

ABSTRACT including 9 TABLES (updated July 2019):

Cardiac catheterization in Austria: Results from the Austrian National Cardiac Catheterization Laboratory Registry (ANCALAR) 2018

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on behalf of the Austrian National Cath Lab Registry Providers

Introduction

The Austrian National Catheterization Laboratory Registry ANCALAR is an observational registry that collects data on cardiac catheterization in Austria, annually, generating benchmarks for PCI capable health centres, data has been collected yearly since 1992. With new data from 2018 now available, trends in cardiac catheterization in Austria are described using international comparisons with Germany and Switzerland

Data & Methods

ANCALAR is an independent registry, the data represents all PCI capable clinics in Austria. Detailed information on data collection tools and indicator definitions are available on the ANCALAR study homepage: <https://iik.i-med.ac.at/>. International comparisons are made with Switzerland and Germany using pooled data from PCI-clinics in each respective country per 1 million population, in line with conventional methodology. To give a more accurate picture of what is happening in Austrian Cath Labs, indicators were also constructed using pooled data from subsets of clinics where data are complete.

Results

33 PCI-clinics with a total of 53 Cath Lab table between them in 2018 reported n= 55,909 diagnostic Coronary Angiographies and n= 24,462 PCI

International Context

In Austria and Switzerland, the absolute numbers of CA are comparable and more or less constant between 2016 and 2018; Germany has consistently higher rates of CA and PCI. In Austria there is a slight increase in the PCI/CA ratio from 40.2% in 2016 to 43.8% in 2018; this ratio (PCI/CA) is almost the same as Germany, Switzerland have a higher ratio. Overall, Austria place just under the top nations in Europe for CA and PCI .

Austria began reducing the use of GP blockers years before guidelines reacted to new evidence and at the same time that Switzerland has stopped counting these cases in their registry. In contrast, reduction in the use of balloon pumps and catheter thrombectomies in Austria has been protracted

For TAVI Austria place just under the middle range nations in Europe is increasing year on year in Austria per 1 million inhabitants, and was 130 per million in 2018

Trends in acute and non-acute PCI use in Austria

In elective non-acute PCI, the number of cases in 2018 (n=14,439) remained almost identical to 10 years ago (n=14,254 cases in 2006). However, the number of patients undergoing non-routine and/or acute PCI (which interrupt daily planned PCI) is increasing year on year. Currently 21 centres fulfil the criterion of more than 36 STEMI PCI cases per year and centre and STEMI-PCI cases accounted for 18.5% of all PCIs in reporting centres in 2018. Furthermore, an increase of complex interventions is evidenced. The number of ad hoc multivessel PCI increased from 19.1 (2015) to 22.1% of all PCI in 2018. There is also an increase of PCI for left main stents from 2.0% (2011) to 3.9% (2018) and in bifurcation of large side branches from 6.7% (2012) to 12.4% (2017) declining to 10.5% in 2018.

The incidence of major bleedings relative to the total number of bleeding complications is declining, especially in non- acute PCI (from 21.9% in 2017 to 17.3% in 2018). Glycoprotein IIb/IIIa (4.3%) or Thrombin Inhibitors (TI, 0.37%) are barely used any more

Trends in Puncture Techniques

Non-femoral (mostly radial) puncture techniques in diagnostic CA increased in absolute terms to n= 35,939 (2018). In total, 58.7% of all therapeutic PCI cases are initiated using a Non-femoral approach. But at the same time the number of “ad hoc” PCIs during diagnostic CA continues to decline (84.4 % in 2015 to 72.6% in 2018) and with additional 8.3% of those radial PCI cases requiring a switch from radial to femoral during the procedure in 2017 and 2018 both puncture both techniques, radial and femoral, still are of importance. Local complications due to radial puncture techniques occurred in 0.9 (2017) and 0.65 % (2018) during all PCI cases.

Use of new intracoronary interventional devices or Special Techniques:

The time of new devices and techniques (“innovations”) within Cath Labs seems few and far between today. For example, the decline in use of biodegradable vascular scaffolds (BVS) accelerated since 2014 and these are now very seldom used (n=37 in 2018). A similar reduction in use can be seen with catheter thrombectomies (n=662) and intra-aortic balloon pumps (n=48).

