Trends in quality of screening colonoscopy in Austria

Authors Elisabeth Waldmann[1,2], Irina Gessl[1,2], Daniela Sallinger[1,2], Philip Jeschek[1,2], Martha Britto-Arias[1,2], Georg Heinze[3], Elisabeth Fasching[4], Werner Weiss[2], Michael Gschwantler[2], Michael Trauner[1,2], Monika Ferlitsch[1,2]

Institutions Institutions are listed at end of article.

submitted: 14. June 2015
accepted after revision: 30. June 2016

Bibliography
DOI http://dx.doi.org/10.1055/s-0042-113185
Published online: 30.8.2016
Endoscopy 2016; 48: 1102–1109

ISSN 0013-726X

Corresponding author
Monika Ferlitsch, MD
Division of Gastroenterology and Hepatology
Department of Internal Medicine III
Medical University of Vienna
Waehringer Guertel 18-20
A-1090 Vienna
Austria
Fax: +43-1-4040047350
monika.ferlitsch@meduniwien.ac.at

Background and study aim: Screening colonoscopy only effectively prevents colorectal cancer if performed with high quality. The aim of this study was to analyze the detection rates of premalignant colorectal lesions in screening colonoscopies performed within a nationwide quality control program for screening colonoscopy in Austria.

Methods: Data from electronic records of the screening program from its implementation in 2007 until December 2014 were analyzed in order to calculate detection rates for adenomas, advanced adenomas, polyps, and proximal lesions, and rates of cecal intubation, sedation, complications, and adequate bowel preparation. Results were evaluated to identify trends and changes in quality parameters over the 8-year study period.

Results: During the study period, 301 endoscopists provided data from 159 246 screening colonoscopies. Mean age of screened individuals was 61.1 years, and 49.1 % were women. Significant increases over time were found for age- and sex-adjusted adenoma detection rates (ADRs), which increased from a mean of 22.2 % (SD 10.7 %) in 2007/2008 to 24.2 % (SD 11.6 %) in 2013/2014. On average, each endoscopist increased their individual ADR by +1.5 percentage points per 2-year period (95 % confidence interval [CI] 0.9 – 2.2 percentage points; $P<0.01$). Similarly, detection rates for proximal lesions rose from 15.8 % (SD 9.8 %) to 21.7 % (SD 13.3 % +2.5 percentage points per 2-year period, 95 %CI 1.9 – 3.1 percentage points; $P<0.01$). ADR in men increased from 27.6 % in 2007/2008 (SD 11.1 %) to 29.2 % in 2013/2014 (SD 12.7 %; $P<0.01$); ADR in women increased from 14.2 % (SD 7.1 %) in 2007/2008 to 19.0 % (SD 10.5 %) in 2013/2014 ($P<0.01$). Advanced adenoma detection rates decreased during the study period, from 11.4 % (SD 9.0 %) in 2007/2008 to 7.6 % (SD 5.4 %) in 2013/2014 ($P=0.06$) in men, and from 5.5 % (SD 5.3 %) in 2007/2008 to 4.0 % (SD 4.1 %) in 2013/2014 in women ($P=0.21$).

Conclusions: This study showed an improvement in the quality of screening colonoscopies performed within a quality assurance program in Austria between 2007 and 2014. Although, overall ADR increased significantly during the study period, there was a decrease in the rate of advanced adenoma detection.

Introduction

Screening colonoscopy is recognized as the gold standard modality for the prevention of colorectal cancer (CRC) [1,2]. In 2013, seven European Union (EU) states used either screening colonoscopy alone or in combination with fecal occult blood testing as a primary screening tool [3]. As screening colonoscopy is an invasive procedure on a healthy screening population, the benefit must be as high as possible and the risks (e.g. bleeding, perforation) must be reduced to a minimum. In recent years, the quality of endoscopic equipment, bowel preparation, and skill of the individual endoscopist has improved considerably, and guidelines have required increasingly higher quality standards [4 – 6]. The current EU guideline emphasizes that "infrequent high quality examinations are probably more effective in prevention of colorectal cancer than are frequent low quality examinations" [7]. The outstanding benefit of quality assurance programs with constant audit and feedback on both improving the procedure as well as setting new standards has been demonstrated in several landmark publications [8 – 10]. However, in Europe such programs are scarce.

