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Cardiology and Acute Coronary Syndrome"

Interventional cardiology in Switzerland 2006

Summary

Background: Since 1987, a nationwide survey of percutaneous cardiac interventions is performed annually in Switzerland, which allows recognition of contemporary trends and comparison with other countries.

Methods: Volume and type of procedures performed during the year 2006 were collected by means of a standardised questionnaire from all adult percutaneous cardiac intervention centres in Switzerland.

Results: During the year 2006, 36817 coronary angiographies (CA; 2005: 36436; +1.0%) and 17061 percutaneous coronary interventions (PCI; 2005: 16624; +2.6%) were performed in 27 centres (5 university hospitals, 9 public, non-university hospitals, and 13 private hospitals) by 193 operators (64 of them performing only diagnostic studies). Ninety-three percent of PCI procedures were performed *ad hoc*, and 78% of them were single-vessel interventions. Stents were used in 89% of all PCI (2005: 91%) procedures with drug-eluting stents (DES) being responsible for the largest share (82% of all stents) (2005: 78%). Emergency procedures (primary PCI or rescue PCI after failed thrombolysis) accounted for 20% of interventions (2005: 19%). Glycoprotein IIb/IIIa inhibitors were used in 19% of PCI (2005: 23%) procedures. In addition, valvuloplasties of mitral, aortic, and pulmonary valves were performed in 42, 21, and 5 cases, respectively. Finally, percutaneous closure of a patent foramen ovale and an atrial septal defect were performed in 515 (2005: 510) and in 88 (2005: 94) cases, respectively.

Conclusions: The increase in the number of CA and PCI has flattened during 2006. The use of DES remained high, though the previously rapidly growing utilisation of these devices reached a plateau. The number of procedures for the percutaneous closure of patent foramen ovale and atrial septal defect has stabilised.

Key words: coronary angiography; angioplasty; stents; balloon valvuloplasty; patent foramen ovale; quality control

Zusammenfassung

Hintergrund: Seit 1987 werden die perkutanen kardiologischen Eingriffe zur Erkennung aktueller Trends und für den internationalen Vergleich schweizweit erfasst.

Methodik: Basierend auf einem standardisierten Fragebogen wurden alle Zentren, die bei Erwachsenen perkutane kardiologische Eingriffe durchführen, über Art und Umfang ihrer interventionellen Aktivitäten im Jahr 2006 befragt.

Ergebnisse: Im Jahr 2006 wurden in 5 Universitätsspitalern, 9 öffentlichen, nicht-universitären Zentren und 13 Privatkliniken 36817 Koronarangiografien (CA; 2005: 36436; +1,0%) und 17061 perkutane koronare Interventionen (PCI; 2005: 16624; +2,6%) durchgeführt, dies durch 193 Operateure, von denen 64 ausschliesslich diagnostische Eingriffe durchführten. 93% der PCI wurden *ad hoc* durchgeführt, und 78% waren Eingefäss-Eingriffe. Stents wurden bei 89% aller PCI implantiert (2005: 91%), und Medikamenten-beschichtete Stents (drug-eluting stents [DES]) machten 82% aller verwendeten Stents aus (2005: 78%). Notfallmässige Eingriffe (primäre PCI oder Rescue-PCI nach Thrombolyse-Versagen) waren für 20% der PCI verantwortlich. Glykoprotein-IIb/IIIa-Antagonisten wurden bei 19% der PCI eingesetzt (2005: 23%). Zusätzlich wurden 42 Mitralkappen-, 21 Aortenklappen- und 5 Pulmonalklappen-Valvuloplastien durchgeführt sowie 515 Eingriffe zum Verschluss eines offenen Foramen ovale (2005: 510) und 88 Interventionen zum Verschluss eines Vorhofseptumdefekts (2005: 94).

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There is no conflict
of interest.

Schlussfolgerungen: Die Zunahme der Anzahl CA und PCI ist im Jahr 2006 abgeflacht, und die Verwendung von DES hat nicht mehr merklich zugenommen. Die Zahl der Eingriffe für den Verschluss vom offenen Foramen ovale und Vorhofseptumdefekt hat nicht weiter zugenommen.

Schlüsselwörter: Koronarangiographie; Angioplastie; Stents; Ballon-Valvuloplastie; offenes Foramen ovale; Qualitätskontrolle

Introduction

Since 1987, a nationwide survey of interventional procedures in all Swiss cardiology centres is performed annually to recognise contemporary trends and the incorporation of

study results and guidelines in daily practice [1–16]. The aim of the present report was to provide cardiologists, primary care physicians, as well as the public health community with the most recent data on interventional cardiology practice in the country. Of particular interest is the use of drug-eluting stents (DES), since these devices are reimbursed without restrictions and have been widely embraced in clinical practice. Thanks to several large-scale randomised trials and analysis of large databases, Switzerland is currently one of the leading countries in the field [17–20]. Given the recently detected problem of late and very late stent thrombosis associated with DES [18, 20], this survey provides interesting insights as to how Swiss interventional cardiologists interpret these widely debated study results.

Methods

Based on a standardised questionnaire all cardiology centres performing interventional procedures in adult patients were asked to report on procedures performed during the year 2006. The questionnaire was not sent to the two centres, whose activities are restricted to pediatric patients. The requested items included data about infrastructure, operators, availability of cardiac surgery, number of coronary angiographies (CA) and percutaneous coronary interventions (PCI), detailed information about circumstances of PCI (ad hoc interventions, single-vessel PCI, multi-vessel PCI), types of stents (bare-metal stents [BMS] or DES), other revascularisation techniques (eg rotablator), adjunctive techniques (eg use of distal protection devices), use of mechanical circulatory support, use of glycoprotein IIb/IIIa inhibitors, number of balloon valvuloplasties, number of interventions for closure of shunts, and complications. The questionnaires were returned by all centres, though for some centres, information was not available for all items.

