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Coronary and structural heart interventions in Switzerland 2019

Wagener Max[a*], Twerenbold Raphael[a*], Cook Stéphane[b], Gaemperli Oliver[c], Meier Pascal[d], Muller Olivier[e], Nietlispach Fabian[f], Raeber Lorenz[g], Weilenmann Daniel[h], Jeger Raban[a]on behalf of the Swiss Working Group Interventional Cardiology of the Swiss Society of Cardiology

[a] Cardiology, University Hospital Basel, University of Basel, Switzerland
[b] Cardiology, Cantonal Hospital Fribourg, Switzerland
[c] HeartClinic, Hirslanden Hospital Zurich, Switzerland
[d] Cardiology, Cantonal Hospital Chur, Switzerland
[e] Cardiology, University Hospital Lausanne, University of Lausanne, Switzerland
[f] HerzGefäss Zentrum, Hirslanden Klinik im Park, Zurich, Switzerland
[g] Cardiology, University Hospital Bern, University of Bern, Switzerland
[h] Cardiology, Cantonal Hospital St Gallen, Switzerland

Summary

Since 1987 the Swiss Working Group Interventional Cardiology of the Swiss Society of Cardiology coordinates the assessment of invasive diagnostic and therapeutic heart interventions across Switzerland. The aim of this report is to summarise the data for the year 2019, which was collected using a standardised questionnaire. In 2019, 37 centres performed a total of 57,975 coronary angiographies. In 48.2% of these cases a subsequent percutaneous coronary intervention was performed. Among a broad spectrum of structural heart interventions, we have observed a constant growth of transcatheter aortic valve implantations, and a total of 1912 transcatheter aortic valve implantations were performed in 2019.

Introduction

Despite a decrease in mortality due to evolving therapeutic options and faster access to interventional treatment in past decades, cardiovascular disease still accounts for 45% of all deaths in Europe with about 20% being caused by coronary heart disease [1]. Current guidelines underline the importance of established international and national networks for the management of acute and chronic heart disease [2, 3]. The Working Group Interventional Cardiology of the Swiss Society of Cardiology (SSC) has coordinated the annual assessment of invasive diagnostic and therapeutic procedures across Switzerland since 1987 [4]. On an evolving, standardised questionnaire, the number of the different cardiovascular procedures are collected and published by the Swiss Working Group Interventional Cardiology of the SSC [5–9].

Methods

All interventional cardiology centres across Switzerland were asked to complete a standardised online questionnaire via the Survio® platform. In the event of technical difficulties with the online platform, the questionnaire was completed via a standardised .pdf file. Overall, 69 items were assessed, regarding general information of the catheterisation centres, the interventions for coronary artery and structural heart disease, the indications for the interventions, the material used, and outcome (if available). Details of the variables assessed are listed in the appendix.

Data were collected using Excel® for Windows® and only descriptive statistics are presented, without formal statistical analysis. As no patient information was assessed, and data collection and analysis for in-hospital mortality after interventional procedures were for quality assurance/control purposes only, no formal approval by local institutional review boards and/or written patient consent was required.

Results

In the year 2019, with the addition of one new institution in the canton of Zurich, Switzerland had 37 centres performing interventional cardiac procedures. The interventional centres consist of the 5 university hospitals, 16 non-university public hospitals and 16 private institutions that are distributed over 17 of 26 cantons across Switzerland. Sixteen (43%) of these centres have the possibility to perform cardiac surgery on site (table 1).

Diagnostic and interventional procedures for coronary heart disease

There were 214 percutaneous coronary intervention (PCI) operators performing a total of 57,975 coronary angiographies in 66 cathlabs. In 27,959 (48.2%) coronary angiography cases, a subsequent PCI was performed (fig. 1), with a PCI per angiography rate ranging between 20% and 73% among different centres (table 2). The average number of total cases/year and PCIs/year per operator were 271 and 131, respectively (tables 1 and 2). Figure 2 displays the

* Equal first authors

Correspondence:
Prof. Raban Jeger, MD, Department of Cardiology, University Hospital Basel, Petersgraben, CH-4031 Basel, raban.jeger[at]usb.ch

Table 1: Interventional cardiology centres in Switzerland 2019.

City, centre	Clinic type	Canton	Number of catheter labs	Cardiac surgery on site	PCI operators		
					2019	2018	Difference
Aarau, Hirslanden Klinik*	p	Aargau	*	Yes	*	14	n.a.
Aarau, Kantonsspital	n-u	Aargau	2	No	5	5	0
Baden, Kantonsspital	n-u	Aargau	1	No	4	5	−1
Basel, St. Claraspital	p	Basel-Stadt	1	No	3	3	0
Basel, University Hospital	u	Basel-Stadt	2	Yes	9	8	1
Bern, Hirslanden Klinik Beau-Site	p	Bern	2	Yes	7	7	0
Bern, Lindenhofspital	p	Bern	2	No	6	4	2
Bern, University Hospital (Inselspital)	u	Bern	4	Yes	11	11	0
Biel, Spitalzentrum	n-u	Bern	1	No	4	5	−1
Chur, Kantonsspital Graubünden	n-u	Graubünden	2	No	4	4	0
Frauenfeld, Spital Thurgau AG	n-u	Thurgau	1	No	1	6	−5
Fribourg, Hôpital Fribourgeois	n-u	Fribourg	1	No	6	5	1
Genève, Hirslanden Clinique d. Grangettes	p	Genève	1	No	4	4	0
Genève, Hôpital de La Tour	p	Genève	2	Yes	8	8	0
Genève, University Hospitals	u	Genève	2	Yes	7	5	2
Genolier, Clinique de Genolier	p	Vaud	1	No	4	4	0
Kreuzlingen, Herz-Neuro-Zentr. Bodensee	p	Thurgau	1	Yes	6	7	−1
Lachen, Spital Lachen AG	n-u	Schwyz	1	No	3	6	−3
Lausanne, CHUV	u	Vaud	2	Yes	6	6	0
Lausanne, Clinique de La Source	p	Vaud	1	No	4	4	0
Lausanne, Hirslanden Clinique Cecil	p	Vaud	2	Yes	19	17	2
Liestal, Kantonsspital Baselland	n-u	Basel-Land	1	No	2	2	0
Lugano, Fondazione Cardiocentro Ticino	n-u	Ticino	4	Yes	9	9	0
Luzern, Hirslanden Klinik St. Anna	p	Luzern	1	No	4	5	−1
Luzern, Kantonsspital	n-u	Luzern	4	Yes	7	5	2
Morges, Hôpital de Morges	n-u	Vaud	1	No	4	4	0
Pfäffikon, Cardiance Clinic	p	Schwyz	1	No	3	3	0
Sion, Centre de cardiologie du Valais	p	Valais	1	No	3	3	0
Sion, Hôpital de Sion	n-u	Valais	2	Yes	5	5	0
Solothurn, Bürgerspital	n-u	Solothurn	2	No	4	4	0
St. Gallen, Kantonsspital	n-u	St. Gallen	3	No	9	8	1
Winterthur, Kantonsspital	n-u	Winterthur	2	No	5	5	0
Zürich, Herz-Gefäss-Klinik Bethanien	p	Zürich	1	No	1	-	-
Zürich, Hirslanden Klinik	p	Zürich	2	Yes	14	12	2
Zürich, Klinik Im Park	p	Zürich	3	Yes	7	6	1
Zürich, Stadtspital Triemli	n-u	Zürich	3	Yes	7	7	0
Zürich, University Hospital	u	Zürich	3	Yes	9	8	1
Total	**37**	**17**	**66**	**16**	**214**	**224**	**−10**

