

A Decade of Information on the Use of Cardiac Implantable Electronic Devices and Interventional Electrophysiological Procedures in the European Society of Cardiology Countries: 2017 Report from the European Heart Rhythm Association

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Aims

The aim of this analysis was to provide comprehensive information on invasive cardiac arrhythmia therapies in the European Society of Cardiology (ESC) area over the past 10 years.

Methods and results

The European Heart Rhythm Association (EHRA) has collected data on invasive arrhythmia therapies since 2008. This year 53 of the 56 ESC member countries provided data for the EHRA White Book. Here we present updated data on procedure rates together with information on demographics, economy, vital statistics, local healthcare systems and training activities. Considerable heterogeneity in the access to invasive arrhythmia therapies still exists across the five geographical ESC regions. In 2016, the device implantation rates per million population were 3–6 times higher in the Western region than in the non-European and Eastern ESC member countries. Catheter ablation activity was highest in the Western countries followed by the Northern and Southern areas. In the non-European countries, atrial fibrillation ablation rate was more than tenfold lower than in the European countries. On the other hand, the growth rate over the past ten years was highest in the non-European and Eastern countries. In some Eastern European countries with relative low gross domestic product the procedure rates exceeded the average values.

Conclusion

It was encouraging to note that during the past decade the growth in invasive arrhythmia therapies was greatest in the areas historically with relatively low activity. Nevertheless, there is substantial disparity and continued efforts are needed to improve harmonization of cardiac arrhythmia therapies in the ESC area.

Keywords

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

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What's new?

- This is the first time that 10-year trends in the rate of CIED implantations and catheter ablation procedures in the ESC member countries have been presented in detail.
- The procedure rates per million population are highest in the Western countries followed by the Northern and Southern European countries.
- Current procedure rates are lower in the non-European and Eastern European ESC member countries, but growth rate over the past ten years was highest in these areas.
- Key areas of growth are in ablation of ventricular arrhythmias in patients with structural heart disease and novel therapeutic modalities such as left atrial appendage closure devices, leadless pacemakers and subcutaneous implantable defibrillators.
- The data will form a steady backbone for future strategic initiatives to harmonise arrhythmia therapies in the ESC area.

Introduction

Access to reliable and up-to-date data on the use and availability of invasive electrophysiological procedures plays an important role in recognising and gaps in cardiac arrhythmia care in the European Society of Cardiology (ESC) area. The European Heart Rhythm Association (EHRA) has collected comprehensive data on the rates of invasive electrophysiology procedures and device implantations along with information on demographics, economy, vital statistics and healthcare resources and reimbursements policies together with the National Cardiac Societies and Working Groups for ten years (1). In 2017 53

of the 56 ESC member countries provided data for the EHRA White Book (2). The participation rate was higher than ever and covered around 95% of the ESC area population.

This year we celebrate the ten-year anniversary of the EHRA White Book. The project was initially overseen by Prof Christian Wolpert and Prof Panos Vardas in 2008. Like in the past (3–7) the main objectives of this auxiliary analysis of the EHRA White Book data were to deliver up-to-date information on the rates of invasive arrhythmia therapies in the ESC area, and to provide each country an opportunity to view its data in a larger context. In order to facilitate detection of potential cross-national disparities and gaps in the rates of cardiac implantable electronic device (CIED) implantations and catheter ablation procedures the statistics for the four geographical European ESC regions (*Figure 1*) and for the non-European ESC member countries are presented separately. This time we have provided unique data on trends in device implantation and ablation rates over the past ten years. The data presented in this article will be augmented by the launch of a website showing complete 10-year data for each country and allowing even more detailed comparisons between different countries and regions (www.ehra-whitebook-analysis.com).

Comprehensive information on the contemporary status of invasive arrhythmia therapies and the ability to directly compare the numbers at the ESC level will provide physicians, health care administrators and policy makers in each country with robust means to demonstrate to the national authorities shortfalls in resource allocation, reimbursement and training requirements. It is our hope that these data will inspire national and international strategic initiatives and awareness activities to acquire more resources for cardiac arrhythmia management and eventually to harmonise arrhythmia care among the ESC member countries.

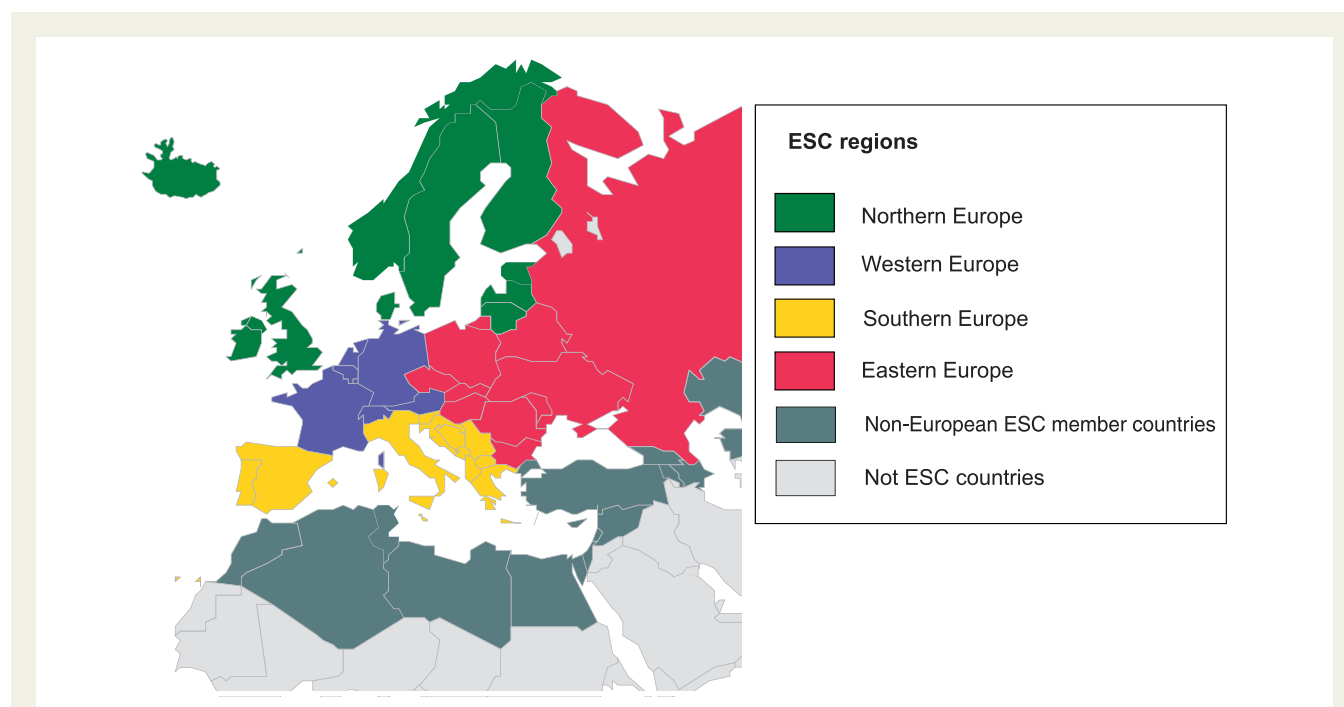


Figure 1 Geographic representation of the 56 European Society of Cardiology (ESC) member countries. The European regions were composed according to the UN Statistics Division (<http://unstats.un.org/unsd/methods/m49/m49regin.htm>).

Methods

Every year the EHRA invites all ESC member countries to participate in the EHRA White Book project. Since 2008 detailed data on invasive electrophysiology procedures together with descriptive and quantitative information on the demographics and economic aspects as well as on the training of electrophysiologists in the constituent ESC member countries have been collected annually. This has been done by surveying the National Cardiac Societies and Arrhythmia Working Groups. After completion of the data collection in early May the national societies or working groups were asked to crosscheck and authorise publication of the information at the Europace congress. In addition, this year all National Cardiac Societies received a copy of the previously reported data, and they were asked to correct potential inaccuracies and to add missing values.

The data on demographics, economy, vital statistics and healthcare resources in each country were acquired from the latest available edition of the World Health Organization (WHO) health statistics (8).

In 2016 a total of 1 087 259 488 people lived in the ESC member countries. After excluding those countries that did not report data it was calculated that in 2016 the EHRA White Book data collection covered 96.1% of the population for pacemaker implantations, 96.1% for implantable cardioverter defibrillator (ICD) implantations, 95.2% for cardiac resynchronisation therapies, 94.5% for catheter ablations and 94.4% for atrial fibrillation (AF) ablations, respectively.

This analysis is based on current and past editions of the EHRA White Book. It provides up-to-date information on the rates of the CIED implantations and catheter ablation procedures in the ESC member countries over the past 10 years. The data presented in this article will be further enhanced on the EHRA White Book website (www.ehra-white-book-analysis.com). On the website, the complete ten-year data are presented for each country in a format that allows more detailed comparisons between different countries and regions.

Demographics and general societal and economic aspects

The ESC member countries are a heterogeneous group of nations with varying political, financial and demographic characteristics. Distribution of the population within these regions over the last 10 years is shown in *Table 1*. During this decade, the population in the ESC member countries increased by 5.5% (approximately 57 million people). The population growth was highest in the non-European ESC member countries and lowest in the Eastern region.

Vital statistics and gross domestic product

Population and vital statistics and gross domestic product (GDP) in the 56 ESC member countries are presented in *Table 2*. Total GDP ranged from 1.56 (San Marino) to 3495 (Germany) trillion US dollars (USD). The GDP per capita was more than 100 times higher in Luxembourg (105 829 USD) than in Kyrgyzstan (956 USD).

Reasonably high-quality data on cause of death are available in most ESC member countries, although they are lacking in many other parts of the world. World Health Organization (WHO) health statistics from 2014 revealed several important differences in the vital statistics between the ESC member countries (8). For example, the life expectancy at birth varied from 70.7 years (Kyrgyzstan and Moldova) to 83.3 years (San Marino). The death rate per 1000 population was

lowest in Turkey (4.70%) and highest in Ukraine (14.80%). 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 organisation of healthcare across the ESC member countries is heterogeneous. 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 on people with no health insurance was highest in the Eastern European and non-European ESC member countries. In the Northern, Southern and Western European ESC member countries, patients do not need to provide any co-payment for invasive electrophysiology procedures, whereas in many Eastern European (e.g., Armenia, Azerbaijan, Romania) and non-European ESC member countries (e.g., Egypt, Georgia, Kyrgyzstan and Turkey) a co-payment is necessary for all invasive electrophysiology procedures (*Table 3*).

The number of hospitals and hospital beds available for healthcare are shown in *Figure 2*. The number of the hospitals and hospital beds were highest in Cyprus and Belarus, respectively. The number of hospitals and beds were not associated with the financial profile of the countries or 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 823 in Germany and only 254 in Sweden, despite the relatively high GDP and healthcare expenditure in both countries.

A national institution to coordinate and guide device recalls was present in 15 of the participating ESC member countries, whereas in 38 (72%) countries it was not available (*Figure 3*).

Healthcare expenditure

Healthcare expenditure nowadays represents the biggest government spending item in many countries. In *Figure 4* the healthcare expenditure is presented as percentage of the national GDP and in *Figure 5* 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 Russian Federation (11.9%) and lowest in the Israel (4.4%).

The health care expenditure per capita was highest in Norway (10 297 USD) and lowest in Kyrgyzstan (93 USD). Hence, there was more than 100-fold difference between the lowest and the highest healthcare expenditure per capita in the ESC area. Given the trend towards a progressive aging of populations and less healthy lifestyles, there is pressure to increase the healthcare expenditure. Despite this, the mean healthcare expenditure per capita in the ESC area was lower in 2014 (2018 USD) than in 2013 (2733 USD).

Certification of professional excellence

General information

Fifty-one (91% of the ESC member countries) and 50 (89%) countries provided data on certification of physicians in device therapy and invasive electrophysiology, respectively (2). A national certification program for CIED therapy and invasive cardiac electrophysiology (EP) was available in 25 (45% of the ESC member countries) of

Region	Country	ISO code	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Northern Europe	Denmark	DK	5 461 199	5 489 022	5 519 441	5 515 575	5 529 888	5 543 453	5 556 452	5 569 077	5 581 503	5 593 785
	Estonia	EE	1 341 672	1 340 675	1 340 271	1 291 170	1 282 963	1 274 709	1 266 375	1 257 921	1 265 420	1 258 545
	Finland	FI	5 288 720	5 313 399	5 338 871	5 255 068	5 259 250	5 262 930	5 266 114	5 268 799	5 476 922	5 498 211
	Iceland	IS	311 396	319 355	319 246	308 910	311 058	313 183	315 281	317 351	331 918	335 878
	Ireland	IE	4 339 026	4 422 077	4 459 305	4 622 917	4 670 976	4 722 028	4 775 982	4 832 765	4 892 305	4 952 473
	Latvia	LV	2 276 100	2 266 094	2 254 834	2 083 703	2 204 708	2 191 580	2 178 443	2 165 165	1 986 705	1 965 686
	Lithuania	LT	3 375 618	3 358 114	3 339 455	3 545 319	3 535 547	3 525 761	3 515 858	3 505 738	2 884 433	2 854 235
	Norway	NO	4 709 153	4 768 212	4 828 726	4 676 305	4 691 849	5 000 000	5 085 582	5 147 792	5 207 689	5 265 158
	Sweden	SE	9 148 092	9 219 638	9 298 515	9 074 055	9 088 728	9 103 798	9 647 386	9 723 809	9 801 616	9 880 604
	United Kingdom	GB	60 975 356	61 383 156	61 791 956	62 348 447	62 698 362	63 047 162	63 395 574	63 742 977	64 088 222	64 430 428
Northern Europe total		97 226 331	97 879 742	98 490 619	98 721 469	99 273 329	99 984 594	101 003 047	101 531 394	101 516 733	102 035 003	
Western Europe	Austria	AT	8 315 379	8 336 549	8 363 040	8 214 160	8 217 280	8 219 743	8 221 646	8 223 062	8 665 550	8 711 770
	Belgium	BE	10 625 701	10 480 393	10 646 804	10 423 493	10 431 477	10 438 353	10 444 268	10 449 361	11 323 973	11 409 077
	France	FR	61 963 276	62 130 520	62 342 668	64 768 389	65 102 719	65 630 692	65 951 611	66 259 012	66 553 766	66 836 154
	Germany	DE	82 262 640	82 119 776	81 874 768	81 644 454	81 471 834	81 305 856	81 147 265	80 996 685	80 854 408	80 722 792
	Luxembourg	LU	479 994	488 650	486 181	497 538	503 302	509 074	514 862	520 672	570 252	582 291
	Netherlands	NL	16 381 696	16 445 594	16 445 593	16 783 092	16 653 734	16 730 632	16 805 037	16 877 351	16 947 904	17 016 967
	Switzerland	CH	7 551 117	7 512 123	7 567 659	7 623 438	7 639 961	7 925 517	7 996 026	8 061 516	8 121 830	8 179 294
			187 579 803	187 513 605	187 726 713	189 954 564	190 020 307	190 759 867	191 080 715	191 387 659	193 037 683	193 458 345
	Belarus	BY	9 702 116	9 680 841	9 665 120	9 612 632	9 577 552	9 643 566	9 625 888	9 608 058	9 498 364	9 570 376
	Bulgaria	BG	7 659 764	7 623 395	7 585 131	7 148 785	7 093 635	7 037 935	6 981 642	6 924 716	7 186 893	7 144 653
Eastern Europe	Czech Republic	CZ	10 322 689	10 429 692	10 491 492	10 201 707	10 190 213	10 177 300	10 609 762	10 627 448	10 644 842	10 660 932
	Hungary	HU	10 055 780	10 038 188	10 022 650	9 992 339	9 976 062	9 958 453	9 939 470	9 919 128	9 897 541	9 874 784
	Moldova	MD	3 855 442	3 811 763	3 770 698	3 731 799	3 694 121	3 656 843	3 619 925	3 583 288	3 546 847	3 510 485
	Poland	PL	38 115 968	38 115 908	38 153 388	38 463 689	38 441 588	38 415 284	38 383 809	38 346 279		

Continued

Table I Continued

Region	Country	ISO code	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	San Marino	SM	32 055	28 775	28 976	31 477	31 817	32 140	32 448	32 742	33 020	33 285
	Serbia	RS	7 381 579	7 350 222	7 320 807	7 344 847	7 310 555	7 276 604	7 243 007	7 209 764	7 176 794	7 143 921
	Slovenia	SI	2 019 406	2 039 399	2 042 335	2 003 136	2 000 092	1 996 617	1 992 690	1 988 292	1 983 412	1 978 029
	Spain	ES	45 236 004	45 983 169	46 367 550	46 505 963	46 736 257	46 766 403	46 593 236	47 737 941	48 146 134	48 563 476
Southern Europe total			152 066 472	153 427 697	154 221 402	155 393 210	155 689 700	155 230 631	155 278 284	156 614 251	157 184 643	157 590 350
Non-European ESC member countries	Algeria	DZ	34 002 400	34 619 419	35 268 128	33 769 669	34 994 937	37 367 226	38 087 812	38 813 722	39 542 166	40 263 711
	Armenia	AM	3 226 520	3 234 031	3 243 729	2 966 802	2 967 975	2 970 495	3 064 267	3 060 927	3 056 382	3 051 250
	Azerbaijan	AZ	9 015 038	9 111 089	9 206 777	9 301 673	9 397 279	9 493 600	9 590 159	9 686 210	9 780 780	9 872 765
	Cyprus	CY	841 353	793 007	803 147	1 102 677	1 120 489	1 138 071	1 155 403	1 172 458	1 189 197	1 205 575
	Egypt	EG	75 814 404	77 516 306	78 866 635	80 471 869	82 079 636	83 688 164	85 294 388	86 895 099	88 487 396	94 666 993
	Georgia Republic of	GE	4 388 400	4 383 750	4 410 900	4 600 825	4 585 874	4 570 934	4 942 157	4 935 880	4 931 226	4 928 052
	Israel	IL	7 180 115	7 308 795	7 485 600	7 353 985	7 473 052	7 590 758	7 707 042	7 821 850	8 049 314	8 174 527
	Kazakhstan	KZ	16 459 828	16 649 642	16 863 280	17 084 817	17 304 513	17 736 896	17 736 896	17 948 816	18 157 122	18 360 353
	Kyrgyzstan	KGZ	5 255 561	5 298 689	5 358 180	5 410 468	5 450 776	5 496 737	5 548 042	5 604 212	5 957 300	5 727 553
	Lebanon	LB	4 334 429	4 424 106	4 475 008	4 125 247	4 143 101	4 140 289	4 131 583	4 136 895	6 184 701	6 237 738
	Libya	LY	5 786 146	5 894 108	6 002 252	6 173 579	6 597 960	5 613 380	6 002 347	6 244 174	6 411 776	6 541 948
	Morocco	MA	30 594 445	30 940 455	31 285 174	31 627 428	31 968 361	32 309 239	32 649 130	33 478 299	33 322 699	33 655 786
	Syria	SY	20 543 421	21 180 801	21 389 802	22 198 110	22 517 750	22 530 746	22 457 336	22 597 531	17 064 854	17 185 170
	Tunisia	TN	10 212 857	10 315 836	10 420 551	10 525 041	10 629 186	10 732 900	10 835 873	10 937 521	11 037 225	11 134 588
	Turkey	TR	70 586 256	71 517 100	72 561 312	73 722 988	74 724 269	75 627 384	76 667 864	77 695 904	78 741 053	80 274 604
Non-European ESC member countries total			298 241 173	303 187 134	307 640 475	310 435 178	315 955 158	321 006 819	325 870 299	331 029 498	331 913 191	341 280 613
Total ESC member countries			1 030 341 400	1 036 653 627	1 042 438 246	1 045 890 757	1 051 167 853	1 061 137 143	1 066 745 346	1 073 555 952	1 076 924 469	1 087 259 488

Table 2 Population, vital statistics and gross domestic product (GDP) in the 56 ESC member countries.

Country	Population	Population growth rate (%)	Life expectancy at birth (years)	Death rate per 1000 population	GDP (x 1000 billion USD)	GDP per capita (USD)	Total health expenditure as % of GDP
Albania	3 038 594	0.31	78.3	5.40	12.14	4 210	5.88
Algeria	40 263 711	1.82	76.8	N/A	168.32	4 129	N/A
Armenia	3 051 250	-0.17	74.6	9.20	10.75	3 596	4.48
Austria	8 711 770	0.53	81.5	9.20	387.30	44 561	11.21
Azerbaijan	9 872 765	0.94	72.5	5.90	35.69	3 759	6.04
Belarus	9 570 376	0.76	72.7	12.80	48.13	5 092	5.69
Belgium	11 409 077	0.75	81.0	9.80	470.18	41 491	10.59
Bosnia & Herzegovina	3 861 912	-0.13	76.7	9.40	16.53	4 289	9.57
Bulgaria	7 144 653	-0.59	74.5	14.40	50.45	7 091	8.44
Croatia	4 313 707	-3.39	75.9	12.00	49.86	11 858	7.80
Cyprus	1 205 575	1.38	78.7	6.10	19.93	23 425	7.37
Czech Republic	10 660 932	0.15	78.6	10.00	193.54	18 326	7.41
Denmark	5 593 785	0.22	79.4	9.30	302.57	53 243	10.80
Egypt	94 666 993	6.98	72.7	N/A	N/A	N/A	N/A
Estonia	1 258 545	-0.54	76.7	11.80	23.48	17 896	6.38
Finland	5 498 211	0.39	80.9	9.60	239.19	43 492	9.68
France	66 836 154	0.42	81.8	8.70	2 488.28	38 537	11.54
Georgia Republic of	4 928 052	-0.06	76.2	13.20	14.46	3 908	7.42
Germany	80 722 792	-0.16	80.7	10.70	3 494.90	42 326	11.30
Greece	10 773 253	-0.02	80.5	10.50	195.88	18 078	8.08
Hungary	9 874 784	-0.23	75.9	12.80	117.07	11 903	7.40
Iceland	335 878	1.19	83.0	6.30	19.44	57 889	8.86
Ireland	4 952 473	1.23	80.8	6.40	307.92	65 871	7.78
Israel	8 174 527	1.56	82.4	5.20	311.74	36 557	7.81
Italy	62 007 540	0.25	82.2	10.30	1 852.50	30 294	9.25
Kazakhstan	18 360 353	1.12	70.8	7.50	128.11	7 138	4.36
Kosovo	1 883 018	0.64	71.6	N/A	6.56	N/A	N/A
Kyrgyzstan	5 727 553	-3.86	70.7	5.80	5.79	956	6.48
Latvia	1 965 686	-1.06	74.5	14.10	27.95	14 141	5.88
Lebanon*	6 237 738	0.86	77.6	N/A	51.82	11 271	N/A
Libya*	6 541 948	2.03	76.5	N/A	39.39	6 169	N/A
Lithuania	2 854 235	-1.05	74.9	13.70	42.78	14 899	6.55
Luxembourg	582 291	2.11	82.3	6.70	60.98	105 829	6.94
FYR Macedonia	2 100 025	0.30	76.2	9.30	10.49	5 060	9.75
Malta	415 196	-0.39	80.4	7.70	10.46	24 298	6.42
Moldova	3 510 485	1.00	70.7	11.10	6.65	1 872	N/A
Montenegro	644 578	0.41	78.6	9.30	4.24	6 809	10.90
Morocco	33 655 786	1.10	76.9	N/A	104.91	3 101	9.72
Netherlands	17 016 967	-0.10	81.3	8.40	769.93	45 210	6.35
Norway	5 265 158	0.08	81.8	7.90	376.27	71 497	9.50
Poland	38 523 261	-1.03	77.6	9.90	467.35	12 309	10.32
Portugal	10 833 816	-0.31	79.3	10.20	205.86	19 759	5.57
Romania	21 599 736	-0.05	75.1	11.40	186.51	9 439	7.07
Russian Federation	142 355 415	0.80	70.8	13.50	1 267.75	8 838	6.13
San Marino	33 285	-0.46	83.3	7.30	1.56	49 579	10.37
Serbia	7 143 921	0.55	75.5	14.20	37.76	5 294	8.05
Slovakia	5 445 802	-0.27	77.1	9.50	90.26	16 648	9.23
Slovenia	1 978 029	0.87	78.2	9.10	44.12	21 370	9.03
Spain	48 563 476	0.81	81.7	8.50	1 252.16	27 012	11.93

Continued

Table 2 *Continued*

Country	Population	Population growth rate (%)	Life expectancy at birth (years)	Death rate per 1000 population	GDP (x 1000 billion USD)	GDP per capita (USD)	Total health expenditure as % of GDP
Sweden	9 880 604	0.71	82.1	9.20	517.44	51 604	11.66
Switzerland	8 179 294	0.71	82.6	8.00	662.48	79 578	N/A
Syria*	17 185 170	0.19	74.9	N/A	N/A	N/A	6.48
Tunisia	11 134 588	0.88	76.1	N/A	42.39	3 777	N/A
Turkey	80 274 604	1.95	74.8	4.70	735.72	9 317	5.41
Ukraine	44 209 733	-0.49	71.8	14.80	87.20	2 052	7.10
United Kingdom	64 430 428	0.53	80.7	9.00	2 649.89	40 412	9.12

*These 3 countries did not submit any data for the EHRA White Book 2017.

Table 3 Healthcare service and insurance systems in the 56 ESC member 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	Yes	0	100	N/A	0	Yes	No	No	Yes
Algeria	Yes	30	100	N/A	N/A	Yes	No	Yes	No
Armenia	No	68	33	64	3	Yes	Yes	Yes	Yes
Austria	Yes	1	70	0	30	Yes	No	No	No
Azerbaijan	Yes	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes
Belarus	Yes	0	100	N/A	N/A	Yes	No	No	No
Belgium	Yes	1	90	0	10	Yes	No	No	Yes
Bosnia & Herzegovina	No	25	75	N/A	25	No	Yes	Yes	N/A
Bulgaria	Yes	17.7	80.78	N/A	0.72	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	1	0	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	No	5	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	No	No	No	No
Georgia Republic of	Yes	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes
Germany	Yes	1	87	11	2	Yes	No	No	No
Greece	Yes	30	85	10	5	Yes	No	No	No
Hungary	Yes	1	99	1	0	Yes	No	No	No
Iceland	Yes	0	100	0	0	No	No	No	No
Ireland	Yes	0	54	46	0	Yes	No	No	No
Israel	Yes	0	100	0	0	Yes	No	No	Yes
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	No	Yes	Yes	N/A
Kyrgyzstan	No	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes
Latvia	Yes	1	80	12	8	Yes	Yes	Yes	No

Continued

Table 3 Continued

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
Lebanon*									
Libya*									
Lithuania	Yes	0	98	0	2	Yes	No	No	No
Luxembourg	Yes	0	100	N/A	N/A	Yes	No	No	No
FYR Macedonia	Yes	10	80	10	10	Yes	No	No	No
Malta	Yes	0	N/A	N/A	N/A	Yes	No	No	No
Moldova	Yes	5	98	1.1	0.9	Yes	No	No	No
Montenegro	Yes	0	95	2	3	Yes	No	No	No
Morocco	No	40	80	19	1	Yes	N/A	No	No
Netherlands	Yes	0	0	100	0	Yes	No	No	No
Norway	Yes	0	99	0	1	Yes	No	No	No
Poland	Yes	N/A	N/A	N/A	N/A	Yes	No	No	No
Portugal	Yes	0	100	0	0	Yes	No	No	No
Romania	Yes	N/A	100	N/A	N/A	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	5	90	5	5	Yes	No	No	No
Slovakia	Yes	0	70	30	0	No	No	No	No
Slovenia	Yes	1	4	0	96	N/A	No	No	No
Spain	Yes	1	79	5	16	Yes	Yes	Yes	No
Sweden	Yes	0	100	0	N/A	Yes	No	No	No
Switzerland	Yes	10	0	0	100	Yes	No	No	No
Syria*									
Tunisia	Yes	30	90	10	0	Yes	No	No	Yes
Turkey	Yes	1	99	1	N/A	Yes	Yes	Yes	Yes
Ukraine	No	N/A	N/A	N/A	N/A	Yes	No	No	No
United Kingdom	No	95	89	11	0	Yes	No	No	No

*These 3 countries did not submit data for the EHRA White Book 2017.

these countries. Certification was an obligatory practice requirement for CIED therapy in 10 countries and for EP in 12 countries, respectively (Figure 6 and 7). A national certification for allied professionals was available in 17 countries and certification was required for practice in 11 countries (Figure 8).

Training centres were accredited in 17 countries, but certification of training centres was mandatory to train fellows in only 13 countries (Figure 9). 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.

EHRA certification

The EHRA certification program plays a key role in EHRA's goal to promote unified and clear standards for the training of cardiac rhythm management specialists and to assure high-quality arrhythmia care across the ESC area. The requirements for the certification

(Level 2) are passing the EHRA exam and completion of the EHRA logbook of interventional procedures/operations. The certification is valid for 10 years.

In 2016, 106 physicians from 32 countries participated in the EP exam, and 158 physicians from 32 countries in the CIED exam. Most of them were male (84% in the EP exam and 75% in the CIED exam). The pass rate was 83% in the invasive EP examination and 58% in the CIED examination. The highest number of candidates participating in the CIED and EP exam were from the Netherlands (24 candidates) and Germany (11), respectively. Over the past ten years 848 physicians from 59 countries have participated in the EP exam and 1271 in the CIED exam (Figure 10). Of them 495 have passed the EP exam (58%) and 830 have passed the CIED exam (65%), respectively. A total of 279 and 384 physicians have achieved full (Level 2) certification in the EP and in the CIED program, respectively.

The EHRA certification program for allied professionals (AP) in cardiac pacing and implantable cardioverter defibrillators was launched in 2011. Since then 420 APs from 19 countries have

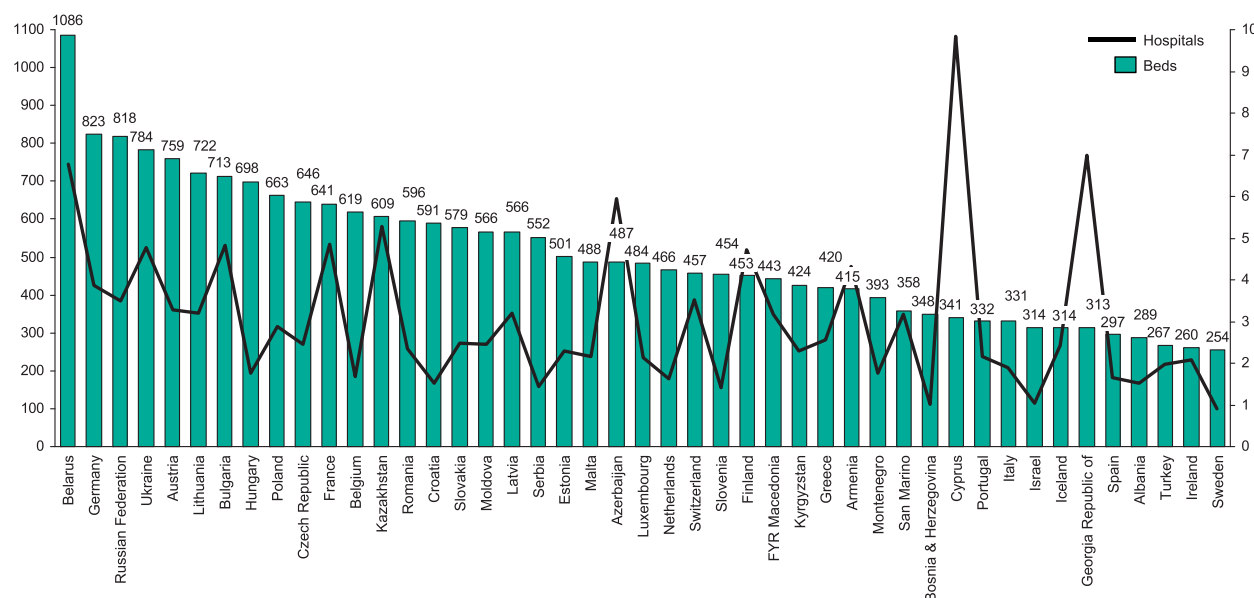


Figure 2 Hospitals and hospital beds per 100 000 inhabitants in the ESC member countries.

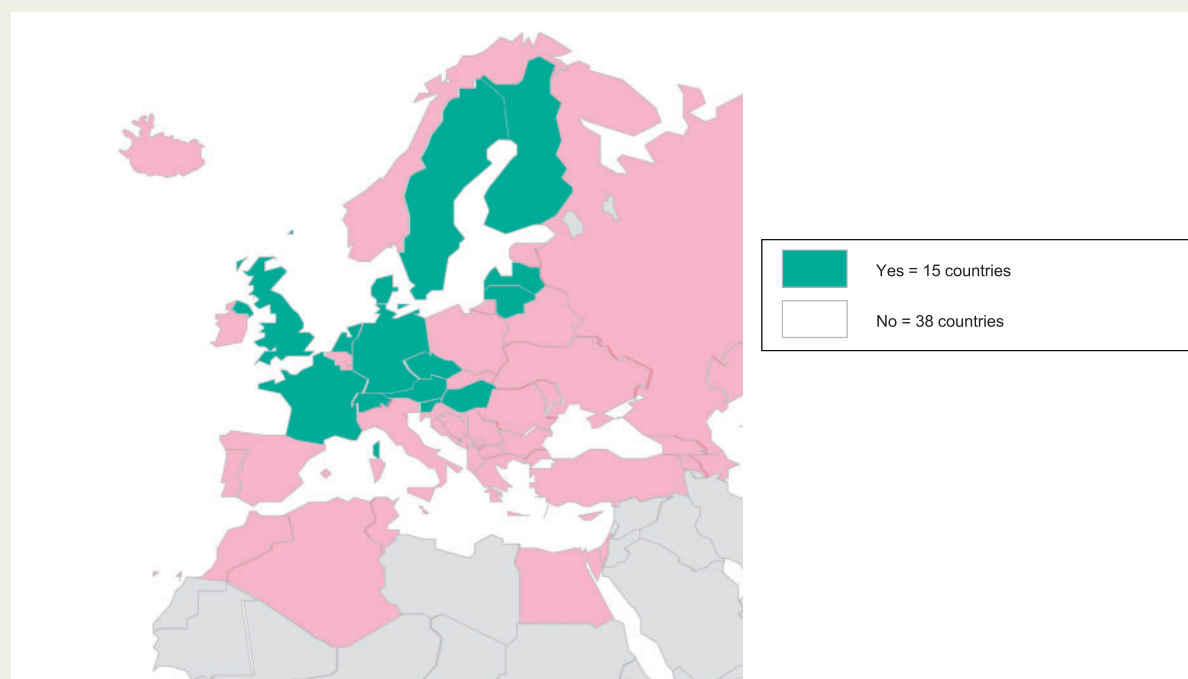


Figure 3 Availability of national institution to coordinate and guide device recalls in the ESC member countries in 2016.

participated in the EHRA examination and 253 of them have been certified (60%). Last year the pass rate in the AP exam was 48%, which was markedly lower than 2015 (67%). Like in the past, the highest number of participants were from the Netherlands. The AP examination is currently available in four languages (English, Dutch, German and Italian).

Pacemakers

General information

The 52 countries (93% of the ESC member countries) which submitted the requested data on pacemaker (PM) implantation for this year's edition of the EHRA White Book are listed in [Table 4](#).

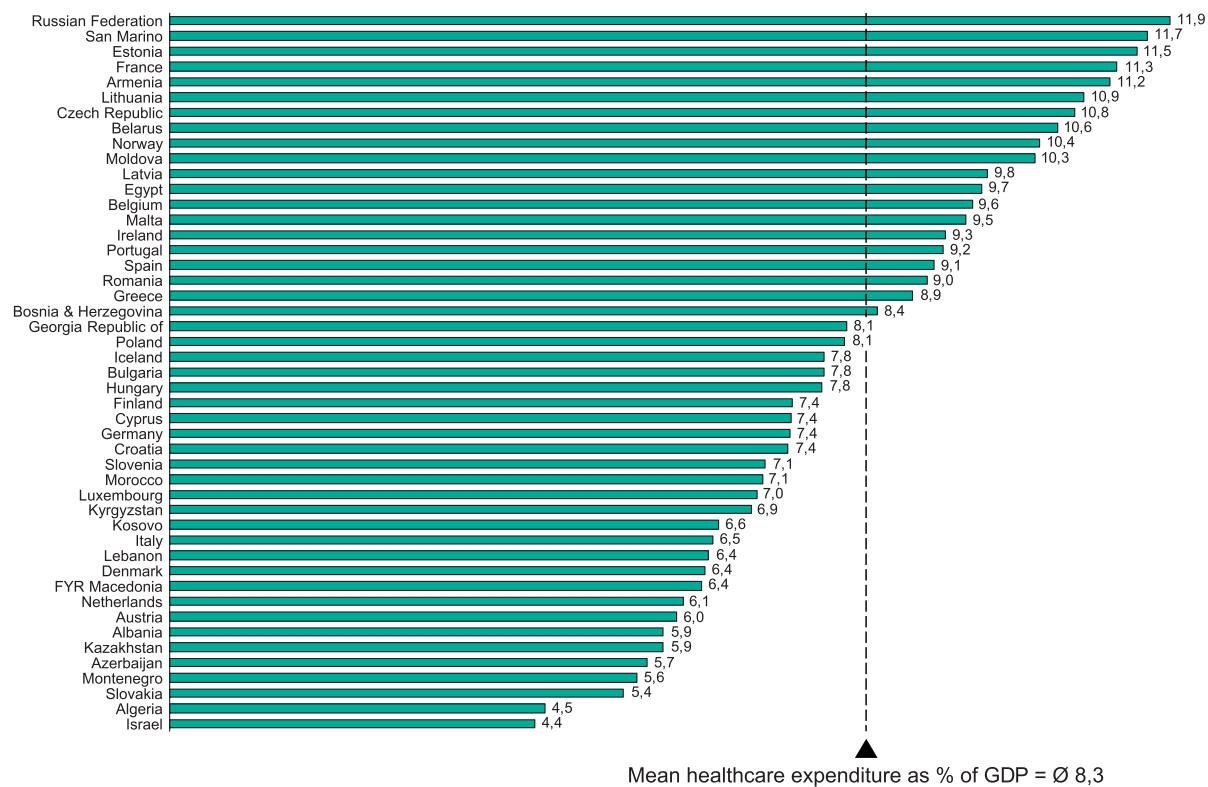


Figure 4 Healthcare expenditure as percentage of national gross domestic product (GDP) in the ESC member countries in 2014. The mean healthcare expenditure as % of GDP is weighted by population.

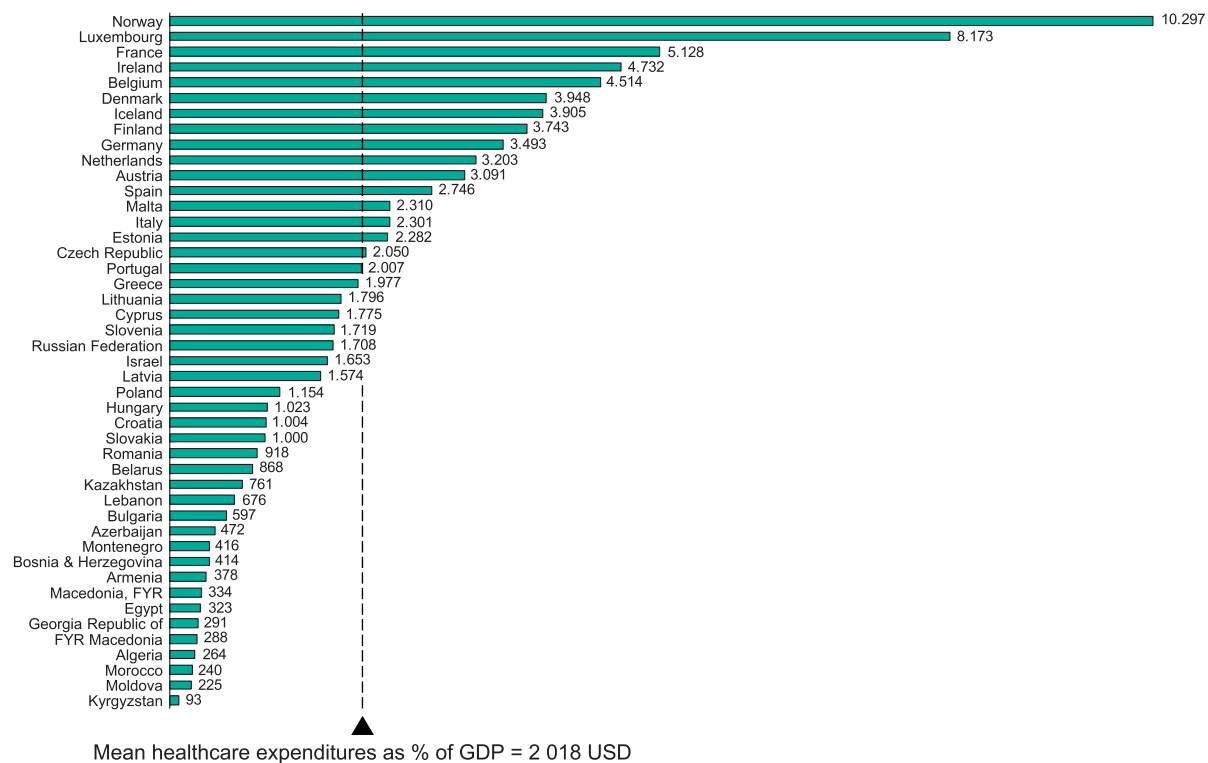
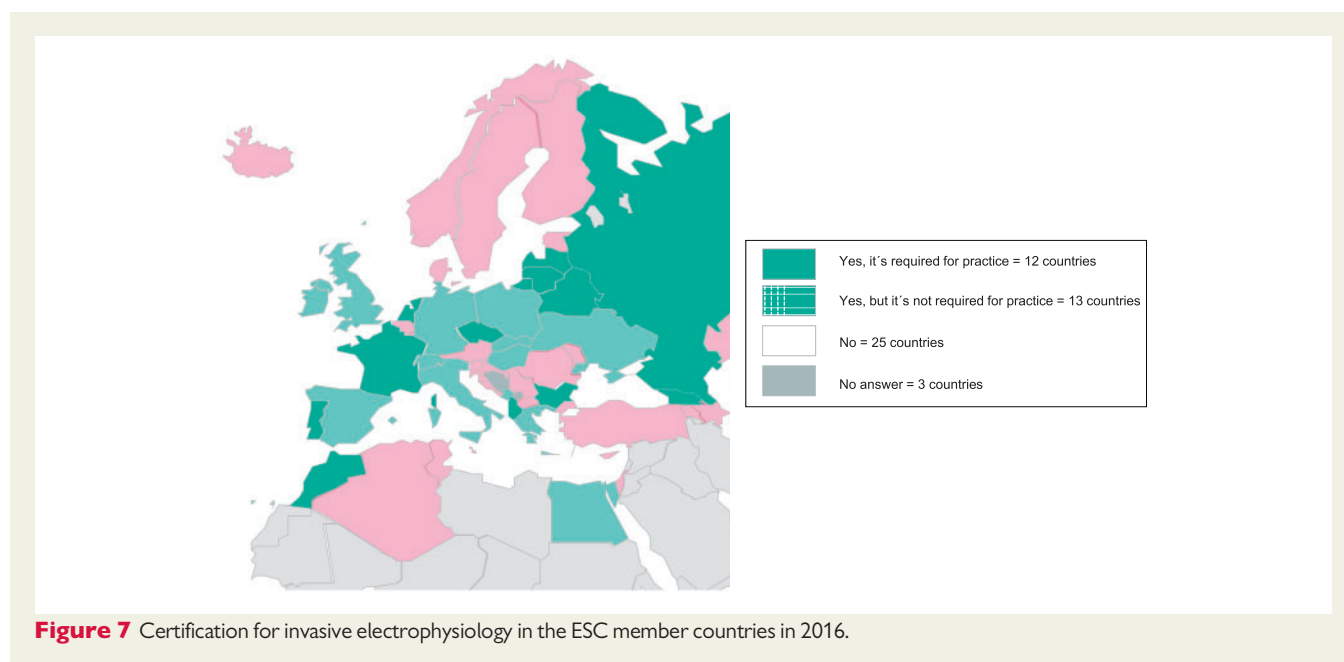
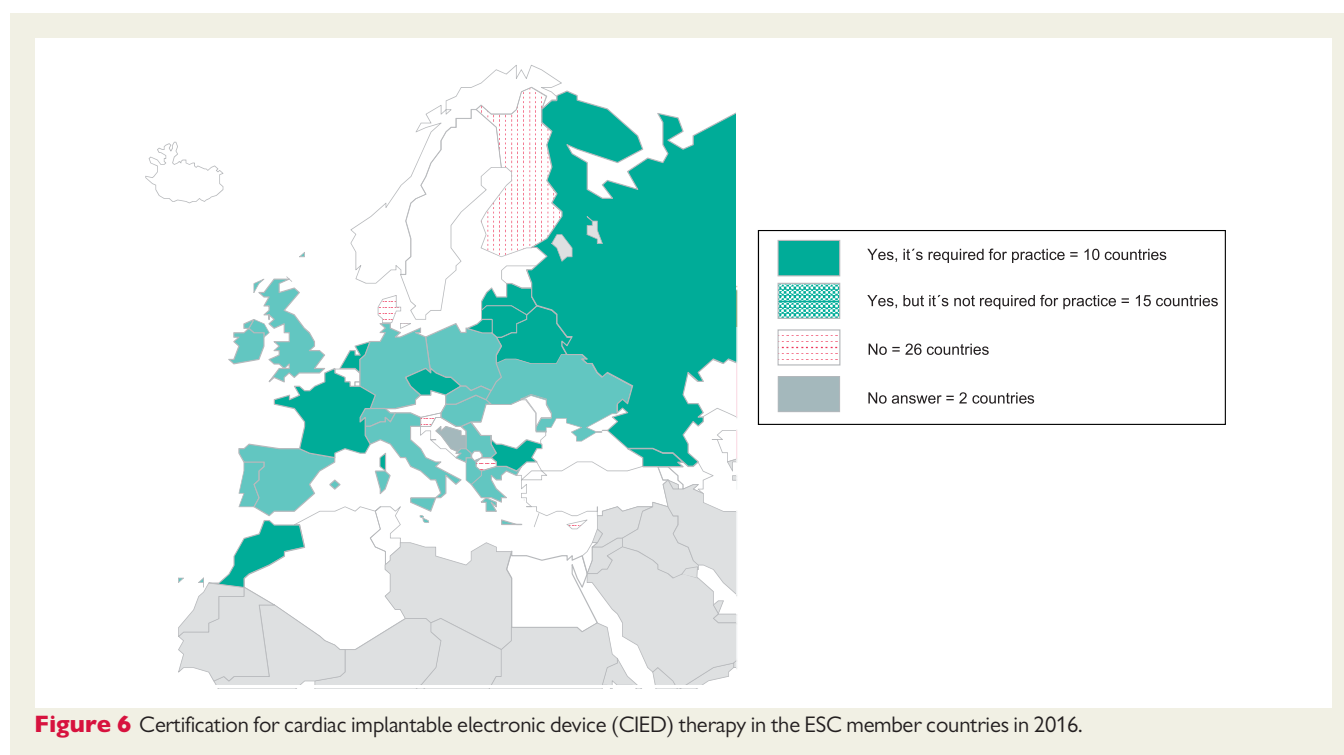


Figure 5 Healthcare expenditure per capita in the ESC member countries in 2014. Mean number of expenditure is weighted by population.

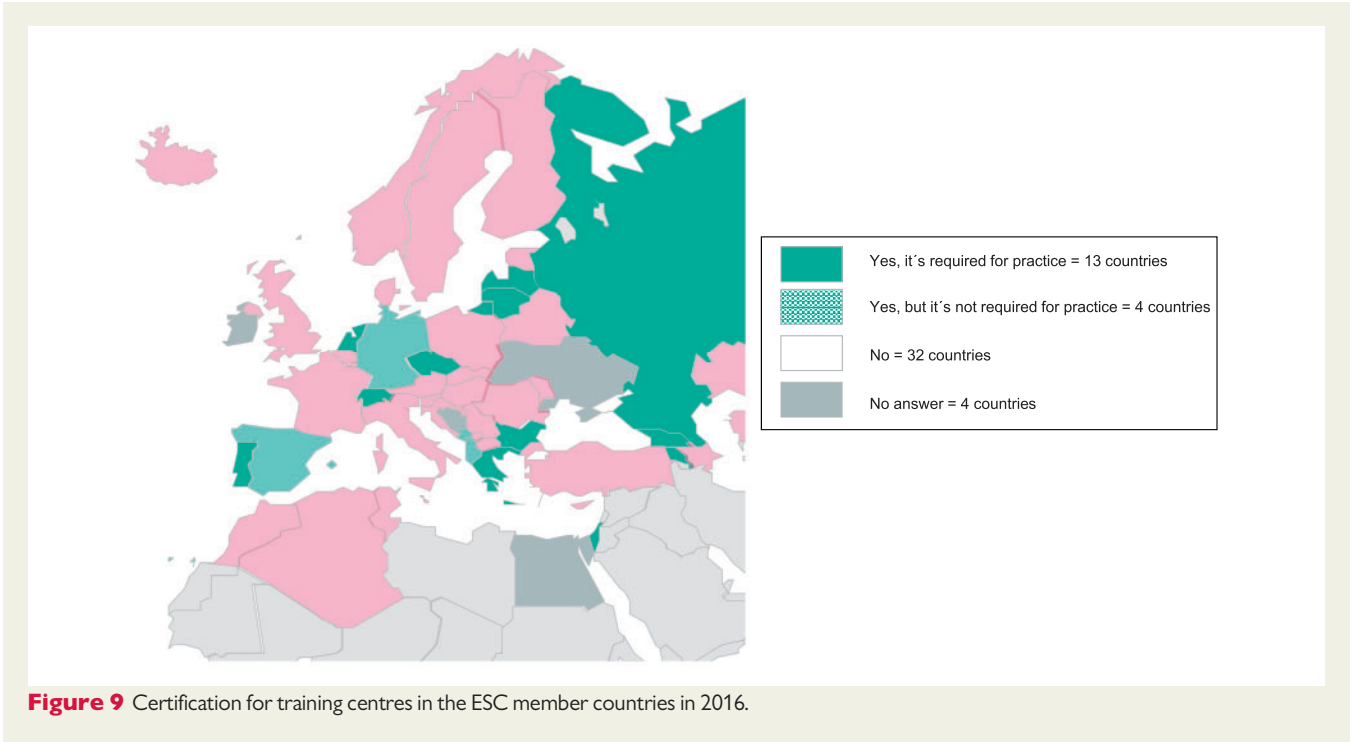
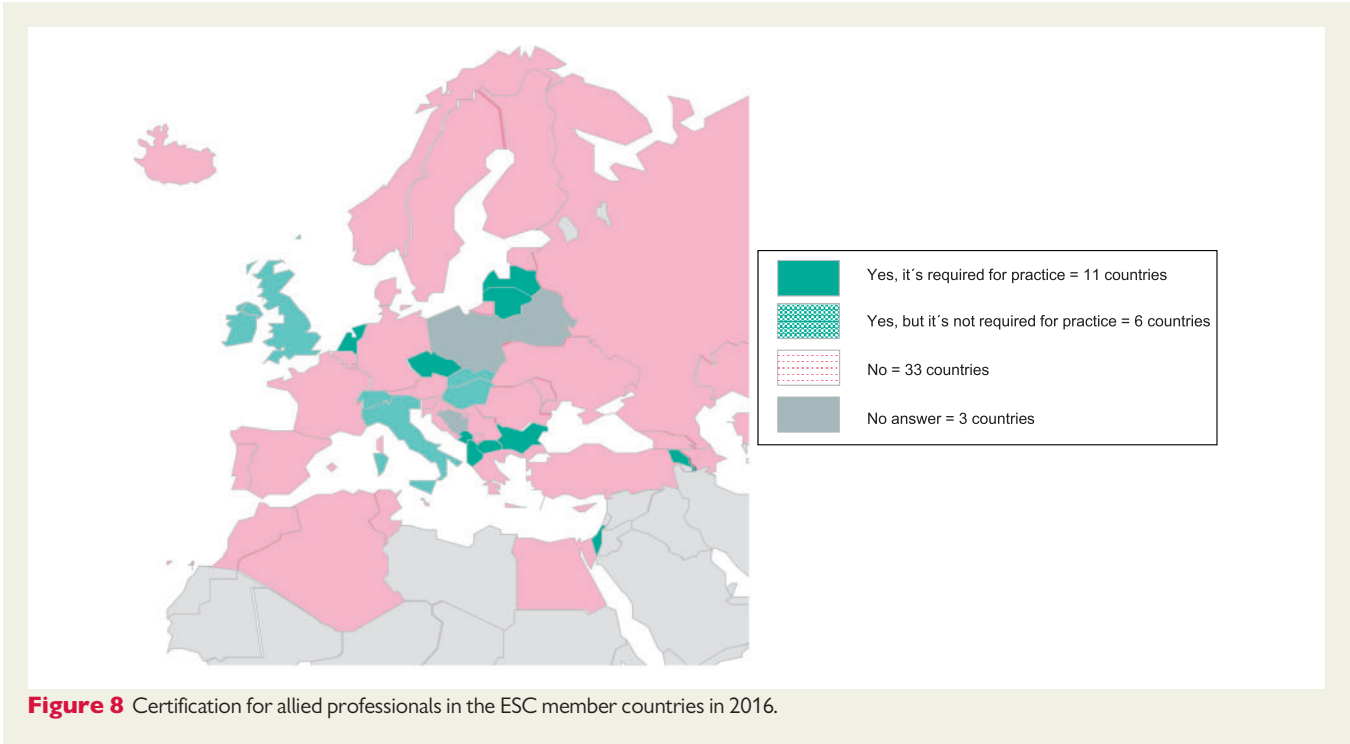


Lebanon, Libya and Syria did not provide any data and Belgium only provided data on the number of the PM implantation facilities. A national registry for PM implantations was available in 22 (39%) of the ESC member countries (*Table 4*). The vast majority of implants were performed by cardiologists, and the remaining implantations were performed by physicians with various training backgrounds, including surgeons, anaesthesiologists, paediatricians, and internists. In four

countries (Belarus, Kyrgyzstan, Slovenia, and Ukraine) the proportion of implanting cardiologists was less than 50% (*Table 5*).