The following definitions were applied:

Coronary angiography (CA)

Diagnostic cardiac catheterisation for visualisation of the coronary arteries, independently whether or not an intervention is performed in the same session. The number of cases is recorded.

Percutaneous coronary intervention (PCI)

Coronary angioplasty with or without stent placement. If PCI is performed directly following the diagnostic procedure during the same session, it is referred to as “ad hoc PCI”. The number of cases, but not the number of vessels dilated is recorded.

Emergency PCI

Primary PCI or rescue PCI after failed thrombolysis for acute ST-segment elevation myocardial infarction (STEMI).

Balloon valvuloplasty

Percutaneous dilatation of stenotic cardiac valves.

Results

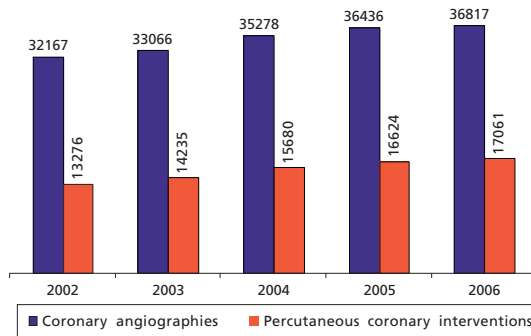
Structure of Swiss centres

In 2006, there were 27 active centres (5 university hospitals, 9 public, non-university hospitals, 13 private hospitals), all of which performed both diagnostic procedures and percutaneous cardiac interventions. The University Hospital Zürich (UniversitätsSpital Zürich [USZ]), the Kantonsspital Winterthur (KSW)

and the Spital Thurgau AG (Frauenfeld) were considered as a single centre as there was a close collaboration and exchange of operators between these hospitals. Among the 27 centres, 12 institutions had one catheterisation laboratory, 11 centres had two, three centres had three, and one centre (USZ/KSW/Frauenfeld) had four labs. Sixty-four (2005: 80) operators performed exclusively diagnostic studies, whereas 129 (2005: 125) cardiologists prac-

Figure 1

Evolution of coronary angiographies and percutaneous coronary interventions from 2002 to 2006.



ticed both CA and PCI. In 18 centres, cardiac surgery was available on site.

Percutaneous coronary interventions

In 2006, 36817 CA (2005: 36436; +1.0%) and 17061 PCI (2005: 16624; +2.6%) were performed. Over the last five years the increase of the number of both CA and PCI has flattened (fig. 1). Figure 2 shows the distribution of diagnostic and interventional procedures among the different centres. The calculated number of CA and PCI performed per operator were 191 (2005: 178) and 132 (2005: 133) respectively. The average number of procedures per operator differed widely among centres as shown in figure 3. The theoretical average number of PCI per operator was 196 in university hospitals, 165 in public non-university hospitals, and 78 in private hospitals.

In 93% of cases (data not available from three centres), PCI was performed *ad hoc*

(2005: 93%). The majority of PCI procedures constituted single-vessel interventions (78%, data not available from three centres; 2005: 78%).

The rate of stent utilisation was 89% (data not available from one centre) and thereby more or less unchanged as compared to previous years (2005: 91%). The evolution of the utilisation of stents from 1992 to 2005 is shown in figure 4. In 42% of PCI procedures (2005: 41%), two or more stents were implanted (data not available from four centres). With 82% of all stents (data not available from two centres), DES constituted the most frequently applied stent type, similar to the previous year (2005: 78%; fig. 5). The proportion of DES varied considerably among different centres ranging from 51 to 100% (fig. 6). Information about the use of different types of DES was available for 18/27 centres: Sirolimus-eluting stents were used in 42%, paclitaxel-eluting stents in 45%, and other DES in 13% of cases.

Emergency interventions in patients presenting with STEMI (primary PCI or rescue PCI after failed thrombolysis) accounted for 20% of PCI procedures (data not available from two centres; 2005: 19%). The proportion of PCI for STEMI among all interventions was higher in university hospitals (23%) and public non-university hospitals (22%) versus private hospitals (11%). Glycoprotein IIb/IIIa inhibitors were used in 19% of PCI procedures (data not available for six centres; 2005: 23%). Over the

Figure 2

Coronary angiographies and percutaneous coronary interventions in different centres. The centres are grouped according to their annual coronary angiography volume. USZ = UniversitätsSpital Zürich; KSW = Kantonsspital Winterthur; FF = Spital AG Thurgau (Frauenfeld).