n.a. = not applicable; n-u = non-university community centre; p = private clinic; PCI = percutaneous coronary intervention; u = university centre * No data provided

numbers of diagnostic and interventional cases per centre, ranked by absolute number. Radial access was used in 66% of all cases, which represents a steep increase compared with 47% observed in 2018 [9]. Of note, radial access rate ranged widely from 15% to 98%, depending on site and operator preference (table 3).

Thirty-four centres provided complete data on reason for PCI (n = 26,490). Among emergency PCIs (42% of total PCIs) non-ST-elevation acute coronary syndromes (ACS), ST-elevation myocardial infarction (STEMI) and cardiogenic shock accounted for 55%, 39% and 6% of cases, respectively (tables 2 and 4). Interventions for chronic total occlusions accounted for 6% of PCIs performed, with an antegrade approach used in 61%. Among all coronary interventions, drug-eluting stents were the most commonly used stent type, used in 99% of all cases, with other stent types playing just a minor role (bare metal stents 0.1%, self-expandable stents 0.1%, bioabsorbable scaffolds 0.3%, bifurcation dedicated stents 0.5%) (table 3).

Additional techniques for lesion preparation other than balloon angioplasty were used in 1405 (5%) of PCI cases. In 6253 cases (10.8% of total cases) the degree of coronary

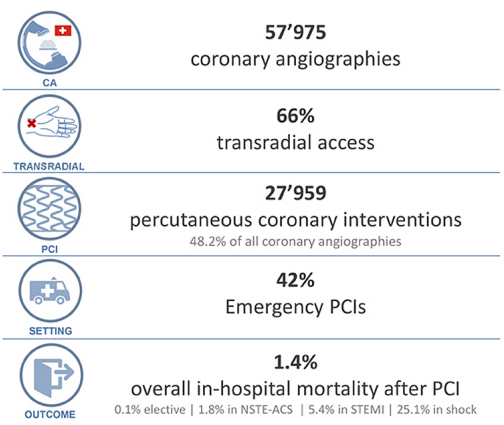
Table 2: Coronary angiographies and percutaneous coronary interventions in Switzerland 2019.

Centre	Total number of cases			Diagnostic cases only			PCI			PCI in % of total			PCI for						
	2019	2018	Diff.	2019	2018	Diff.	2019	2018	Diff.	2019	2018	Diff.	N-ST ACS	STEMI	Cardiogenic shock	CTO	Antegrade CTO	Retrograde CTO	% emergency PCI
Aarau, Hirslanden Klinik*	–	582	n.a.	–	377	n.a.	–	205	n.a.	–	35	n.a.	–	–	–	–	–	–	–
Aarau, Kantonsspital	1935	2226	−291	988	1249	−261	947	977	−30	49	44	5	262	233	–	–	–	–	52
Baden, Kantonsspital	645	550	95	457	1234	−777	188	166	22	29	30	−1	62	2	0	15	15	0	34
Basel, St. Claraspital	457	500	−43	287	301	−14	170	199	−29	37	40	−3	23	17	0	9	9	0	24
Basel, University Hospital	2649	2489	160	1425	1281	144	1224	1208	16	46	49	−2	314	302	61	88	72	16	55
Bern, Hirslanden Klinik Beau-Site	1319	1582	−263	791	884	−93	528	698	−170	40	44	−4	–	–	–	–	–	0	–
Bern, Lindenhofspital	1482	1395	87	692	655	37	790	740	50	53	53	0	98	57	–	–	–	–	20
Bern, University Hospital (Inselspital)	6567	6483	84	3877	3732	145	2690	2751	−61	41	42	−1	468	500	61	159	–	–	38
Biel, Spitalzentrum	1074	903	171	612	524	88	462	379	83	43	42	1	90	90	6	34	25	9	40
Chur, Kantonsspital Graubünden	1317	1127	190	553	474	79	764	653	111	58	58	0	192	158	14	79	56	23	48
Frauenfeld, Spital Thurgau AG	713	691	22	381	386	−5	332	305	27	47	44	2	115	3	3	15	15	0	36
Fribourg, Hôpital Fribourgeois	2169	2187	−18	1090	1111	−21	1079	1076	3	50	49	1	841	133	–	–	–	–	90
Genève, Hirslanden Clinique d. Grangettes	693	568	125	330	255	75	363	313	50	52	55	−3	33	3	0	31	26	5	10
Genève, Hôpital de La Tour	771	820	−49	434	508	−74	337	312	25	44	38	6	62	27	3	24	18	6	27
Genève, University Hospitals	1821	1893	−72	988	1001	−13	833	892	−59	46	47	−1	255	250	42	50	32	18	66
Genolier, Clinique de Genolier	491	440	51	212	199	13	279	241	38	57	55	2	–	1	0	9	–	–	0
Kreuzlingen, Herz-Neuro-Zentr. Bodensee	1231	1235	−4	687	578	109	544	657	−113	44	53	−9	58	75	4	36	34	2	25
Lachen, Spital Lachen AG	169	190	−21	126	130	−4	43	60	−17	25	32	−6	3	0	0	2	2	0	7
Lausanne, CHUV	2491	2249	242	1468	1233	235	1023	1016	7	41	45	−4	441	309	23	57	42	15	76
Lausanne, Clinique de La Source	1031	1040	−9	519	522	−3	512	518	−6	50	50	0	34	0	0	49	49	0	7
Lausanne, Hirslanden Clinique Cecil	2060	2098	−38	1119	1234	−115	941	864	77	46	41	4	–	–	–	–	–	–	–
Liestal, Kantonsspital Baselland	1001	933	68	381	406	−25	620	527	93	62	56	5	157	55	12	75	–	–	36
Lugano, Fondazione Cardiocentro Ticino	2352	2402	−50	1029	1037	−8	1323	1365	−42	56	57	−1	237	217	37	44	31	13	37
Luzern, Hirslanden Klinik St. Anna	1345	1196	149	436	453	−17	909	743	166	68	62	5	82	38	3	55	48	7	14
Luzern, Kantonsspital	3256	3279	−23	1747	1858	−111	1509	1421	88	46	43	3	388	339	103	190	157	34	55
Morges, Hôpital de Morges	389	473	−84	217	255	−38	172	218	−46	44	46	−2	68	3	0	13	13	0	41

