ABSTRACT, 8 TABLES and ADDENDUM :

V.Mühlberger, L.Kaltenbach, H.Ulmer
on behalf of theAustrian National CathLab Registry (ANCALAR):

CARDIAC CATHETERIZATION, CORONARY ANGIOGRAPHY (CA) AND PERCUTANEOUS CORONARY INTERVENTIONS (PCI) IN AUSTRIA DURING THE YEAR 2017 (Registry Data including AUDIT 2018)

Introduction: Our independent, purely academic activity is located in the area of health services research, and has also the option to generate benchmarks for individual centres. Participation in our surveys is voluntary, but no centre is missing. Since 1992, every year, without interruption 90 – 100 parameters are applicable. The questionnaire will be optimized and adapted to current conditions. This is done in cooperation with the participating centres. To provide comparability we make only minimal and absolutely most necessary modifications. The data are collected and summarized at the end of the year by each centre itself. During the year the centres are visited or contacted to perform audits and to keep personal feedback with all of them.

Results and Discussion: Concerning international comparison for the year 2016/2017, Austria (A /AU/AUT) is situated with

- 6468/6422 Diagnostic Coronary Angiographies (CA)
- 2603/2705 Percutaneous Coronary Interventions (PCI)
- 397/414 Electrophysiologic Ablations
- 95 / 115 Transarterial Aortic Valve Implantations (TAVI)

per one million inhabitants under the top nations in Europe, concerning TAVI in the middle range. The absolute numbers concerning coronary diagnoses (CA) and coronary therapy (PCI) are constant, the relation PCI/CA is 42.1%.

Elective non-acute PCI cases (n=14255) during the year 2017 have constant numbers compared to ten years earlier (during 2006 n=14254 cases). But patients disrupting the routine program are getting more and more. There are **more acute and complex cases which is shown by an increase of** ST-Segment–elevation–myocardial-infarction PCI **(STEMI PCI** in 20,0% of all PCI), by more **adhoc-multivessel**-PCI (20,8%), more PCI in **bifurcation** of large side branches since 2011 (they have increased from 6.7% to 12.4% in 2017). At the same time **left main stents** increased from 2.0 to 3.3 %.

The continuous increase in CA-cases using **non-femoral (mostly radial) puncture techniques** showed increasing n= 18441 to n= 34627 non-femoral CA cases during the years 2013 to 2017. But 30.9% of acute PCI cases still are started by the femoral route in 2017 and additional 5.2 % have to be **switched to femoral (=conversion/crossover to femoral)** during the procedure. During elective non acute PCI 40.7% are started femoral. At the same time **less „ad-hoc“ PCI** (CA at the same time with PCI) is performed (75,0 % instead of 84.4 % two years before) possibly due to another opportunity to switch to femoral, which means that patients are dismissed to perform PCI for a femoral approach later on. During diagnostic CA cases a sometimes necessary "Switch to femoral" decreased to 6,4%.

Complications due to radial puncture techniques were documented for the first time during 2017 in Austria, during diagnostic CA in 0,55%, during elective non acute PCI in 0,9% and during acute PCI cases in 1,1 % as far as reported. A prolongation of „catheter-door - balloon- time“ in acute cases due to radial puncture techniques and/or switch to femoral was observes only by single centres. Silent closures of radial artery, higher technical and x-ray load or a different learning curve in radial puncture techniques are not analysed by our registry. But data are available in the special Austrian (DAPT) registry which observes STEMI patients.

A phenomenon are n = 2148 cases with **intracoronary (i.c) devices but without following therapeutic** intervention (11.9 % of PCI during 2017). This results to a rate of 42.4 % (2148/5061) of all i.c- devices without following therapeutic intervention (like **pressure wire** – with or without adenosine – i.c - **ultrasound, optical coherence** tomography; n=3668/ 755/ 638) in reporting centres in 2017, the year before it was 49.2% (2532/5146).

Major **bleedings** in relation to all bleeding complications decreased especially in acute PCI to 15,8 % (from 34,0 % during the year 2010). Glykoprotein IIb/IIIa - or Thrombin **– Inhibitors** (5,0 % versus 0,83 %) are hardly used.

The question during 2016 and 2017 is causation/association (or hidden confounders) between documented increasing radial puncture, decreasing glycoprotein IIb/IIIA, decreasing direct thrombin inhibitors, switch (=conversion/crossover) to femoral techniques, decreasing “ad-hoc“ PCI and decreasing peripheral bleeding complications ?