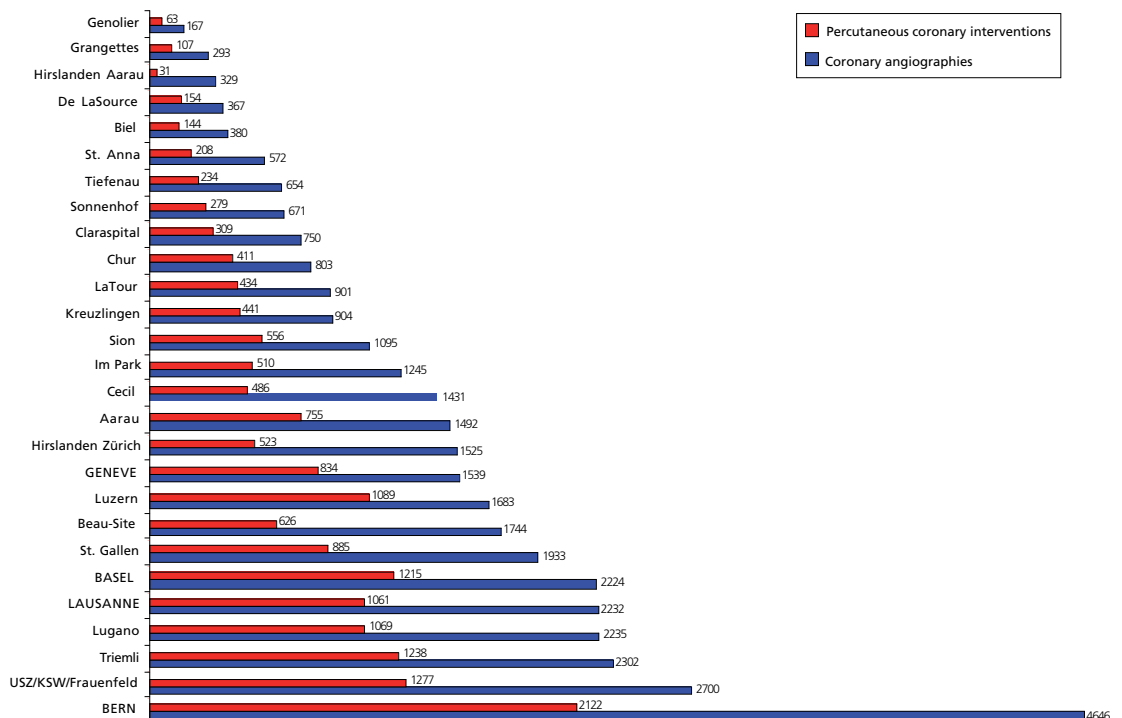
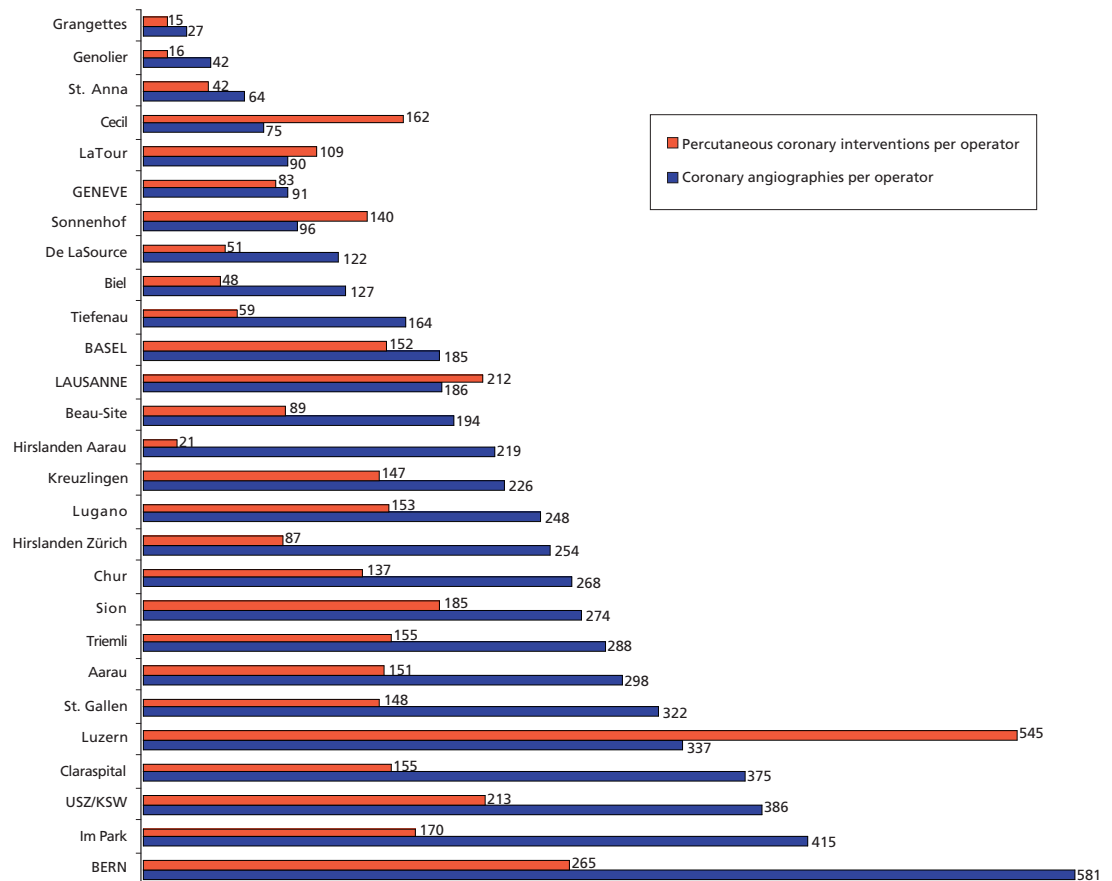


Figure 3

Coronary angiographies and percutaneous coronary interventions per operator in different centres (grouped according to the annual average coronary angiography volume per operator).
USZ = UniversitätsSpital Zürich; KSW = Kantonsspital Winterthur; FF = Spital AG Thurgau (Frauenfeld).



last three years, the utilisation rate of glycoprotein IIb/IIIa inhibitors decreased from 27 to 19% as illustrated in figure 7.

Distal protection devices were used in only 3.3% of PCI cases (2005: 2.4%), an intracoronary pressure wire was employed in 2.6% (2005: 2.6%) of cases, and intravascular ultra-

sound was performed in 3.9% of PCI (2005: 3.4%). Revascularisation techniques other than balloon angioplasty including rotablator (62 cases; 2005: 59) and sonotherapy (9 cases, 2005: 14 patients) have rarely been applied. Atherectomy (2005: 0) and brachytherapy (2005: 17) were not employed in any case. During 2006, 437 (2005: 436) intraaortic balloon pumps and 56 (2005: 37) percutaneous left ventricular assist devices were implanted.