Austria implemented screening colonoscopy in 2005. Due to the lack of obligatory quality control, a quality assurance program was implemented in 2007. The aim of this current study was to analyze trends in detection rates of premalignant colorectal lesions in screening colonoscopies performed

within the nationwide quality assurance program for screening colonoscopy in Austria.

Methods

Data from electronic records of the quality assurance program for screening colonoscopy, from its implementation in 2007 until December 2014, were analyzed in order to calculate detection rates for adenomas, advanced adenomas, polyps, and proximal lesions, and rates of cecal intubation, sedation, complications, and adequate bowel preparation. Results were evaluated to identify trends and changes in quality parameters over the 8-year study period. The study period was divided into four 2-year blocks and detection rates were computed within these blocks. Only those participants who had performed at least 20 colonoscopies during the study blocks were included in the study.

The screening program

In Austria, publicly funded opportunistic screening colonoscopy was implemented in 2005 as a primary CRC screening method for the average-risk population starting at the age of 50 years for both men and women. Because of the lack of obligatory quality assurance for screening colonoscopy, the Austrian Society of Gastroenterology and Hepatology in cooperation with the Austrian Federation of the Statutory Insurance Institutions and the Austrian Cancer Aid founded, in 2007, a national project for quality assurance in screening colonoscopy, the "Certificate of Quality for Screening Colonoscopy."

Minimum quality requirements for participation in the screening program include proof of performing at least 200 supervised colonoscopies and 50 supervised polypectomies, as well as an ongoing rate of 100 colonoscopies and 10 polypectomies per year of participation, photographic documentation of the cecum in each screened individual, and annual hygiene checks of the endoscopic equipment [11 – 17]. Every internist, gastroenterologist, or surgeon who meets these criteria, can apply for the certificate; nurses do not perform endoscopy in Austria. Participation in the quality assurance program is on a voluntary basis. The certificate of the quality assurance program is issued for a period of 2 years, after which it must be renewed in order for the operator to continue performing screening colonoscopies within the program.

Data on patient characteristics (age, sex) and the following colonoscopy report details are transmitted electronically via a standardized report form to the database of the quality assurance program: number, size, location and histology of the lesion detected; polypectomy technique; complications; recommended surveillance interval. If more than one lesion is detected, details of the size, shape, histology, location, and polypectomy technique for the most advanced lesion only are documented. The electronic reporting form is adapted continually according to ongoing progress in scientific research, for example introduction of the terms "traditional" and "sessile serrated adenoma," assessment of bowel preparation (excellent, good, fair, poor, poor only in the right-sided colon, not sufficient; based on the Aronchick scale). Screening data can only be transmitted and used if the screened individuals have provided written informed consent for data transmission, and the use of their data for quality assurance and scientific purposes. The ethics committee of the Medical University of Vienna and the Data Protection commission approved the "Certificate of Quality for Screening Colonoscopy" (DVR number 0504211 from 17.10.2007).

Definitions

Advanced adenomas are defined as adenomas that are at least 10 mm in size or have high grade dysplasia, or villous or tubulovillous histology, or any combination thereof. Adenoma detection rate (ADR) is defined as the number of colonoscopies with at least one adenoma detected divided by the overall number of colonoscopies performed by respective endoscopists. This definition also applies correspondingly to advanced adenoma detection rate (AADR), polyp detection rate (PDR), and proximal lesion detection rate (PLDR). Proximal lesion is defined as a lesion located proximally to the sigmoid colon.