A visible phenomenon in 2018 are n= 2,056 cases with intracoronary (IC) devices but without following therapeutic intervention (10.6 % of PCI during 2018) such as pressure wire with or without adenosine (FFR), IC ultrasound (IVUS), or optical coherence tomography (OCT) but without following therapeutic intervention. The number of IC devices without following therapeutic intervention is declining (13.1% during 2015 and 10.6 % of PCI during 2018) and

for the first time since introduction FFR is declining from n=3,631 (15.9% of PCI) in 2016 to n=3,497 (14.3%) in 2018

Extracoronary interventions

The use of percutaneous renal denervation was no longer evaluated in 2017. The number of procedures on peripheral vessels, e.g. kidney and legs and the number of carotid procedures within the cardiac catheterization laboratories remained constant on a low level.

Electrophysiology

Electrophysiology continued to increase in 2018 in all 21 performing centres. Electrophysiological Ablations (n=3,903, total) are increasing and well established, of which n=1,783 were for atrial fibrillation (AF) and n=289 for ventricular arrhythmia (VT, n= 396 in 2017). Of the n=2,300 pacemaker implantations within the Cath Labs (the "Leadless Pacemaker" (n=157 in 2017 an n= 125 in 2018) is a real innovation pioneered in 2014 at an Austrian centre, now spreading worldwide

Percutaneous Valve Implantations

Increases are also found in percutaneous valve implantations or valve replacements, e.g. transarterial aortic valve procedures (TAVI / TAVR) in all 10 Austrian performing centres in 2018 (n=1,142), as well as in the MitraClip (n=181)

Data Quality

The methods of ANCALAR have meant that data for benchmark parameters including CA, PCI, ablations, TAVI and numbers of left ventricular angiography, right heart catheterization, mode of puncture site, PCI in acute or non-acute situation, number of stents, Drug Eluting Stents (DES) and Fractional Flow Reserve (FFR), have been reported by 100% of clinics in each year the data were requested, generating a rich database from which to assess trends in cardiac catheterization in Austria. For a few specific parameters, particularly indicators of negative outcomes such as severe bleeding during CA or PCI, not all clinics report data. Where applicable, a description of missingness is also available in Table 2, which notes the exact number of clinics (out of the 33 possible) from which only complete data were pooled to calculate the respective indicator. Nonetheless, ANCALAR provides the most comprehensive data concerning cardiac catheterization in Austria today, across all PCI capable health facilities operating in the country.

Conclusion

The most recent results from ANCALAR highlight that interventional cardiology in Austria is, in the main, in line with the top countries in Europe with some idiosyncrasies in its response to new evidence and guidelines, where Austria is often both ahead of the curve, adapting daily practice before new guidelines are released and at same time facing obstacles in timely adoption of others.

The dynamic nature of cardiac catheterization and increasing number of complex cases has implications for cardiac registries, including ANCALAR. Quantitative changes in complication and mortality rates may in fact reflect qualitative changes in data reporting resultant of such

dynamism, cardiac registers and the interpretation of their data need to continue to adapt in the face of such changes.

In conclusion our registry data show that Austria is another example of the difficulties of real life and science meeting in the world of Interventional Cardiology; with registry data careful interpretation is needed to identify artefacts and understand real differences in the practice of interventional cardiology.

Tabelle 1 Herzkatheter Struktur in Österreich 2011–2018.

Table 1 Cardiac catheter (Cath Lab) structure in Austria 2011–2018.

Year	2011	2012	2013	2014	2015	2016	2017	2018
Number of centres	36	34	34	34	34	34	34	33
Number of tables	49	50	50	52	53	53	54	53
Number of physicians for diagnostics ONLY*	243	261	272	271	291	309	304	313
Number of physicians for diagnostics AND PCI*	214	222	226	238	250	250	262	268

Extended questionnaire of the European Society of Cardiology (ESC).

