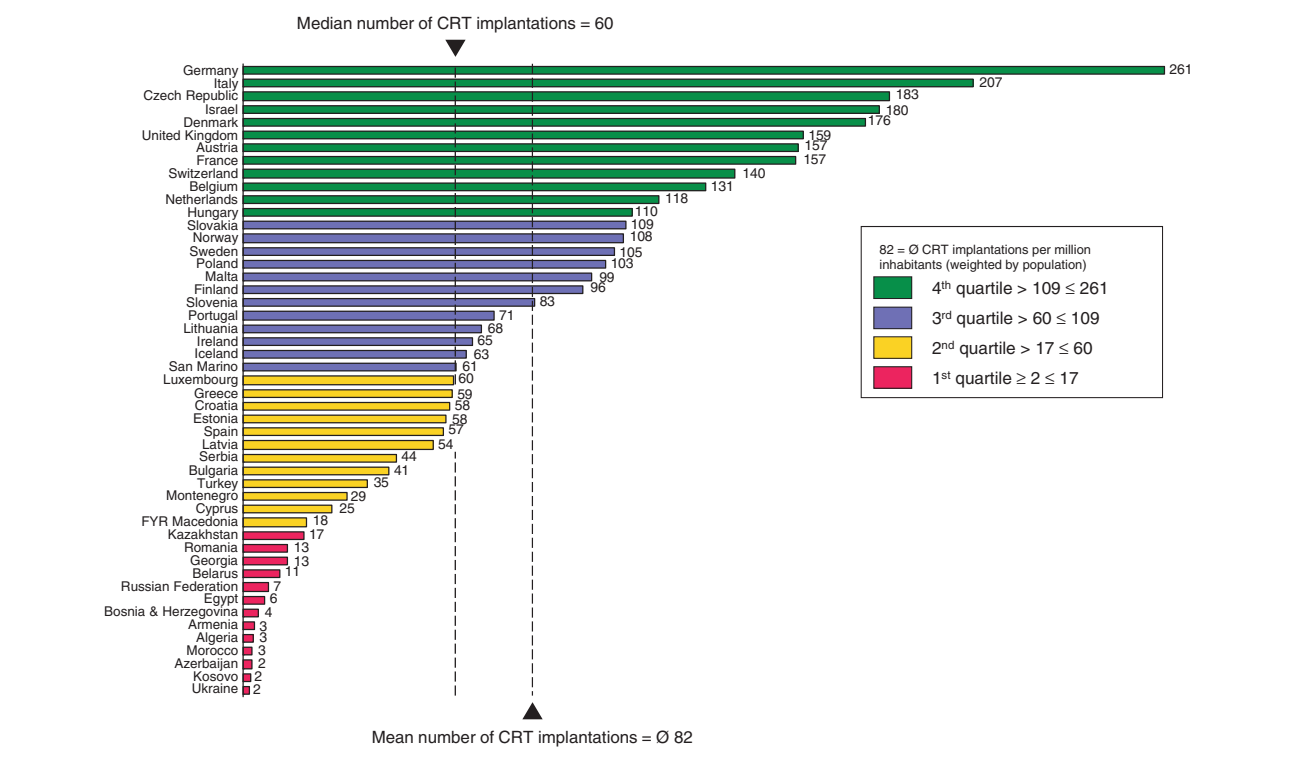

Figure 41 Cardiac resynchronization therapy device implantations per million inhabitants 2015. The mean number of CRT implantations is weighted by population.

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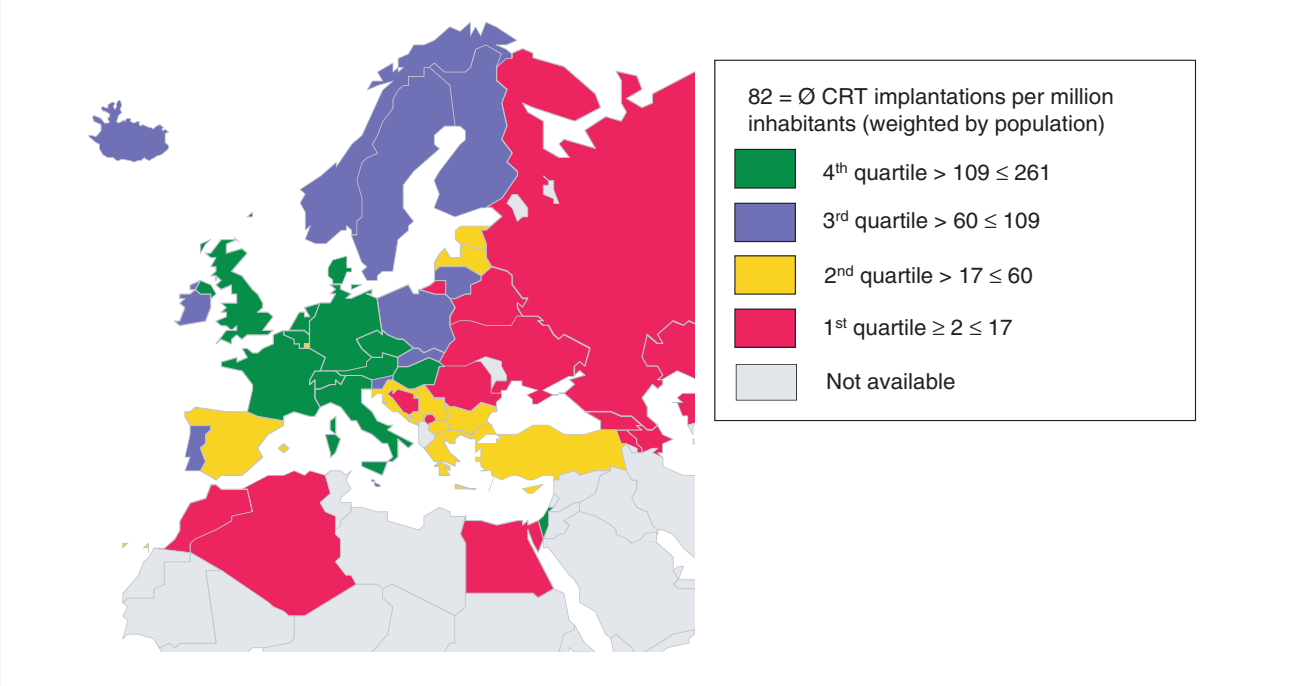

Figure 42 Cardiac resynchronization therapy device implantations in the ESC countries in 2015.

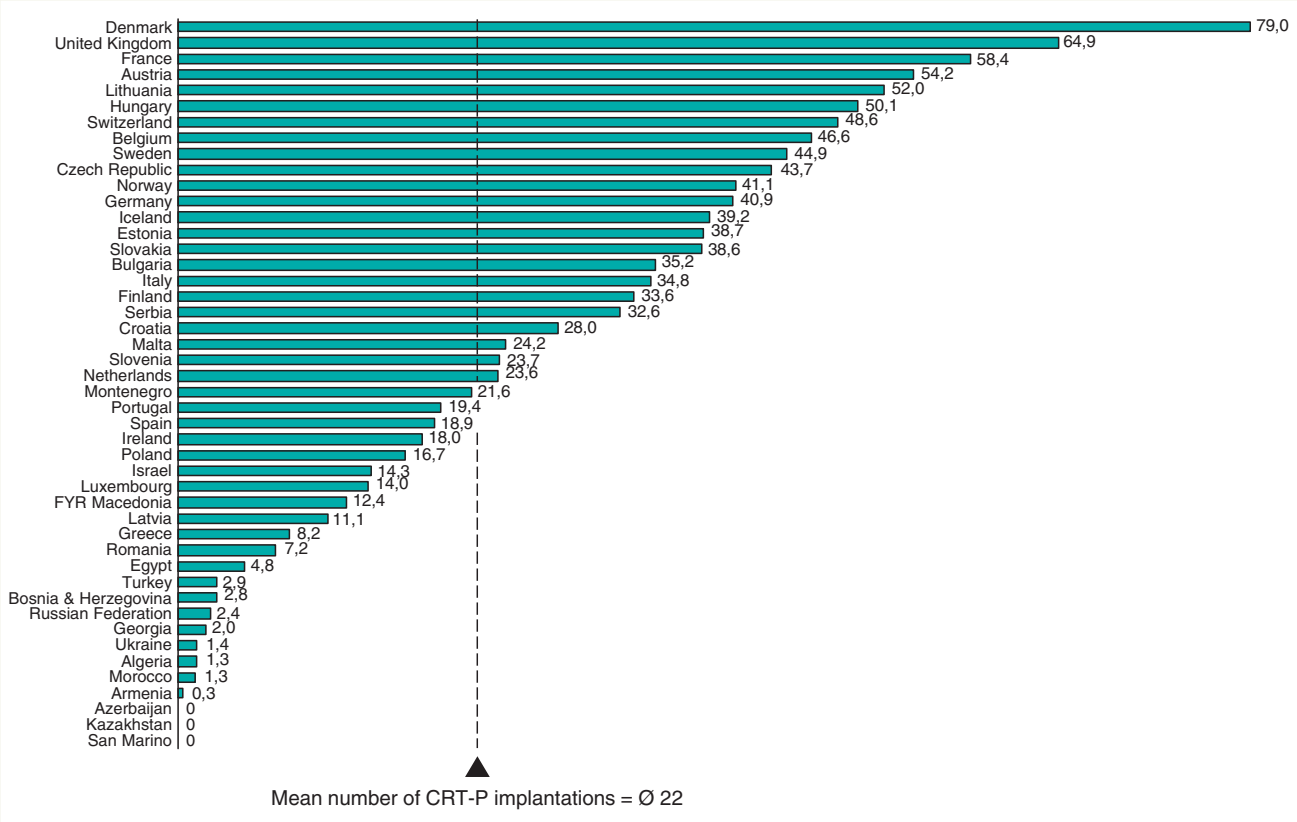

Figure 43 Cardiac resynchronization therapy PM implantations per million inhabitants in 2015. The mean number of implantations is weighted by population.

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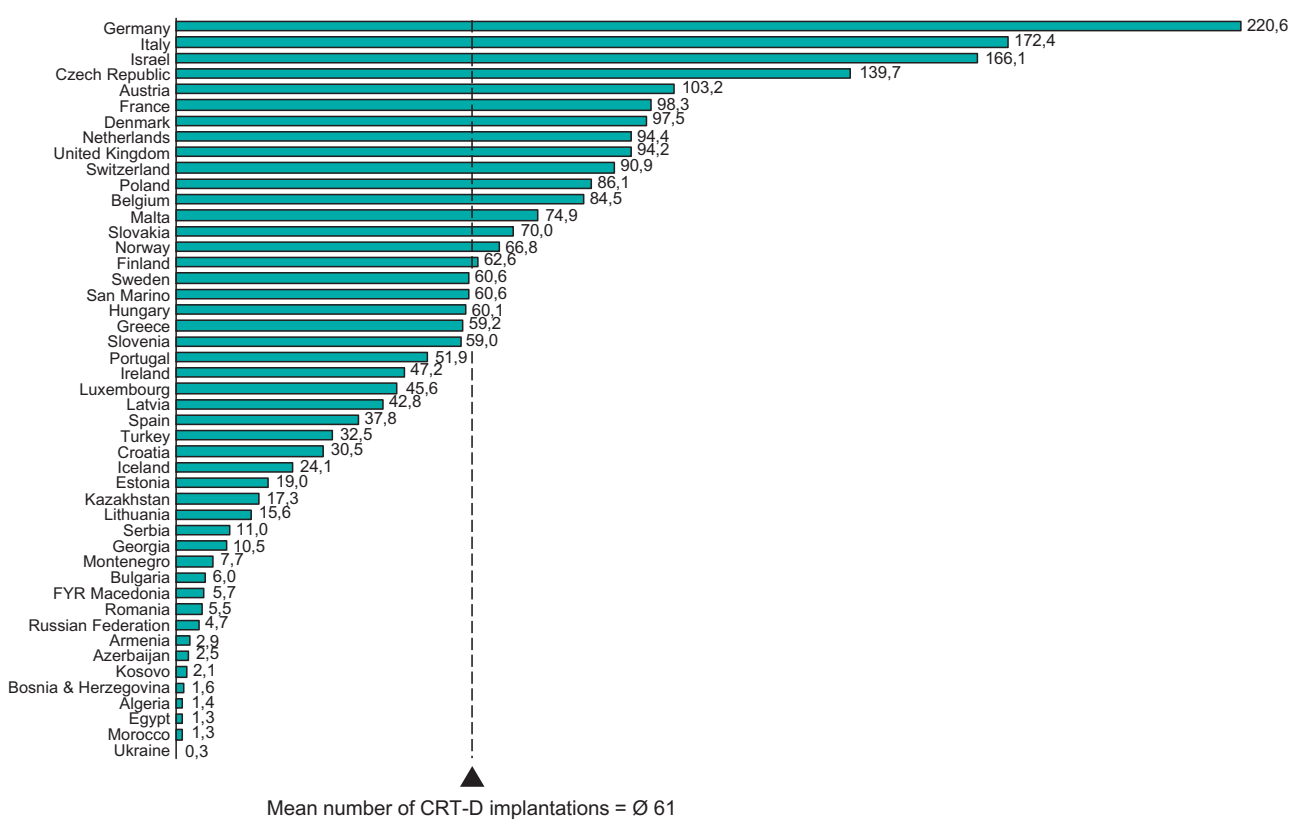

Figure 44 Cardiac resynchronization therapy defibrillator implantations per million inhabitants in 2015. The mean number of implantations is weighted by population.

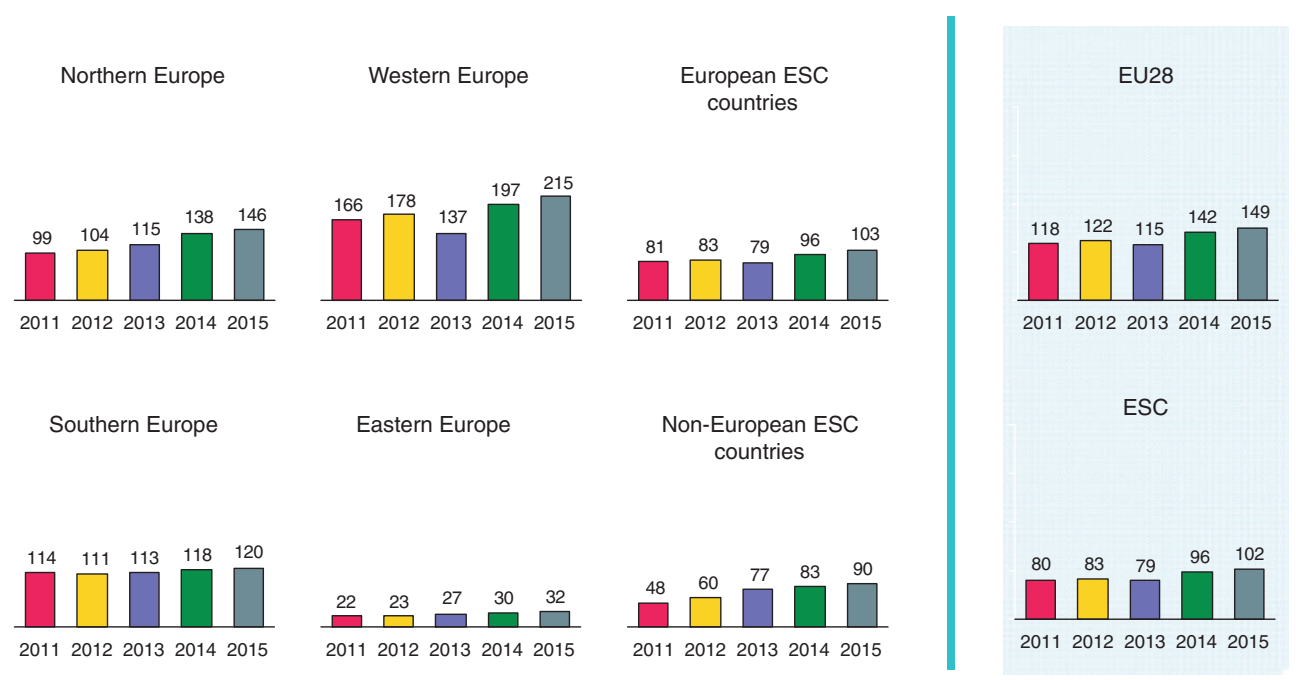

Figure 45 Cardiac resynchronization therapy device implantations per million inhabitants 2011–15 in the five geographical regions of the ESC and comparison with the total ESC area and the 28 member countries of the European Union (EU28).

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Figure 46 Cardiac resynchronization therapy implantations per million inhabitants 2011–15 in Northern Europe.

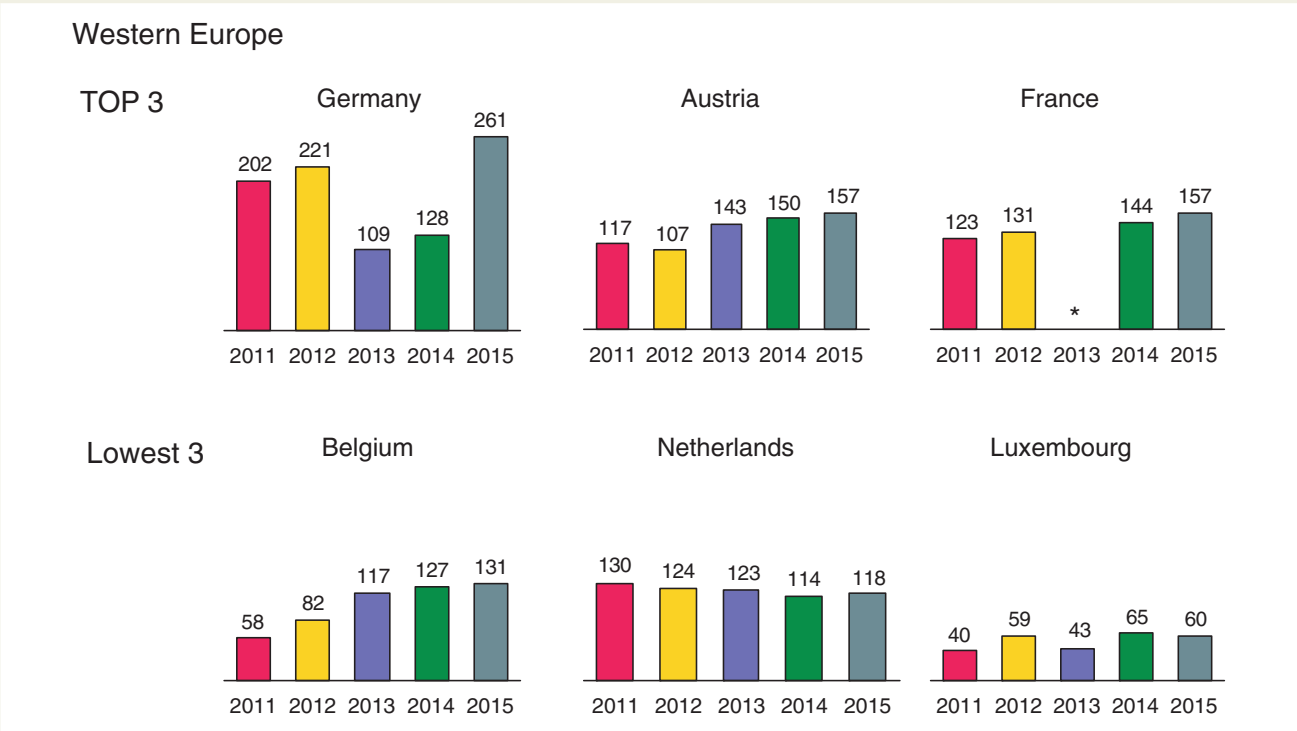

Figure 47 Cardiac resynchronization therapy implantations per million inhabitants 2011–15 in Western Europe. *No data available.

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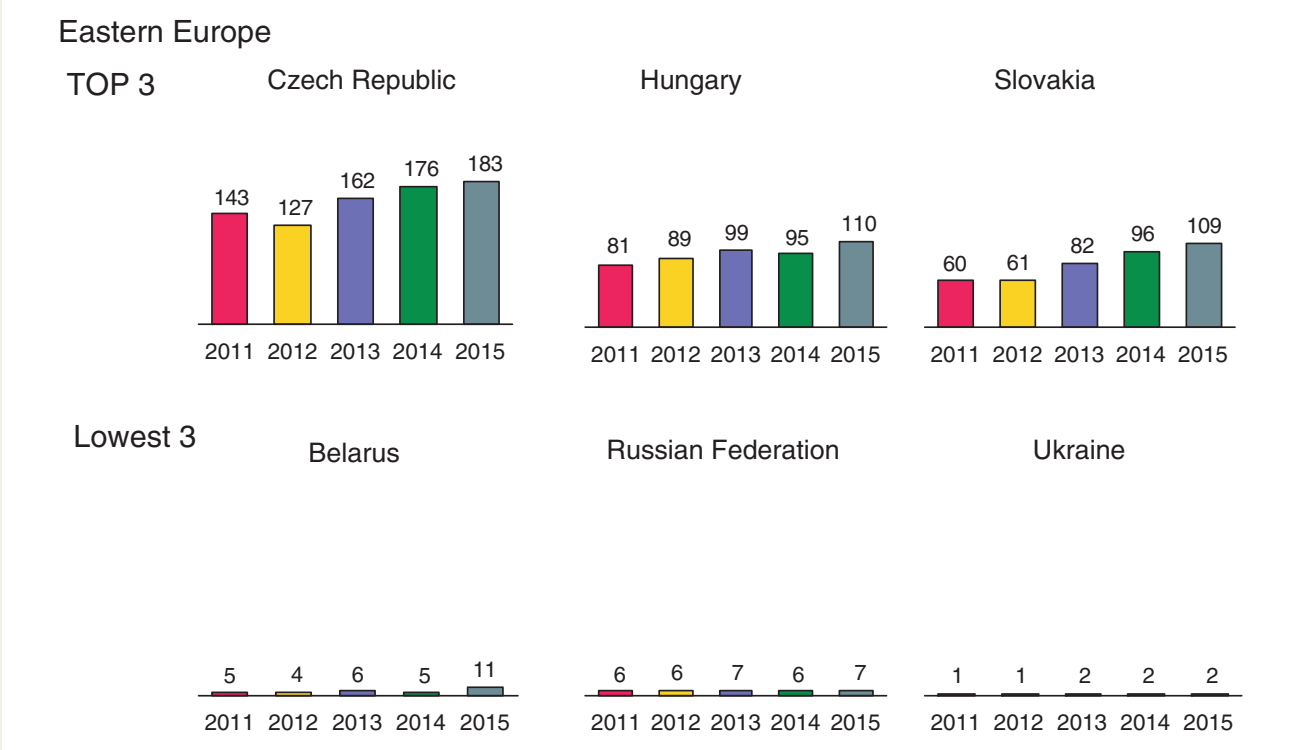

Figure 48 Cardiac resynchronization therapy implantations per million inhabitants 2011–15 in Eastern Europe.