PM facilities and procedure rate

In 2016 a total of 547 586 PMs were implanted in 4022 centres across the ESC area (*Table 4*). The mean number of centres implanting PMs



per million inhabitants was 3.80 approximately the same as in the preceding year (3.85) (Figure 11). Countries with the highest density of implanting facilities were Germany (14.9 per million in habitants), Belgium (9.1) and Switzerland (8.7) and those with the lowest density were Egypt and Morocco. The changes in the number of implanting centres from 2015 to 2016 are shown in Table 6 and Figure 12.

The mean PM implantation rate in the participating ESC member countries was slightly higher in 2016 than in 2015 (524 vs. 518 PM units per million inhabitants). As seen in Figures 13 and 14, where the ESC member countries are grouped into quartiles according to the number of PM implantations per million inhabitants, there was a marked heterogeneity in the PM implantation rate per million

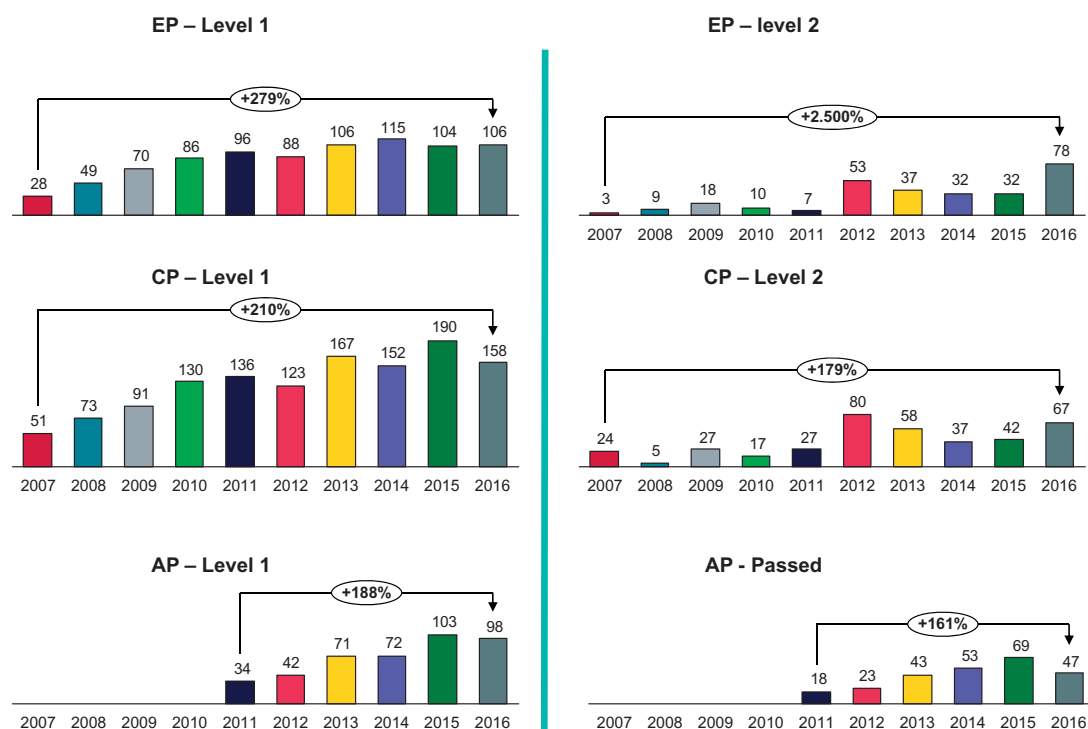


Figure 10 The number of individuals who have participated in the EHRA exam (level 1 certification) and those who have achieved full certification (level 2) over the past 10 years.

inhabitants in the ESC area. The implantation rate was highest in Germany (1364), followed by Finland (1124) and Italy (1050). The three countries with the lowest PM implantation rate were Kyrgyzstan (16), Kosovo (24) and Azerbaijan (46).

The changes in the number of PM implantations per million inhabitants from 2015 to 2016 are shown in Table 7 and Figure 15, and a comparison to the previous four years in each country is shown in Table 4. The PM implantation rate decreased in 18 countries including some Western and Northern countries with high activities (e.g., United Kingdom, the Netherlands, Italy, Spain and Norway). The increase in the number of new PM implantations was highest in countries with rather small implant numbers (e.g., San Marino, Slovenia and Montenegro). The changes in the *de novo* PM implantations and PM replacements rate are shown in Figure 16 and Figure 17, respectively. The relationship between the mean annual PM implantation rate per million inhabitants and the number of PM implanting centres per million inhabitants in the ESC member countries and in the EU28 is shown in Figure 18.

Trends in PM implantation activity over the past 10 years

The number of PM implantations in the European and non-European ESC member countries over the entire EHRA White Book data collection period and comparison with the total ESC area and the 28 member countries of the European Union (EU28) are shown in Figure 19. The corresponding numbers for the European ESC regions are presented in Figure 20. In 2016 the rate of PM implantations was almost fourfold higher in the European ESC member countries, than

in the non-European ESC member countries (759 vs 198). Within Europe the most active area was Western Europe with 1174 PM implantations per million population. The changes from 2007 to 2016 in the number of PM implanting centres for all participating countries are shown in Figure 21.

The growth in PM implantation rate per million population was highest in the non-European (80%) and Eastern European (60%) countries. In the Northern (23%), Southern (11%) and Western European region (9%), there was a small but steady growth in the number of PM implantations from 2007 to 2016. Countries with the highest and lowest activities in each region and trends over the ten-year period are shown in Figures 22-26. The changes from 2007 to 2016 in the number of PM implantations for all participating countries are shown in Figure 27. The most active countries in the five geographical ESC regions were Germany (1364 PM implantations per million inhabitants), Finland (1124), Italy (1050), Czech Republic (873), and Israel (514). Overall the growth in the PM implantation rates was small compared to the changes in other device therapies and catheter ablations which with a very few exceptions had more than 100% increases over the past 10 years.

Leadless pacemakers

Leadless pacing, as an alternative to traditional pacing (9,10) has become available in a number of ESC member countries in the past few years. This was the second year that data on leadless pacemaker implantations was collected for the EHRA White Book. In 2016 a total

Table 4 Pacemaker (PM) implantation facilities and implantation rates in 2016 and comparison with four previous years

Country	ISO code	National Registry for PM implants	Number of PM implanting centres 2016		PM implantations 2016		Development potential - target number of PM implantations		PM implantations per million inhabitants				
			Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012	2013	2014	2015	2016
Albania	AL	No	6	2	440	145	1591	2753	N/A	N/A	44	N/A	145
Algeria	DZ	No	19	0	3248	81	21081	36483	N/A	N/A	65	65	74 81
Armenia	AM	No	3	1	188	62	1598	2765	74	31	42	38	62
Austria	AT	Yes	72	8	7567	869	—	7894	957	967	1006	912	869
Azerbaijan	AZ	No	6	1	452	46	5169	8946	N/A	14	19	40	46
Belarus	BY	No	10	1	3005	314	5011	8672	275	292	309	332	314
Belgium*	BE	Yes	104	9	N/A	N/A	N/A	N/A	1224	1237	1235	1110	N/A
Bosnia & Herzegovina	BA	No	6	2	1008	261	2022	3499	234	224	215	221	261
Bulgaria	BG	Yes	20	3	3816	534	—	6474	448	503	538	550	534
Croatia	HR	No	17	4	2740	635	—	3909	561	540	582	639	635
Cyprus	CY	No	6	5	290	241	631	1092	211	216	213	235	241
Czech Republic	CZ	Yes	37	3	9311	873	—	9660	899	887	889	843	873
Denmark	DK	Yes	15	3	4899	876	—	5068	841	850	866	863	876
Egypt	EG	No	33	0	4428	47	49564	85777	30	33	38	40	47
Estonia	EE	No	5	4	1006	799	—	1140	748	912	838	857	799
Finland	FI	No	20	4	6180	1124	—	—	990	1020	1051	1063	1124
France	FR	No	453	7	69042	1033	—	—	958	945	958	961	1033
Georgia Republic of	GE	No	15	3	849	172	2580	4465	102	125	123	166	172
Germany	DE	Yes	1200	15	110100	1364	—	—	1311	1152	1152	1320	1364
Greece	GR	Yes	56	5	9400	873	—	9762	691	724	742	817	873
Hungary	HU	Yes	18	2	6424	651	—	8947	607	618	645	650	651
Iceland	IS	No	2	6	322	959	—	—	967	996	939	928	959
Ireland	IE	N/A	17	3	2290	462	2593	4487	451	479	N/A	465	462
Israel	IL	No	20	2	4200	514	4280	7407	558	515	537	490	514
Italy	IT	Yes	434	7	65100	1050	—	—	1001	1012	1029	1055	1050
Kazakhstan	KZ	No	28	2	1964	107	9613	16636	69	84	131	99	107
Kosovo	XK	N/A	3	2	46	24	986	1706	N/A	N/A	68	65	24
Kyrgyzstan	KGZ	No	3	1	92	16	2999	5190	N/A	N/A	22	21	16
Latvia	LV	Yes	3	2	1228	625	—	1781	548	591	571	705	625
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	218	218	N/A	N/A
Libya*	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	2588	907	—	—	756	772	789	895	907
Luxembourg	LU	No	4	7	404	694	—	528	621	365	670	689	694

Continued

Table 4 Continued

Country	ISO code	National Registry for PM implants	Number of PM implanting centres 2016		PM implantations 2016		Development potential - target number of PM implantations		PM implantations per million inhabitants				
			Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012	2013	2014	2015	2016
FYR Macedonia	MK	No	3	1	403	192	1 099	1 903	166	154	170	224	192
Malta	MT	No	1	2	427	1 028	–	–	644	552	887	966	1 028
Moldova	MD	Yes	2	1	317	90	1 838	3 181	N/A	79	N/A	N/A	90
Montenegro	ME	No	1	2	320	496	337	584	218	312	280	382	496
Morocco	MA	N/A	12	0	1 823	54	17 621	30 495	38	34	44	54	54
Netherlands	NL	Yes	85	5	10 000	588	–	15 419	560	605	600	590	588
Norway	NO	Yes	22	4	3 908	742	–	4 771	691	680	755	791	742
Poland	PL	No	147	4	30 295	786	–	34 906	716	716	742	791	786
Portugal	PT	No	43	4	9 613	887	–	9 816	825	814	817	810	887
Romania	RO	No	24	1	5 161	239	11 309	19 571	144	110	196	181	239
Russian Federation	RU	Yes	142	1	36 462	256	74 532	128 987	212	244	266	284	256
San Marino	SM	Yes	0	0	21	631	–	30	809	431	367	333	631
Serbia	RS	Yes	16	2	3 004	420	3 740	6 473	431	546	507	519	420
Slovakia	SK	Yes	14	3	3 776	693	–	4 934	567	630	606	677	693
Slovenia	SI	Yes	9	5	1 620	819	–	1 792	668	646	736	623	819
Spain	ES	Yes	230	5	37 466	771	–	44 003	758	782	761	803	771
Sweden	SE	Yes	43	4	9 378	949	–	–	1 041	995	969	947	949
Switzerland	CH	Yes	71	9	6 601	807	–	7 411	753	767	815	786	807
Syria*	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	TN	No	19	2	2 700	242	5 830	10 089	233	240	201	231	242
Turkey	TR	No	245	3	9 993	124	42 029	72 736	N/A	N/A	94	117	124
Ukraine	UA	No	38	1	5 444	123	23 147	40 058	121	148	119	109	123
United Kingdom	GB	Yes	215	3	46 227	717	–	58 380	615	702	708	719	717
Total ESC member countries	56		4 022	3.80	547 586	524			553	554	564	589	592

*These 4 countries did not submit any data on PM implantations for the EHRA White Book 2017.

Table 5 Specialty of physicians performing device implantations and lead extraction

Country	ISO code	Specialist performing PM implantations (%)			Specialist performing ICD implantations (%)			Specialist performing CRT implantations (%)			Specialist performing loop recorder implantations (%)			Specialist performing lead extractions (%)		
		Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other
Albania	AL	95	5	0	100	0	0	100	0	0	0	0	0	100	0	0
Algeria	DZ	95	5	0	100	0	0	100	0	0	100	0	0	60	40	0
Armenia	AM	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Austria	AT	50	50	0	50	50	0	66	33	0	80	20	0	20	80	0
Azerbaijan	AZ	50	50	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	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
Bosnia & Herzegovina	BA	90	10	0	100	0	0	100	0	0	100	0	0	N/A	N/A	N/A
Bulgaria	BG	98	2	0	100	0	0	100	0	0	100	0	0	100	0	0
Croatia	HR	93	7	0	97	3	0	100	0	0	100	0	0	N/A	N/A	N/A
Cyprus	CY	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Czech Republic	CZ	95	5	0	98	2	0	98	2	0	100	0	0	N/A	N/A	N/A
Denmark	DK	100	0	0	100	0	0	100	0	0	100	0	0	90	10	0
Egypt	EG	70	0	30	80	0	20	70	0	30	50	0	50	80	0	20
Estonia	EE	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Finland	FI	90	5	5	100	0	0	100	0	0	100	0	0	100	0	0
France	FR	95	5	0	100	0	0	100	0	0	100	0	0	95	5	0
Georgia Republic of	GE	95	5	0	99	1	0	99	1	0	100	0	0	100	0	0
Germany	DE	68	20	12	67	21	12	N/A	N/A	N/A	N/A	N/A	N/A	18	82	0
Greece	GR	99	1	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	N/A	N/A	N/A
Iceland	IS	70	30	0	60	40	0	100	0	0	100	0	0	0	0	100
Ireland	IE	100	0	0	100	0	0	100	0	0	100	0	0	40	60	0
Israel	IL	100	0	0	100	0	0	100	0	0	100	0	0	98	2	0
Italy	IT	100	0	0	100	0	0	100	0	0	100	0	0	N/A	N/A	N/A
Kazakhstan	KZ	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
Kosovo	XK	100	0	0	100	0	0	100	0	0	N/A	N/A	N/A	N/A	N/A	N/A
Kyrgyzstan	KGZ	0	100	0	N/A	N/A	N/A	0	100	0	0	100	0	0	100	0
Latvia	LV	70	30	0	70	30	0	70	30	0	70	30	0	0	100	0
Lebanon*	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*	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

Continued

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 lead extractions (%)		
		Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other	Cardiologists	Surgeons	Other
Lithuania	LT	99	1	0	100	0	0	100	0	0	100	0	0	100	0	0
Luxembourg	LU	90	10	0	95	5	0	95	5	0	100	0	0	10	90	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
Moldova	MD	100	0	0	100	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	67	33	0	70	30	0	100	0	0	50	50	0	50	50	0
Morocco	MA	98	2	0	99	1	0	100	0	0	N/A	N/A	N/A	100	0	0
Netherlands	NL	95	2	3	95	3	2	97	3	0	85	5	10	90	10	0
Norway	NO	99.6	0.4	0	99.6	0.4	0	95	5	0	100	0	0	100	0	0
Poland	PL	99	1	0	99	1	0	99	1	0	100	0	0	99	1	0
Portugal	PT	100	0	0	100	0	0	100	0	0	100	0	0	90	10	0
Romania	RO	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
Russian Federation	RU	80	18	2	70	30	0	60	40	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	100	0	0
Serbia	RS	100	0	0	100	0	0	100	0	0	100	0	0	90	10	0
Slovakia	SK	98	2	0	99	1	0	100	0	0	100	0	0	99	1	0
Slovenia	SI	30	70	0	58	42	0	89	11	0	83	17	0	0	100	0
Spain	ES	72	24	4	92	8	0	98	2	0	100	0	0	30	70	0
Sweden	SE	51	25	21	68	15	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Switzerland	CH	97	3	0	97	3	0	100	0	0	100	0	0	90	10	0
Syria*	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	TN	100	0	0	100	0	0	100	0	0	100	0	0	75	25	0
Turkey	TR	95	5	0	99	1	0	97	3	0	100	0	0	75	25	0
Ukraine	UA	10.5	89.5	0	25	75	0	10	90	0	30	70	0	0	100	0
United Kingdom	GB	100	0	0	100	0	0	100	0	0	99	0	1	100	0	0

*These 3 countries did not submit data for the EHRA White Book 2017.

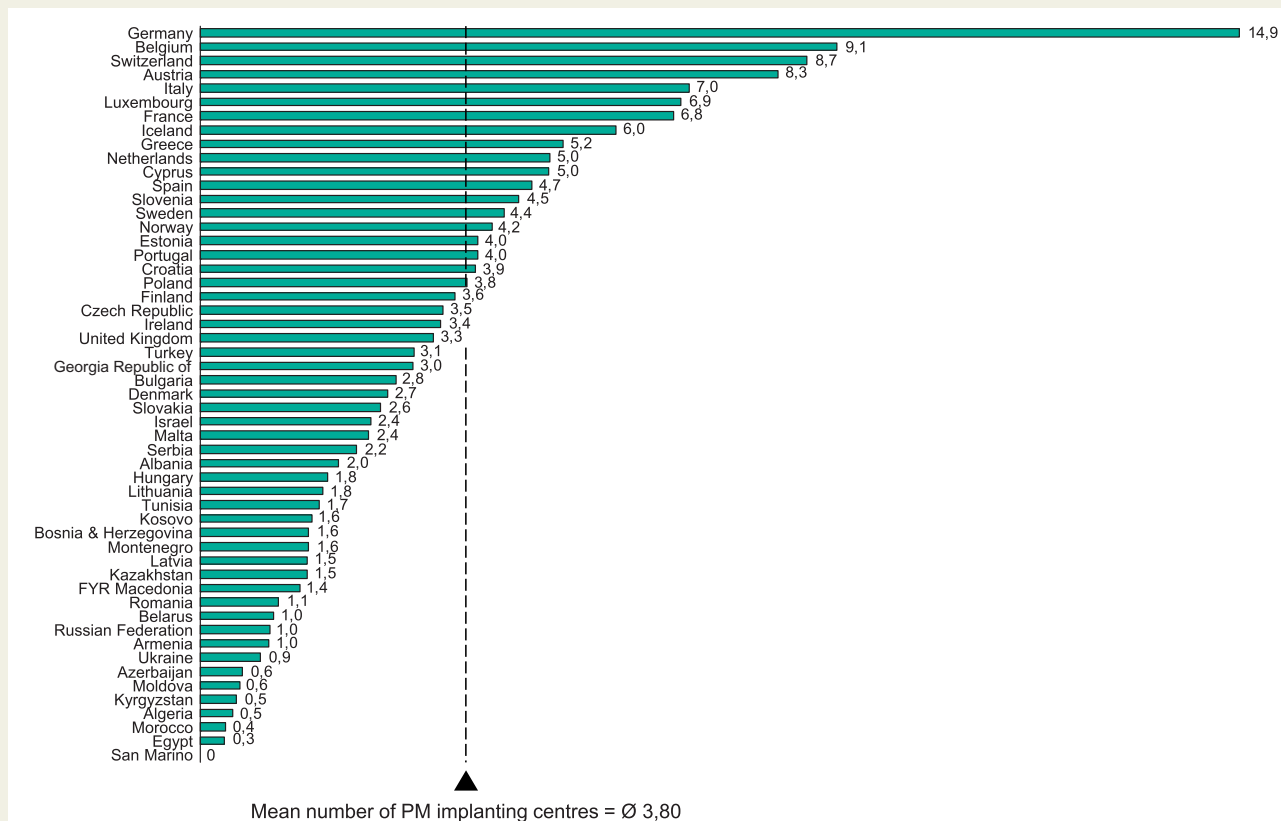


Figure 11 Number of pacemaker (PM) implanting centres per million inhabitants in the ESC member countries in 2016. The mean number of implantation centres is weighted by population.

Table 6 Changes in the number of pacemaker (PM) implantation centres from 2015 to 2016

Country	ISO code	Number of PM implanting centres 2015		Number of PM implanting centres 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania	AL	N/A	N/A	6	1.97	N/A
Algeria	DZ	19	0.48	19	0.47	-1.8%
Armenia	AM	2	0.65	3	0.98	50.3%
Austria	AT	57	6.58	72	8.26	25.6%
Azerbaijan	AZ	8	0.82	6	0.61	-25.7%
Belarus	BY	10	1.05	10	1.04	-0.8%
Belgium	BE	104	9.18	104	9.12	-0.7%
Bosnia & Herzegovina	BA	6	1.55	6	1.55	0.1%
Bulgaria	BG	19	2.64	20	2.80	5.9%
Croatia	HR	17	3.81	17	3.94	3.5%
Cyprus	CY	5	4.20	6	4.98	18.4%
Czech Republic	CZ	37	3.48	37	3.47	-0.2%
Denmark	DK	15	2.69	15	2.68	-0.2%
Egypt	EG	33	0.37	33	0.35	-6.5%

Continued

Table 6 *Continued*

Country	ISO code	Number of PM implanting centres 2015		Number of PM implanting centres 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Estonia	EE	5	3.95	5	3.97	0.5%
Finland	FI	20	3.65	20	3.64	-0.4%
France	FR	453	6.81	453	6.78	-0.4%
Georgia Republic of	GE	15	3.04	15	3.04	0.1%
Germany	DE	1 135	14.04	1 200	14.87	5.9%
Greece	GR	56	5.20	56	5.20	0.0%
Hungary	HU	18	1.82	18	1.82	0.2%
Iceland	IS	2	6.03	2	5.95	-1.2%
Ireland	IE	17	3.47	17	3.43	-1.2%
Israel	IL	20	2.48	20	2.45	-1.5%
Italy	IT	435	7.03	434	7.00	-0.5%
Kazakhstan	KZ	25	1.38	28	1.53	10.8%
Kosovo	XK	3	1.60	3	1.59	-0.6%
Kyrgyzstan	KGZ	2	0.34	3	0.52	56.0%
Latvia	LV	3	1.51	3	1.53	1.1%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	5	1.73	5	1.75	1.1%
Luxembourg	LU	6	10.52	4	6.87	-34.7%
FYR Macedonia	MK	3	1.43	3	1.43	-0.2%
Malta	MT	1	2.42	1	2.41	-0.3%
Moldova	MD	N/A	N/A	2	0.57	N/A
Montenegro	ME	1	1.55	1	1.55	0.4%
Morocco	MA	11	0.33	12	0.36	8.0%
Netherlands	NL	85	5.02	85	5.00	-0.4%
Norway	NO	23	4.42	22	4.18	-5.4%
Poland	PL	145	3.76	147	3.82	1.5%
Portugal	PT	40	3.70	43	3.97	7.4%
Romania	RO	24	1.11	24	1.11	0.3%
Russian Federation	RU	140	0.98	142	1.00	1.5%
San Marino	SM	1	30.28	0	0.00	-100.0%
Serbia	RS	17	2.37	16	2.24	-5.4%
Slovakia	SK	14	2.58	14	2.57	-0.5%
Slovenia	SI	9	4.54	9	4.55	0.3%
Spain	ES	230	4.78	230	4.74	-0.9%
Sweden	SE	44	4.49	43	4.35	-3.1%
Switzerland	CH	71	8.74	71	8.68	-0.7%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	N/A	N/A	19	1.71	N/A
Turkey	TR	N/A	N/A	245	3.05	N/A
Ukraine	UA	38	0.86	38	0.86	0.5%
United Kingdom	GB	211	3.29	215	3.34	1.4%
Total ESC member countries		3 660	3.85	4 022	3.80	-1.2%

*These 3 countries did not submit data for the EHRA White Book 2017

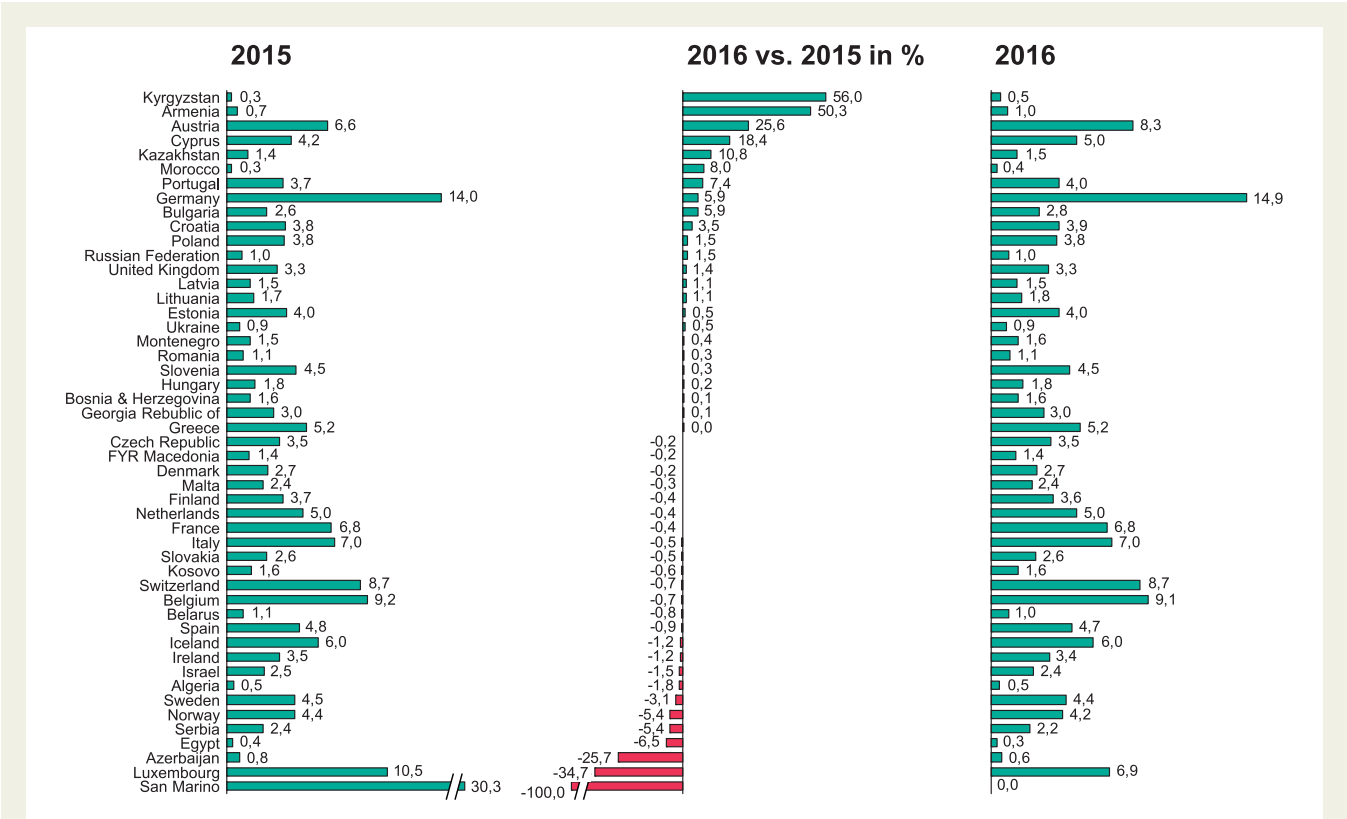


Figure 12 Change in the number of pacemaker implanting centres per million inhabitants from 2015 to 2016.

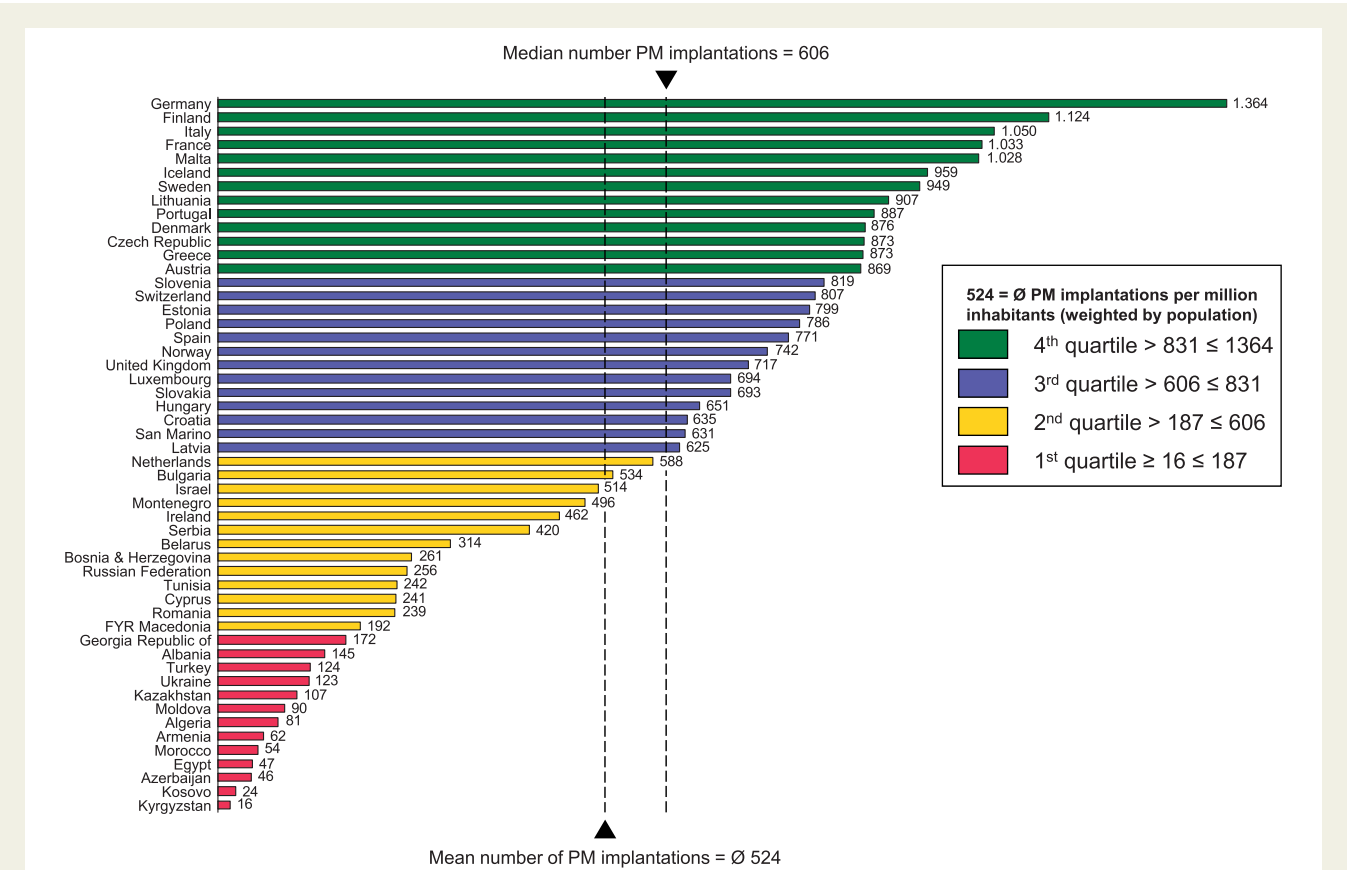


Figure 13 Pacemaker implantations per million inhabitants in the ESC member countries in 2016. The mean number of implantations is weighted by population.

Table 7 Changes in pacemaker (PM) implantations from 2015 to 2016

Country	ISO code	Number of PM implantations 2015		Number of PM implantations 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania	AL	N/A	N/A	440	145	N/A
Algeria	DZ	2 915	74	3 248	81	9.4%
Armenia	AM	117	38	188	62	61.0%
Austria	AT	7 905	912	7 567	869	-4.8%
Azerbaijan	AZ	395	40	452	46	13.4%
Belarus	BY	3 149	332	3 005	314	-5.3%
Belgium*	BE	12 572	1 110	N/A	N/A	N/A
Bosnia & Herzegovina	BA	854	221	1 008	261	18.2%
Bulgaria	BG	3 953	550	3 816	534	-2.9%
Croatia	HR	2 855	639	2 740	635	-0.7%
Cyprus	CY	280	235	290	241	2.2%
Czech Republic	CZ	8 969	843	9 311	873	3.7%
Denmark	DK	4 818	863	4 899	876	1.5%
Egypt	EG	3 552	40	4 428	47	16.5%
Estonia	EE	1 085	857	1 006	799	-6.8%
Finland	FI	5 821	1 063	6 180	1 124	5.8%
France	FR	63 946	961	69 042	1 033	7.5%
Georgia Republic of	GE	817	166	849	172	4.0%
Germany	DE	106 700	1 320	110 100	1 364	3.4%
Greece	GR	8 800	817	9 400	873	6.8%
Hungary	HU	6 432	650	6 424	651	0.1%
Iceland	IS	308	928	322	959	3.3%
Ireland	IE	2 277	465	2 290	462	-0.7%
Israel	IL	3 946	490	4 200	514	4.8%
Italy	IT	65 234	1 055	65 100	1 050	-0.5%
Kazakhstan	KZ	1 801	99	1 964	107	7.8%
Kosovo	XK	122	65	46	24	-62.5%
Kyrgyzstan	KGZ	126	21	92	16	-24.1%
Latvia	LV	1 400	705	1 228	625	-11.3%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	2 583	895	2 588	907	1.3%
Luxembourg	LU	393	689	404	694	0.7%
FYR Macedonia	MK	470	224	403	192	-14.4%
Malta	MT	400	966	427	1 028	6.4%
Moldova	MD	N/A	N/A	317	90	N/A
Montenegro	ME	247	382	320	496	30.1%
Morocco	MA	1 801	54	1 823	54	0.2%
Netherlands	NL	10 000	590	10 000	588	-0.4%
Norway	NO	4 121	791	3 908	742	-6.2%
Poland	PL	30 494	791	30 295	786	-0.6%
Portugal	PT	8 769	810	9 613	887	9.5%
Romania	RO	3 918	181	5 161	239	32.1%
Russian Federation	RU	40 461	284	36 462	256	-9.8%
San Marino	SM	11	333	21	631	89.4%
Serbia	RS	3 724	519	3 004	420	-19.0%
Slovakia	SK	3 664	677	3 776	693	2.5%
Slovenia	SI	1 235	623	1 620	819	31.5%
Spain	ES	38 662	803	37 466	771	-3.9%

Continued

Table 7 Continued

Country	ISO code	Number of PM implantations 2015		Number of PM implantations 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Sweden	SE	9 282	947	9 378	949	0.2%
Switzerland	CH	6 381	786	6 601	807	2.7%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	2 550	231	2 700	242	5.0%
Turkey	TR	9 200	117	9 993	124	6.5%
Ukraine	UA	4 851	109	5 444	123	12.8%
United Kingdom	GB	46 110	719	46 227	717	-0.3%
Total ESC member countries		550 476	529	547 586	524	-1.0%

*These 4 countries did not submit data on PM implantations for the EHRA White Book 2017.

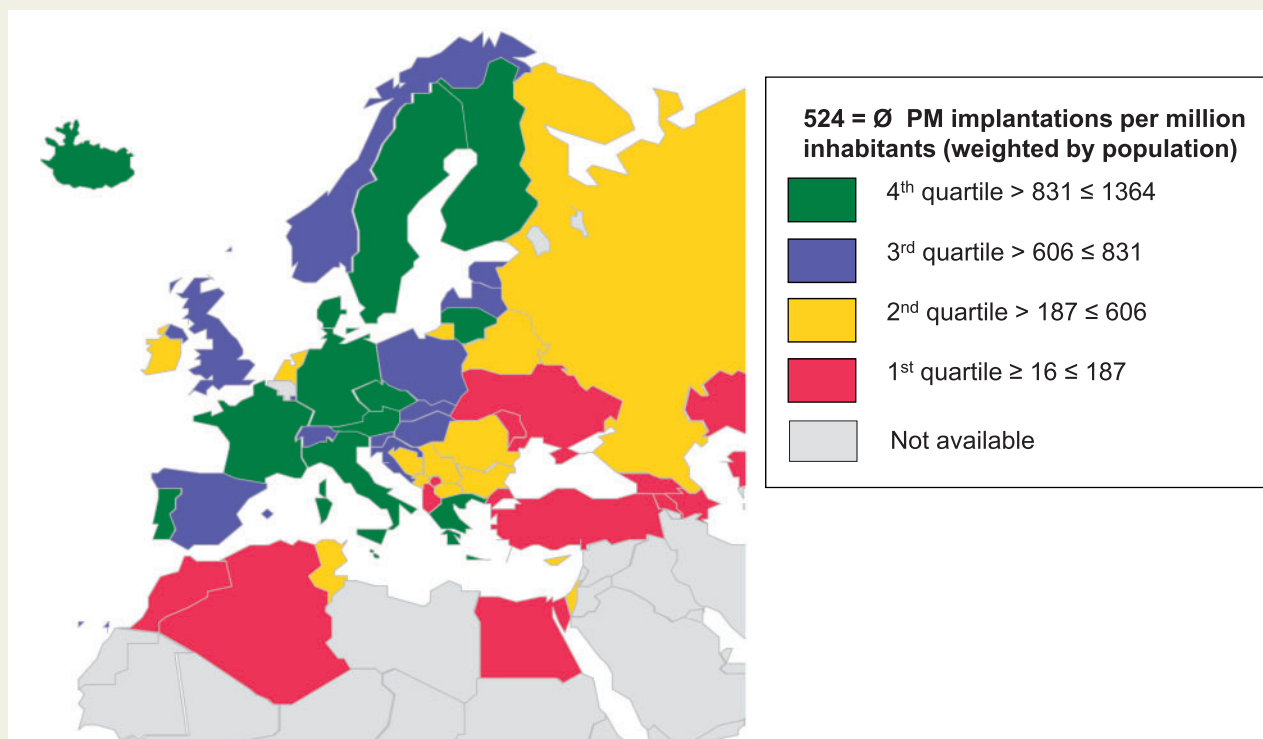


Figure 14 Pacemaker implantations per million inhabitants in the ESC member countries in 2016. The mean number of implantations is weighted by population.

of 1067 leadless pacemakers were implanted in 19 countries. This was about four times more than in 2015 (244). No leadless pacemakers were implanted in 21 countries, and data on these devices were not available from 16 ESC member countries. The most active countries in the ESC area with regards to leadless pacemaker implantations were Spain (182 implantations), Switzerland (167) and the Netherlands (150) (Figure 28).

Implantable cardioverter defibrillators

General information

The data from the 52 countries (93%) which submitted data for the EHRA White Book on implantable cardioverter defibrillator

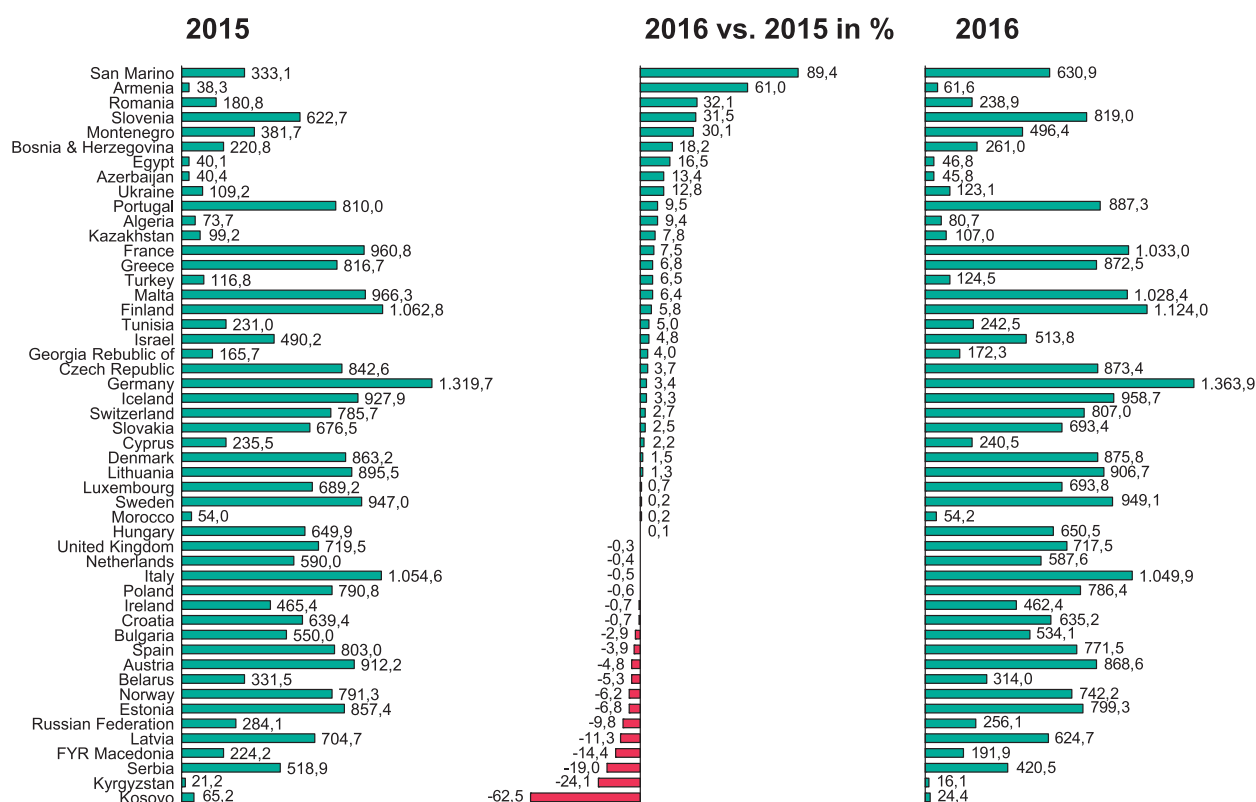


Figure 15 Change in the number of pacemaker implantations per million inhabitants from 2015 to 2016.

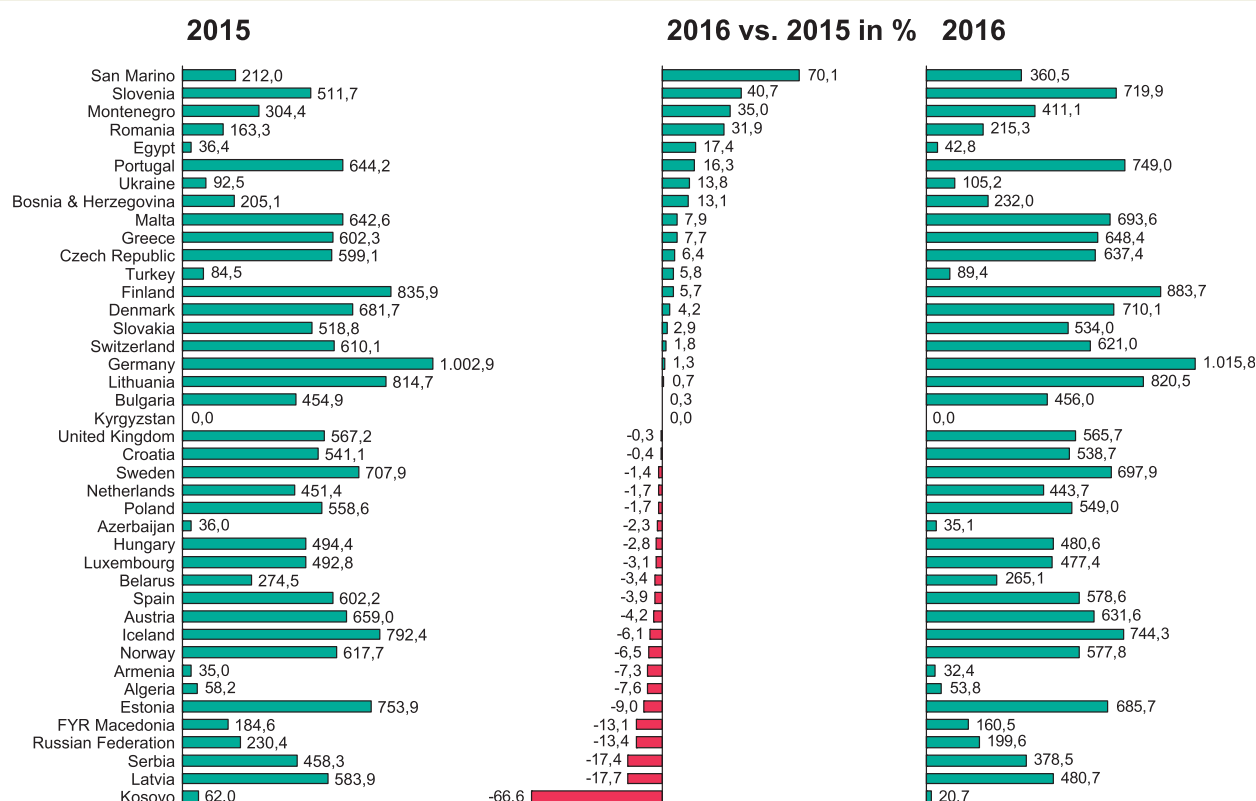


Figure 16 Change in the number of new pacemaker implantations per million inhabitants from 2015 to 2016.

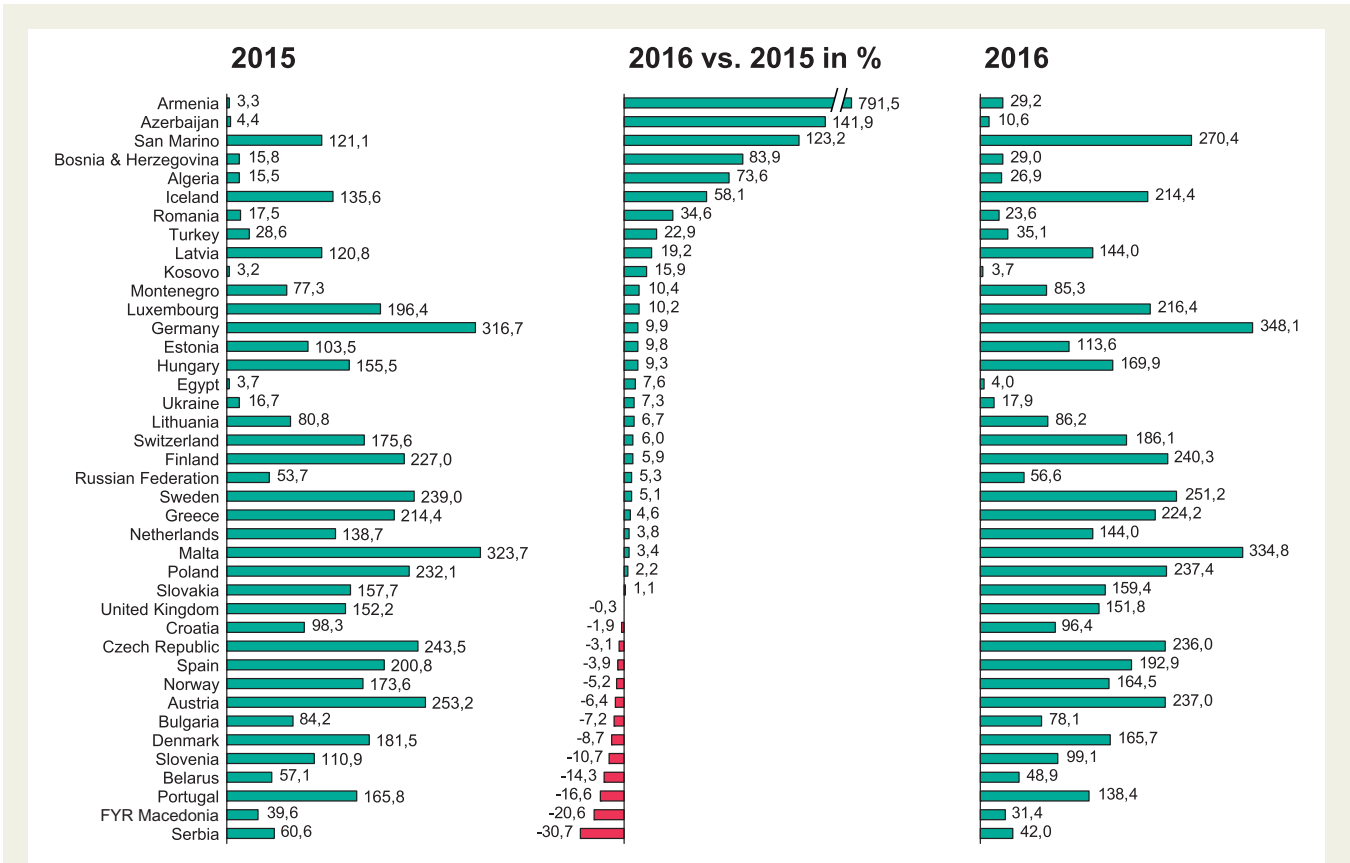


Figure 17 Change in the number of pacemaker replacements per million inhabitants from 2015 to 2016.

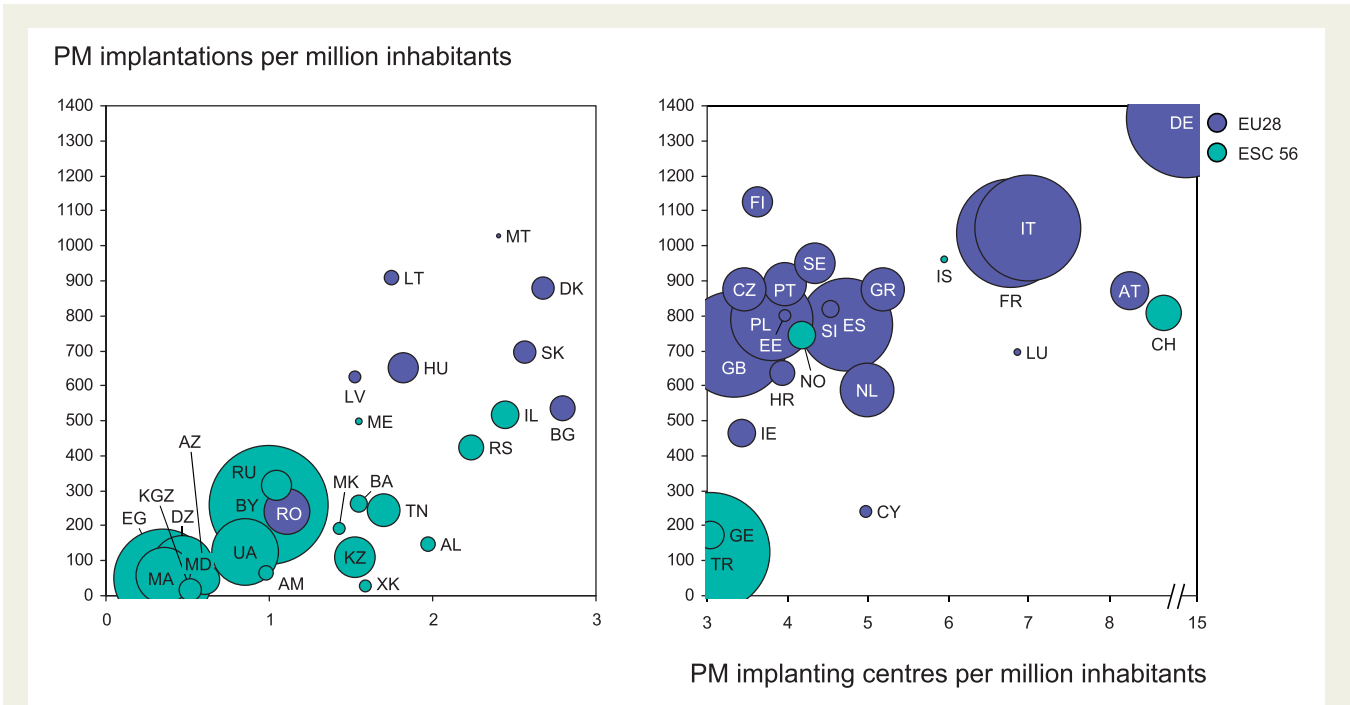


Figure 18 Pacemaker implantation centres and rates in the ESC and European Union (EU28) member countries in 2016. Bubble size is related to population in the country. The ISO codes of the countries are explained in Table 1.