Reintervention (REDO) reporting centres during 2010-2017 observed constant numbers of **REDOs due to restenosis** from 4.6 % to 4.4% in such cases (n= 782 REDOs in 2017).

From 2010 (15.2%) to 2015 (15.4 %) the relative percentage of **very late, chronic stent thromboses** stayed constant in those REDO cases. But in 2016 and in 2017 a reduction to 11.0 % and 9.6 % of their REDO cases due to very late, chronic stent thromboses took place. Perhaps the use of dual antiplatelet therapy (DAPT even in all-comers) finally is effective.

In the moment n= 21 centres fulfil **the criterion of more than 36 STEMI PCI cases per year and centre,** but the years before up to n= 24 centres fulfilled this criterion . **Emergency surgery** in combination with PCI increased, but not only coronary bypass surgery counts, also surgery for oxygenation procedures lead to n= 35 cases during 2017, which was not expected for emergency coronary bypass surgery alone, leading to a lethal outcome in four cases (11.4%).

But this is not the only reason why **mortality statistics in PCI are complex**. Reporting (n=20) centres documented a mortality of 34.7% in PCI-patients due **to a pre-existing shock** in **STEMI PCI.** Complications of PCI are generally underreported. Some centres in Austria - like in Switzerland - publish their rates of complications on their own. **Myocardial infarction** as a complication due to PCI is reported in 0.73% (122/16778) in Austria's reporting centres and underreporting still is present, within centres and within our community, but from year to year the percentage of reported parameters increases.

Innovations within the Cath Labs in Austria are rare in 2017 (e.g. n= 30 cases in 2017 compared to n= 241 cases with new devices in 2009). Innovations of former days do not hold the promise, like biodegradable vascular scaffolds (BVS) decreased from n= 1693 in 2014 to n= 112 in 2017, at the same time clot catcher (n=891) and intraaortic balloon pump (n=53) decreased as well. Percutaneous renal denervation suffered the expected downslope. One innovation of former years, **the drug eluting balloon, still increases** (from n= 370 in 2010 to n= 1090 in 2017).

In electrophysiology there is one innovation, the **leadless pacemaker**, which is coming through from 2014 on (with a pioneer centre in Austria) to 2017 (n= 157) and also **electrophysiologic ablations** (n=3640) for atrial (n=1514) or for ventricular (n=396) arrhythmias increased from 2014 to 2017 in all 21 centres.

Transarterial aortic valve replacement (TAVR in the US) called implantation **in Europe** (**TAVI**) increased in 2017 to n= 1016 cases in all 10 Austrian centres. At the same time implantation of **MitraClip** (n=139) increased within CathLabs and interventions on peripheral vessels like renal, leg angioplasty or carotid angioplasty fluctuated. Left atrial appendage closures (n= 76 **LAA closures**) have a light renaissance in Austria.

Data are presented in Vienna (November 16 th, 2018) at the autumn meeting of the working group “Interventional Cardiology of the Austrian Society of Cardiology” (ÖKG) as a basis for discussion. The presentation 2017/2018 is also placed under the website http://iik.i-med.ac.at. The presentation 2016/2017 was published at : Mühlberger V, Kaltenbach L, Ulmer H. Herzkathetereingriffe in Österreich im Jahr 2016 (mit Audit 2017). J.Kardiol 2018; 25 (1-2):9 - 15 (J.Kardiol online seit 17.11.2017).

Table 1 Cardiac catheter (CathLab) structure in Austria 2011–2017. Extended questionnaire of the European Society of Cardiology (ESC). Striking differences are marked. The number of active physicians may be overrepresented due to multiple appointments

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

Table 2 Cardiac catheter interventions in Austria 2012– 2017; Austrian Questionnaire **"diagnostics and related procedures "** (cases; n=; pooled analysis). Striking differences are marked („-„ or „n.a." = not available)