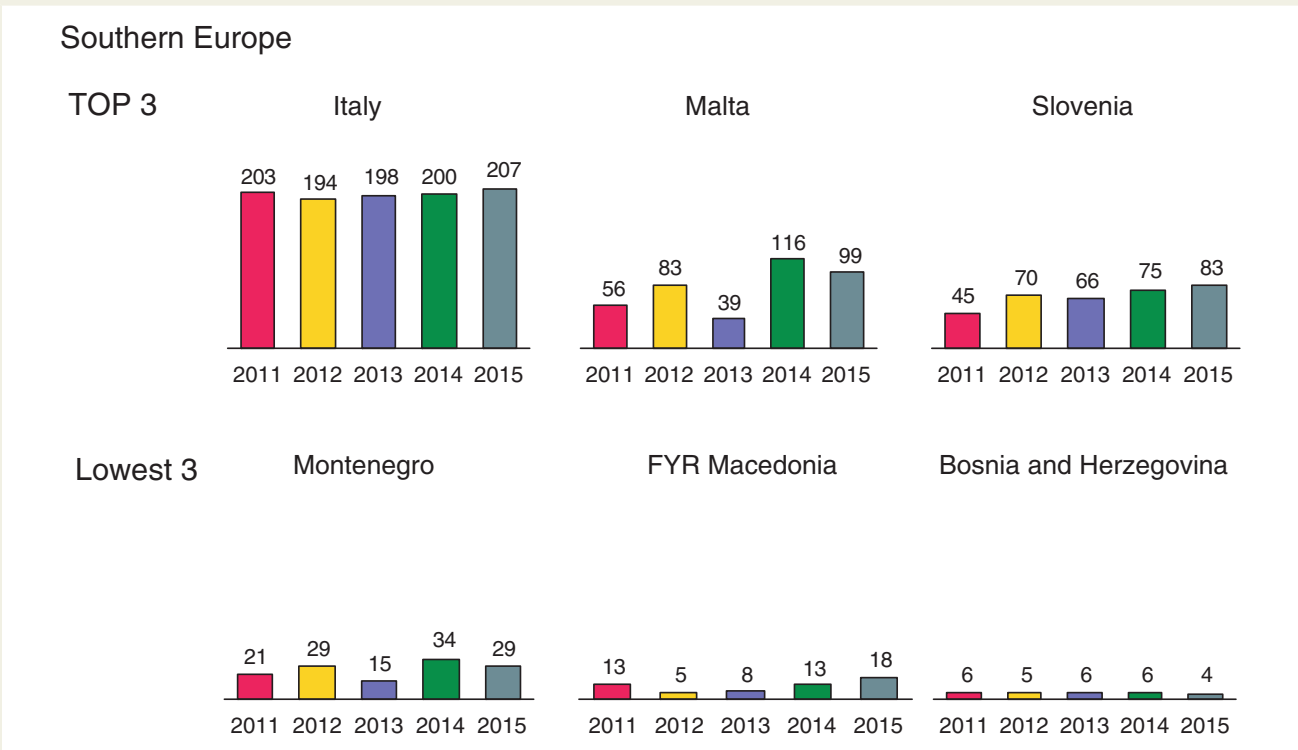

Figure 49 Cardiac resynchronization therapy implantations per million inhabitants 2011–15 in Southern Europe.

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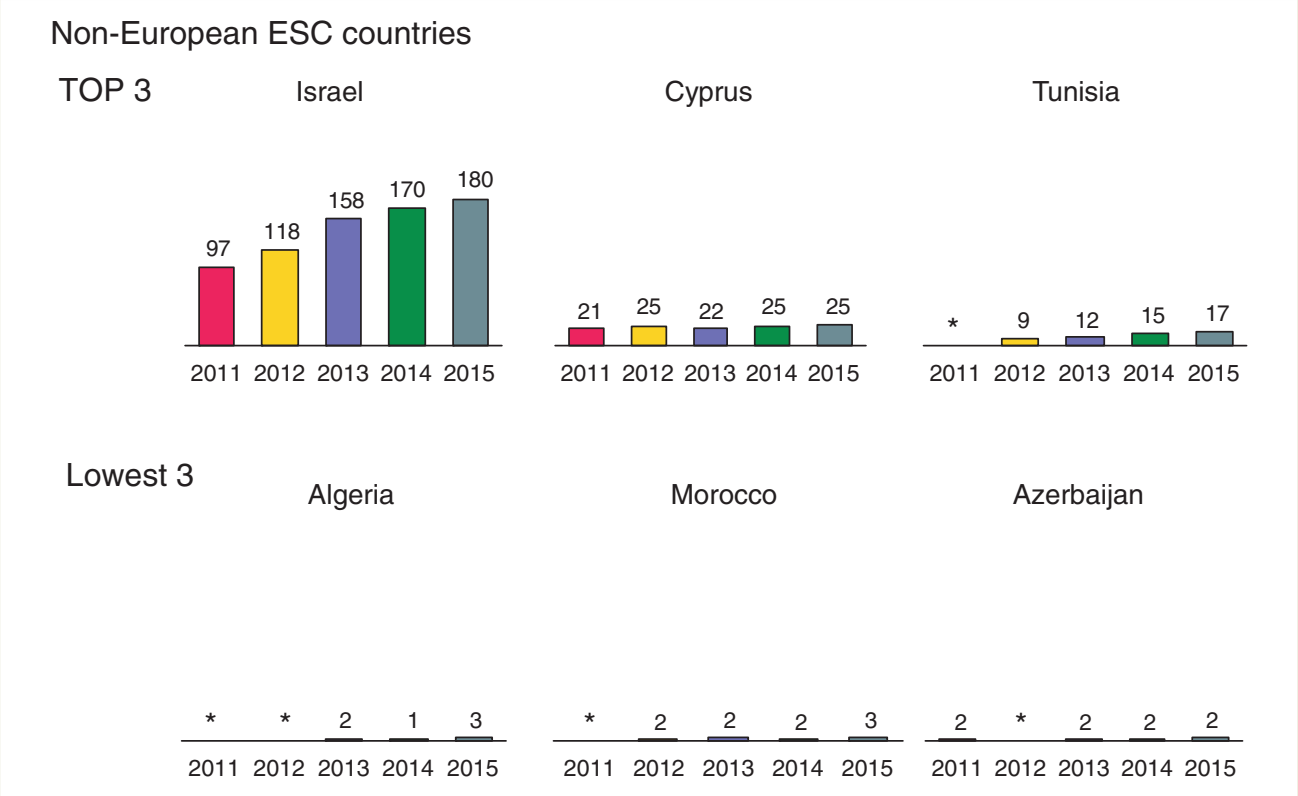

Figure 50 Cardiac resynchronization therapy implantations per million inhabitants 2011–15 in the non-European ESC countries. *No data available.

ICDs (*Table 14*). Seventeen countries did not submit any data on LEs, and four submitted incomplete data. In most countries, the primary operators in LE procedures were cardiologists.

Lead extraction facilities and procedure rates

A total of 8748 LE procedures (*Table 14*) were performed in 326 LE centres in 2015. The mean number of LEs was 12.8 per million, but this needs to be put into context with a large number of missing data (*Figure 56*). It has been suggested that in an active centre the minimum annual number of LE should be at least 15 per million inhabitants.[14,15] Assuming that each centre treated an equivalent number of patients, it can be extrapolated that the numbers of LE per centre in 2015 were lower than that recommended in most of the countries. The mean number of LE was highest in France (45.1 per million population) followed by Norway (37.3) and Germany (29.2) (*Figure 56*). Due to missing or incomplete data and a very low LE rate in some countries, we chose not to provide full representation of the regional LE data.

Catheter ablation

General information

A total of 46 countries (82% of the ESC countries) submitted data on catheter ablation facilities and procedures to the EHRA White Book (*Table 15*). Sixteen had a national registry on catheter ablation, and in the remainder the numbers originated from a survey or an estimate by the national working groups. In 2015, a total of 1 077 305 324 people lived in the ESC countries. After excluding those countries that did not report the number of ablations or ablation centres, the population covered by the EHRA White Book for ablation procedures was 967 796 331 (~90% coverage), which is about the same in the previous year. Like in previous years, a major problem in 2015 was that no ablation data were received from Italy, which is known to have well-developed ablation programmes.

Catheter ablation facilities and procedure rates

In 2015, the total number of ablation centres in the countries that submitted data for the EHRA White Book was 1159 (*Table 15*), and the mean number of ablation centres per million population was 1.34 (*Figure 57*). The changes in the number of ablation centres from 2014 to 2015 are shown in *Table 16* and *Figure 58*.

The total number of catheter ablations in the ESC area in 2015 was 243 808 (*Table 15*), which was ~3% more than that reported in 2014 (235 793). The mean number of ablations done per million population was also slightly higher in 2015 (259) than in 2014 (244).

The number of catheter ablations per million inhabitants is shown in *Figures 59* and *60*. In these figures, the ESC countries are grouped into quartiles according to their ablation activities. As in previous years, most countries in the top quartile were from Northern and

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Table 12 Changes in the number of CRT implanting centres in year 2015 vs. 2014

Country	ISO code	Number of CRT implanting centres 2014		Number of CRT implanting centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	1	0.33	N/A	N/A	N/A
Algeria	DZ	8	0.21	8	0.20	−1.8
Armenia	AM	3	0.98	2	0.65	−33.2
Austria	AT	18	2.19	18	2.08	−5.1
Azerbaijan	AZ	3	0.31	2	0.20	−34.0
Belarus	BY	6	0.62	6	0.63	1.2
Belgium	BE	40	3.83	40	3.53	−7.7
Bosnia and Herzegovina	BA	2	0.52	2	0.52	0.1
Bulgaria	BG	7	1.01	9	1.25	23.9
Croatia	HR	11	2.46	8	1.79	−27.2
Cyprus	CY	4	3.41	4	3.36	−1.4
Czech Republic	CZ	17	1.60	18	1.69	5.7
Denmark	DK	5	0.90	5	0.90	−0.2
Egypt	EG	16	0.18	17	0.19	4.3
Estonia	EE	2	1.59	2	1.58	−0.6
Finland	FI	15	2.85	15	2.74	−3.8
France	FR	146	2.20	174	2.61	18.7
Georgia	GE	7	1.42	10	2.03	43.0
Germany	DE	670	8.27	250	3.09	−62.6
Greece	GR	16	1.48	16	1.48	0.0
Hungary	HU	13	1.31	14	1.41	7.9
Iceland	IS	1	3.15	1	3.01	−4.4
Ireland	IE	17	3.52	17	3.47	−1.2
Israel	IL	20	2.56	20	2.48	−2.8
Italy	IT	378	6.13	380	6.14	0.2
Kazakhstan	KZ	13	0.72	18	0.99	36.9
Kosovo	XK	0	0.00	1	0.53	N/A
Kyrgyzstan[a]	KGZ	0	0.00	N/A	N/A	N/A
Latvia	LV	2	0.92	2	1.01	9.0
Lebanon[a]	LB	15	3.63	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	3	0.86	3	1.04	21.5
Luxembourg	LU	1	1.92	1	1.75	−8.7
FYR Macedonia	MK	2	0.96	3	1.43	49.7
Malta	MT	1	2.42	1	2.42	−0.3
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	1	1.54	1	1.55	0.5
Morocco	MA	7	0.21	6	0.18	−13.9
The Netherlands	NL	31	1.84	29	1.71	−6.8
Norway	NO	10	1.94	9	1.73	−11.0
Poland[a]	PL	35	0.91	N/A	N/A	N/A
Portugal	PT	24	2.22	26	2.40	8.2
Romania	RO	12	0.55	12	0.55	0.3
Russian Federation	RU	42	0.29	37	0.26	−11.9

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Table 12 *Continued*

Country	ISO code	Number of CRT implanting centres 2014		Number of CRT implanting centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
San Marino	SM	N/A	N/A	1	30.28	N/A
Serbia	RS	6	0.83	6	0.84	0.5
Slovakia	SK	6	1.09	4	0.74	−32.4
Slovenia	SI	2	1.01	2	1.01	0.2
Spain	ES	130	2.72	130	2.70	−0.8
Sweden	SE	15	1.54	25	2.55	65.3
Switzerland	CH	48	5.95	36	4.43	−25.6
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	8	0.73	N/A	N/A	N/A
Turkey[a]	TR	N/A	N/A	N/A	N/A	N/A
Ukraine	UA	9	0.20	10	0.23	10.8
UK	GB	129	2.02	126	1.97	−2.9
Total ESC countries		**1978**	**2.13**	**1527**	**1.68**	**−21.0**

[a]These nine countries did not submit any data on CRT implanting centres for the EHRA White Book 2016.

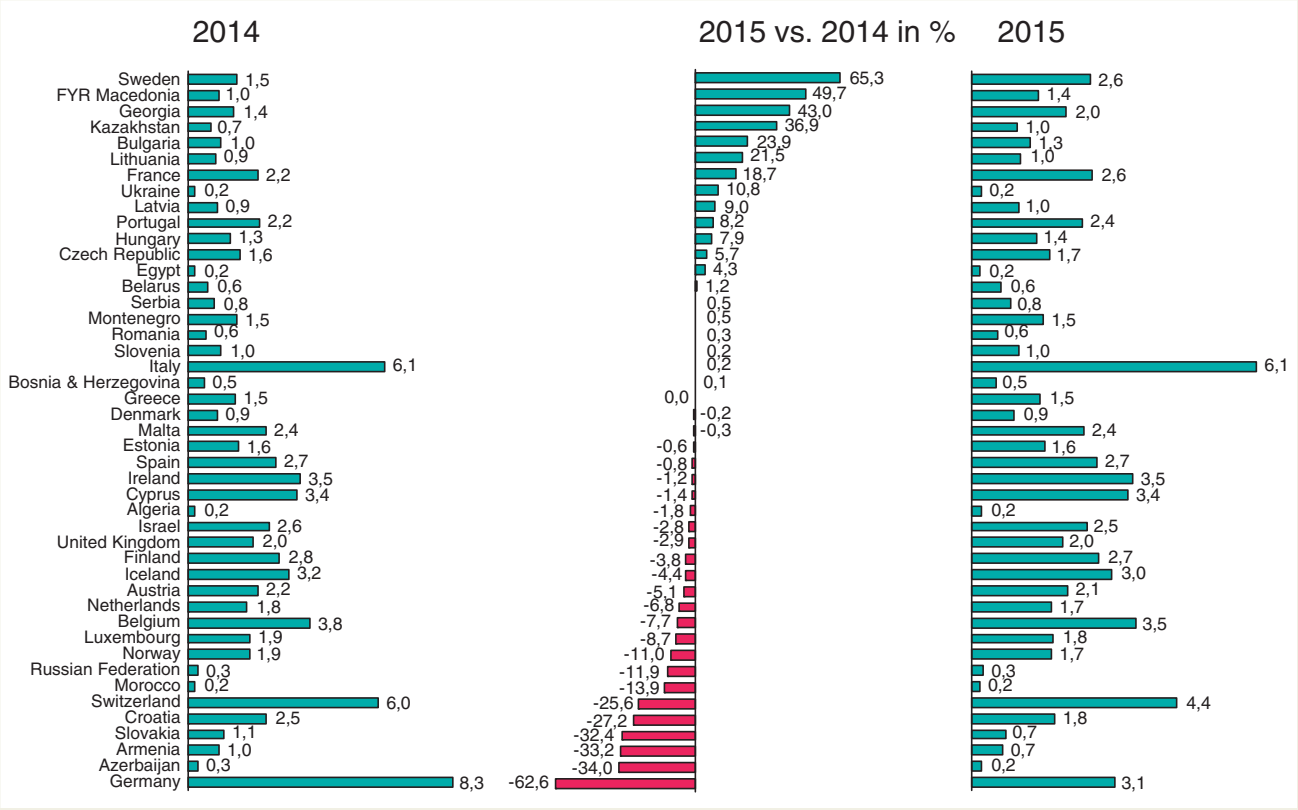

Figure 51 Change in the number of CRT implanting centres per million inhabitants from 2014 to 2015.

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Table 13 Change in the number of total CRT device (CRT-D + CRT-P) implantations in year 2015 vs. 2014

Country	ISO code	Total CRT implantations 2014		Total CRT implantations 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	2	1	N/A	N/A	N/A
Algeria	DZ	56	1	108	3	89.3
Armenia	AM	4	1	10	3	150.4
Austria	AT	1236	150	1364	157	4.7
Azerbaijan	AZ	18	2	24	2	32.0
Belarus	BY	49	5	100	11	106.4
Belgium	BE	1332	127	1485	131	2.9
Bosnia and Herzegovina	BA	23	6	17	4	−26.0
Bulgaria	BG	303	44	296	41	−5.9
Croatia	HR	124	28	261	58	110.8
Cyprus	CY	29	25	30	25	2.0
Czech Republic	CZ	1872	176	1952	183	4.1
Denmark	DK	965	173	985	176	1.8
Egypt	EG	530	6	545	6	1.0
Estonia	EE	51	41	73	58	42.3
Finland	FI	526	100	527	96	−3.6
France	FR	9570	144	10 432	157	8.5
Georgia	GE	55	11	62	13	12.8
Germany	DE	10 378	128	21 139	261	104.0
Greece	GR	580	54	638	59	10.0
Hungary	HU	941	95	1091	110	16.2
Iceland	IS	26	82	21	63	−22.8
Ireland	IE	N/A	N/A	319	65	N/A
Israel	IL	1330	170	1452	180	6.1
Italy	IT	12 336	200	12 815	207	3.6
Kazakhstan	KZ	262	15	314	17	18.5
Kosovo	XK	0	0	4	2	N/A
Kyrgyzstan[a]	KGZ	0	0	N/A	N/A	N/A
Latvia	LV	105	48	107	54	11.1
Lebanon[a]	LB	160	39	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	192	55	195	68	23.4
Luxembourg	LU	34	65	34	60	−8.7
FYR Macedonia	MK	28	13	38	18	35.4
Malta	MT	48	116	41	99	−14.9
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	22	34	19	29	−13.2
Morocco	MA	62	2	84	3	36.1
The Netherlands	NL	1931	114	2000	118	3.1
Norway	NO	514	100	562	108	8.1
Poland	PL	3718	97	3964	103	6.0
Portugal	PT	696	64	772	71	10.8
Romania	RO	289	13	276	13	−4.2

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Table 13 *Continued*

Country	ISO code	Total CRT implantations 2014		Total CRT implantations 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Russian Federation	RU	863	6	1006	7	16.6
San Marino	SM	N/A	N/A	2	61	N/A
Serbia	RS	321	45	313	44	−2.0
Slovakia	SK	529	96	588	109	12.7
Slovenia	SI	150	75	164	83	9.6
Spain	ES	2974	62	2728	57	−9.0
Sweden	SE	854	88	1034	105	20.1
Switzerland	CH	583	72	1133	140	92.9
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	180	16	N/A	N/A	N/A
Turkey	TR	2460	30	2810	35	17.4
Ukraine	UA	85	2	73	2	−14.4
UK	GB	9516	149	10 198	159	6.6
Total ESC countries		**68 912**	**77**	**84 205**	**82**	**7.5**

[a]These seven countries did not submit any data on CRT implantations for the EHRA White Book 2016.

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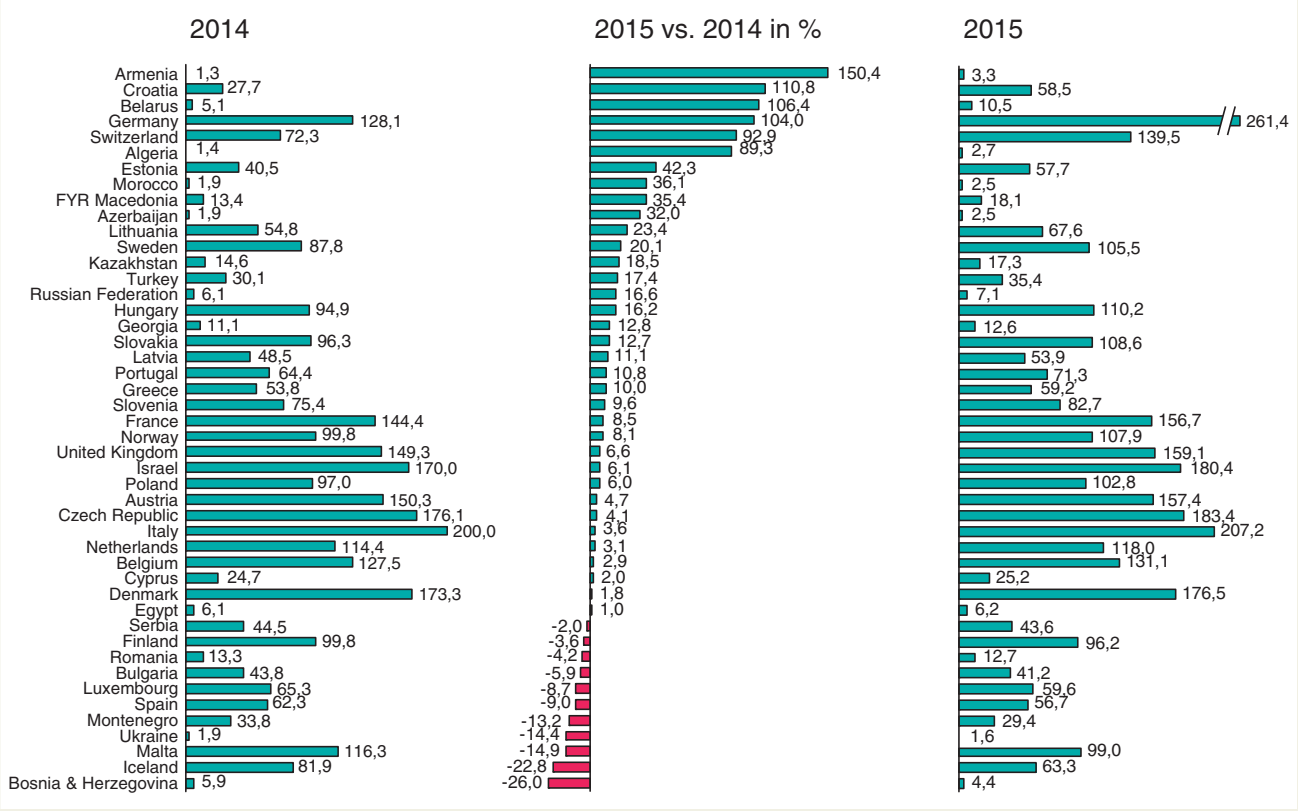

Figure 52 Change in the number of total CRT implantations per million inhabitants from 2014 to 2015.

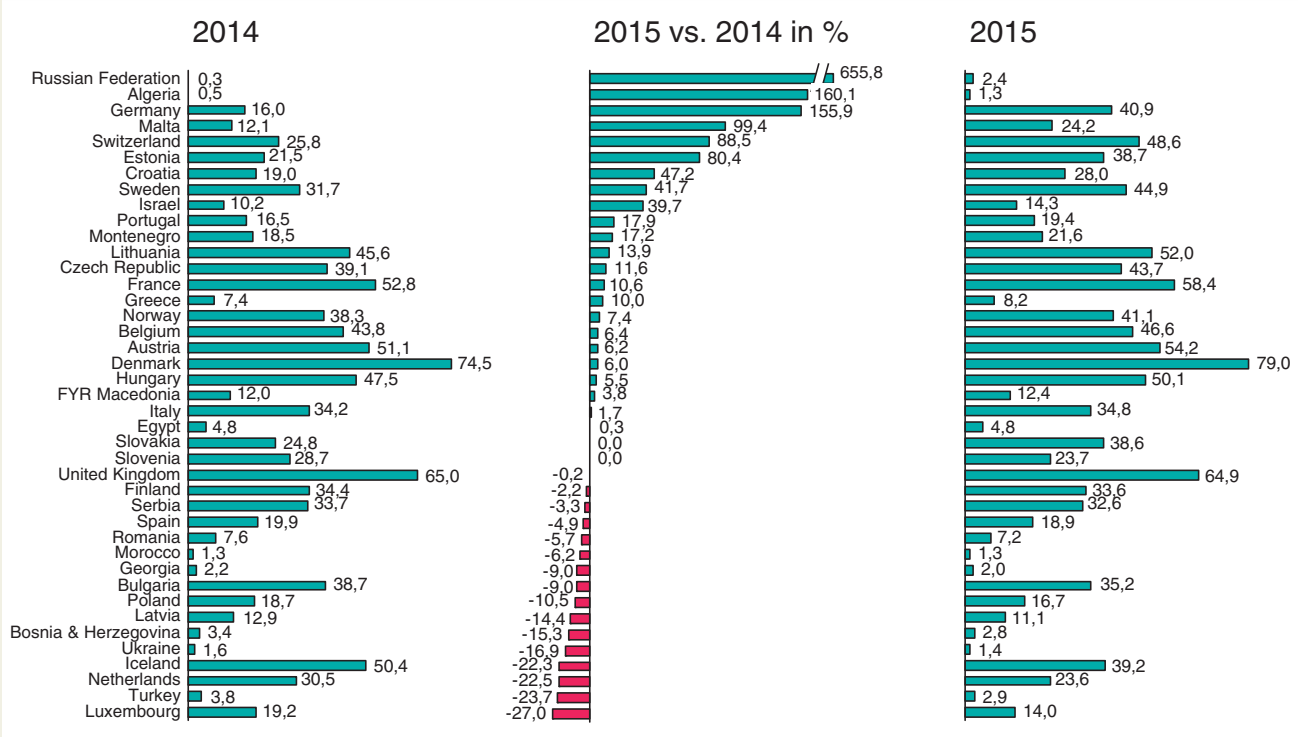

Figure 53 Change in the number of CRT-P implantations per million inhabitants from 2014 to 2015.