Centre	Total number of cases			Diagnostic cases only			PCI			PCI in % of total			PCI for						
	2019	2018	Diff.	2019	2018	Diff.	2019	2018	Diff.	2019	2018	Diff.	N-ST ACS	STEMI	Cardiogenic shock	CTO	Antegrade CTO	Retrograde CTO	% emergency PCI
Pfäffikon, Cardiance Clinic	433	395	38	217	193	24	216	202	14	50	51	−1	36	3	0	26	24	2	18
Sion, Centre de cardiologie du Valais	723	336	387	347	196	151	376	140	236	52	42	10	5	1	0	35	35	0	2
Sion, Hôpital de Sion	1621	1436	185	823	749	74	798	687	111	49	48	1	213	145	16	50	35	15	47
Solothurn, Bürgerspital	1537	1391	146	609	648	−39	928	743	185	60	53	7	202	126	–	–	–	–	35
St. Gallen, Kantonsspital	2931	2740	191	1510	1436	74	1421	1314	107	48	48	1	281	215	15	141	83	58	36
Winterthur, Kantonsspital	1331	1293	38	507	523	−16	824	770	54	62	60	2	226	234	48	42	37	5	62
Zürich, Herz-Gefäss-Klinik Bethanien†	131	n.a.	n.a.	36	–	n.a.	96	–	n.a.	73	–	n.a.	1	0	0	12	12	0	1
Zürich, Hirslanden Klinik	2520	2591	−71	1281	1320	−39	1239	1271	−32	49	49	0	94	79	16	40	38	2	15
Zürich, Klinik Im Park	1202	1111	91	634	606	28	568	505	63	47	45	2	54	52	8	21	16	0	20
Zürich, Stadtspital Triemli	2949	2971	−22	1599	1557	42	1350	1414	−64	46	48	−2	395	375	45	61	–	–	60
Zürich, University Hospital	3169	3514	−345	1608	1746	−138	1561	1768	−207	49	50	−1	263	275	125	43	–	–	42
Total	**57,975**	**57,309**	**666**	**30,017**	**30,851**	**−834**	**27,959**	**27,318**	**641**	**48.2**	**47.7**	**0.6**	**6053**	**4317**	**645**	**1505**	**924**	**230**	

CTO = chronic total occlusions; n.a. = not applicable; N-ST-ACS = non-ST-segment elevation acute coronary syndrome; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction * No data provided; † estimated numbers

Figure 1: Summary of coronary interventions and their outcomes in Switzerland 2019.



artery stenosis was quantified by fractional flow reserve (42.3%), instantaneous wave-free ratio (28.7%), intravascular ultrasound (10.0%) or optical coherence tomography (19.0%). With a total of 554 cases (1%), left ventricular assist devices were rarely needed (table 5).

Interventions for structural heart disease

As described previously [9], after the steep rise in the early years after its introduction in 2007 there is still a constant growth in case numbers for transcatheter aortic valve implantation (TAVI, fig. 3), reflecting the implementation of TAVI in current guidelines for valvular heart disease [10]. In 2019, 1912 TAVIs were performed, with femoral access being used in 95.5% of implantations (table 6). Figure 4 displays the numbers of TAVIs with transfemoral or alternative access routes per centre, ranked by absolute number.

Compared with 2018 there was a decrease in mitral edge-to-edge procedures from 382 to 362 [9]. As for other interventions for structural heart disease, the numbers of left atrial appendix closures decreased from 406 to 317. Interventional closure of patent foramen ovale increased by 33 to 866. Interventions for pulmonary embolism did not differ much compared with 2018 (105 vs 98 cases) (tables 7 and 8)

Figure 3: Summary of transcatheter aortic valve implantations in Switzerland 2019.

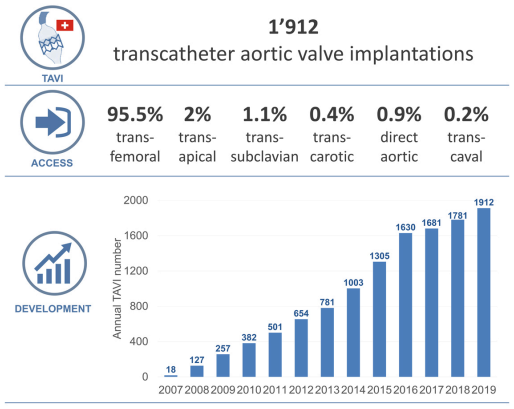


Table 3: Percutaneous coronary intervention details.