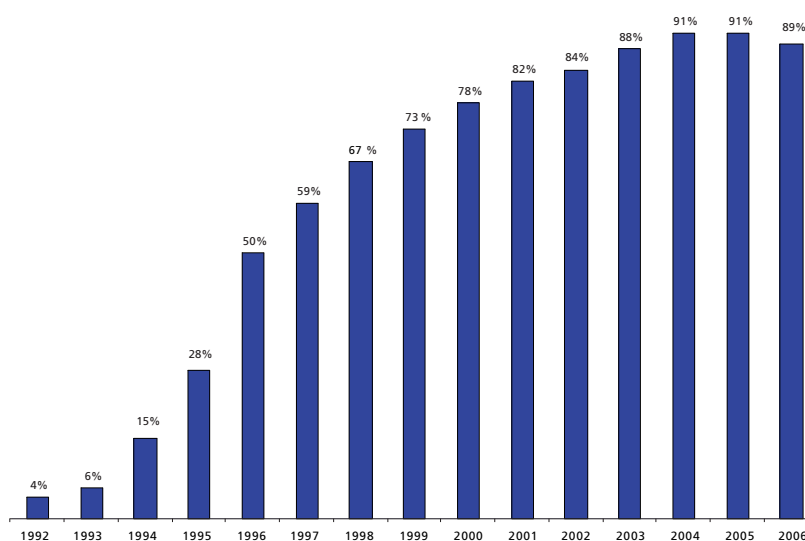
Complications after PCI

Myocardial infarction after PCI was reported in 1.5% of PCI procedures (2005: 1.1%), emergency coronary artery bypass grafting was required in 0.2% of cases (2005: 0.1%), and in-hospital mortality rate following PCI was reported to be 0.6% (2005: 0.5%). Data on complications were not provided by five centres.

Non-coronary interventions

The number of balloon valvuloplasties (fig. 8) did not markedly differ from previous years. The number of procedures for closure of structural defects (fig. 9) was similar as in 2005, whereas in the preceding years, there has been a continuous increase.

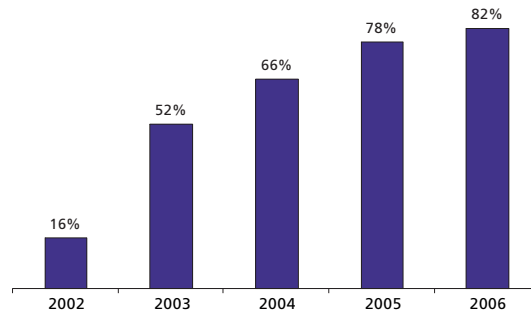
Peripheral angioplasties were carried out by radiologists and angiologists in most hospi-

**Figure 4**

Evolution of the use of stents between 1992 and 2006. The bars represent the stent utilisation rates (percutaneous coronary interventions with stent placement/all percutaneous coronary interventions).

Figure 5

Evolution of the use of drug-eluting stents between 2002 and 2006. The bars represent the drug-eluting stent utilisation rates (interventions with drug-eluting stent placement/all interventions with stent implantation).



tals. However, cardiologist reported 237 (2005: 197) iliac or lower extremity interventions (43% with stent placement), 158 (2005: 93) carotid artery angioplasties (88% with stent implantation), and 201 (2005: 152) renal artery interventions (74% with stent placement). In addition, alcohol ablation of septal hypertrophy was done in 44 (2005: 17) patients.

Discussion

Despite the fact that the present report represents a retrospective survey and that data reporting was incomplete with respect to several items, it provides important insight of the contemporary practice of interventional cardiology in Switzerland. We found a smaller increase in the overall number of CA (approximately 400 per year) and PCI (approximately

400 per year) as compared to the period between 2002 and 2005 (CA: 800–2000 per year, PCI: 1000–1400 per years). In addition, the marked increase in the DES utilisation rate between 2002 and 2005 seems to flatten.

A variety of reasons might account for the smaller increase in the number of CA and PCI procedures during the last year as compared to previous years. Current guidelines recommend primary PCI for patients with STEMI presenting within 12 hours after onset of chest pain or other symptoms, and rescue-PCI if thrombolysis has failed within 45–60 minutes, and for high-risk patients with non-ST-segment elevation myocardial infarction (NSTEMI) [21]. Thus, several centres have established a 7 day per 24 hour service for acute PCI during the last years. According to an analysis from the Acute Myocardial Infarction in Switzerland Plus (AMIS Plus) registry the percentage of patients with STEMI receiving no reperfusion has decreased from 44.8 to 31.4% between 1997 and 2002, and the percentage of patients undergoing primary PCI has increased from 8.0 to 43.1%, whereas the percentage of those treated by thrombolysis has decreased from 47.2 to 25.6% [22]. However, also patients treated with thrombolysis during AMI in previous years most often had undergone CA and PCI (or coronary artery bypass grafting) later in the disease course, and thus the net number of CA and PCI might not

Figure 6

Drug-eluting stent utilisation rates (interventions with drug-eluting stent placement/all interventions with stent implantation) for percutaneous coronary interventions in different centres.

USZ = UniversitätsSpital Zürich; KSW = Kantonsspital Winterthur; FF = Spital AG Thurgau (Frauenfeld).

