

Percutaneous coronary interventions in Europe in 2006

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KEYWORDS

Coronary angiography,
PCI, coronary stent,
PFO closure, ASD
closure, registry

Abstract

Aims: This registry has aimed to collect data on cardiac catheterisation procedures in Europe in 2006.

Methods and results: Numbers and types of procedures were collected by means of a standardised questionnaire from all adult percutaneous cardiac intervention centres in Europe. Questionnaires were collected from all national member societies of the European Association of Percutaneous Cardiovascular Interventions (EAPCI): 23 of 30 countries provided data. The analyses were performed for all countries based on the most up-to-date available data. With 2.5 million coronary angiographies performed, the overall number of diagnostic procedures continues to increase (+8%) at a faster rate than the population (+0.6%). The number of percutaneous coronary interventions (PCI: >1 million) paralleled this increment (+10%). A marked disparity prevails between different countries in Europe. There was a comparative slight reduction in the stenting/PCI ratio (0.85). Use of drug-eluting stents (DES) remained virtually unchanged in comparison to the previous report, despite “safety concern warnings” regarding their use in 2006.

Conclusions: Interventional cardiology in European countries is ever expanding. Despite the drug eluting stent firestorm that took place in the course of 2006, the number of implanted DES even increased slightly. Mortality and complications remained low. Among the noncoronary procedures, percutaneous shunt closures increased, albeit moderately.

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Introduction

Starting in 1992, a European wide survey of interventional procedures in all member countries of the European Society of Cardiology (ESC) has been performed annually to record temporary trends in percutaneous cardiac interventions in Europe.¹⁻¹⁵ The report of these interventions in 2006 represents the 15th edition of the yearly census, and summarises the real-life practice of catheter-based cardiac interventions in 30 European countries. The year 2006 witnessed startling presentations at the 2006 ESC-World Congress of Cardiology held in Barcelona warning against a high stent thrombosis risk with the use of drug-eluting stents.

Methods

A detailed questionnaire, together with instructions and examples for completion, was sent to the presidents or designated delegates of each national society of cardiology represented in the European Society of Cardiology. These national leaders distributed it within each country to all facilities performing diagnostic and/or interventional cardiac catheterisation. A summary data sheet, supplied by the national representatives, was used to aggregate data per country. These forms were available online at the ESC web services. Finally, the data were entered into the central database and analysed. In the case of missing or incomplete data, the national representatives were reminded repeatedly for completion or correction. Cyprus, Denmark, Luxembourg, Portugal, Romania, The Netherlands, and Turkey did not report their data. For these countries, the most up-to-date available data were substituted to allow a meaningful comparison with prior years. The definitions of diseases and procedures were those of previous reports. Briefly, coronary angiography (CA) was the term for diagnostic angiographic visualisation of the coronary arteries, independent of whether or not an intervention was performed. Percutaneous coronary intervention (PCI) was used for coronary angioplasty with or without stent placement, regardless of the number of segments treated. *Ad hoc* PCI was defined as PCI performed directly following the diagnostic procedure during the same session. Stent procedures were PCIs with stent implantation regardless of the number of stents used.

Prior to submission for publication, the national representatives were asked to review the manuscript for accuracy.

Results

Figures for the year 2006

Table 1 lists the number of centres and operators, as well as the major coronary procedures (coronary angiography, PCI and coronary stenting) for each country. The numbers per population are also given.

Catheterisation facilities

The numbers of cardiac catheterisation centres per million inhabitants in Europe remained basically unchanged in 2006 (2.6 ± 1.2) as compared to 2005 (2.4), with still the highest density seen in Germany (5.6) and the lowest in Bulgaria (0.9). The number of cardiac catheterisation rooms per million inhabitants in 2006 was 3.0 ± 1.6 , with the highest reported density in Iceland and Switzerland (6.5) and the lowest in Bulgaria and Slovakia (1.3). A slightly decreasing mean of $1,091 \pm 317$ coronary angiographies and 448 ± 144 PCIs were performed per catheterisation room. The mean numbers of operators per million inhabitants were 11.5 ± 7.5 and ranged from 27 in Switzerland to four in Slovakia.

Coronary angiography

A total of 2,481,605 coronary angiograms were reported for 2006 (Figure 1), an 8% increase compared with 2005. The mean population-adjusted number in 2006 was 1,747 procedures (PCI) per million inhabitants, representing an increase of 9% compared with 2005.