Centre	Total number of CA	Radial access		Type of stent used					DEB
		n	%	BMS	DES	Self-expandable (DES or BMS)	Bioabsorbable scaffolds	Bifurcation dedicated stents	
Aarau, Hirslanden Klinik	–	–	–	–	–	–	–	–	–
Aarau, Kantonsspital	1935	1449	75	0	834	0	0	0	–
Baden, Kantonsspital	645	516	80	3	183	0	3	0	15
Basel, St. Claraspital	457	68	15	–	154	–	–	–	12
Basel, University Hospital	2649	1925	73	0	1126	14	0	0	98
Bern, Hirslanden Klinik Beau-Site	1319	–	–	–	–	–	–	–	–
Bern, Lindenhofspital	1482	1275	86	0	790	0	0	120	20
Bern, University Hospital (Inselspital)	6567	4070	62	1	2468	–	0	–	151
Biel, Spitalzentrum	1074	850	79	0	455	0	0	0	3
Chur, Kantonsspital Graubünden	1317	881	67	0	764	0	0	0	5
Frauenfeld, Spital Thurgau AG	713	548	77	0	331	1	0	0	10
Fribourg, Hôpital Fribourgeois	2169	506	23	0	1062	0	0	0	63
Genève, Hirslanden Clinique d. Grangettes	693	650	94	0	348	0	0	0	15
Genève, Hôpital de La Tour	771	683	89	0	309	0	0	0	19
Genève, University Hospitals	1821	830	46	6	744	0	5	0	60
Genolier, Clinique de Genolier	491	323	66	0	235	0	0	0	30
Kreuzlingen, Herz-Neuro-Zentrum	1231	701	57	0	544	0	0	0	12
Lachen, Spital Lachen AG	169	139	82	0	43	0	0	0	0
Lausanne, CHUV	2491	1768	71	–	961	–	3	–	65
Lausanne, Clinique de La Source	1031	711	69	11	481	0	0	0	29
Lausanne, Hirslanden Clinique Cecil	2060	1451	70	6	–	0	0	0	–
Liestal, Kantonsspital Baselland	1001	936	94	0	620	0	30	0	27
Lugano, Fondazione Cardiocentro	2352	1899	81	0	1220	1	29	0	55
Luzern, Hirslanden Klinik St. Anna	1345	715	53	0	852	0	1	0	172
Luzern, Kantonsspital	3256	2637	81	0	1490	10	0	0	24
Morges, Hôpital de Morges	389	149	38	0	163	0	0	–	9
Pfäffikon, Cardiance Clinic	433	220	51	0	215	0	0	0	1
Sion, Centre de cardiologie du Valais	723	712	98	0	344	0	0	0	–
Sion, Hôpital de Sion	1621	1264	78	0	792	–	–	–	20
Solothurn, Bürgerspital	1537	523	34	0	756	0	0	0	30
St. Gallen, Kantonsspital	2931	2638	90	0	1255	7	3	0	373
Winterthur, Kantonsspital	1331	780	59	1	773	0	0	0	45
Zürich, Herz-Gefäss-Klinik Bethanien*	131	100	76	0	92	0	0	0	3
Zürich, Hirslanden Klinik	2520	1227	49	0	1145	1	0	0	89
Zürich, Klinik Im Park	1202	722	60	0	436	0	0	0	83
Zürich, Stadtspital Triemli	2949	2299	78	0	1340	0	0	0	–
Zürich, University Hospital	3169	1373	43	0	1225	0	0	–	88
Total	**57,975**	**37,538**	**66%**	**28**	**24550**	**34**	**74**	**120**	**1626**
				0.1%	**99.0%**	**0.1%**	**0.3%**	**0.5%**	

BMS = bare metal stent; CA = coronary angiography; DEB = drug-eluting balloon; DES = drug-eluting stent; PCI = percutaneous coronary intervention * Estimated numbers

Table 4: Indication for percutaneous coronary intervention.

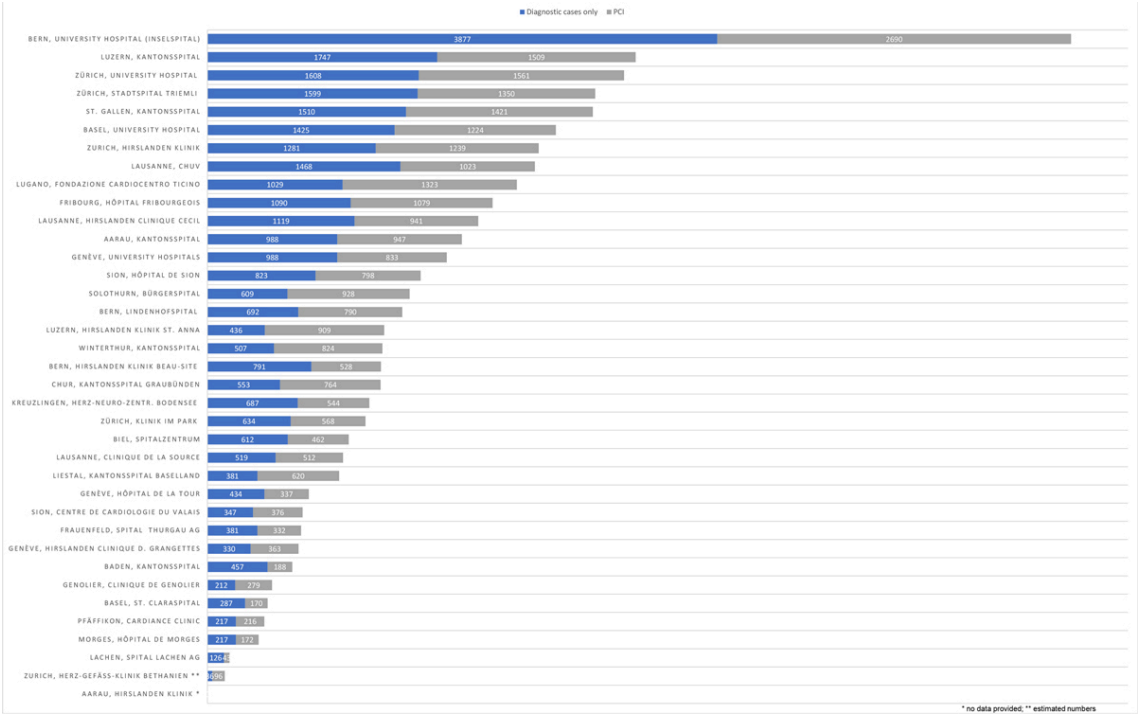
PCIs with data on PCI indication provided (34 centres)	26,490		
Emergency PCIs	11,015	42%	Of total PCIs
Non-ST-ACS	6053	55%	Of emergency PCIs
STEMI	4317	39%	
Cardiogenic shock	645	6%	

Non-ST-ACS = non-ST-segment elevation acute coronary syndrome; PCI = percutaneous coronary intervention; STEMI = ST-segment-elevation myocardial infarction

Outcome

Only few centres (n = 14) reported data on in-hospital mortality, thus the percentages may not be representative. With interventions for chronic coronary artery disease, non-ST-elevation ACS, STEMI, and cardiogenic shock, there was an in-hospital mortality of 0.1%, 1.8%, 5.4%, and 25.1%, respectively, which was comparable to the previous year.