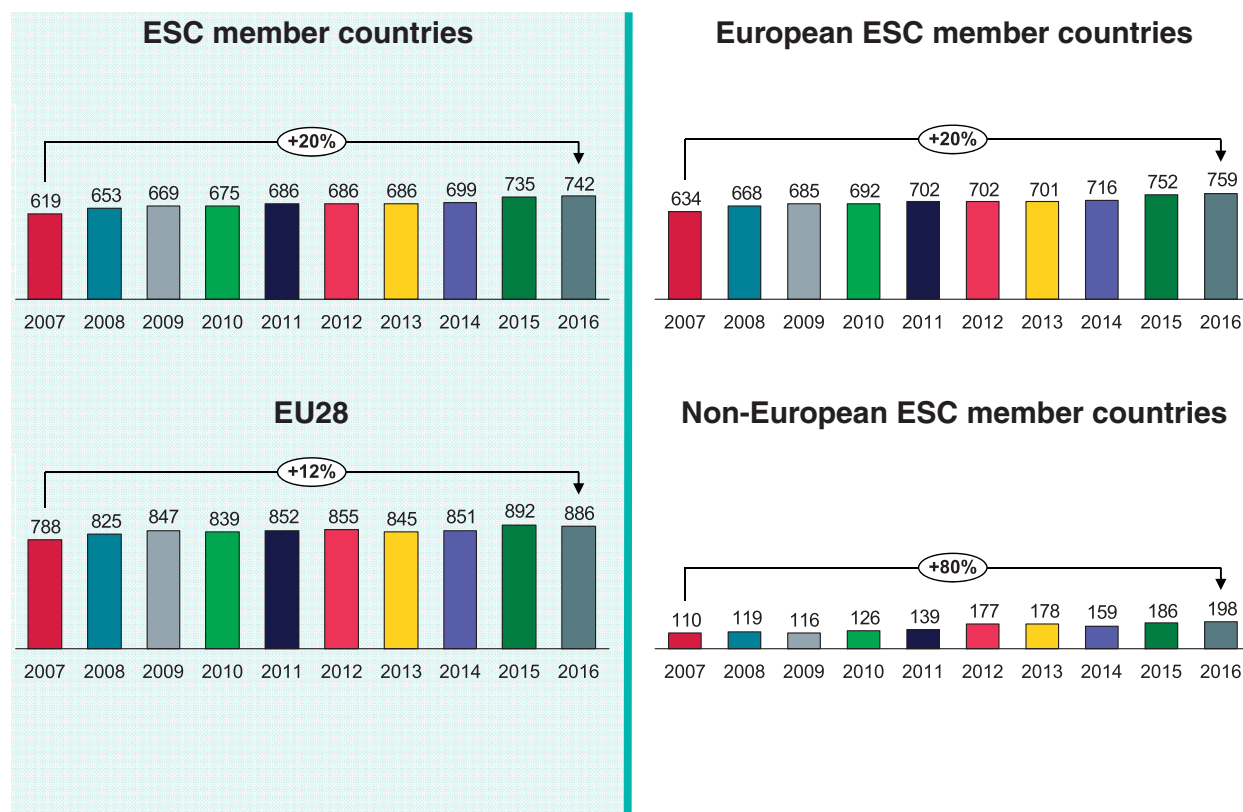


Figure 19 Pacemaker implantations per million inhabitants 2007-2016 in the European and non-European ESC member countries and comparison to the total ESC area and the 28 member countries of the European Union (EU28).

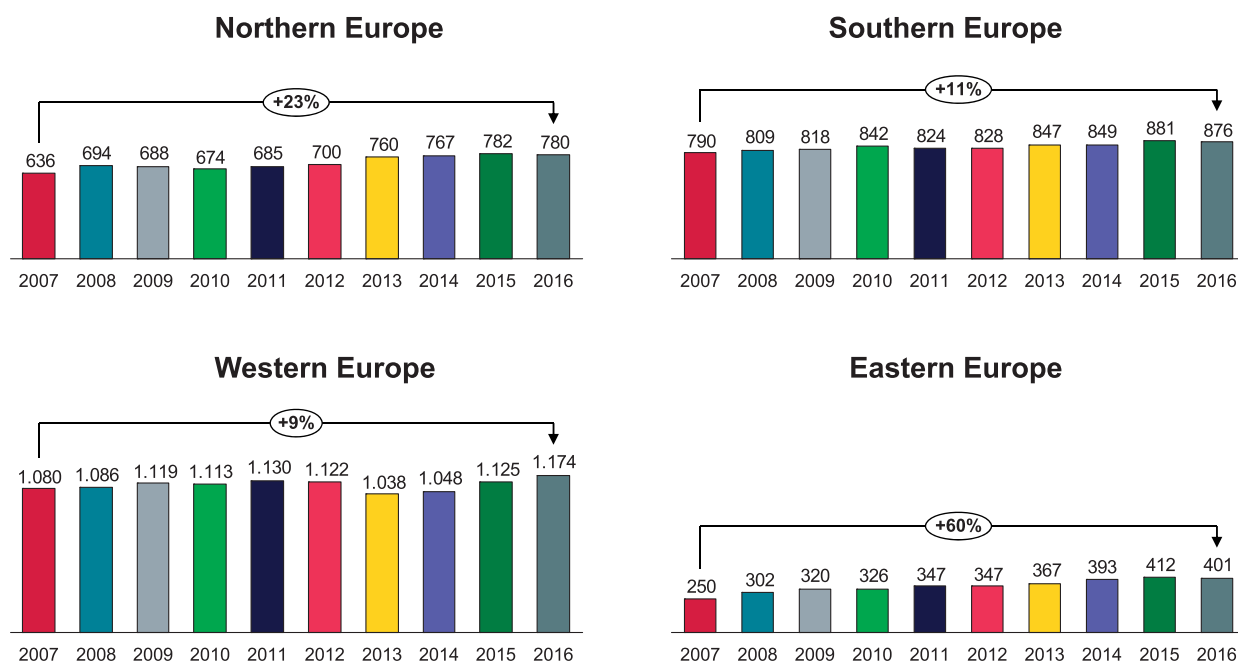


Figure 20 Pacemaker implantations per million inhabitants 2007-2016 in the four European ESC regions.

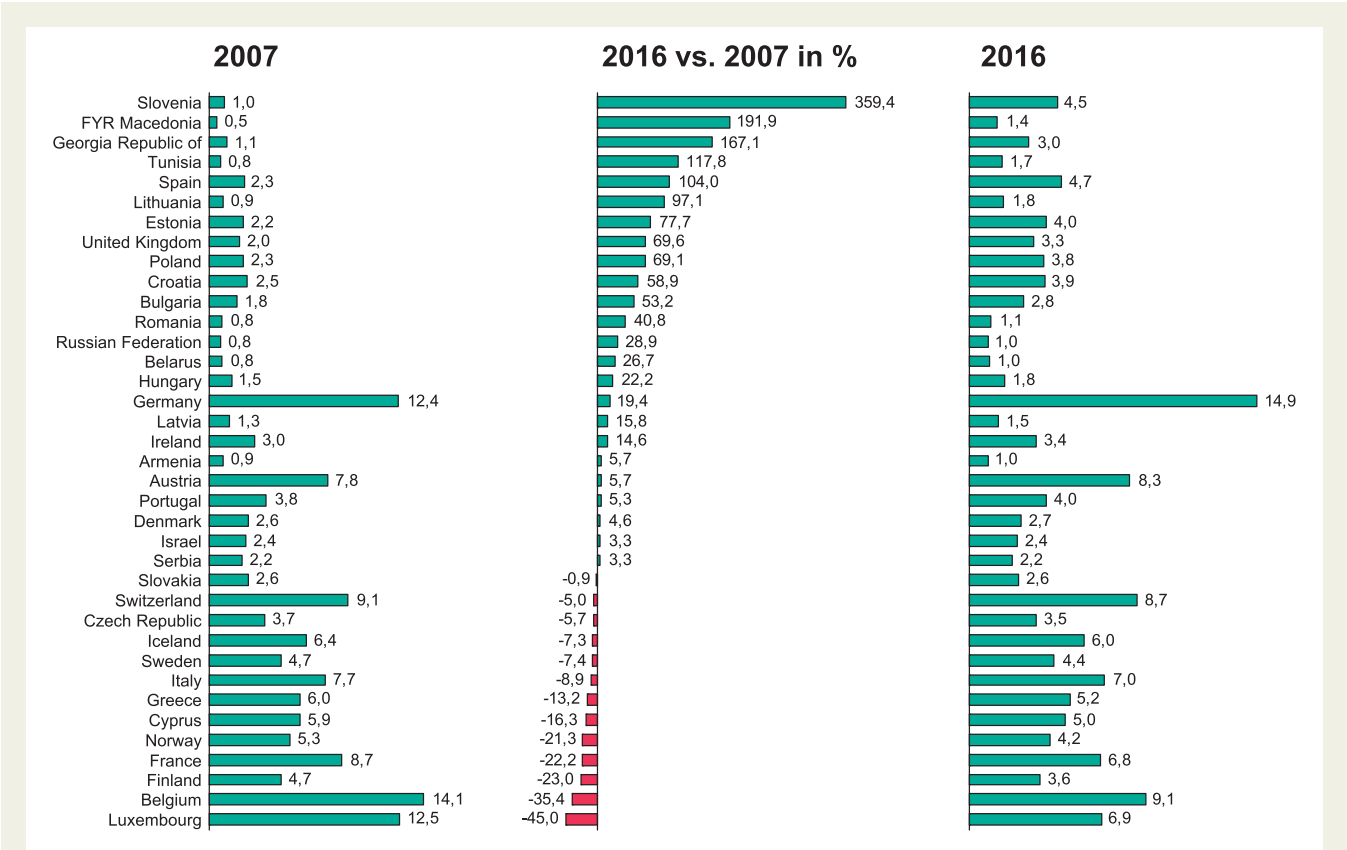


Figure 21 Change in the number of pacemaker implanting centres per million inhabitants from 2007 to 2016.

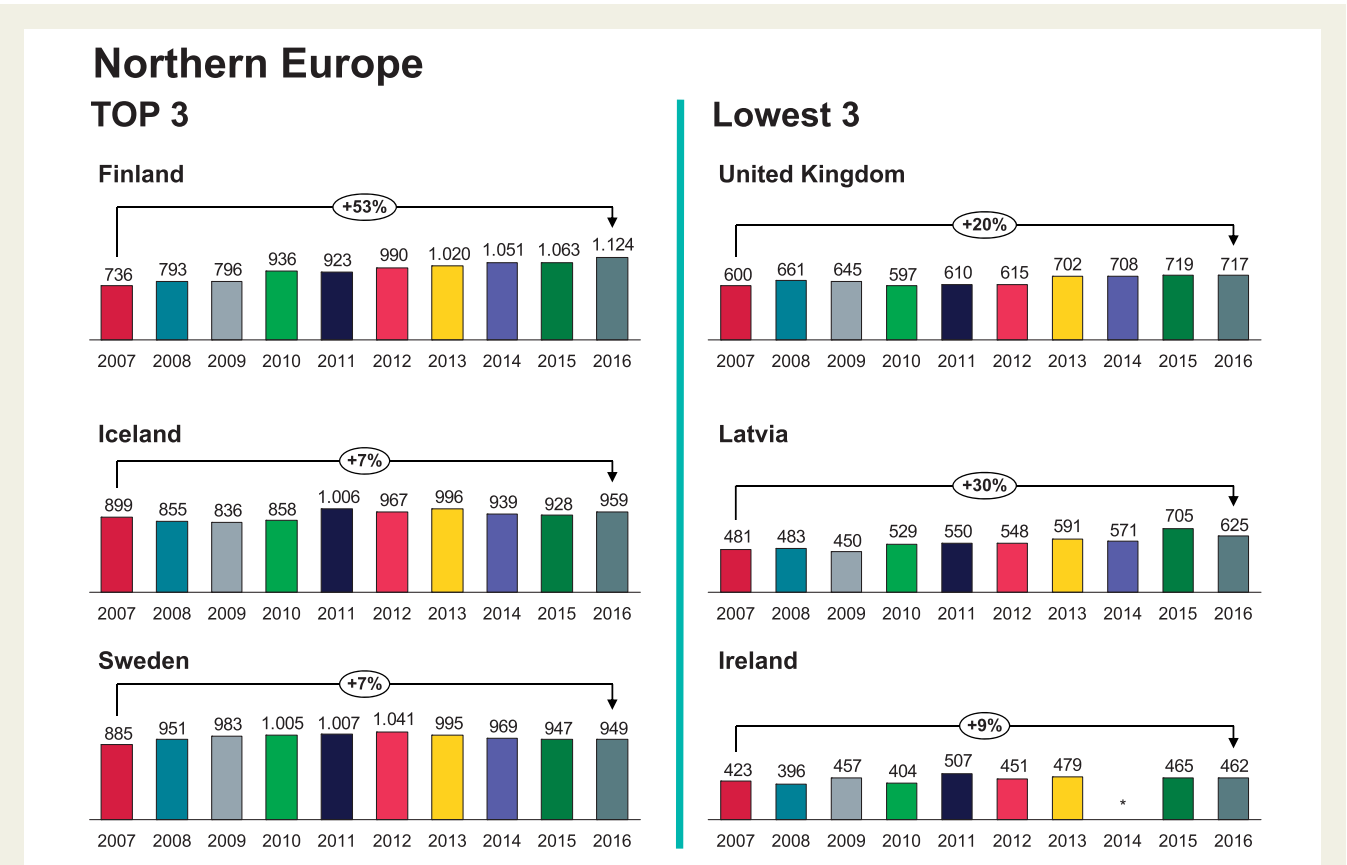
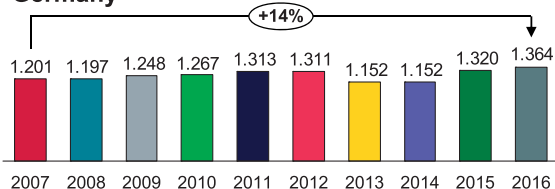


Figure 22 Pacemaker implantations per million inhabitants 2007-2016 in Northern Europe. *No data available.

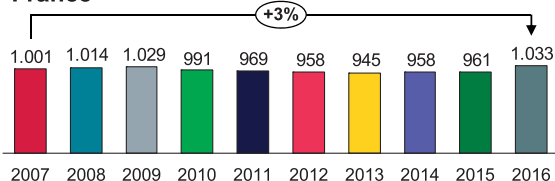
Western Europe

TOP 3

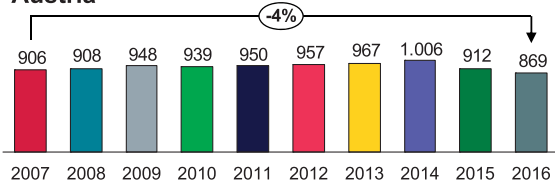
Germany



France

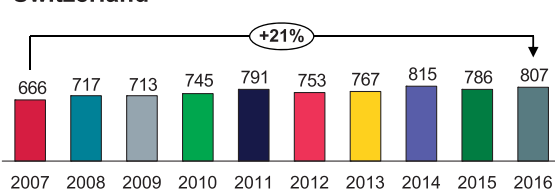


Austria

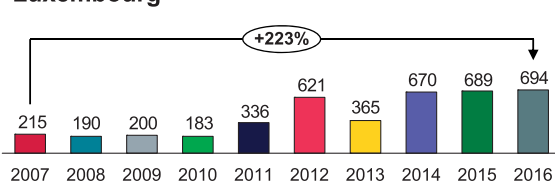


Lowest 3

Switzerland



Luxembourg



Netherlands

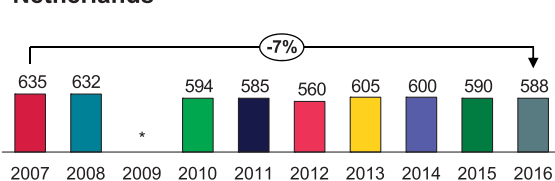
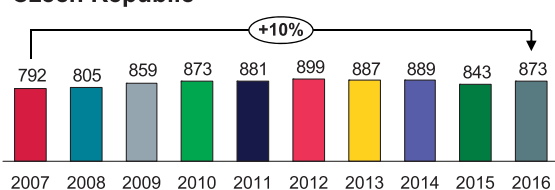


Figure 23 Pacemaker implantations per million inhabitants 2007-2016 in Western Europe. *No data available.

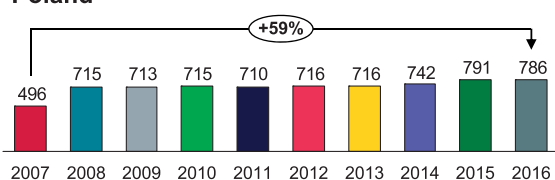
Eastern Europe

TOP 3

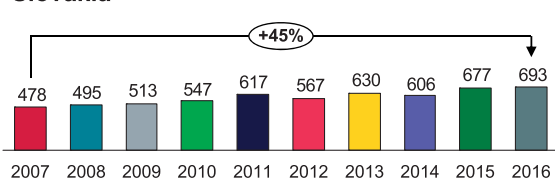
Czech Republic



Poland

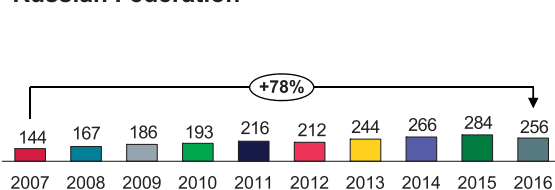


Slovakia

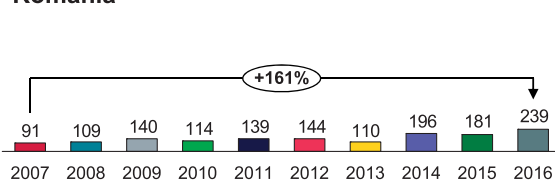


Lowest 3

Russian Federation



Romania



Ukraine

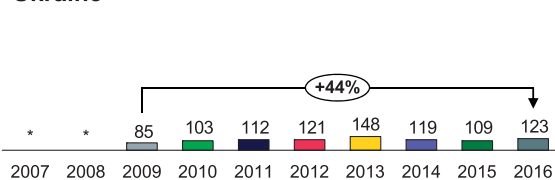
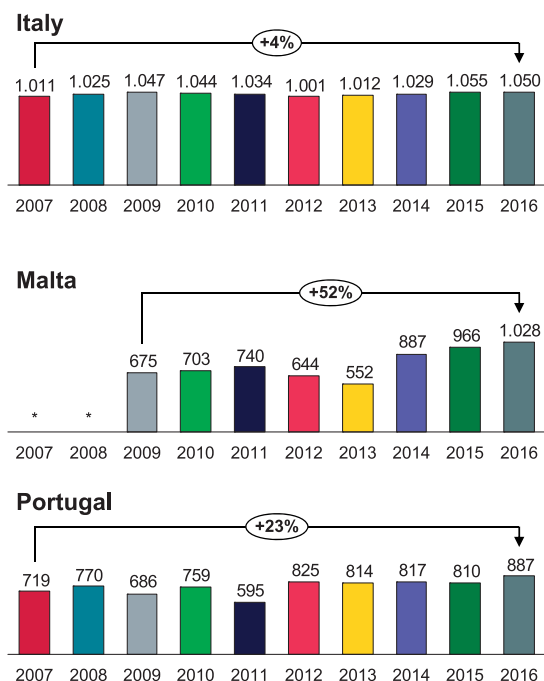


Figure 24 Pacemaker implantations per million inhabitants 2007-2016 in Eastern Europe. *No data available.

Southern Europe

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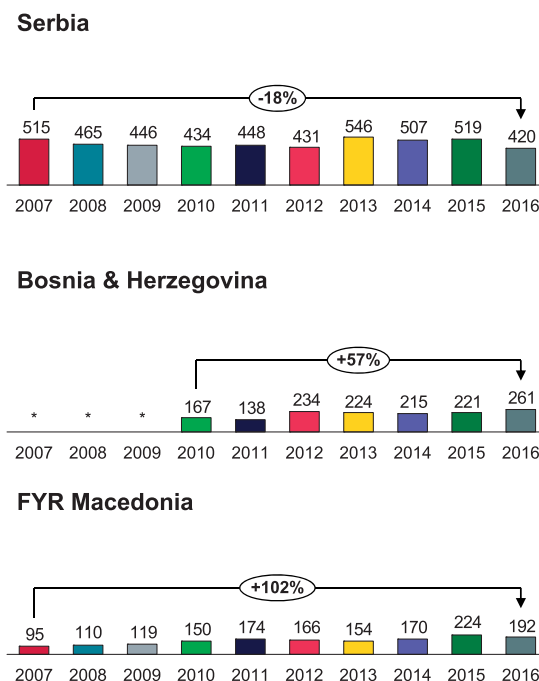
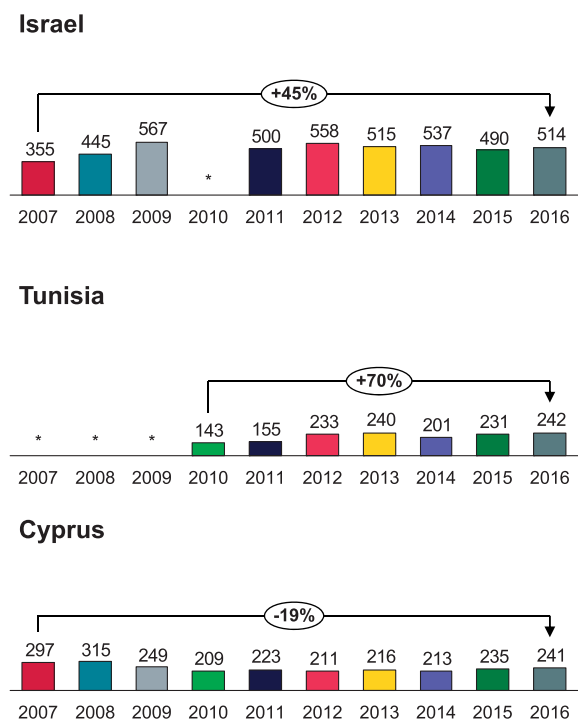


Figure 25 Pacemaker implantations per million inhabitants 2007-2016 in Southern Europe. *No data available.

Non-European ESC member countries

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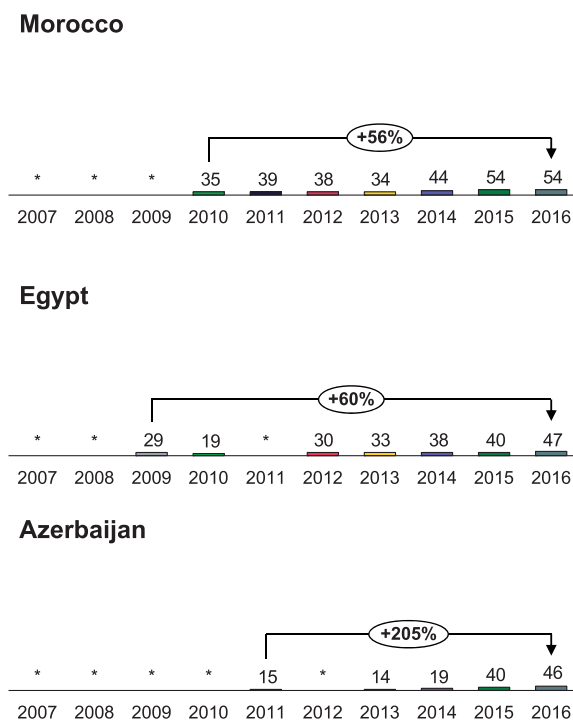


Figure 26 Pacemaker implantations per million inhabitants 2007-2016 in non-European ESC member countries. *No data available.

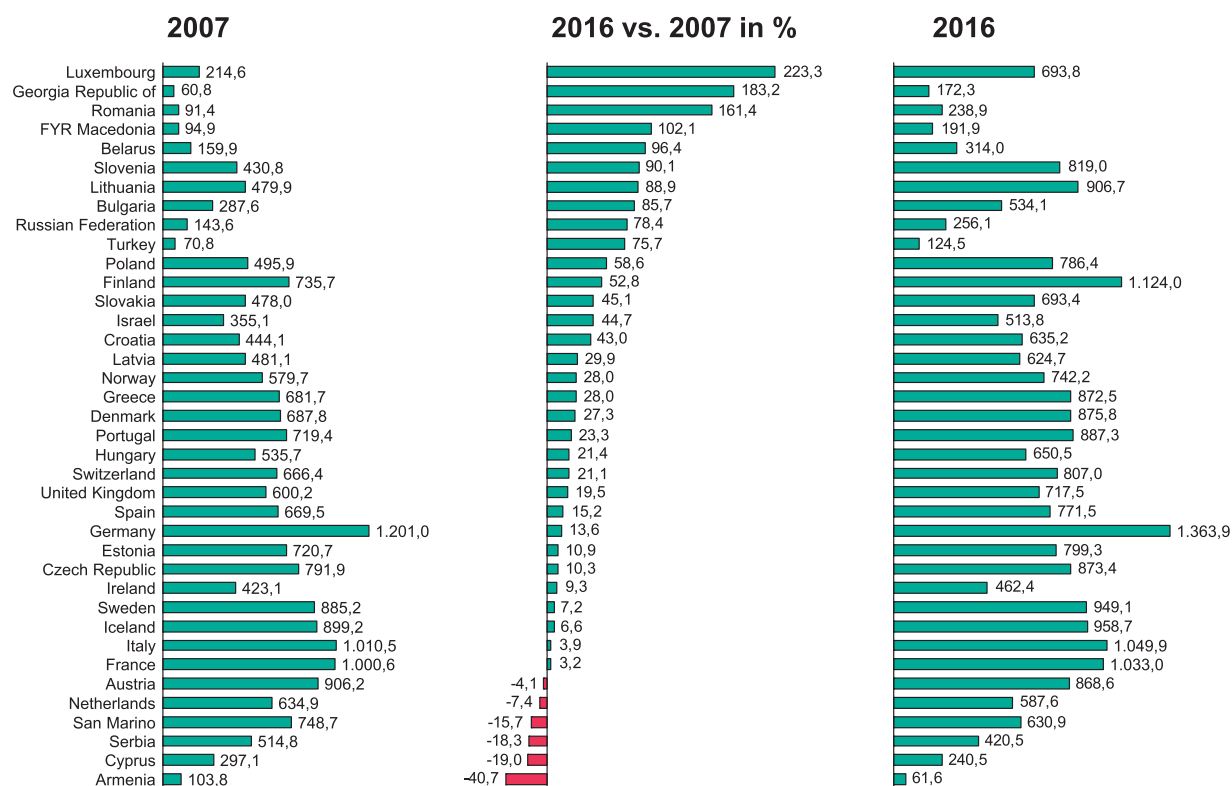


Figure 27 Change in the number of pacemaker implantations per million inhabitants from 2007 to 2016.

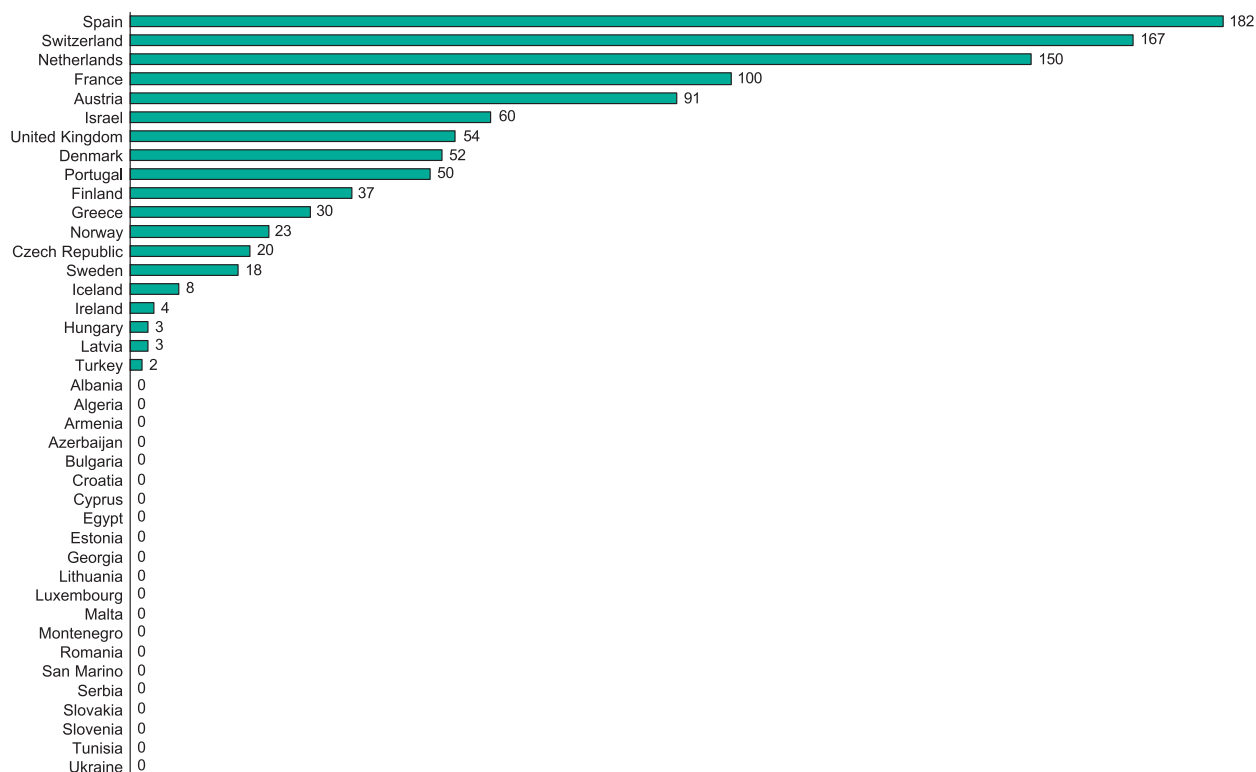


Figure 28 Number of leadless pacemaker implantations in 2016.

(ICD) implantations in 2016 are listed in *Table 8*. Lebanon, Libya, and Syria did not provide any data and Belgium provided data only on ICD implantation facilities. In 22 countries, a national registry for ICD implantations was in use. Most of the ICD implantations were performed by cardiologists, and the remaining implantations were performed by physicians having various other training backgrounds, mainly surgical. However, in Austria, Belarus, and Ukraine, the proportion of implanting cardiologists was less than 50% (*Table 5*).

ICD facilities and procedure rates

In 2016 a total of 105 730 ICDs were implanted in 2555 centres across the ESC area (*Table 8*). The mean number of centres implanting ICDs in the ESC area was slightly higher in 2016 than in 2015 (2.65 vs. 2.38 per million population). The country with the highest density of ICD implanting facilities was Germany (9.7 centres per million population) followed by Italy (6.4) and Switzerland 6.0) (*Figure 29*).

In the participating countries, the mean number of ICD implantations per million inhabitants was approximately the same in 2016 as in the previous year (101 vs. 102). As seen in *Figures 30* and *31* there were large variations in the ICD implantation rates in the ESC area. In Western Europe, the number of ICD implantations per million inhabitants (294) was almost twice as high as in any other ESC region. Among the participating countries the implantation rate was highest in Germany (334 per million inhabitants) followed by San Marino (300) and Finland (237). The lowest reported implantation rate was in Morocco and Ukraine (1 per million inhabitants), while Kyrgyzstan reported no ICD implantation in 2016.

The changes from 2015 to 2016 in the number of centres implanting ICDs are shown in *Table 9* and *Figure 32*, and the changes in the number of ICD implantations per million inhabitants during the same period are presented in *Table 10* and *Figure 33*. A comparison to the previous four years in each country is shown in *Table 8*. The ICD implantation rate continued to increase especially in the Eastern European and non-European ESC member countries (e.g., Romania, Latvia, Kazakhstan and Turkey), whereas in some countries with well-developed ICD programs (e.g., Germany, Spain and Norway) the implantation rate decreased slightly. In *Figures 34* and *35* these numbers are divided into *de novo* implantations and ICD generator replacements. The relationship between the mean annual ICD implantation rate per million inhabitants and the number of ICD implanting centres per million inhabitants in the ESC member countries and in the EU28 is shown in *Figure 36*.

Trends in ICD implantation activity over the past 10 years

The number of ICD implantations per million population over the past 10 years in the European and non-European ESC member countries and comparison with the total ESC area and the 28 member countries of the European Union (EU28) are shown in *Figure 37*. The corresponding numbers for the European ESC regions are presented in *Figure 38*. In the Eastern European (59) and non-European ESC member countries (54) ICD implantation rate was almost three times lower than in the Western ESC member countries (229).

However, the growth in the rate of ICD implantations per million population was highest in the Eastern European (228%) and Northern European (95%) countries. In the Southern European countries, the increase in the ICD implantation rate over the past 10 years was only 11%. Countries with the highest and lowest activities in each region and trends over the ten-year data collection period are shown in *Figures 39–43*. The most active countries in the five geographical ESC regions (after excluding San Marino) were Germany (334 ICD implantations per million inhabitants), Finland (237), Italy (234), Czech Republic (222), and Israel (126). The changes from 2007 to 2016 in the number of ICD implanting centres and ICD implantation for each participating country are shown in *Figure 44* and *Figure 45*, respectively. During the 10-year period, the rate of ICD implantation increased in all countries except for Switzerland, Italy, Armenia and San Marino.

Subcutaneous ICDs

The subcutaneous ICD (S-ICD) is a recently developed device for prevention of sudden cardiac death. It is implanted entirely under the skin with no intravascular leads. It is best suited for patients with no need for pacing and increased risk for transvenous lead complications (11).

This was the second year that data on S-ICD implantations was collected for the EHRA White Book. Only 43 countries (77%) provided data on the S-ICD implantations. A total of 2012 S-ICDs were implanted in 22 countries in 2016, which is about 90% more than in the previous year (1049). The most active country with regards to the S-ICD implantations was France with 820 implantations followed by the United Kingdom (310 implantations) and the Netherlands (300 implantations). No S-ICDs were implanted in 21 of the participating countries (*Figure 46*).

Cardiac resynchronisation therapy devices

General information

The 46 (82%) countries which submitted data on cardiac resynchronization therapy (CRT) for the EHRA White Book are listed in *Table 11*. Ten countries reported no data or only limited data on CRT therapy. The majority of CRT implantations were done by cardiologists, and the remaining implantations were performed by physicians having various other training backgrounds, mainly surgeons. However, in Belarus, Kazakhstan, Kyrgyzstan and Ukraine most of the CRT implantations were done by surgeons (*Table 5*).

CRT facilities and procedure rates

According to the White Book data 87 654 CRT devices were implanted in 2220 national centres across the ESC area in 2016. The number of CRT implanting centres per million inhabitants in the ESC member countries is shown in *Table 11* and *Figure 47*. The mean number of the CRT implanting centres was markedly higher in 2016 than in 2015 (2.41 vs. 1.68 centres per million inhabitants). Countries with the highest density of CRT implanting centres were Germany (9.3 per million population), Italy (6.1) and Austria (4.1). The density of

Table 8 Implantable cardioverter-defibrillator (ICD) implantation facilities and rates in 2016 and comparison with four previous years

Country	ISO code	National Registry for ICD implants	Number of ICD implanting centres 2016		ICD implantations 2016		Development potential - target number of ICD implantations		ICD implantations per million inhabitants					
			Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012 2013 2014 2015 2016					
Albania	AL	No	4	1.32	16	5	307	539	N/A	N/A	1	N/A	5	
Algeria	DZ	No	9	0.22	67	2	4070	7146	N/A	1	2	2	2	
Armenia	AM	No	3	0.98	37	12	308	542	11	9	8	7	12	
Austria	AT	Yes	38	4.36	1457	167	–	1546	145	158	166	161	167	
Azerbaijan	AZ	No	5	0.51	29	3	998	1752	N/A	1	2	2	3	
Belarus	BY	No	10	1.04	136	14	967	1698	12	16	18	14	14	
Belgium*	BE	Yes	23	2.02	N/A	N/A	N/A	N/A	210	163	154	135	N/A	
Bosnia & Herzegovina	BA	No	6	1.55	56	15	390	685	14	17	14	22	15	
Bulgaria	BG	Yes	10	1.40	73	10	722	1268	7	5	7	7	10	
Croatia	HR	No	14	3.25	412	96	436	766	26	35	39	87	96	
Cyprus	CY	No	5	4.15	80	66	122	214	46	52	62	63	66	
Czech Republic	CZ	Yes	19	1.78	2362	222	–	–	277	301	201	192	222	
Denmark	DK	Yes	6	1.07	1262	226	–	–	218	231	217	216	226	
Egypt	EG	No	N/A	N/A	278	3	9570	16800	2	2	3	3	3	
Estonia	EE	No	2	1.59	73	58	127	223	79	82	76	72	58	
Finland	FI	No	19	3.46	1303	237	–	–	166	194	220	219	237	
France	FR	No	164	2.45	8174	122	–	11861	106	114	114	118	122	
Georgia Republic of	GE	No	12	2.44	182	37	498	875	12	12	21	28	37	
Germany	DE	No	780	9.66	27000	334	–	–	326	336	295	358	334	
Greece	GR	Yes	24	2.23	1685	156	–	1912	87	97	100	110	156	
Hungary	HU	Yes	13	1.32	958	97	998	1752	85	95	96	100	97	
Iceland	IS	No	1	2.98	50	149	–	60	134	171	186	178	149	
Ireland	IE	No	17	3.43	761	154	–	879	144	153	N/A	151	154	
Israel	IL	Yes	20	2.45	1026	126	–	1451	137	166	215	162	126	
Italy	IT	Yes	396	6.39	14500	234	–	–	196	204	223	238	234	
Kazakhstan	KZ	No	25	1.36	791	43	1856	3258	7	12	22	29	43	
Kosovo	XK	N/A	1	0.53	3	2	190	334	N/A	N/A	2	6	2	
Kyrgyzstan	KGZ	No	3	0.52	0	0	579	1016	N/A	N/A	0	N/A	0	
Latvia	LV	Yes	3	1.53	150	76	199	349	32	40	35	45	76	
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	73	73	N/A	N/A	
Libya*	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	1.05	149	52	289	507	42	35	38	43	52	

Continued

Table 8 Continued

Country	ISO code	National Registry for ICD implants	Number of ICD implanting centres 2016		ICD implantations 2016		Development potential - target number of ICD implantations		ICD implantations per million inhabitants				
			Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012	2013	2014	2015	2016
Luxembourg	LU	No	1	1.72	94	161	—	103	149	138	119	114	161
FYR Macedonia	MK	No	3	1.43	21	10	212	373	7	6	5	14	10
Malta	MT	No	1	2.41	42	101	—	74	132	163	87	85	101
Moldova	MD	Yes	1	0.28	8	2	355	623	N/A	0	N/A	N/A	2
Montenegro	ME	No	1	1.55	59	92	65	114	44	58	63	82	92
Morocco	MA	N/A	5	0.15	36	1	3402	5973	1	1	1	2	1
Netherlands	NL	Yes	29	1.70	3500	206	—	—	160	244	212	207	206
Norway	NO	Yes	11	2.09	915	174	—	934	199	214	220	233	174
Poland	PL	No	133	3.45	8467	220	—	—	182	234	219	221	220
Portugal	PT	No	32	2.95	1141	105	—	1923	92	105	116	113	105
Romania	RO	No	15	0.69	535	25	2184	3833	8	9	15	14	25
Russian Federation	RU	Yes	49	0.34	1418	10	14391	25264	11	13	12	17	10
San Marino	SM	Yes	0	0.00	10	300	—	—	404	616	550	242	300
Serbia	RS	Yes	13	1.82	586	82	722	1268	38	62	63	61	82
Slovakia	SK	Yes	4	0.73	615	113	—	966	105	108	120	123	113
Slovenia	SI	Yes	2	1.01	315	159	—	351	61	71	88	115	159
Spain	ES	Yes	180	3.71	5656	116	—	8618	112	120	125	133	116
Sweden	SE	Yes	30	3.04	1375	139	—	1753	193	198	216	139	139
Switzerland	CH	Yes	49	5.99	1121	137	—	1452	195	202	218	224	137
Syria*	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	TN	No	8	0.72	201	18	1126	1976	9	11	13	13	18
Turkey	TR	No	220	3	9254	115	—	14246	N/A	N/A	81	81	115
Ukraine	UA	No	8	0.18	49	1	4469	7846	1	2	1	1	1
United Kingdom	GB	Yes	125	1.94	7242	112	—	11434	91	92	102	105	112
Total ESC member countries	56		2555	2.65	105730	101			96	105	103	110	107

*These 4 countries did not submit any data on ICD implantations for the EHRA White Book 2017.

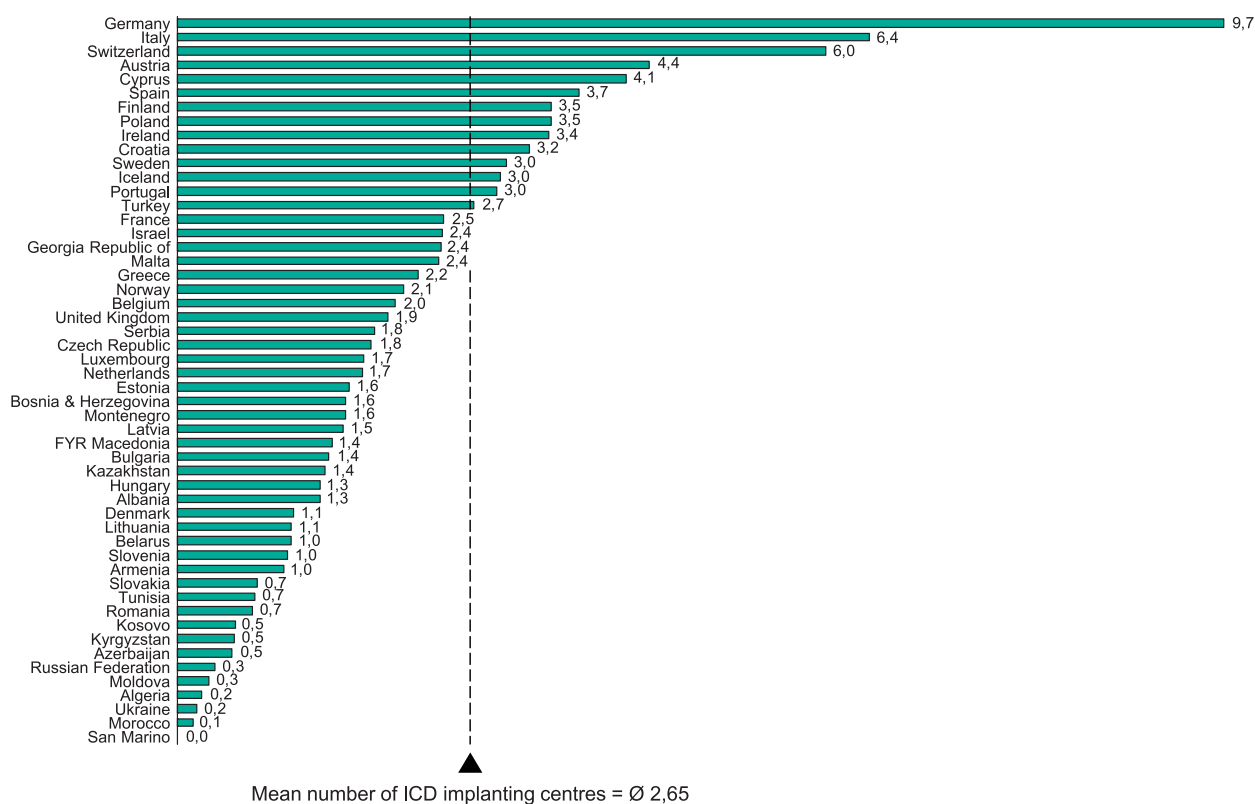


Figure 29 Implantable cardioverter-defibrillator (ICD) implanting centres per million inhabitants in 2016. The mean number of implantation centres is weighted by population.

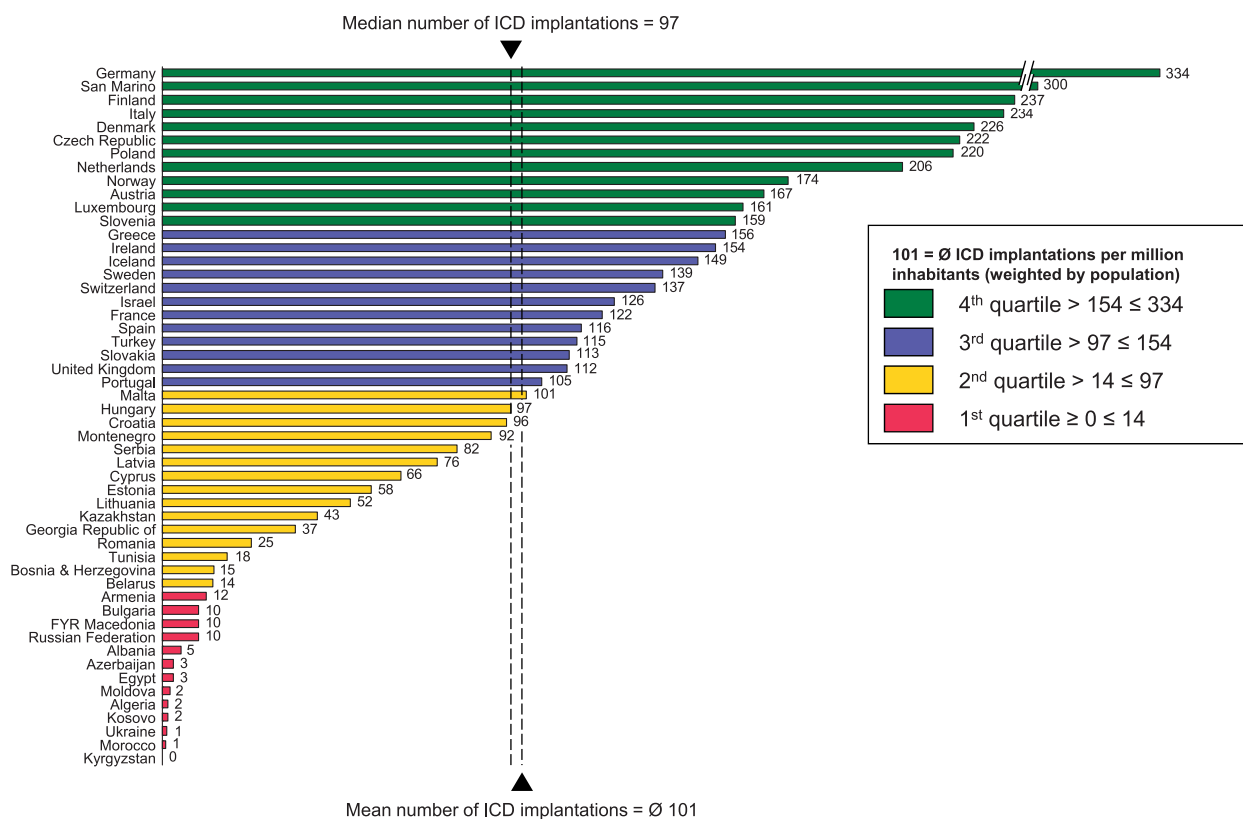


Figure 30 Implantable cardioverter-defibrillator implantations per million inhabitants in 2016. Mean number of implantations is weighted by population.

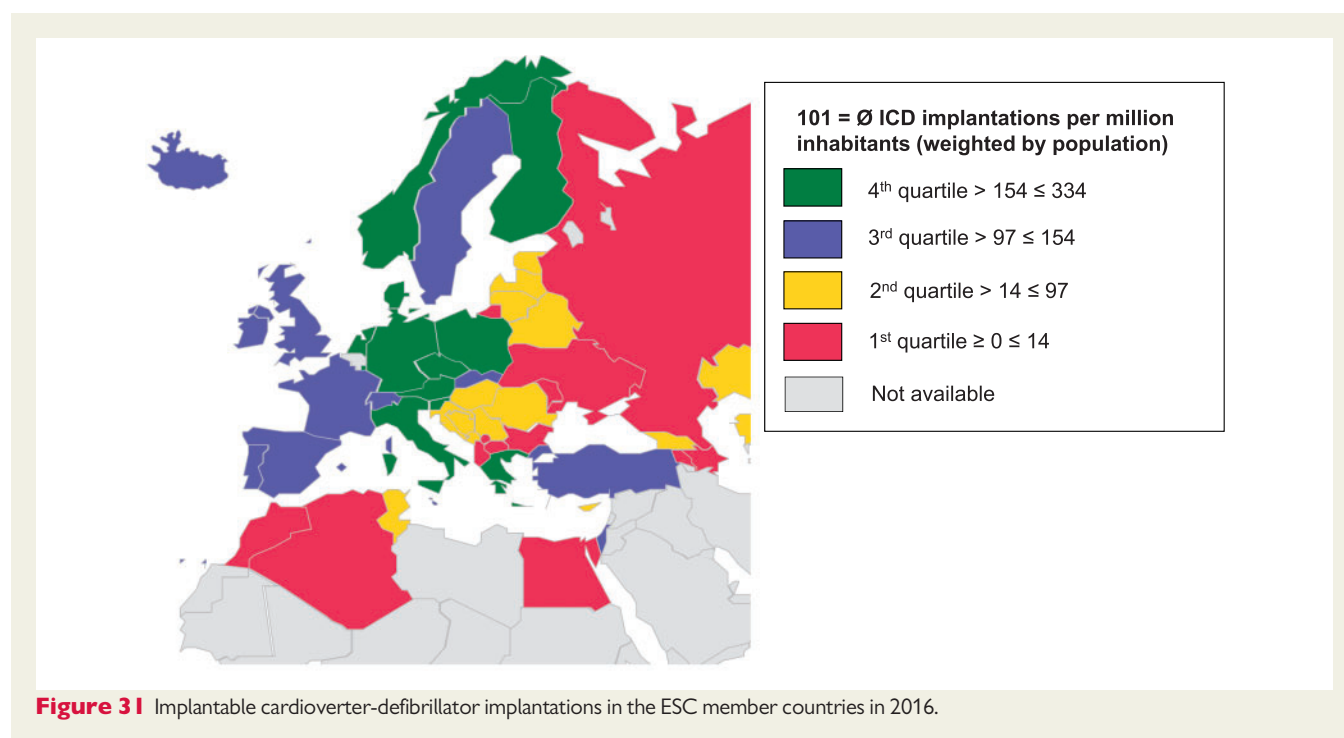


Figure 31 Implantable cardioverter-defibrillator implantations in the ESC member countries in 2016.

the CRT implanting centres was less than one per million inhabitants in 16 countries. In these countries except for Denmark the implantation rate was also low. The changes in the number of implanting centres from 2015 to 2016 are shown in Table 12 and Figure 48.