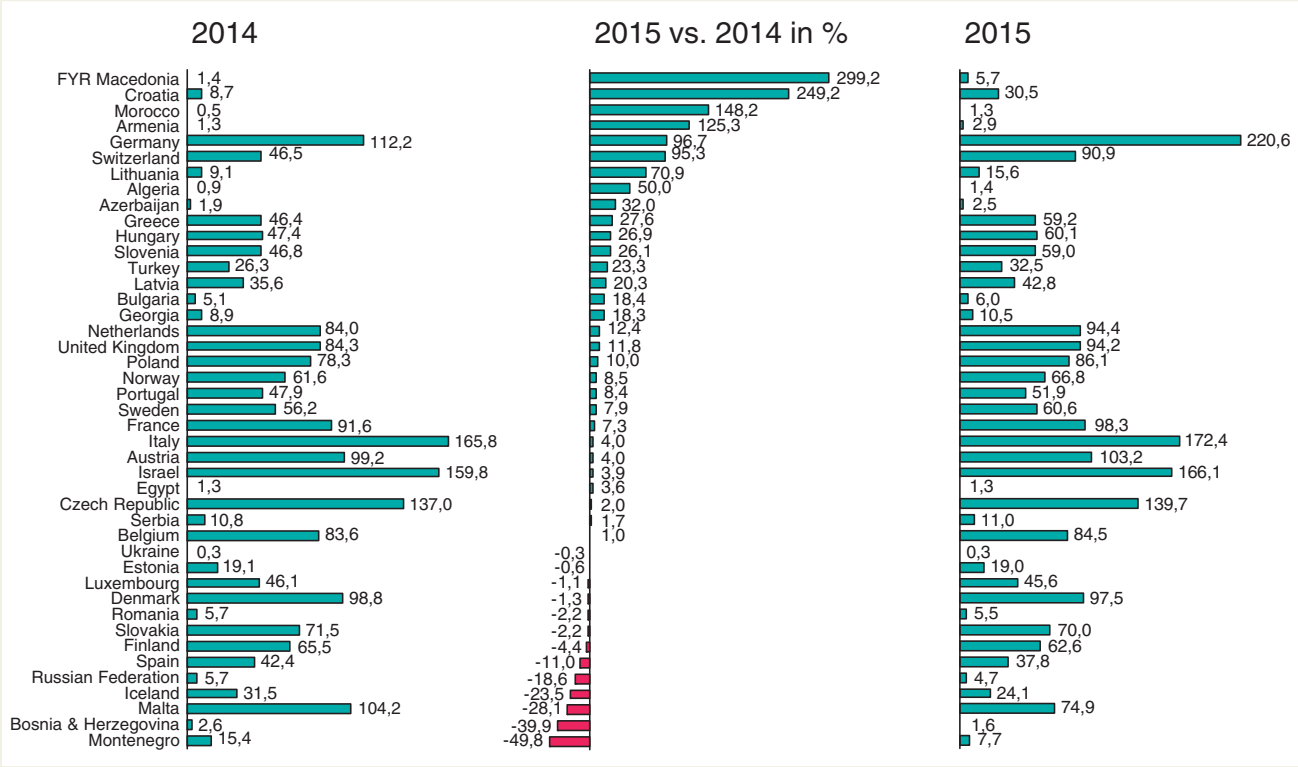

Figure 54 Change in the number of CRT-D implantations per million inhabitants from 2014 to 2015.

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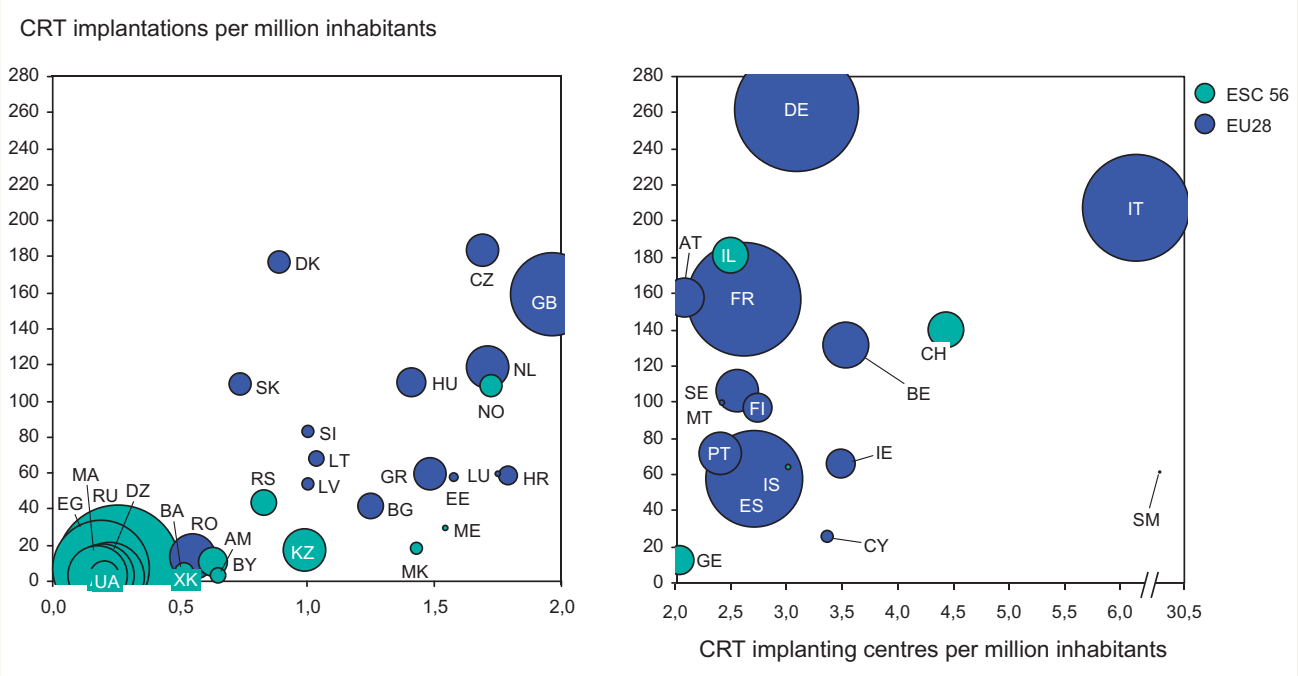

Figure 55 Cardiac resynchronization therapy implantation centres and rates in the ESC and European Union (EU28) member countries in 2015. Bubble size is related to population in the country.

Western Europe. European Society of Cardiology countries outside Europe had low ablation activity, and they are mostly found in the lowest (first) quartile. Eastern European countries had a heterogeneous distribution, which spanned over all four quartiles. Data on the number of catheter ablations during the last 5 years are shown in *Table 15*, and detailed information on the changes in the number of ablation procedures from 2014 to 2015 is presented in *Table 17* and *Figure 61*. The mean number of ablations performed per centre was almost exactly the same in 2015 (259) as in 2014 (260), indicating the ablation activities in the centres that reported their numbers were constant. The relationship between the annual catheter ablation rate and the number of ablation centres per million population in the EU28 countries and the whole ESC area is shown in *Figure 62*.

More detailed data on ablation activity in the five geographical ESC regions are presented in *Figure 63*. The mean number of ablations per million inhabitants was higher in the Western than in the other European regions and in the non-European ESC countries. In the non-European ESC countries, catheter ablation rate was almost 30 times lower than in the European ESC countries (13 vs. 310 per million population). In 2015, the most active countries were Germany, Denmark, and Switzerland with 789, 703, and 703 ablations per million population, respectively (*Table 15* and *Figure 59*). In San Marino, no ablations were performed.

Data for the last 5 years from the 3 most active and 3 least active countries in the different ESC regions are presented in *Figures 64–68*. The most active countries in the Northern, Western, Southern, and Eastern Europe were Denmark (703 ablations per million inhabitants), Germany (789), Slovenia (359), and Czech Republic (578), respectively. Among the non-European ESC countries, Kazakhstan was the most active with 136 catheter ablations per million population. In 2015, the rate of ablations per million population increased in most of the ESC countries, but Cyprus, Armenia, and Morocco reported more than 50% decrease in catheter ablation activities. The growth in the mean ablation rate per million population was highest in the Eastern and Southern European regions. In Slovenia, the increase in ablation rate was 63%.

Atrial fibrillation ablation rates

In 2015, a total of 87 527 atrial fibrillation (AF) ablations were performed in the 43 ESC countries that submitted AF ablation data for the EHRA White Book (*Table 18*). In *Figures 69* and *70*, countries performing AF ablations are grouped into quartiles according to their activity. The mean number of AF ablations per million inhabitants was 96, which is about the same as in 2014 (96 per million). The most active countries were Germany (416 AF ablations per million population), Denmark (337), and Belgium (289). Like 2014, most countries in the top quartile were from the Northern and Western European regions, and the countries with the lowest activity (first and second quartiles) were mainly from Southern Europe and from the non-European ESC region. In the Eastern region, the AF ablations activity was extremely heterogeneous. The growth in AF ablation rate per million population was highest in Azerbaijan (197%), Turkey (87%), and Bulgaria (79%), whereas in Armenia, Cyprus, and Serbia the AF ablation rate decreased by 91, 81, and 36%, respectively (*Table 19* and *Figure 71*). In Armenia, Algeria, Bosnia and Herzegovina, Malta, and San Marino, no AF ablations were performed in 2015 (*Figure 69*).

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Table 14 Lead extraction facilities and rates in 2015 and comparison with 3 previous years

Country	ISO code	Number of LE centres 2015		Number of LE procedures 2015		Development potential—target number of LE procedures		LE procedures per million inhabitants			
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2012	2013	2014	2015
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	3	0.08	41	1.04	507	945	N/A	N/A	1	1
Armenia	AM	0	0.00	0	0.00	39	73	0	1	0	0
Austria	AT	5	0.58	250	28.85	–	–	27	30	34	29
Azerbaijan	AZ	1	0.10	5	0.51	125	234	N/A	1	1	1
Belarus	BY	3	0.32	11	1.16	122	227	4	N/A	1	1
Belgium[a]	BE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bosnia and Herzegovina	BA	0	0.00	0	0.00	50	92	N/A	0	0	0
Bulgaria[a]	BG	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	0	N/A
Croatia	HR	5	1.12	49	10.97	57	107	2	0	7	11
Cyprus	CY	2	1.68	4	3.36	15	28	0	2	3	3
Czech Republic	CZ	6	0.56	300	28.18	–	–	29	30	17	28
Denmark[b]	DK	4	0.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Egypt	EG	3	0.03	20	0.23	1134	2114	0	0	0	0
Estonia[a]	EE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Finland[b]	FI	5	0.91	N/A	N/A	N/A	N/A	N/A	N/A	3	N/A
France	FR	30	0.45	3000	45.08	–	–	30	N/A	33	45
Georgia[a]	GE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	1	N/A
Germany	DE	126	1.56	2357	29.15	–	–	10	N/A	61	29
Greece	GR	4	0.37	55	5.10	138	257	2	3	5	5
Hungary	HU	8	0.81	105	10.61	127	237	7	13	10	11
Iceland	IS	0	0.00	0	0.00	4	8	0	0	3	0
Ireland[b]	IE	2	0.41	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Israel	IL	5	0.62	80	9.94	103	192	0	N/A	10	10
Italy[a]	IT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kazakhstan	KZ	1	0.06	16	0.88	233	434	0	N/A	0	1
Kosovo[a]	XK	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A
Kyrgyzstan[a]	KGZ	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A
Latvia	LV	1	0.50	19	9.56	25	47	3	4	5	10
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	2	0.69	19	6.59	37	69	3	3	3	7
Luxembourg	LU	1	1.75	6	10.52	7	14	18	N/A	13	11
FYR Macedonia	MK	2	0.95	1	0.48	27	50	3	0	0	0
Malta	MT	1	2.42	9	21.74	–	10	0	0	17	22
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A
Montenegro	ME	0	0.00	0	0.00	8	15	0	0	0	0
Morocco	MA	3	0.09	10	0.30	427	796	0	0	0	0
The Netherlands	NL	12	0.71	120	7.08	217	405	N/A	24	30	7
Norway	NO	3	0.58	194	37.25	–	–	36	42	43	37
Poland	PL	30	0.78	1050	27.23	–	–	14	12	16	27
Portugal[a]	PT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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Table 14 *Continued*

Country	ISO code	Number of LE centres 2015		Number of LE procedures 2015		Development potential—target number of LE procedures		LE procedures per million inhabitants			
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2012	2013	2014	2015
Romania	RO	4	0.18	15	0.69	278	518	0	0	0	1
Russian Federation[a]	RU	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
San Marino	SM	0	0.00	0	0.00	0	1	0	0	N/A	0
Serbia	RS	3	0.42	28	3.90	92	171	7	5	9	4
Slovakia	SK	3	0.55	119	21.97	–	129	25	20	25	22
Slovenia[b]	SI	1	0.50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spain	ES	35	0.73	400	8.31	617	1150	N/A	N/A	N/A	8
Sweden[a]	SE	N/A	N/A	N/A	N/A	N/A	N/A	22	51	46	N/A
Switzerland[b]	CH	6	0.74	N/A	N/A	N/A	N/A	N/A	11	11	N/A
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	N/A	N/A	7	N/A	2	N/A
Turkey	TR	N/A	N/A	420	5.29	1018	1898	N/A	N/A	4	5
Ukraine	UA	6	0.14	45	1.01	569	1062	1	1	1	1
UK[a]	GB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ESC countries	**56**	**326**	**0.52**	**8748**	**13**			**5**	**6**	**6**	**8**

[a]These 17 countries did not submit any data on LE for the EHRA White Book 2016.
[b]These 5 countries only submitted data on LE centres for the EHRA White Book 2016.

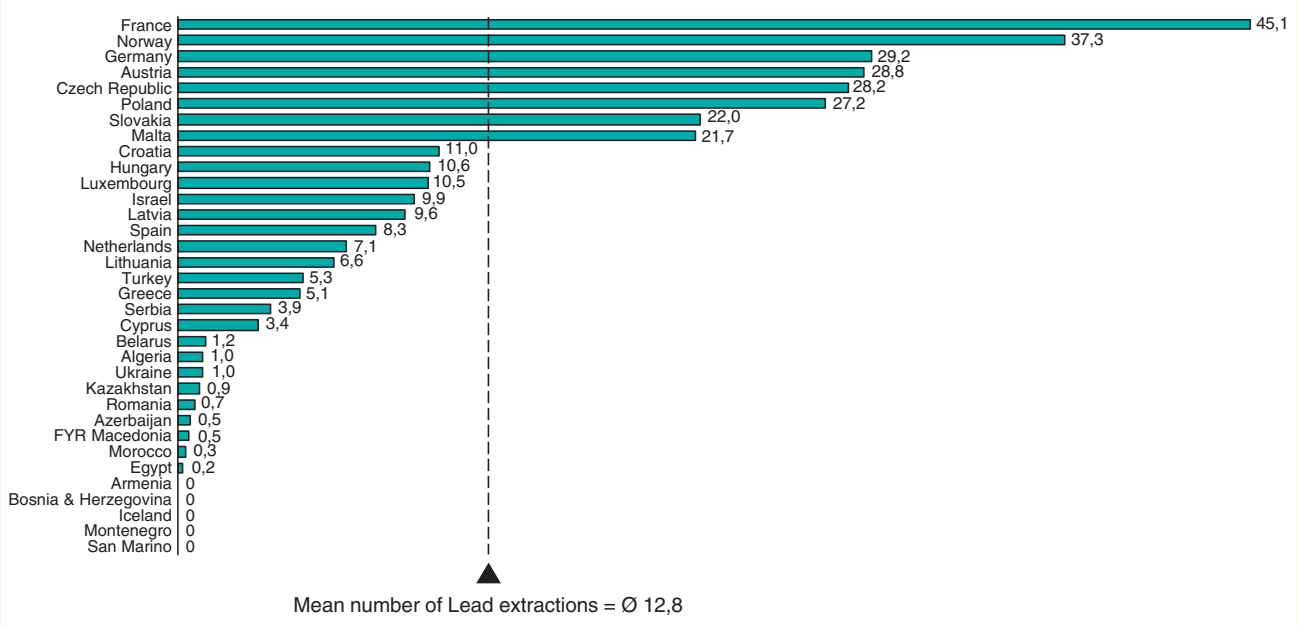

Figure 56 Lead extractions per million inhabitants in 2015. The mean number of LEs is weighted by population.

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Table 15 Catheter ablation facilities and rates in 2015 and in comparison with 4 previous years

Country	ISO code	National Registry for EP	Number of ablation centres 2015		Ablation procedures 2015		Development potential—target number of ablation procedures		Ablation procedures per million inhabitants				
			Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	No	3	0.08	303	8	10 259	18 867	N/A	N/A	6	6	8
Armenia	AM	No	3	0.98	48	16	793	1458	33	23	46	43	16
Austria	AT	Yes	19	2.19	2777	320	–	4135	220	339	294	319	320
Azerbaijan	AZ	No	5	0.51	398	41	2538	4667	20	N/A	24	40	41
Belarus	BY	No	7	0.74	993	105	2464	4532	61	54	76	84	105
Belgium	BE	No	N/A	N/A	7091	626	–	–	534	564	580	586	626
Bosnia and Herzegovina	BA	No	1	0.26	N/A	N/A	N/A	N/A	5	1	0	0	N/A
Bulgaria	BG	Yes	5	0.70	961	134	1865	3429	39	60	54	96	134
Croatia	HR	No	6	1.34	1348	302	–	2130	101	132	183	191	302
Cyprus	CY	No	3	2.52	60	50	309	567	36	35	39	121	50
Czech Republic	CZ	Yes	23	2.16	6158	578	–	–	440	474	482	551	578
Denmark	DK	Yes	6	1.07	3925	703	–	–	457	590	652	694	703
Egypt	EG	No	15	0.17	1448	16	22 958	42 221	N/A	11	12	16	16
Estonia	EE	No	2	1.58	426	337	–	604	300	260	302	327	337
Finland	FI	No	9	1.64	2550	466	–	2613	362	415	418	422	466
France	FR	No	196	2.94	39 596	595	–	–	479	472	N/A	503	595
Georgia	GE	No	8	1.62	403	82	1279	2353	55	75	54	72	82
Germany	DE	No	346	4.28	63 790	789	–	–	614	467	412	741	789
Greece	GR	Yes	29	2.69	1710	159	2796	5142	130	131	134	153	159
Hungary	HU	No	11	1.11	3723	376	–	4723	293	314	338	350	376
Iceland	IS	No	1	3.01	78	235	86	158	203	239	254	239	235
Ireland	IE	No	12	2.45	N/A	N/A	N/A	N/A	214	212	209	N/A	N/A
Israel	IL	No	16	1.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Italy[a]	IT	No	N/A	N/A	N/A	N/A	N/A	N/A	311	N/A	N/A	N/A	N/A
Kazakhstan	KZ	No	13	0.72	2461	136	4711	8664	N/A	57	83	112	136
Kosovo[a]	XK	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A
Kyrgyzstan	KGZ	No	2	0.35	59	10	1470	2703	N/A	N/A	N/A	10	10
Latvia	LV	Yes	2	1.01	726	365	–	948	247	269	238	295	365
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	36	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	No	3	1.04	1078	374	–	1376	227	243	239	252	374
Luxembourg	LU	Yes	1	1.75	145	254	148	272	252	301	251	303	254
FYR Macedonia	MK	No	2	0.95	166	79	544	1000	26	30	38	50	79
Malta	MT	No	1	2.42	32	77	107	198	20	24	29	73	77
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A
Montenegro	ME	No	1	1.55	83	128	168	309	11	149	69	102	128
Morocco	MA	Yes	5	0.15	60	2	8646	15 900	3	7	5	5	2
The Netherlands	NL	Yes	16	0.94	8500	502	–	–	N/A	382	N/A	495	502
Norway	NO	No	5	0.96	3067	589	–	–	487	530	507	575	589
Poland	PL	No	85	2.20	10 795	280	–	18 400	214	229	248	285	280
Portugal	PT	Yes	25	2.31	2580	238	2809	5165	187	186	191	215	238
Romania	RO	No	12	0.55	1194	55	5621	10 338	50	50	60	62	55

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Table 15 *Continued*

Country	ISO code	National Registry for EP	Number of ablation centres 2015		Ablation procedures 2015		Development potential—target number of ablation procedures		Ablation procedures per million inhabitants				
			Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
Russian Federation	RU	Yes	69	0.48	21 482	151	36 953	67 957	118	120	149	168	151
San Marino	SM	No	0	0.00	0	0	9	16	0	0	0	N/A	0
Serbia	RS	No	3	0.42	700	98	1862	3424	125	133	139	113	98
Slovakia	SK	Yes	4	0.74	1204	222	1405	2584	177	168	195	202	222
Slovenia	SI	Yes	3	1.51	712	359	–	946	162	136	140	220	359
Spain	ES	Yes	80	1.66	12 353	257	12 492	22 973	188	205	253	270	257
Sweden[a]	SE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	450	478	465	494	N/A
Switzerland	CH	Yes	25	3.08	5709	703	–	–	612	598	566	637	703
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	N/A	N/A	N/A	56	47	N/A	78	N/A
Turkey	TR	No	N/A	N/A	13 000	164	20 604	37 892	N/A	N/A	N/A	137	164
Ukraine	UA	No	11	0.25	2294	52	11 527	21 199	47	55	60	54	52
UK	GB	Yes	65	1.01	17 622	275	–	30 579	240	254	251	276	275
Total ESC countries			**1159**	**1.34**	**243 808**	**259**			**227**	**217**	**223**	**282**	**289**

[a]These 10 countries did not submit any data on catheter ablations for the EHRA White Book 2016.