Figure 2: Coronary angiographies and interventions in Switzerland 2019 – centres ranked by total number of cases.



In patients undergoing a TAVI procedure, an in-hospital mortality of 1.0% was observed.

Limitations

The main limitation of this study is the result of its design, with data being submitted on a voluntary basis by the individual centres. By sending a standardised questionnaire to all the involved centres we tried to minimise this effect. Unfortunately, not all centres were able to retrospectively collect and submit answers to all items of the questionnaire (missing information from Kardiologie Mittelland/Hirslanden Klinik Aarau, and Herz-Gefäss-Klinik Bethanien, Zürich). Definition of chronic coronary artery disease, non-ST-elevation ACS, STEMI, and cardiogenic shock was based on international guidelines but not predefined by the registry, and therefore may differ among the centres

Conclusion

The current national numbers show an increase in interventional procedures for coronary and structural heart disease, specifically for TAVI. Regarding coronary angiography and PCI, the rate of radial access shows a further increase to currently 66%, whereas TAVI procedures are performed by the transfemoral route in 96% of cases. Other structural interventions such as mitral edge-to- edge repair, and patent foramen ovale and left atrial appendix occlusions seemed to stabilise at a high level. Overall, the information gathered shows performance numbers in interventional cardiology for Switzerland comparable to its European neighbours [11–14].

As a result of a tight and functional national network of the Swiss Working Group for interventional Cardiology, nationwide data on interventions for coronary and structural heart disease were collected. National data collection and registries remain an important tool to assess performance of a healthcare system and confirm the outcomes and safety of procedures in interventional cardiology [15, 16].

Disclosure statement

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Note added after publication

The originally published version of this article contained an incorrect version of figure 1. This has been corrected.

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Table 5: Auxiliary coronary revascularisation techniques, quantification methods of coronary stenosis and left ventricular assist devices.

Centre	Revascularisation techniques, other than balloon angioplasty, by number of cases				Quantification methods of the degree of stenosis				Left ventricular assist devices			
	Rotabl	Shock wave	Thromb asp	Filters	FFR	iFR	IVUS	OCT	IABP	Impella®	ECMO	Other
Aarau, Hirslanden Klinik*	–	–	–	–	–	–	–	–	–	–	–	–
Aarau, Kantonsspital	12	14	–	6	–	–	10	22	1	19	2	0
Baden, Kantonsspital	0	0	16	7	78	0	0	0	0	0	0	0
Basel, St. Claraspital	10	–	14	0	–	54	–	40	1	–	–	–
Basel, University Hospital	32	0	63	0	103	0	19	18	0	42	2	6
Bern, Hirslanden Klinik Beau-Site	19	0	0	0	0	0	0	0	0	0	0	0
Bern, Lindenhofspital	7	1	2	0	0	0	0	0	0	0	0	0
Bern, University Hospital	34	6	178	6	301	2	51	373	7	55	23	0
Biel, Spitalzentrum	19	0	21	1	42	0	5	4	0	7	0	0
Chur, Kantonsspital Graubünden	11	0	51	0	0	72	7	22	0	15	0	0
Frauenfeld, Spital Thurgau AG	0	2	0	0	18	91	0	24	0	0	0	0
Fribourg, Hôpital Fribourgeois	13	0	78	0	91	0	13	94	5	2	3	0
Genève, Clinique d. Grangettes	5	1	0	1	97	0	0	31	0	0	0	0
Genève, Hôpital de La Tour	7	0	9	2	76	0	13	0	3	0	1	0
Genève, University Hospitals	11	14	58	5	0	218	63	45	4	12	7	2
Genolier, Clinique de Genolier	6	0	0	1	151	151	0	30	0	0	0	0
Kreuzlingen, Herz-Neuro-Zentrum	0	0	26	0	11	148	4	0	0	0	2	0
Lachen, Spital Lachen AG	0	0	0	0	10	0	10	0	0	0	0	0
Lausanne, CHUV	16	–	75	7	250	–	21	115	7	–	4	–
Lausanne, Clinique de La Source	0	0	5	0	156	0	0	0	0	0	0	0
Lausanne, Hirslanden Clinique Cecil	2	0	–	–	–	0	0	0	0	0	0	0
Liestal, Kantonsspital Baselland	15	2	11	1	36	0	0	21	0	6	0	0
Lugano, Fondazione Cardiocentro	5	10	72	11	54	216	48	38	5	10	8	0
Luzern, Hirslanden Klinik St. Anna	8	0	15	0	68	3	5	0	0	4	0	0
Luzern, Kantonsspital	12	1	–	2	162	0	19	113	15	74	3	0
Morges, Hôpital de Morges	2	–	2	0	38	–	–	8	–	1	–	–
Pfäffikon, Cardiance Clinic	0	0	1	0	5	40	3	0	0	0	0	0
Sion, Centre de cardiologie d. Valais	0	0	0	0	115	0	0	15	0	0	0	0
Sion, Hôpital de Sion	–	–	18	–	124	–	–	16	12	–	4	–
Solothurn, Bürgerspital	3	21	0	1	139	0	0	0	0	0	0	0
St. Gallen, Kantonsspital	154	19	120	0	183	49	140	43	18	8	28	0
Winterthur, Kantonsspital	5	0	–	–	16	133	26	0	3	8	0	0
Zürich, Herz-Gef.-Klinik Bethanien†	3	0	2	0	4	3	7	6	0	0	0	0
Zürich, Hirslanden Klinik	6	3	37	4	–	287	31	7	10	9	1	0
Zürich, Klinik Im Park	4	0	4	2	23	193	3	0	11	2	1	0
Zürich, Stadtspital Triemli	2	10	–	12	164	–	0	53	18	9	1	0

Centre	Revascularisation techniques, other than balloon angioplasty, by number of cases				Quantification methods of the degree of stenosis				Left ventricular assist devices			
	Rotabl	Shock wave	Thromb asp	Filters	FFR	iFR	IVUS	OCT	IABP	Impella®	ECMO	Other
Zürich, University Hospital‡	–	–	–	0	132	132	126	52	5	33	15	0
Total	**423**	**104**	**878**	**69**	**2647**	**1792**	**624**	**1190**	**125**	**316**	**105**	**8**
	1.5%	**0.4%**	**3.1%**	**0.2%**	**42.3%**	**28.7%**	**10.0%**	**19.0%**	**22.6%**	**57.0%**	**19.0%**	**1.4%**
	5.0%				10.8%				1.0%			
	% of PCI Cases				% of TOTAL Cases							

ECMO = extracorporeal membrane oxygenation; FFR = fractional flow reserve; IABP = intra-aortic balloon pump; iFR = instantaneous wave-free ratio; IVUS = intravascular ultrasound; OCT = optical coherence tomography; Rotabl = rotablator; thromb asp = thrombus aspiration * No data provided; † estimated numbers; ‡ cardiology department only

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Table 6: Transcatheter aortic valve implantations in Switzerland 2019.