*The number of active physicians may be overrepresented due to multiple appointments

Striking differences are in **bold text**

Tabelle 2: Indikatoren (relative Prozentsätze %) berechnet aus gepoolten Daten aller respektive nur der meldenden Österreichischen Katheter Labore (n) 2015-2018 [5-7]

Table 2: Indicators (relative percentage %) constructed on Pooled Data from all Respective Reporting Austrian Cath Labs Only (n) 2015-2018 [5-7]

Year	2015	2016	2017	2018
Intracoronary diagnostics but without therapy	13.1 (22)	12.8 (29)	11.9 (27)	10.6 (29) ↓
PCI acute	-	37.7 (34)	40.1 (34) ↑	41.0 (33)
More than 36 STEMI per centre and year	-	(23)	(21)	(21)
STEMI / PCI	17.20 (33)	18.4 (33)	20.0 (33) ↑	18.5 (33) ↓
diagnostic angiography with radial puncture	-	56.1 (34)	62.02 (33) ↑	64.8 (33) ↑
PCI all with radial puncture	-	56.7 (33)	59.3 (32) ↑	58.7 (33) ↓
PCI acute with radial puncture	-	60.4 (28)	69.1 (25) ↑	71.6 (25) ↑
Switch to femoral in diagnostic angiography with radial puncture	7.8	7.0 (24)	6.4 (27) ↓	5.8 (26) ↓
Switch to femoral in PCI with radial puncture	-	9.3 (22)	8.3 (26) ↓	8.3 (26)
Switch to femoral in PCI acute with radial puncture	-	8.1 (20)	5.2 (20) ↓	6.6 (20) ↑
Local complication in diagnostic angiography with radial puncture	-	-	0.55 (22)	0.29 (26) ↓
Local complication in PCI with radial puncture	-	-	0.9 (21)	0.65 (26) ↓
Local complication in PCI acute with radial puncture	-	-	1.1 (19)	0.35 (21) ↓
PCI ad hoc during diagnostic angiography	-	77.4 (31)	75.0 (31) ↓	72.6 (31) ↓
PCI in bifurcation of large vessels	-	11.4 (26)	12.4 (23) ↑	10.5 (24) ↓
Left main stent	-	3.2 (30)	3.3 (28)	3.9 (31) ↑
Multivessel PCI in one session	19.1 (34)	19.9 (33)	20.8 (30) ↑	22.1 (31) ↑
Re-stenosis REDO in reporting Centres (% of stent)	4.7	3.7	4.4 (29)	5.2 (25) ↑
REDO due to very late chronic thrombus (% of REDO)	15.4	11.0 (26)	9.6 (24) ↓	9.6 (21)
Severe bleeding per bleeding in diagnostic angiography	20.5	21.5	23.4 (13) ↑	17.7 (25) ↓
Severe bleeding per bleeding in PCI nonacute	18.5	13	21.9 (13)	17.3 (22) ↓
Severe bleeding per bleeding in PCI acute	64 (23)	18.5 (23)	15.8 (23) ↓	17.6 (22) ↑
Mortality due to cardiogenic shock PCI in reporting centres with plausible data	-	-	34.7 (20)	34.4 (26)
Myocardial infarction post PCI in all reporting centres	-	1.1 (28)	0.73 (26)	0.61 (29) ↓
Myocardial Infarction post PCI in reporting centres with plausible data	-	1.07 (21)	1.1 (22)	0.91 (22) ↓

% = Percentage within the Cath Labs providing data; - = not available

(n = Number of Cath Labs providing data, total Cath Labs 2015 -2017 total n= 34 and 2018 total n= 33,)

Tabelle 3 Herzkatheter Diagnostik in Österreich 2012–2018 in allen berichtenden Zentren mit verfügbaren Daten

Table 3 Cardiac catheter diagnostics in Austria 2012–2018 across all reporting centres with available data