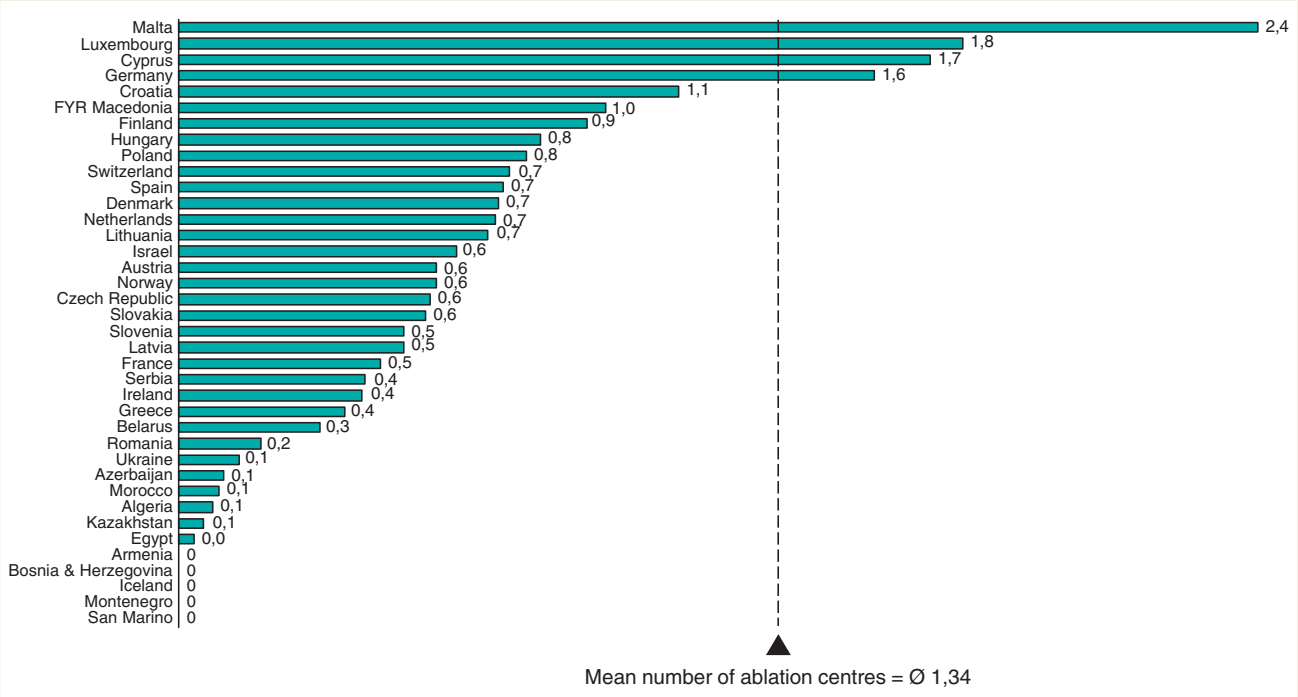

Figure 57 Catheter ablation centres per million inhabitants in 2015. The mean number of catheter ablation centres is weighted by population.

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Table 16 Change in the number of catheter ablation centres in year 2015 vs. 2014

Country	ISO code	Number of ablation centres 2014		Number of ablation centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	1	0.33	N/A	N/A	N/A
Algeria	DZ	2	0.05	3	0.08	47.2
Armenia	AM	3	0.98	3	0.98	0.1
Austria	AT	17	2.07	19	2.19	6.1
Azerbaijan	AZ	3	0.31	5	0.51	65.1
Belarus	BY	6	0.62	7	0.74	18.0
Belgium[a]	BE	44	4.21	N/A	N/A	N/A
Bosnia and Herzegovina	BA	0	0.00	1	0.26	N/A
Bulgaria	BG	4	0.58	5	0.70	20.4
Croatia	HR	5	1.12	6	1.34	20.2
Cyprus	CY	3	2.56	3	2.52	−1.4
Czech Republic	CZ	22	2.07	23	2.16	4.4
Denmark	DK	6	1.08	6	1.07	−0.2
Egypt	EG	15	0.17	15	0.17	−1.8
Estonia	EE	2	1.59	2	1.58	−0.6
Finland	FI	9	1.71	9	1.64	−3.8
France	FR	130	1.96	196	2.94	50.1
Georgia	GE	7	1.42	8	1.62	14.4
Germany	DE	200	2.47	346	4.28	73.3
Greece	GR	29	2.69	29	2.69	0.0
Hungary	HU	11	1.11	11	1.11	0.2
Iceland	IS	1	3.15	1	3.01	−4.4
Ireland	IE	12	2.48	12	2.45	−1.2
Israel	IL	16	2.05	16	1.99	−2.8
Italy[a]	IT	0	0.00	N/A	N/A	N/A
Kazakhstan	KZ	9	0.50	13	0.72	42.8
Kosovo[a]	XK	0	0.00	N/A	N/A	N/A
Kyrgyzstan	KGZ	2	0.36	2	0.35	−1.1
Latvia	LV	2	0.92	2	1.01	9.0
Lebanon[a]	LB	5	0.85	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	3	1.03	3	1.04	1.0
Luxembourg	LU	1	1.92	1	1.75	−8.7
FYR Macedonia	MK	3	1.43	2	0.95	−33.5
Malta	MT	1	2.42	1	2.42	−0.3
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	1	1.54	1	1.55	0.5
Morocco	MA	5	0.15	5	0.15	0.5
The Netherlands	NL	16	0.95	16	0.94	−0.4
Norway	NO	5	0.97	5	0.96	−1.2
Poland	PL	83	2.16	85	2.20	1.8
Portugal	PT	24	2.22	25	2.31	4.1
Romania	RO	12	0.55	12	0.55	0.3

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Table 16 *Continued*

Country	ISO code	Number of ablation centres 2014		Number of ablation centres 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Russian Federation	RU	81	0.57	69	0.48	−14.8
San Marino	SM	N/A	N/A	0	0.00	N/A
Serbia	RS	2	0.28	3	0.42	50.7
Slovakia	SK	4	0.73	4	0.74	1.4
Slovenia	SI	3	1.51	3	1.51	0.2
Spain	ES	85	1.78	80	1.66	−6.7
Sweden[a]	SE	10	1.03	N/A	N/A	N/A
Switzerland	CH	23	2.85	25	3.08	7.9
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	9	0.82	N/A	N/A	N/A
Turkey[a]	TR	0	0.00	N/A	N/A	N/A
Ukraine	UA	8	0.18	11	0.25	37.1
UK	GB	61	0.96	65	1.01	6.0
Total ESC countries		**1006**	**1.09**	**1159**	**1.34**	**23.0**

[a]These 11 countries did not submit any data on ablation centres for the EHRA White Book 2016.

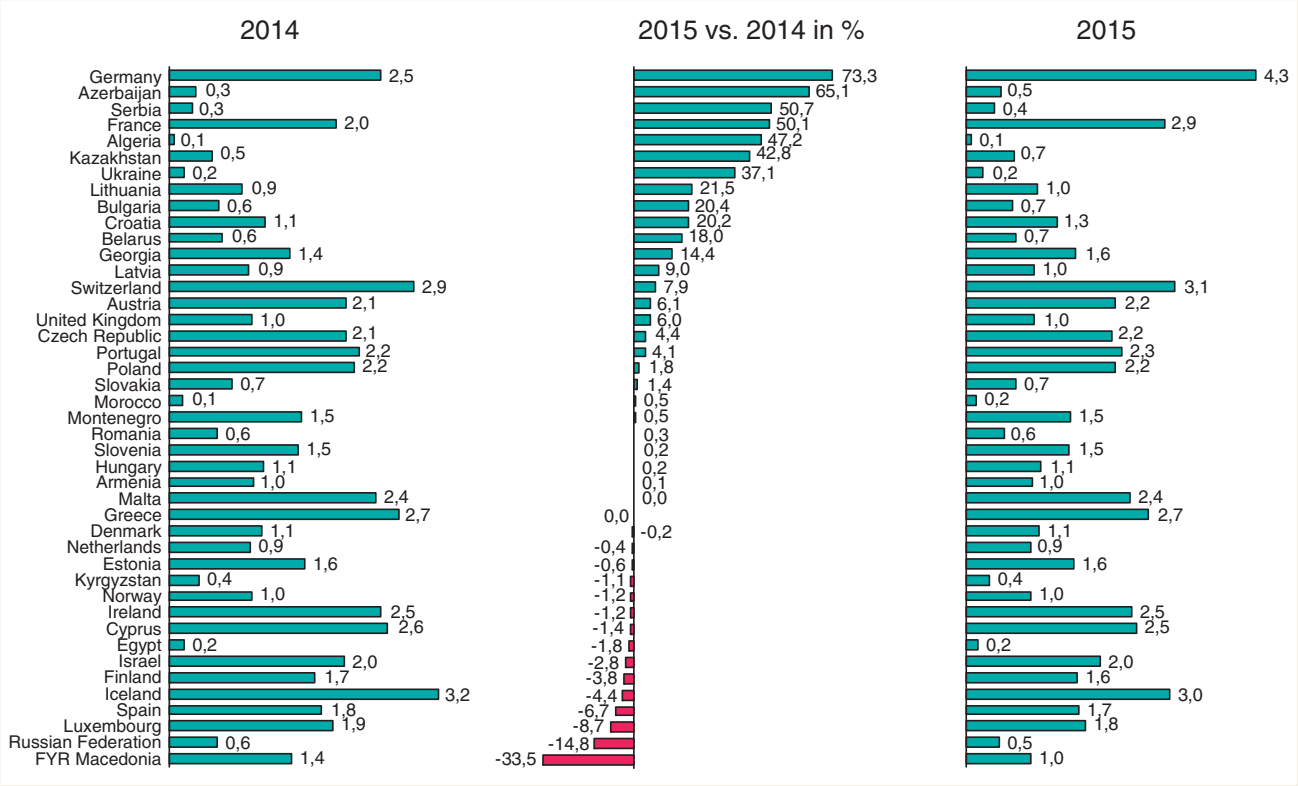

Figure 58 Change in the number of catheter ablation centres per million inhabitants from 2014 to 2015.

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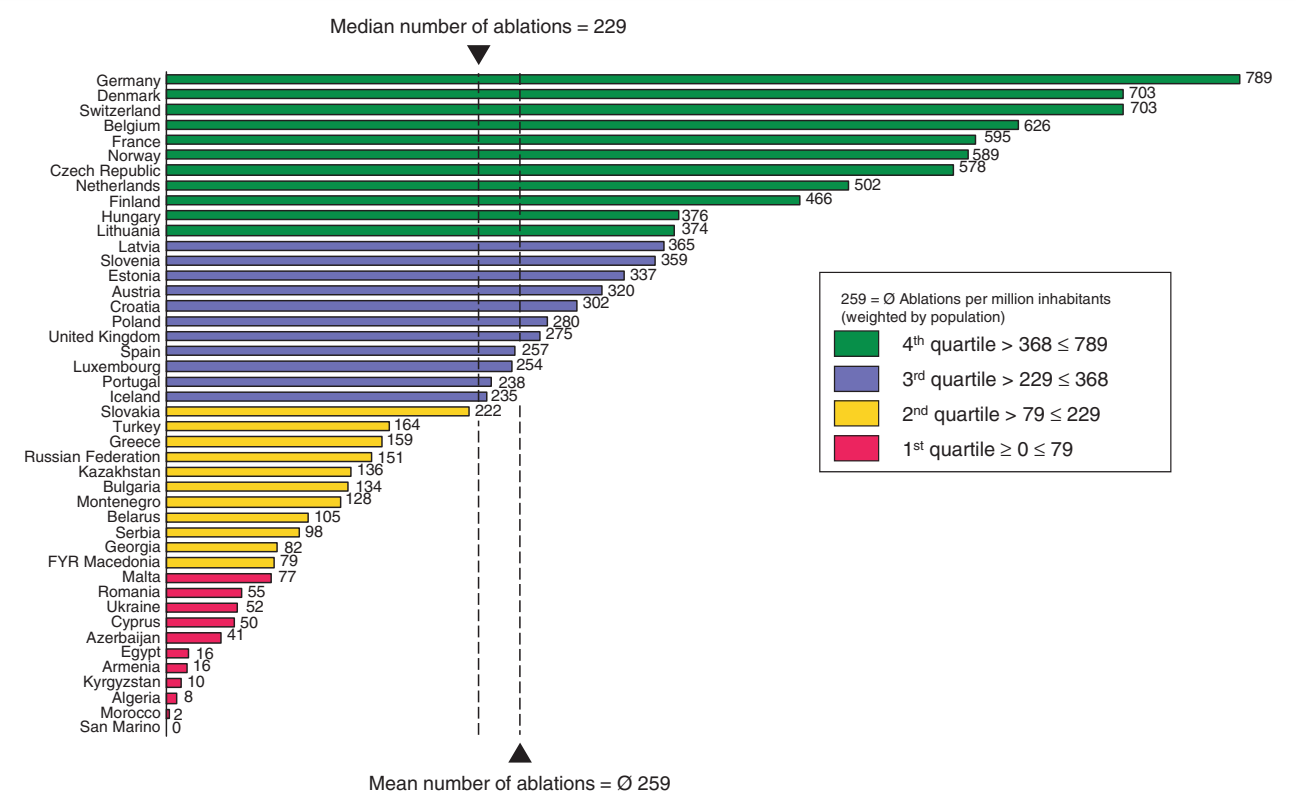

Figure 59 Catheter ablations per million inhabitants in 2015. The mean number of ablations is weighted by population.

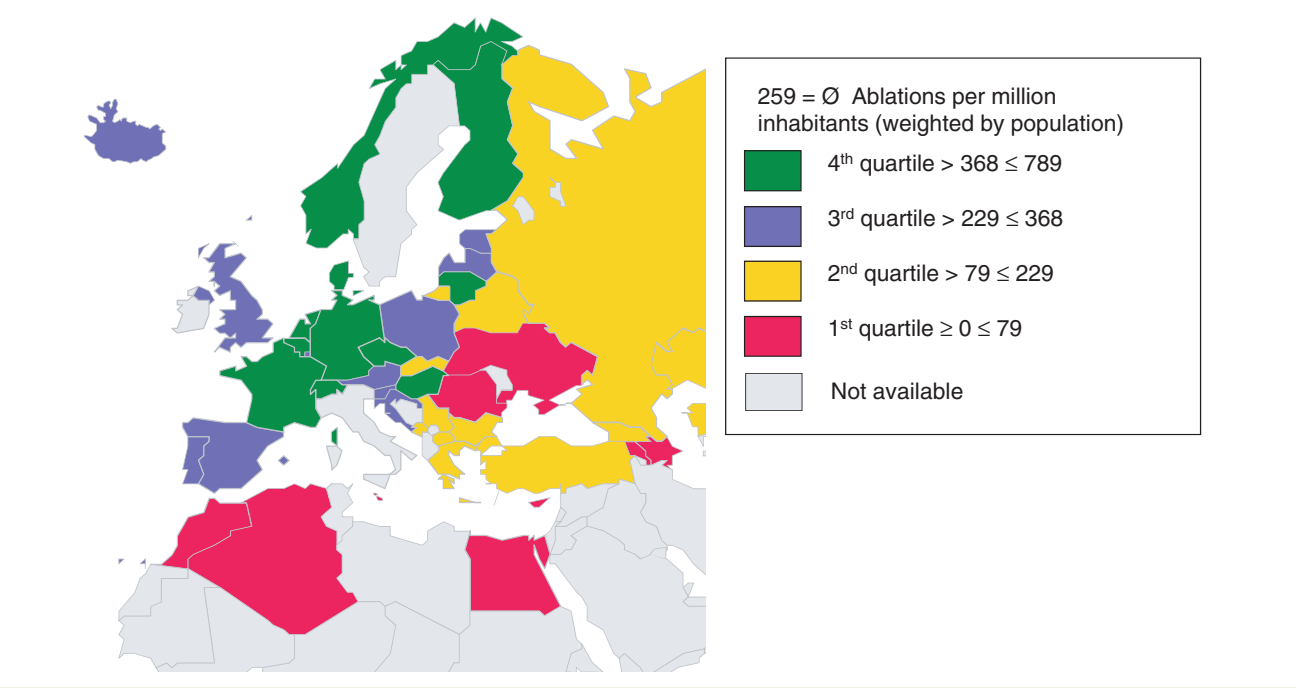

Figure 60 Catheter ablations in the ESC countries in 2015.

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Table 17 Change in the number of catheter ablations in year 2015 vs. 2014

Country	ISO code	Total ablations 2014		Total ablations 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	240	6	303	8	23.9
Armenia	AM	132	43	48	16	−63.6
Austria	AT	2622	319	2777	320	0.5
Azerbaijan	AZ	384	40	398	41	2.6
Belarus	BY	807	84	993	105	24.5
Belgium	BE	6126	586	7091	626	6.8
Bosnia and Herzegovina[a]	BA	0	0	N/A	N/A	N/A
Bulgaria	BG	663	96	961	134	39.7
Croatia	HR	852	191	1348	302	58.4
Cyprus	CY	142	121	60	50	−58.3
Czech Republic	CZ	5855	551	6158	578	5.0
Denmark	DK	3867	694	3925	703	1.3
Egypt	EG	1354	16	1448	16	5.0
Estonia	EE	411	327	426	337	3.0
Finland	FI	2222	422	2550	466	10.4
France	FR	33 300	503	39 596	595	18.4
Georgia	GE	356	72	403	82	13.3
Germany	DE	60 000	741	63 790	789	6.5
Greece	GR	1653	153	1710	159	3.4
Hungary	HU	3469	350	3723	376	7.6
Iceland	IS	76	239	78	235	−1.9
Ireland[a]	IE	N/A	N/A	N/A	N/A	N/A
Israel[a]	IL	N/A	N/A	N/A	N/A	N/A
Italy[a]	IT	N/A	N/A	N/A	N/A	N/A
Kazakhstan	KZ	2018	112	2461	136	20.6
Kosovo[a]	XK	0	0	N/A	N/A	N/A
Kyrgyzstan	KGZ	58	10	59	10	0.6
Latvia	LV	638	295	726	365	24.0
Lebanon[a]	LB	150	25	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	885	304	1078	374	23.1
Luxembourg	LU	158	303	145	254	−16.2
FYR Macedonia	MK	105	50	166	79	57.8
Malta	MT	30	73	32	77	6.3
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	66	102	83	128	26.3
Morocco	MA	170	5	60	2	−64.5
The Netherlands	NL	8358	495	8500	502	1.3
Norway	NO	2959	575	3067	589	2.5
Poland	PL	10 922	285	10 795	280	−1.7
Portugal	PT	2324	215	2580	238	10.9
Romania	RO	1358	62	1194	55	−11.8
Russian Federation	RU	23 874	168	21 482	151	−10.0

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Table 17 *Continued*

Country	ISO code	Total ablations 2014		Total ablations 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
San Marino	SM	N/A	N/A	0	0	N/A
Serbia	RS	815	113	700	98	−13.7
Slovakia	SK	1111	202	1204	222	9.9
Slovenia	SI	437	220	712	359	63.3
Spain	ES	12 871	270	12 353	257	−4.8
Sweden[a]	SE	4803	494	N/A	N/A	N/A
Switzerland	CH	5135	637	5709	703	10.4
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	850	78	N/A	N/A	N/A
Turkey	TR	11 218	137	13 000	164	19.1
Ukraine	UA	2371	54	2294	52	−3.5
UK	GB	17 578	276	17 622	275	−0.3
Total ESC countries		**235 793**	**246**	**243 808**	**259**	**5.7**

[a]These 12 countries did not submit any data on ablations for the EHRA White Book 2016.

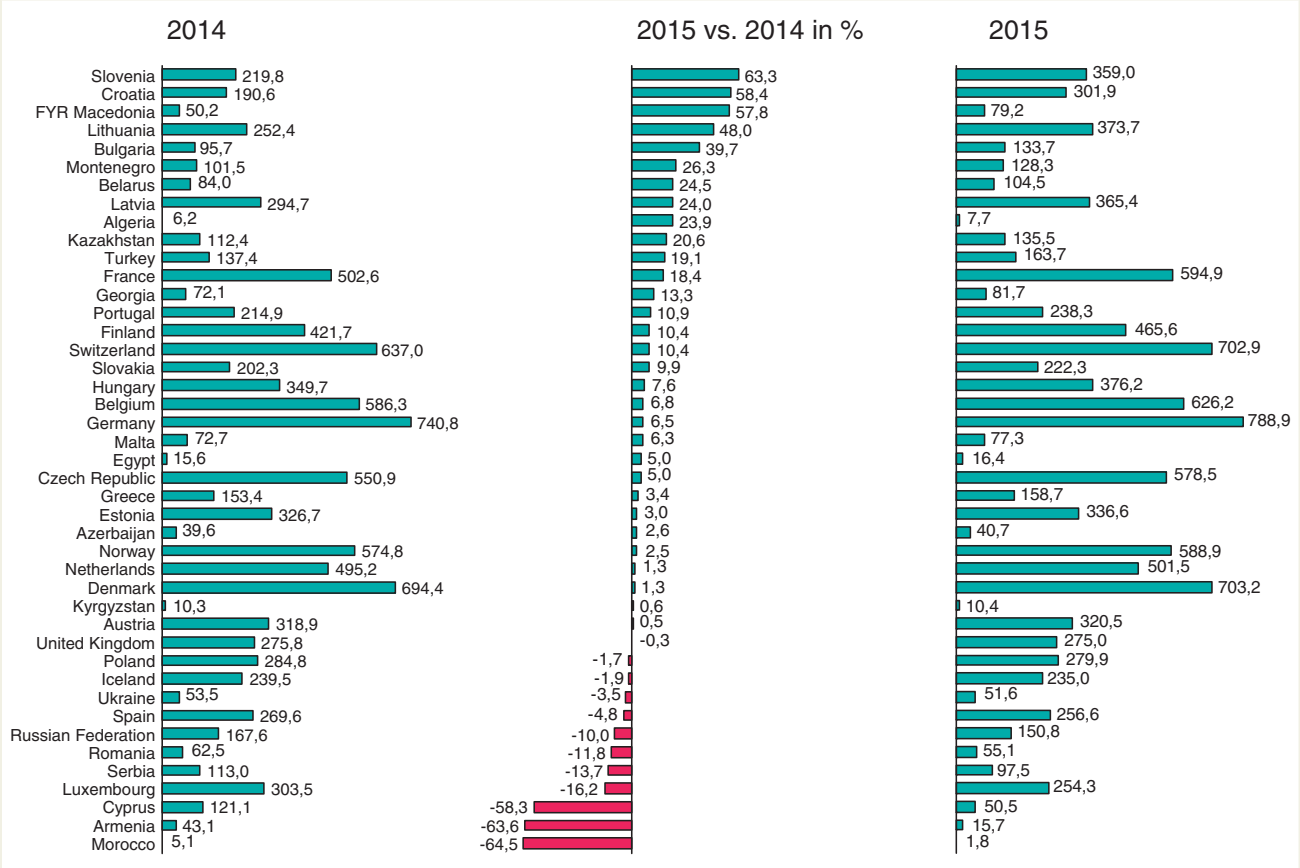

Figure 61 Change in the number of catheter ablations per million inhabitants from 2014 to 2015.