YEAR	2012	2013	2014	2015	2016	2017
Diagnostic coronary angiography (CA)	53064	54566	56062	54853	56750	56515
➢ Mortality CA overall	76	61	59	61	59	25
CA without shock due to infarction	7969	7769	9467	9210	9453	9263
➢ Mortality CA without shock	29	23	23	20	27	12
CA with shock due to infarction	520	434	505	474	429	358
➢ Mortality CA with shock	27	25	28	19	15	11
Myocardial infarction as complication	31	28	25	32	32	8
➢ With new Q - wave	9	9	3	0	0	1
➢ Defined by Troponin or CK	24	23	6	32	28	4
Non femoral (radial) approach	12055	18441	20735	27673	31850	**34627**
Switch to femoral during procedure	-	-	-	1500	1702	**1901**
Local radial artery complications					**n.a**	**112**
Reversible neurologic complications	33	41	37	**48**	37	44
Irreversible neurologic complications	3	**13**	9	6	10	6
Vascular peripheral complication	277	309	264	223	192	**113**
➢ With Surgery or transfusion	56	41	49	42	28	**25**
➢ With local injection of thrombin	77	115	105	75	59	**34**
Adverse reactions to contrast media	70	70	86	204	201	n.a.
Angiography of left ventricles	18163	18572	11834	12628	11646	**10941**
Right Heart - Catheterization	3142	3288	3515	3401	3489	3368

Table 3 Cardiac catheter interventions in Austria 2012– 2017; Austrian Questionnaire **"Non-acute percutaneous coronary interventions PCI"** (cases; n=; pooled analysis). Striking differences are marked („-„ or „n.a." = not available)

YEAR	2012	2013	2014	2015	2016	2017
NUMBER OF NON ACUTE PCI	13517	14550	15253	14454	14225	14255
➢ Mortality PCI non-acute overall	14	15	25	13	26	23
Myocardial infarction as complication	83	78	80	107	174	101
➢ With new Q - wave	22	11	8	13	15	5
➢ Defined by troponin or CK	58	66	55	79	132	93
Non femoral (radial) approach	3084	4260	5834	5817	5580	**6868**
Switch to femoral during procedure	-	-	-	256	366	**551**
Local radial artery complications					n.a.	33
Reversible neurologic complications	19	14	17	7	11	24
Irreversible neurologic complications	4	4	2	1	1	6
Vascular peripheral complication	110	123	105	95	**225**	108
➢ With Surgery or tansfusion	17	32	18	15	**25**	23
➢ With local injection of thrombin	24	32	25	23	**55**	31
Adverse reactions to contrast media	27	29	30	24	30	n.a.

Table 4 Cardiac catheter interventions in Austria 2012– 2017; Austrian Questionnaire **"Acute percutaneous coronary interventions = PCI** in myocardial infarction**"** (cases; n=; pooled analysis). Striking differences are marked („-„ or „n.a." = not available)

YEAR	2012	2013	2014	2015	2016	2017
NUMBER OF ACUTE PCI for suspected coronary disease						
Acute PCI	7026	**7148**	**7791**	**8084**	**8612**	**9553**
➢ Mortality acute overall	156	170	218	192	213	157
PCI acute without shock	6537	6754	7316	7648	7648	7867
➢ Mortality PCI without shock	51	68	70	81	78	56
PCI acute with shock	489	**394**	**475**	**436**	**467**	**318**
➢ Mortality PCI with shock	96	102	148	111	135	101
Non femoral (radial) approach	**1319**	**1912**	**2389**	**3004**	**3567**	**3937**
Switch to femoral during procedure	-	-	-	144	186	145
Local radial artery complications					n.a.	29
Reversible neurologic complications	10	7	6	4	5	5
Irreversible neurologic complications	2	1	1	3	3	2
Vascular peripheral complication	90	67	62	34	75	62
➢ With Surgery or tansfusion	19	17	10	9	12	9
➢ With local injection of thrombin	25	13	7	7	13	18

Table 5 Percutaneous coronary interventions **(PCI) and related procedures** in Austria 2012–2017. Original questionnaire of the European Society of Cardiology (ESC) ; (cases; n=; pooled analysis). Striking differences are marked („-„ or „n.a.“ = not available)

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

Table 6 Percutaneous CathLab interventions and related procedures in Austria 2012–2017; „**Special techniques“**. Original questionnaire of the European Society of Cardiology (ESC), (cases; n=; pooled analysis), („-„ or „n.a.“ = not available). Differences are marked (Decreasing numbers = Yellow; Increasing numbers = green)

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

Table 7 Percutaneous CathLab interventions and related procedures in Austria 2012–2017; Austrian questionnaire **„Diagnostics und Elektrophysiology“** (cases; n=; pooled analysis). Differences are marked (Decreasing numbers = Yellow; Increasing numbers = green)