Year	2012	2013	2014	2015	2016	2017	2018
Diagnostic coronary angiography (CA)	53064	54566	56062	54853	56750	56515	55909
➤ Mortality CA overall (%)	76 (0.14)	61 (0.11)	59 (0.11)	61 (0.11)	59 (0.10)	25 (0.04)	27 (0.05)
CA without shock due to infarction	7969	7769	9467	9210	9453	9263	9537
➤ Mortality CA without shock (%)	29 (0.36)	23 (0.30)	23 (0.24)	20 (0.22)	27 (0.29)	12 (0.13)	8 (0.08)
CA with shock due to infarction	520	434	505	474	429	358	412
➤ Mortality CA with shock (%)	27 (5.19)	25 (5.76)	28 (5.54)	19 (4.01)	15 (3.50)	11 (3.07)	14 (3.40)
Myocardial infarction as complication	31	28	25	32	32	8	10
➤ With new Q-wave	9	9	3	0	0	1	4
➤ Defined by Troponin or CK	24	23	6	32	28	4	7
Non femoral (radial) approach	12055	18441	20735	27673	31850	34627	35939
Switch to femoral during procedure	-	-	-	1500	1702	1901	1615
Local radial artery complications					N.A.	112	72
Reversible neurological complications	33	41	37	48	37	44	24
Irreversible neurological complications	3	13	9	6	10	6	14
Vascular peripheral complication	277	309	264	223	192	113	145
➤ With Surgery or transfusion	56	41	49	42	28	25	20
➤ With local injection of thrombin	77	115	105	75	59	34	64
Adverse reactions to contrast media	70	70	86	204	201	N.A.	N.A.
Left ventricular angiography	18163	18572	11834	12628	11646	10941	10391
Right Heart Catheterization	3142	3288	3515	3401	3489	3368	3381

Source: Austrian Questionnaire “diagnostics and related procedures”

Striking differences in **bold text**

“-“ or “N.A.“ = Data Not Available

Table 4 Perkutane coronare Interventionen (PCI) und verwandte Verfahren in Österreich 2012–2018; Original Fragebogen der European Society of Cardiology (ESC)

Tabelle 4 Percutaneous coronary interventions (PCI) and related procedures in Austria 2012–2018; Original questionnaire of the European Society of Cardiology (ESC)

Year	2012	2013	2014	2015	2016	2017	2018
Intracoronary diagnostic device without PCI (cases) eg. FFR,IVUS, OCT	-	-	-	1808	2532	2148	2056
PCI (cases) therapeutic interventions	20543	21698	23044	22538	22837	23808	24462
PCI for acute situation OR ongoing infarction	7026	7148	7791	8084	8612	9553	10023 ↑
➤ PCI for ongoing STEMI	3476	3546	3959	3943	4070	4581	4524
Bifurcation PCI with large sidebranch	989	1081	1175	1454	1922	1920	1626↓
Multivessel PCI (in one session)	3231	3094	4309	4300	4519	4478	4809 ↑
PCI during diagnostic study (ad hoc)	17559	16085	18596	16652	16313	16195	16172
Radial/brachial approach (non-femoral) during PCI	4727	6664	9104	9713	12551	13468	13960
Switch (crossover) to femoral during or before PCI	-	-	474	479	794	1017	893↓
Local radial artery complication		-	-	-	N.A.	77	73
Infarction as complication (by any definition)	82	78	80	114	174	122	112
Iatrogenic left main artery dissection	18	16	24	20	14	27	21
emergency surgery after PCI and/or CA	19	17	22	19	27	35	22
In-hospital death after PCI	170	185	243	205	239	180	146
In-hospital death despite emergency surgery post PCI	1	1	1	1	5	4	3
<i>Number of STENT cases:</i>	18577	19995	21008	20646	21257	22417	22537
- drug eluting stents (cases) (DES)	15778	17010	19451	19735	20509	21565	22042
➤ drug eluting balloon (DEB) (cases)	723	847	782	937	1169	1090	1188
➤ biodegradable vascular scaffolds (BVS) (aka Biostent)	113	1019	1693	1058	593	112	37 ↓
- left main stents	402	452	473	522	636	636	836 ↑
- multiple stents (cases)	5360	5668	8021	6680	7496	6933	7160
PCI for in stent restenosis	687	801	617	814	794	782	721
➤ PCI due to chronic hyperplasia	329	505	470	559	639	613	434
➤ PCI due to very late chronic stent thrombosis	82	102	94	103	71	65	46

(cases; n=; pooled analysis).