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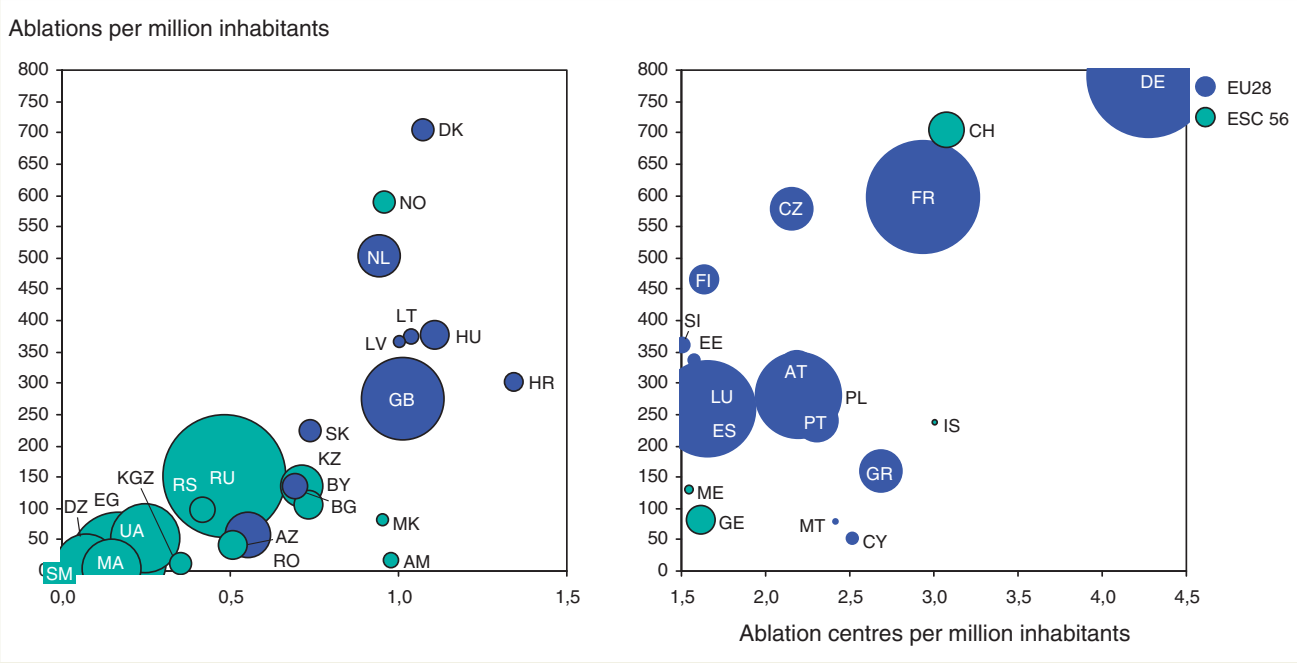

Figure 62 Catheter ablation centres and rates in the ESC and European Union (EU28) member countries in 2015. Bubble size is related to population in the country.

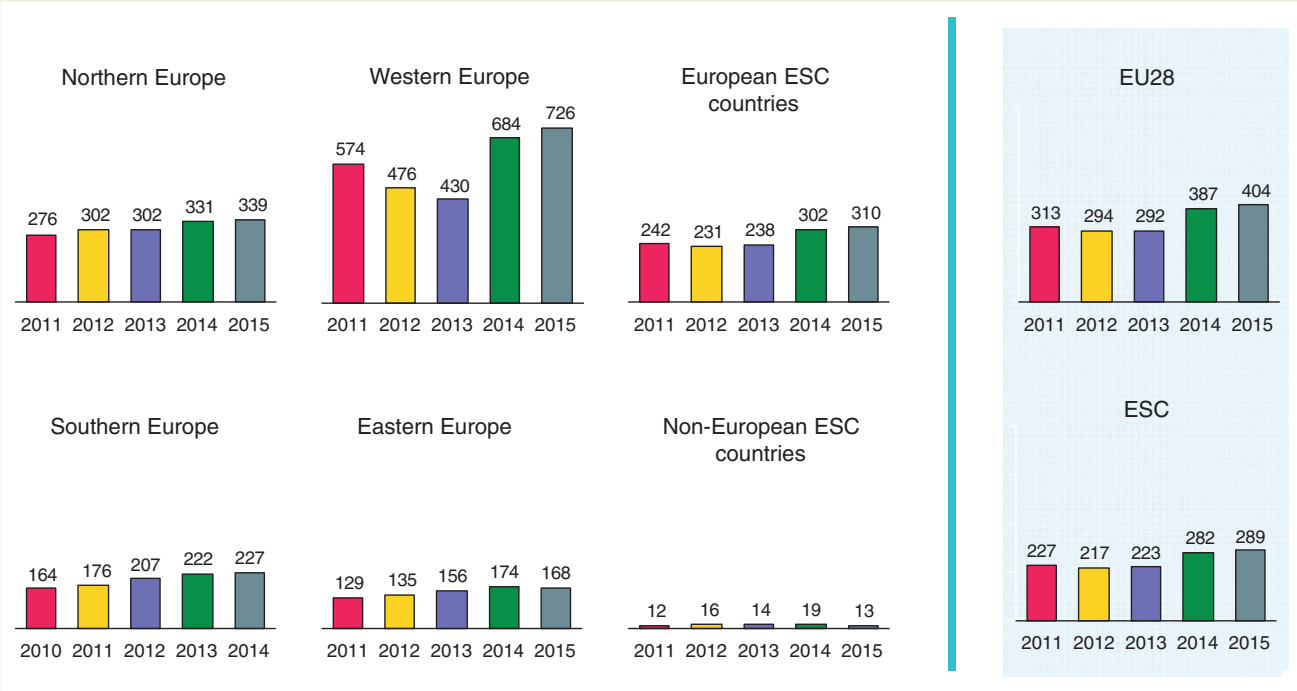

Figure 63 Catheter ablations per million inhabitants 2011–15 in the five geographical regions of the ESC and comparison with the total ESC area and the 28 member countries of the European Union (EU28).

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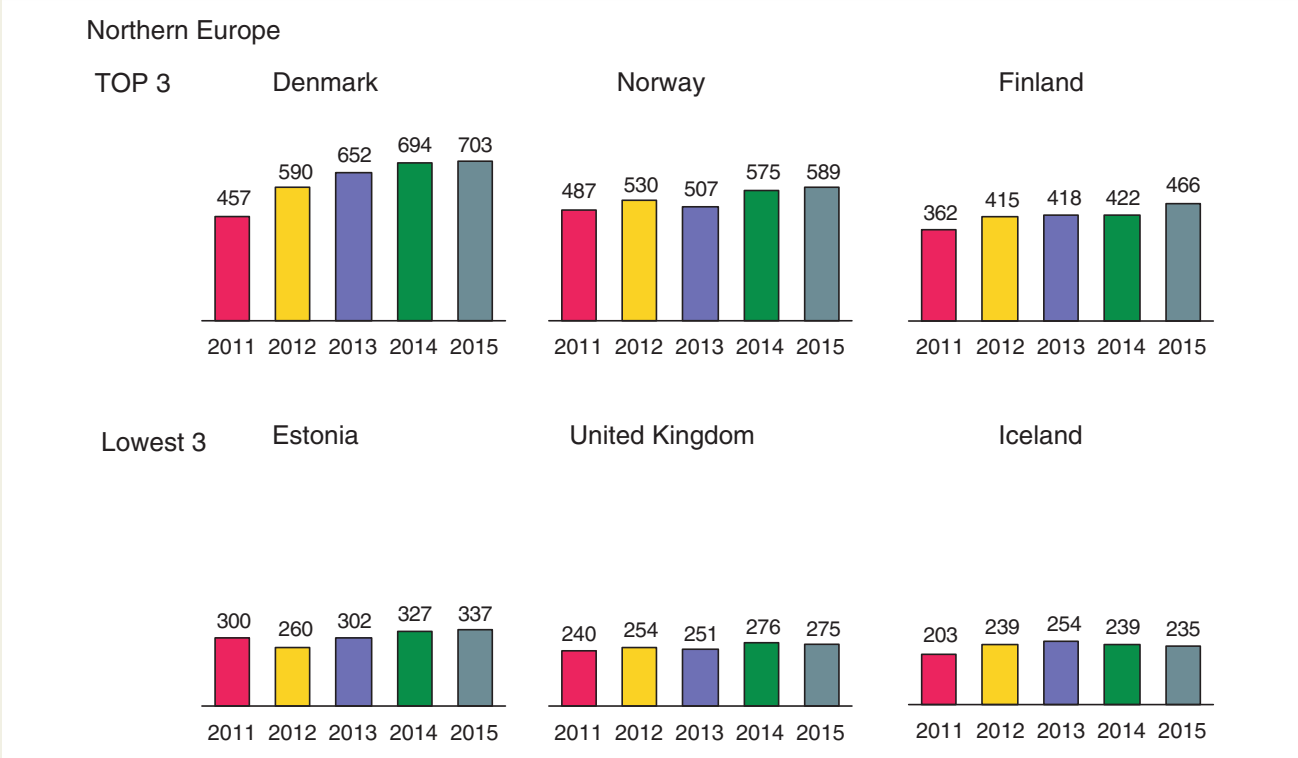

Figure 64 Catheter ablations per million inhabitants 2011–15 in Northern Europe.

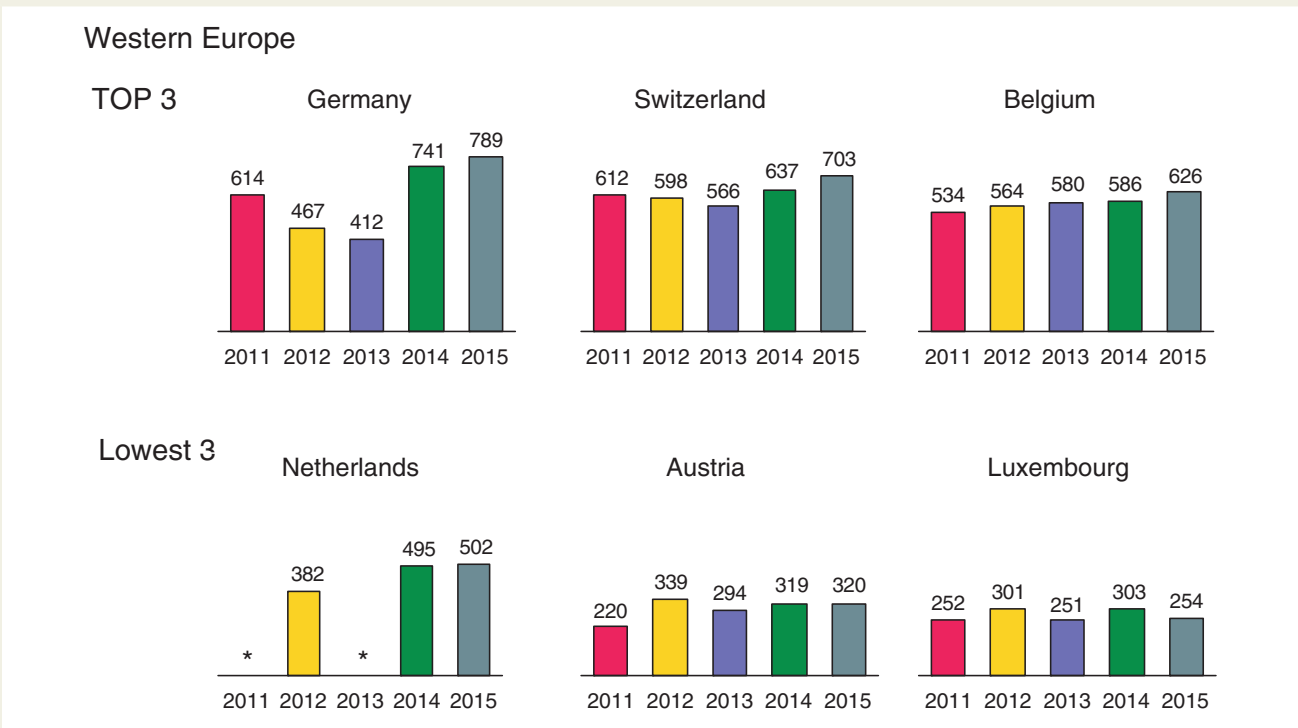

Figure 65 Catheter ablations per million inhabitants 2011–15 in Western Europe. *No data available.

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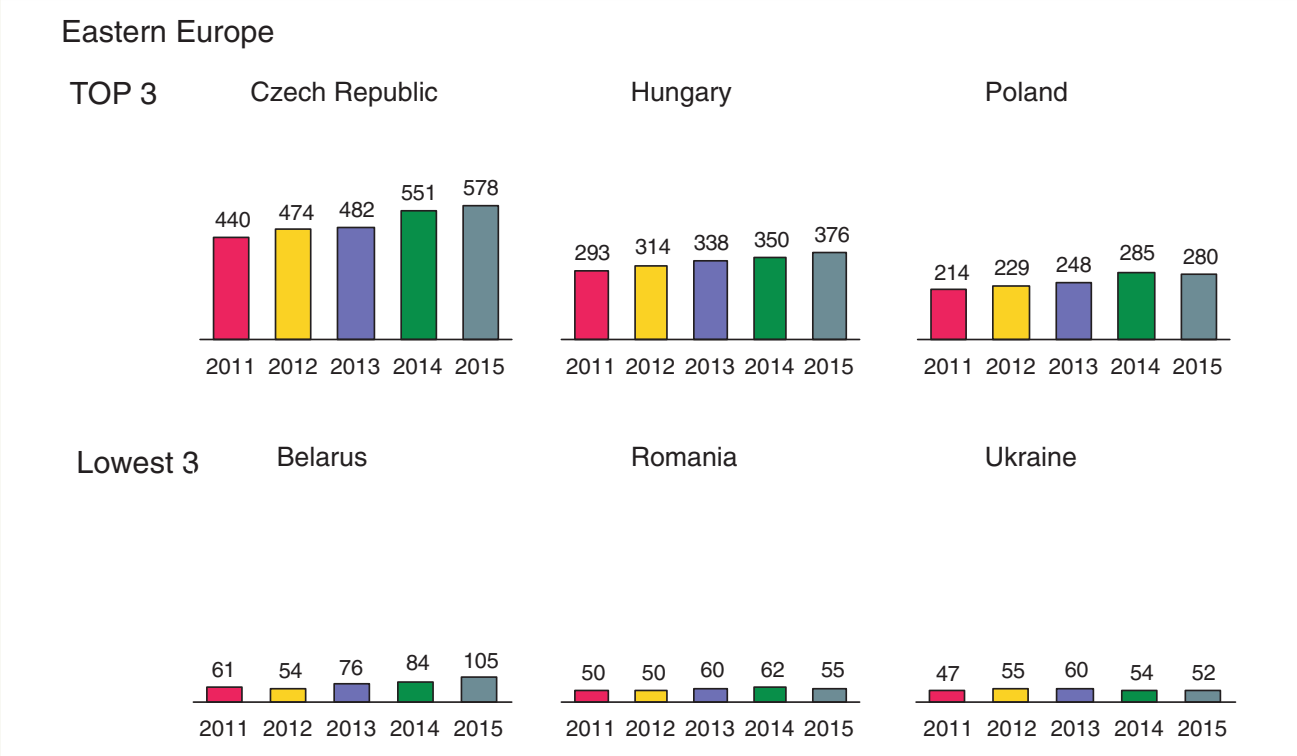

Figure 66 Catheter ablations per million inhabitants 2011–15 in Eastern Europe.

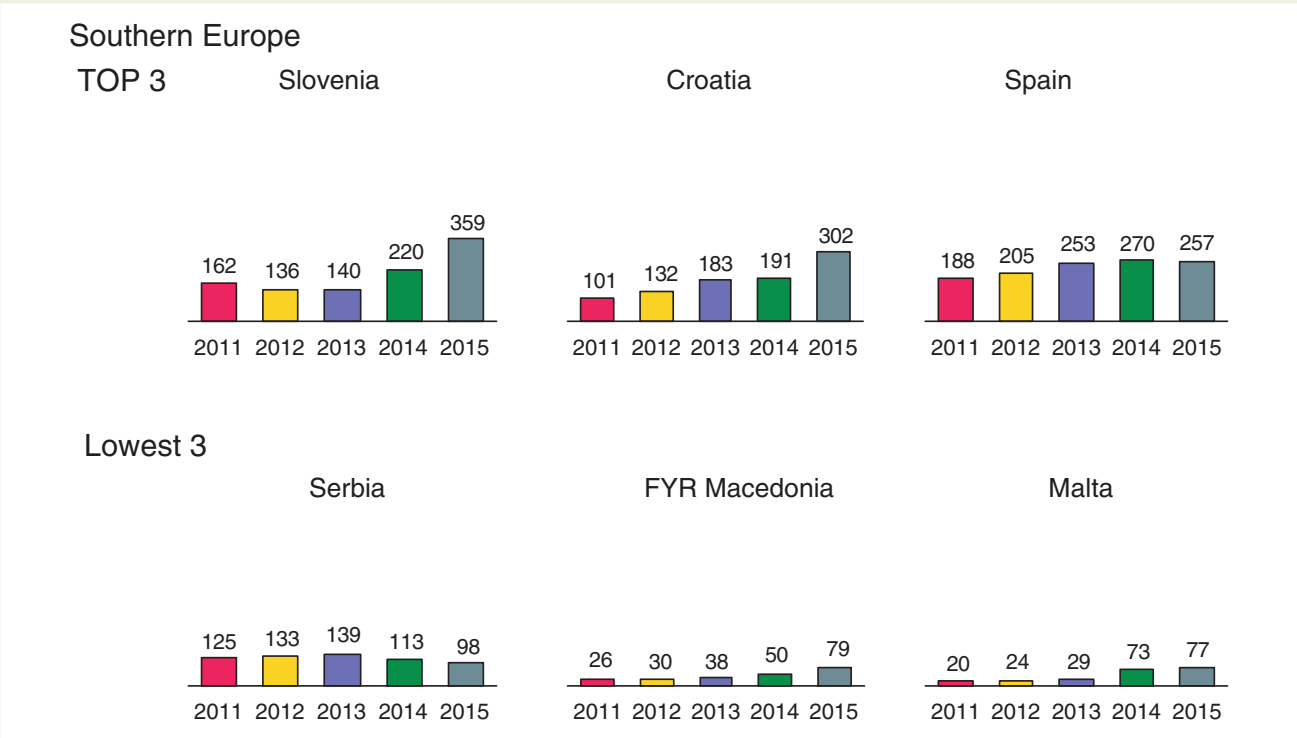

Figure 67 Catheter ablations per million inhabitants 2011–15 in Southern Europe.

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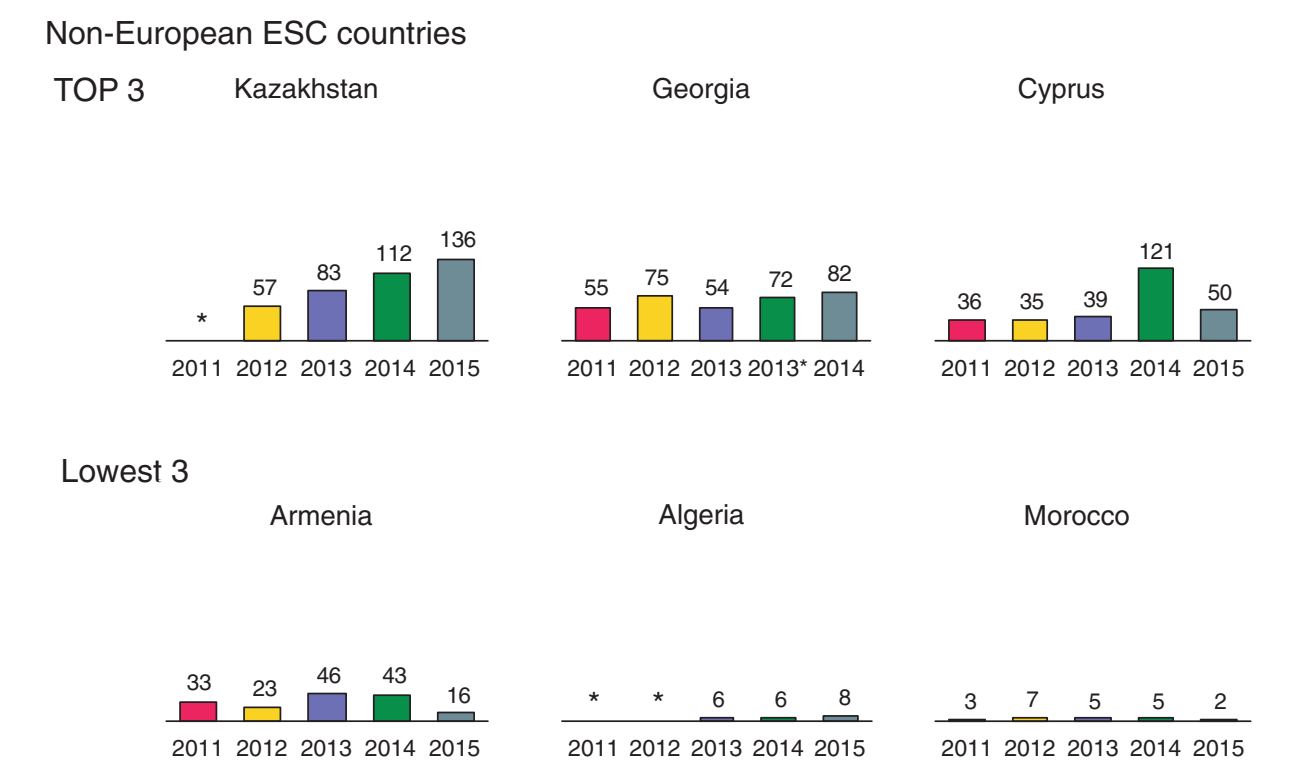

Figure 68 Catheter ablations per million inhabitants 2011–15 in the non-European ESC countries. *No data available.

Detailed data on AF ablation activities in the five ESC regions and a comparison with the corresponding numbers in the ESC and EU28 countries are presented in *Figure 72*. The rate of AF ablations was markedly lower in the non-European countries than in the European ESC countries (8 vs. 125 per million population). The most active countries in the Northern, Western, Southern, and Eastern European regions and among the non-European ESC countries were Denmark (337 AF ablation per million population), Germany (416), Slovenia (108), Czech Republic (238), and Kazakhstan (42), respectively (*Figures 73–77*). The proportion of AF ablations out of the total number of ablations varied between 1.5% in Azerbaijan and 52.7% in Germany. The mean ratio of AF ablations out of the total ablations was 35.7%, and the proportion of AF ablations compared with all ablations was more than 40% in 7 countries (*Figure 78*).

Ventricular tachyarrhythmia ablation rates

In 2015, the number of centres performing more than 10 ventricular tachyarrhythmia ablations for patients with structural heart disease per million population was highest in Germany (1.71) and lowest in Ukraine (0.02) (*Figure 79*). Data on ventricular tachyarrhythmia ablations in patients with structural heart disease were collected for the second time in 2015. A total of 35 (63%) countries reported data on ventricular tachycardia (VT) or ventricular fibrillation (VF) ablations. The mean number of VT/VF ablations per million population in the ESC countries had increased from 9.2 in 2014 to 16.0 in 2015. It was highest in Germany (83 per million population) followed by Finland (30), Czech Republic (28), and Denmark (26) (*Figures 80* and *81*). Many countries did not report any data on VT/VF ablation ($n = 21$) or did not perform any VT/VF ablations ($n = 5$) in 2015.

Percutaneous left atrial appendage closures

During recent years, percutaneous left atrial appendage (LAA) closure has become an attractive option to prevent AF-related thromboembolic complications among patients with high risk of bleeding and contraindications to oral anticoagulation therapy.[16,17] The mean number of centres performing LAA closures in the ESC area was 0.9 per million population (*Figure 82*). In 2015, however, only 26 of the 56 ESC member countries (46%) submitted the requested data on the numbers of LAA closures for the EHRA White Book. The mean number of procedures in the ESC countries performing LAA closures was the same in 2015 as that in 2014 (8.9 per million inhabitants). Germany was by far the most active country (54.8 LAA closure per million inhabitants) followed by Finland (22.5) and Latvia (14.1) (*Figure 83*). Of note is that in Kazakhstan, where the CIED implantation and catheter ablations numbers were generally quite low, 4.5 LAA occlusions were performed per million inhabitants.