Quality of data entry, audit, and feedback

Every year three randomly selected colonoscopy reports within the database are checked for data accuracy for each participating endoscopist in order to verify the accuracy of data entry. The endoscopist presents the original colonoscopy report, including all data assessed within the electronically submitted colonoscopy report and including the statement of the reporting pathologist as well as photographic documentation of the cecum. If one or more entries are incorrect (missing data or incorrect data), the participating endoscopist is asked to submit data on another five patients randomly selected from the database; if these data are also incorrect, the endoscopist is excluded from the quality assurance program. In exchange for data transmission, participants receive benchmark reports twice a year containing detailed information on their personal performance compared with the anonymized performance of other participating endoscopists, as well as with the performance of each Austrian federal state.

Hygiene control

As hygiene controls for colonoscopes are mandatory in hospitals, only hygiene inspections of colonoscopes used in private practices are required within the quality assurance project. A germ-free sample of the working channel, and the air and water channels of the colonoscope, as well as of the rinsing fluid from the endoscope washing machine must be provided annually. Test results have been assessed electronically since 2010.

Statistical analysis

The detection rates were adjusted for age using the indirect method, and using the age distribution of all individuals who underwent colonoscopies between 2007 and 2014 as the reference population. Cecal intubation rates (CIR), and rates of sedation, complications, and excellent or good bowel preparation were similarly adjusted. The adjusted rates were then analyzed for time trends, and for differences between private practices and endoscopy units of hospitals or outpatient clinics, using linear mixed models, including fixed effects for period and setting, and random effects for period and endoscopist. Pearson correlation coefficients were computed between adjusted complication rates, adjusted proximal lesion detection rates, and adjusted ADRs for the period 2013/2014.

The SAS System V9.4 (2014 SAS Institute Inc., Cary, North Carolina, USA) was used for statistical analysis, and the software package R (R Core Team, 2014, Vienna, Austria) was used for statistical graphics.

Results

Between January 2007 and December 2014, 301 endoscopists, who were eligible to be included in the current study, participated in the screening program and provided data on a total of 159 246 screening colonoscopies (2007 n=642; 2008 n=13 510; 2009 n=18 459; 2010 n=20 954; 2011 n=21 769; 2012 n=25 535; 2013 n=29 342; 2014 n=29 035). Of the screenees, 49.1% (n=78 270) were women and 50.9% (n=80 976) were men. The mean age for both men and women was 61.1 years (SD 9.2).

Approximately 67% of the participating endoscopists were internists (gastroenterologists and nongastroenterologists) and 33% were surgeons.

The cecum was reached in 96.2% (n=153 191, unadjusted rate). Reasons for incomplete colonoscopy (n=6055) were pain in 30.1% (n=1821), poor bowel preparation in 22.3% (n=1350), stenosis in 11.8% (n=715), complications in 1.8% (n=111), and others in 34.0% (n=2058). Sedation was used in 87.2% of procedures (n=138 863).

Quality parameters and trends

Detection rates

At least one polyp was found in 38.1% of colonoscopies (n=60 597), at least one adenoma was detected in 21.6% (n=34 365), and at least one advanced adenoma was detected in 6.3% (n=10 094). The polypectomy rate was 95.5% (n=57 890), and 97.3% (n=56 322) of the polyps were retrieved for pathological examination.

Significant time trends were found for ADRs, which increased by +1.5 percentage points per 2-year period for an average endoscopist (95% confidence interval [95%CI] 0.9–2.2 percentage points; $P<0.01$). Overall, the mean ADR was 22.2% (SD 10.7%, data from n=106 participating endoscopists) in 2007/2008 and 24.2% (SD 11.6%, n=226) in 2013/2014.

ADR in men increased from 27.6% (SD 11.1%) in 2007/2008 to 29.2% (SD 12.7%) in 2013/2014 (average increase per 2-year period +1.6 percentage points; 95%CI 0.8–2.4 percentage points; $P<0.01$). In women, the ADR increased from 14.2% (SD 7.1%) in 2007/2008 to 19.0% (SD 10.5%) in 2013/2014 (average increase per 2-year period +1.9 percentage points; 95%CI 1.3–2.4 percentage points; $P<0.01$).