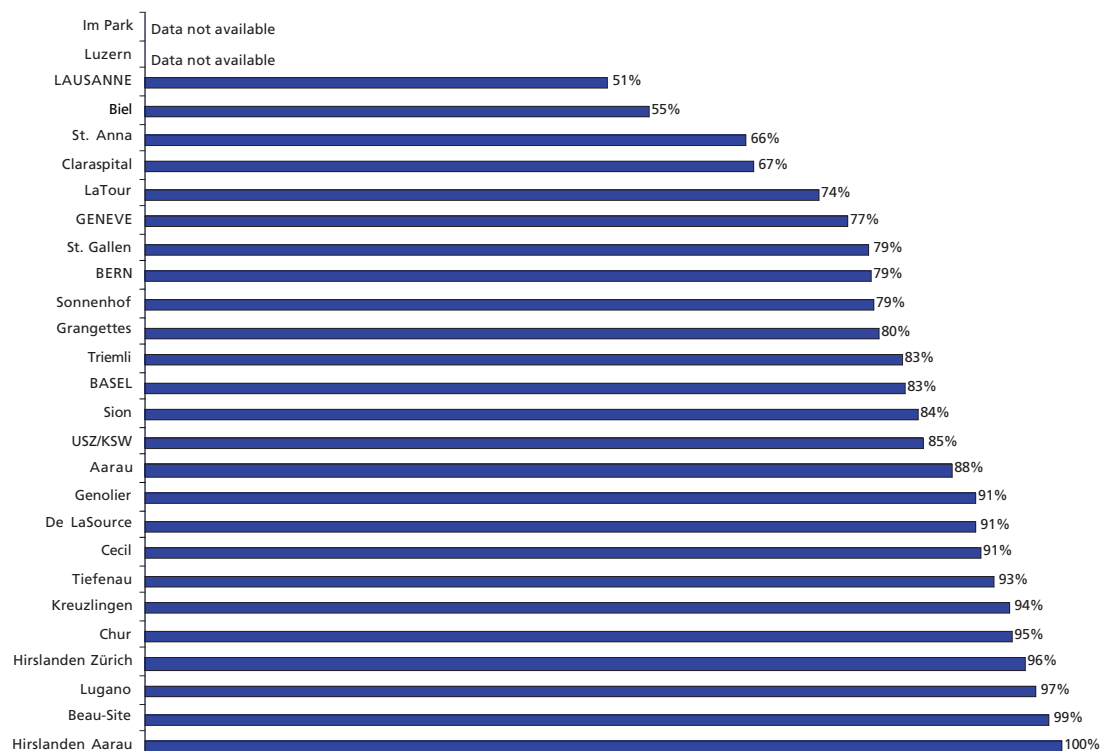
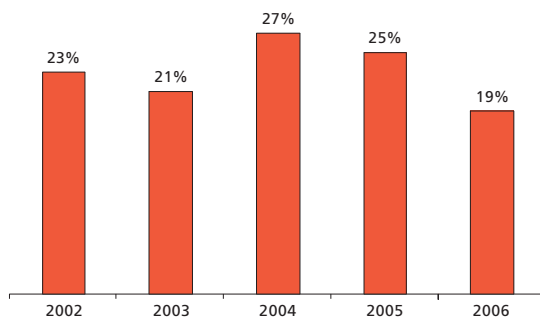


Figure 7

Evolution of the use of glycoprotein IIb/IIIa inhibitors between 2002 and 2006. The IIb/IIIa inhibitor utilisation rates (percutaneous coronary interventions with glycoprotein IIb/IIIa inhibitors/all percutaneous coronary interventions) are given.



have increased in parallel to the number of acute PCI after PCI for acute myocardial had been established.

Given the availability of DES, there is a trend towards more aggressive multivessel PCI as an alternative to surgery. On the other hand, the Occluded Artery Trial (OAT) showed that PCI of an occluded infarct-related artery three to 28 days after myocardial infarction was not superior to medical therapy with respect to the occurrence death, reinfarction, or heart failure [23]. In addition, the Clinical Outcomes Utilizing percutaneous coronary Revascularization and Aggressive Drug Evaluation (COURAGE) trial has confirmed previous data in that in patients with stable angina, PCI as initial strategy was not superior to medical management as initial strategy with respect to death, myocardial infarction and other major cardiovascular events [24]. The latter study however was published in 2006 and is unlikely to have had significant influence on practice in 2006 but might influence the 2007 and 2008 data. Furthermore, alternatives to CA, *ie*, coronary computed tomogra-

phy, can nowadays replace CA in certain situations. Thus, a further marked increase in the number of CA and PCI procedures seems unlikely given the evolution over the last years.

There was no further increase in the percentage of interventions with stent placement within the last three years, which is most likely related to technical limitations (small vessels, tortuous vessels, proximal stent with the impossibility to deploy a stent distally) rather than lack of an indication.

In contrast to the evolution within the previous three years, the DES utilisation rate remained more or less stable at 80%. The use of DES is associated with a dramatic benefit in terms of both angiographic (late lumen loss) and clinical (target vessel revascularisation) endpoints observed in large trials with medium-term follow-up [25, 26]. Thus, the problem of in-stent-restenosis has been markedly reduced, and alternative procedures to resolve this problem, *eg* brachytherapy that are inferior to DES with respect to the occurrence of restenosis [27, 28] have disappeared with the introduction of DES. On the other hand, the phenomenon of late stent thrombosis after DES implantation is now well documented [18, 20] and new questions regarding the use of DES have arisen.

Due to the increased costs, the introduction of DES was slower in most European countries (*eg* 28% DES utilisation in Germany in 2005 [29]) than in Switzerland. Thus, Switzerland has an exceptional position with a comparatively large experience with DES, and several important studies in the field were published by Swiss centres [17–20]. The BASel

Figure 8

Balloon valvuloplasties from 1987 to 2006.