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Table 18 Atrial fibrillation ablations in 2015 in comparison with 4 previous years

Country	ISO code	AF ablation procedures 2015		Development potential—target number of AF ablation procedures		AF ablation procedures per million inhabitants				
		Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU28 level	2011	2012	2013	2014	2015
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	0	0	3814	6590	N/A	N/A	0	0	0
Armenia	AM	1	0	295	509	1	3	3	4	0
Austria	AT	966	111	–	1444	62	122	94	107	111
Azerbaijan	AZ	6	1	943	1630	0	N/A	0	0	1
Belarus	BY	106	11	916	1583	4	6	7	7	11
Belgium	BE	3273	289	–	–	182	224	225	245	289
Bosnia and Herzegovina	BA	0	0	373	644	0	0	0	0	0
Bulgaria	BG	147	20	693	1198	0	7	7	11	20
Croatia	HR	385	86	431	744	10	18	38	50	86
Cyprus	CY	10	8	115	198	3	5	5	45	8
Czech Republic	CZ	2537	238	–	–	156	177	196	216	238
Denmark	DK	1882	337	–	–	194	262	290	305	337
Egypt	EG	65	1	8536	14 747	N/A	0	0	1	1
Estonia	EE	110	87	122	211	90	27	56	78	87
Finland	FI	926	169	–	–	91	110	124	140	169
France	FR	10 138	152	–	11 091	100	130	N/A	166	152
Georgia	GE	64	13	476	822	9	11	7	10	13
Germany	DE	33 628	416	–	–	184	172	144	494	416
Greece	GR	650	60	1039	1796	32	37	40	52	60
Hungary	HU	1204	122	–	1649	61	75	86	109	122
Iceland	IS	36	108	–	55	48	77	73	104	108
Ireland	IE	650	133	–	815	96	95	94	N/A	133
Israel[a]	IL	N/A	N/A	N/A	N/A	N/A	0	N/A	70	N/A
Italy[a]	IT	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A
Kazakhstan	KZ	762	42	1751	3026	6	11	15	29	42
Kosovo[a]	XK	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A
Kyrgyzstan[a]	KGZ	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Latvia	LV	88	44	192	331	31	26	29	35	44
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	81	28	278	481	19	8	9	21	28
Luxembourg	LU	48	84	55	95	54	61	60	109	84
FYR Macedonia[a]	MK	N/A	N/A	N/A	N/A	0	0	0	0	N/A
Malta	MT	0	0	40	69	0	0	2	0	0
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A
Montenegro	ME	18	28	62	108	0	0	0	26	28
Morocco[a]	MA	N/A	N/A	N/A	N/A	0	0	N/A	N/A	N/A
The Netherlands	NL	3600	212	–	–	N/A	156	N/A	202	212
Norway	NO	1460	280	–	–	242	249	293	278	280
Poland	PL	3253	84	3720	6427	N/A	44	50	57	84
Portugal	PT	743	69	1044	1804	43	49	51	63	69
Romania	RO	132	6	2090	3611	3	4	6	4	6
Russian Federation	RU	6329	44	13 739	23 735	27	27	41	45	44
San Marino	SM	0	0	3	6	0	0	0	N/A	0
Serbia	RS	150	21	692	1196	8	14	17	33	21
Slovakia	SK	224	41	522	903	17	18	27	23	41
Slovenia	SI	214	108	–	331	59	55	83	75	108
Spain	ES	2426	50	4644	8024	31	33	46	52	50
Sweden[a]	SE	N/A	N/A	N/A	N/A	157	178	179	184	N/A
Switzerland	CH	1991	245	–	–	209	193	184	209	245
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	N/A	N/A	N/A	N/A	2	3	N/A	4	N/A
Turkey	TR	2200	28	7660	13 235	N/A	N/A	N/A	15	28
Ukraine	UA	634	14	4286	7404	11	14	15	14	14
UK	GB	6390	100	–	10 681	74	80	85	102	100
Total ESC countries	**56**	**87 527**	**123**			**66**	**69**	**72**	**122**	**123**

[a]These 13 countries did not submit any data on AF ablations for the EHRA White Book 2016.

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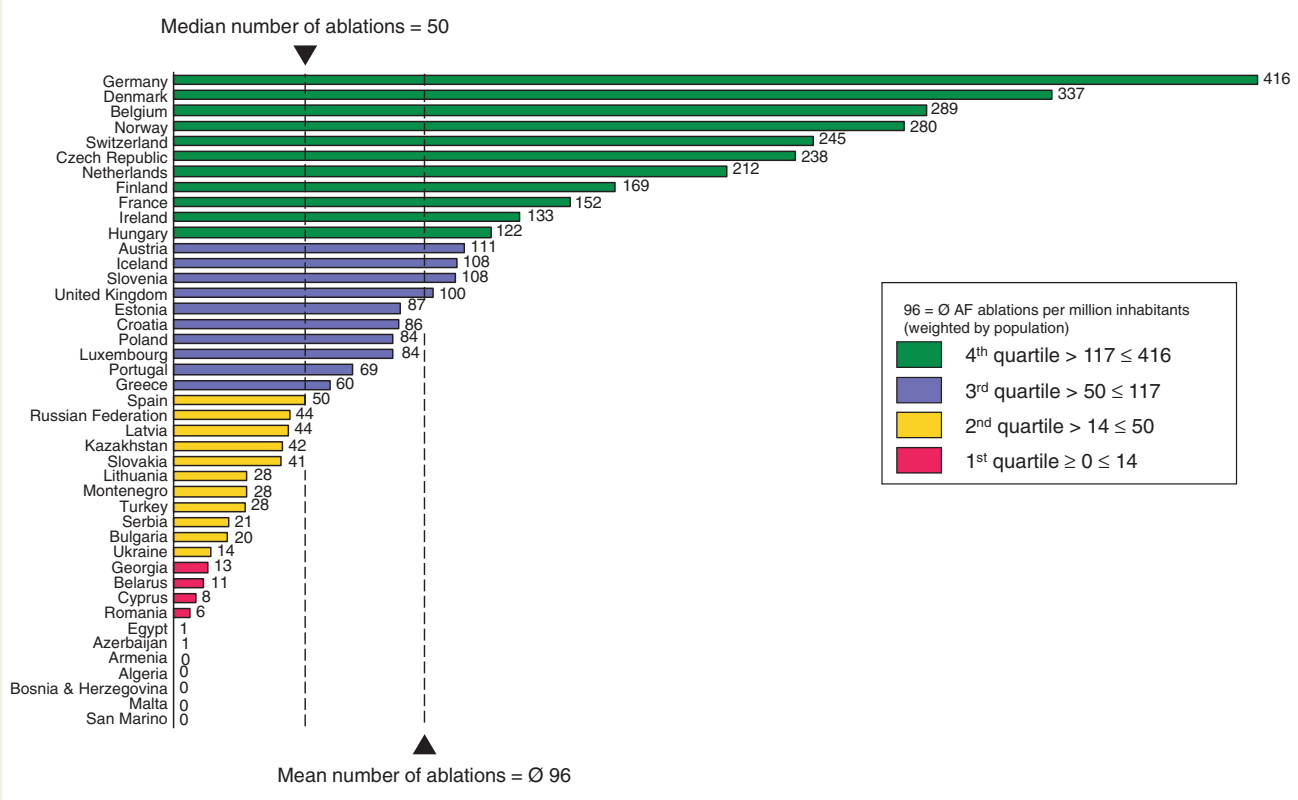

Figure 69 Atrial fibrillation ablations per million inhabitants in 2015. The mean number of AF ablations is weighted by population.

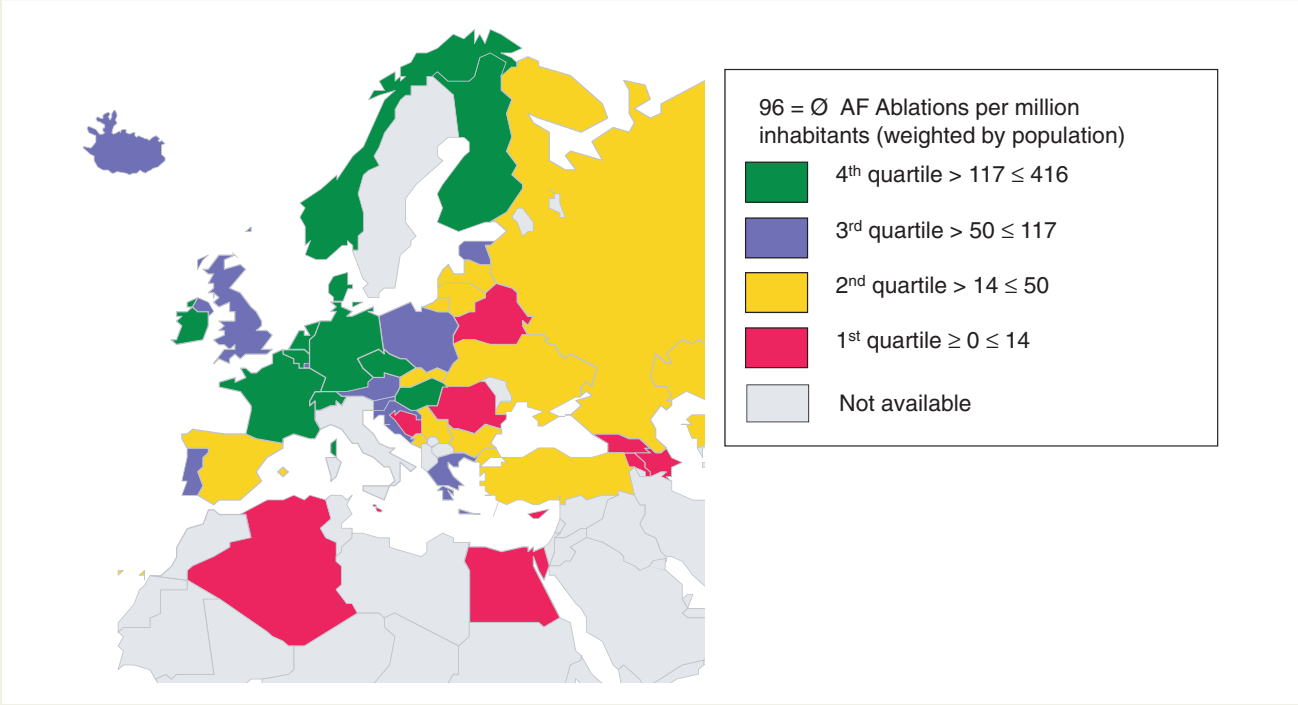

Figure 70 Atrial fibrillation ablations in the ESC countries in 2015.

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Table 19 Change in the number of catheter ablations of AF in year 2015 vs. 2014

Country	ISO code	AF ablation procedures 2014		AF ablation procedures 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania[a]	AL	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	0	0	0	0	0.0
Armenia	AM	11	4	1	0	−90.9
Austria	AT	878	107	966	111	4.4
Azerbaijan	AZ	2	0	6	1	197.1
Belarus	BY	69	7	106	11	55.4
Belgium	BE	2560	245	3273	289	18.0
Bosnia and Herzegovina	BA	0	0	0	0	0.0
Bulgaria	BG	79	11	147	20	79.3
Croatia	HR	223	50	385	86	72.9
Cyprus	CY	53	45	10	8	−81.4
Czech Republic	CZ	2297	216	2537	238	10.3
Denmark	DK	1698	305	1882	337	10.6
Egypt	EG	60	1	65	1	6.4
Estonia	EE	98	78	110	87	11.6
Finland	FI	736	140	926	169	21.0
France	FR	11 000	166	10 138	152	−8.2
Georgia	GE	50	10	64	13	28.1
Germany	DE	35 000	432	33 628	416	−3.8
Greece	GR	560	52	650	60	16.1
Hungary	HU	1081	109	1204	122	11.6
Iceland	IS	33	104	36	108	4.3
Ireland	IE	N/A	N/A	650	133	N/A
Israel[a]	IL	550	70	N/A	N/A	N/A
Italy[a]	IT	N/A	N/A	N/A	N/A	N/A
Kazakhstan	KZ	524	29	762	42	43.8
Kosovo[a]	XK	0	0	N/A	N/A	N/A
Kyrgyzstan[a]	KGZ	N/A	N/A	N/A	N/A	N/A
Latvia	LV	75	35	88	44	27.9
Lebanon[a]	LB	N/A	N/A	N/A	N/A	N/A
Libya[a]	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	74	25	81	28	10.6
Luxembourg	LU	57	109	48	84	−23.1
FYR Macedonia[a]	MK	0	0	N/A	N/A	N/A
Malta	MT	0	0	0	0	0.0
Moldova[a]	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	17	26	18	28	6.4
Morocco[a]	MA	N/A	N/A	N/A	N/A	N/A
The Netherlands	NL	3413	202	3600	212	5.0
Norway	NO	1432	278	1460	280	0.8
Poland	PL	2169	57	3253	84	49.1
Portugal	PT	684	63	743	69	8.5
Romania	RO	88	4	132	6	50.4
Russian Federation	RU	6462	45	6329	44	−2.0
San Marino	SM	N/A	N/A	0	0	N/A
Serbia	RS	236	33	150	21	−36.1
Slovakia	SK	129	23	224	41	76.1
Slovenia	SI	149	75	214	108	44.0

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Table 19 *Continued*

Country	ISO code	AF ablation procedures 2014		AF ablation procedures 2015		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Spain	ES	2498	52	2426	50	−3.7
Sweden[a]	SE	1791	184	N/A	N/A	N/A
Switzerland	CH	1684	209	1991	245	17.4
Syria[a]	SY	N/A	N/A	N/A	N/A	N/A
Tunisia[a]	TN	40	4	N/A	N/A	N/A
Turkey	TR	1208	15	2200	28	87.2
Ukraine	UA	622	14	634	14	1.6
UK	GB	6505	102	6390	100	−2.3
Total ESC countries		**86 895**	**93**	**87 527**	**96**	**3.2**

[a]These seven countries did not submit any data on AF ablations for the EHRA White Book 2016.

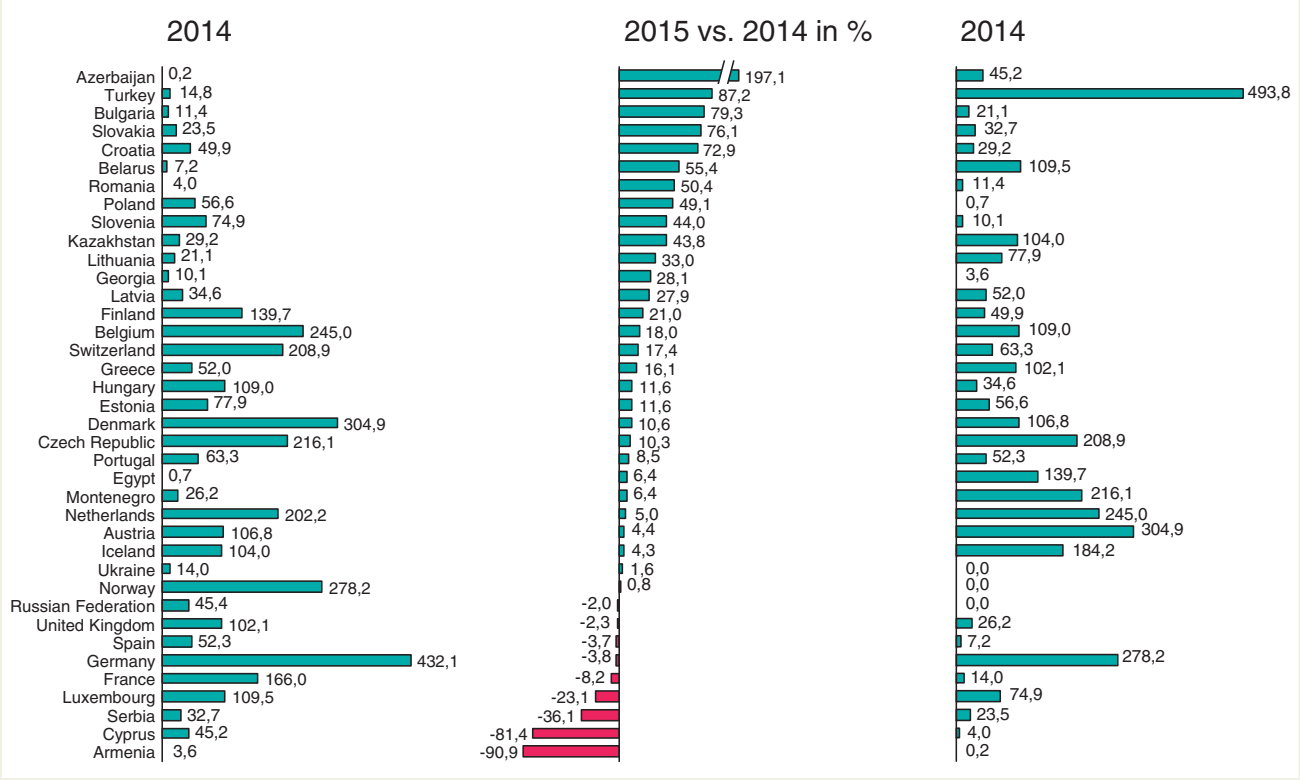

Figure 71 Change in the number of AF ablations per million inhabitants from 2014 to 2015.

Discussion

For almost a decade, the EHRA White Book has been a key resource for healthcare professionals and stakeholders with an interest in the advancement of cardiac arrhythmia therapies in Europe. It has already played an important role in the ICD for life programme[3] and many other strategic initiatives and awareness activities of the EHRA. Current analysis of the EHRA White Book data showed that considerable variations in access to and use of invasive EPs continue to exist within the ESC area. Despite several improvements over the last 5 years, there is still a clear need to improve the availability of invasive procedures for complex arrhythmias in many ESC countries.

As in previous years, the mean CIED implantation rates were markedly lower in the Eastern European and non-European ESC countries than in the other regions. The catheter ablation activity

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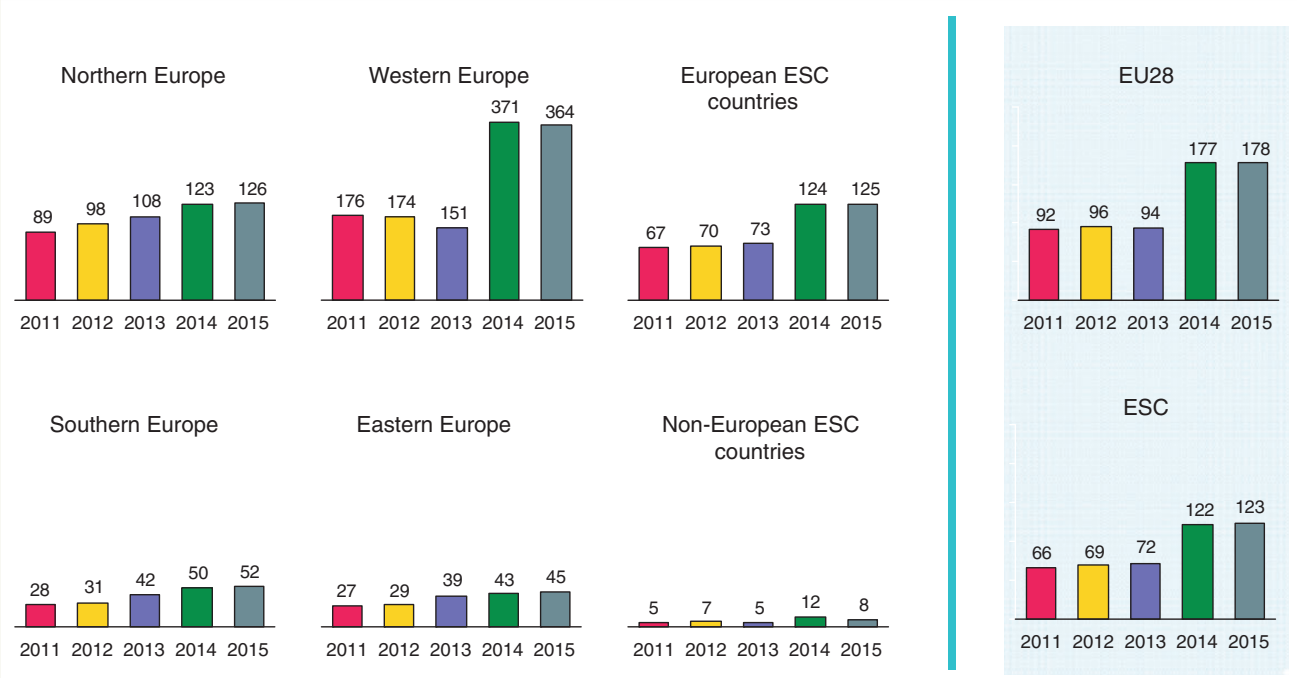

Figure 72 Atrial fibrillation ablations per million inhabitants 2011–15 in the five geographical regions of the ESC and comparison with the total ESC area and the 28 member countries of the European Union (EU28).

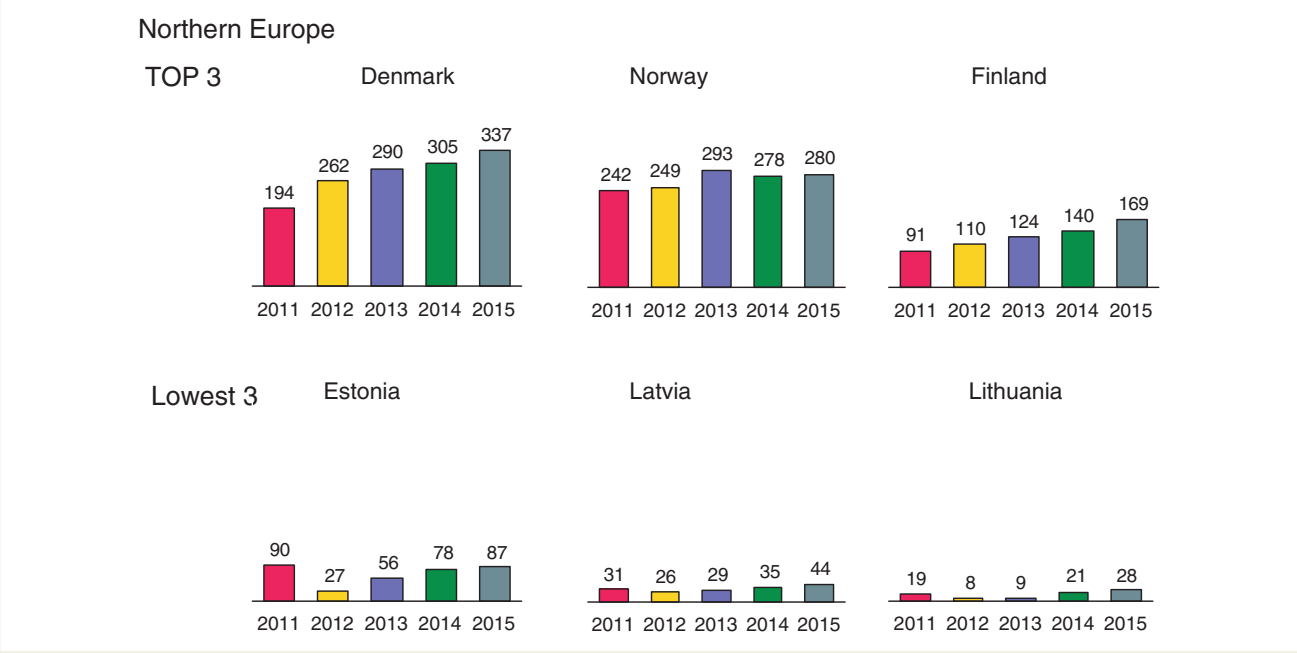

Figure 73 Atrial fibrillation ablations per million inhabitants 2011–15 in Northern Europe.

was substantially higher in the Western and Northern European than in the non-European ESC countries. The Eastern European ESC countries were characterized by large variations in the procedure rates, with numbers spanning over all four quartiles of the activity distribution. Surprisingly, there was a drop in the number of LEs between 2014 and 2015, although continued increase in numbers was expected. The reasons for this are unclear, and it cannot be excluded that this was related to a reporting bias.