Centre	Aortic valvuloplasty without percutaneous valve replacement	Total number of TAVIs			TAVI access	Use of embolic protection device during TAVI					
		2019	2018	Diff.	Trans-femoral		Trans-apical	Trans-subclavian	Direct aortic	Trans-carotid	Trans-caval
Aarau, Hirslanden Klinik*	–	–	–	–	–	–	–	–	–	–	–
Aarau, Kantonsspital	0	75	–	–	72	0	3	0	0	0	0
Baden, Kantonsspital	–	–	–	–	–	–	–	–	–	–	–
Basel, St. Claraspital	–	–	–	–	–	–	–	–	–	–	–
Basel, University Hospital	0	165	118	47	152	8	5	0	0	0	1
Bern, Hirslanden Klinik Beau-Site	0	83	52	31	–	–	–	–	–	–	–
Bern, Lindenhofspital	–	–	–	–	–	–	–	–	–	–	–
Bern, University Hospital	4	403	299	104	398	1	0	0	0	4	–
Biel, Spitalzentrum	–	–	–	–	–	–	–	–	–	–	–
Chur, Kantonsspital Graubünden	–	–	–	–	–	–	–	–	–	–	–
Frauenfeld, Spital Thurgau AG	–	–	–	–	–	–	–	–	–	–	–
Fribourg, Hôpital Fribourgeois	2	–	–	–	–	–	–	–	–	–	–
Genève, Clinique d. Grangettes	–	–	–	–	–	–	–	–	–	–	–
Genève, Hôpital de La Tour	1	33	24	9	32	0	1	0	0	0	3
Genève, University Hospitals	–	86	68	18	85	1	0	0	0	0	80
Genolier, Clinique de Genolier	–	–	–	–	–	–	–	–	–	–	–
Kreuzlingen, Herz-Neuro-Zentrum	0	28	30	–2	27	0	0	1	0	0	0
Lachen, Spital Lachen AG	–	–	–	–	–	–	–	–	–	–	–
Lausanne, CHUV	2	120	100	20	109	2	0	2	7	0	3
Lausanne, Clinique de La Source	–	–	–	–	–	–	–	–	–	–	–
Lausanne, Hirslanden Clinique Cecil	0	64	67	–3	–	–	–	–	–	–	–
Liestal, Kantonsspital Baselland	–	–	–	–	–	–	–	–	–	–	–
Lugano, Fondazione Cardiocentro	0	76	79	–3	51	14	0	11	0	0	14
Luzern, Hirslanden Klinik St. Anna	–	–	–	–	–	–	–	–	–	–	–
Luzern, Kantonsspital	9	116	107	9	116	0	0	0	0	0	76
Morges, Hôpital de Morges	–	–	–	–	–	–	–	–	–	–	–
Pfäffikon, Cardiance Clinic	–	–	–	–	–	–	–	–	–	–	–
Sion, Centre de cardiologie du Valais	–	–	–	–	–	–	–	–	–	–	–
Sion, Hôpital de Sion	–	–	–	–	–	–	–	–	–	–	–
Solothurn, Bürgerspital	–	–	–	–	–	–	–	–	–	–	–
St. Gallen, Kantonsspital	–	–	–	–	–	–	–	–	–	–	–
Winterthur, Kantonsspital	1	–	–	–	–	–	–	–	–	–	–
Zürich, Herz-Gefäss-Klinik Bethanien	–	–	–	–	–	–	–	–	–	–	–

Centre	Aortic valvuloplasty without percutaneous valve replacement	Total number of TAVIs			TAVI access	Use of embolic protection device during TAVI					
		2019	2018	Diff.	Trans-femoral		Trans-apical	Trans-subclavian	Direct aortic	Trans-carotid	Trans-caval
Zürich, Hirslanden Klinik	0	150	157	–7	149	0	0	1	0	0	3
Zürich, Klinik Im Park	2	75	60	15	74	0	0	1	0	0	0
Zürich, Stadtspital Triemli	0	78	101	–23	69	8	1	0	0	0	0
Zürich, University Hospital	0	360	358	2	349	1	10	0	0	0	140
Total	**21**	**1912**	**1620**	**292**	**1683**	**35**	**20**	**16**	**7**	**4**	**320**
% of total					**95.4%**	**2.0%**	**1.1%**	**0.9%**	**0.4%**	**0.2%**	

TAVI = transcatheter aortic valve implantation * No data provided

Figure 4: Transcatheter aortic valve implantations in Switzerland 2019 – centres ranked by total number of cases.

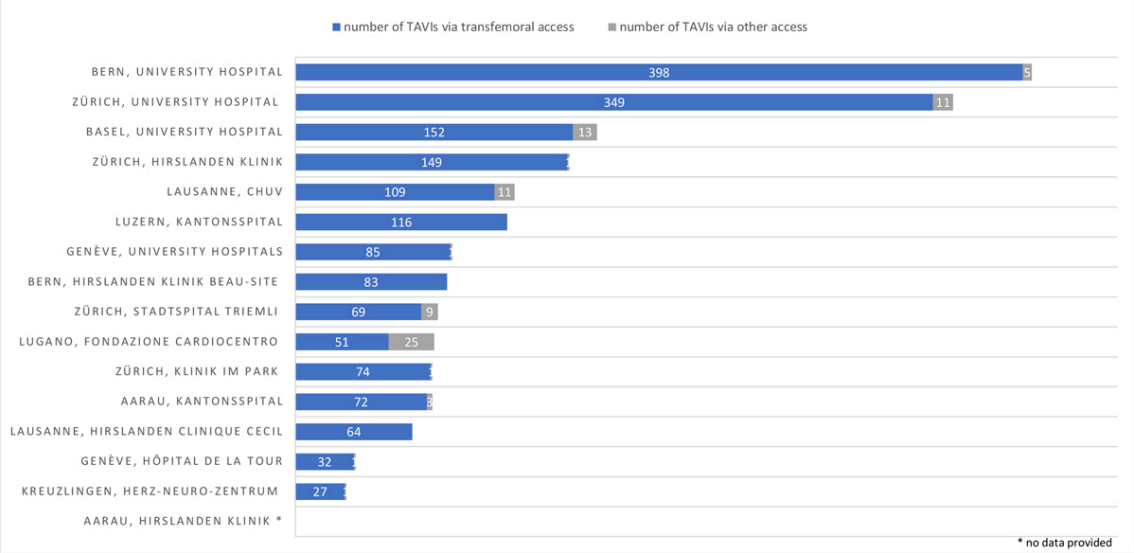

Table 7: Interventional valve interventions other than TAVI in Switzerland 2019.