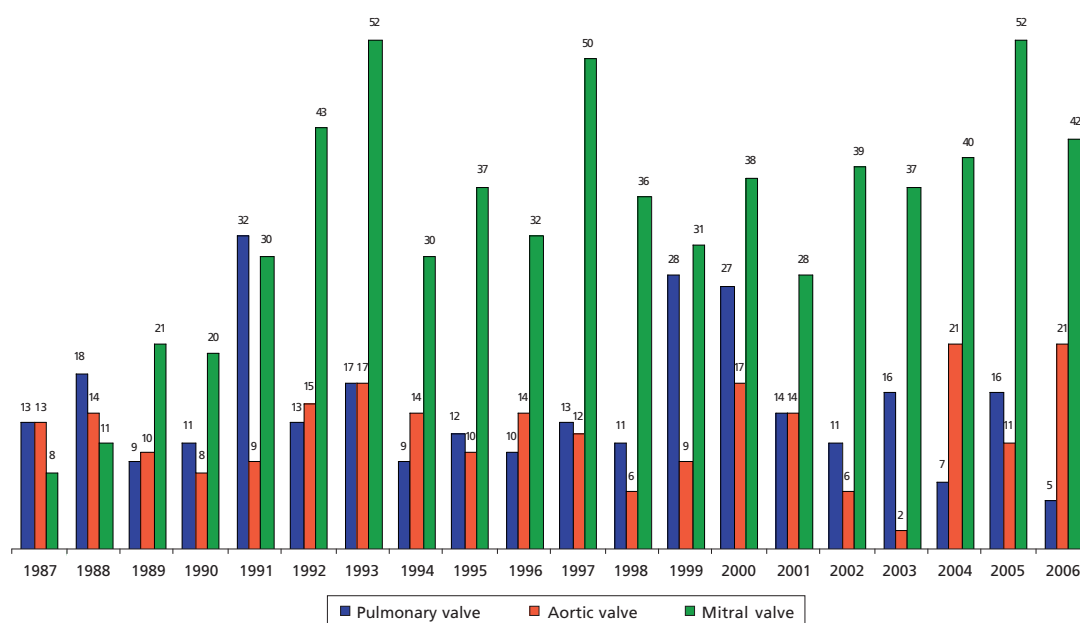
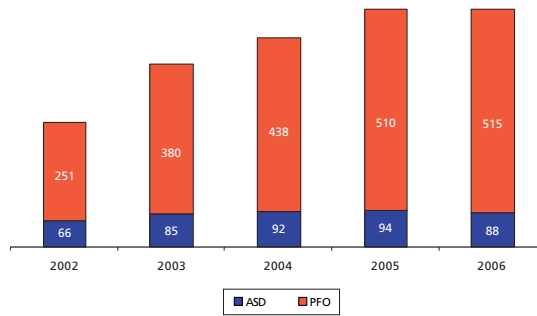


Figure 9

Interventions for closure of structural defects from 2002 to 2006. ASD = atrial septal defect; PFO = patent foramen ovale.



KostenEffektivitäts Trial (BASKET) trial revealed that in an “all-comers” setting, the higher costs for DES as compared to BMS were not compensated by lower follow-up costs at six months, and that DES were cost-effective only in elderly patients in specific high-risk groups [17]. The 18 months follow-up of this study revealed that the benefit of DES in reducing target vessel revascularisation was maintained but that late stent thrombosis was twice as frequent in patients treated with DES as compared to those receiving BMS [18]. Similar data were reported by other investigators [30] but were not confirmed by others [31]. Although an increased mortality due to late stent thrombosis in DES has not been proven, indications of DES implantation are now more critically evaluated. Another analysis from the BASKET trial suggested that patients undergoing PCI in small vessels and bypass grafts benefited from the use of DES in terms of major cardiac events, whereas in those undergoing interventions in comparatively large vessels, DES use was not superior to BMS use [32]. The targeted use of DES might be an effective strategy, and prospective studies are underway to address this issue.

Although we were only able to calculate average annual numbers of CA and PCI per operator for the different centres, a large spectrum of operator volumes for PCI became obvious. Current guidelines recommend a minimum of 75 PCI per year per operator [33], and this recommendation was reinforced in a recent statement on clinical competence [34]. An analysis from the US from 2002 showed that there was a similarly large spectrum of operator volumes [35]. This study found a relationship between lower operator volume and higher morbidity but not mortality [35].

The number of balloon valvuloplasties did not significantly change as compared to previous years, probably due to the fact that the diagnosis of congenital or rheumatic valve disease in adults has become rare. However, major changes in the field of percutaneous valve

interventions can be expected in the next years. Several studies have demonstrated that percutaneous aortic valve implantation is feasible [36–38]. Although large studies comparing surgical aortic valve replacement and percutaneous aortic valve implantation are not available yet, the latter might be increasingly used for patients who are considered too ill for cardiac surgery. In addition, techniques for percutaneous mitral annuloplasty have been established and await introduction in practice [39].

Interestingly, the number of procedures for PFO remained more or less unchanged too, which is in contrast to the trend in the previous years. Indications for PFO closure are still under debate, and there is no consensus of optimal management of patients with PFO and stroke. It is widely accepted that young patients with recurrence of stroke despite therapeutic anticoagulation should undergo PFO closure [40]. Although in practice, indications might be interpreted more liberally, the number of procedures did not increase. This might have been due to the fact that young patients with stroke and lack of an alternative explanation for stroke are comparatively rare. The association between PFO and atrial septal aneurysm respectively and stroke is accepted only for younger patients (<55 years). However, recent data from a large observational study suggest such a relationship also for older patients [41], which might give rise to speculations about expanding the indications for PFO closure. However, prospective studies are needed before the practice of PFO can change.