Interestingly, the AADR decreased during the same periods. The AADR in men was 11.4% (SD 9.0%) in 2007/2008 and 7.6% (SD 5.4%) in 2013/2014 (average decrease per 2-year period –0.4 percentage points; 95%CI –0.9 to +0.1 percentage points; $P=0.06$). The AADR in women decreased from 5.5% (SD 5.3%) in 2007/2008 to 4.0% (SD 4.1%) in 2013/2014 (average decrease per period –0.3 percentage points; 95%CI –1.6 to +0.3 percentage points; $P=0.21$).

PDRs increased from 36.7% (SD 15.4%) in 2007/2008 to 42.0% (SD 17.3%) in 2013/2014 (+2.9 percentage points per 2-year period; 95%CI 2.0–3.8 percentage points; $P<0.01$). PLDRs increased from 15.8% (SD 9.8%) to 21.7% (SD 13.3%; +2.5 percentage points per 2-year period; 95%CI 1.9–3.1 percentage points; $P<0.01$). CIRs increased from 94.2% (SD 6.2%) to 97.0% (4.8%; +1.1 percentage points per 2-year period; 95%CI 0.8–1.4 percentage points; $P<0.01$). Sedation rates increased from 85.4% (SD 21.0%) to 89.1% (SD 18.4%; +1.8 percentage points per 2-year period; 95%CI 1.2–2.4 percentage points; $P<0.01$).

Fig. 1, **Fig. 2**, **Fig. 3** and **Fig. 4** show the annual sex-specific age-adjusted ADRs, AADRs, PLDRs, and CIRs for all participating endoscopists over the years 2007–2014.

Bowel cleansing quality

Adjusted rates of excellent or good quality of bowel cleansing were on average 45.9% (SD 49.0%, number of participants who provided data on bowel preparation=8) in 2009/2010, 78.1% (SD 30.9%, n=150) in 2011/2013, and 83.9% (SD 13.5%, n=226) in 2014 (+6.7 percentage points per period; 95%CI +2.5–+10.9 percentage points; $P=0.02$).

Private practice vs. hospitals and outpatient clinics

The age- and sex-adjusted detection rates of hospitals and outpatient clinics compared with private practices during the periods 2007/2008, 2009/2010, 2011/2012, and 2013/14 are shown in **Table 1**. Averaged over all periods, hospitals and outpatient clinics exhibited higher PDRs (+3.3 percentage points; 95%CI 0.2–6.5 percentage points; $P=0.04$) and sedation rates (+4.0 per-

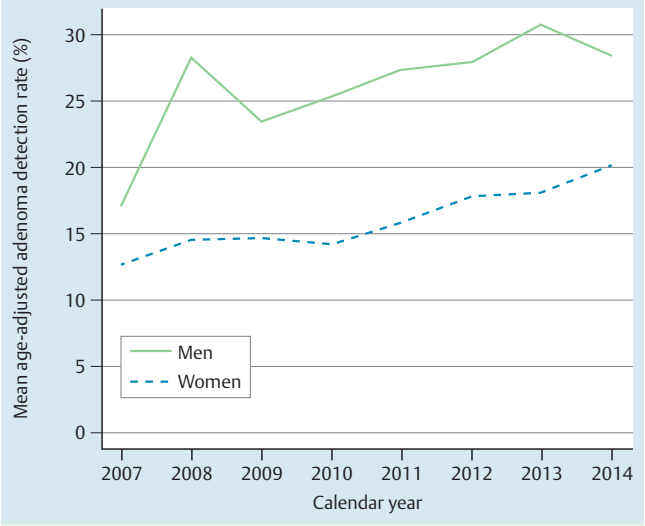

Fig. 1 Age-adjusted adenoma detection rates for men and women per endoscopist in 2007/2008, 2009/2010, 2011/2012, and 2013/2014.

Fig. 2 Age-adjusted advanced adenoma detection rates per endoscopist for men and women in 2007/2008, 2009/2010, 2011/2012, and 2013/2014.