CRT implantation rates with the ESC member countries divided into quartiles are shown as a bar graph in Figure 49 and as a geographical map in Figure 50. There was a slight increase in both the absolute number of implants (87 654 vs. 84 205) and the rate of implants per million inhabitants (85 vs. 82) compared to 2015. Like in the past, there were large variations in the CRT implantation rates within the ESC area. In 2016 the CRT implantation rate per million inhabitants was 267 in Germany, while in ten countries it was less than 10. Figures 51 and 52 show the corresponding numbers for CRT pacemakers (CRT-P) and CRT defibrillators (CRT-D). The ratio of CRT-D/CRT-P implants was 2.62 with a mean of 62.7 CRT-Ds and 23.9 CRT-Ps per million inhabitants. Both the overall CRT implantation rate (267 per million inhabitants) and CRT-D implantation rate (221) were highest in Germany, while the CRT-P implantation rate was highest in Denmark (89). The changes from 2015 to 2016 in the number of total CRT, CRT-P and CRT-D implantations are shown in Table 13 and Figures 53 to 55 respectively. 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 56.

Trends in CRT implantation activity over the past 10 years

The number of CRT implantations in the European and non-European ESC member countries from 2007 to 2016 and

comparison with the total ESC area and the 28 member countries of the European Union (EU28) are shown in Figure 57. The corresponding numbers for the European ESC regions are presented in Figure 58. The changes in the number of implanting centres and CRT implantations per million inhabitants in each participating country from 2007 to 2016 are shown in Figure 59 and Figure 60, respectively. During these ten years, the growth in CRT implantation rate per million population was highest in the Eastern European (235%) followed by the Northern (157%) and the non-European ESC member countries (146%). Countries with the highest and lowest activities in each region and trends over the ten-year period are shown in Figures 61-65. The growth in the CRT implantation rate exceeded 100% in most countries, and only in Armenia the rate of the implantations was lower in 2016 than in 2007. The changes in the number of CRT-P and CRT-D implantations from 2007 to 2016 in each participating country are shown in Figure 66 and Figure 67, respectively.

Lead extraction

General information

This was the fifth time that information on lead extractions (LE) was included in the EHRA White Book. Over the years the number of countries submitting data on LE procedures has been steadily increasing. This year 38 countries (79% of the ESC member countries) provided data for lead extractions (LE). Six countries submitted incomplete data and 12 countries did not submit any data on LE (Table 14). In most countries, the primary operator in LE procedures was a cardiologist.

Table 9 Changes in the number of ICD implantation centres in year 2015 vs. 2016

Country	ISO code	Number of ICD implanting centres 2015		Number of ICD implanting centres 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania	AL	N/A	N/A	4	1.32	N/A
Algeria	DZ	9	0.23	9	0.22	-1.8%
Armenia	AM	3	0.98	3	0.98	0.2%
Austria	AT	21	2.42	38	4.36	80.0%
Azerbaijan	AZ	7	0.72	5	0.51	-29.2%
Belarus	BY	10	1.05	10	1.04	-0.8%
Belgium	BE	23	2.03	23	2.02	-0.7%
Bosnia & Herzegovina	BA	6	1.55	6	1.55	0.1%
Bulgaria	BG	10	1.39	10	1.40	0.6%
Croatia	HR	11	2.46	14	3.25	31.7%
Cyprus	CY	4	3.36	5	4.15	23.3%
Czech Republic	CZ	18	1.69	19	1.78	5.4%
Denmark	DK	6	1.07	6	1.07	-0.2%
Egypt	EG	17	0.19	N/A	N/A	N/A
Estonia	EE	2	1.58	2	1.59	0.5%
Finland	FI	18	3.29	19	3.46	5.1%
France	FR	161	2.42	164	2.45	1.4%
Georgia Republic of	GE	12	2.43	12	2.44	0.1%
Germany	DE	745	9.21	780	9.66	4.9%
Greece	GR	24	2.23	24	2.23	0.0%
Hungary	HU	13	1.31	13	1.32	0.2%
Iceland	IS	1	3.01	1	2.98	-1.2%
Ireland	IE	17	3.47	17	3.43	-1.2%
Israel	IL	20	2.48	20	2.45	-1.5%
Italy	IT	396	6.40	396	6.39	-0.2%
Kazakhstan	KZ	19	1.05	25	1.36	30.1%
Kosovo	XK	1	0.53	1	0.53	-0.6%
Kyrgyzstan	KGZ	2	0.34	3	0.52	56.0%
Latvia	LV	3	1.51	3	1.53	1.1%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	3	1.04	3	1.05	1.1%
Luxembourg	LU	1	1.75	1	1.72	-2.1%
FYR Macedonia	MK	3	1.43	3	1.43	-0.2%
Malta	MT	1	2.42	1	2.41	-0.3%
Moldova	MD	N/A	N/A	1	0.28	N/A
Montenegro	ME	1	1.55	1	0.28	-81.6%
Morocco	MA	6	0.18	5	0.28	58.2%
Netherlands	NL	29	1.71	29	0.28	-83.4%
Norway	NO	11	2.11	11	0.28	-86.5%
Poland	PL	122	3.16	133	0.28	-91.0%
Portugal	PT	29	2.68	32	0.28	-89.4%
Romania	RO	16	0.74	15	0.28	-61.4%
Russian Federation	RU	48	0.34	49	0.28	-15.5%
San Marino	SM	1	30.28	0	0.28	-99.1%
Serbia	RS	11	1.53	13	0.28	-81.4%
Slovakia	SK	4	0.74	4	0.28	-61.4%
Slovenia	SI	3	1.51	2	0.28	-81.2%
Spain	ES	180	3.74	180	0.28	-92.4%
Sweden	SE	30	3.06	30	0.28	-90.7%
Switzerland	CH	49	6.03	49	0.28	-95.3%
Syria*	SY	N/A	N/A	N/A	0.28	N/A
Tunisia	TN	N/A	N/A	8	0.28	N/A
Turkey	TR	n/a	N/A	220	0.28	N/A
Ukraine	UA	14	0.32	8	0.28	-9.6%
United Kingdom	GB	125	1.95	125	0.28	-85.4%
Total ESC member countries		2 266	2.20	2 555	2.65	20.6%

*These 3 countries did not submit data for the EHRA White Book 2017.

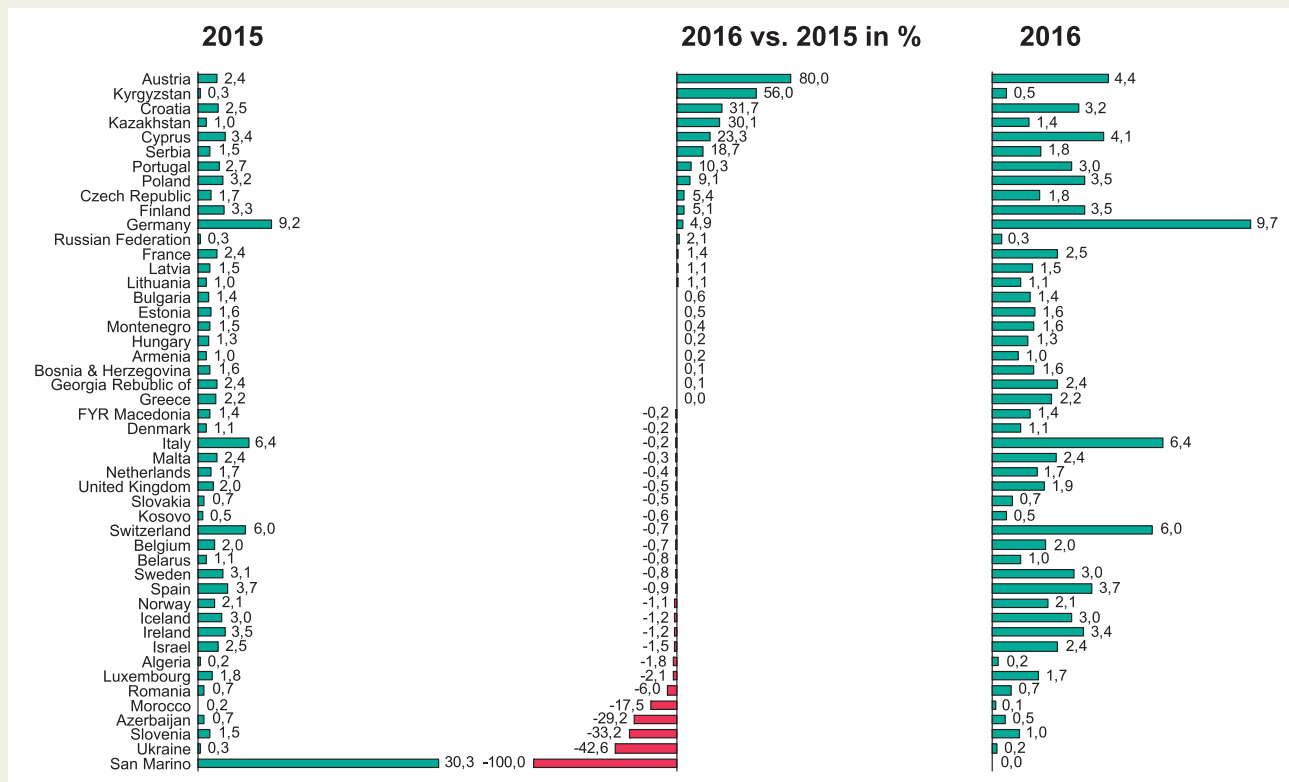


Figure 32 Change in the number of ICD implanting centres per million inhabitants from 2015 to 2016.

Lead extraction facilities and procedure rates

A total of 9374 LE procedures were performed in 361 LE centres in 2016 (Table 14). The mean number of centres performing LE was 0.53 per million inhabitants (Figure 68), and the mean number of LE was 14.3 per million (Figure 69). Assuming that each centre treated an equivalent number of patients it can be approximated that in many centres the number of LE was lower than the recommended annual rate of at least 15 extractions per million inhabitants (12–14). The rate of LE was highest in France (41.9 per million population) followed by Norway (38.0) and Austria (34.4). 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

This year 48 countries (86% of the ESC member countries) submitted complete data and eight countries did not provide any data on catheter ablation facilities and procedures for the EHRA White Book. A major issue in 2016 was that no ablation data was received from Belgium, which is known to have well developed ablation programs. A national registry for catheter ablations was available in 16 countries (Table 15).

Catheter ablation facilities and procedure rates

In 2016 a total of 296798 catheter ablations including AF and VT ablations were performed in 1241 national centres across the ESC area (Table 15). The mean number of ablation centres in the ESC area was slightly lower in 2016 than in 2015 (1.26 vs. 1.34 per million population). Countries with the highest density of catheter ablation centres were Germany (3.6 per million in habitants), Cyprus (3.3), Switzerland (3.1) and Iceland (3.0), and those with the lowest density were Morocco and Algeria (0.1 in both) and San Marino with no ablation centres (Table 15 and Figure 70). The changes in the number of the ablation centres from 2015 to 2016 are summarised in Table 16 and in Figure 71.

The number of catheter ablations per million population in the participating ESC member countries is shown in Figure 72. The mean number of catheter ablation was slightly higher in 2016 than in the previous year (288 vs. 259 per million population). As seen in Figures 72 and 73 there was marked heterogeneity in the catheter ablation activities in the ESC area. As in previous years, most countries in the top quartile were from Western and Northern Europe, while the non-European ESC member countries had low ablation activity and they were mostly found in the lowest (1st) quartile. In the Eastern European countries, the ablation activity spanned over all four quartiles. The most active countries were Germany, Switzerland and Denmark with 999, 784 and, 737 catheter ablations per million population, respectively. In San Marino, no ablations were performed.

Table 10 Changes in the number of implantable cardioverter defibrillator (ICD) implantations from 2015 to 2016

Country	ISO code	Number of ICD implants 2015		Number of ICD implants 2016		Change %
		Absolute number	Per millio inhabitants	Absolute number	Per million inhabitants	
Albania	AL	N/A	N/A	16	5.27	N/A
Algeria	DZ	91	2.30	67	1.66	-27.7%
Armenia	AM	21	6.87	37	12.13	76.5%
Austria	AT	1 393	160.75	1 457	167.25	4.0%
Azerbaijan	AZ	21	2.15	29	2.94	36.8%
Belarus	BY	133	14.00	136	14.21	1.5%
Belgium*	BE	1 531	135.20	N/A	N/A	N/A
Bosnia & Herzegovina	BA	87	22.50	56	14.50	-35.5%
Bulgaria	BG	51	7.10	73	10.22	44.0%
Croatia	HR	388	86.90	412	95.51	9.9%
Cyprus	CY	75	63.07	80	66.36	5.2%
Czech Republic	CZ	2 039	191.55	2 362	221.56	15.7%
Denmark	DK	1 208	216.43	1 262	225.61	4.2%
Egypt	EG	253	2.86	278	2.94	2.7%
Estonia	EE	91	71.91	73	58.00	-19.3%
Finland	FI	1 198	218.74	1 303	236.99	8.3%
France	FR	7 825	117.57	8 174	122.30	4.0%
Georgia Republic of	GE	140	28.39	182	36.93	30.1%
Germany	DE	28 914	357.61	27 000	334.48	-6.5%
Greece	GR	1 188	110.25	1 685	156.41	41.9%
Hungary	HU	986	99.62	958	97.01	-2.6%
Iceland	IS	59	177.75	50	148.86	-16.3%
Ireland	IE	740	151.26	761	153.66	1.6%
Israel	IL	1 300	161.50	1 026	125.51	-22.3%
Italy	IT	14 709	237.80	14 500	233.84	-1.7%
Kazakhstan	KZ	527	29.02	791	43.08	48.4%
Kosovo	XK	12	6.41	3	1.59	-75.2%
Kyrgyzstan	KGZ	N/A	N/A	0	0.00	N/A
Latvia	LV	90	45.30	150	76.31	68.4%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	123	42.64	149	52.20	22.4%
Luxembourg	LU	65	113.98	94	161.43	41.6%
FYR Macedonia	MK	29	13.84	21	10.00	-27.7%
Malta	MT	35	84.55	42	101.16	19.6%
Moldova	MD	N/A	N/A	8	2.28	N/A
Montenegro	ME	53	81.91	59	91.53	11.8%
Morocco	MA	57	1.71	36	1.07	-37.5%
Netherlands	NL	3 500	206.52	3 500	205.68	-0.4%
Norway	NO	1 214	233.12	915	173.78	-25.5%
Poland	PL	8 526	221.10	8 467	219.79	-0.6%
Portugal	PT	1 224	113.07	1 141	105.32	-6.9%
Romania	RO	300	13.85	535	24.77	78.9%
Russian Federation	RU	2 401	16.86	1 418	9.96	-40.9%
San Marino	SM	8	242.28	10	300.44	24.0%
Serbia	RS	437	60.89	586	82.03	34.7%
Slovakia	SK	665	122.79	615	112.93	-8.0%
Slovenia	SI	228	114.95	315	159.25	38.5%
Spain	ES	6 406	133.05	5 656	116.47	-12.5%
Sweden	SE	1 358	138.55	1 375	139.16	0.4%
Switzerland	CH	1 822	224.33	1 121	137.05	-38.9%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	143	12.96	201	18.05	39.3%
Turkey	TR	6 381	81.04	9 254	115.28	42.3%
Ukraine	UA	52	1.17	49	1.11	-5.3%
United Kingdom	GB	6 701	104.56	7 242	112.40	7.5%
Total ESC member countries		106 798	103	105 730	101	-2.1%

*These 4 countries did not submit data for ICD implantation the EHRA White Book 2017

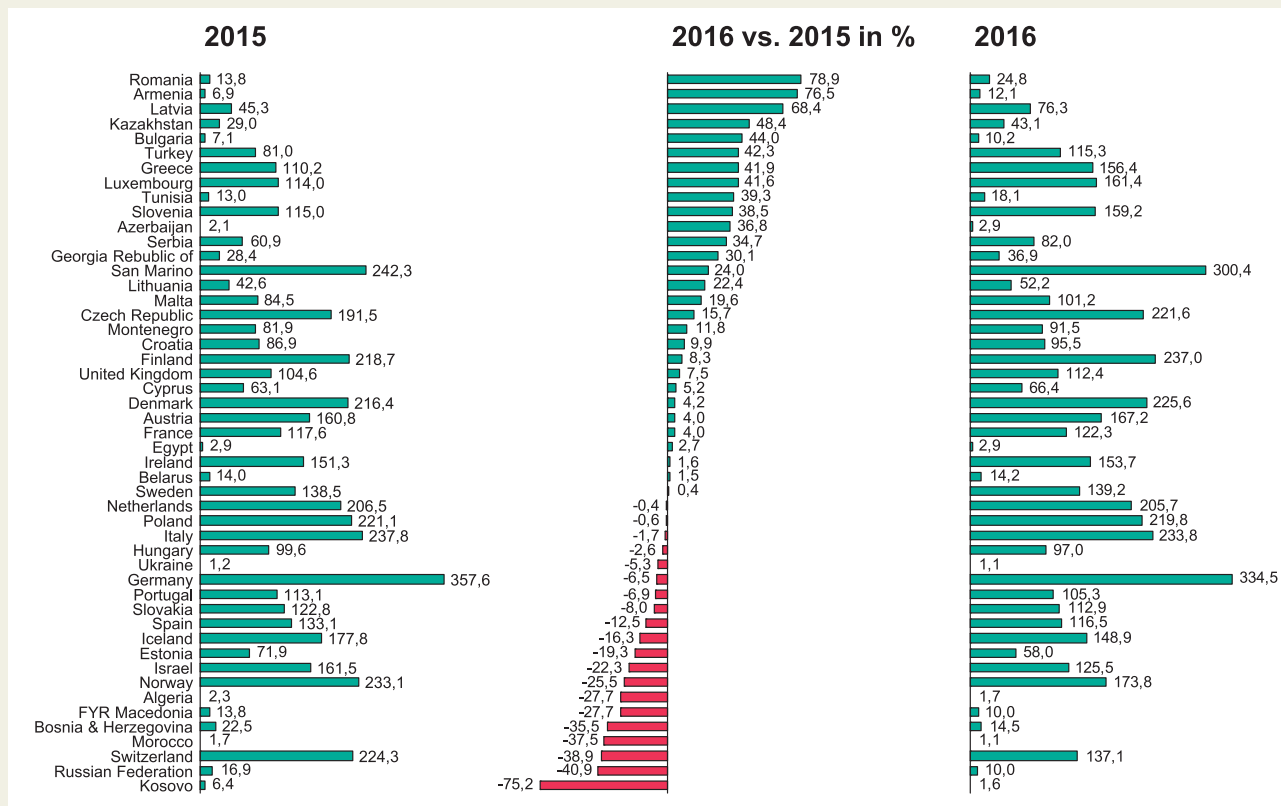


Figure 33 Change in the number of ICD implantations per million inhabitants from 2015 to 2016.

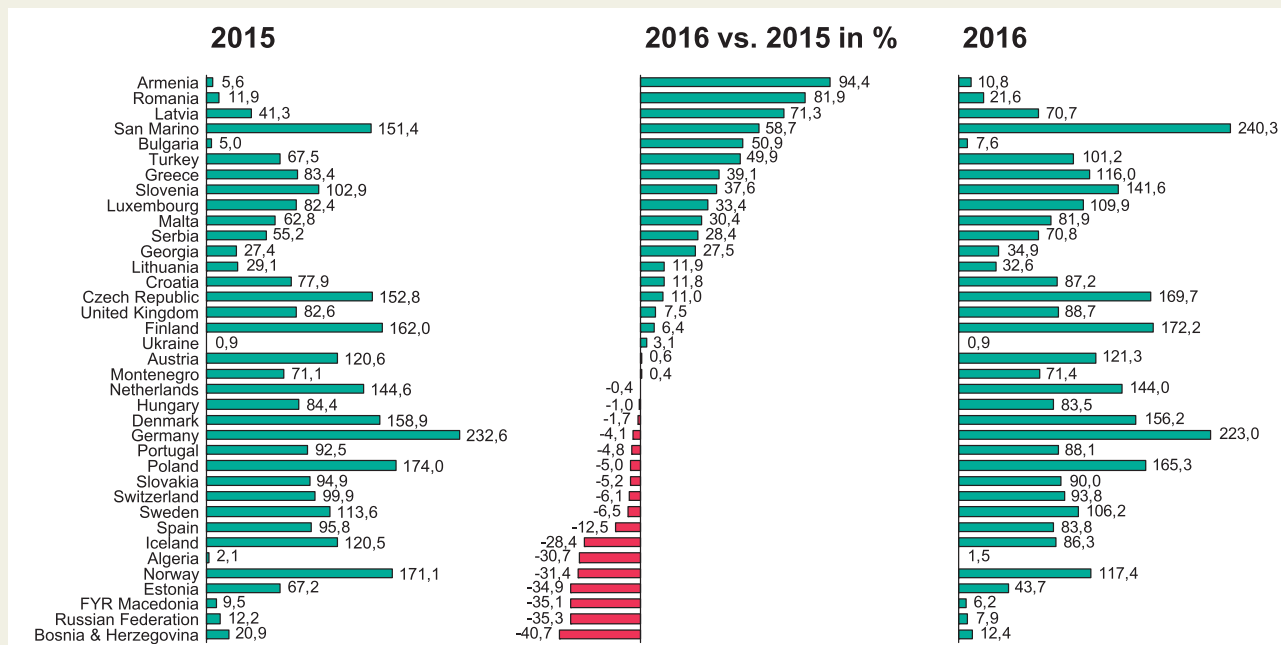


Figure 34 Change in the number of new ICD implantations per million inhabitants from 2015 to 2016.

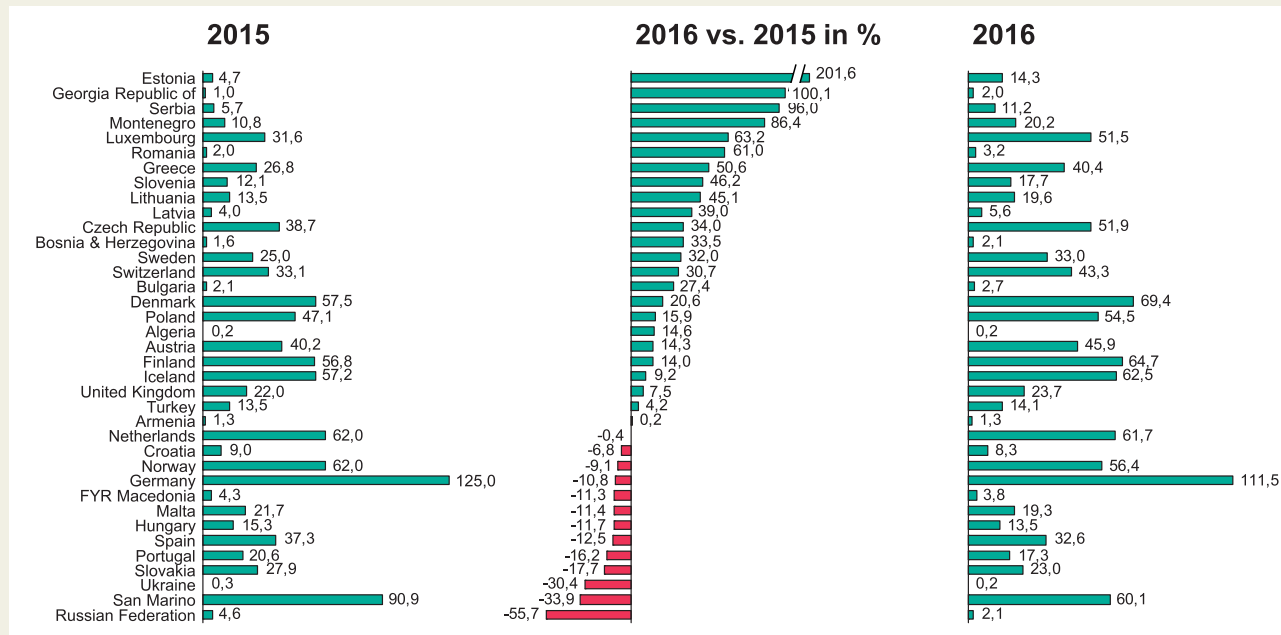


Figure 35 Change in the number of ICD replacements per million inhabitants from 2015 to 2016.

ICD implantations per million inhabitants

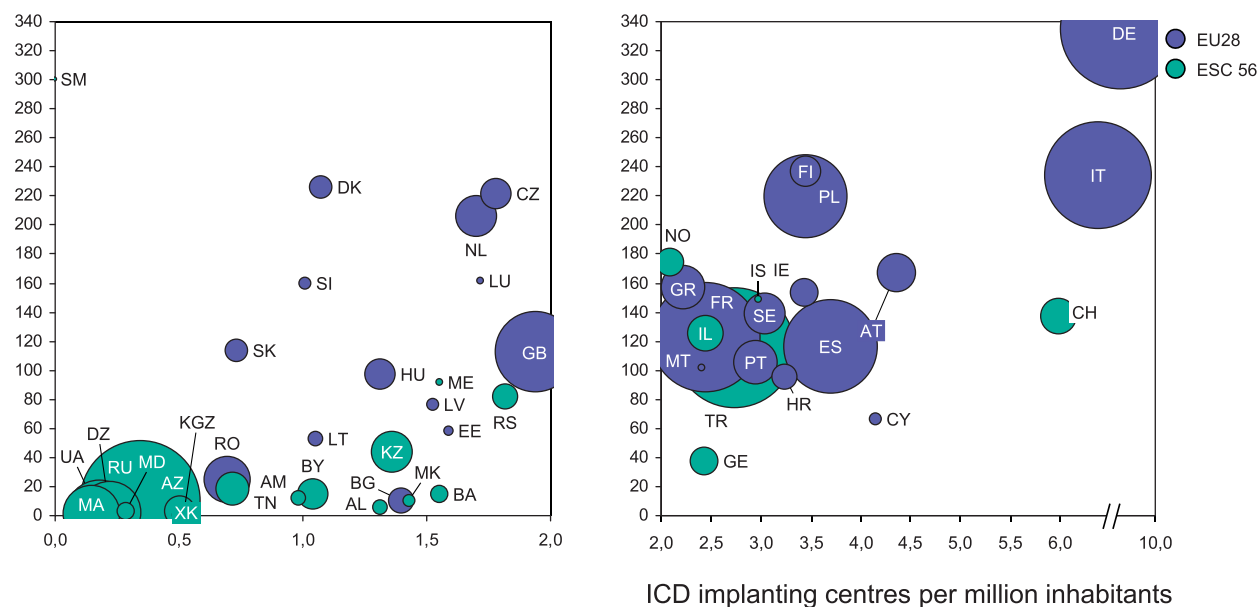


Figure 36 Implantable cardioverter defibrillator implantation centres and rates in the ESC and European Union (EU28) member countries in 2016. Bubble size is related to population in the country. The ISO codes of the countries are explained in Table 1.

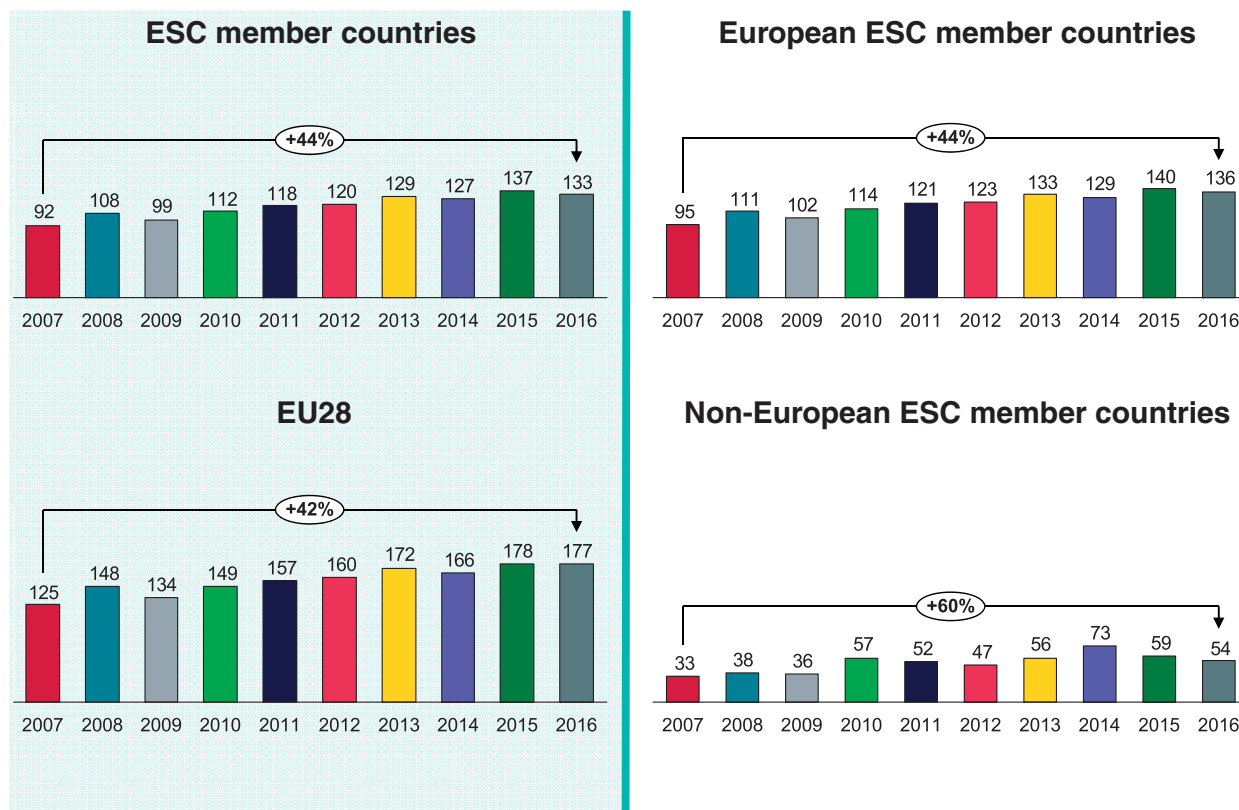


Figure 37 Implantable cardioverter-defibrillator per million inhabitants 2007-2016 in the European and non-European ESC member countries and comparison to the total ESC area and the 28 member countries of the European Union (EU28).

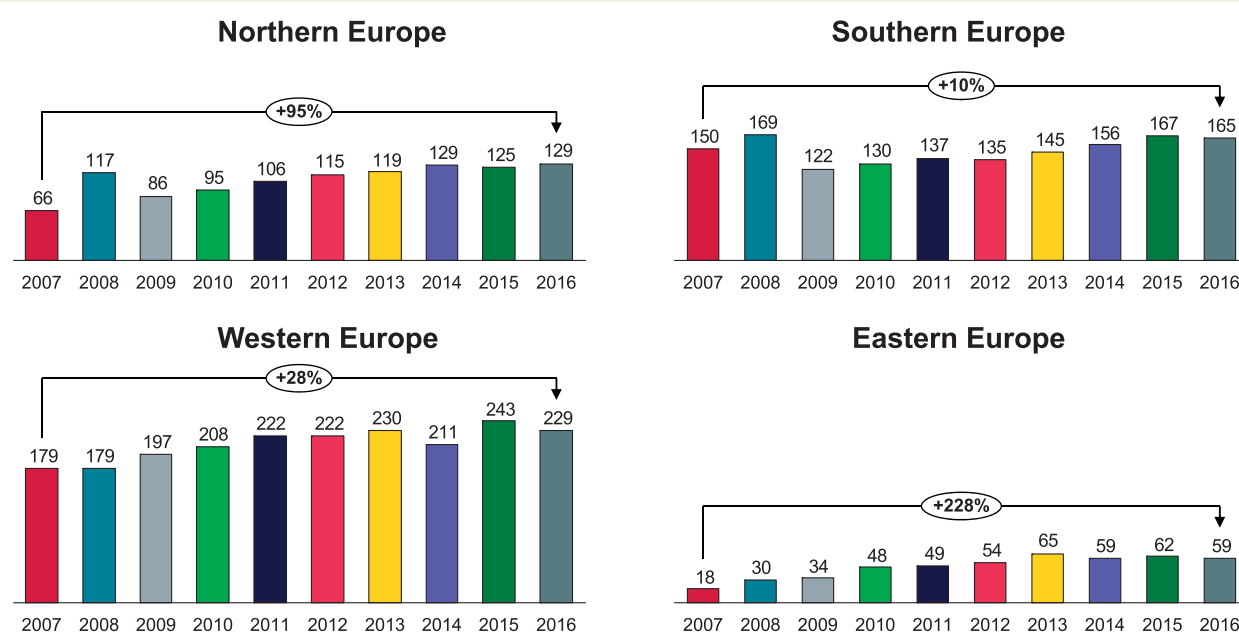
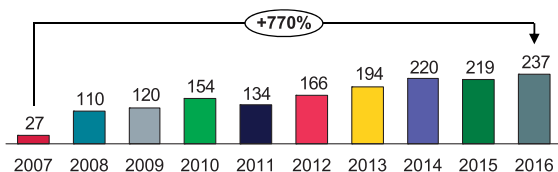


Figure 38 Implantable cardioverter-defibrillator implantations per million inhabitants 2007-2016 in the four European ESC regions.

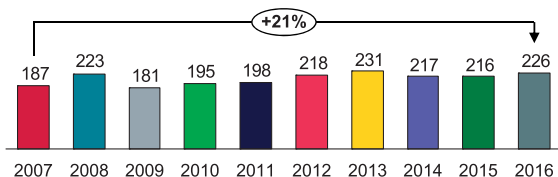
Northern Europe

TOP 3

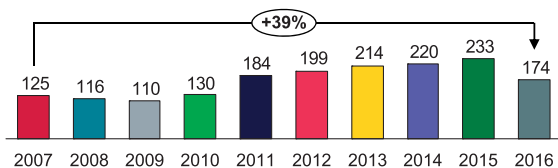
Finland



Denmark

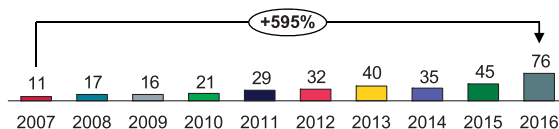


Norway

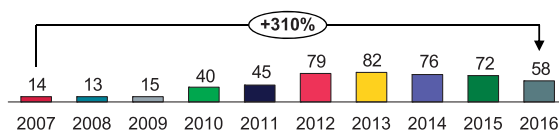


Lowest 3

Latvia



Estonia



Lithuania

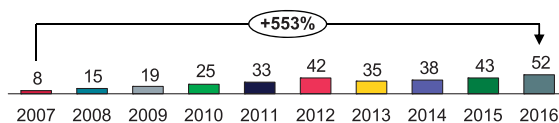
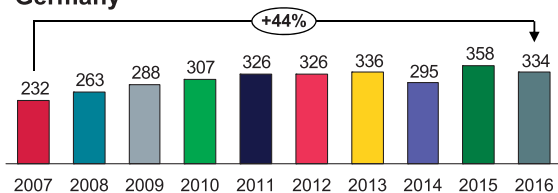


Figure 39 Implantable cardioverter-defibrillator implantations per million inhabitants 2007-2016 in Northern Europe.

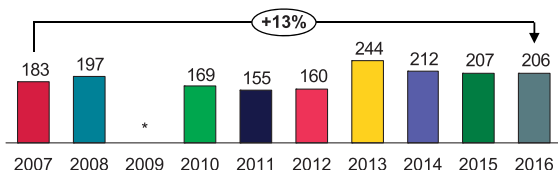
Western Europe

TOP 3

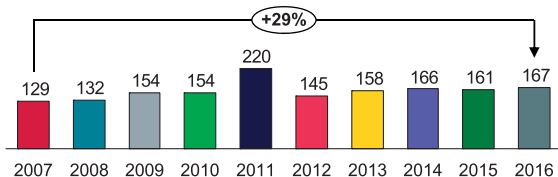
Germany



Netherlands

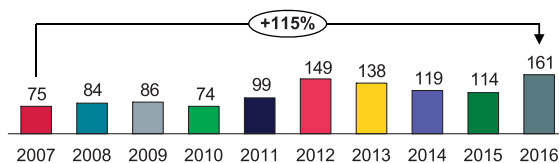


Austria

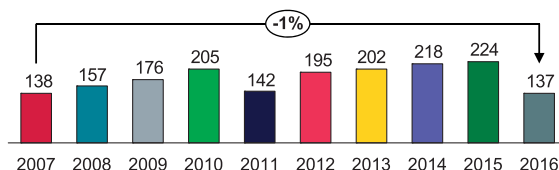


Lowest 3

Luxembourg



Switzerland



France

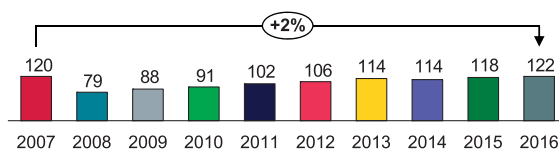
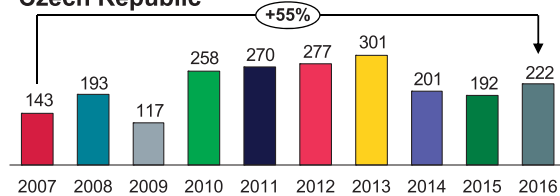


Figure 40 Implantable cardioverter-defibrillator implantations per million inhabitants 2007-2016 in Western Europe. *No data available.

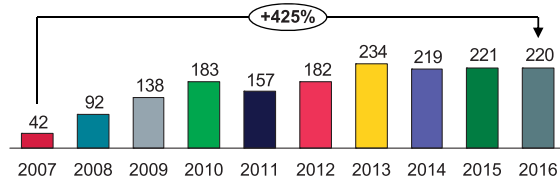
Eastern Europe

TOP 3

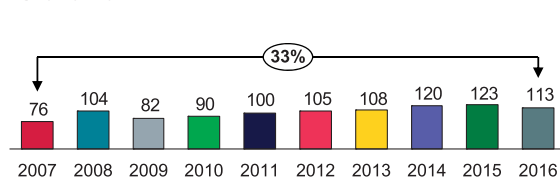
Czech Republic



Poland

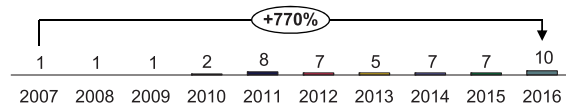


Slovakia

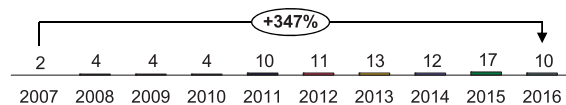


Lowest 3

Bulgaria



Russian Federation



Ukraine

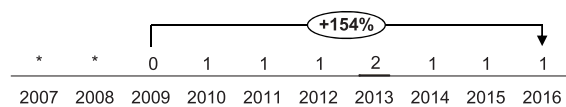
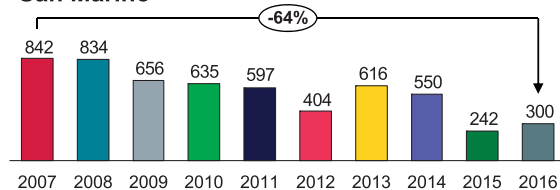


Figure 41 Implantable cardioverter-defibrillator implantations per million inhabitants 2007-2016 in Eastern Europe. *No data available.

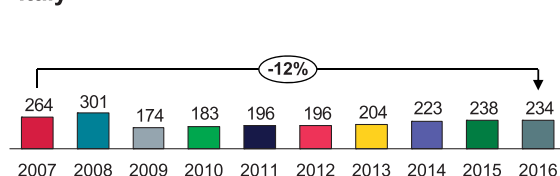
Southern Europe

TOP 3

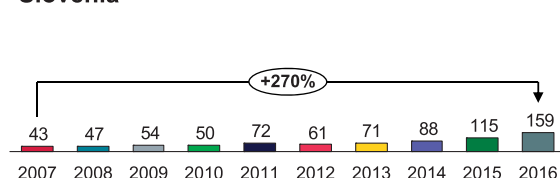
San Marino



Italy

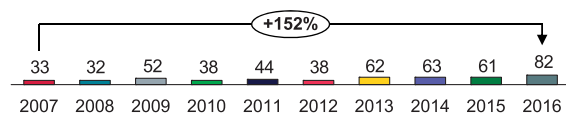


Slovenia

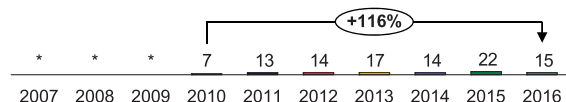


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Serbia



Bosnia & Herzegovina



FYR Macedonia

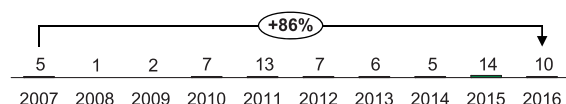
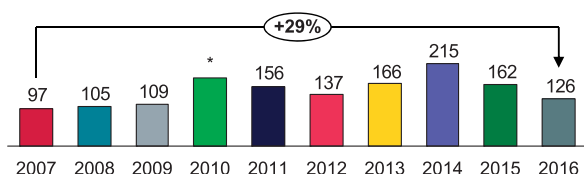


Figure 42 Implantable cardioverter-defibrillator implantations per million inhabitants 2007-2016 in Southern Europe. *No data available.

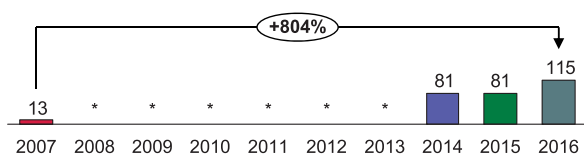
Non-European ESC member countries

TOP 3

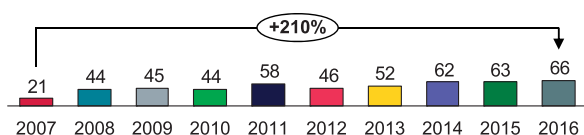
Israel



Turkey

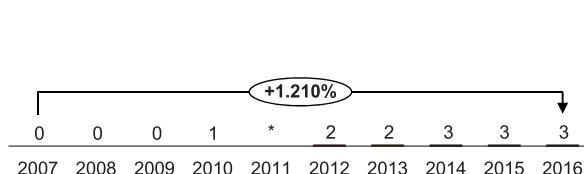


Cyprus

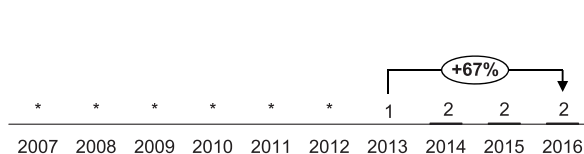


Lowest 3

Egypt



Algeria



Morocco

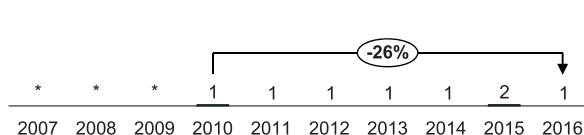


Figure 43 Implantable cardioverter-defibrillator implantations per million inhabitants 2007-2016 in the non-European ESC member countries.
* No data available.

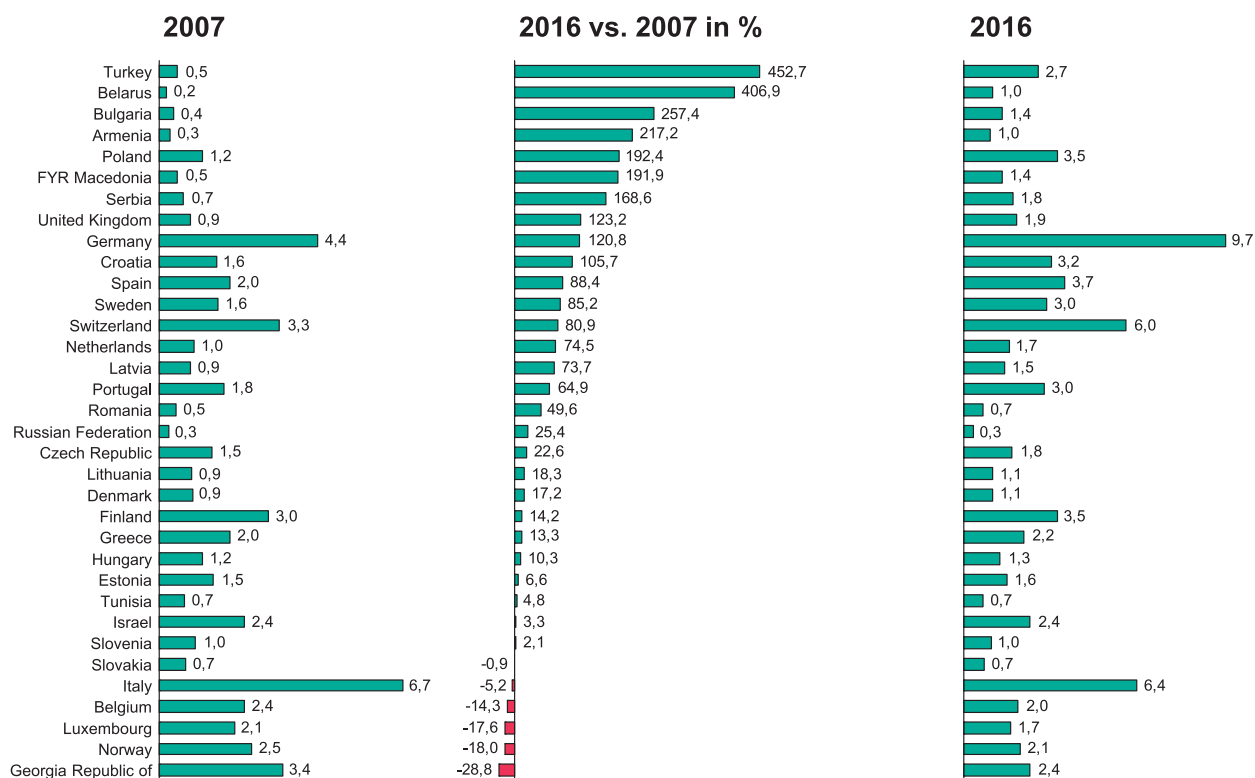


Figure 44 Change in the number of ICD implanting centres per million inhabitants from 2007 to 2016.

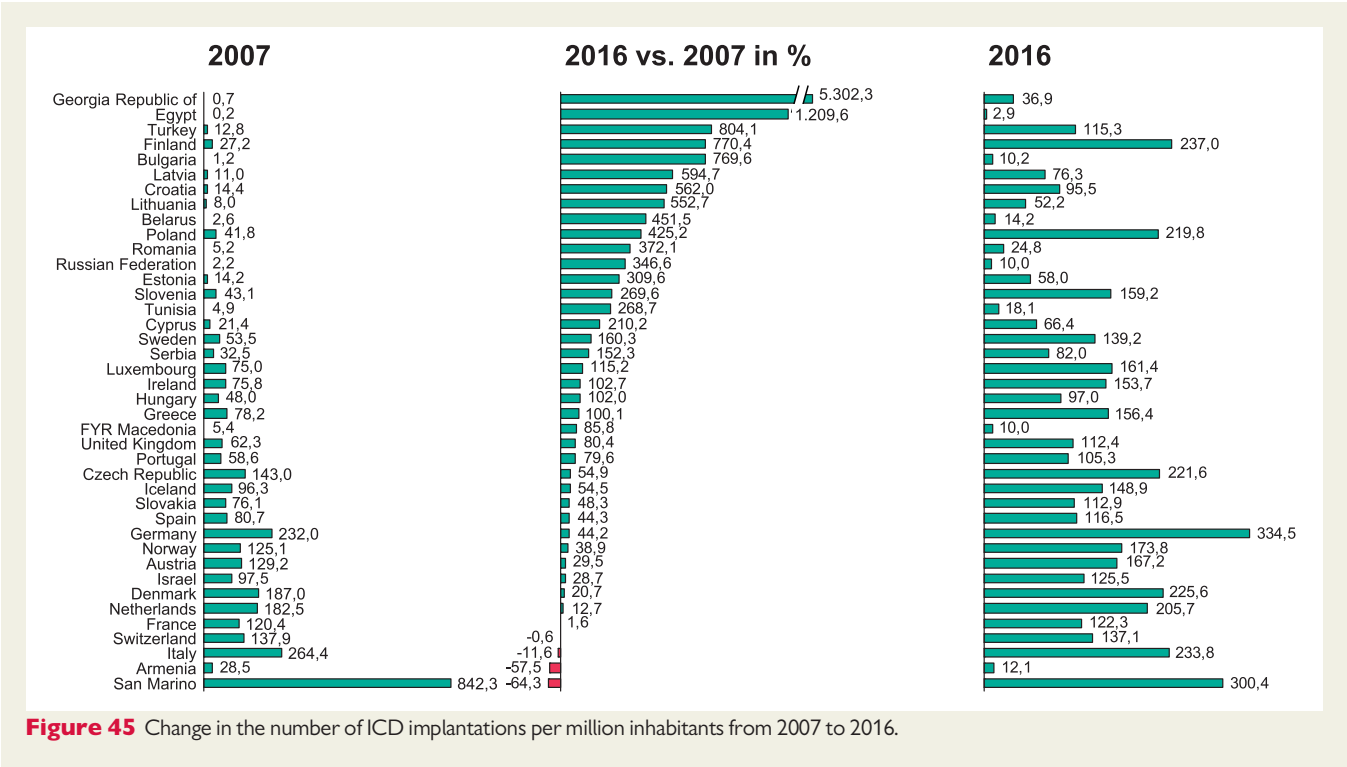


Figure 45 Change in the number of ICD implantations per million inhabitants from 2007 to 2016.

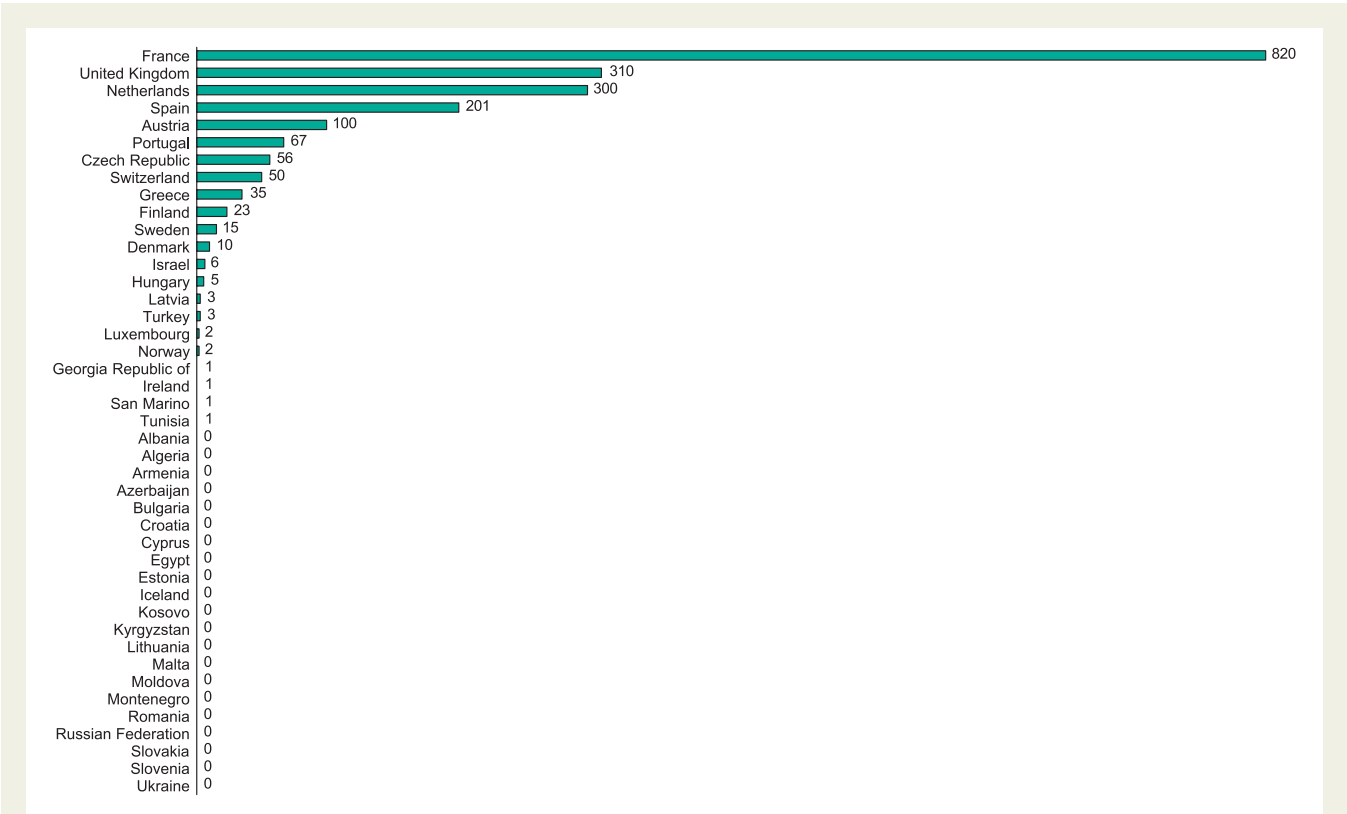


Figure 46 Number of subcutaneous ICD (S-ICD) implantations in 2016.