Limitations of the study

Due to the retrospective nature of the study, some inaccuracies must be assumed. Unfortunately, data reporting was incomplete with respect to several items, and some centres were not able to present all of the data of interest. Accordingly, results must be interpreted cautiously. We decided to omit figures showing comparisons with previous years if a relevant number of centres did not provide data on a specific item. In addition, the rate of periprocedural complications is likely underestimated. A catheterisation laboratory-based retrospective analysis is unlikely to be complete, and we can assume that only complications occurring immediately at the time of catheterisation have been included. Regarding the high mortality of patients undergoing PCI for cardiogenic shock, these patients have probably not been included into the statistics. Thus, we

give the reported figures on complications but we do not present a figure as it might be inaccurate and misleading. A more comprehensive data collection with respect to complications is planned based on a work sheet already discussed at the business meeting of the Working Group in 2005 in Lausanne. This sheet has been sent to all centres to be included in the local databases and awaits broad application.

Conclusions

The increase in the number of CA and PCI in Switzerland has flattened over the last few years, and a sizable increase in the volume of interventional procedures in the next years in the country is unlikely. DES utilisation remained high (82%), though stabilised. A plateau was observed with respect to PFO closures.

Appendix

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References

- 1 Meier B. Örtliche Entwicklung der Koronarangioplastie. *Schweiz Med Wochenschr.* 1989;119:1033–9.
- 2 Meier B, Pfisterer M. Coronarographie, angioplastie percutanee transluminale coronaire et chirurgie coronaire, interventions valvulaires et anti-arrhythmiques et fibrinolyse pour infarctus aigu du myocarde en Suisse. *Schweiz Med Wochenschr.* 1990;120:1559–64.
- 3 Meier B, Pfisterer M, Bertel O. Interventions cardiaque en Suisse. *Schweiz Med Wochenschr.* 1992;122:432–40.
- 4 Rouvinez G, Bertel O, Urban P, Meier B. Herzeingriffe in der Schweiz 1992. *Schweiz Med Wochenschr.* 1994;124:1284–94.
- 5 Röthlisberger C, Meier B, Urban P. Herzeingriffe in der Schweiz 1993. *Schweiz Rundsch Med Prax.* 1995;84:402–11.
- 6 Goerre S. Herzeingriffe in der Schweiz 1994. *Schweiz Rundsch Med Prax.* 1996;85:1071–80.
- 7 Goerre S. Herzeingriffe in der Schweiz 1995. *Schweiz Rundsch Med Prax.* 1997;86:425–31.
- 8 Pedrazzini G. Herzeingriffe in der Schweiz 1996. *Schweiz Rundsch Med Prax.* 1998;87:821–31.
- 9 Roffi M. Herzeingriffe in der Schweiz. 1997. *Kardiovaskuläre Medizin.* 1999;2:302–18.
- 10 Roffi M. Herzeingriffe in der Schweiz. 1998. *Kardiovaskuläre Medizin.* 2000;3:89–103.
- 11 Wahl A. Herzeingriffe in der Schweiz 1999. *Kardiovaskuläre Medizin.* 2001;4:268–81.
- 12 Togni M, Meier B. Herzeingriffe in der Schweiz 2000. *Kardiovaskuläre Medizin.* 2002;5:238–48.
- 13 Schlüter L, Rickli H, Vuillomenet A, Chatelain P, Eberli F, Meier B, et al. Interventions cardiaque percutanées en Suisse en 2001. *Kardiovaskuläre Medizin.* 2004;7:61–70.
- 14 Reho I, Eberli F. Trends of percutaneous cardiac interventions in Switzerland [abstract]. *Kardiovaskuläre Medizin.* 2005;8(Suppl 8):S39.
- 15 Maeder M, Stauffer JC, Windecker S, Eberli F, Pedrazzini G, Vuillomenet A, et al. Interventional cardiology in Switzerland 2004. *Kardiovaskuläre Medizin.* 2006;9:213–26.
- 16 Maeder MT, Stauffer JC, Windecker S, Pedrazzini G, Vuillomenet A, Rickli H. Interventional cardiology in Switzerland during the year 2005. *Kardiovaskuläre Medizin.* 2007;10:92–100.
- 17 Kaiser C, Brunner-La Rocca HP, Buser PT, Bonetti PO, Osswald S, Linka A, et al.; BASKET Investigators. Incremental cost-effectiveness of drug-eluting stents compared with a third-generation bare-metal stent in a real-world setting: randomised Basel Stent Kosten Effektivitäts Trial (BASKET). *Lancet.* 2005;366:921–9.
- 18 Pfisterer M, Brunner-La Rocca HP, Buser PT, Rickenbacher P, Hunziker P, Mueller C, et al. for the BASKET investigators. Late thrombotic events after clopidogrel discontinuation may limit the benefit of drug-eluting stents: an observational study of drug-eluting vs. bare-metal stents. *J Am Coll Cardiol.* 2006; 48:2584–91.
- 19 Windecker S, Remondino A, Eberli F, Jüni P, Räber L, Wenaweser P, et al. Sirolimus-eluting and paclitaxel-eluting stents for coronary revascularization. *N Engl J Med.* 2005; 353:653–62.
- 20 Daemen J, Wenaweser P, Tsuchida K, Abrecht L, Vaina S, Morger C, et al. Early and late coronary stent thrombosis of sirolimus-eluting and paclitaxel-eluting stents in routine clinical practice: data from a large two-institutional cohort study. *Lancet.* 2007;369(9562):667–78.
- 21 Silber S, Albertson P, Avilés FF, Camici PG, Colombo A, Hamm C, et al., for the Task Force for Percutaneous Coronary Interventions of the European Society of Cardiology. *Eur Heart J.* 2005;26:804–47.