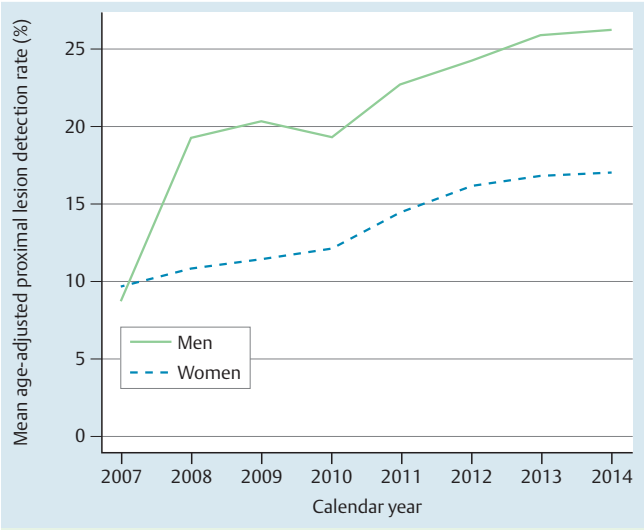

Fig. 3 Age-adjusted proximal lesion detection rates per endoscopist for men and women in 2007/2008, 2009/2010, 2011/2012, and 2013/2014.

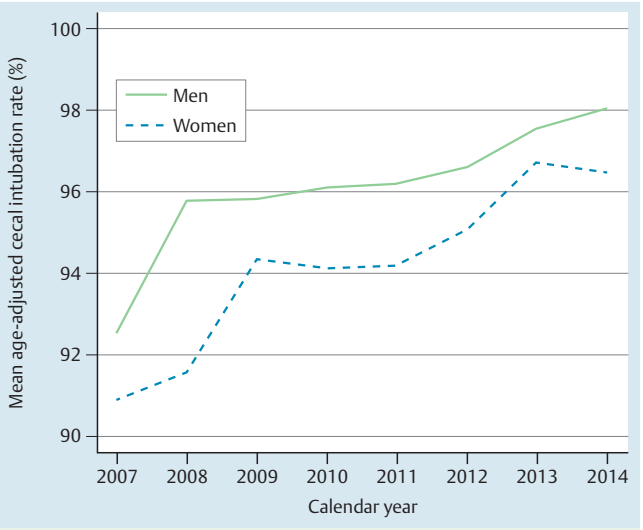

Fig. 4 Age-adjusted cecal intubation rates per endoscopist for men and women in 2007/2008, 2009/2010, 2011/2012, and 2013/2014.

Table 1 Trends in age- and sex-adjusted rates.