Centre	Occlusion of paravalvular leakage	Mitral valve interventions					Transcath. tricuspid valve intervention	Pulmonary artery/valve interventions		
		Percut. transvenous valvuloplasty	Edge-to-edge repair devices	Direct annuloplasty (e.g., Cardioband®)	Indirect mitral annuloplasty (e.g., Carillon®)	Transcath. valve replacement (TMVI, e.g., Tendyne™)		PTA / stenting pulmonary artery	Transcatheter pulmonary valvuloplasty	TPVI (e.g., Melody®)
Aarau, Hirslanden Klinik*	–	–	–	–	–	–	–	–	–	–
Aarau, Kantonsspital	2	–	28	–	–	–	–	–	–	–
Baden, Kantonsspital	–	–	–	–	–	–	–	–	–	–
Basel, St. Claraspital	–	–	–	–	–	–	–	–	–	–
Basel, University Hospital	–	–	16	4	–	1	1	–	–	–
Bern, Hirslanden Klinik Beau-Site	–	–	–	–	–	–	–	–	–	–
Bern, Lindenhofspital	–	–	–	–	–	–	–	–	–	–
Bern, University Hospital (Inselspital)	8	3	66	–	–	5	10	36	–	5
Biel, Spitalzentrum	–	–	–	–	–	–	–	–	–	–
Chur, Kantonsspital Graubünden	–	–	–	–	–	–	–	–	–	–
Frauenfeld, Spital Thurgau AG	–	–	–	–	–	–	–	–	–	–
Fribourg, Hôpital Fribourgeois	–	–	8	–	–	–	–	–	–	–
Genève, Clinique des Grangettes	–	–	–	–	–	–	–	–	–	–
Genève, Hôpital de La Tour	3	1	–	–	–	–	1	–	–	–
Genève, University Hospitals	–	1	9	–	–	3	–	18	–	–
Genolier, Clinique de Genolier	–	–	–	–	–	–	–	–	–	–
Kreuzlingen, Herz-Neuro-Zentrum	–	–	1	–	–	–	–	–	–	–
Lachen, Spital Lachen AG	–	–	–	–	–	–	–	–	–	–
Lausanne, CHUV	5	2	18	–	–	1	2	2	7	–
Lausanne, Clinique de La Source	–	–	–	–	–	–	–	–	–	–
Lausanne, Hirslanden Clinique Cecil	–	–	–	–	–	–	–	–	–	–
Liestal, Kantonsspital Baselland	–	–	–	–	–	–	–	–	–	–
Lugano, Fondazione Cardiocentro	–	2	20	–	–	–	2	–	–	–
Luzern, Hirslanden Klinik St. Anna	–	–	2	–	–	–	–	–	–	–
Luzern, Kantonsspital	1	2	35	–	–	–	2	–	1	–
Morges, Hôpital de Morges	–	–	–	–	–	–	–	–	–	–
Pfäffikon, Cardiance Clinic	1	–	–	–	–	–	–	–	–	–

Centre	Occlusion of paravalvular leakage	Mitral valve interventions					Transcath. tricuspid valve intervention	Pulmonary artery/valve interventions		
		Percut. transvenous valvuloplasty	Edge-to-edge repair devices	Direct annuloplasty (e.g., Cardioband®)	Indirect mitral annuloplasty (e.g., Cardilon®)	Transcath. valve replacement (TMVI, e.g., Tendyne™)		PTA / stenting pulmonary artery	Transcatheter pulmonary valvuloplasty	TPVI (e.g., Melody®)
Sion, Centre de cardiologie du Valais	–	–	–	–	–	–	–	–	–	–
Sion, Hôpital de Sion	–	–	–	–	–	–	–	–	–	–
Solothurn, Bürgerspital	1	–	–	–	–	–	–	–	–	–
St. Gallen, Kantonsspital	1	–	7	–	–	–	–	–	–	–
Winterthur, Kantonsspital	–	–	–	–	–	–	–	–	–	–
Zürich, Herz-Gefäss-Klinik Bethanien	–	–	–	–	–	–	–	–	–	–
Zürich, Hirslanden Klinik	1	–	44	–	–	–	6	1	–	–
Zürich, Klinik Im Park	4	1	18	–	–	–	3	–	–	–
Zürich, Stadtspital Triemli	4	4	10	–	–	–	–	–	–	–
Zürich, University Hospital	1	1	80	1	–	–	9	–	–	2
Total	**32**	**17**	**362**	**5**	**0**	**10**	**36**	**57**	**8**	**7**

PTA = percutaneous transluminal angioplasty; TMVI = transcatheter mitral valve implantation; TPVI = transcatheter pulmonary valve implantation * No data provided

Table 8: Non-valvular structural heart and catheter-based pulmonary/renal interventions in Switzerland 2019.