- 22 Fassa AA, Urban P, Radovanovic D, Duvoisin N, Gaspoz JM, Stauffer JC, et al., for the AMIS Plus Investigators. Trends in reperfusion therapy of ST segment elevation myocardial infarction in Switzerland: six year results from a nationwide registry. *Heart.* 2005;91:882–8.
- 23 Hochman JS, Lamas GA, Buller CE, Dzavik V, Reynolds HR, Abramsky SJ, et al.; Occluded Artery Trial Investigators. Coronary intervention for persistent occlusion after myocardial infarction. *N Engl J Med.* 2006;355:2395–407.
- 24 Boden WE, O'Rourke RA, Teo KK, Hartigan PM, Maron DJ, Kostuk WJ, et al.; COURAGE Trial Research Group. Optimal medical therapy with or without PCI for stable coronary disease. *N Engl J Med.* 2007;356:1503–16.
- 25 Morice MC, Serruys PW, Sousa JE, Fajadet J, Ban Hayashi E, Perin M, et al. A randomised comparison of a sirolimus-eluting stent with a standard stent for coronary revascularization. *N Engl J Med.* 2002;346:1773–80.
- 26 Stone GW, Ellis SG, Cox DA, Hermiller J, O'Shaughnessy C, Mann JT, et al. A polymer-based, paclitaxel-eluting stent in patients with coronary artery disease. *N Engl J Med.* 2004; 350:221–31.
- 27 Holmes DR, Jr., Teirstein P, Satler L, Sketch M, O'Malley J, Popma JJ, et al. Sirolimus-eluting stents vs vascular brachytherapy for in-stent restenosis within bare-metal stents: the SISR randomized trial. *JAMA.* 2006;295:1264–73.
- 28 Stone GW, Ellis SG, O'Shaughnessy CD, Martin SL, Satler L, McGarry T, et al. Paclitaxel-eluting stents vs vascular brachytherapy for in-stent restenosis within bare-metal stents: the TAXUS V ISR randomized trial. *JAMA.* 2006; 295:1253–63.
- 29 Brucknerberger E. Herzbericht 2005 mit Transplantationschirurgie. 18. Bericht. Hannover: Eigenverlag; 2006. Website: www.brucknerberger.de.
- 30 Lagerqvist B, James SK, Stenestrand U, Lindback J, Nilsson T, Wallentin L. Long-term outcomes with drug-eluting stents versus bare-metal stents in Sweden. *N Engl J Med.* 2007;356:1009–19.
- 31 Mauri L, Hsieh W, Massaro JM, Ho KKL, D'Agostino R, Cutlip DE. Stent thrombosis in randomized clinical trials of drug-eluting stents. *N Engl J Med.* 2007;356:1020–9.
- 32 Brunner-La Rocca HP, Kaiser C, Pfisterer M; Basket Investigators. Targeted stent use in clinical practice based on evidence from the Basel Stent Cost Effectiveness Trial (BASKET). *Eur Heart J.* 2007;28:719–25.
- 33 Smith SC Jr., Dove JT, Jacobs AK, et al. ACC/AHA guidelines of percutaneous coronary interventions (revision of the 1993 PTCA guidelines) – executive summary. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1993 Guidelines for Percutaneous Transluminal Coronary Angioplasty). *J Am Coll Cardiol.* 2001;37:2215–39.
- 34 King SB 3rd, Aversano T, Ballard WL, Beekman RH 3rd, Cowley MJ, Ellis SG, et al.; American College of Cardiology Foundation; American Heart Association; American College of Physicians Task Force on Clinical Competence and Training (writing Committee to update the 1998 Clinical Competence Statement on Recommendations for the Assessment and Maintenance of Proficiency in Coronary Interventional Procedures). ACCF/AHA/SCAI 2007 update of the clinical competence statement on cardiac interventional procedures. A report of the American College of Cardiology Foundation/American Heart Association/American College of Physicians Task Force on Clinical Competence and Training (writing Committee to update the 1998 Clinical Competence Statement on Recommendations for the Assessment and Maintenance of Proficiency in Coronary Interventional Procedures). *J Am Coll Cardiol.* 2007;50:82–108.
- 35 Moscucci M, Share D, Smith D, et al. Relationship between operator volume and adverse outcome in contemporary percutaneous coronary intervention practice. An analysis of quality-controlled multicenter percutaneous coronary intervention clinical database. *J Am Coll Cardiol.* 2005;46:625–32.
- 36 Cribier A, Eltchaninoff H, Tron C, et al. Early experience with percutaneous transcatheter implantation of heart valve prosthesis for the treatment of end-stage inoperable patients with calcific aortic stenosis. *J Am Coll Cardiol.* 2004;43:698–703.
- 37 Grube E, Laborde JC, Gerckens U, et al. Percutaneous implantation of the CoreValve self-expanding valve prosthesis in high-risk patients with aortic valve disease: the Siegburg first-in-man study. *Circulation.* 2006;114:616–24.
- 38 Webb JG, Chandavimol M, Thompson CR, et al. Percutaneous aortic valve implantation retrograde from the femoral artery. *Circulation* 2006;113:842–50.
- 39 Webb JG, Harnek J, Munt BI, et al. Percutaneous transvenous mitral annuloplasty: initial human experience with device implantation in the coronary sinus. *Circulation.* 2006; 113:851–5.
- 40 Kizer JR, Devereux RB. Patient foramen ovale in young adults with unexplained stroke. *N Engl J Med* 2005;353: 2361–72.
- 41 Handke M, Harloff A, Olschewski M, Hetzel A, Geibel A. Patent foramen ovale and cryptogenic stroke in older patients. *N Engl J Med.* 2007;357:2262–8.