	Period			
	2007/2008	**2009/2010**	**2011/2012**	**2013/2014**
Number or participants with > 20 colonoscopies per period, n	106	178	202	226
Private practices	71	113	154	174
Hospitals/outpatient clinics	35	65	48	52
ADR, mean (SD), %	22.2 (10.7)	19.2 (8.3)	21.9 (9.5)	24.2 (11.6)
Private practices	21.2 (9.5)	18.4 (8.3)	20.6 (9.5)	23.7 (12.1)
Hospitals/outpatient clinics	24.3 (12.7)	20.5 (8.2)	26.1 (8.3)	26.0 (9.4)
AADR, mean (SD), %	9.1 (8.3)	5.6 (4.0)	7.0 (5.2)	6.0 (4.9)
Private practices	9.0 (7.5)	5.5 (4.0)	6.6 (5.0)	6.1 (5.1)
Hospitals/outpatient clinics	9.4 (10)	5.6 (4.0)	8.2 (5.6)	5.9 (4.1)
PDR, mean (SD), %	36.7 (15.4)	34.8 (15.3)	40.6 (14.8)	42.0 (17.3)
Private practices	35.6 (14.1)	34.4 (15.9)	39.2 (15.1)	41.6 (18.2)
Hospitals/outpatient clinics	38.9 (17.7)	35.4 (14.4)	45.3 (12.8)	43.6 (13.9)
PLDR, mean (SD), %	15.8 (9.8)	15.3 (8.8)	19.6 (10.6)	21.7 (13.3)
Private practices	15.1 (9.9)	14.8 (8.9)	18.4 (10.6)	21.4 (14.1)
Hospitals/outpatient clinics	17.3 (9.6)	16.2 (8.6)	23.3 (9.6)	22.8 (10.4)
CIR, mean (SD), %	94.2 (6.2)	95.1 (5.8)	95.5 (5.5)	97.0 (4.8)
Private practices	93.4 (6.9)	94.1 (6.8)	95.0 (6.0)	96.7 (5.2)
Hospitals/outpatient clinics	96.1 (3.7)	96.8 (2.8)	97.1 (3.1)	97.7 (3.1)
Sedation rate, mean (SD), %	85.4 (21.0)	85.6 (19.5)	87.7 (17.4)	89.1 (18.4)
Private practices	84.6 (23.1)	84.2 (21.7)	86.6 (18.9)	89.9 (17.7)
Hospitals/outpatient clinics	87.1 (16)	87.9 (14.8)	91.1 (10.9)	86.4 (20.6)
Complications per 10 000 colonoscopies, mean (SD), n	43.2 (113.5)	31.8 (81.0)	34.8 (110.5)	14.6 (36.6)
Private practices	49.1 (128.6)	30.1 (86.4)	28.6 (92.7)	13.7 (39)
Hospitals/outpatient clinics	31.2 (74.3)	34.7 (71)	92.4 (145.1)	17.6 (27.2)
Rate of excellent or good quality of bowel cleansing*, mean (SD), %	N/A	45.9 (49.0)	78.1 (30.9)	83.9 (13.5)
Private practices	N/A	45.9 (49)	82.9 (25.8)	85.2 (12.6)
Hospitals/outpatient clinics	N/A	N/A	61.1 (40.5)	79.5 (15.7)

ADR, adenoma detection rate; AADR, advanced adenoma detection rate; CIR, cecal intubation rate; PDR, polyp detection rate; PLDR, proximal lesion detection rate; N/A, not applicable.

* Number of participants who provided data on bowel preparation for the respective year blocks: overall n = 0, n = 8, n = 150, n = 226; private practice n = 1, n = 8, n = 117, n = 174; hospital/outpatient clinics n = 0, n = 0, n = 33, n = 52.

centage points; 95%CI 1.0–6.9 percentage points; $P=0.01$) compared with private practices. In private practices, the quality of bowel cleansing was excellent or good more often than in hospitals and outpatient clinics (+6.7 percentage points, 95%CI 2.5–10.9 percentage points; $P<0.01$). CIRs were higher for hospitals and outpatient clinics (+1.3 percentage points; 95%CI 0.2–2.4 percentage points). No significant differences between private practices and hospitals/outpatient clinics were found for ADRs ($P=0.62$), AADRs ($P=0.96$), and PLDRs ($P=0.22$).

While in 2007/2008 47.9% (34 of 71) of private practice-based endoscopists fell below the quality standard of ADR (20%), this figure decreased to 37.4% (65 of 174) in 2013/2014 ($P<0.01$). In 2007/2008, the CIR was lower than 90% for 18.3% of the private practice-based endoscopists, whereas in 2013/2014, only 7.5% of these endoscopists fell below this limit ($P=0.01$). Similar trends, though not significant, were observed for hospitals and outpatient clinics (**Table2**).

During the period 2013/2014, the correlation between adjusted ADRs and adjusted complication rates amounted to R=0.24 ($P<0.01$; see **Fig. 5**), and between adjusted ADRs and adjusted PLDRs it was R=0.85 ($P<0.01$; see **Fig. 6**).