Percutaneous coronary intervention (PCI)

A total of 1,001,000 percutaneous coronary interventions were reported for 2006, a 10% increase compared with 2005. As in past years, the smallest numbers of procedures per million people were reported in countries from eastern Europe (e.g., Slovakia 573) nevertheless showing a relevant increase in number of

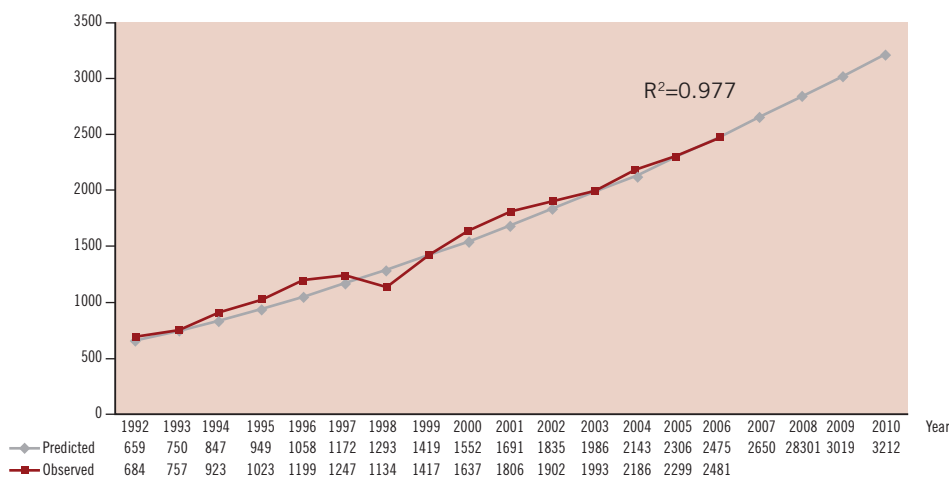


Figure 1. Observed and predicted coronary angiograms expressed in thousands from 1992 to 2006 per million inhabitants in Europe, based on the "consumption method" for prediction medicine on the data 1992-2004 with $R^2 = 0.977$ (see reference 14 for details).

Table 1. Coronary facilities and procedures.

Country	Population in millions	Catheterisation centres	Operators per million	Coronary angiography per million	PCI cases	Stent cases per million	DES/stent cases (%)	Multivessel PCI in 1 session, %	PCI for ongoing infarction % of total PCI	Ad hoc PCI, %	I.c. pressure or Doppler, %	IVUS, % of PCI	IABP + pVAD, % of PCI	GP IIb/IIIa antagonist, % of PCI
Austria	8.3	34	22	6104	19263	2096	12037/17399 (69)	18%	26%	75%	4.6%	4%	0.9%	16%
Belgium	10.5	47	14	5714	23149	na	7723/21530 (36)	9%	16%	69%	2.1%	1%	2.0%	31%
Bulgaria	7.5	7	5	1715	6711	770	85/5774 (1)	15%	12%	60%	0%	1%	0.3%	8%
Croatia	4.5	11	7	1835	3501	720	338/3239 (10)	26%	31%	49%	0.1%	<1%	0.3%	13%
Cyprus*	0.7	1	4	4494	1066	1700	360/1190 (30)	7%	6%	81%	0.0%	<1%	0.3%	53%
Czech Republic	10.3	24	8	5502	22258	2072	2440/21345 (11)	na	29%	85%	0.7%	1%	1.0%	6%
Denmark*	5.3	14	5	4151	8959	1434	na/7601 (na)	na	21%	na	8.9%	8%	1.3%	23%
Estonia	1.4	3	8	3584	2018	1384	318/1869 (17)	na	37%	80%	0.0%	<1%	0.3%	na
Finland	5.2	18	na	4453	9001	na	na	na	na	na	na	na	na	na
France	59.6	214	8	4561	117000	1864	na/111150 (na)	na	na	na	0.1%	1%	na	9%
Germany	82.5	460	na	9798	291050	3022	81535/249486 (33)	11%	18%	52%	0.3%	1%	1.2%	na
Greece	10.9	38	18	4669	20719	1800	13571/19626 (69)	36%	6%	94%	0.1%	3%	1.6%	21%
Hungary	10.1	12	7	3673	15070	na	2879/13864 (21)	16%	44%	88%	4.6%	<1%	3.6%	28%
Iceland	0.3	1	23	4716	609	1732	163/537 (30)	12%	21%	81%	0.0%	2%	0.8%	24%
Italy	58.0	240	na	4488	124091	1977	100472/114693 (88)	22%	16%	81%	3%	na	na	na
Latvia	2.3	3	5	3868	3992	1643	1548/3780 (41)	23%	12%	31%	0.9%	4%	3.4%	15%
Lithuania	3.4	6	8	2925	3482	634	345/2155 (16)	9%	36%	37%	0.0%	<1%	2.0%	4%
Luxembourg*	0.4	1	14	5027	927	1791	na/788 (na)	8%	36%	88%	0.2%	6%	8.7%	30%
Norway	4.7	10	10	6178	11954	2322	3376/10914 (31)	19%	25%	85%	2.6%	2%	2.0%	16%
Poland	38.4	86	11	3537	69820	1570	5946/60284 (10)	28%	51%	59%	2.1%	2%	1.4%	2%
Portugal*	10.0	23	6	2113	8660	1033	5061/10329 (49)	34%	na	na	0.3%	na	na	27%
Romania*	22.0	11	1	675	4158	137	105/3010 (3)	25%	12%	45%	na	1%	0.6%	na
Slovakia	5.4	6	3	1477	3092	559	289/3018 (10)	9%	32%	53%	0.0%	<1%	1.1%	17%
Slovenia	2.0	5	8	2136	3336	na	na	18%	31%	90%	0.3%	<1%	3.6%	13%
Spain	44.7	125	9	2533	57041	1226	na/54816 (na)	28%	18%	79%	0.0%	7%	1.8%	24%
Sweden	9.2	30	16	4011	17771	1762	7908/16214 (49)	16%	26%	95%	8.2%	2%	2.4%	33%
Switzerland	7.2	29	18	5113	17061	2109	12451/15184 (82)	22%	20%	93%	8.7%	4%	2.9%	19%
The Netherlands*	16.0	19	2	3574	28800	1566	na/25060 (na)	16%	21%	na	2.6%	na	na	na
Turkey*	72.0	102	5	1667	40030	542	5000/39000 (13)	na	9%	na	Na	1%	0.2%	10%
United Kingdom	60.9	181	9	3540	73692	1142	44174/69565 (64)	26%	8%	na	0.3%	1%	1.4%	31%