Striking differences in bold text

“-“ or “N.A.“ = Data Not Available

Striking changes from 2017 to 2018 are indicated with directional arrows ↑ (increase) ↓ (decrease)

Tabelle 5 Perkutane Interventionen im Herzkatheterlabor **und verwandte Verfahren** in Österreich 2012–2018, **“Spezielle Techniken”**; Original Fragebogen der European Society of Cardiology (ESC)

Table 5 Percutaneous Cath Lab interventions and related procedures in Austria 2012–2018, **“Special techniques”**; Original questionnaire of the European Society of Cardiology (ESC)

Year	2012	2013	2014	2015	2016	2017	2018
Rotablator	312	369	418	373	312	300	356
Catheter thrombectomy (Clot catcher / remover)	1848	1799	1606	1317	1077	891	662 ↓
Intracoronary pressure registration („fractional flow reserve“ (FFR))	2182	2547	2524	3153	3631	3668	3497↓
FFR decision with adenosine and/or	-	-	-	N.A.	3220	3164	2104↓
FFR decision without adenosine (= iFR)	-	-	19	64	411	604	1020 ↑
PCI for chronic total occlusion (CTO)	637	589	559	790	782	808	891
Intracoronary ultrasound (IVUS)	816	783	711	670	808	755	706
Intra-aortic balloon pump during PCI	121	87	82	69	37	53	48
Other devices (incl. Impella, protection device e.g.) in PCI	53	22	118	102	18	30	77
Platelet glycoprotein IIb/IIIa antagonist	2025	1775	1815	1597	1467	1201	1046↓
Direct thrombin inhibitor in PCI	1110	1277	1406	858	439	198	91↓
Optical coherence tomography (OCT)	350	570	503	580	707	638	540
Alcohol ablation for septal hypertrophy (PTSMA)	8	14	11	6	13	9	10

(cases; n=; pooled analysis).

Striking differences in bold text

“-“ or “N.A.“ = Data Not Available

Striking changes from 2017 to 2018 are indicated with directional arrows ↑ (increase) ↓ (decrease)

Tabelle 6 Herzkatheterinterventionen in Österreich 2012– 2018. Österreichischer Fragebogen „Nicht-akute perkutane coronare Interventionen PCI“

Table 6 Cardiac catheter interventions in Austria 2012– 2018. Austrian Questionnaire “Non-acute percutaneous coronary interventions PCI”

Year	2012	2013	2014	2015	2016	2017	2018
Non-Acute PCI	13517	14550	15253	14454	14225	14255	14439
➤ Mortality PCI non-acute overall (%)	14 (0.10)	15 (0.10)	25 (0.16)	13 (0.09)	26 (0.18)	23 (0.16)	17 (0.12)
Myocardial infarction as complication	83	78	80	107	174	101	112
➤ With new Q - wave	22	11	8	13	15	5	10
➤ Defined by troponin or CK	58	66	55	79	132	93	75
Non femoral (radial) approach	3084	4260	5834	5817	5580	6868	6686
Switch to femoral during procedure	-	-	-	256	366	551	427
Local radial artery complications					N.A.	33	17
Reversible neurologic complications	19	14	17	7	11	24	13
Irreversible neurologic complications	4	4	2	1	1	6	5
Vascular peripheral complication	110	123	105	95	225	108	81
➤ With Surgery or transfusion	17	32	18	15	25	23	14
➤ With local injection of thrombin	24	32	25	23	55	31	29
Adverse reactions to contrast media	27	29	30	24	30	N.A.	N.A.

(cases; n=; pooled analysis).

Striking differences in bold text

“-“ or “N.A.“ = Data Not Available

Tabelle 7 Herzkatheterinterventionen in Österreich 2012– 2018. Österreichischer Fragebogen „Akute perkutane coronare Interventionen = PCI bei Verdacht auf Myokardinfarkt“

Table 7 Cardiac catheter interventions in Austria 2012– 2018. Austrian Questionnaire “Acute percutaneous coronary interventions = PCI in suspected myocardial infarction”