Table II Cardiac resynchronisation therapy device (CRT-P and CRT-D) implantation facilities and rates in the ESC member countries in 2016 and comparison with four previous years

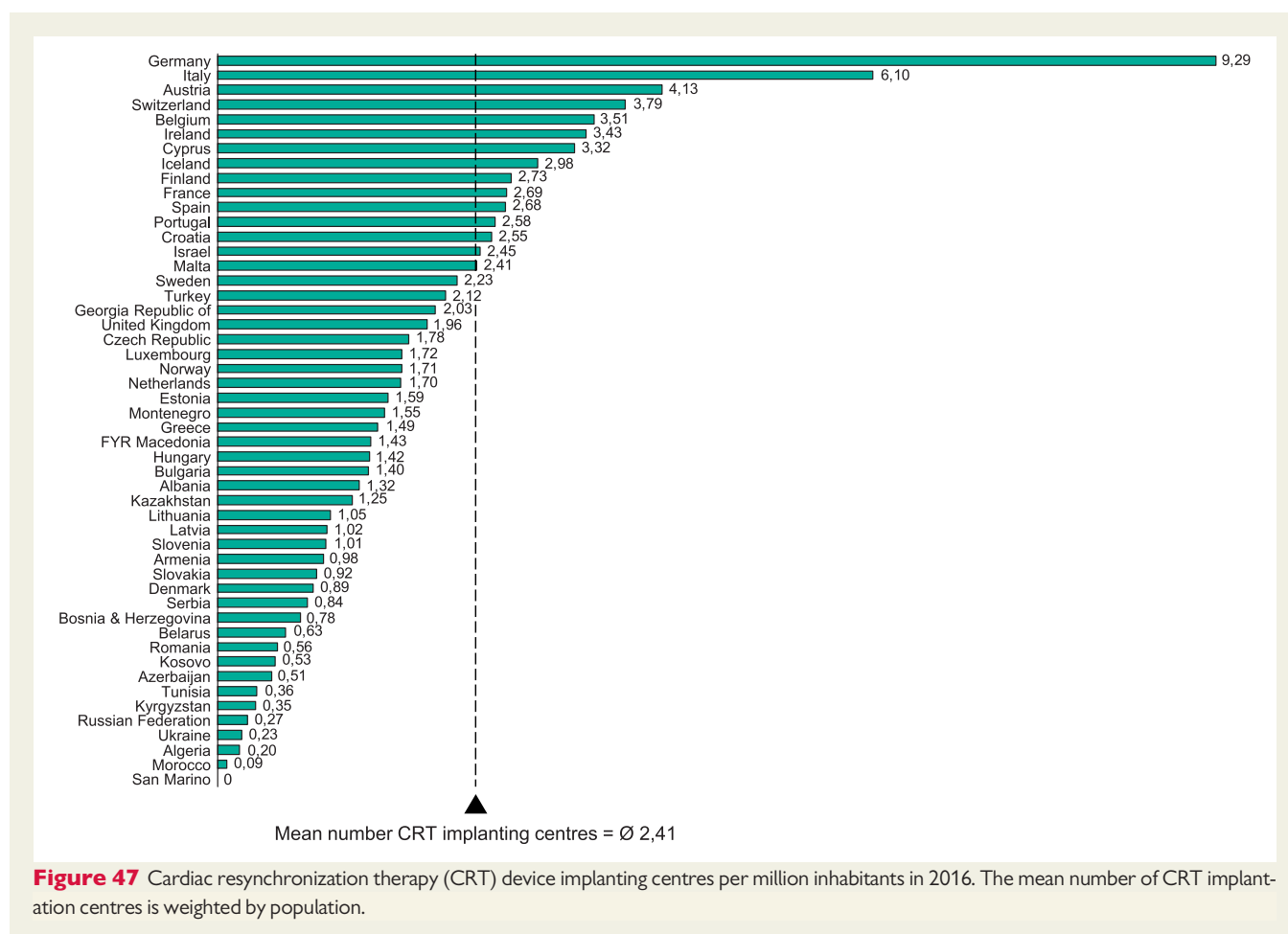
Country	ISO code	Number of CRT implanting centres 2016			CRT implantations 2016		Total CRT implantations 2016		Development potential - target number of CRT implantations		CRT implantations per million inhabitants				
		Absolute number	Per million inhabitants	CRT-P implantations Absolute number	CRT-D implantations Absolute number	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012	2013	2014	2015	2016	
Albania	AL	4	1.32	18	4	22	7	257	471	N/A	N/A	1	N/A	7	
Algeria	DZ	8	0.20	62	27	89	2	3 411	6 242	N/A	N/A	2	1	3	2
Armenia	AM	3	0.98	10	10	20	7	258	473	6	3	1	3	7	
Austria	AT	36	4.13	400	870	1 270	146	–	1 350	107	143	150	157	146	
Azerbaijan	AZ	5	0.51	2	63	65	7	836	1 530	N/A	2	2	2	7	
Belarus	BY	6	0.63	N/A	N/A	60	6	811	1 484	4	6	5	11	6	
Belgium*	BE	40	3.51	N/A	N/A	N/A	N/A	N/A	N/A	82	117	127	131	N/A	
Bosnia & Herzegovina	BA	3	0.78	8	9	17	4	327	599	5	6	6	4	4	
Bulgaria	BG	10	1.40	325	46	371	52	605	1 108	28	37	44	41	52	
Croatia	HR	11	2.55	132	145	277	64	365	669	13	18	28	58	64	
Cyprus	CY	4	3.32	N/A	N/A	25	21	102	187	25	22	25	25	21	
Czech Republic	CZ	19	1.78	450	1 643	2 093	196	–	–	127	162	176	183	196	
Denmark	DK	5	0.89	500	629	1 129	202	–	–	170	180	173	176	202	
Egypt	EG	N/A	N/A	600	26	626	7	8 019	14 675	4	5	6	6	7	
Estonia	EE	2	1.59	23	21	44	35	107	195	53	55	41	58	35	
Finland	FI	15	2.73	212	366	578	105	–	852	72	83	100	96	105	
France	FR	180	2.69	4 046	6 686	10 732	161	–	–	131	140	144	157	161	
Georgia Republic of	GE	10	2.03	13	99	112	23	417	764	7	8	11	13	23	
Germany	DE	750	9.29	3 700	17 850	21 550	267	–	–	221	150	242	261	267	
Greece	GR	16	1.49	650	100	750	70	913	1 670	45	46	54	67	70	
Hungary	HU	14	1.42	471	636	1 107	112	–	1 531	89	99	95	110	112	
Iceland	IS	1	2.98	11	8	19	57	28	52	32	44	82	63	57	
Ireland	IE	17	3.43	90	240	330	67	420	768	61	79	N/A	65	67	
Israel	IL	20	2.45	239	1 196	1 435	176	–	–	118	158	170	180	176	
Italy	IT	378	6.10	2 300	10 800	13 100	211	–	–	194	198	200	207	211	
Kazakhstan	KZ	23	1.25	N/A	N/A	414	23	1 555	2 846	9	12	15	17	23	
Kosovo*	XK	1	0.53	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	2	N/A	
Kyrgyzstan*	KGZ	2	0.35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	
Latvia	LV	2	1.02	26	85	111	56	167	305	35	29	48	54	56	
Lebanon*	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	N/A
Libya*	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

Continued

Table II Continued

Country	ISO code	Number of CRT implanting centres 2016		CRT implantations 2016		Total CRT implantations 2016		Development potential - target number of CRT implantations		CRT implantations per million inhabitants				
		Absolute number	Per million inhabitants	CRT-P Absolute number	CRT-D implantations Absolute number	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012	2013	2014	2015	2016
Lithuania	LT	3	1.05	140	41	181	63	242	442	39	47	55	68	63
Luxembourg	LU	1	1.72	11	25	36	62	49	90	59	43	65	60	62
FYR Macedonia	MK	3	1.43	47	9	56	27	178	326	5	8	13	18	27
Malta	MT	1	2.41	8	31	39	94	—	64	83	39	116	99	94
Moldova*	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A	N/A
Montenegro	ME	1	1.55	15	16	31	48	55	100	29	15	34	29	48
Morocco	MA	3	0.09	38	43	81	2	2 851	5 217	2	2	2	3	2
Netherlands	NL	29	1.70	450	1 650	2 100	123	—	2 638	124	123	114	118	123
Norway	NO	9	1.71	179	341	520	99	—	816	77	84	100	108	99
Poland	PL	N/A	N/A	691	3 473	4 164	108	—	5 972	73	78	97	103	108
Portugal	PT	28	2.58	204	597	801	74	918	1 679	52	60	64	71	74
Romania	RO	12	0.56	238	183	421	19	1 830	3 348	7	9	13	13	19
Russian Federation	RU	39	0.27	284	711	995	7	12 059	22 067	6	7	6	7	7
San Marino	SM	0	0.00	0	2	2	60	3	5	62	0	31	61	60
Serbia	RS	6	0.84	242	71	313	44	605	1 107	42	45	45	44	44
Slovakia	SK	5	0.92	164	326	490	90	—	844	61	82	96	109	90
Slovenia	SI	2	1.01	45	90	135	68	168	307	70	66	75	83	68
Spain	ES	130	2.68	1 124	2 032	3 156	65	4 114	7 528	53	58	63	71	65
Sweden	SE	22	2.23	709	993	1 702	172	—	—	49	100	88	154	172
Switzerland	CH	31	3.79	329	628	957	117	—	1 268	66	62	73	141	117
Syria*	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	TN	4	0.36	150	40	190	17	943	1 726	23	21	16	19	17
Turkey	TR	170	2.12	359	3 126	3 485	43	6 800	12 444	N/A	N/A	32	36	43
Ukraine	UA	10	0.23	43	29	72	2	3 745	6 853	1	2	2	2	2
United Kingdom	GB	126	1.96	4 318	7 063	11 381	177	—	—	110	122	149	159	177
Total ESC member countries		2 220	2.41	24 076	63 079	87 654	85			73	71	84	91	93

*These 7 countries did not submit any data on CRT implantations for the EHRA White Book 2017.



The changes in the number of ablation procedures from 2015 to 2016 are presented in Table 17 and Figure 74, and a comparison to the previous four years in each participating ESC member country is shown in Table 15. Compared to the previous year the rate of ablations per million population was quite stable, and only three countries (i.e., Morocco, Iceland and Azerbaijan) reported more than 50% increase in the procedure rate. In Kyrgyzstan, the ablation rate decreased 63%. The relationship between the mean annual catheter ablation rate per million inhabitants and the number of catheter ablation centres per million inhabitants in the ESC member countries and in the EU28 is shown in Figure 75.

Trends in catheter ablation activity over the past 10 years

The changes in the number of ablation centres in the various ESC member countries from 2007 to 2016 are shown in Figure 76. During the 10-year period, the number of ablation centres increased in all participating countries except for Austria, Hungary, Luxembourg and France.

The number of catheter ablations in the European and non-European ESC member countries over the past 10 years and comparison with the total ESC area and the 28 member countries of the European Union (EU28) are shown in Figure 77. The corresponding numbers for the four European ESC regions are presented in

Figure 78. In 2016 the rate of catheter ablations was 3-13 times higher in the Western Europe (923 per million population) than in the other ESC regions. In the non-European ESC member countries catheter ablation rate was over fivefold lower than in the European ESC member countries (71 vs. 378 per million population). The growth in the rate of catheter ablations exceeded 100% in all geographical ESC regions except for the Southern Europe. The greatest increases were reported in Belarus, Croatia, Republic of Georgia and Ireland – all with more than 500% increase in the ablation rate (Figure 79).

Ten-year data for the three most active and three least active countries in the different ESC regions are presented in Figures 80-84. The most active countries in the Northern, Western, Southern and Eastern Europe were Denmark (737 ablation per million inhabitants), Germany (999), Croatia (420) and Czech Republic (617), respectively. Among the non-European ESC member countries Kazakhstan was the most active with 168 catheter ablations per million population.

Atrial fibrillation ablation rates

The data from the 47 ESC member countries (84%) that submitted data on atrial fibrillation (AF) ablation for the EHRA White Book are listed in Table 18. In 2016 a total of 113098 atrial fibrillation (AF) ablations were performed in the ESC area. Despite the increase in the total number of the ablations the rate of AF ablation was slightly

Table 12 Changes in the number of ardiac resynchronisation therapy (CRT) implanting centres in from 2015 to 2016

Country	ISO code	Number of CRT implanting centres 2015		Number of CRT implanting centres 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania	AL	N/A	N/A	4	1.32	N/A
Algeria	DZ	8	0.20	8	0.20	-1.8%
Armenia	AM	2	0.65	3	0.98	50.3%
Austria	AT	18	2.08	36	4.13	98.9%
Azerbaijan	AZ	2	0.20	5	0.51	147.7%
Belarus	BY	6	0.63	6	0.63	-0.8%
Belgium	BE	40	3.53	40	3.51	-0.7%
Bosnia & Herzegovina	BA	2	0.52	3	0.78	50.2%
Bulgaria	BG	9	1.25	10	1.40	11.8%
Croatia	HR	8	1.79	11	2.55	42.3%
Cyprus	CY	4	3.36	4	3.32	-1.4%
Czech Republic	CZ	18	1.69	19	1.78	5.4%
Denmark	DK	5	0.90	5	0.89	-0.2%
Egypt*	EG	17	0.19	N/A	N/A	N/A
Estonia	EE	2	1.58	2	1.59	0.5%
Finland	FI	15	2.74	15	2.73	-0.4%
France	FR	174	2.61	180	2.69	3.0%
Georgia Republic of	GE	10	2.03	10	2.03	0.1%
Germany	DE	250	3.09	750	9.29	200.5%
Greece	GR	16	1.48	16	1.49	0.0%
Hungary	HU	14	1.41	14	1.42	0.2%
Iceland	IS	1	3.01	1	2.98	-1.2%
Ireland	IE	17	3.47	17	3.43	-1.2%
Israel	IL	20	2.48	20	2.45	-1.5%
Italy	IT	380	6.14	378	6.10	-0.8%
Kazakhstan	KZ	18	0.99	23	1.25	26.4%
Kosovo	XK	1	0.53	1	0.53	-0.6%
Kyrgyzstan	KGZ	N/A	N/A	2	0.35	N/A
Latvia	LV	2	1.01	2	1.02	1.1%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	3	1.04	3	1.05	1.1%
Luxembourg	LU	1	1.75	1	1.72	-2.1%
FYR Macedonia	MK	3	1.43	3	1.43	-0.2%
Malta	MT	1	2.42	1	2.41	-0.3%
Moldova*	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	1	1.55	1	1.55	0.4%
Morocco	MA	6	0.18	3	0.09	-50.5%
Netherlands	NL	29	1.71	29	1.70	-0.4%
Norway	NO	9	1.73	9	1.71	-1.1%
Poland*	PL	N/A	N/A	N/A	N/A	N/A
Portugal	PT	26	2.40	28	2.58	7.6%
Romania	RO	12	0.55	12	0.56	0.3%
Russian Federation	RU	37	0.26	39	0.27	5.5%
San Marino	SM	1	30.28	0	0.00	-100.0%
Serbia	RS	6	0.84	6	0.84	0.5%
Slovakia	SK	4	0.74	5	0.92	24.3%
Slovenia	SI	2	1.01	2	1.01	0.3%
Spain	ES	130	2.70	130	2.68	-0.9%
Sweden	SE	25	2.55	22	2.23	-12.7%
Switzerland	CH	36	4.43	31	3.79	-14.5%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	N/A	N/A	4	0.36	N/A
Turkey	TR	N/A	N/A	170	2.12	N/A
Ukraine	UA	10	0.23	10	0.23	0.5%
United Kingdom	GB	126	1.97	126	1.96	-0.5%
Total ESC member countries		1 527	1.68	2 220	2.41	43.1%

*These 6 countries did not submit any data on CRT implanting centres for the EHRA White Book 2017.

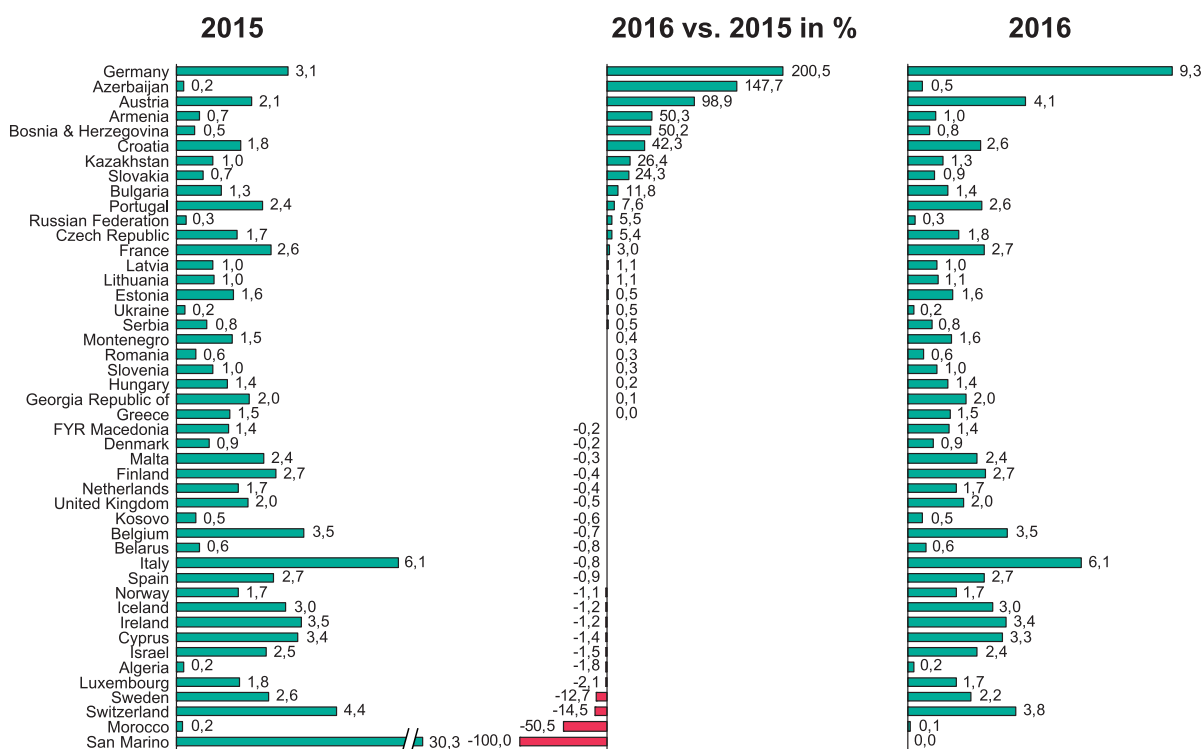


Figure 48 Change in the number of CRT implanting centres per million inhabitants from 2015 to 2016.

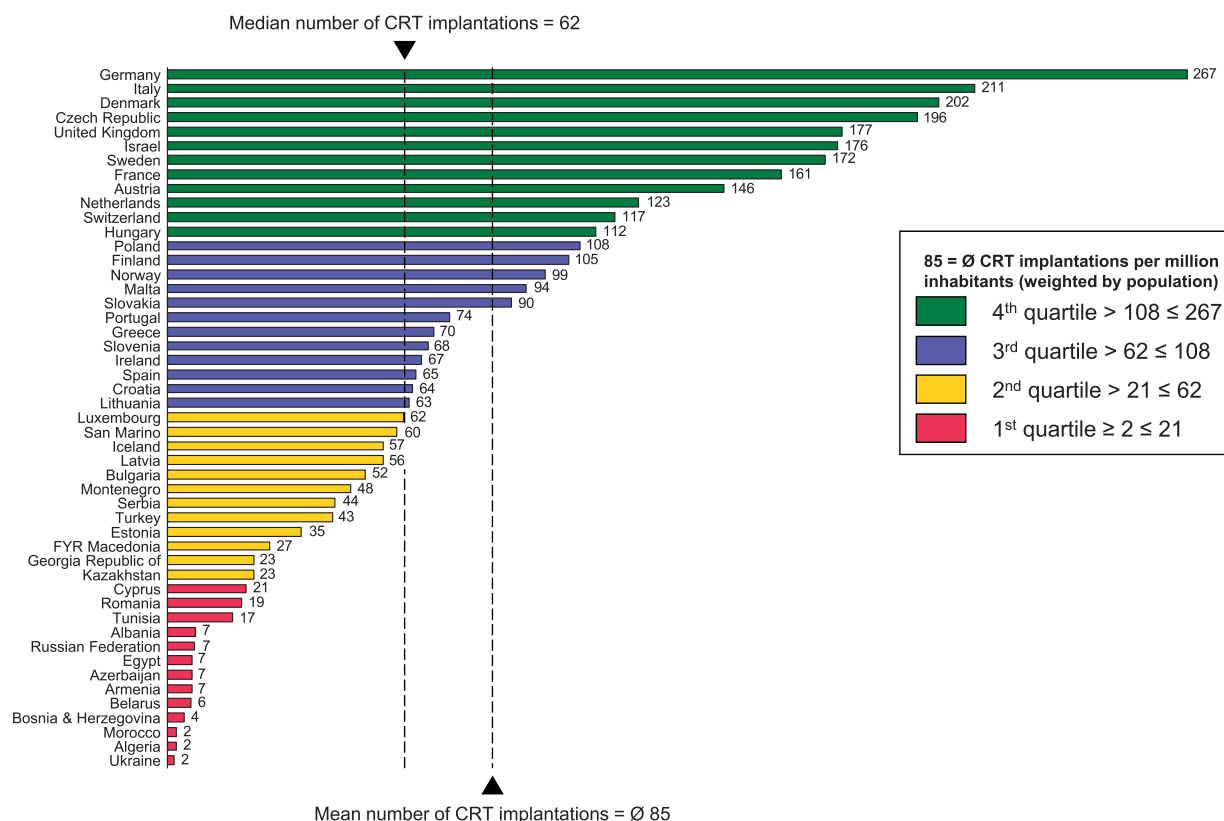


Figure 49 Cardiac resynchronization therapy device implantations per million inhabitants 2016. The mean number of CRT implantations is weighted by population.

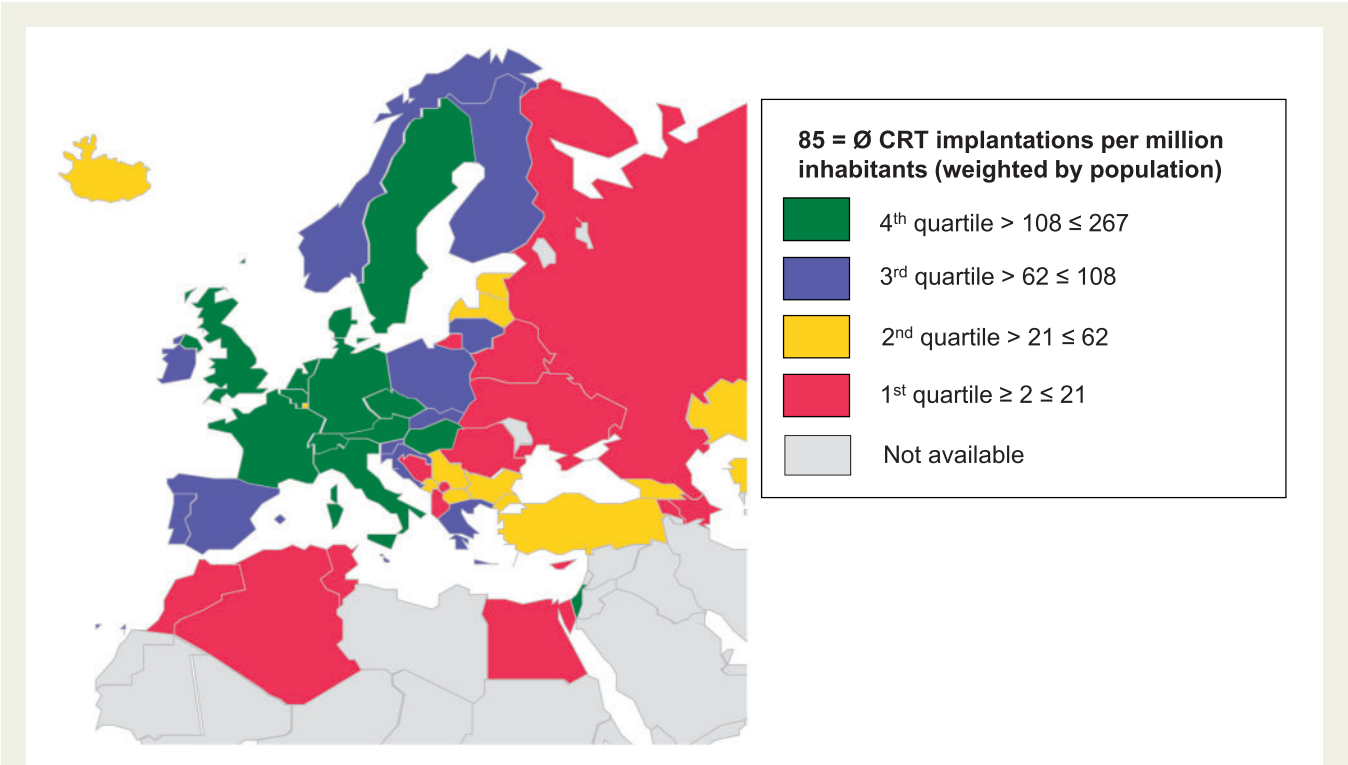


Figure 50 Cardiac resynchronization therapy device implantations in the ESC member countries in 2016.

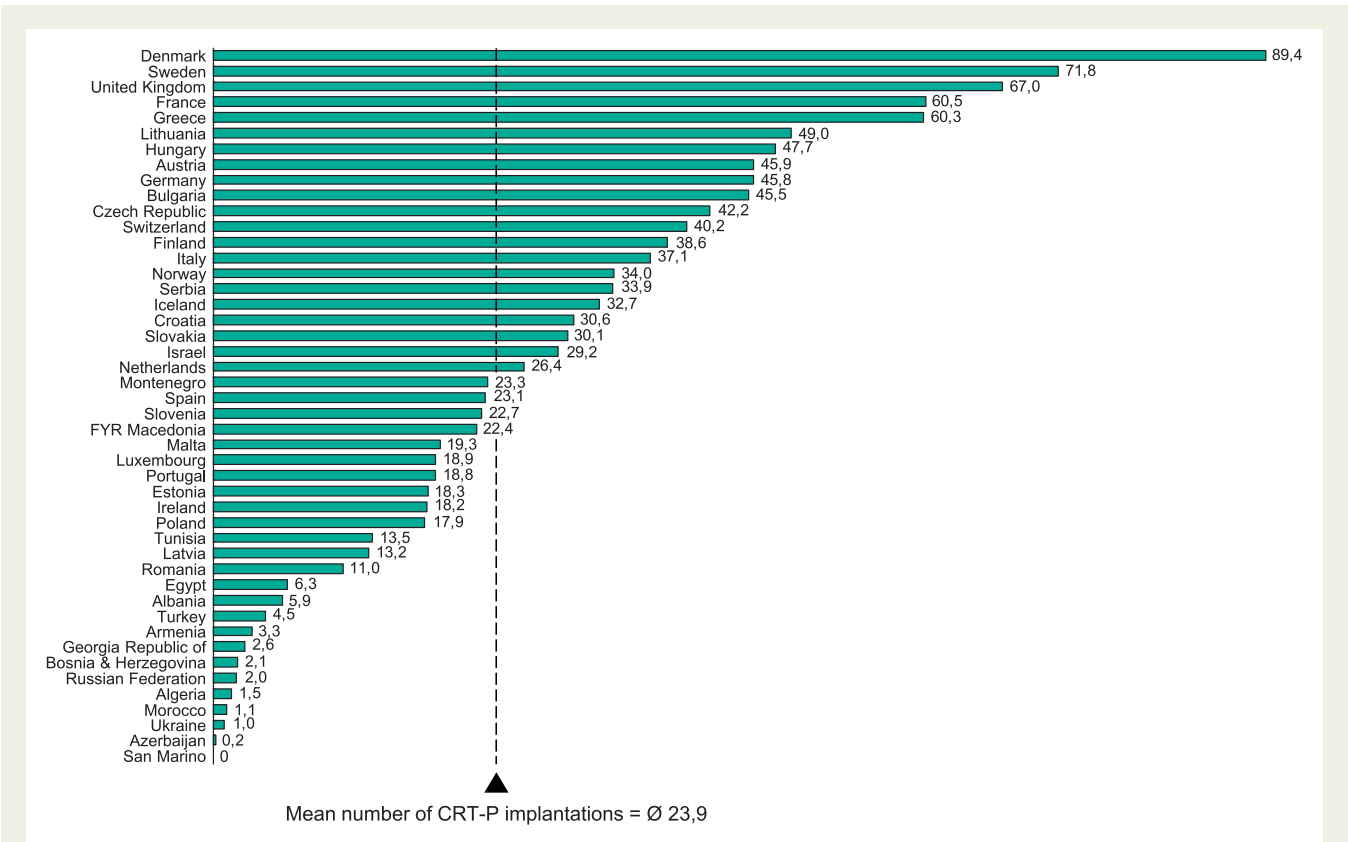
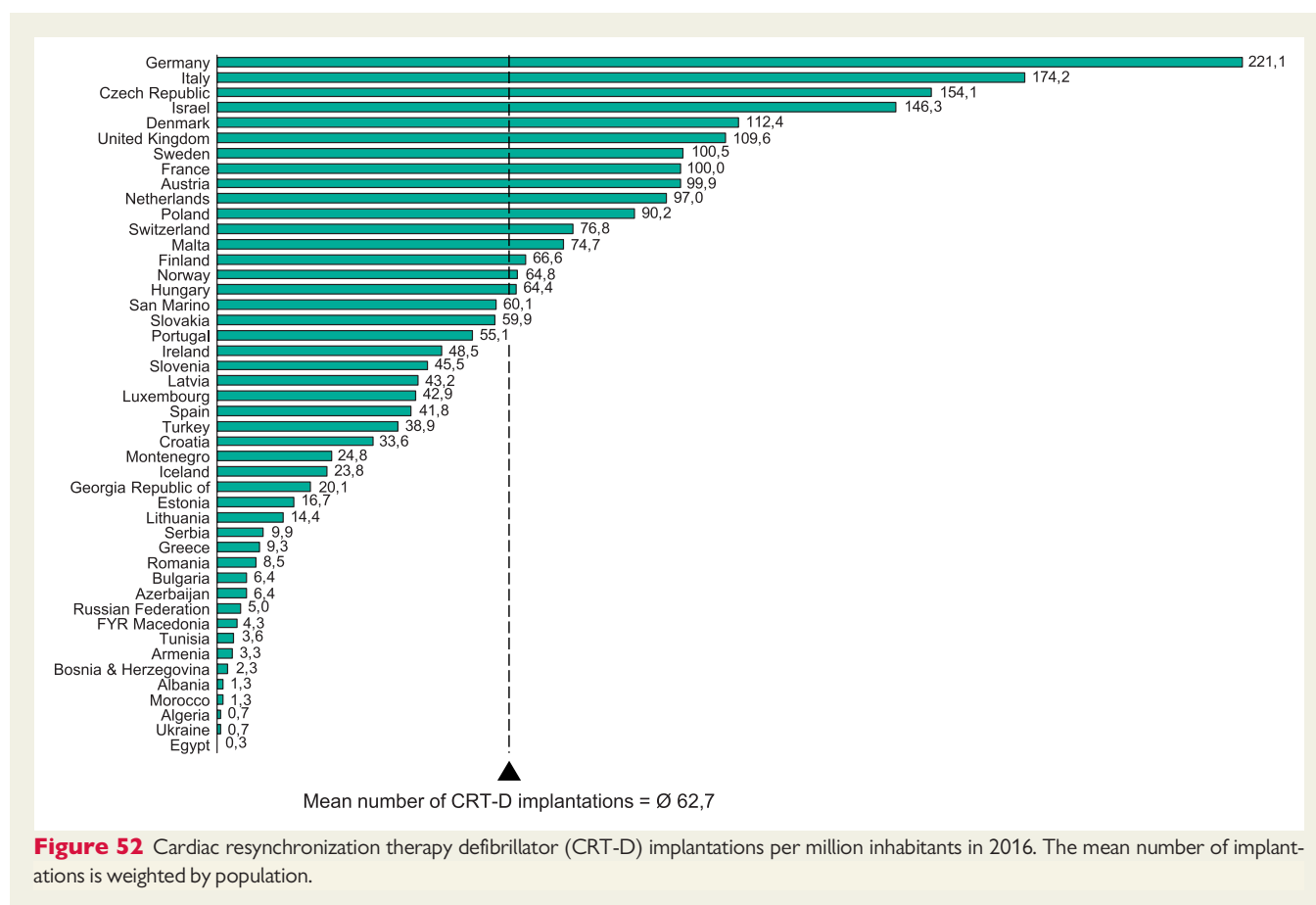


Figure 51 Cardiac resynchronization therapy pacemaker (CRT-P) implantations per million inhabitants in 2016. The mean number of implantations is weighted by population.



smaller (110 vs. 123 per million inhabitants) than in the previous year. The most active countries were Germany (506 AF ablations per million population), Denmark (337) and Norway (319). No AF ablations were performed in Morocco, Algeria, Kyrgyzstan and San Marino (Figure 85). Nine countries including Belgium did not report data on AF ablations.

In Figures 85 and 86 the ESC member countries performing AF ablations are grouped in quartiles according to their activity. Most countries in the top quartile were from the Western and Northern European region, and the countries with low activity (1st and 2nd quartiles) were mainly from the non-European ESC region. In the Eastern region, the AF ablation activity was extremely heterogeneous varying from 271 in Czech Republic to 6 ablations per million population in Romania. The growth in AF ablation rate per million population from 2015 to 2016 was highest in Armenia (200%), Egypt (141) and Cyprus (117%). In Turkey, the rate of AF ablation decreased by 46% and in the Russian Federation by 13% (Table 19 and Figure 87).

Trends in atrial fibrillation ablation activity over the past 10 years

The trend in the number of catheter ablations per million inhabitants from 2007 to 2016 in the European and non-European ESC member countries and comparison to the total ESC area and the 28 member countries of the European Union (EU28) are shown in Figure 88. Over the past ten years the rate of AF ablation increased by more

than 200% in all ESC areas with the greatest increases in the non-European ESC member countries and in the Southern and Eastern European countries. In Belarus, Poland, Bulgaria and Serbia the increase in AF ablation rate exceeded 1200% (Figure 87).

Detailed information on AF ablation activities in the various ESC regions and a comparison to the corresponding numbers in the total ESC area and the EU28 countries are presented in Figures 88 and 89. The most active countries in the Northern, Western, Southern and Eastern European region, and among the non-European ESC member countries were Denmark (355 AF ablation per million population), Germany (506), Croatia (128), Czech Republic (271) and Kazakhstan (58), respectively (Figures 90-94). The changes in the AF ablation rates in the various ESC member countries are shown in Figure 95. The proportion of AF ablation to the total number of ablation varied between 1.5% in Azerbaijan to 50.7% in Germany and Norway. The mean ratio of AF ablations of total ablations was 39.6%, and the proportion of AF ablations compared to all ablations was 40% or more in 10 countries (Figure 96).

Ventricular tachyarrhythmia ablation rates

Data on ventricular tachyarrhythmia ablations in patients with structural heart disease were collected for the third time in 2016. A total of 41 (73%) ESC member countries reported data on ventricular tachycardia (VT) or ventricular fibrillation (VF) ablations. In 2016 the

Table 13 Change in the number of total cardiac resynchronisation therapy (CRT) device implantations from 2015 to 2016

Country	ISO code	Total CRT implantations 2015		Total CRT implantations 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania	AL	N/A	N/A	22	7	N/A
Algeria	DZ	108	2.73	89	2	-19.1%
Armenia	AM	10	3.27	20	7	100.3%
Austria	AT	1 364	157.40	1 270	146	-7.4%
Azerbaijan	AZ	24	2.45	65	7	168.3%
Belarus	BY	100	10.53	60	6	-40.5%
Belgium*	BE	1 485	131.14	N/A	N/A	N/A
Bosnia & Herzegovina	BA	17	4.40	17	4	0.1%
Bulgaria	BG	296	41.19	371	52	26.1%
Croatia	HR	261	58.46	277	64	9.8%
Cyprus	CY	30	25.23	25	21	-17.8%
Czech Republic	CZ	1 952	183.38	2 093	196	7.1%
Denmark	DK	985	176.48	1 129	202	14.4%
Egypt	EG	545	6.16	626	7	7.4%
Estonia	EE	73	57.69	44	35	-39.4%
Finland	FI	527	96.22	578	105	9.3%
France	FR	10 432	156.75	10 732	161	2.4%
Georgia Republic of	GE	62	12.57	112	23	80.8%
Germany	DE	21 139	261.45	21 550	267	2.1%
Greece	GR	726	67.37	750	70	3.3%
Hungary	HU	1 091	110.23	1 107	112	1.7%
Iceland	IS	21	63.27	19	57	-10.6%
Ireland	IE	319	65.20	330	67	2.2%
Israel	IL	1 452	180.39	1 435	176	-2.7%
Italy	IT	12 815	207.18	13 100	211	2.0%
Kazakhstan	KZ	314	17.29	414	23	30.4%
Kosovo*	XK	4	2.14	N/A	N/A	N/A
Kyrgyzstan*	KGZ	N/A	N/A	N/A	N/A	N/A
Latvia	LV	107	53.86	111	56	4.8%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	195	67.60	181	63	-6.2%
Luxembourg	LU	34	59.62	36	62	3.7%
FYR Macedonia	MK	38	18.13	56	27	47.1%
Malta	MT	41	99.04	39	94	-5.2%
Moldova*	MD	N/A	N/A	N/A	N/A	N/A
Montenegro	ME	19	29.36	31	48	63.8%
Morocco	MA	84	2.52	81	2	-4.5%
Netherlands	NL	2 000	118.01	2 100	123	4.6%
Norway	NO	562	107.92	520	99	-8.5%
Poland	PL	3 964	102.79	4 164	108	5.2%
Portugal	PT	772	71.31	801	74	3.7%
Romania	RO	276	12.74	421	19	53.0%
Russian Federation	RU	1 006	7.06	995	7	-1.0%
San Marino	SM	2	60.57	2	60	-0.8%
Serbia	RS	313	43.61	313	44	0.5%
Slovakia	SK	588	108.57	490	90	-17.1%
Slovenia	SI	164	82.69	135	68	-17.5%
Spain	ES	3 415	70.93	3 156	65	-8.4%
Sweden	SE	1 512	154.26	1 702	172	11.7%
Switzerland	CH	1 148	141.35	957	117	-17.2%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	210	19.03	190	17	-10.3%
Turkey	TR	2 810	35.69	3 485	43	21.7%
Ukraine	UA	73	1.64	72	2	-0.9%
United Kingdom	GB	10 198	159.12	11 381	177	11.0%
Total ESC member countries		85 683	83	87 654	85	2.3%

*These 7 countries did not submit any data on CRT implantations for the EHRA White Book 2017

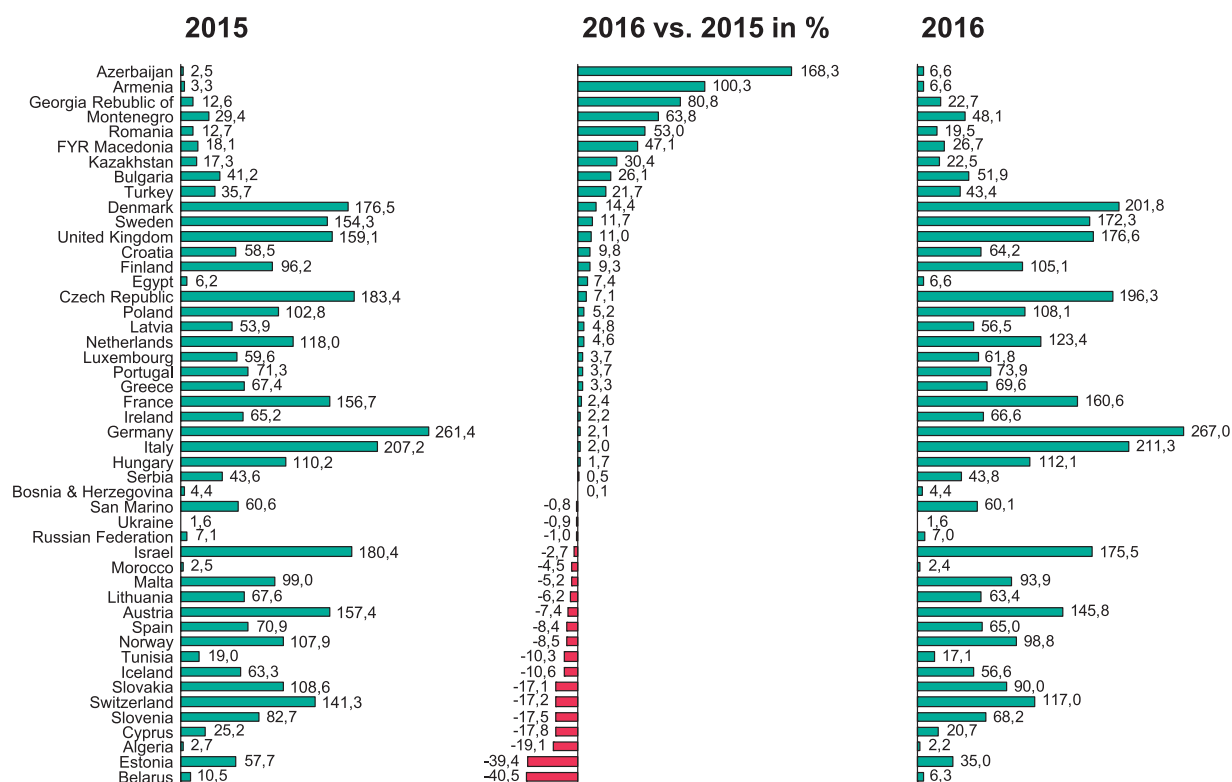


Figure 53 Change in the number of total CRT implantations per million inhabitants from 2015 to 2016.

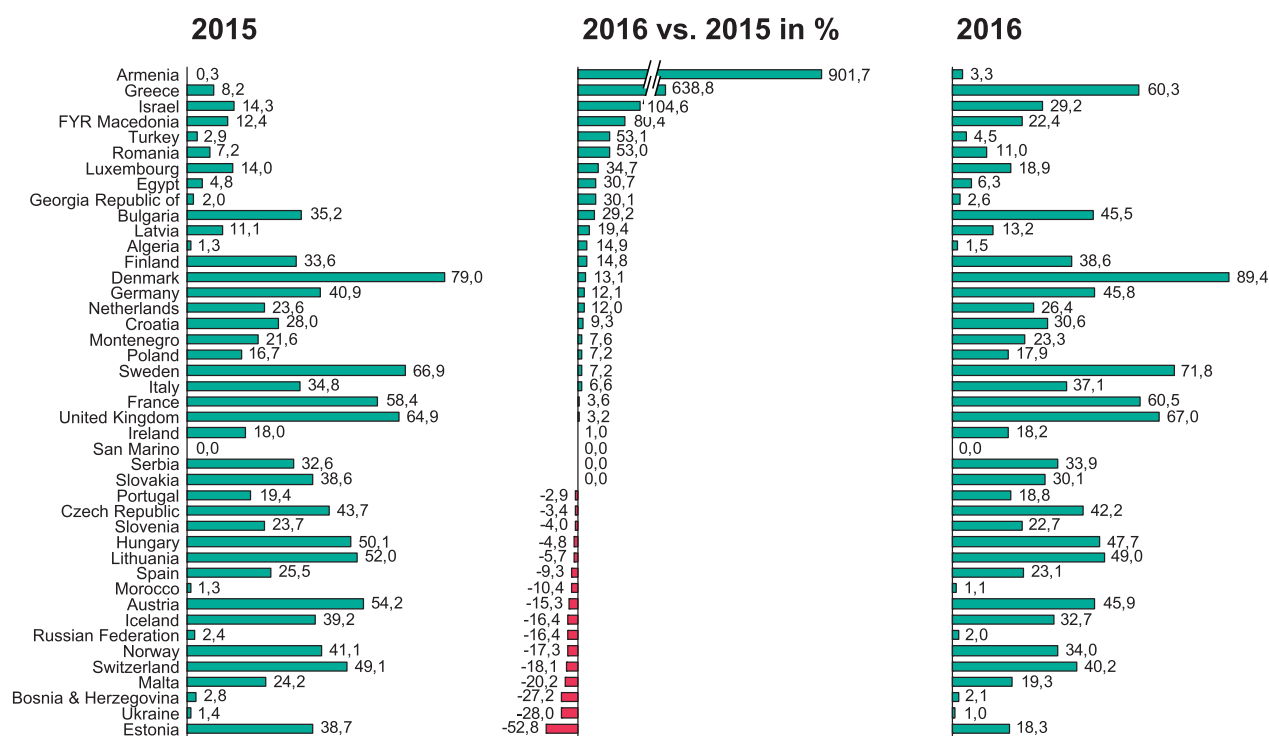


Figure 54 Change in the number of CRT-P implantations per million inhabitants from 2015 to 2016.

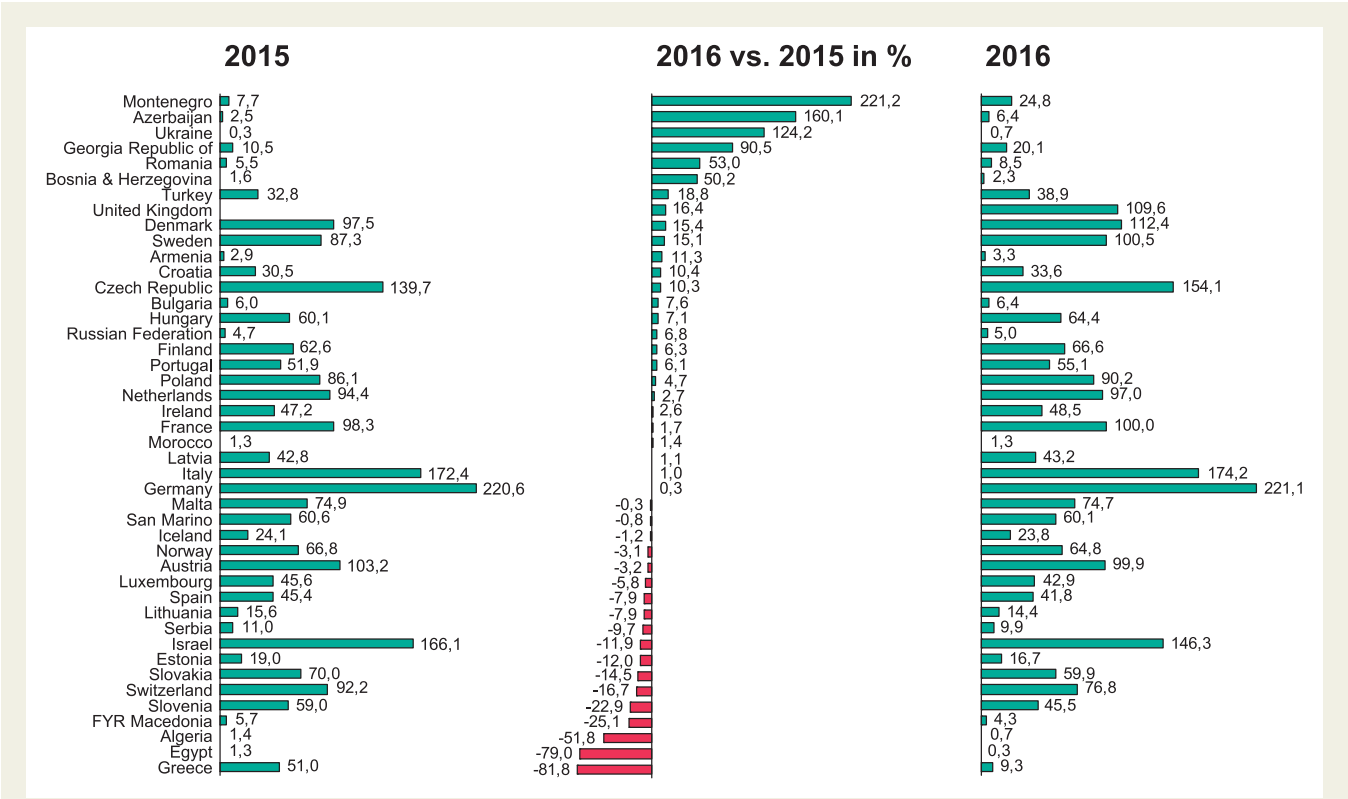


Figure 55 Change in the number of CRT-D implantations per million inhabitants from 2015 to 2016.

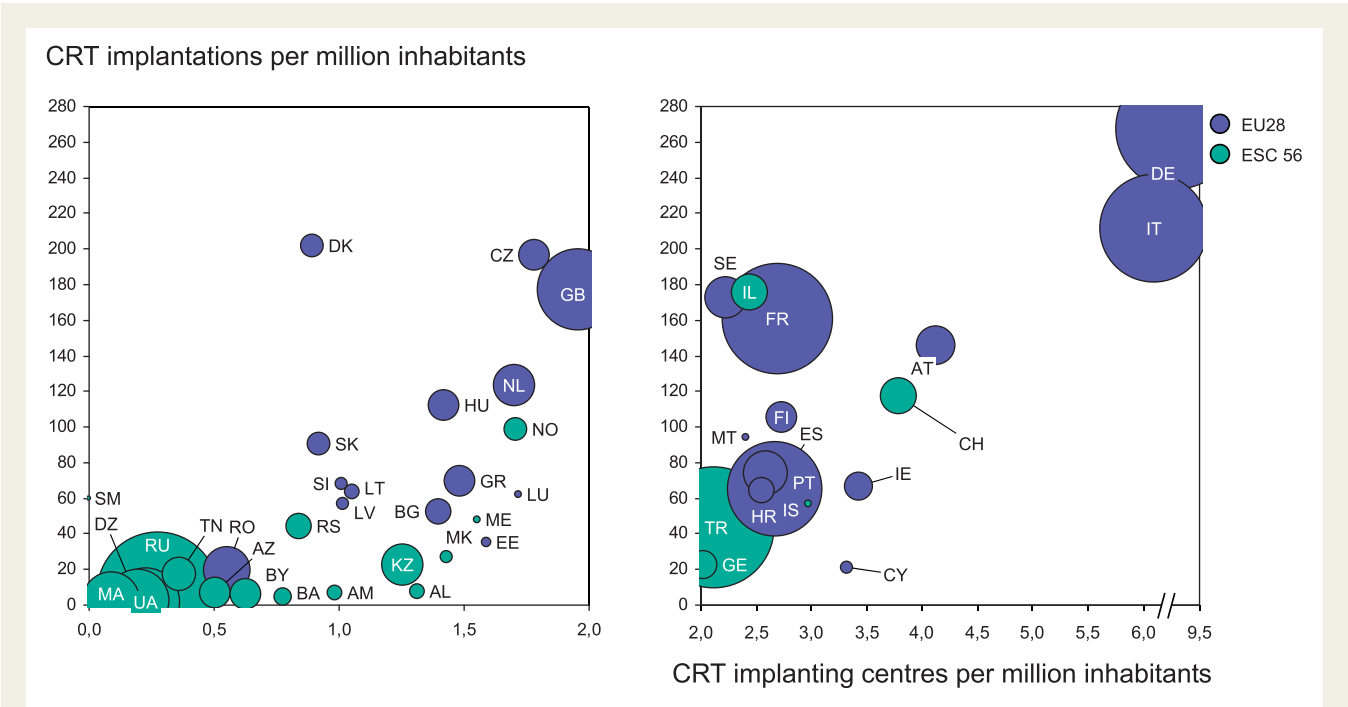


Figure 56 Cardiac resynchronization therapy implantation centres and rates in the ESC and European Union (EU28) member countries in 2016. Bubble size is related to population in the country.