Centre	TASH	Pericardial drainage (ad hoc or scheduled)	Catheter-based therapy of pulmonary embolism	Catheter-based renal sympathetic denervation for treatment of hypertension	Coronary sinus reduction	Closure devices			
						PFO	ASD	VSD	LAA
Aarau, Hirslanden Klinik*	–	–	–	–	–	–	–	–	–
Aarau, Kantonsspital	–	11	–	–	–	60	1	–	19
Baden, Kantonsspital	–	35	–	–	–	–	–	–	–
Basel, St. Claraspital	–	9	–	–	–	–	–	–	–
Basel, University Hospital	1	32	21	–	2	40	3	–	19
Bern, Hirslanden Klinik Beau-Site	–	–	–	–	–	13	–	–	–
Bern, Lindenhofspital	–	4	–	–	–	10	–	–	–
Bern, University Hospital	5	36	70	5	–	157	27	–	102
Biel, Spitalzentrum	–	11	–	–	–	6	3	–	–
Chur, Kantonsspital Graubünden	1	5	–	–	–	4	–	–	1
Frauenfeld, Spital Thurgau AG	–	–	–	–	–	12	–	–	–
Fribourg, Hôpital Fribourgeois	1	10	6	–	–	22	8	–	5
Genève, Hirslanden Clinique des Grangettes	–	1	–	–	–	2	–	–	–
Genève, Hôpital de La Tour	–	8	–	–	–	12	2	–	–
Genève, University Hospitals	3	19	–	–	–	37	–	–	3
Genolier, Clinique de Genolier	–	1	–	3	–	4	–	–	–
Kreuzlingen, Herz-Neuro-Zentrum Bodensee	–	3	–	–	–	12	–	–	–
Lachen, Spital Lachen AG	–	3	–	–	–	3	–	–	–
Lausanne, CHUV	2	15	–	3	–	33	14	1	10
Lausanne, Clinique de La Source	–	6	–	–	–	3	–	–	–
Lausanne, Hirslanden Clinique Cecil	–	–	–	1	–	–	–	–	–
Liestal, Kantonsspital Baselland	1	7	5	–	–	18	2	–	3
Lugano, Fondazione Cardiocentro Ticino	1	25	1	–	4	23	6	1	9
Luzern, Hirslanden Klinik St. Anna	–	2	–	–	–	10	1	1	3
Luzern, Kantonsspital	7	–	2	–	8	68	7	–	25
Morges, Hôpital de Morges	–	–	–	–	–	3	–	–	–
Pfäffikon, Cardiance Clinic	2	1	–	–	–	12	2	–	3
Sion, Centre de cardiologie du Valais	–	–	–	–	–	–	–	–	–
Sion, Hôpital de Sion	–	18	–	2	–	13	–	–	3
Solothurn, Bürgerspital	–	7	–	1	–	25	–	–	7
St. Gallen, Kantonsspital	2	16	–	–	–	32	3	–	7
Winterthur, Kantonsspital	–	–	–	–	–	26	–	–	–
Zürich, Herz-Gefäss-Klinik Bethanien†	–	5	–	–	–	–	–	–	–
Zürich, Hirslanden Klinik	–	15	–	1	–	36	7	–	30
Zürich, Klinik Im Park	7	10	–	4	–	45	4	1	10
Zürich, Stadtspital Triemli	5	17	–	–	2	70	12	–	25
Zürich, University Hospital	–	24	–	–	–	55	21	4	33
Total	**38**	**356**	**105**	**20**	**16**	**866**	**123**	**8**	**317**

ASD = atrial septal defect; LAA = left atrial appendix; PFO = patent foramen ovale; VSD = ventricular septal defect * No data provided; † estimated data

Appendix

Data collected within the registry

General information of the catheterisation centre (hospital and city), catheter labs (number), number of percutaneous coronary interventions (PCIs) operators, number of diagnostic operators (no PCI), centre with cardiac surgery (yes or no) and name of catheterisation database.

Interventions for coronary artery disease:

- coronary angiography (total number of cases)
- diagnostic cases only (number of cases)
- PCI (total number of cases)
- PCI for non-ST-elevation acute coronary syndrome (NST-ACS)
- PCI for ST-elevation myocardial infarction (STEMI)
- PCI for cardiogenic shock
- PCI for chronic total occlusions (CTO)
- antegrade recanalisation (attempted or succeeded)
- retrograde recanalisation (attempted or succeeded)
- radial access for coronary angiography (numbers)
- bare metal stents (BMS) (number of cases, not number of stents)
- drug-eluting stents (DES) (number of cases, not number of stents),
- self-expandable stents (DES or BMS) (number of cases, not number of stents)
- bioabsorbable scaffolds (Absorb®/Magmaris®/etc.) (number of cases, not number of stents)
- bifurcation dedicated stents (number of cases, not number of stents)
- drug-coated balloon only (number of cases, not number of balloons),
- rotablator (number of cases), shockwave balloon (number of cases)
- thrombus aspiration (number of cases)
- distal protection device (filters), distal protection device (filters)
- instant wave free ratio (iFR), intravascular ultrasound (IVUS)
- intravascular optical coherence tomography (OCT)
- intra-aortic balloon counterpulsation (IABP), Impella®, extracorporeal membrane oxygenation (ECMO)
- other left ventricular assist devices (e.g., Tandem Heart®) Interventions for structural heart disease:
- aortic valvuloplasty without percutaneous valve replacement
- transcatheter aortic valve implantation (TAVI)
- transfemoral TAVI,transapical TAVI, transsubclavian TAVI, direct aortic TAVI, transcarotid TAVI, transcaval TAVI
- use of embolic protection device during TAVI
- occlusion of paravalvular leakage
- percutaneous transvenous mitral valvuloplasty
- mitral edge-to-edge repair devices (e.g., Mitraclip®)
- transcatheter direct mitral annuloplasty (e.g., Cardioband®)
- transcatheter indirect mitral annuloplasty (e.g., Carillon®)
- transcatheter mitral valve replacement (TMVI, e.g., Tendyne®)
- transcatheter tricuspid valve intervention
- PTA/stenting pulmonary artery
- transcatheter pulmonary valvuloplasty
- transcatheter pulmonary valve implantation (TPVI) (e.g., Melody®)
- alcohol ablation for septal hypertrophy (TASH)
- pericardial drainage (ad hoc or scheduled)
- catheter based therapy of pulmonary embolism
- catheter–based renal sympathetic denervation for treatment of hypertension
- coronary sinus reduction
- closure of patent foramen ovale (PFO)
- atrial septal defects (ASD)
- ventricular septal defects (VSD)
- left atrial appendix (LAA) closure

Data on outcome (if available):

- in-hospital mortality – overall after any intervention (coronary and not-coronary, number of cases)
- in-hospital mortality – overall after any PCI (number of cases)
- in-hospital mortality – after PCI for stable coronary artery disease (number of cases)
- in-hospital mortality – after PCI for NSTE-ACS (number of cases)
- in-hospital mortality – after PCI for STEMI (number of cases)
- in-hospital mortality – after PCI for cardiogenic shock / cardiac arrest (number of cases)
- in-hospital mortality – after TAVI (number of cases)