* value of 2005; i.c.: intracoronary; IABP: intra-aortic balloon pump; IVUS: intravascular; ultrasound; GP: glycoprotein; na: not available; pAVD: percutaneous ventricular assist device; PCI: percutaneous coronary interventions

procedures as compared to previous reports. With the exception of Iceland (−7%), Norway (−4%), and Sweden (−2%), all countries reported increases in procedures. Some European countries reported particularly high relative increases (Bulgaria +59%, Latvia +48% and Slovenia +33%). Ad hoc procedures averaged 70% of all PCIs (65 in 2005 and 46% in 2004). The mean ratio of PCIs to coronary angiograms was 0.43 (2005: 0.40). The ratio of PCIs to coronary angiograms ranged from 0.34 in the United Kingdom to 0.78 in Slovenia. Multivessel interventions in one session remained fairly stable with 15% of all PCI (2005 and

2004: 18%). The same holds true for interventions for acute and ongoing myocardial infarction with 18% in 2006 (17% in 2005 and 19% in 2004).

Coronary stenting

A total of 854,164 stenting procedures were reported in 2006, resulting in an increase of 6.6% compared with 2005 (801,215 procedures) (Table 2). The ratio of coronary stenting to PCI procedures averaged 0.85 (2005: 0.87). Unchanged to the preceding year, most countries reported ratios >0.7. Drug eluting

Table 2. Evolution of coronary angioplasty and coronary stenting since 1992.

Year	PCI*	Stenting*	Stenting/PCI
1992	148	3	2%
1993	184	6	3%
1994	225	22	10%
1995	272	77	28%
1996	327	143	55%
1997	405	235	58%
1998	388	238	61%
1999	426	313	73%
2000	525	395	75%
2001	617	488	79%
2002	678	558	82%
2003	728	571	78%
2004	885	770	87%
2005	913	801	88%
2006	1,001	854	85%

* value are expressed in thousands of procedures

stents were used overall in about one third (32%) of stenting procedures in 2006 (26% in 2005); the highest rate being seen in Italy (88%), the lowest in Bulgaria (1%).

Noncoronary interventions

The major noncoronary procedures (alcohol ablation for septal hypertrophy, valvuloplasty, shunt occlusion, coarctation angioplasty, and atrial appendage occlusion) are listed in Table 3. Among these, percutaneous closure of patent foramen ovals (PFO) and atrial septal defects remained the leading procedures. They show a constant progression with 6,220 procedures in 2006, +24% since 2005. For PFO closure, Switzerland is the leading country in Europe with 72 cases per million inhabitants. Data concerning the new addition to interventional cardiology, percutaneous aortic valve replacement, were not yet collected.