Complications

Complications occurred in 0.2% of all colonoscopies performed (n=361). The most common complication was bleeding (n=165, 0.1% of all colonoscopies) followed by cardiopulmonary events (n=134, 0.08%) and others (n=42, 0.03%). Perforation occurred in 0.01% of all colonoscopies (n=20). In 341 cases with complications, patients reached a restitutio ad integrum (no consequential damage), one adverse event (a perforation) caused secondary damage, and 19 outcomes were unknown. There were no fatal outcomes reported in the screening cohort. Most (63.4%, n=229) of the complications occurred in colonoscopies in which polypectomy had been performed: 94.6% (n=156) of bleedings, 31.3% (n=42) of cardiopulmonary events, 55.0% (n=11) of perforations, and 47.6% (n=20) of other complications. About a third of complications (30.2%, n=109) occurred in colonoscopies with no pathological findings, 1.4% (n=5) in colonoscopies with at least one polyp detected but not resected, and 4.2% (n=15) in colonoscopies with pathological findings other than polyps.

Sedation increased the probability of complications. Adverse events occurred in 0.24% (95%CI 0.21%–0.26%) of colonoscopies in which sedation was administered and in 0.16% (95%CI 0.11%–0.22%) of procedures without sedation ($P=0.03$; relative risk 1.51, 95%CI 1.05–2.17). Notably, all perforations occurred in sedated patients; the perforation rate was 0.01% in sedated patients (20/138 845; $P=0.17$).

Data quality

Verification of the electronic documentation of data had been performed since 2011 (**Table 3**). The majority of participants (82% in 2011, 89% in 2012, 94% in 2013, 88% in 2014) had entered the correct data in the reports that were randomly selected for verification. Those with incorrect or missing data in the first-line verification had correct data in the second-line verification (3% in 2011, 8% in 2012, 4% in 2013, 3% in 2014) or were excluded from continuing in the quality assurance program for other reasons (11% in 2011, 3% in 2012, 2% in 2013, 0% in 2014).

To date, no endoscopist had to be excluded from the quality assurance project because of incorrect data entry.

Table 2 Break down of participating endoscopists who did not meet quality standards.

	Period			
	2007/2008	2009/2010	2011/2012	2013/2014
ADR < 20%, n (%)	45 (42.5)	99 (55.6)	85 (42.1)	79 (35.0)
Private practices	34 (47.9)	69 (61.1)	72 (46.8)	65 (37.4)
Hospitals/outpatient clinics	11 (31.4)	30 (46.2)	13 (27.1)	14 (26.9)
CIR < 90%, n (%)	16 (15.1)	20 (11.2)	20 (9.9)	16 (7.1)
Private practices	13 (18.3)	18 (15.9)	18 (11.7)	13 (7.5)
Hospitals/outpatient clinics	3 (9)	2 (3)	2 (4)	3 (6)

ADR, adenoma detection rate; CIR, cecal intubation rate.

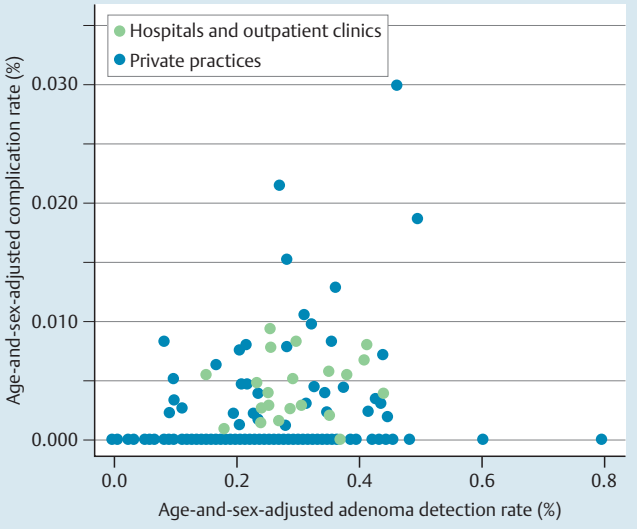

Fig. 5 Correlation of age- and sex-adjusted complication rate and age- and sex-adjusted adenoma detection rate of endoscopists who participated in 2013/2014.