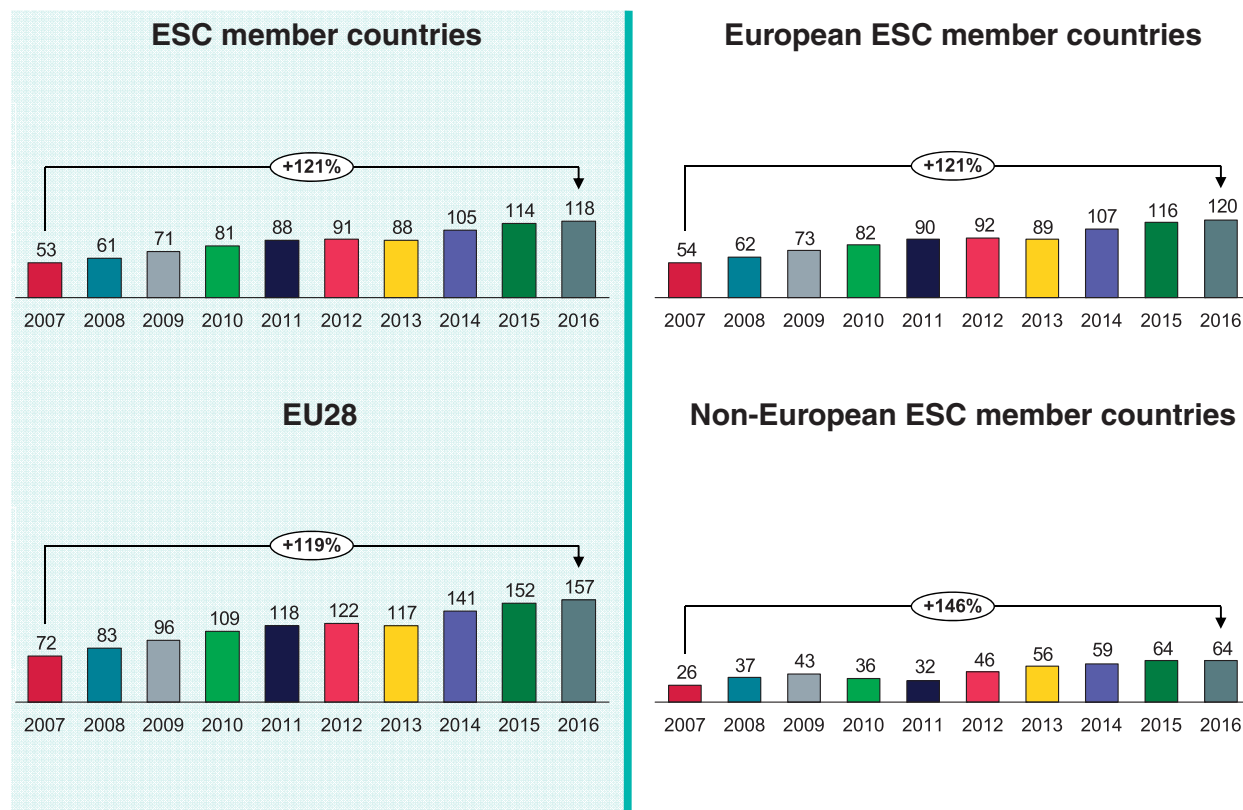


Figure 57 Cardiac resynchronization therapy device implantations per million inhabitants 2007-2016 in the European and non-European ESC member countries and comparison to the total ESC area and the 28 member countries of the European Union (EU28).

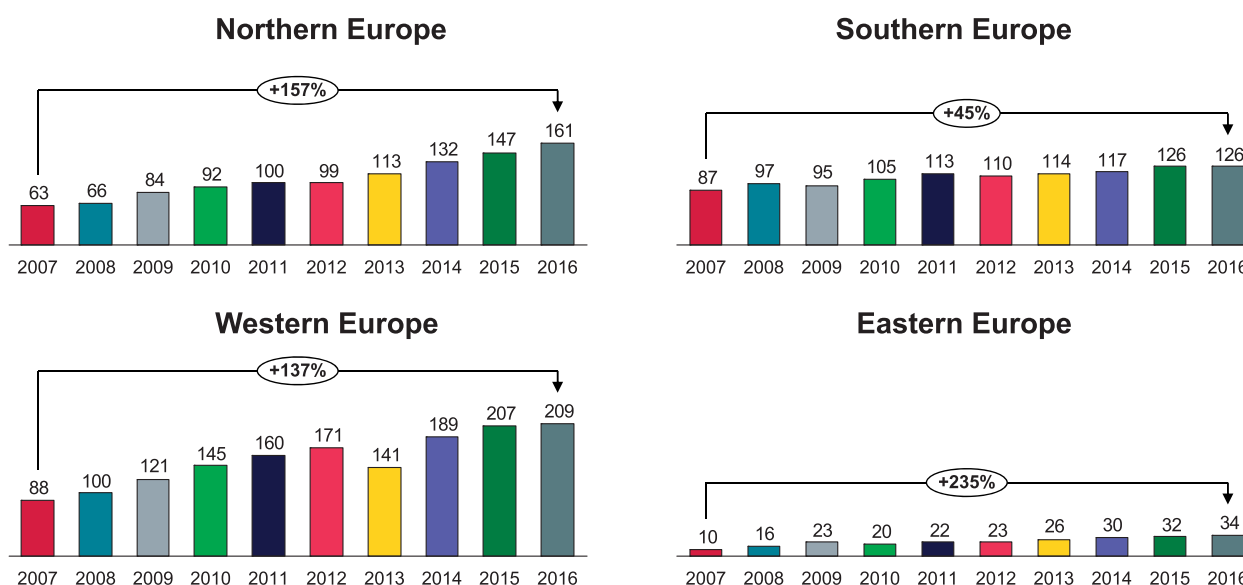


Figure 58 Cardiac resynchronization therapy device implantations per million inhabitants 2007-2016 in the four European ESC regions.

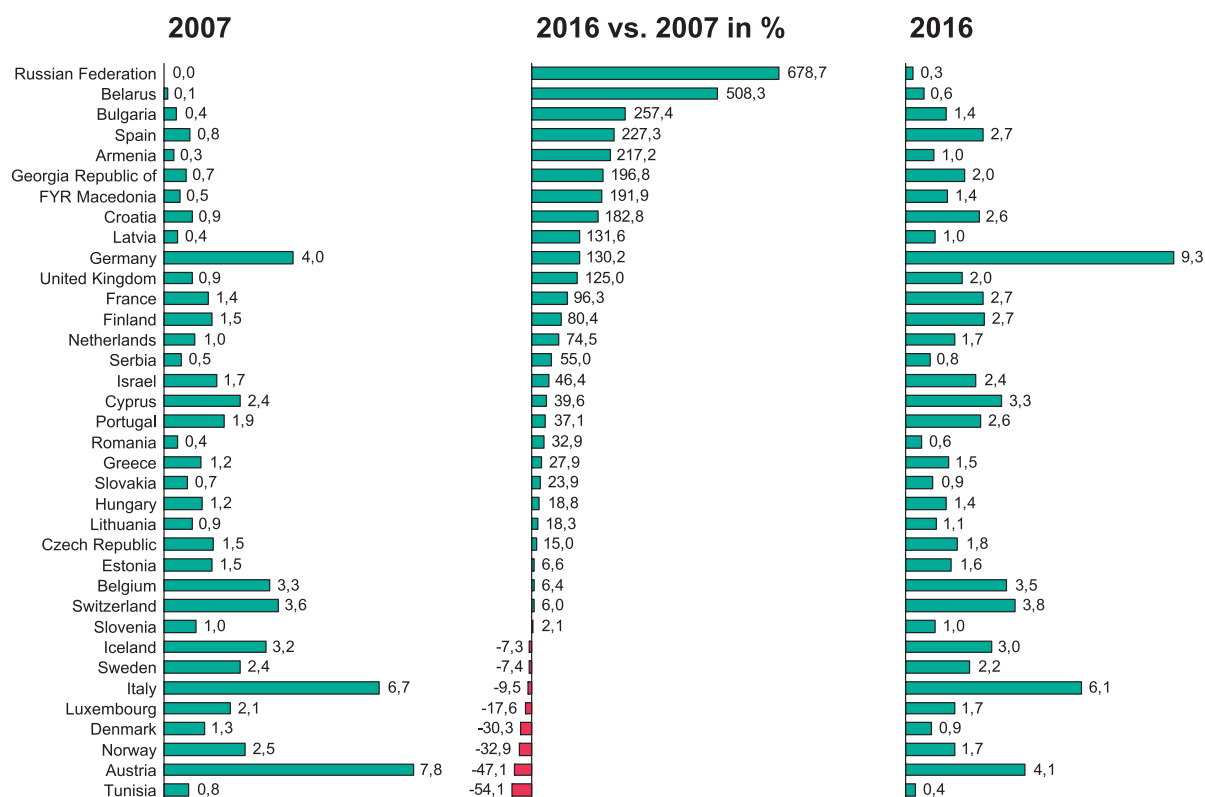


Figure 59 Change in the number of CRT implanting centres per million inhabitants from 2007 to 2016.

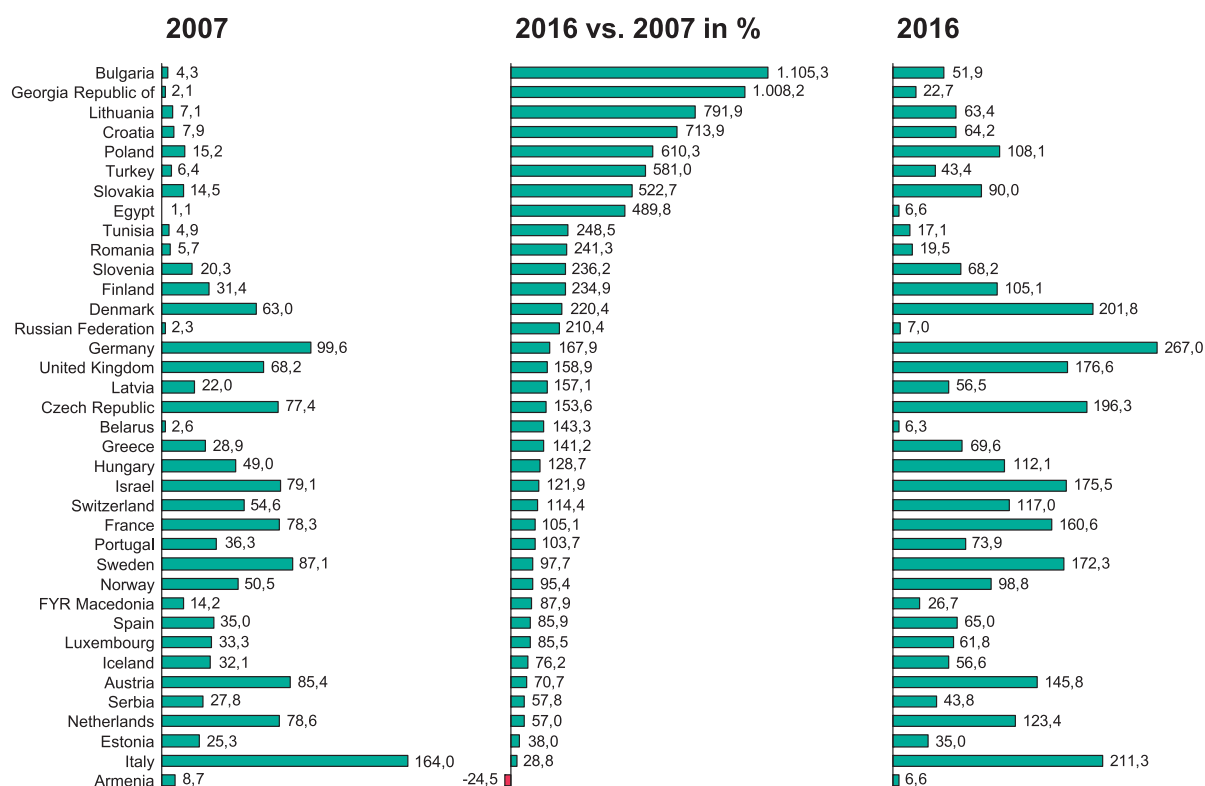
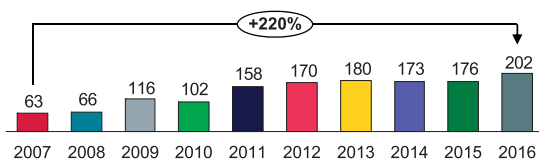


Figure 60 Change in the number of total CRT implantations per million inhabitants from 2007 to 2016.

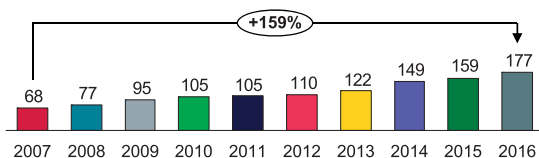
Northern Europe

TOP 3

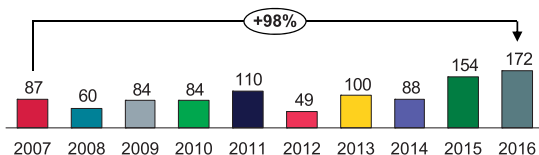
Denmark



United Kingdom

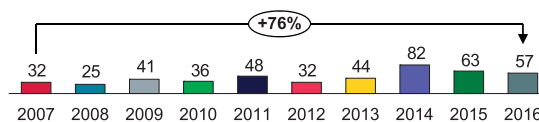


Sweden

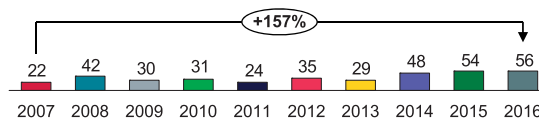


Lowest 3

Iceland



Latvia



Estonia

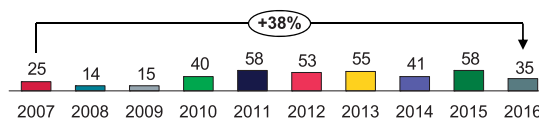
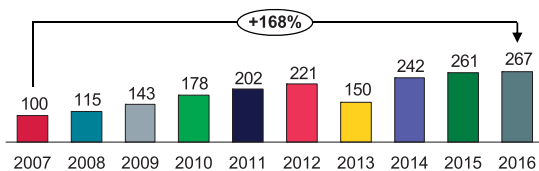


Figure 61 Cardiac resynchronization therapy implantations per million inhabitants 2007-2016 in Northern Europe.

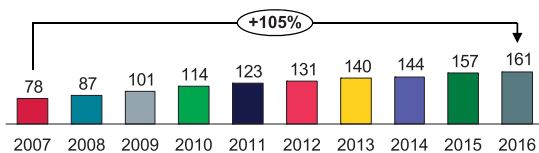
Western Europe

TOP 3

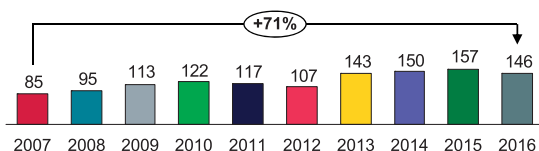
Germany



France

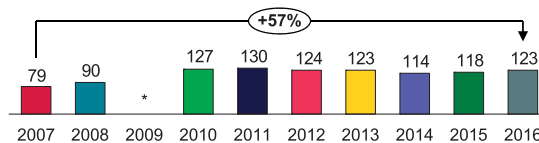


Austria

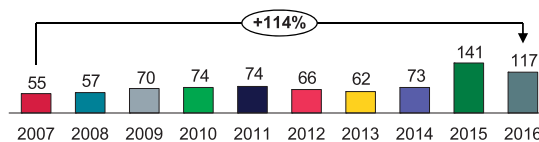


Lowest 3

Netherlands



Switzerland



Luxembourg

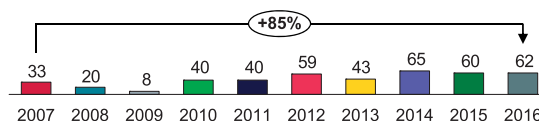
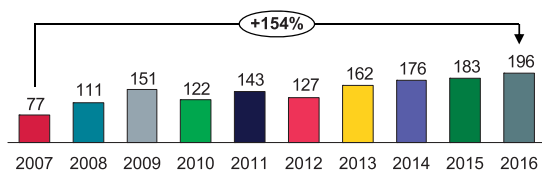


Figure 62 Cardiac resynchronization therapy implantations per million inhabitants 2007-2016 in Western Europe. *No data available.

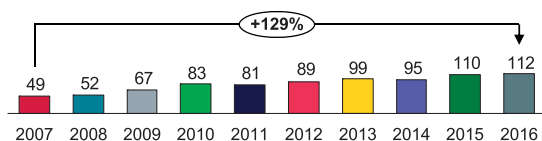
Eastern Europe

TOP 3

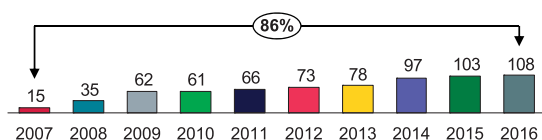
Czech Republic



Hungary

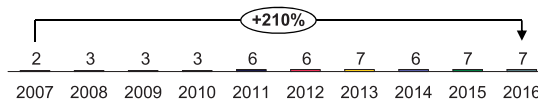


Poland

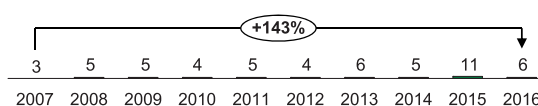


Lowest 3

Russian Federation



Belarus



Ukraine

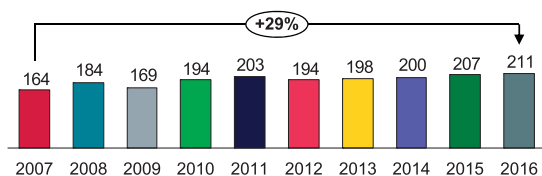


Figure 63 Cardiac resynchronization therapy implantations per million inhabitants 2007-2016 in Eastern Europe. *No data available.

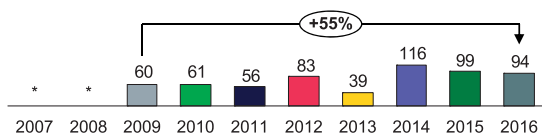
Southern Europe

TOP 3

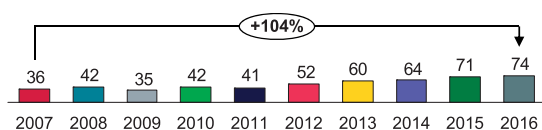
Italy



Malta

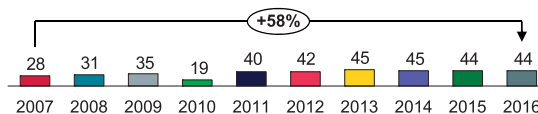


Portugal

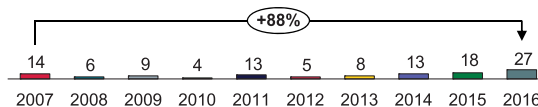


Lowest 3

Serbia



FYR Macedonia



Bosnia & Herzegovina

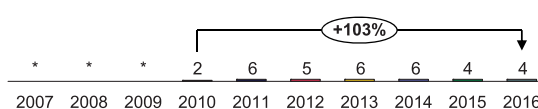
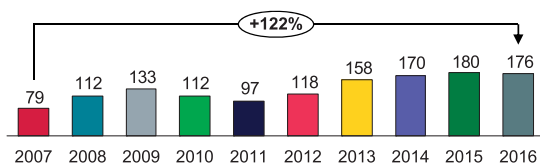


Figure 64 Cardiac resynchronization therapy implantations per million inhabitants 2007-2016 in Southern Europe. *No data available.

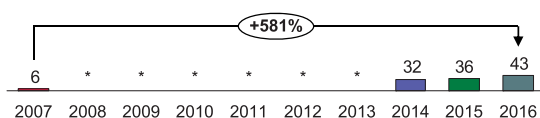
Non-European ESC member countries

TOP 3

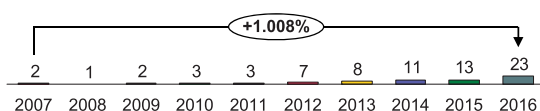
Israel



Turkey

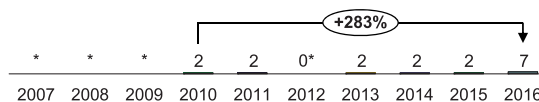


Georgia Republic of

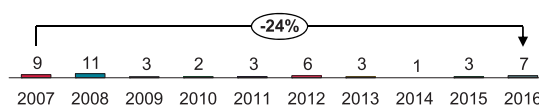


Lowest 3

Azerbaijan



Armenia



Morocco

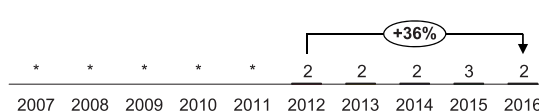


Figure 65 Cardiac resynchronization therapy implantations per million inhabitants 2007-2016 in the non-European ESC member countries. *No data available.

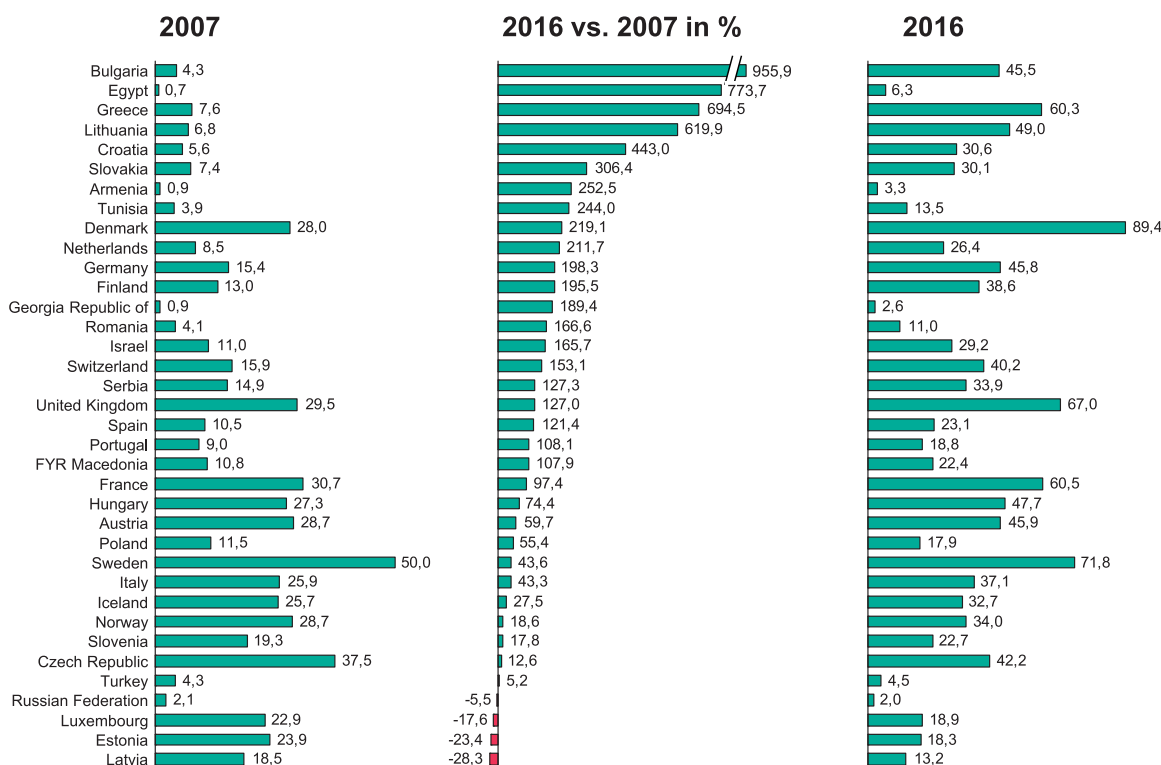


Figure 66 Change in the number of CRT-P implantations per million inhabitants from 2007 to 2016.

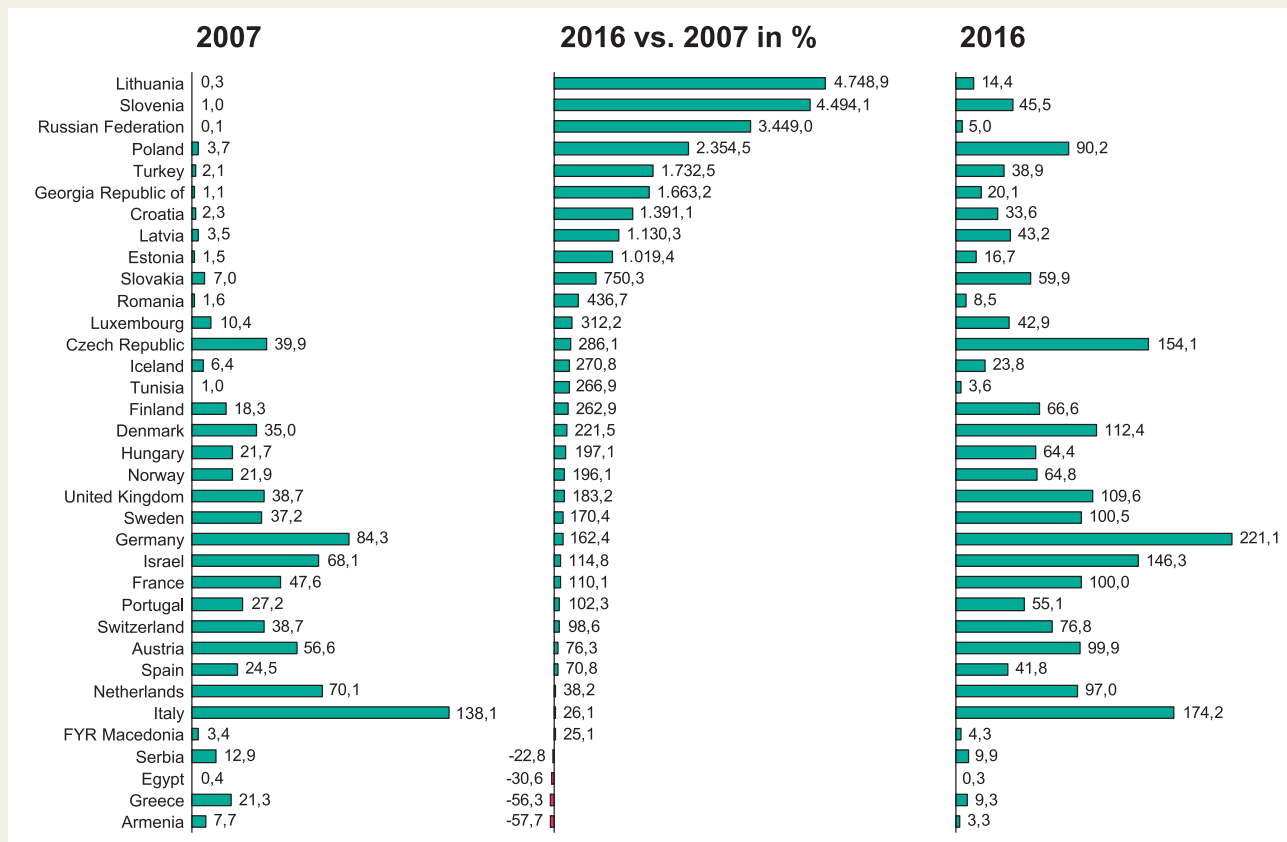


Figure 67 Change in the number of CRT-D implantations per million inhabitants from 2007 to 2016.

number of centres performing more than 10 ventricular tachyarrhythmia ablations per million population in patients with structural heart disease was highest in Germany (2.30) and lowest in Algeria (0.02) (Figure 97).

Most countries in the top quartile were from the Western Europe region, and the countries with the lowest activity were mainly from the non-European ESC region (Figure 98 and 99). The mean number of VT/VF ablations per million population in the ESC member countries was higher in 2016 (19) than in 2015 (16). It was markedly higher in Germany (118 per million population) than in any other ESC member country. Many countries did not report any data on VT/VF ablation ($n = 15$) and no VT/VF ablation were performed in five countries.

Percutaneous left atrial appendage closures

Percutaneous left atrial appendage (LAA) closure is an option of for preventing AF related thromboembolic complications among patients with high risk of bleeding and contraindications to oral anticoagulation therapy (15,16). In 2016 only 35 of the 56 ESC member countries (63%) submitted the requested data on LAA closures for the EHRA White Book. The mean number of centres performing LAA closures in the ESC area was 0.8 per million population (Figure 100). No LAA closures were performed in 12 countries. In the

countries performing LAA closures the mean number of procedures was slightly higher in 2016 than in 2015 (12.1 vs. 8.9 per million population). Germany was by far the most active country (63.2 LAA closure per million inhabitant) followed by San Marino (60.1) and Finland (24.2) (Figure 101). Of note is that in Kazakhstan, where the CIED implantation and catheter ablations numbers were quite low 3.8 LAA occlusions were performed per million inhabitants.

Discussion

This year we celebrate the 10-year anniversary of the EHRA White Book project. For a decade, the White Book has been a key resource for health care professionals and other stakeholders with an interest in the advancement of cardiac arrhythmia therapies in the ESC area. The White Book has formed the backbone for the “ICD for life” and many other strategic initiatives and awareness activities of the EHRA (17,18).

This is the first time that 10-year trends in the rate of CIED implantations and catheter ablation procedures in Europe have been presented in detail. Overall, procedure rates are lower in the non-European and Eastern European ESC member countries than in the other ESC regions. On the other hand, it was encouraging that in many arrhythmia therapies the growth rate over the past ten years was highest in the non-European and Eastern European regions.

Table 14 Lead extraction facilities and rates in 2016 and comparison with 4 previous years

Country	ISO code	Number of Lead extraction centres 2016		Number of Lead extraction procedures 2016		Development potential - target number of lead extraction procedures		Lead extraction procedures per million inhabitants				
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012	2013	2014	2015	2016
Albania	AL	2	0.66	4	1.32	44	75	N/A	N/A	N/A	N/A	1
Algeria	DZ	3	0.07	23	0.57	577	989	N/A	N/A	1	1	1
Armenia	AM	3	0.98	0	0.00	44	75	0	1	0	0	0
Austria	AT	6	0.69	300	34.44	—	—	27	30	34	29	34
Azerbaijan	AZ	1	0.10	3	0.30	141	243	N/A	1	1	1	0
Belarus	BY	4	0.42	59	6.16	137	235	4	N/A	1	1	6
Belgium*	BE	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bosnia & Herzegovina*	BA	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0	N/A
Bulgaria	BG	1	0.14	14	1.96	102	176	N/A	2	0	N/A	2
Croatia	HR	3	0.70	53	12.29	62	106	2	0	7	11	12
Cyprus	CY	2	1.66	3	2.49	17	30	0	2	3	3	2
Czech Republic	CZ	5	0.47	350	32.83	—	—	29	30	17	28	33
Denmark**	DK	4	0.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Egypt	EG	2	0.02	30	0.32	1356	2326	0	0	0	0	0
Estonia**	EE	2	1.59	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Finland**	FI	5	0.91	N/A	N/A	N/A	N/A	N/A	N/A	3	N/A	N/A
France	FR	40	0.60	2800	41.89	—	—	30	N/A	33	45	42
Georgia Republic of	GE	N/A	N/A	4	0.81	71	121	N/A	0	1	N/A	1
Germany	DE	126	1.56	2451	30.36	—	—	10	N/A	61	29	30
Greece	GR	5	0.46	70	6.50	154	265	2	3	5	5	6
Hungary	HU	8	0.81	145	14.68	—	243	7	13	10	11	15
Iceland	IS	0	0.00	0	0.00	5	8	0	0	3	0	0
Ireland**	IE	4	0.81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Israel	IL	5	0.61	90	11.01	117	201	0	N/A	10	10	11
Italy*	IT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kazakhstan	KZ	3	0.16	32	1.74	263	451	0	N/A	0	1	2
Kosovo*	XK	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A
Kyrgyzstan**	KGZ	3	0.52	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Latvia	LV	1	0.51	22	11.19	28	48	3	4	5	10	11
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	2	0.70	18	6.31	41	70	3	3	3	7	6
Luxembourg	LU	1	1.72	10	17.17	—	14	18	N/A	13	11	17
FYR Macedonia	MK	3	1.43	1	0.48	30	52	3	0	0	0	0

Continued

Table I4 Continued

Country	ISO code	Number of Lead extraction centres 2016		Number of Lead extraction procedures 2016		Development potential - target number of lead extraction procedures		Lead extraction procedures per million inhabitants				
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	To attain mean ESC area level	To attain mean EU-28 level	2012	2013	2014	2015	2016
Malta	MT	1	2.41	9	21.68	—	10	0	0	17	22	22
Moldova*	MD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A	N/A	N/A
Montenegro	ME	0	0.00	0	0.00	9	16	0	0	0	0	0
Morocco	MA	2	0.06	5	0.15	482	827	0	0	0	0	0
Netherlands	NL	12	0.71	400	23.51	—	418	N/A	24	30	7	24
Norway	NO	3	0.57	200	37.99	—	—	36	42	43	37	38
Poland	PL	22	0.57	1 272	33.02	—	—	14	12	16	27	33
Portugal	PT	6	0.55	91	8.40	155	266	N/A	N/A	N/A	N/A	8
Romania	RO	5	0.23	31	1.44	309	531	0	0	0	1	1
Russian Federation*	RU	N/A	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	1	30.04	—	—	0	0	N/A	0	30
Serbia	RS	1	0.14	24	3.36	102	176	7	5	9	4	3
Slovakia	SK	3	0.55	82	15.06	—	134	25	20	25	22	15
Slovenia**	SI	1	0.51	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spain	ES	35	0.72	400	8.24	696	1 193	N/A	N/A	N/A	8	8
Sweden	SE	5	0.51	275	27.83	—	—	22	51	46	N/A	28
Switzerland**	CH	8	0.98	N/A	N/A	N/A	N/A	N/A	11	11	N/A	N/A
Syria*	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	4	0.36	33	2.96	160	274	7	N/A	2	N/A	3
Turkey*	TR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	5	N/A
Ukraine	UA	9	0.20	69	1.56	633	1 086	1	1	1	1	2
United Kingdom*	GB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ESC member countries		361	0.53	9 374	14.33			5.42	5.53	5.91	7.61	8.73

*These 11 countries did not submit data on LE for the EHRA White Book 2017.

**These 7 countries only submitted data on LE centres for the EHRA White Book 2017.

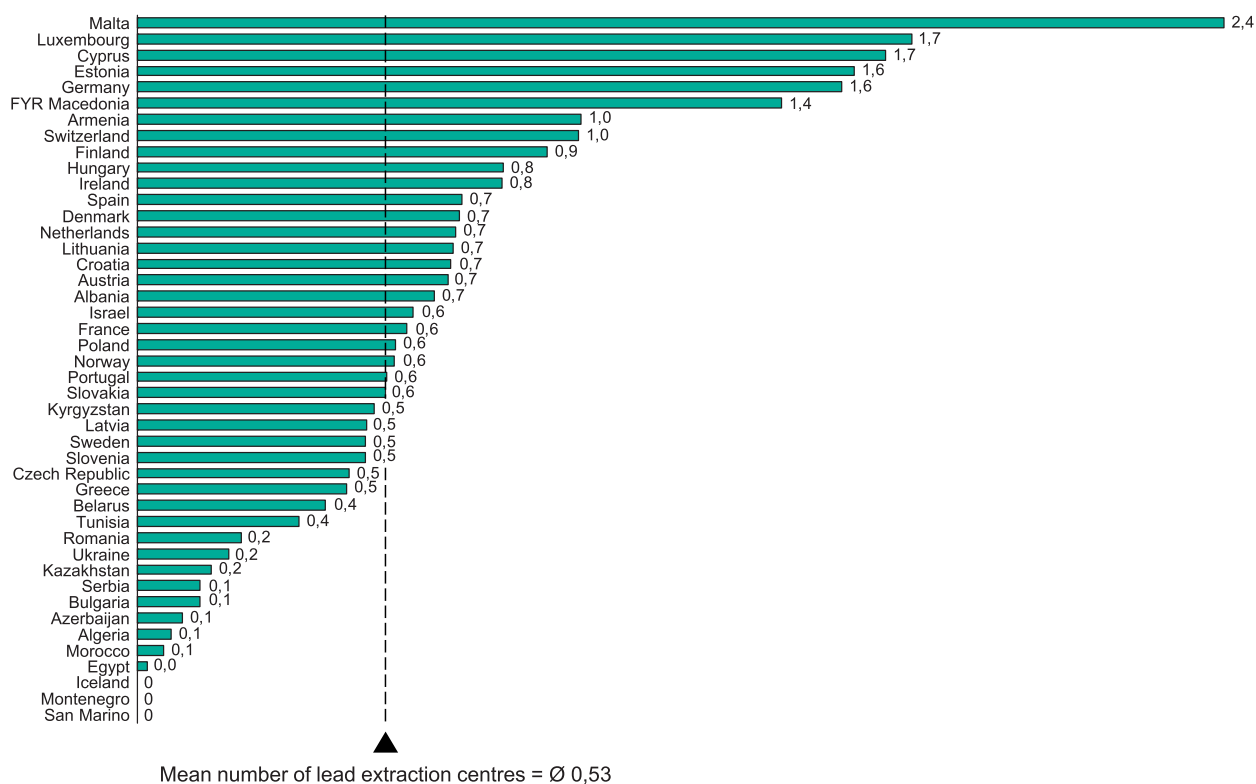


Figure 68 Lead extraction centres per million inhabitants in 2016. The mean number of lead extraction centres is weighted by population.

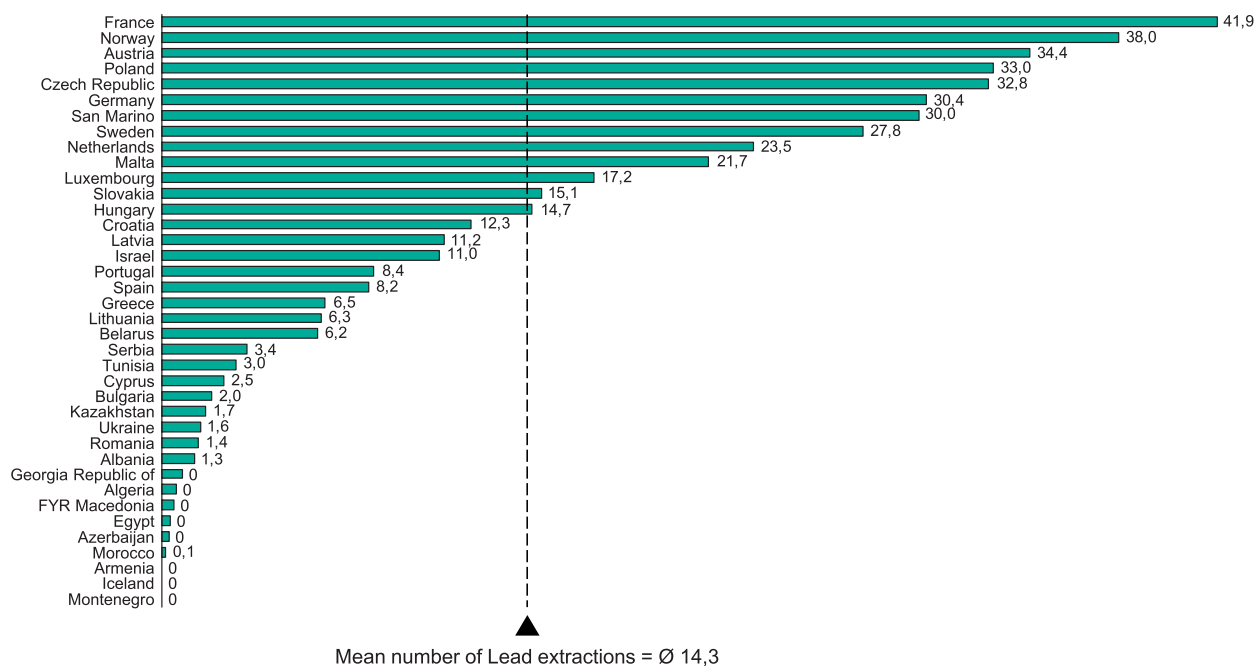


Figure 69 Lead extractions per million inhabitants in 2016. The mean number of lead extractions is weighted by population.

Table 15 Catheter ablation facilities and rates in 2016 and comparison to the four previous years

Country	ISO code	National Registry for EP	Number of ablation centres 2016		Ablation procedures 2016		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 EU-28 level	2012	2013	2014	2015	2016
Albania*	AL	No	2	0.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	No	3	0.07	374	9	11 614	17 792	N/A	6	6	8	9
Armenia	AM	No	3	0.98	52	17	880	1 348	23	46	43	16	17
Austria	AT	Yes	19	2.18	3 342	384	—	3 850	339	294	319	320	384
Azerbaijan	AZ	No	5	0.51	742	75	2 848	4 363	N/A	24	40	41	75
Belarus	BY	No	7	0.73	1 138	119	2 761	4 229	54	76	84	105	119
Belgium*	BE	No	N/A	N/A	N/A	N/A	N/A	N/A	564	580	586	626	N/A
Bosnia & Herzegovina*	BA	No	1	0.26	N/A	N/A	N/A	N/A	1	—	—	N/A	N/A
Bulgaria	BG	Yes	4	0.56	1 136	159	2 061	3 157	60	54	96	134	159
Croatia	HR	No	6	1.39	1 810	420	—	1 906	132	183	191	302	420
Cyprus	CY	No	4	3.32	78	65	348	533	35	39	121	50	65
Czech Republic	CZ	Yes	23	2.16	6 577	617	—	—	474	482	551	578	617
Denmark	DK	Yes	6	1.07	4 125	737	—	—	590	652	694	703	737
Egypt	EG	No	16	0.17	1 592	17	27 307	41 833	11	12	16	16	17
Estonia	EE	No	2	1.59	459	365	—	556	260	302	327	337	365
Finland	FI	No	9	1.64	2 957	538	—	—	418	418	422	466	538
France	FR	No	135	2.02	38 855	581	—	—	502	547	595	652	581
Georgia Republic of	GE	No	8	1.62	464	94	1 422	2 178	75	54	72	82	94
Germany	DE	No	293	3.63	80 661	999	—	—	467	412	741	789	999
Greece	GR	Yes	29	2.69	1 950	181	3 108	4 761	131	134	153	159	181
Hungary	HU	No	11	1.11	3 769	382	—	4 364	314	338	350	376	382
Iceland	IS	No	1	2.98	173	515	—	—	239	254	239	235	515
Ireland	IE	No	12	2.42	2 300	464	—	—	212	209	N/A	N/A	464
Israel*	IL	No	16	1.96	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Italy	IT	No	N/A	N/A	26 982	435	—	27 401	N/A	N/A	N/A	421	435
Kazakhstan	KZ	No	12	0.65	3 089	168	5 296	8 113	57	83	112	136	168
Kosovo*	XK	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kyrgyzstan	KGZ	No	1	0.17	21	4	1 652	2 531	N/A	N/A	10	10	4
Latvia	LV	Yes	2	1.02	697	355	—	869	269	238	295	365	355
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	24	36	N/A	N/A
Libya*	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	1.05	1 061	372	—	1 261	243	239	252	374	372
Luxembourg	LU	No	1	1.72	185	318	—	257	301	251	303	254	318

Continued

Table I5 Continued

Country	ISO code	National Registry for EP	Number of ablation centres 2016		Ablation procedures 2016		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 EU-28 level	2012	2013	2014	2015	2016
FYR Macedonia	MK	No	2	0.95	158	75	606	928	30	38	50	79	75
Malta	MT	No	1	2.41	37	89	120	183	24	29	73	77	89
Moldova*	MD	Yes	1	0.28	45	13	1013	1551	N/A		N/A	N/A	13
Montenegro	ME	No	1	1.55	80	124	186	285	149	69	102	128	124
Morocco	MA	N/A	5	0.15	200	6	9708	14872	7	5	5	2	6
Netherlands	NL	Yes	16	0.94	8750	514	—	—	382	N/A	495	502	514
Norway	NO	No	5	0.95	3307	628	—	—	530	507	575	589	628
Poland	PL	No	91	2.36	12439	323	—	17023	229	248	285	280	323
Portugal	PT	No	21	1.94	2974	275	3125	4787	186	191	215	238	275
Romania	RO	No	14	0.65	1180	55	6231	9545	50	60	62	55	55
Russian Federation	RU	Yes	72	0.51	22618	159	41063	62906	120	149	168	176	159
San Marino	SM	Yes	0	0.00	0	0	10	15					
Serbia	RS	Yes	4	0.56	1030	144	2061	3157	134	144	145	147	144
Slovakia	SK	Yes	4	0.73	1329	244	1571	2406	168	195	202	222	244
Slovenia	SI	Yes	2	1.01	639	323	—	874	136	140	220	359	323
Spain	ES	Yes	80	1.65	13378	275	14008	21460	236	257	270	267	275
Sweden	SE	No	11	1.11	4887	495	—	—	472	459	490	486	495
Switzerland	CH	Yes	25	3.06	6409	784	—	—	598	573	647	707	784
Syria*	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	TN	No	15	1.35	850	76	3212	4920	47	66	78	76	76
Turkey	TR	No	160	1.99	10920	136	23156	35473	N/A	N/A	144	165	136
Ukraine	UA	No	11	0.25	2342	53	12752	19536	55	60	54	52	53
United Kingdom	GB	Yes	66	1.02	18637	289	—	28471	254	251	276	275	289
Total ESC member countries			1 241	1.26	296 798	288			213	220	271	286	306

*These 8 countries submitted either incomplete or no data on catheter ablations for the EHRA White Book 2017.

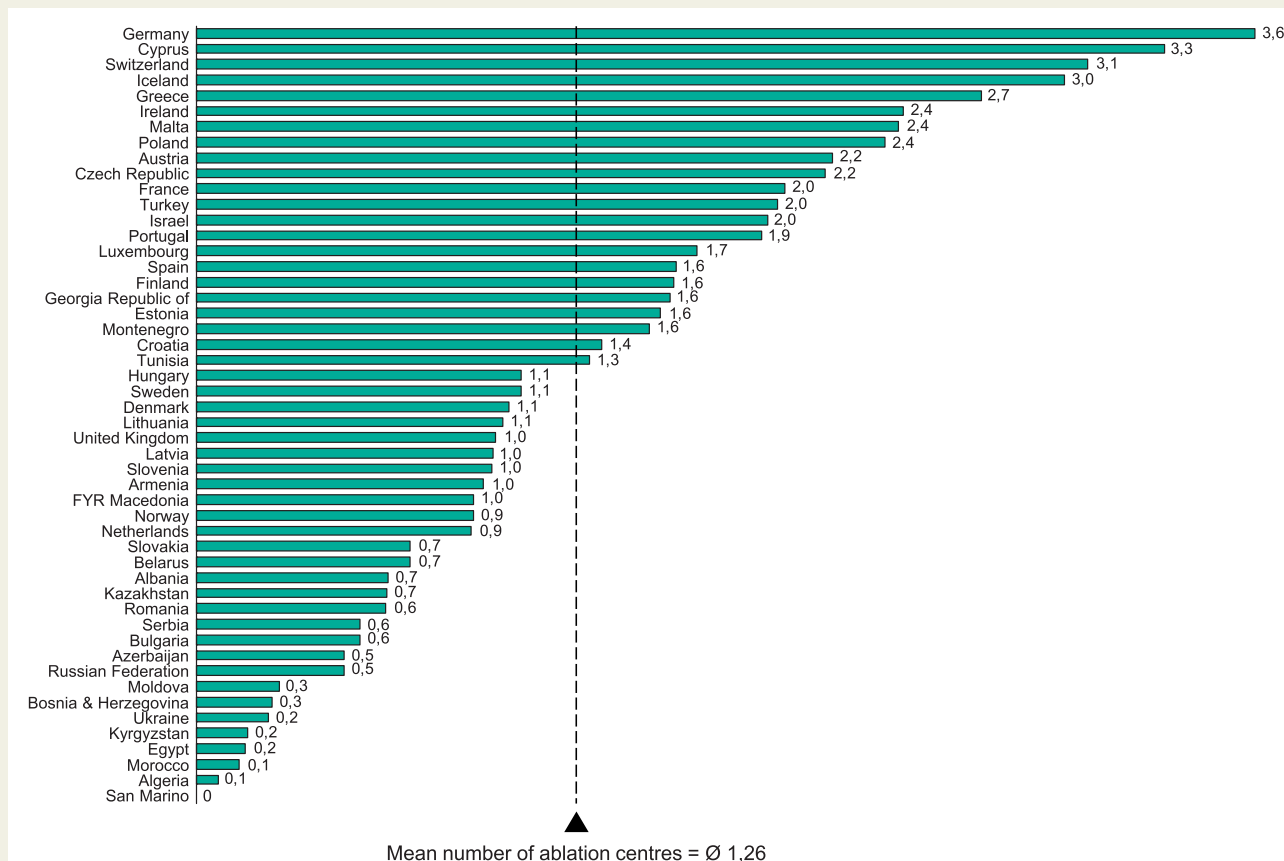


Figure 70 Catheter ablation centres per million inhabitants in 2016. The mean number of catheter ablation centres is weighted by population.

Geographical variations in the access to and use of arrhythmia therapies

The current analysis of the EHRA White Book data indicate that considerable variations in access to and use of invasive electrophysiological procedures continue to be the case within the ESC area. Despite several improvements over the past 10 years, there is still a clear need to increase the availability of procedures for complex arrhythmias in many ESC member countries. As in previous years, the mean CIED implantation rates were markedly lower in the Eastern European and non-European ESC member countries than in the other regions. Likewise, the catheter ablation activity was substantially higher in the Western and Northern European than in the non-European ESC member countries. The Eastern European ESC region was characterised by large variations in the procedure rates, with numbers spanning over all four quartiles of the activity distribution.

The rate of growth for PM implantations over the past decade was comparatively high in the Eastern and non-European regions. The growth in the number of ICD implantation was, along these lines, most impressive in the Eastern region. This trend is especially positive and implies that the EHRA initiatives like the “ICD for life” are potentially beneficial. The same applies to the CRT therapy where the implantation rate has also increased significantly in the Eastern region. For catheter ablation, the growth rate was quite similar across the ESC regions except for the Southern European region where the growth rate was

lower than in the other areas. On the other hand, the growth in AF ablation rate was more than 400% in the Southern region - second only to the growth in the non-European ESC member countries.

Possible explanations for the disparities in arrhythmia care among the ESC member countries

As is shown in Figure 3 the healthcare expenditure currently amounts to 4.4 to 11.9% of GDP in the ESC member 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 member countries with regards to CIED implantation and catheter ablation facilities and rates.

Almost through the whole decade of data collection for the White Book project, an important limitation for improvements in arrhythmia management across the ESC area has been a difficult economic situation. Following the financial collapse in the autumn of 2008 many countries had to make substantial cuts in their healthcare budget (19–21). At the same time, the number of elderly people requiring complex medical and different social services has grown rapidly. In this context, socioeconomic disparities pose a major threat to the required growth of healthcare systems, and may even limit the use of innovative technologies such as ICD therapy for primary prevention of sudden cardiac death and catheter ablation of AF and VT.