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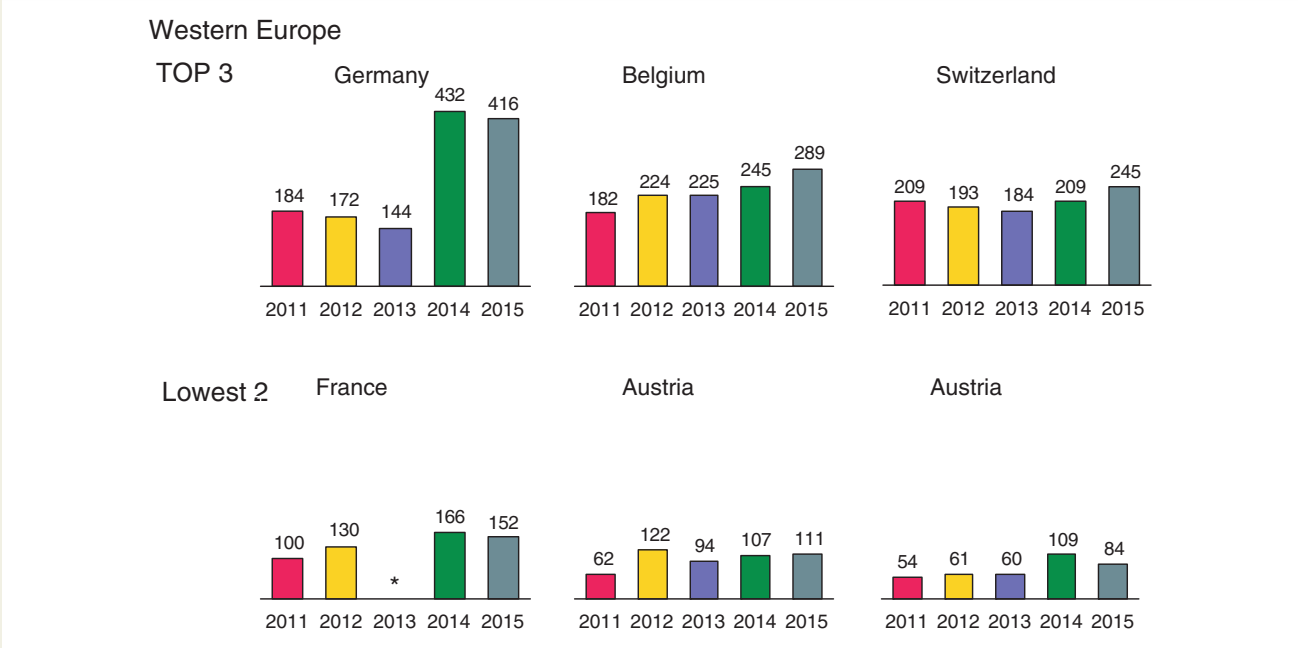

Figure 74 Atrial fibrillation ablations per million inhabitants 2011–15 in Western Europe. *No data available.

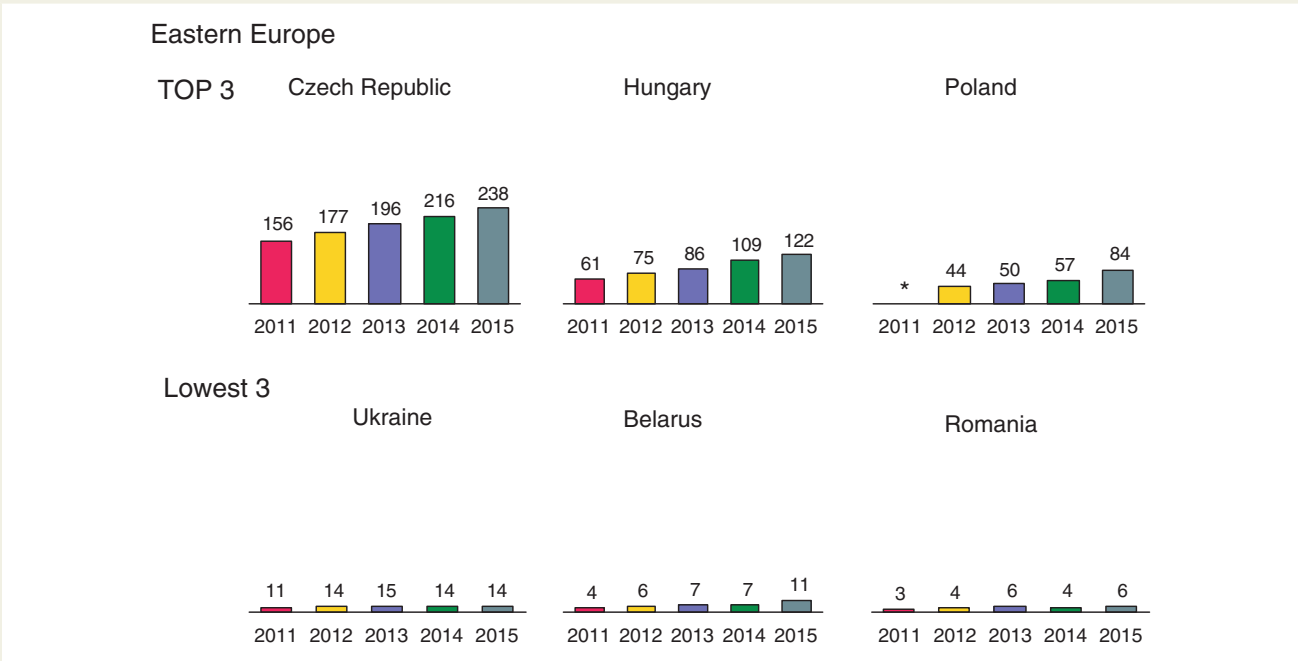

Figure 75 Atrial fibrillation ablations per million inhabitants 2011–15 in Eastern Europe. *No data available.

Potential explanations for the disparities between the European Society of Cardiology countries

As shown in *Figure 3*, the healthcare expenditure currently absorbs from 4.3 to 12.9% of GDP in the ESC countries. Hence, it is not surprising that there continues to be a large gap between the EU28 countries and selected Eastern European and non-European ESC countries in the CIED implantation facilities and rates. Likewise, catheter ablation facilities and rates were markedly lower in the non-European than in the European ESC member countries.

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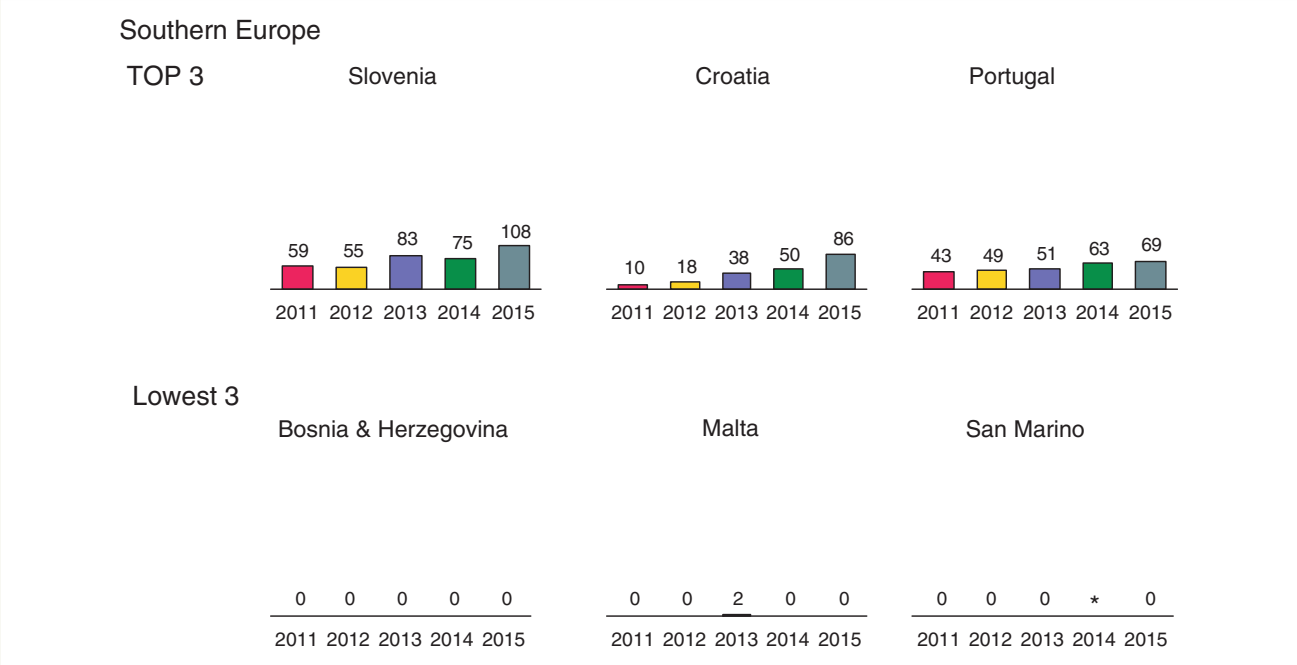

Figure 76 Atrial fibrillation ablations per million inhabitants 2011–15 in Southern Europe. *No data available.

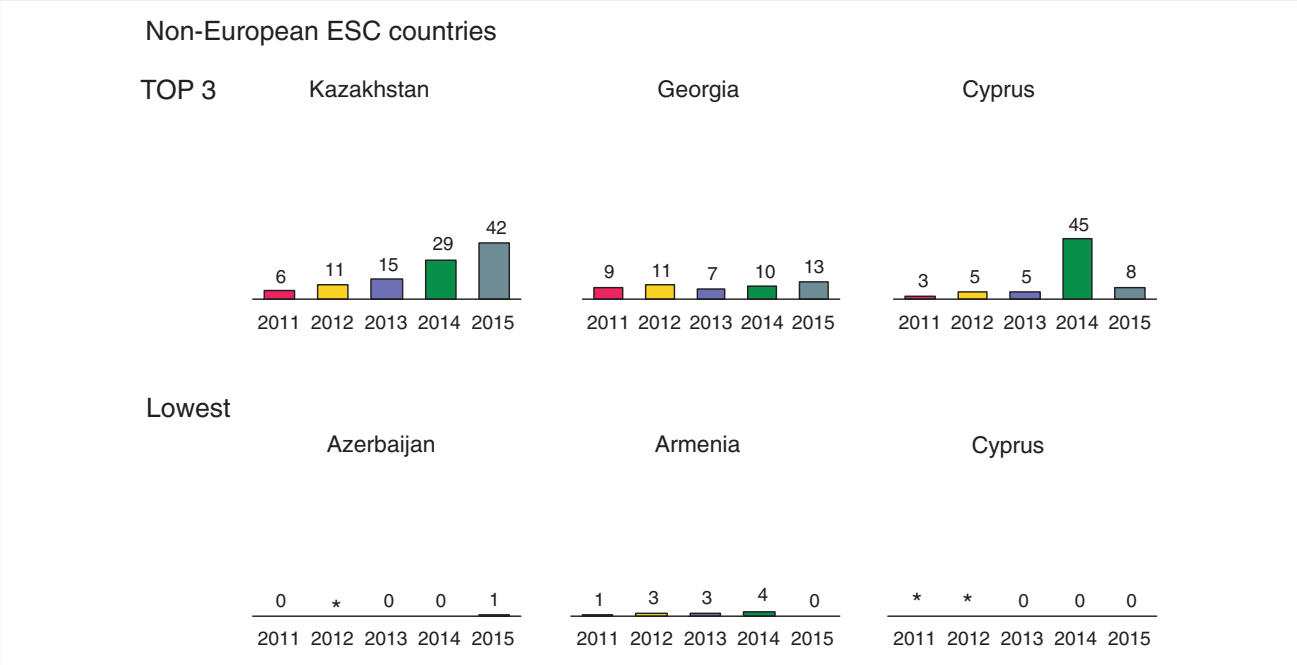

Figure 77 Atrial fibrillation ablations per million inhabitants 2011–15 in the non-European ESC countries. *No data available.

Data on health expenditures and CIED implantation rate per capita indicate that a low proportion of healthcare expenditure is, as would be expected, associated with a lower use of device therapy and the use of complex interventional electrophysiology procedures (*Figure 83*). However, in some Eastern European countries with relatively low GDP, device implantation and catheter ablation rates per million population exceed those of certain Western and Northern European countries. Good examples of this are Czech Republic and Hungary, which were in the most active quartile for CRT therapy and AF ablations. Furthermore, despite the economic

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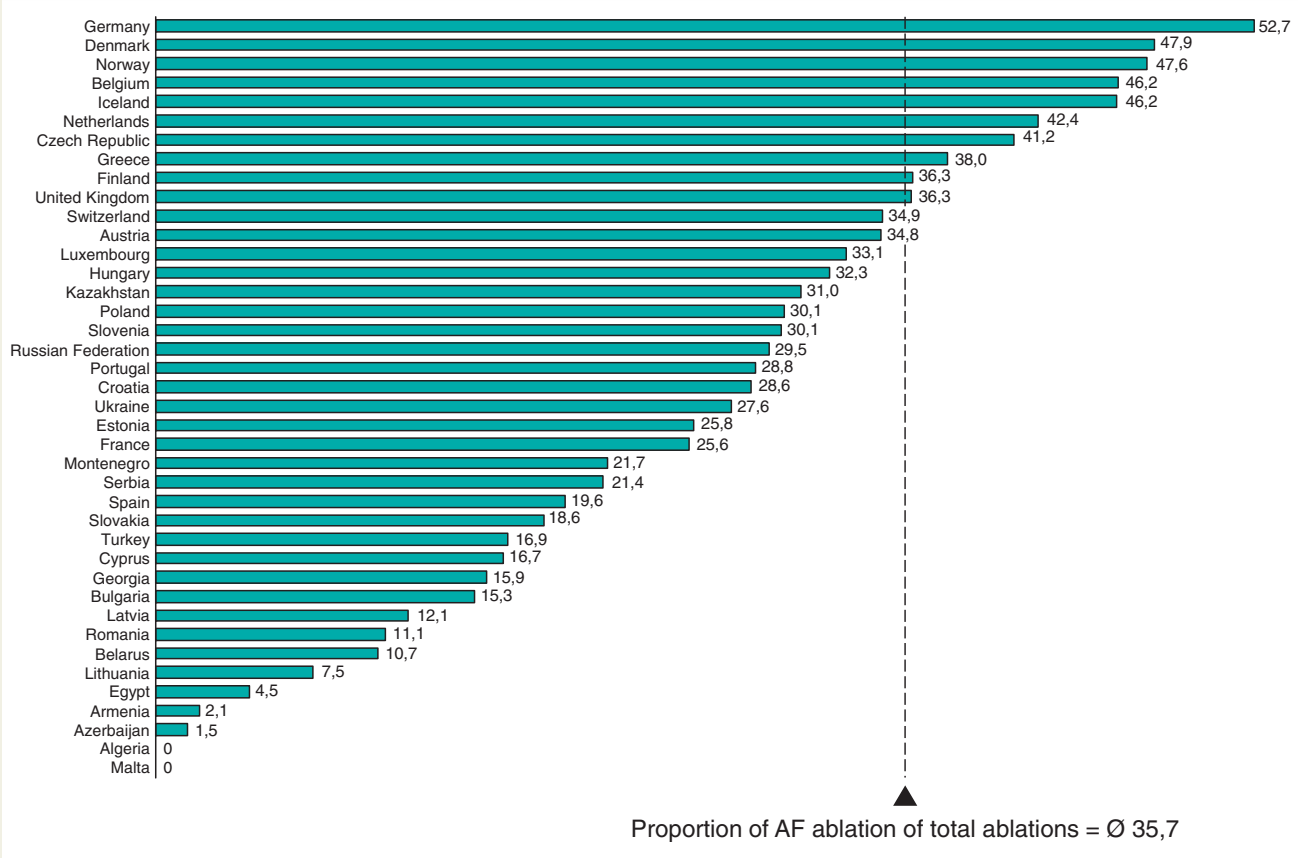

Figure 78 Proportion of AF ablations of total ablations in 2015.

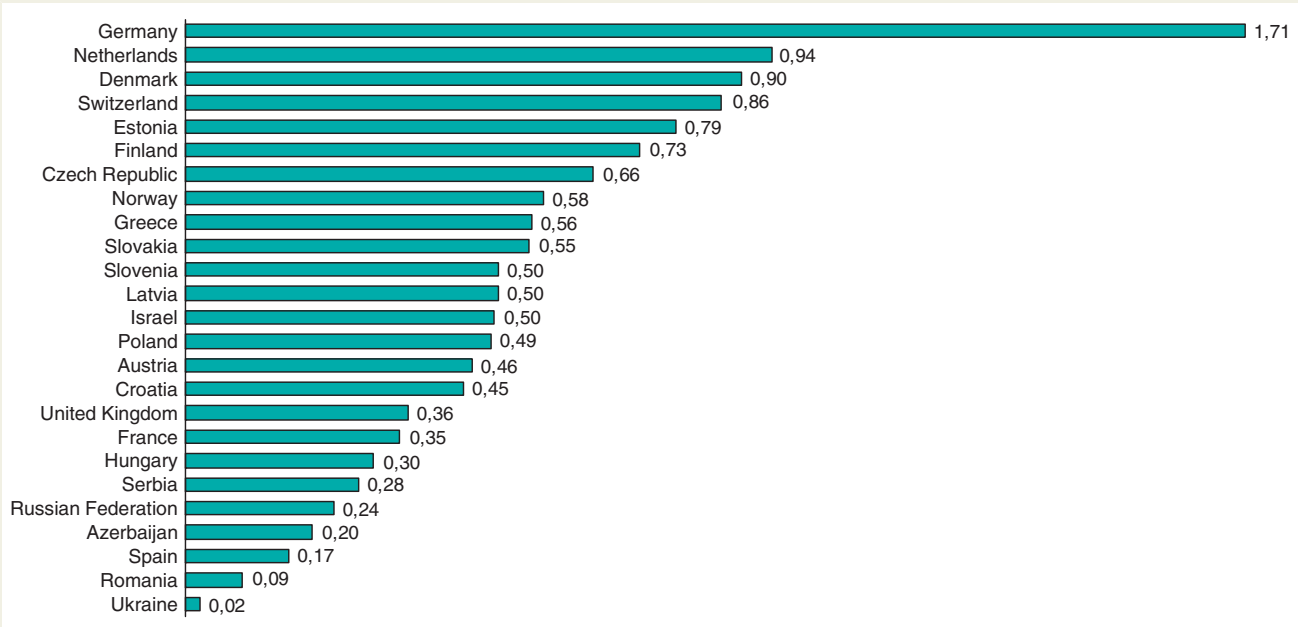

Figure 79 Number of centres which performed more than 10 VT or VF ablations per million inhabitants in patients with structural heart disease in 2015. The mean number of VT/VF ablation centres is weighted by population.

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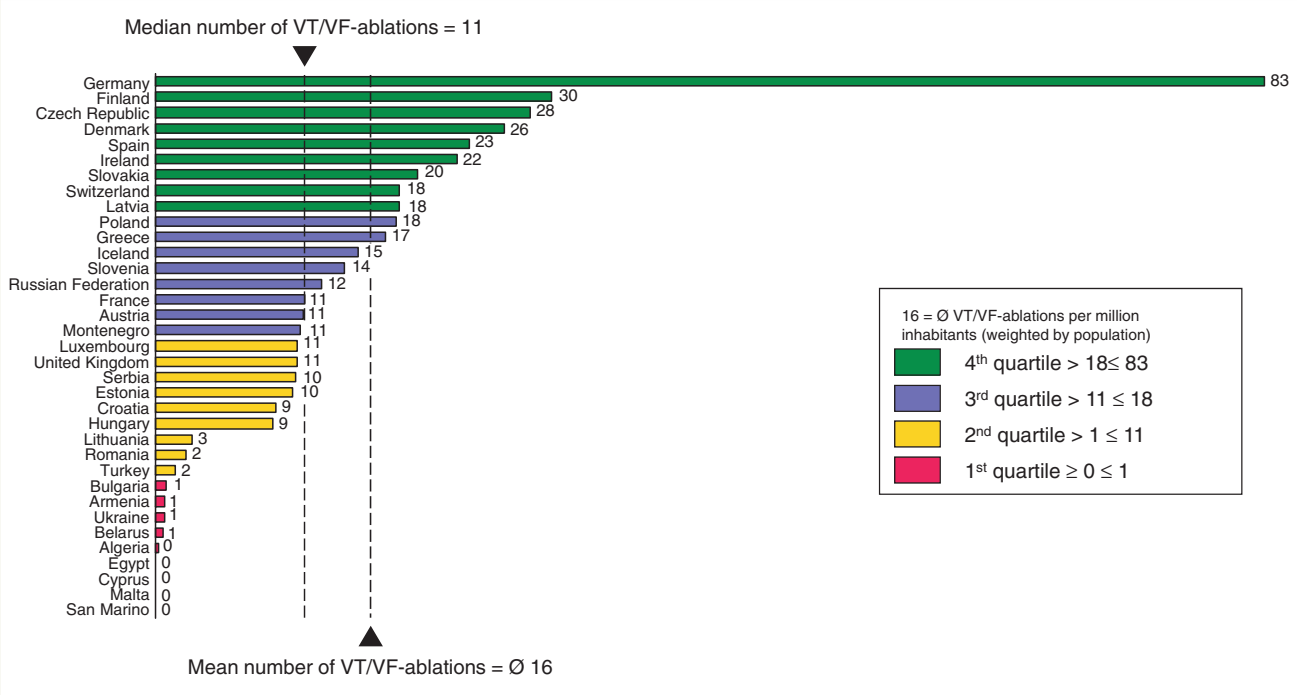

Figure 80 Ablations for VT or VF per million inhabitants in patients with structural heart disease in 2015. The mean number of VT/VF ablations is weighted by population.

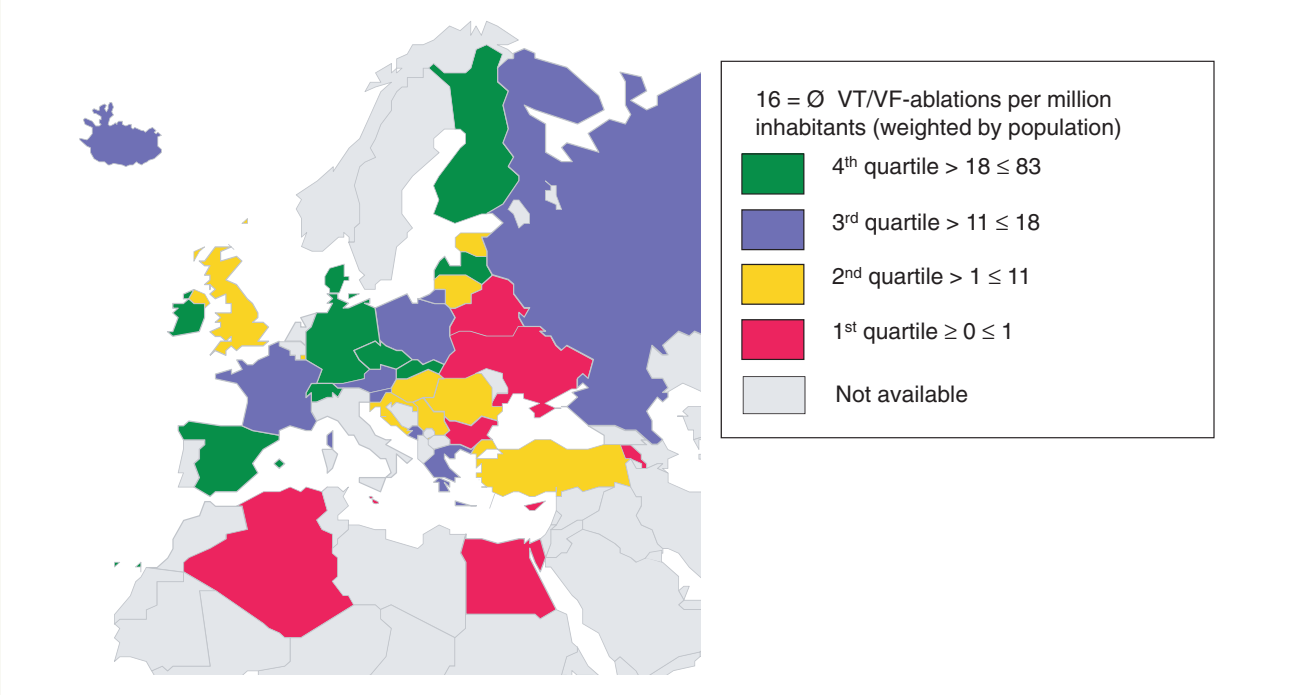

Figure 81 Ablations for VT or VF in patients with structural heart disease in 2015.