Other devices

Other therapeutic devices (directional atherectomy, rotablator, laser catheter or wire, ultrasound therapy, brachytherapy, clot catcher/remover) were reported in slightly increasing numbers for

Table 3. Noncoronary procedures.

Country	Population (millions)	Alcohol ablation for obstructive hypertrophic cardiomyopathy	Mitral valvuloplasty	Aortic valvuloplasty	Pulmonary valvuloplasty	PDA closure	PFO closure	ASD closure	VSD closure	Coarctation angioplasty	Left atrial appendage occlusion
Austria	8.3	11	9	0	na	2	163	49	na	na	0
Belgium	10.5	50	50	50	na	na	150	25	na	na	0
Bulgaria	7.5	21	53	11	13	5	8	3	0	7	0
Croatia	4.5	2	0	0	1	0	0	0	0	0	0
Cyprus*	0.7	0	0	0	0	0	0	0	0	0	0
Czech Republic	10.3	29	11	27	18	44	135	108	3	9	0
Denmark*	5.3	25	12	8	10	52	5	53	3	18	2
Estonia	1.4	0	0	3	2	8	2	17	0	7	0
Finland	5.2	na	na	na	na	na	na	na	na	na	na
France	59.6	na	na	na	na	na	na	na	na	na	na
Germany	82.5	598	na	na	na	na	na	na	na	na	na
Greece	10.9	na	na	na	na	0	73	93	0	na	na
Hungary	10.1	5	4	10	23	26	18	57	0	16	0
Iceland	0.3	0	0	0	4	4	0	26	0	0	0
Italy	58.0	na	174	148	196	284	902	1495	na	204	na
Latvia	2.3	6	0	0	0	8	0	25	0	0	0
Lithuania	3.4	3	0	0	2	17	0	0	0	2	0
Luxembourg*	0.4	na	na	na	na	na	na	na	na	na	na
Norway	4.7	11	7	0	na	na	na	na	na	na	na
Poland	38.4	20	91	35	24	109	137	314	15	0	0
Portugal*	10.0	0	53	na	23	na	na	136	na	0	0
Romania*	22.0	6	11	12	18	20	8	14	3	13	0
Slovakia	5.4	4	22	0	2	0	17	40	2	0	0
Slovenia	2.0	1	0	0	na	na	na	na	na	na	0
Spain	44.7	28	390	14	27	13	192	334	10	34	na
Sweden	9.2	na	na	na	na	na	na	na	na	na	na
Switzerland	7.2	44	52	11	16	na	515	88	na	na	na

* value of 2005; ASD: atrial septal defect; na: not available; PDA: patent ductus arteriosus; PFO: patent foramen ovale; VSD: ventricular septal defect

a total of 19,864 cases (15,645 in 2005) in 2006 (+27%), mainly driven by rotablator procedures (+23%) and clot catcher/clot remover/filter (+70%). The most frequently used additional diagnostic techniques in PCI remain intravascular ultrasound (in 1.7% of PCI procedures) and intracoronary pressure measurements to assess the fractional flow reserve (in 1.0%).

Complications

Reported mortality showed no significant change since 1992, and was reported 0.4% in 2006 (3,763 cases per 1,000,752 PCIs) compared to 0.3% in 2005. The need for emergency coronary artery bypass grafting (CABG) has remained virtually unchanged (0.2% of PCIs), whereas the incidence of PCI-induced myocardial infarction was reported with a slight increase at 0.8% (0.6% in 2005; it is doubtful that all centres measure enzymes the day post-procedure and/or use universal definition of MI).

Discussion

Since its inception by the European Society of Cardiology, the aim of the reported registry has been to demonstrate availability and use of cardiovascular diagnostic and therapeutic procedures within Europe. Although the design of the survey is retrospective and based on self-reporting (subject to bias and under-reporting of complications), the European Survey provides a unique insight of the contemporary practice of interventional cardiology within Europe with a target-population of more than 570 million people.

With 2.5 million coronary angiographies performed, the overall number of diagnostic procedures continues to increase (+8%) faster than the population (+0.6%) (Figure 1). The number of percutaneous coronary interventions topped the one million mark, with an increment of 10% in comparison with 2005, which can be seen in parallel with the number of coronary angiographies. The number of percutaneous interventions for acute and ongoing

myocardial infarctions remains stable at 18%, consistent with recently published data by Widimsky et al (primary PCI per all PCI in Europe ranging from 5 to 39%)¹⁶. Coronary stenting showed a significant deceleration in growth (–9% of the prediction, Figure 2). A variety of reasons might account for this.