Table 16 Change in the number of ablation centres in from 2015 to 2016

Country	ISO code	Number of ablation centres 2015		Number of ablation centres 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania	AL	N/A	N/A	2	0.66	N/A
Algeria	DZ	3	0.08	3	0.07	-1.8%
Armenia	AM	3	0.98	3	0.98	0.2%
Austria	AT	19	2.19	19	2.18	-0.5%
Azerbaijan	AZ	5	0.51	5	0.51	-0.9%
Belarus	BY	7	0.74	7	0.73	-0.8%
Belgium*	BE	N/A	N/A	N/A	N/A	N/A
Bosnia & Herzegovina	BA	1	0.26	1	0.26	0.1%
Bulgaria	BG	5	0.70	4	0.56	-19.5%
Croatia	HR	6	1.34	6	1.39	3.5%
Cyprus	CY	3	2.52	4	3.32	31.5%
Czech Republic	CZ	23	2.16	23	2.16	-0.2%
Denmark	DK	6	1.07	6	1.07	-0.2%
Egypt	EG	15	0.17	16	0.17	-0.3%
Estonia	EE	2	1.58	2	1.59	0.5%
Finland	FI	9	1.64	9	1.64	-0.4%
France	FR	196	2.94	135	2.02	-31.4%
Georgia Republic of	GE	8	1.62	8	1.62	0.1%
Germany	DE	346	4.28	293	3.63	-15.2%
Greece	GR	29	2.69	29	2.69	0.0%
Hungary	HU	11	1.11	11	1.11	0.2%
Iceland	IS	1	3.01	1	2.98	-1.2%
Ireland	IE	12	2.45	12	2.42	-1.2%
Israel	IL	16	1.99	16	1.96	-1.5%
Italy*	IT	N/A	N/A	N/A	N/A	N/A
Kazakhstan	KZ	13	0.72	12	0.65	-8.7%
Kosovo*	XK	N/A	N/A	N/A	N/A	N/A
Kyrgyzstan	KGZ	2	0.34	1	0.17	-48.0%
Latvia	LV	2	1.01	2	1.02	1.1%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	3	1.04	3	1.05	1.1%
Luxembourg	LU	1	1.75	1	1.72	-2.1%
FYR Macedonia	MK	2	0.95	2	0.95	-0.2%
Malta	MT	1	2.42	1	2.41	-0.3%
Moldova	MD	N/A	N/A	1	0.28	N/A
Montenegro	ME	1	1.55	1	1.55	0.4%
Morocco	MA	5	0.15	5	0.15	-1.0%
Netherlands	NL	16	0.94	16	0.94	-0.4%
Norway	NO	5	0.96	5	0.95	-1.1%
Poland	PL	85	2.20	91	2.36	7.2%
Portugal	PT	25	2.31	21	1.94	-16.1%
Romania	RO	12	0.55	14	0.65	17.0%
Russian Federation	RU	69	0.48	72	0.51	4.4%
San Marino	SM	0	0	0	0.00	0.0%
Serbia	RS	3	0.42	4	0.56	33.9%
Slovakia	SK	4	0.74	4	0.73	-0.5%
Slovenia	SI	3	1.51	2	1.01	-33.2%
Spain	ES	80	1.66	80	1.65	-0.9%
Sweden	SE	N/A	N/A	11	1.11	N/A
Switzerland	CH	25	3.08	25	3.06	-0.7%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	N/A	N/A	15	1.35	N/A
Turkey	TR	N/A	N/A	160	1.99	N/A
Ukraine	UA	11	0.25	11	0.25	0.5%
United Kingdom	GB	65	1.01	66	1.02	1.0%
Total ESC member countries		1 159	1.34	1 241	1.26	-5.6%

*These 6 countries did not submit any data on ablation centres for the EHRA White Book 2017.

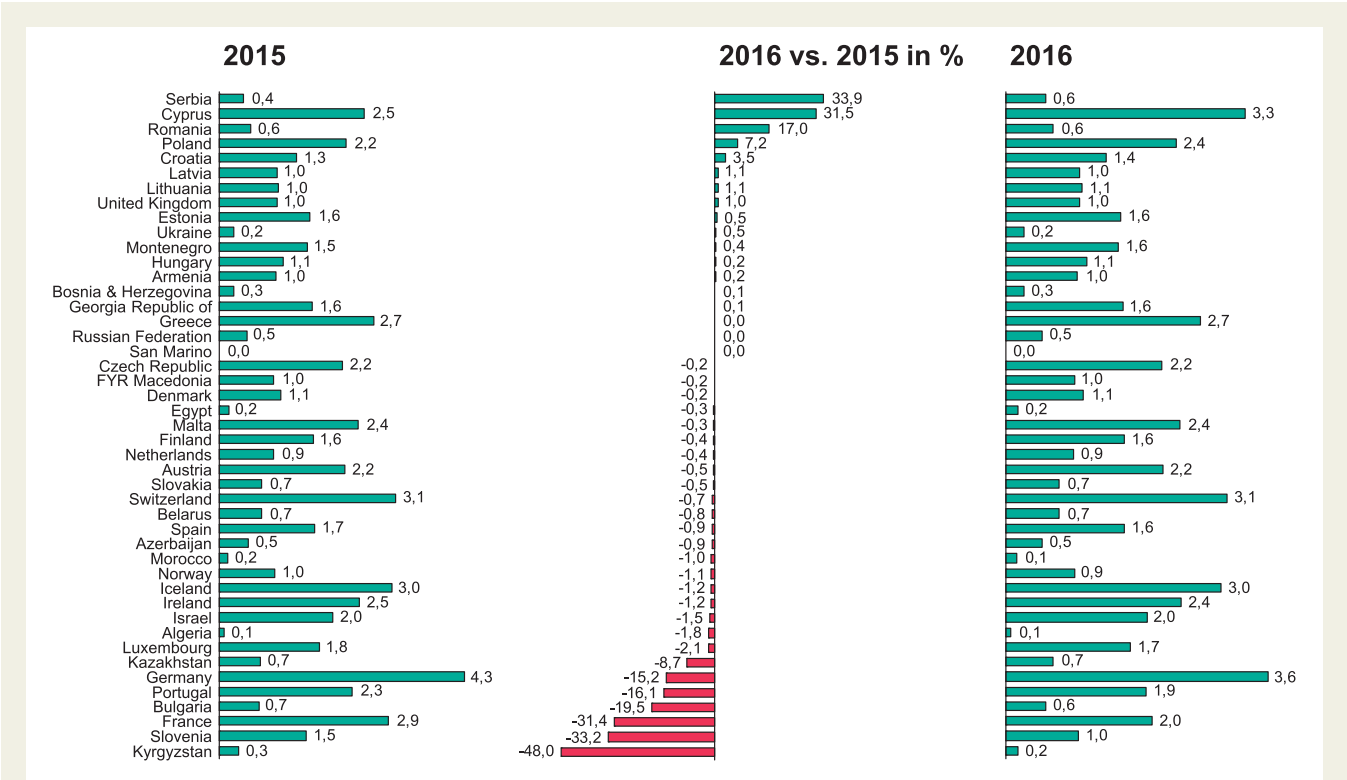


Figure 71 Change in the number of catheter ablation centres per million inhabitants from 2015 to 2016.

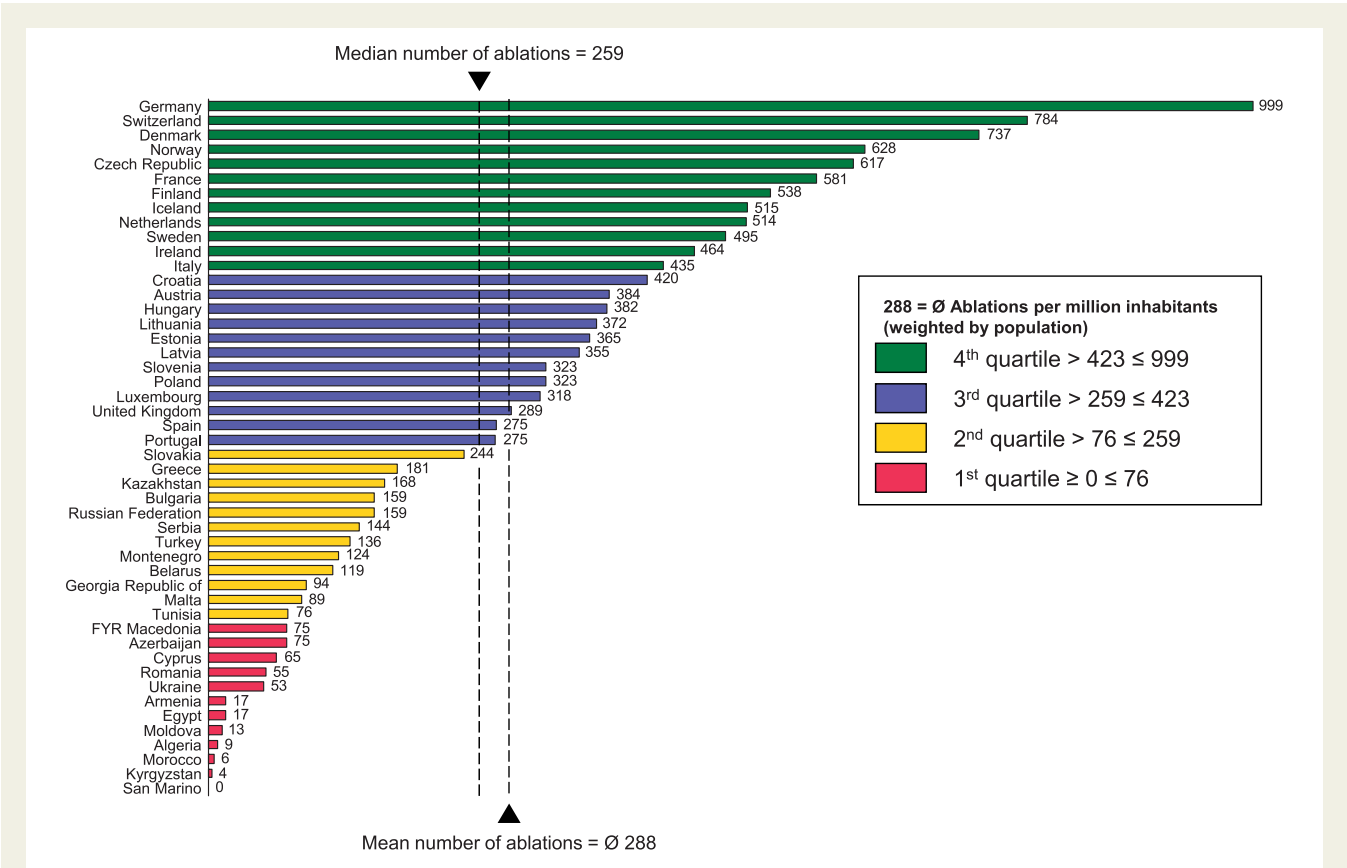


Figure 72 Catheter ablations per million inhabitants in 2016. The mean number of ablations is weighted by population.

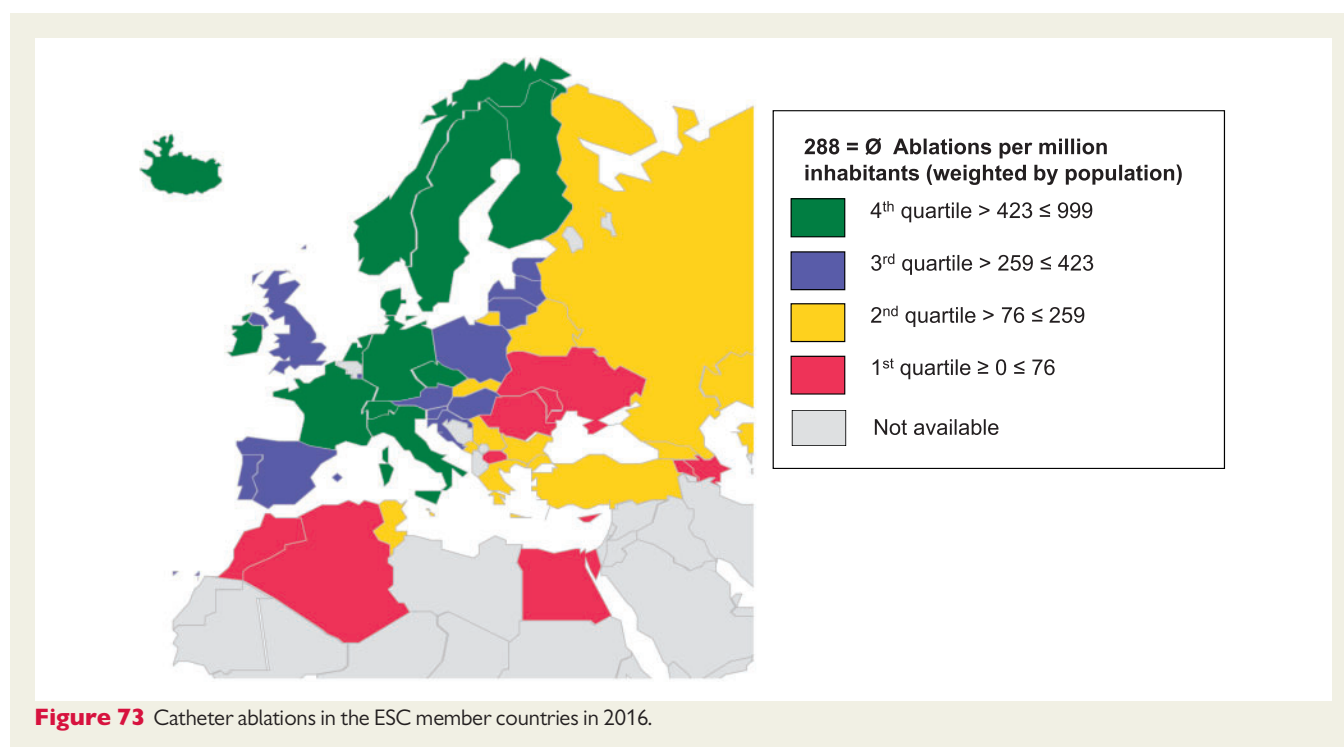


Figure 73 Catheter ablations in the ESC member countries in 2016.

Data on health expenditures and CIED implantation rate per capita indicate that a low proportion of GDP spent on healthcare is associated with a lower use of device therapy and complex interventional electrophysiology procedures (Figure 102). 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. A good example of this is Czech Republic which was in the most active quartile for ICD and CRT therapy and AF ablations. Furthermore, despite the ongoing economic constraints across Europe 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 in some cases even declined slightly. It is unclear whether this is a consequence of healthcare budget limitations or simply that supply is meeting the demand or a combination of both. Nevertheless, these data indicate that high GDP is not the only driver for early adaptation of novel healthcare innovations with relatively high initial cost. Other potential explanations for the observed disparity include lack of manpower, training opportunities, facilities and low referral rates. A personal co-payment for the procedures may additionally limit access to CIED and catheter ablation therapies in countries not providing full coverage for the whole population.

Evolving areas in cardiac arrhythmia therapy

In the future, the key areas for growth in invasive arrhythmia care include ablation of ventricular arrhythmias in patients with structural heart disease and novel therapeutic modalities such as left atrial

appendage closure devices, leadless pacemakers and subcutaneous implantable defibrillators. These innovative medical technologies have a high initial cost. Therefore, their efficacy and safety need to be proven before they can reach wide acceptance and clinical use. However, one of the main issues in analysing the current use of the evolving arrhythmia therapies was that many countries did not report data on these developing therapies.

Leadless pacing has recently been introduced in many ESC member countries. The most active countries in the ESC area with regards to leadless pacemaker implantations were France and the Netherlands, which were active also in the studies evaluating the safety and efficacy of this therapy (9,10). Although the overall implantation rates were rather low also in these early adopters, the use of leadless pacing is expected to gradually grow in the coming years, especially if the dual chamber option proves successful.

The results of numerous randomised, multicentre trials have established the role of traditional ICD therapy in both primary and secondary prevention of sudden cardiac death (22). Still, access to this potentially life-saving therapy differs widely among the ESC member countries, as documented in the White Book. Transvenous ICD leads have significant short- and long-term complications, offsetting some of the benefit of this therapy. This has led to the development of an entirely subcutaneous ICD (11). This was the second year that the White Book questionnaire asked about S-ICD implantation. The S-ICD implantation rate almost doubled from the previous year, suggesting increasing acceptance of this therapy.

Yet another important evolving area in arrhythmia management is the use of percutaneous LAA closure devices to prevent AF related thromboembolic complications (15,16). According a recent meta-analysis LAA occlusion is a viable alternative to anticoagulation with warfarin in patients at high risk of thromboembolic and bleeding

Table 17 Change in the number of catheter ablations from 2015 to 2016

Country	ISO code	Total ablations 2015		Total ablations 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania*	AL	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	303	8	374	9	21.2%
Armenia	AM	48	16	52	17	8.5%
Austria	AT	2 777	320	3 342	384	19.7%
Azerbaijan	AZ	398	41	742	75	84.7%
Belarus	BY	993	105	1 138	119	13.7%
Belgium*	BE	7 091	626	N/A	N/A	N/A
Bosnia & Herzegovina*	BA	N/A	N/A	N/A	N/A	N/A
Bulgaria	BG	961	134	1 136	159	18.9%
Croatia	HR	1 348	302	1 810	420	39.0%
Cyprus	CY	60	50	78	65	28.2%
Czech Republic	CZ	6 158	578	6 577	617	6.6%
Denmark	DK	3 925	703	4 125	737	4.9%
Egypt	EG	1 448	16	1 592	17	2.8%
Estonia	EE	426	337	459	365	8.3%
Finland	FI	2 550	466	2 957	538	15.5%
France	FR	43 414	652	38 855	581	-10.9%
Georgia Republic of	GE	403	82	464	94	15.2%
Germany	DE	63 790	789	80 661	999	26.7%
Greece	GR	1 710	159	1 950	181	14.1%
Hungary	HU	3 723	376	3 769	382	1.5%
Iceland	IS	78	235	173	515	119.2%
Ireland	IE	N/A	N/A	2 300	464	N/A
Israel*	IL	N/A	N/A	N/A	N/A	N/A
Italy	IT	26 044	421	26 982	435	3.3%
Kazakhstan	KZ	2 461	136	3 089	168	24.1%
Kosovo*	XK	N/A	N/A	N/A	N/A	N/A
Kyrgyzstan	KGZ	59	10	21	4	-63.0%
Latvia	LV	726	365	697	355	-3.0%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	1 078	374	1 061	372	-0.5%
Luxembourg	LU	145	254	185	318	24.9%
FYR Macedonia	MK	166	79	158	75	-5.0%
Malta	MT	32	77	37	89	15.3%
Moldova	MD	N/A	N/A	45	13	N/A
Montenegro	ME	83	128	80	124	-3.2%
Morocco	MA	60	2	200	6	230.0%
Netherlands	NL	8 500	502	8 750	514	2.5%
Norway	NO	3 067	589	3 307	628	6.6%
Poland	PL	10 795	280	12 439	323	15.3%
Portugal	PT	2 580	238	2 974	275	15.2%
Romania	RO	1 194	55	1 180	55	-0.9%
Russian Federation	RU	25 020	176	22 618	159	-9.6%
San Marino	SM	0	0	0	0	0.0%
Serbia	RS	1 052	147	1 030	144	-1.6%
Slovakia	SK	1 204	222	1 329	244	9.8%
Slovenia	SI	712	359	639	323	-10.0%
Spain	ES	12 863	267	13 378	275	3.1%
Sweden	SE	4 764	486	4 887	495	1.8%
Switzerland	CH	5 746	707	6 409	784	10.8%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	840	76	850	76	0.3%
Turkey	TR	13 000	165	10 920	136	-17.6%
Ukraine	UA	2 294	52	2 342	53	2.6%
United Kingdom	GB	17 622	275	18 637	289	5.2%
Total ESC member countries		283 711	278	296 798	288	3.9%

*These 8 countries did not submit any data on ablations for the EHRA White Book 2017.

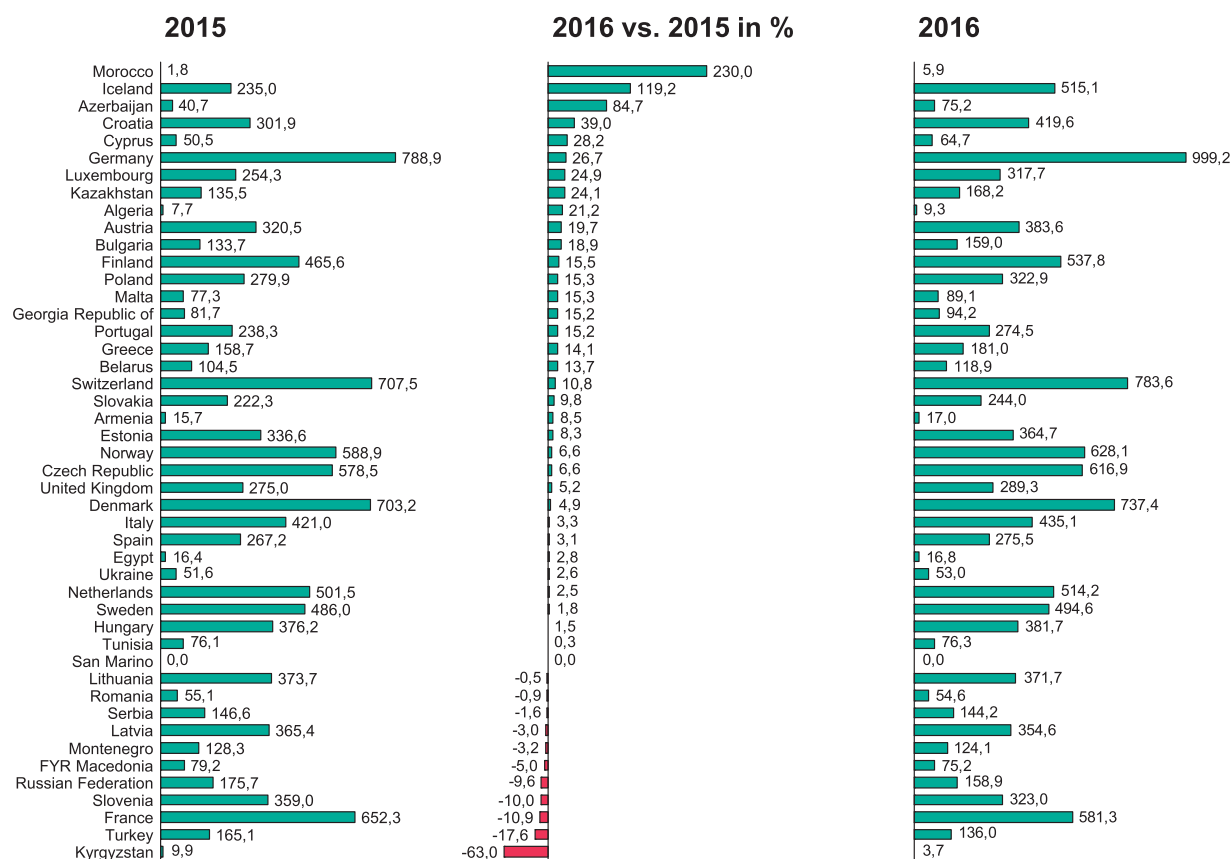


Figure 74 Change in the number of catheter ablations per million inhabitants from 2015 to 2016.

Ablations per million inhabitants

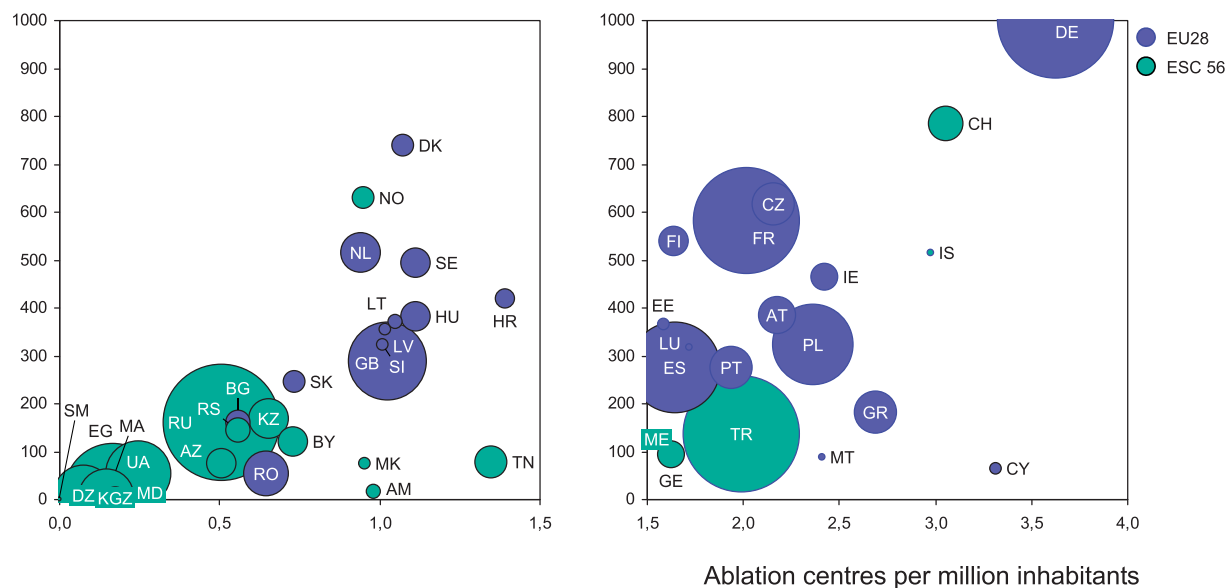


Figure 75 Catheter ablation centres and rates in the ESC and European Union (EU28) member countries in 2016. Bubble size is related to population in the country.

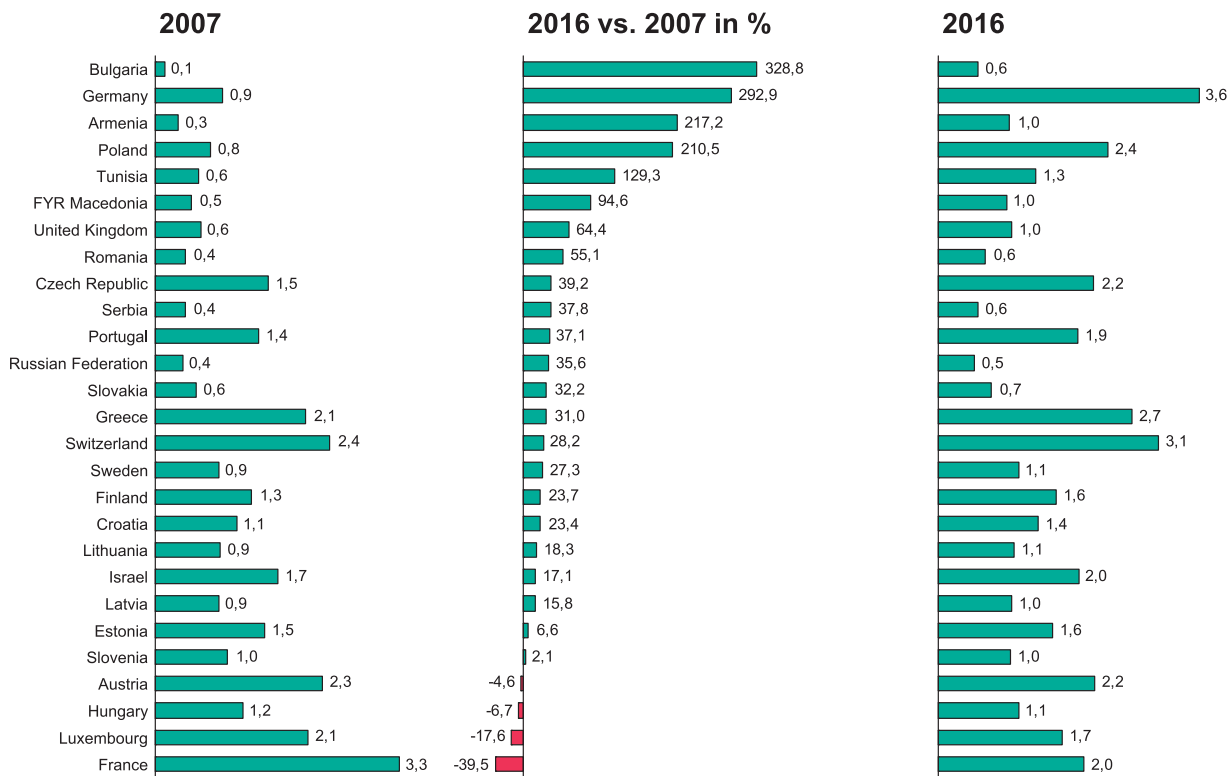


Figure 76 Change in the number of catheter ablation centres per million inhabitants from 2007 to 2016.

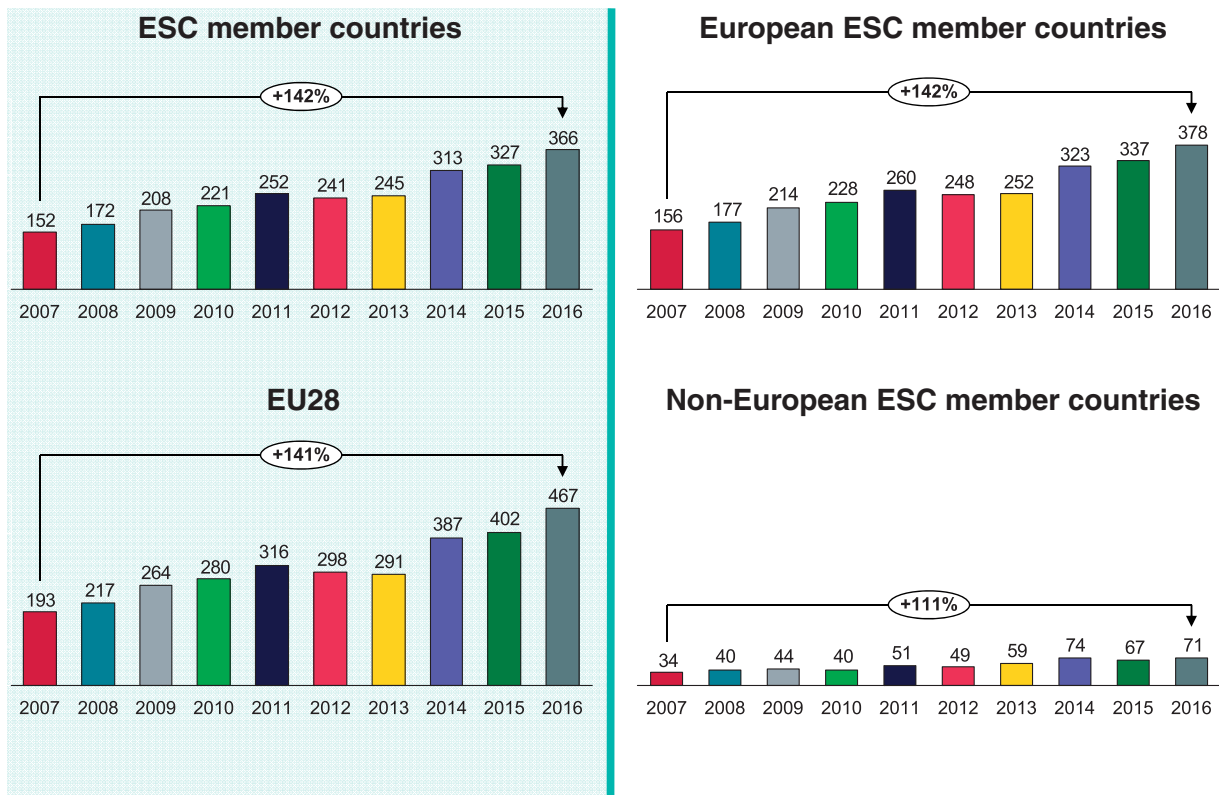


Figure 77 Catheter ablations per million inhabitants 2007-2016 in the European and non-European ESC member countries and comparison to the total ESC area and the 28 member countries of the European Union (EU28).



Figure 78 Catheter ablations per million inhabitants 2007-2016 in the four geographical regions of the ESC.

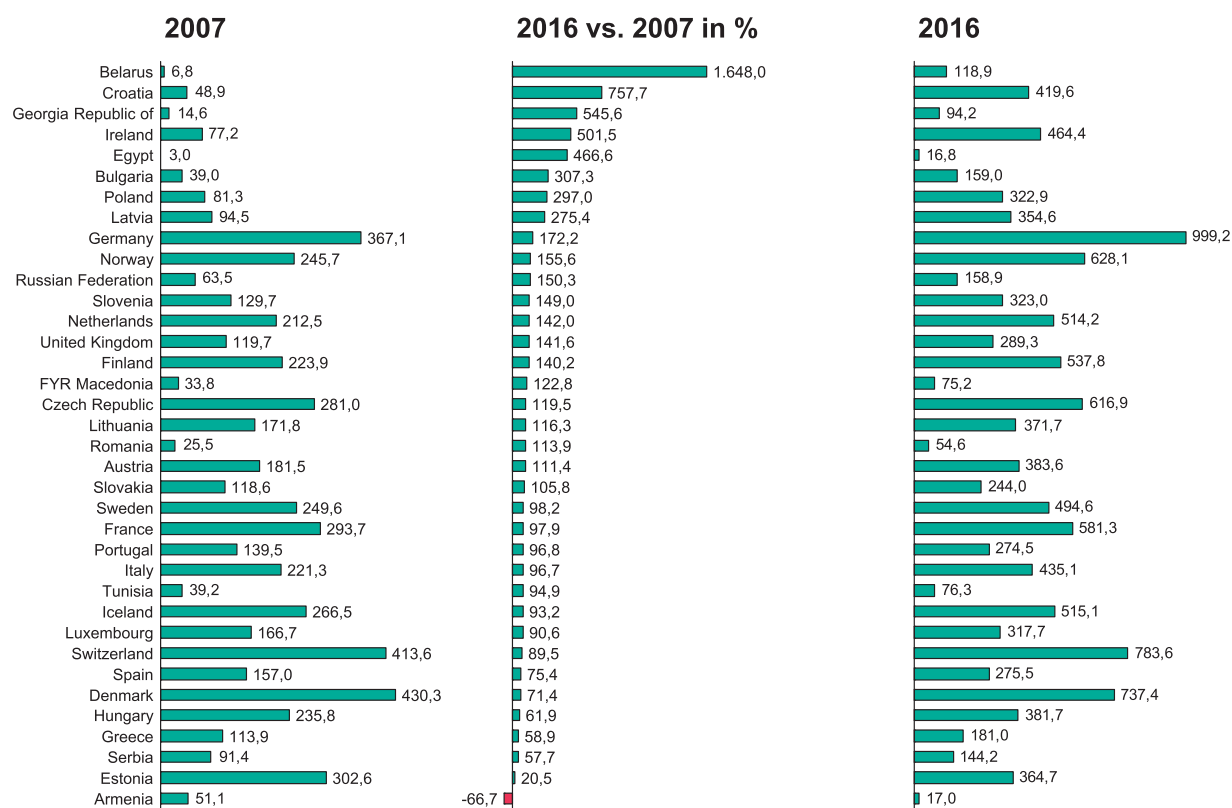
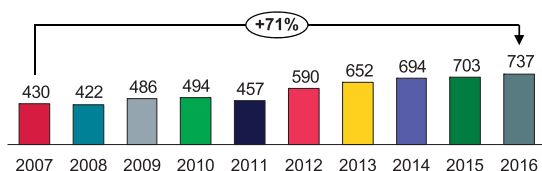


Figure 79 Change in the number of catheter ablations per million inhabitants from 2007 to 2016.

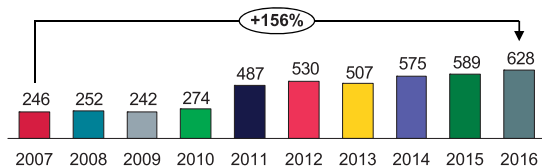
Northern Europe

TOP 3

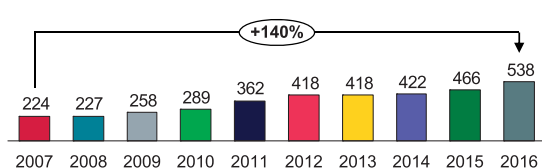
Denmark



Norway

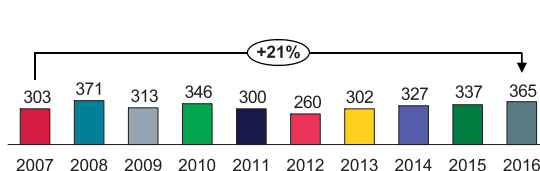


Finland

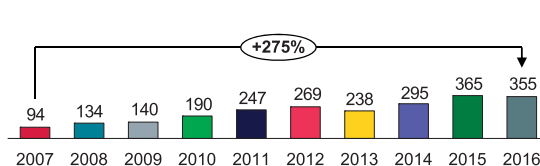


Lowest 3

Estonia



Latvia



United Kingdom

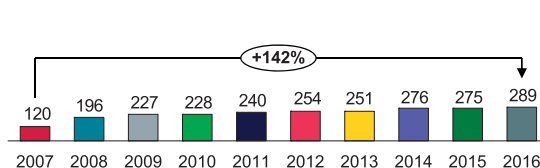
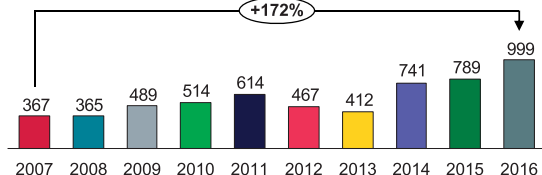


Figure 80 Catheter ablations per million inhabitants 2007-2016 in Northern Europe.

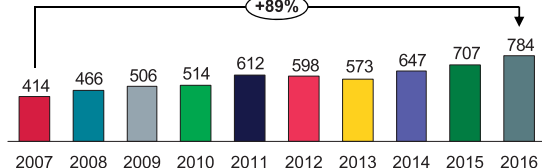
Western Europe

TOP 3

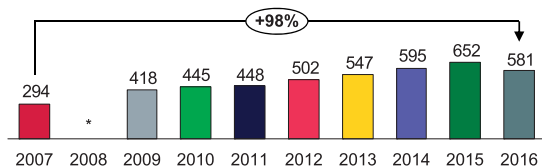
Germany



Switzerland

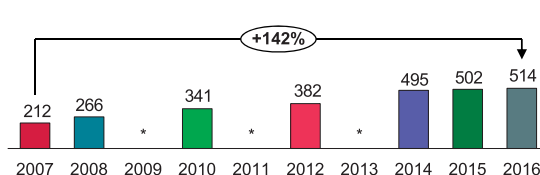


France

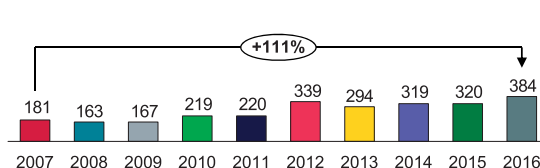


Lowest 3

Netherlands



Austria



Luxembourg

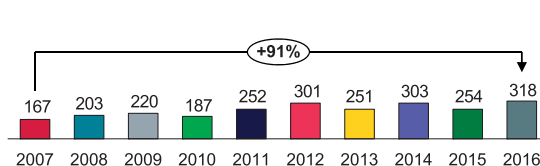
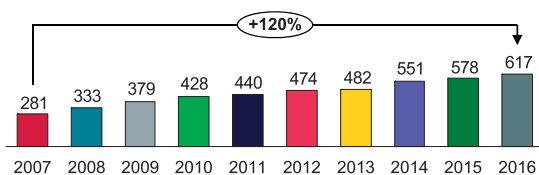


Figure 81 Catheter ablations per million inhabitants 2007-2016 in Western Europe. *No data available.

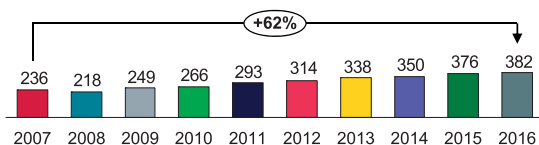
Eastern Europe

TOP 3

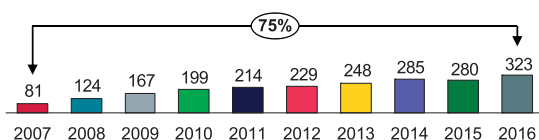
Czech Republic



Hungary

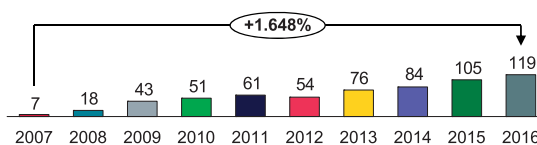


Poland

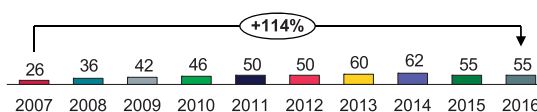


Lowest 3

Belarus



Romania



Ukraine

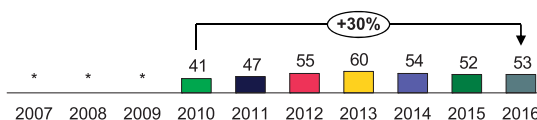
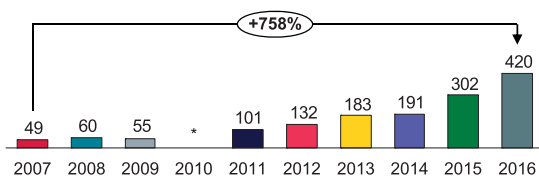


Figure 82 Catheter ablations per million inhabitants 2007-2016 in Eastern Europe. *No data available.

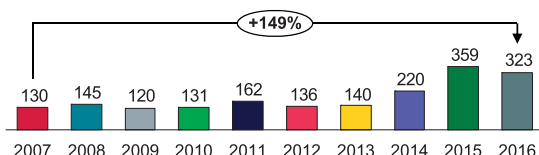
Southern Europe

TOP 3

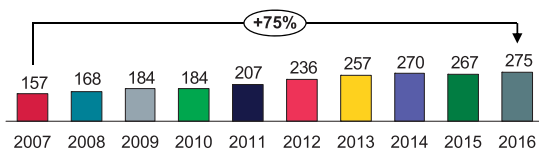
Croatia



Slovenia

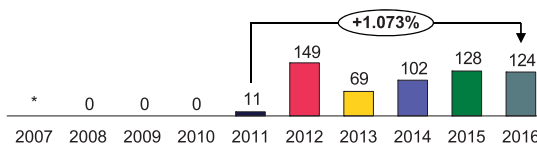


Spain

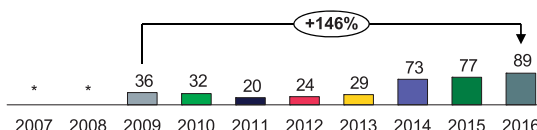


Lowest 3

Montenegro



Malta



FYR Macedonia

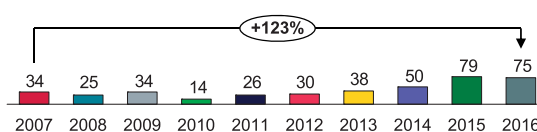
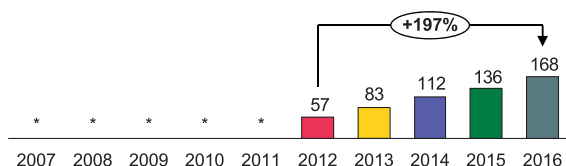


Figure 83 Catheter ablations per million inhabitants 2007-2016 in Southern Europe. *No data available.

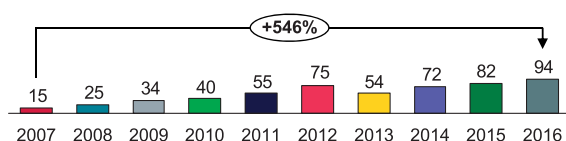
Non-European ESC member countries

TOP 3

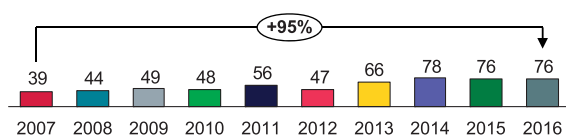
Kazakhstan



Georgia Republic of

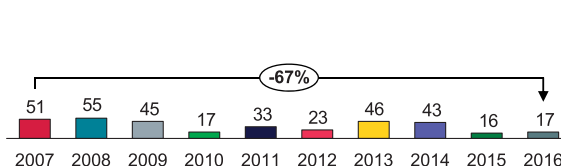


Tunisia

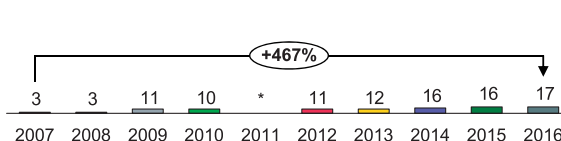


Lowest 3

Armenia



Egypt



Morocco

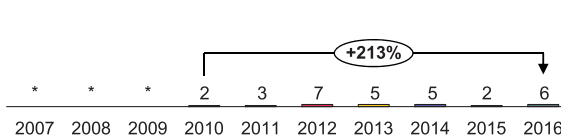


Figure 84 Catheter ablations per million inhabitants 2007-2016 in the non-European ESC member countries. *No data available.

events (15). The number of LAA closures was largest in Germany, but interestingly many of the countries in top quartile were from Eastern Europe, demonstrating that the ability to initiate new therapies is by no means limited to a selected few.

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 member 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 clearly reflected in the White Book data where the number of VT/VF ablation procedures per million inhabitants increased from 9.2 in 2014 to 19.0 in 2016.

The role of the European Heart Rhythm Association

It is likely that disparity in the implementation of arrhythmia treatment and practice guidelines will be difficult to abolish, unless there is an additional investment in the infrastructure of arrhythmia care. This includes electrophysiology laboratories, specialised equipment, and not least improved training opportunities. Likewise, standardisation of training requirements and implementation of current up to date 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 in trying to assure high quality in arrhythmia care in a broad sense. The 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 member countries. The ability to evaluate its own performance in a European context provides each country with robust means to demonstrate shortfalls in resource allocation, reimbursement and training requirements to the national or local authorities. In addition, it provides a sound basis for preparation of recommendations to improve decision and policy making concerning the cardiac arrhythmia care field at a national and cross-national levels.

The EHRA certification program provides an excellent platform to improve and standardise the training and the level of arrhythmia care in the ESC area. The introduction of the EHRA recognition program for teaching centres will provide further support to harmonise training. EHRA fellowship grants have already allowed many junior physicians from countries with relatively low procedure rates to receive training in high volume centres across the ESC area. The number of applications for the EHRA Fellowship grants have been increasing gradually and the certification program is now also available for allied professionals. Last year the EHRA Training Fellowship committee awarded 10 grants for young physicians mainly from emerging economies. In addition, a specific proctor programme was recently launched to provide further education in the field of cardiac arrhythmia management.

Table 18 Atrial fibrillation ablations in 2016 and comparison with the four previous years

Country	ISO code	AF Ablation procedures 2016		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 EU-28 level	2012	2013	2014	2015	2016
Albania*	AL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	10	0	4435	7835	N/A	0	0	0	0
Armenia	AM	3	1	336	594	3	3	4	0	1
Austria	AT	1209	139	—	1695	122	94	107	111	139
Azerbaijan	AZ	10	1	1087	1921	N/A	0	0	1	1
Belarus	BY	175	18	1054	1862	6	7	7	11	18
Belgium*	BE	N/A	N/A	N/A	N/A	224	225	245	289	N/A
Bosnia & Herzegovina*	BA	N/A	N/A	N/A	N/A	0	0	0	0	N/A
Bulgaria	BG	248	35	787	1390	7	7	11	20	35
Croatia	HR	551	128	—	839	18	38	50	86	128
Cyprus	CY	22	18	133	235	5	5	45	8	18
Czech Republic	CZ	2884	271	—	—	177	196	216	238	271
Denmark	DK	1988	355	—	—	262	290	305	337	355
Egypt	EG	168	2	10427	18421	0	0	1	1	2
Estonia	EE	121	96	139	245	27	56	78	87	96
Finland	FI	1006	183	—	1070	110	124	140	169	183
France	FR	16116	241	—	—	122	148	178	209	241
Georgia Republic of	GE	63	13	543	959	11	7	10	13	13
Germany	DE	40884	506	—	—	172	144	432	416	506
Greece	GR	780	72	1187	2096	37	40	52	60	72
Hungary	HU	1236	125	—	1921	75	86	109	122	125
Iceland	IS	45	134	—	65	77	73	104	108	134
Ireland	IE	950	192	—	964	95	94	N/A	133	192
Israel*	IL	N/A	N/A	N/A	N/A	N/A	N/A	70	N/A	N/A
Italy	IT	8900	144	—	12066	N/A	N/A	N/A	133	144
Kazakhstan	KZ	1059	58	2022	3573	11	15	29	42	58
Kosovo*	XK	N/A	N/A	N/A	N/A	N/A	N/A	0	N/A	N/A
Kyrgyzstan	KGZ	0	0	631	1114	N/A	N/A	N/A	N/A	0
Latvia	LV	127	65	217	382	26	29	35	44	65
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	113	40	314	555	8	9	21	28	40
Luxembourg	LU	54	93	64	113	61	60	109	84	93
FYR Macedonia*	MK	N/A	N/A	N/A	N/A	0	0	0	N/A	N/A

Continued

Table I8 Continued

Country	ISO code	AF Ablation procedures 2016		Development potential - target number of AF ablation procedures		AF Ablation procedures per million inhabitants				
		Absolute number	Per million inhabitants	To attain mean	To attain mean EU-28 level	2012	2013	2014	2015	2016
Malta	MT	9	22	46	81	0	0	0	0	22
Moldova	MD	7	2	387	683	N/A	0	N/A	N/A	2
Montenegro	ME	32	50	71	125	0	0	26	28	50
Morocco	MA	15	0	3 707	6 549	0	N/A	N/A	N/A	0
Netherlands	NL	4 000	235	—	—	156	N/A	202	212	235
Norway	NO	1 677	319	—	—	249	293	278	280	319
Poland	PL	3 512	91	4 243	7 496	44	50	57	84	91
Portugal	PT	885	82	1 193	2 108	49	51	63	69	82
Romania	RO	227	11	2 379	4 203	4	6	4	6	11
Russian Federation	RU	7 219	51	15 679	27 700	27	41	45	58	51
San Marino	SM	0	0	4	6	0	0	0	0	0
Serbia	RS	335	47	787	1 390	16	21	33	42	47
Slovakia	SK	271	50	600	1 060	18	27	23	41	50
Slovenia	SI	207	105	218	385	55	83	75	108	105
Spain	ES	2 938	60	5 349	9 450	40	47	52	55	60
Sweden	SE	2 019	204	—	—	177	177	184	191	204
Switzerland	CH	2 278	279	—	—	193	187	212	247	279
Syria*	SY	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	65	6	1 226	2 167	3	3	4	5	6
Turkey	TR	1 215	15	8 842	15 620	N/A	N/A	16	28	15
Ukraine	UA	731	17	4 869	8 603	14	15	14	14	17
United Kingdom	GB	6 744	105	7 097	12 537	80	85	102	100	105
Total ESC member countries		113 098	110			62	67	105	113	127

*These 9 countries did not submit any data on AF ablations for the EHRA White Book 2017.