YEAR	2012	2013	2014	2015	2016	2017
Myocardial biopsies	180	226	292	303	340	**356**
Diagnostic elektrophysiology	3087	3185	3417	3584	3742	**3906**
Elektrophysiologic ablations	3098	3019	3254	3313	3482	**3640**
- Ablation in atrial fibrillation (reported since 2013 on)		142*)	1162	1238	1285	**1514**
- Ablation in venticular rhythm disorders (reported since 2013 on)		4*)	230	249	369	**396**
DEVICE-Implantations	2109	2198	1932	2061	2102	2143
Leadless Pacemaker		4**)	32	64	84	**157**

*) .. incomplete response
**) .. worldwide pioneer

Table 8 Percutaneous CathLab interventions and related procedures in Austria 2012–2017; Austrian questionnaire **„non- coronary or non- cardiac interventions“** (cases; n=; pooled analysis), („-„ or „n.a.“ = not available). Differences are marked (Decreasing numbers = Yellow; Increasing numbers = green)

YEAR	2012	2013	2014	2015	2016	2017
Renal, iliac or leg artery intervention in cathlab	559	475	551	593	**816**	706
Carotid artery intervention in cathlab	70	55	52	56	65	**49**
Mitral Valvuloplastie	**42**	-	-	-	-	-
MitraClip implantation	51	62	89	91	123	**139**
Transcatheter aortic valve implantation (TAVI)	432	480	604	668	834	**1016**
➢ transapical valve (reporting incomplete)	29	35	26	55	46	**133**
➢ transarterial valve	403	445	578	613	788	**881**
PFO/ASD/PDA closure by catheter	193	191	218	217	218	198
Renal Denervation (PRD = RND)	151	144	58	29	**14**	n.a
other valve interventions					13	15
Left atrial appendix (LAA) closure				n.a	57	**76**

ADDENDUM

Absolute Number of Austrian CathLabs over the years 2015 - 2017 providing distinct parameter für statistics (n= 34 = ALL Austrian CathLabs) and **relative Percentage** of collected distinct parameter für statistics (%) in relation to percutaneous coronary intervention, to diagnostic coronary angiography or in relation to a denoted 100% parameter (Decrease = Yellow; Increase = green)

% = Percentage within CathLabs providing parameters **n= Number of CathLabs providing parameters**	**Year 2015**	**Year 2016**	**Year 2017**
i.c. diagnostics but without therapy %	13,1	12,8	**11,9**
n=	22	29	27
PCI acute %		37,7	**40,1**
n=		34	34
More than 36 STEMI per centre and year %			
n=		23	21
STEMI / PCI %	17,20	18,4	**20,0**
n=	33	33	33
diagnostic angiography with radial puncture %		56,1	**62,02**
n=		34	33
PCI all with radial puncture %		56,7	**59,3**
n=		33	32
PCI acute with radial puncture %		60,4	**69,1**
n=		28	25
Switch to femoral in diagnostic angiography with radial puncture %	7,8	7,0	**6,4**
n=		24	27
Switch to femoral in PCI with radial puncture %		9,3	**8,3**
n=		22	26
Switch to femoral in PCI acute with radial puncture		8,1	**5,2**
n=		20	20
Local complication in diagnostic angiography with radial puncture = new question %			0,55
n=			22
Local complication in PCI with radial puncture = new question %			0,9
n=			21

% = Percentage within CathLabs providing parameters **n= Number of CathLabs providing parameters**	**Year 2015**	**Year 2016**	**Year 2017**
Local complication in PCI acute with radial puncture = new question %			1,1
n=			19
PCI adhoc during diagnostic angiography %		77,4	**75,0**
n=		31	30
Severe bleeding per bleeding in PCI acute %	64	18,5	**15,8**
n=	23	23	23
PCI in bifurcation vessel %		11,4	**12,4**
n=		26	23
Left main stent %		3,2	3,3
n=		30	28
Myocardial infarction post PCI %		1,1	0,73
n=		28	26
Multivessel PCI in one session %	19,1	19,9	**20,8**
n=	34	33	30
Re-stenosis =REDO in reporting Centres (% of PCI)	4,7	3,7	4,4
N=			29
REDO due to very late chronic thrombus (% of REDO PCI)	15,4	11,0	**9,6**
N=		26	24
Severe bleeding per bleeding in diagnostic angiography %	20,5	21,5	23,4
N=			13
Severe bleeding per bleeding in PCI elective %	18,5	13	21,9
N=			13
Mortality in shock PCI in realistic centres %			34,7
N=			20
Myocardial Infarction in PCI in realistic centres %		1,07	1,1
N=			22