DES use rose to more than 312,000 cases in 2006. Once again, a large variability was reported, ranging from Bulgaria (1%) to Italy (88%) with a European mean of about 36%. The impact of safety concerns regarding DES voiced since early 2006 seemed to have caused a slight slowing down in the increase of the use of such devices¹⁷.

For noncoronary procedures, only closures of atrial shunts have shown a constant progression during the past five years. This trend probably translates by the fact that the simpler and safer occlusion techniques get, the more lightly decisions are being taken to close shunts, in particular PFOs. This is bound to continue – if not accelerate – in the future.

Limitations

Registry data are approximate. Sources of potential error include missing external validation of the raw data provided by the local institutions and communication errors between the institutions, national coordinators, and the central database. Under-reporting of complication is germane. However, the involvement of the national societies of cardiology ensures conformity with national registries and statistics and thus guarantees the best achievable level of accuracy for elementary data on coronary angiography, PCI, coronary stenting, and noncoronary catheter-based procedures.

Acknowledgement

We are indebted to all the representatives of the national societies of cardiology who participated in this survey. Furthermore we acknowledge the effort of all single centres in collecting the surveyed data and completing the questionnaires. The principal data coordinators for each individual country participating in this

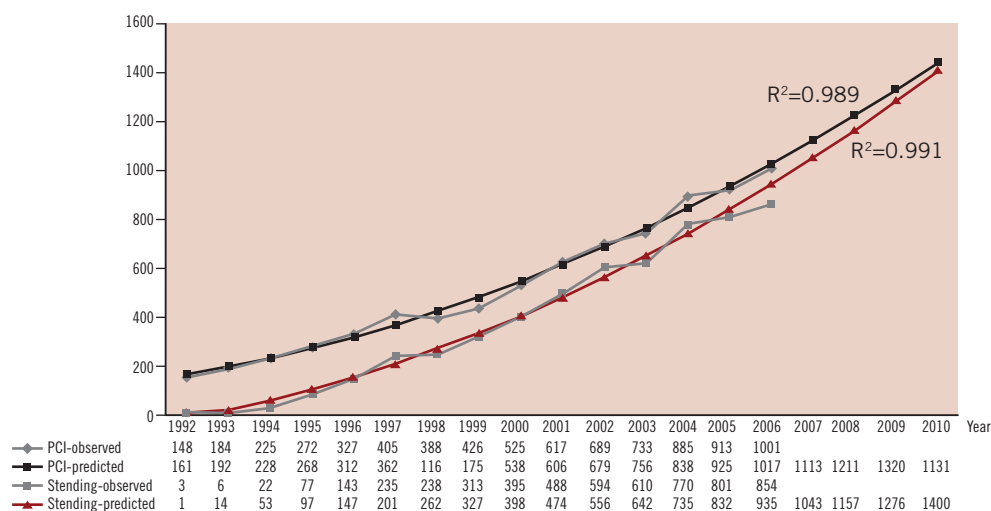


Figure 2. Observed and predicted PCI and stenting procedures expressed in thousands from 1992 to 2006 per million inhabitants in Europe, based on the “consumption method” for prediction medicine on the data 1992-2004 with $R^2=0.989$ for PCIs and $R^2=0.991$ for stenting procedures (see reference 14 for details).

survey are alphabetical order: Austria: V. Mühlberger, Belgium: V. Legrand, Bulgaria: G. Mazhdrakov, Croatia: A. Ernst, Cyprus: P. Nicolaidis, Czech Republic: P. Kala, Denmark: S. Helqvist, Estonia M. Peeba, Finland: M. Laine, France: D. Blanchard, Germany: F. van Buuren, Greece: G. Papaioannou, Hungary: G. Fontos, Iceland: K. Eijolfsson, Italy: F. Piscione, Latvia: A. Erglis, Lithuania: R. Navickas, Luxemburg: J. Beissel, The Netherlands: K. Koch, J. Bronzwaer, Norway: T. Melberg, Poland: A. Witkowski, Portugal: P. Helder, Romania: D. Deleanu, Slovakia: V. Fridrich, Slovenia: M. Noc, Spain: J.A. Baz Alonso, Sweden: S. James, Switzerland: M. Maeder, H. Rickli, Turkey: M. Degertekin, United Kingdom: P. Ludman.

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