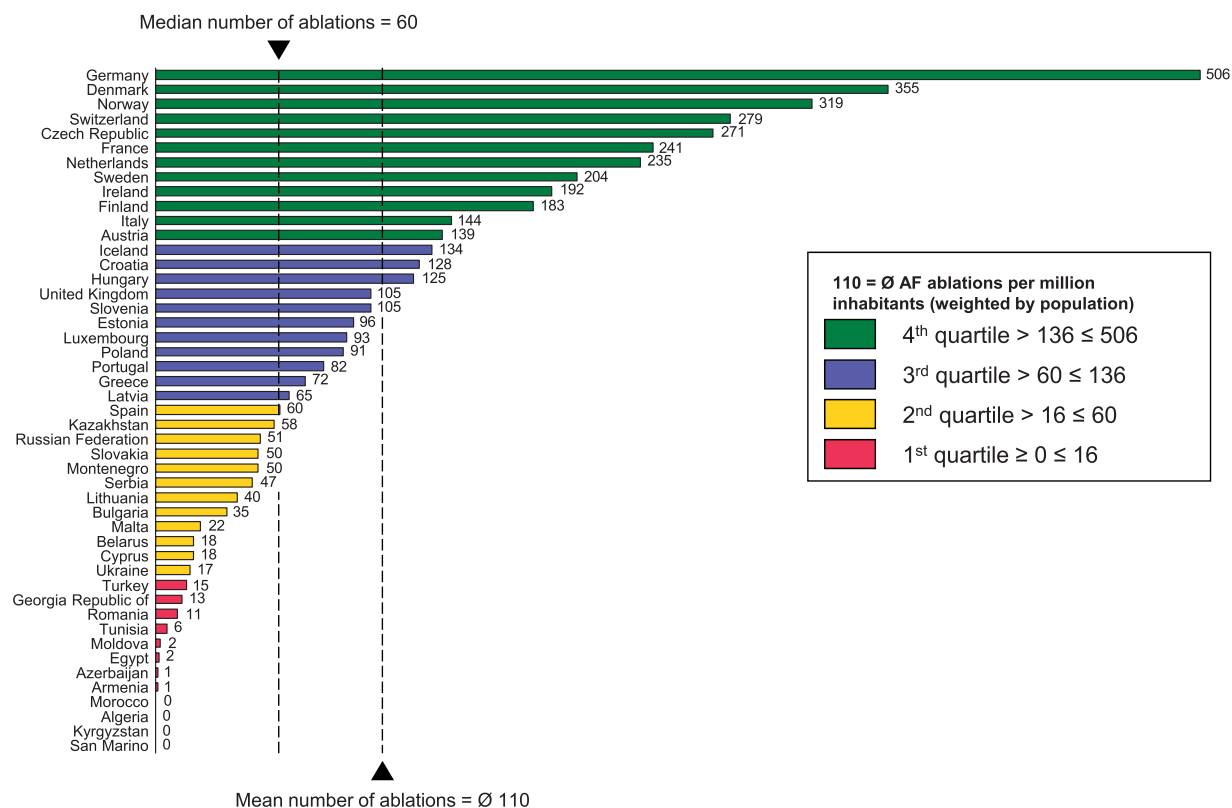


Figure 85 Atrial fibrillation (AF) ablations per million inhabitants in 2016. The mean number of AF ablations is weighted by population.

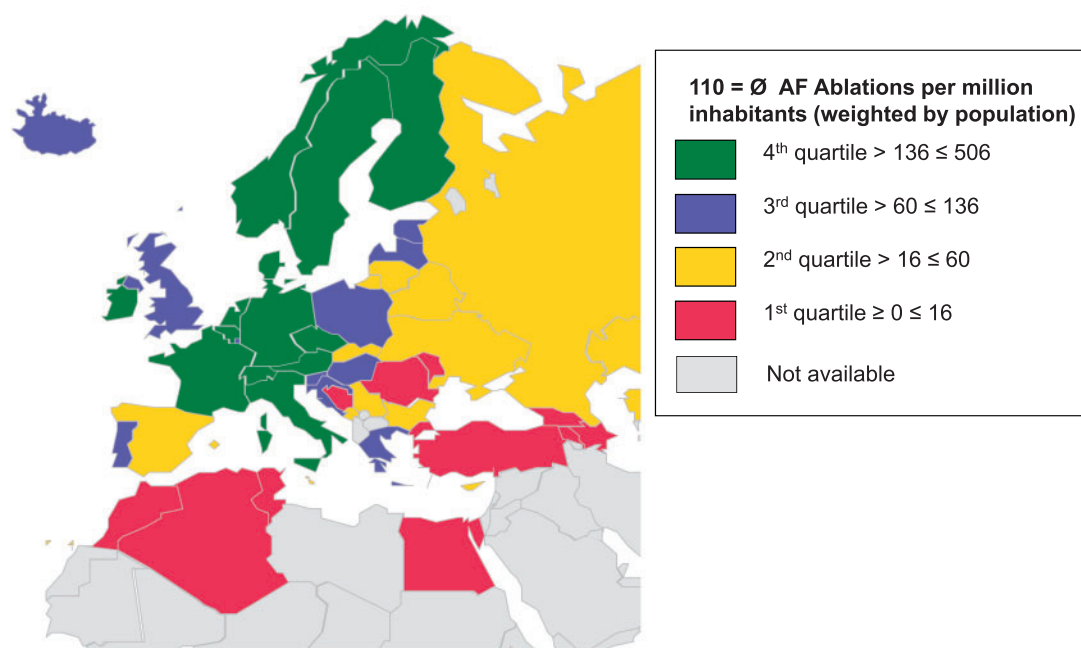


Figure 86 Atrial fibrillation ablations in the ESC member countries in 2016.

Table 19 Change in the number of atrial fibrillation (AF) ablations from 2015 to 2016

Country	ISO code	AF Ablation procedures 2015		AF Ablation procedures 2016		Change %
		Absolute number	Per million inhabitants	Absolute number	Per million inhabitants	
Albania*	AL	N/A	N/A	N/A	N/A	N/A
Algeria	DZ	0	0	10	0	N/A
Armenia	AM	1	0	3	1	200.5%
Austria	AT	966	111	1 209	139	24.5%
Azerbaijan	AZ	6	1	10	1	65.1%
Belarus	BY	106	11	175	18	63.9%
Belgium*	BE	3 273	289	N/A	N/A	N/A
Bosnia & Herzegovina*	BA	0	0	N/A	N/A	N/A
Bulgaria	BG	147	20	248	35	69.7%
Croatia	HR	385	86	551	128	48.1%
Cyprus	CY	10	8	22	18	117.0%
Czech Republic	CZ	2 537	238	2 884	271	13.5%
Denmark	DK	1 882	337	1 988	355	5.4%
Egypt	EG	65	1	168	2	141.6%
Estonia	EE	110	87	121	96	10.6%
Finland	FI	926	169	1 006	183	8.2%
France	FR	13 890	209	16 116	241	15.5%
Georgia	GE	64	13	63	13	-1.5%
Germany	DE	33 628	416	40 884	506	21.8%
Greece	GR	650	60	780	72	20.0%
Hungary	HU	1 204	122	1 236	125	2.9%
Iceland	IS	36	108	45	134	23.5%
Ireland	IE	650	133	950	192	44.4%
Israel*	IL	N/A	N/A	N/A	N/A	N/A
Italy	IT	8 200	133	8 900	144	8.3%
Kazakhstan	KZ	762	42	1 059	58	37.4%
Kosovo*	XK	N/A	N/A	N/A	N/A	N/A
Kyrgyzstan	KGZ	N/A	N/A	0	0	N/A
Latvia	LV	88	44	127	65	45.9%
Lebanon*	LB	N/A	N/A	N/A	N/A	N/A
Libya*	LY	N/A	N/A	N/A	N/A	N/A
Lithuania	LT	81	28	113	40	41.0%
Luxembourg	LU	48	84	54	93	10.2%
FYR Macedonia*	MK	N/A	N/A	N/A	N/A	N/A
Malta	MT	0	0	9	22	N/A
Moldova	MD	N/A	N/A	7	2	N/A
Montenegro	ME	18	28	32	50	78.5%
Morocco*	MA	N/A	N/A	15	0	N/A
Netherlands	NL	3 600	212	4 000	235	10.7%
Norway	NO	1 460	280	1 677	319	13.6%
Poland	PL	3 253	84	3 512	91	8.1%
Portugal	PT	743	69	885	82	19.0%
Romania	RO	132	6	227	11	72.5%
Russian Federation	RU	8 289	58	7 219	51	-12.9%
San Marino	SM	0	0	0	0	0.0%
Serbia	RS	305	42	335	47	10.3%
Slovakia	SK	224	41	271	50	20.3%
Slovenia	SI	214	108	207	105	-3.0%
Spain	ES	2 640	55	2 938	60	10.3%
Sweden	SE	1 868	191	2 019	204	7.2%
Switzerland	CH	2 003	247	2 278	279	12.9%
Syria*	SY	N/A	N/A	N/A	N/A	N/A
Tunisia	TN	60	5	65	6	7.4%
Turkey	TR	2 200	28	1 215	15	-45.8%
Ukraine	UA	634	14	731	17	15.9%
United Kingdom	GB	6 390	100	6 744	105	5.0%
Total ESC member countries		103 748	105	113 108	110	5.0%

*These 9 countries did not submit any data on AF ablations for the EHRA White Book 2017.

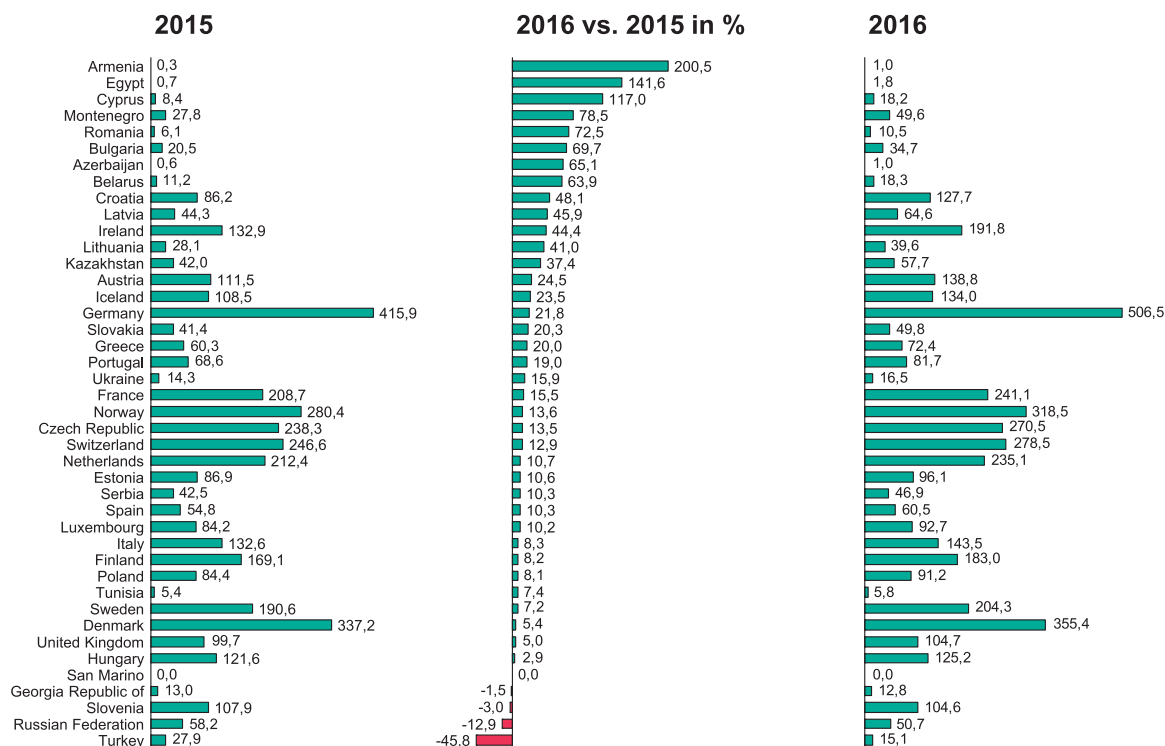


Figure 87 Change in the number of AF ablations per million inhabitants from 2015 to 2016.

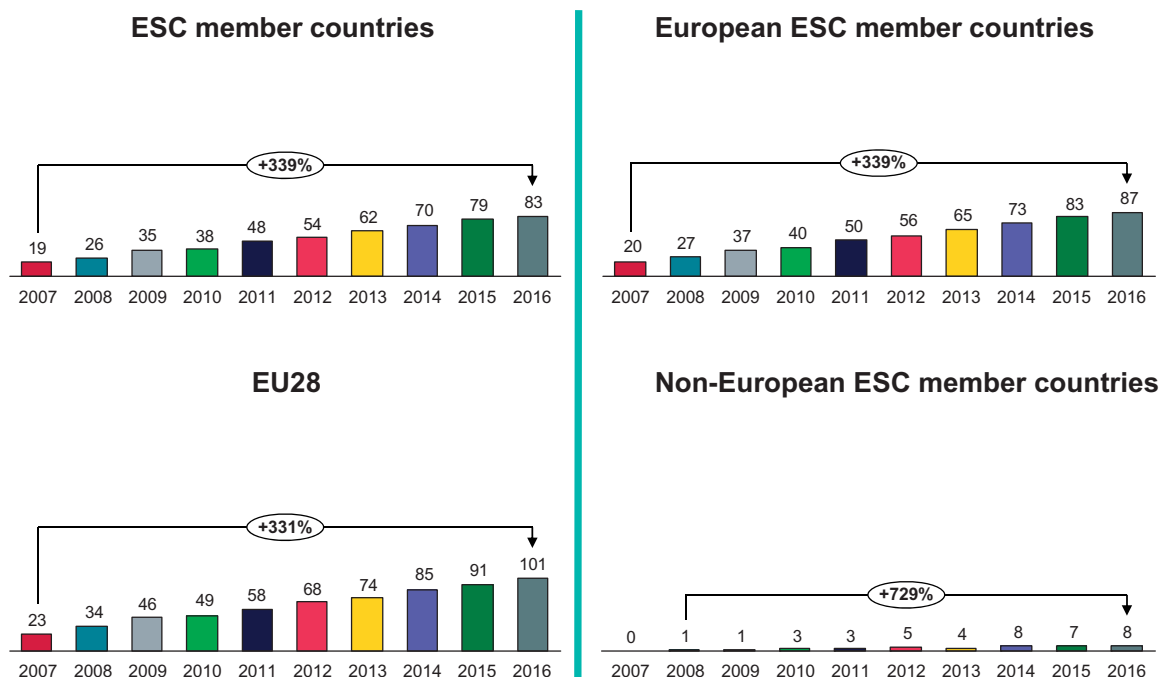


Figure 88 Atrial fibrillation ablations per million inhabitants 2007-2016 in the European and non-European ESC member countries and comparison to the total ESC area and the 28 member countries of the European Union (EU28).

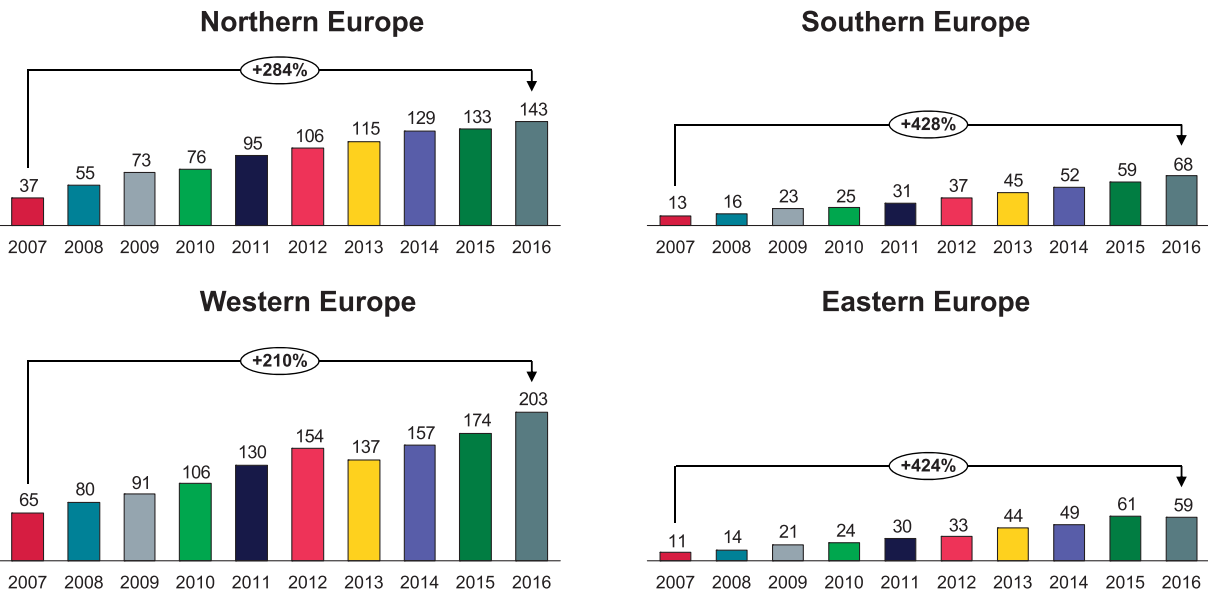
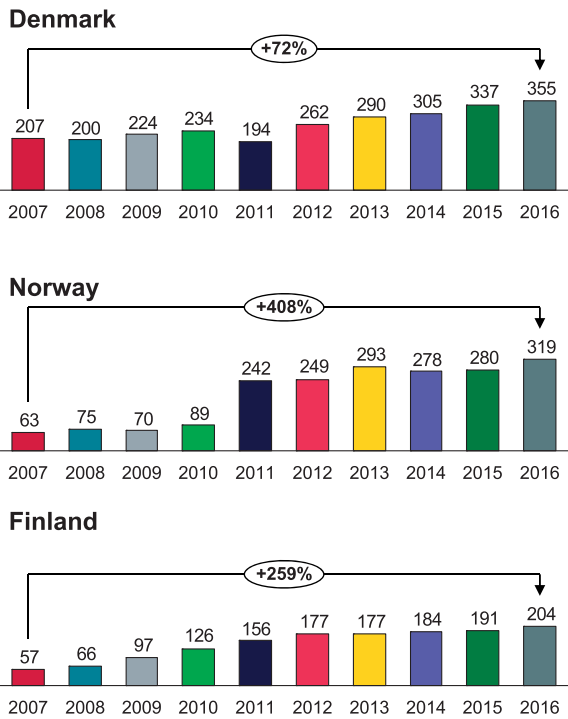


Figure 89 Atrial fibrillation ablations per million inhabitants 2007-2016 in the four European ESC regions.

**Northern Europe
TOP 3**



Lowest 3

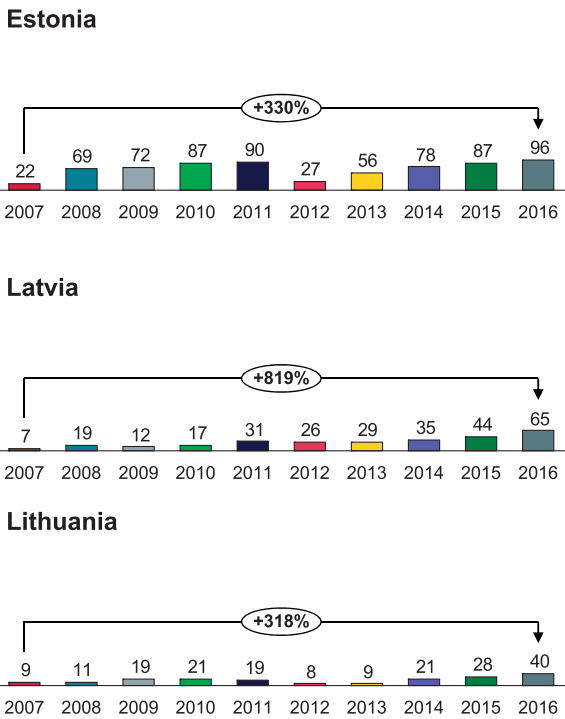
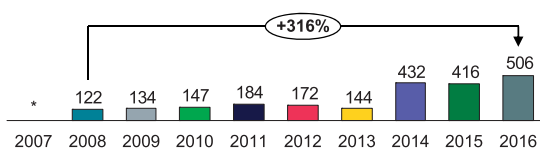


Figure 90 Atrial fibrillation ablations per million inhabitants 2007-2016 in Northern Europe.

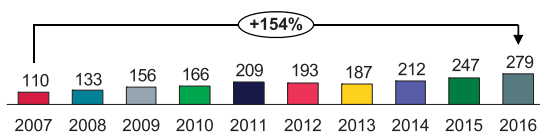
Western Europe

TOP 3

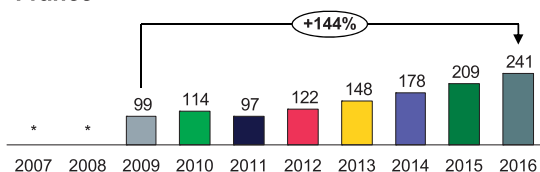
Germany



Switzerland

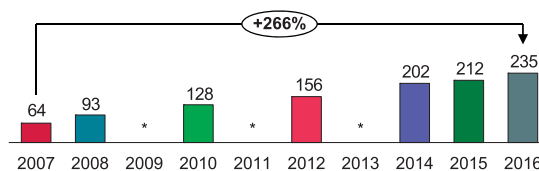


France

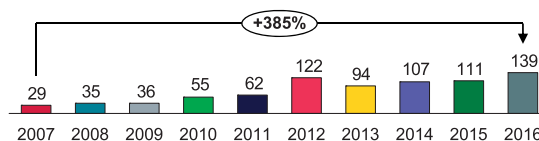


Lowest 3

Netherlands



Austria



Luxembourg

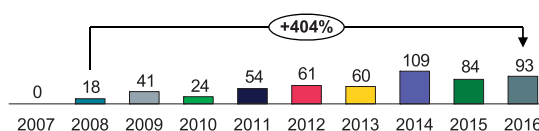
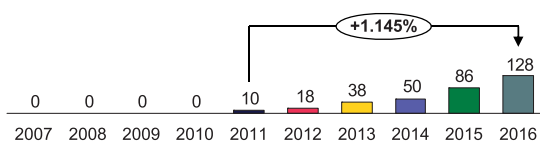


Figure 91 Atrial fibrillation ablations per million inhabitants 2007-2016 in Western Europe. *No data available.

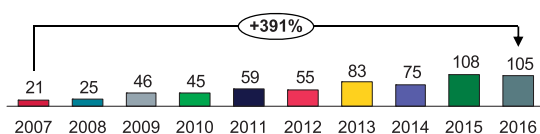
Southern Europe

TOP 3

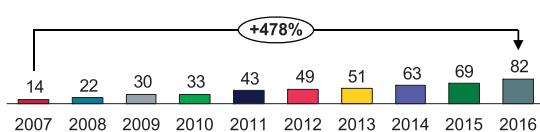
Croatia



Slovenia

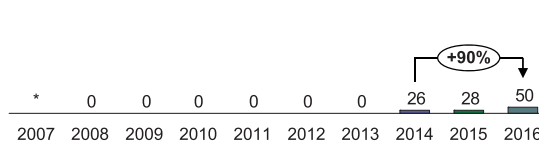


Portugal

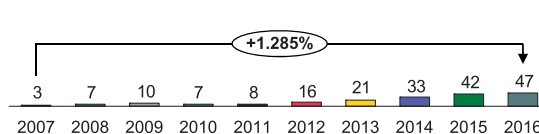


Lowest 3

Montenegro



Serbia



Malta

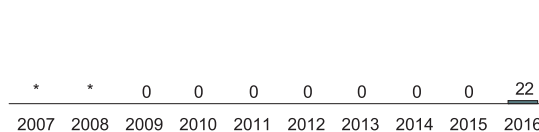
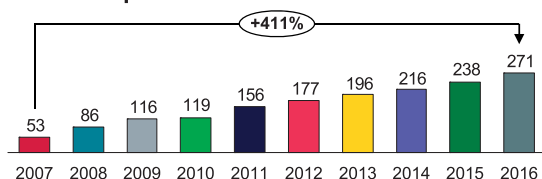


Figure 92 Atrial fibrillation ablations per million inhabitants 2007-2016 in Southern Europe. *No data available.

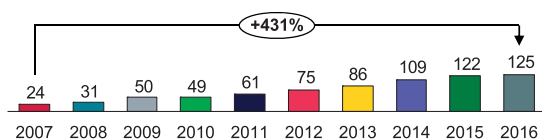
Eastern Europe

TOP 3

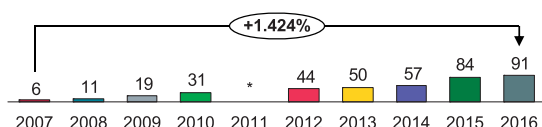
Czech Republic



Hungary

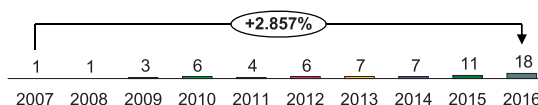


Poland

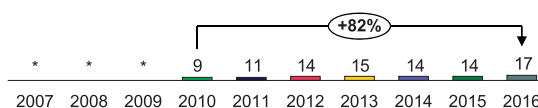


Lowest 3

Belarus



Ukraine



Romania

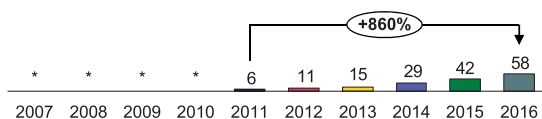


Figure 93 Atrial fibrillation ablations per million inhabitants 2007-2016 in Eastern Europe. *No data available.

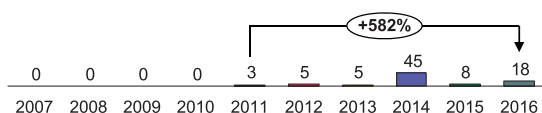
Non-European ESC member countries

TOP 3

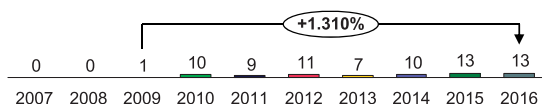
Kazakhstan



Cyprus

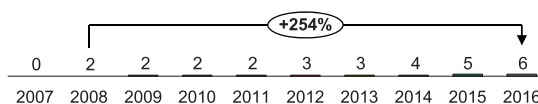


Georgia Republic of

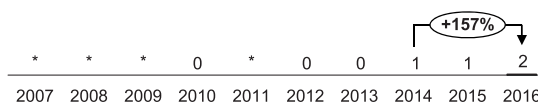


Lowest 3

Tunisia



Egypt



Armenia



Figure 94 Atrial fibrillation ablations per million inhabitants 2007-2016 in the non-European ESC member countries. *No data available.

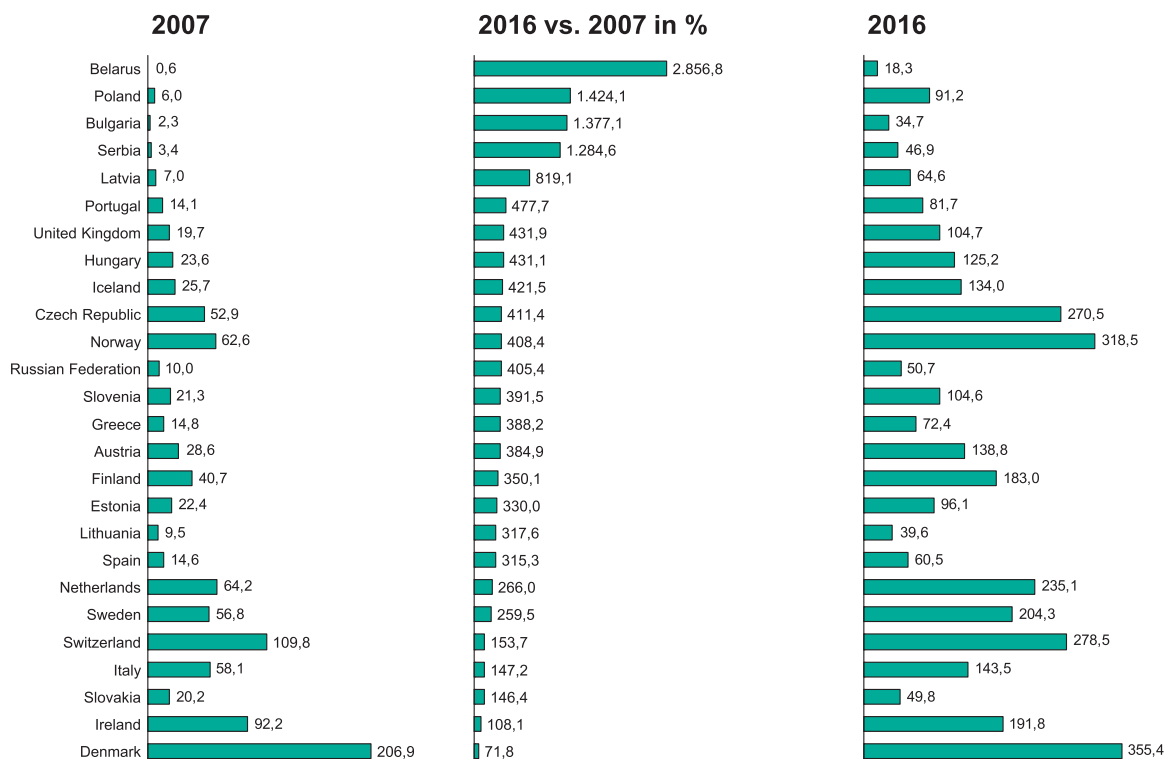


Figure 95 Change in the number of AF ablations per million inhabitants from 2007 to 2016.

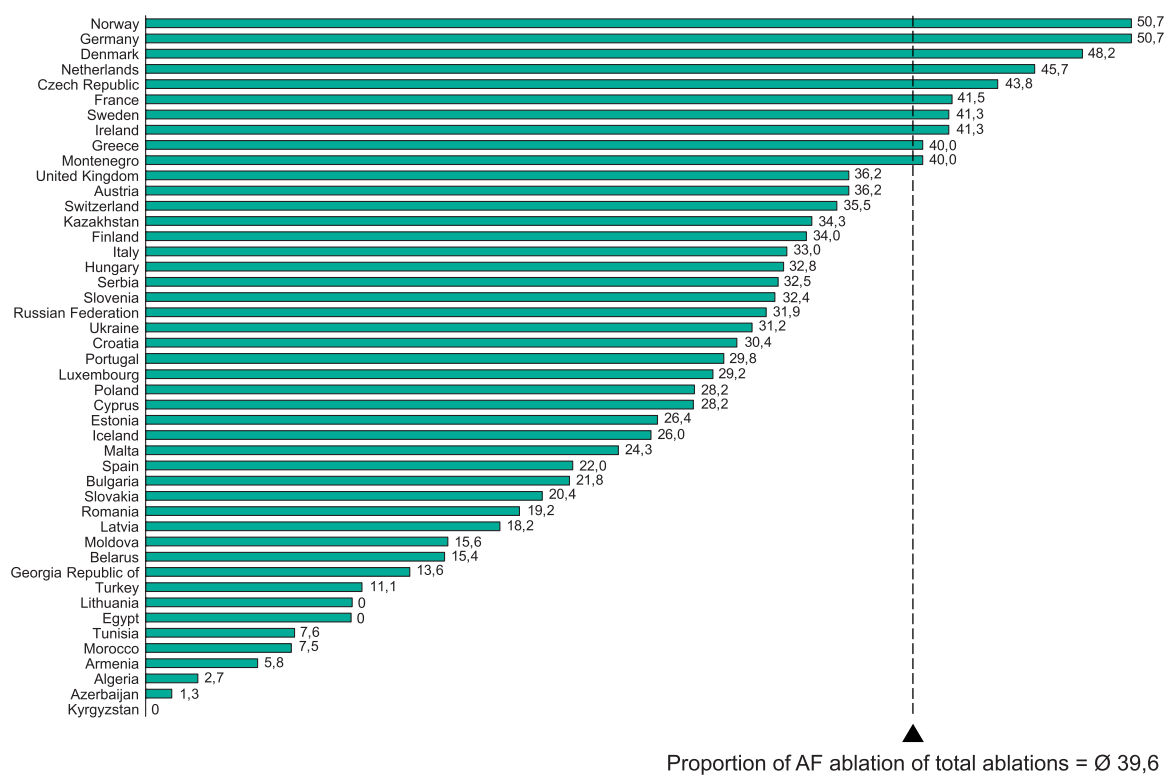


Figure 96 Proportion of AF ablations of total ablations in 2016.

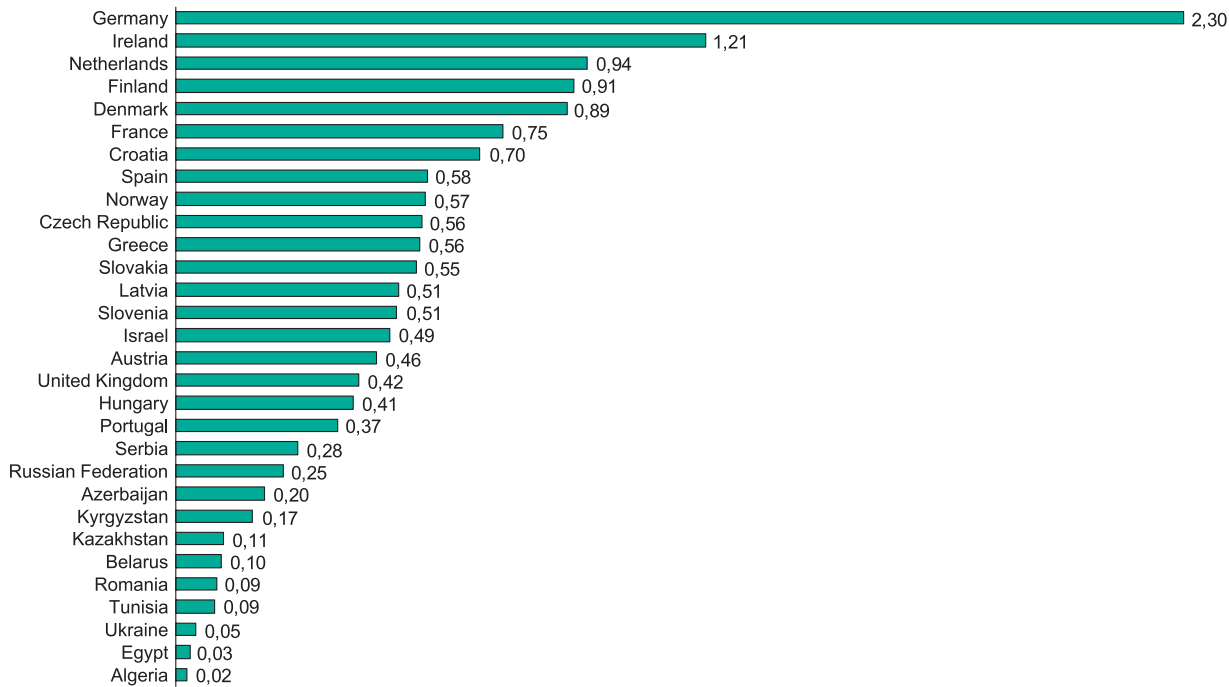


Figure 97 Number of centres which performed more than 10 VT or VF ablations per million inhabitants in patients with structural heart disease in 2016.

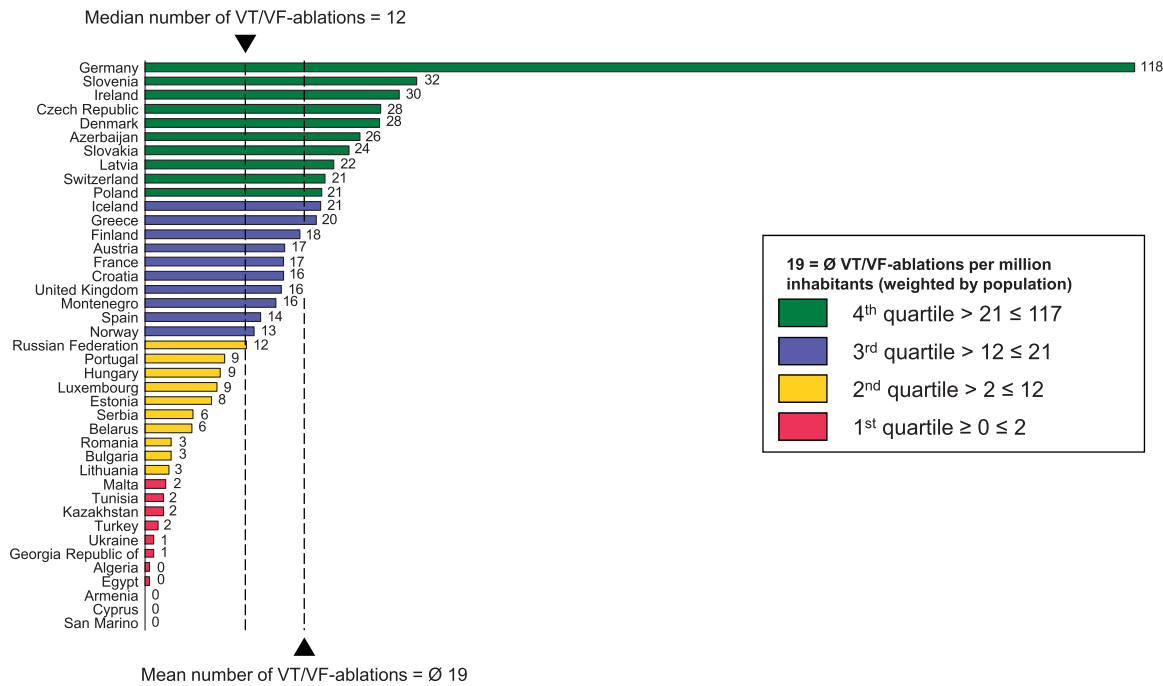
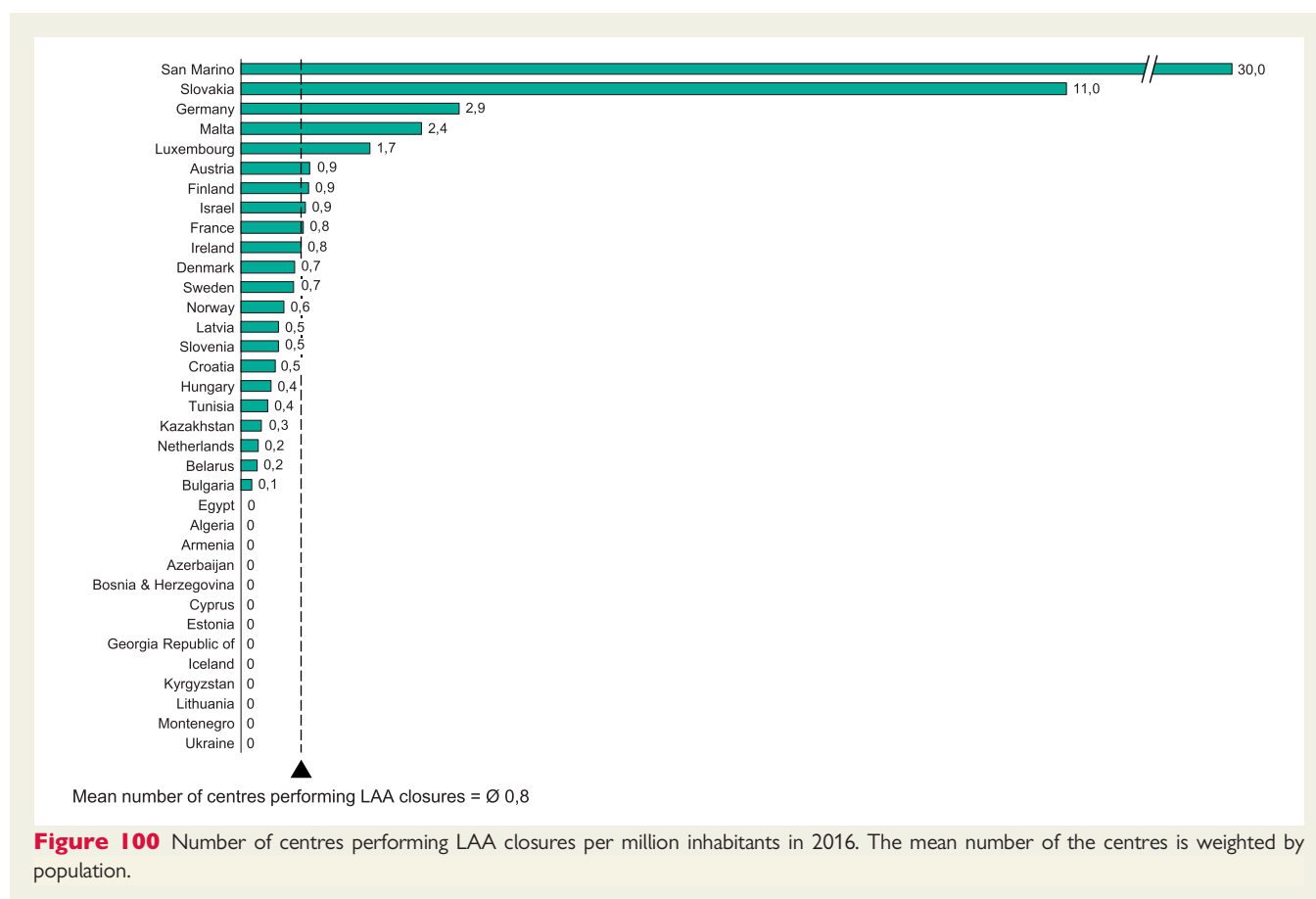
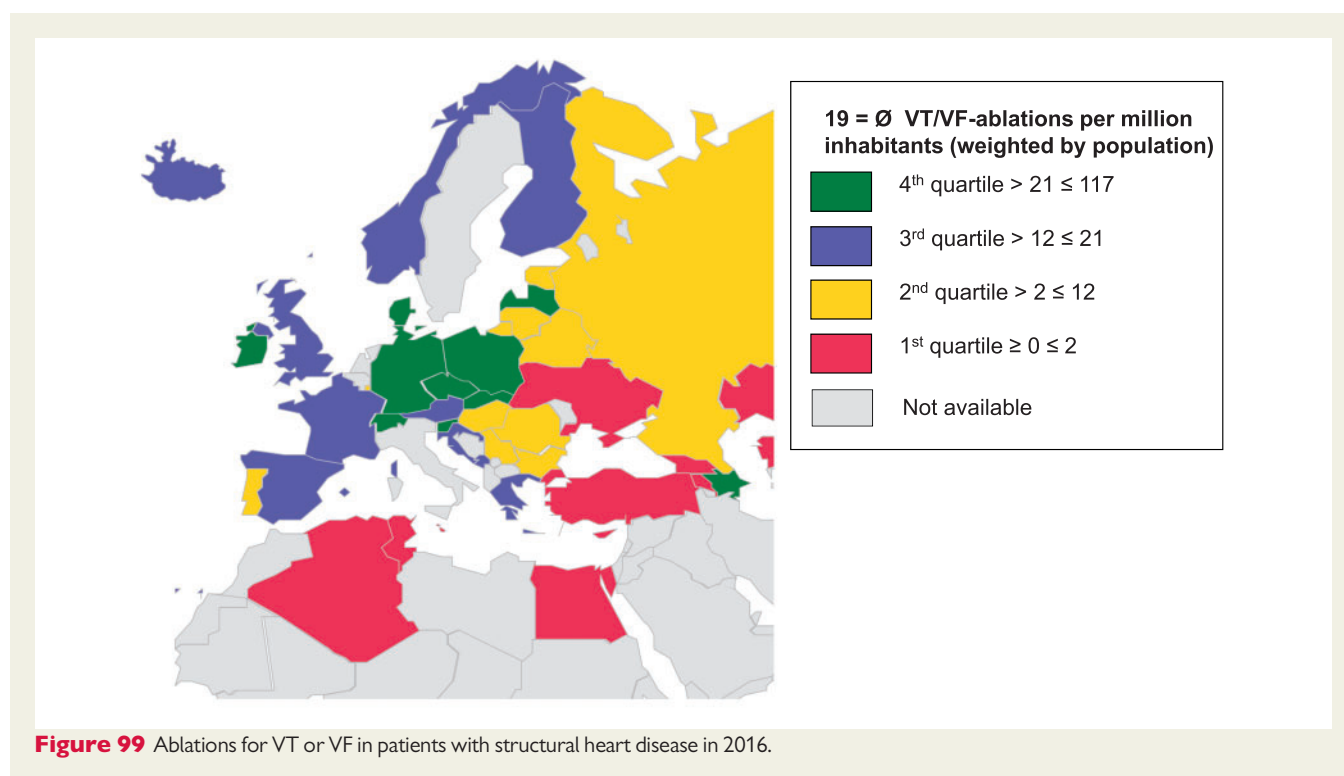


Figure 98 Ablations for VT or VF per million inhabitants in patients with structural heart disease in 2016. The mean number of VT/VF-ablations is weighted by population.



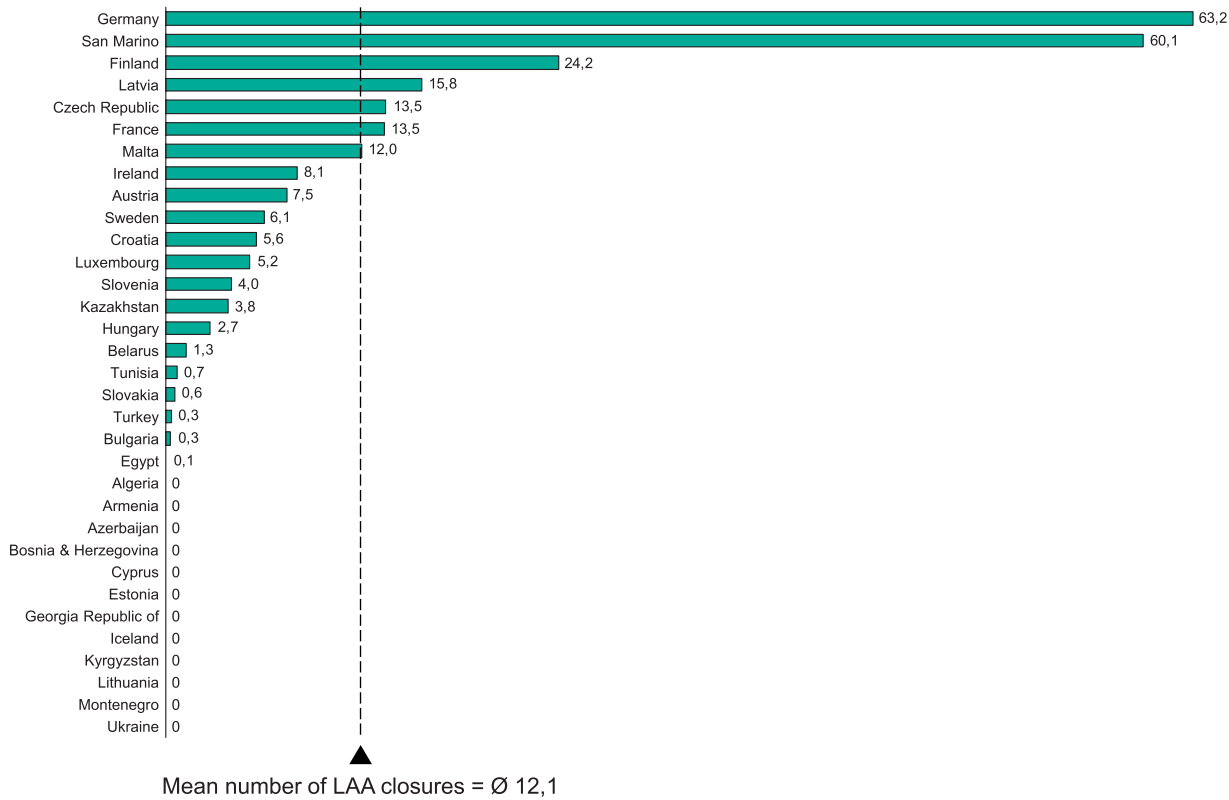


Figure 101 Percutaneous LAA closures per million inhabitants in 2016. The mean number of the centres is weighted by population.

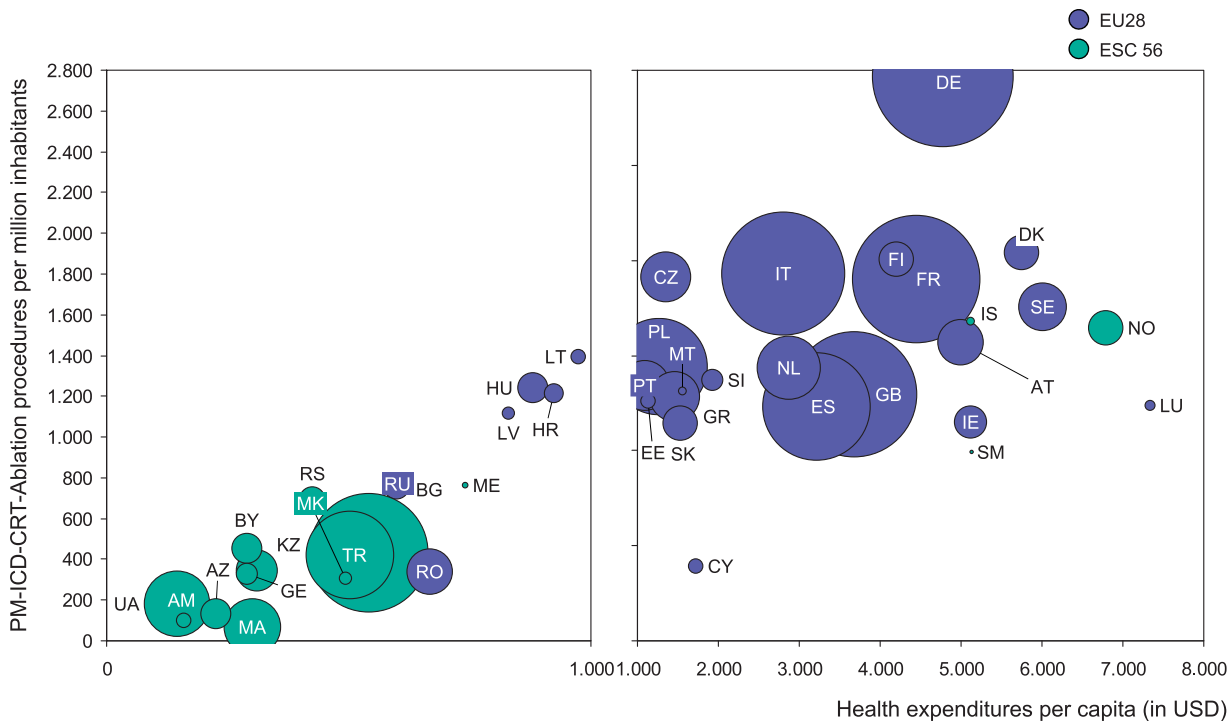


Figure 102 Healthcare spending per capita and interventional electrophysiology procedures (sum of PM-ICD-CRT-Ablation procedures per million inhabitants). The ISO codes of the countries are explained in Table 1.

In summary, the EHRA White Book data indicate that there are still significant differences in training and certification requirements between the ESC member 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 of practice.

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 53 out of the 56 ESC nations responded to the White Book questionnaire. The data covered about 95% of the population in the ESC area. Nevertheless, few countries have never reported data for the White Book and some countries reported incomplete data. In particular, some countries did not provide data on new therapies like leadless pacing, S-ICD and VT/VF ablations. This may in part be due to incomplete collection of data on these procedures, which are relatively new and performed only in a few centres.

With regards to the current analysis and interpretation of the ten-year data it was a major drawback that Belgium did not submit any data on the procedure numbers this year. It also needs to be noted that there were large variations in national data sources. About 50% of the data came from national registries and the other half were based on surveys conducted by the National Working Groups and some even on estimates. This is relevant since the coverage of the registries in some of the ESC member countries is far from complete and many procedures are not included in the registry data. On the other hand, surveys and other estimates conducted by the National Working Groups may overestimate the procedure numbers.

Future directions

There is no doubt that the EHRA White Book and the subsequent comparative analysis of the data published in the EP Europace journal is of substantial value. However, the data collection could be improved for example with an internet-based electronic database and/or by adapting national databases towards uniform standards. Such a database would not only allow easy comparisons between and within the ESC member countries but might also provide a unique platform for multicentre registry based clinical trials in arrhythmia therapy (26). The ESC recently launched the Atlas of Cardiology project (27) with similar goals but far more widespread aims than the White Book. The Atlas will provide descriptive and quantitative information on economy, demographics, health system and health policies alongside data concerning health care resources and a wide range of cardiology interventions in the ESC member countries.

Conclusions

During the past decade, the EHRA White Book has developed into a substantial asset not only for the cardiac electrophysiology community but also for healthcare administrators, politicians and other stakeholders in the ESC area. The availability of up-to-date key information is critical to those facing the constant challenge of balancing

healthcare budgets and allocating resources that may be limited. 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 these disparities continues to be one of the main goals of the EHRA.

Acknowledgements

The EHRA White Book 2017 and this analysis were possible thanks to the continuing efforts of several key contributors including chairmen and co-chairs of National Cardiac Societies and the Working Groups for Arrhythmias in the 56 ESC member countries. We are grateful for their invaluable contribution. In addition, we would like to thank Lauren Tapp and other members of the EHRA staff at the European Heart House as well as BIOTRONIK SE & Co. KG for continuous support to the project. In particular, we would like to acknowledge Robert Wuestenberg and Anja Thuemen from BIOTRONIK for their dedication and unwavering enthusiasm for the EHRA White Book project. The EHRA White Book 2017 is supported by BIOTRONIK SE & Co. KG in the form of an educational grant. The content has not been influenced in any way by its sponsor.

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