Year	2012	2013	2014	2015	2016	2017	2018
Acute PCI (interrupts routine program) (“intention to treat” with PCI)	7026	7148	7791	8084	8612	9553	10023
➤ Mortality acute overall (%)	156 (2.22)	170 (2.38)	218 (2.80)	192 (2.38)	213 (2.47)	157 (1.64)	129 (1.29)
PCI acute without shock	6537	6754	7316	7648	7648	7867	7104
➤ Mortality PCI without shock (%)	51 (0.78)	68 (1.01)	70 (0.96)	81 (1.06)	78 (1.02)	56 (0.71)	50 (0.70)
PCI acute with shock	489	394	475	436	467	318	364
➤ Mortality PCI with shock (%)	96 (19.63)	102 (25.89)	148 (31.16)	111 (25.46)	135 (28.91)	101 (31.76)	79 (21.70)
Non femoral (radial) approach	1319	1912	2389	3004	3567	3937	3610
Switch to femoral during procedure	-	-	-	144	186	145	207
Local radial artery complications					N.A.	29	10
Reversible neurologic complications	10	7	6	4	5	5	3
Irreversible neurologic complications	2	1	1	3	3	2	2
Vascular peripheral complication	90	67	62	34	75	62	43
➤ With Surgery or transfusion	19	17	10	9	12	9	6
➤ With local injection of thrombin	25	13	7	7	13	18	18

Acute PCI: PCI in patients that interrupt routine programme

(cases; n=; pooled analysis).

Striking differences in bold text

“-“ or “N.A.“ = Data Not Available

Tabelle 8 Perkutane Interventionen im Herzkatheterlabor **und verwandte Verfahren** in Österreich 2012–2018. Österreichischer Fragebogen „**Nicht -coronare und nicht - kardiale Interventionen**“

Table 8 Percutaneous Cath Lab interventions and related procedures in Austria 2012–2018. Austrian questionnaire “**non- coronary or non- cardiac interventions**”

Year	2012	2013	2014	2015	2016	2017	2018
Renal, iliac or leg artery intervention in Cath lab	559	475	551	593	816	706	464
Carotid artery intervention in Cath lab	70	55	52	56	65	49	71 ↑
Mitral Valvuloplasty	42	-	-	-	-	-	-
MitraClip implantation	51	62	89	91	123	139	181 ↑
Transcatheter aortic valve implantation (TAVI)	432	480	604	668	834	1016	1142 ↑
➤ transapical valve (reporting incomplete)	29	35	26	55	46	133	133
➤ transarterial valve	403	445	578	613	788	881	842
PFO/ASD/PDA closure by catheter	193	191	218	217	218	198	311 ↑
Renal Denervation (PRD = RND)	151	144	58	29	14	N.A.	N.A.
Other valve interventions					13	15	20
Left atrial appendix (LAA) closure				N.A.	57	76	58

(cases; n=; pooled analysis).

Striking differences in bold text

“-“ or “N.A.” = Data Not Available

Striking changes from 2018 to 2019 are indicated with directional arrows ↑ (increase) ↓ (decrease)

Tabelle 9 Perkutane Interventionen im Herzkatheterlabor **und verwandte Verfahren** in Österreich 2012–2018. Österreichischer Fragebogen “**Diagnostik und Elektrophysiologie**“

Table 9 Percutaneous Cath Lab interventions and related procedures in Austria 2012–2018. Austrian questionnaire “**Diagnostics and Electrophysiology**”

Year	2012	2013	2014	2015	2016	2017	2018
Myocardial biopsies	180	226	292	303	340	356	344
Diagnostic electrophysiology	3087	3185	3417	3584	3742	3906	4417 ↑
Electrophysiological ablations	3098	3019	3254	3313	3482	3640	3903 ↑
- Ablation in atrial fibrillation (reported since 2013 on)	-	142*)	1162	1238	1285	1514	1783 ↑
- Ablation in ventricular rhythm disorders (reported since 2013 on)	-	4*)	230	249	369	396	289↓
DEVICE-Implantations (Pacemakers)	2109	2198	1932	2061	2102	2143	2300 ↑
Leadless Pacemaker	N.A.	4**)	32	64	84	157	125*)

(cases; n=; pooled analysis).

Striking differences in bold text

“-“ or “N.A.“ = Data Not Available

Striking changes from 2017 to 2018 are indicated with directional arrows ↑ (increase) ↓ (decrease)

*) .. incomplete response

***) .. worldwide pioneer