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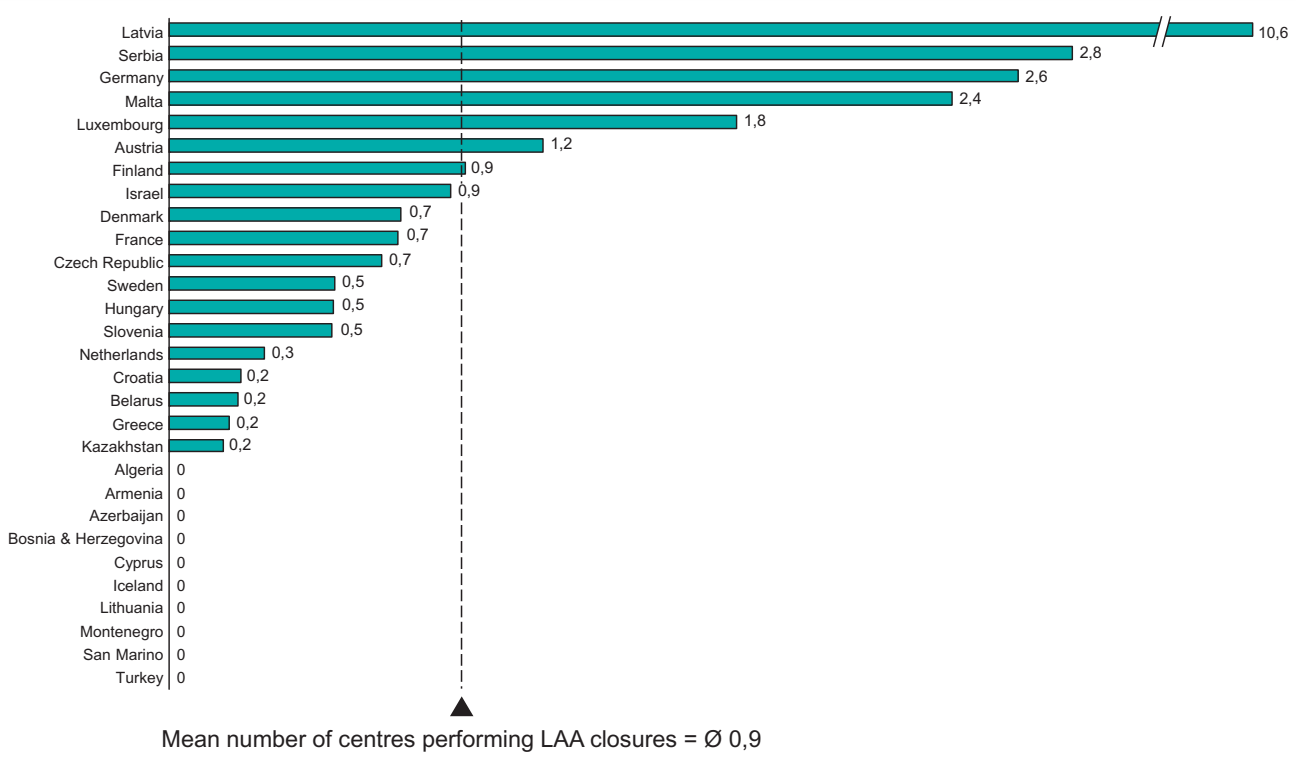

Figure 82 Number of centres performing LAA closures per million inhabitants in 2015. The mean number of the centres is weighted by population.

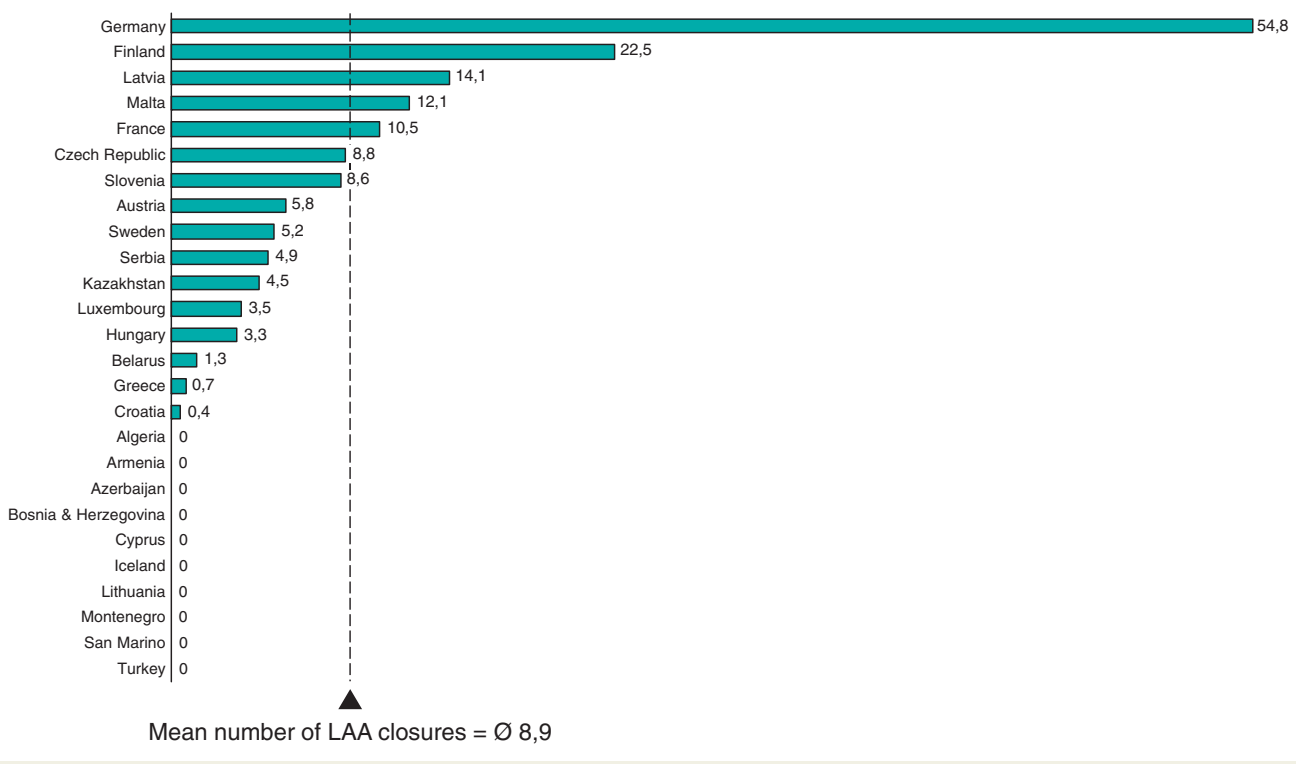

Figure 83 Percutaneous LAA closures per million inhabitants in 2015. The mean number of the centres is weighted by population.

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difficulties all across Europe in the past 7–8 years, the use of device and catheter ablation therapies has been growing in a number of countries with relatively low GDP. On the other hand, in many Western and Northern European countries with high GDP, the use of device and ablation therapies has remained stable or even in some cases declined slightly. It is unclear whether this is a consequence of constraints on healthcare expenditure in the wake of the financial crisis or if that supply has already met the demand or both. Nevertheless, these data indicate that relatively high GDP is not the only explanation for early adaptation of novel healthcare innovations with a relatively high initial cost. Other potential excuses for the observed disparity include lack of manpower, training, facilities, and likely low referral rates.[18] A personal co-payment for the procedures may limit access to CIED and catheter ablation therapies in countries not providing full coverage for the whole population.

Impact of the economic crisis

In recent years, a clear limitation for improvements in arrhythmia management across the ESC area has been a difficult economic situation. Due to the ongoing financial problems, many countries have made substantial budget cuts for healthcare.[18–22] At the same time, the number of elderly people requiring vast medical and social care has grown rapidly. In this context, socioeconomic disparities pose a major threat to healthcare systems and may limit the use of innovative technologies such as ICD therapy for primary prevention of sudden cardiac death and catheter ablation of AF and VT/VF, unless the effectiveness and efficacy of the healthcare system are improved.[18–22]

The cost of health and social care is escalating not only due to population aging and costly developments in the medical technology field but also as a result of unhealthy life styles, higher expectations for better services, unit cost inflation, inefficiency, and suboptimal use of resources. Therefore, we need an integrated and comprehensive approach to improve patient access arrhythmia care. With regard to this, it was interesting to note that the numbers of hospitals and beds were not directly related to the financial profile or healthcare expenditure of a given country. Rather, some countries have directed more resources towards hospital care than ambulatory and home care (*Figure 84*).

Evolving areas in cardiac arrhythmia therapy

Most of the innovative medical technologies have a high initial cost. Therefore, their efficacy and safety need to be proved before they can reach wide acceptance and clinical use. Evolving areas in the cardiac arrhythmia therapy include leadless pacing, subcutaneous ICD therapy, use of percutaneous LAA occlusion devices for prevention of thromboembolic complications in patients with AF, and catheter ablation of complex atrial and ventricular tachyarrhythmias. The main problem in analysing the current access and use of the evolving arrhythmia therapies was that many countries did not report data on these developing therapies.

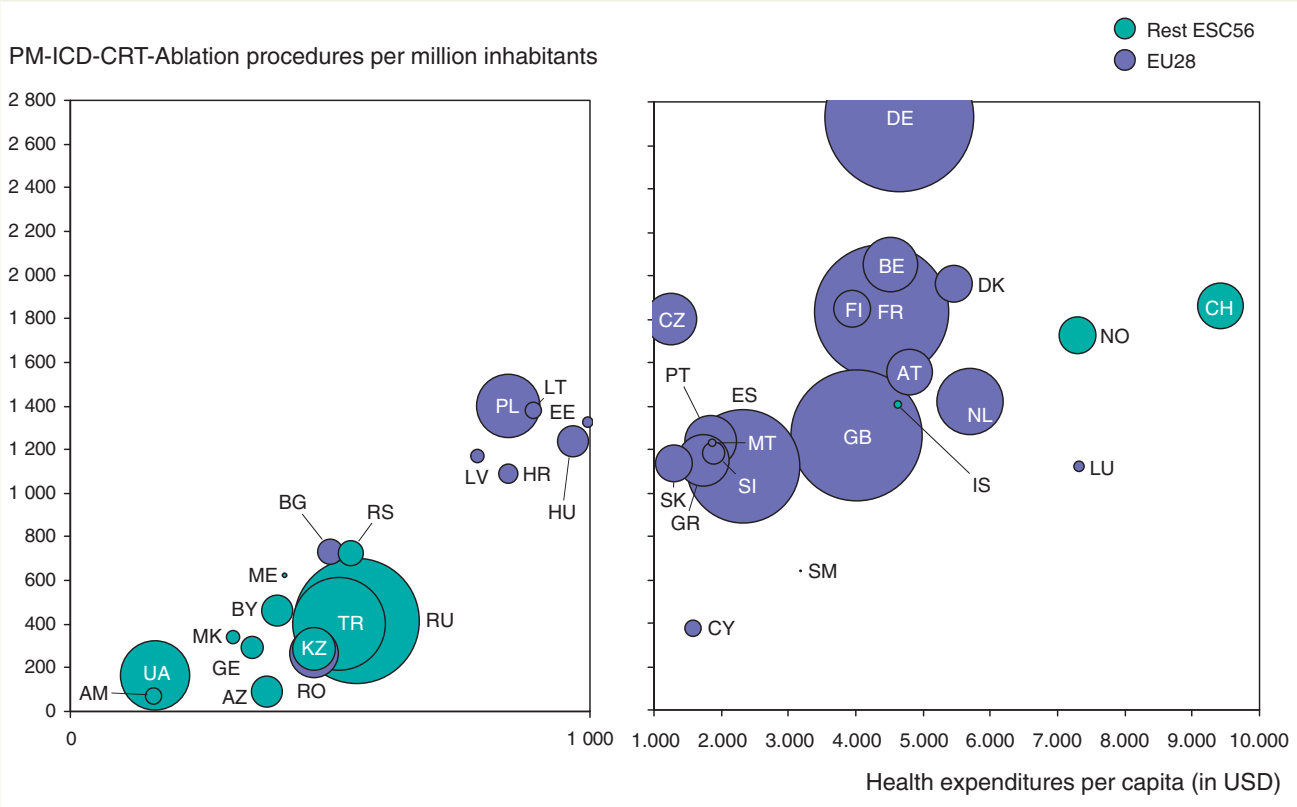

Figure 84 Healthcare spending per capita and interventional electrophysiology procedures (sum of PM-ICD-CRT ablation procedures per million inhabitants). The ISO codes of the countries are explained in *Table 1*.

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Leadless pacing has recently been introduced in most ESC countries. The most active countries in the ESC area with regard to leadless PM implantations were France and the Netherlands, which were active also in the studies evaluating the safety and efficacy of this therapy.[10] Although the overall implantation rates were rather low also in these early adopters, leadless pacing is expected to grow rapidly.

The results of numerous randomized, multicentre trials have established the role of traditional ICD therapy in secondary and primary preventions of sudden cardiac death.[23] However, transvenous ICD leads have significant short- and long-term complications, offsetting some of the benefits of this therapy. This has led to the development of the entirely subcutaneous ICD.[12,13] This was the first year that the White Book questionnaire asked about S-ICD implantation. Italy reported by far the highest implantation rate for these devices. Obviously, the limited data do not allow for much interpretation, but the plan is to continue to gather data in coming years on this emerging procedure.

According to the White Book data, the role of catheter ablation in treatment of symptomatic AF is well established in Western and Northern Europe and in some countries in Southern and Eastern Europe, whereas in the non-European ESC countries the access to AF ablation is limited. Catheter ablation of VT has been one of the key areas of growth in electrophysiology in recent years. The growing need for VT/VF ablations in patients with structural heart disease[23–25] was reflected in the White Book data where the number of VT/VF ablation procedures per million inhabitants increased from 9.2 in 2014 to 16.0 in 2015.

Another important evolving area in cardiac rhythm management is the use of percutaneous LAA closure devices to prevent AF-related thromboembolic complications.[16,17] According to a recent meta-analysis, LAA occlusion is non-inferior to warfarin in patients at high risk of thromboembolic and bleeding events.[16] As with VT/VF ablations, the number reported for LAA occlusion has grown significantly within the last 2 years. The number of LAA occlusion was largest in Germany, but interestingly many of the countries in the top 10 were from Eastern Europe.

The role of European Heart Rhythm Association

European Heart Rhythm Association has collected information on the resources and characteristics of procedures performed throughout the ESC area in the field of cardiac arrhythmias for almost a decade. The White Book data have formed a backbone for many national and cross-national strategic initiatives and awareness activities such as the 'ICD for Life' campaign.

Disparity in the implementation of arrhythmia treatment and practice guidelines is likely to continue, unless there is an improved investment in the infrastructure. This includes electrophysiology laboratories, specialized equipment, and not least-improved training opportunities. Likewise, standardization of training requirements and implementation of current clinical practice guidelines are important steps. European Heart Rhythm Association has been very active in promoting unified standards for training of cardiac rhythm management specialists and to try to assure high quality in arrhythmia care in a broad sense. The ongoing White Book project has revealed important disparities in this field also and provided a solid base to improve and align arrhythmia management strategies across ESC countries. The ability to see its own numbers in a European context provides each country robust means to demonstrate shortfalls in resource allocation, reimbursement and training requirements to the national or local authorities, and to make recommendations to improve decision- and policymaking concerning the cardiac arrhythmia care field at national and cross-national levels.

The EHRA certification programme provides an excellent platform to improve and harmonize the training and the level of arrhythmia care in the ESC area. The introduction of the EHRA accreditation programme for teaching centres will provide further support to standardization of training. European Heart Rhythm Association fellowship grants have already allowed many junior physicians from countries with low procedure rates to receive training in high-volume centres across the ESC area. The number of applications for the EHRA fellowship grants has been increasing steadily, and the certification programme is now available for allied professionals. Last year, the EHRA Training Fellowship committee awarded 10 grants for young physicians. In addition, a specific proctor programme was recently launched in order to provide further education in the field of cardiac arrhythmia management.

In summary, the EHRA White Book data indicate that there are still significant differences in training and certification requirements between the ESC countries. Accordingly, there is a need to involve more physicians and allied professionals in the EHRA certification system to assure uniform and high-level theoretical and practical training for all healthcare professionals, regardless of their country of origin.

Limitations

There are several limitations in the methodology of the EHRA White Book data collection. Data collection is exclusively based on voluntary activity of the National Cardiac Societies or Arrhythmia Working Groups. This year 50 out of the 56 ESC nations responded to the White Book questionnaire. Some countries, on the other hand, have never reported data for the White Book, and many countries reported incomplete data. In particular, many countries did not provide data on new therapies like leadless pacing, S-ICD, and VT/VF ablations. This may be related to incomplete collection of data on these procedures, which are relatively new and performed only in a few select centres.

With regard to the analysis and interpretation of summary data, it was a major drawback that Italy, one of the most populated countries in the ESC area, once again, did not submit any data on catheter ablations. In addition, there were large variations in national data sources. About 50% of the data came from national registries (20 countries), and the other half was based on surveys and other estimates conducted by the National Societies. This is relevant since the coverage of the registries in some of the ESC countries is relatively poor and many procedures are not included in the registry data. In contrast, surveys and other estimates may overestimate the procedure numbers. The lack of a national quality control institution in many countries (*Figure 85*)

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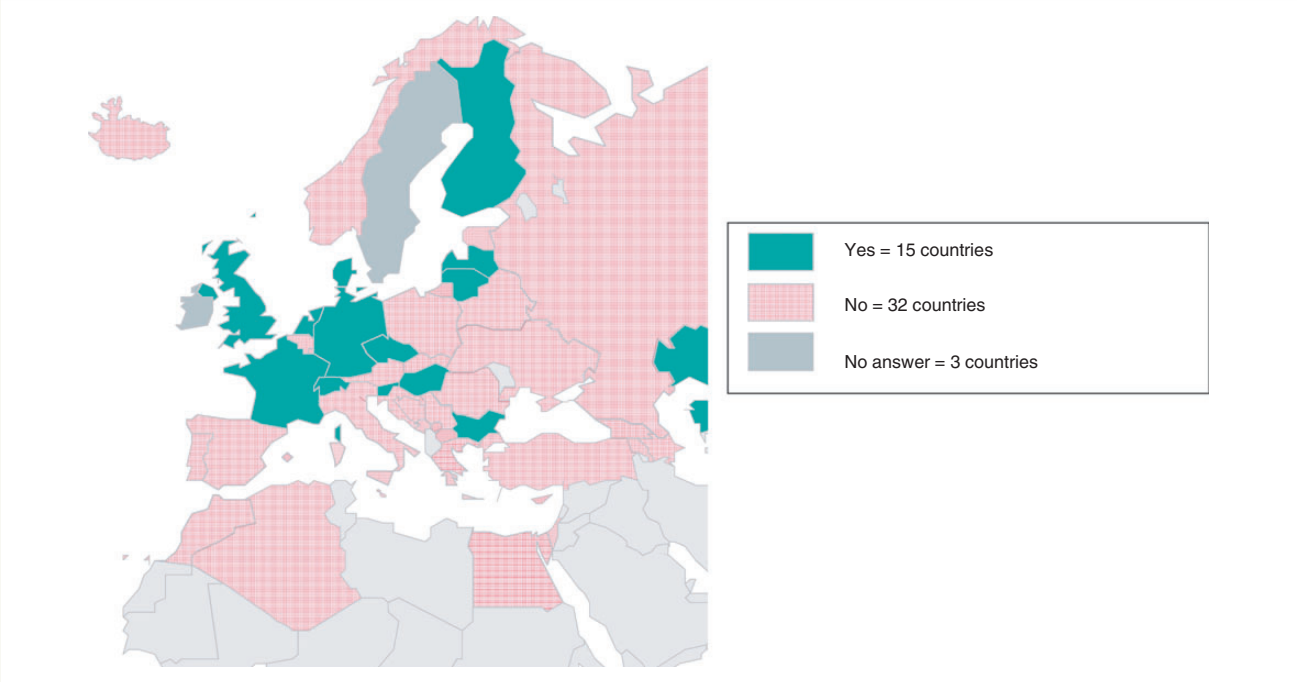

Figure 85 Availability of national institution to coordinate and guide device recalls in the ESC countries in 2015.

also reflects the need for centralized data collection and quality assurance.

Comparison of results between nations or regions can be a major driver in leading to changes within health systems. Therefore, for the third year in row, the data were presented separately for the five geographical regions within the ESC area. In order to avoid any economic, political, or historical bias, the European regions were composed according to the United Nations Statistics Division, and all other ESC countries were included in the non-European ESC region. This classification is not free of limitations. Nevertheless, we feel that as a well-defined and widely accepted geographical classification, the UN grouping provides a neutral platform for regional comparisons within the ESC area.

Future directions of the European Heart Rhythm Association White Book project

The goal is to continue to improve the reliability of the EHRA White Book data and to ensure the quality of the collected data. In this regard, it is important that the national registries continue to develop and that their coverage will expand in the future. We also encourage the adoption of such a registry if not already present.

Next year, we will celebrate the 10-year anniversary of the EHRA White Book data collection. Our goal is, together with the National Cardiac Societies and Working Groups, to recheck the prior data and to complete the missing values in the dataset before the end of this year. All National Societies will receive a copy of the previously reported data after the ESC Congress, and we hope to get the updated data within a couple of months after that. Collection of the 2016 data will be launched as previously in February 2017. We hope to reach 100% coverage for the anniversary edition of the White Book.

An attractive long-term goal with regard to the data collection and analysis is to develop an internet-based electronic database, which would allow free comparisons between and within the ESC countries. Such a database would also provide a unique future platform for online multicentre registry-based clinical trials in arrhythmia therapy.[26] The ESC recently launched the Atlas on Cardiology project[27] with similar goals as the White Book. The Atlas will provide descriptive and quantitative information on economy, demographics, health system, and health policies alongside data concerning healthcare resources and a wide range of cardiology interventions in the ESC member countries. There are currently no plans to discontinue the White Book, but eventually it is possible that these two projects will merge.

Conclusions

During the past 9 years, the White Book has developed into a substantial asset not only for the cardiac electrophysiology community but also for healthcare administrators and politicians in the ESC area. The availability of up-to-date information is critical to those facing the challenge of balancing healthcare budgets and allocating limited resources. The statistics presented herein show that, despite significant improvements in many areas of arrhythmia care, there still is considerable heterogeneity in the availability of invasive arrhythmia therapies across the ESC area. Reducing this gap continues to be one of the main goals of the EHRA.

Acknowledgements

The EHRA White Book 2016 and this analysis were possible thanks to the continuing efforts of several key contributors including chairpersons and co-chairs of the National Societies and Working

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Groups of the ESC countries that have provided data. We are grateful for their invaluable contribution and hope that even more countries will be reporting data for the White Book next year. In addition, we want to thank Yasmine Carrasset, Lauren Tapp, and other members of the EHRA staff at the Heart House as well as BIOTRONIK SE & Co. KG for continuous support to the project. In particular, special thanks to Robert Wuestenberg and Anja Thuemen from BIOTRONIK for their dedication and passion in the conduction of the project. Finally, Prof. Panos Vardas and Prof. Christian Wolpert deserve special thanks as the 'founding fathers' of the White Book project.

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