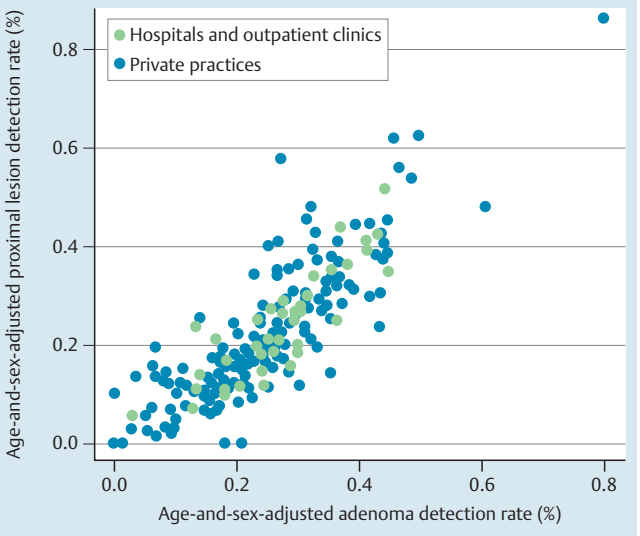

Fig. 6 Correlation of age- and sex-adjusted proximal lesion detection rate and age- and sex-adjusted adenoma detection rate of endoscopists who participated in 2013/2014.

Table 3 Random sample test.

	2011 (n = 219)	2012 (n = 207)	2013 (n = 220)	2014 (n = 220)
No random sample test, % participating endoscopists	14 (n = 30)	8 (n = 16)	14 (n = 30)	2 (n = 5)
New participation toward the end of the year, %	10	31	3	80
Too few endoscopy reports submitted, %	90	38	37	–
No electronic data submission, %	–	–	17	–
Exclusion, %	–	31	43	20
Random sample test, % participating endoscopists	86 (n = 189)	92 (n = 191)	86 (n = 190)	98 (n = 215)
Correct data entry, %	81	89	94	88
Correct data entry in the second run, %	3	8	4	3
Exclusion, %	13	3	2	–
No documentation/data missing by the time of creation of the manuscript, %	3	–	–	9
Reasons for negative random sample test	Not reported for this year	(n = 15)	(n = 8)	(n = 7)
Incorrect classification of the detected lesion, %		13	50	57
Incorrect indication of size, %		40	12.5	–
Incorrect count of polyps, %		7	–	29
Incorrect patient records, %		13	–	–
Unknown, %		27	–	–
Record form lost, %		–	25	–
Missing photographic documentation of the cecum/ cecum not reached, %		–	12.5	14

Hygiene control

In 2010, hygiene controls of endoscopic equipment used by 89 participants were required. In 7.9% (n = 7) of cases, pathological germs were detected and the participants provided a second, germ-free result after eradication. In 2011, 98 private practices were certified, and 5.1% (n = 5) had positive test result. This was a decrease of 2.8% compared with 2010. In 2012, 5.0% (n = 6) of 120 participants had contaminated instruments, which was again a decrease of 0.1% compared with 2011. In 2013, 8.1% (n = 10) of 123 showed contamination, which was an increase of 3.1% compared with 2012; in 2014, 6.0% (n = 8) of 133, a decrease of 2.1% compared with 2013 and a decrease of 1.9% compared with 2010. In 2012 and 2013, 100% of germs were *Pseudomonas* spp.; in 2014, 87.5% were *Pseudomonas* spp. and 12.5% were *Sphingomonas* spp.

Discussion

Screening colonoscopy in Austria performed within the quality assurance project described in this paper meets international standards in terms of both premalignant lesion detection rates and safety standards. Age- and sex-adjusted ADR significantly increased during the study period investigated from 22.2% to 24.2%, corresponding to an average increase of +1.5 percentage points per 2-year period for an average endoscopist. In addition, the detection rate of proximal lesions increased from 15.8% to 21.7%. Overall, 95.5% of polyps were resected, and 97.3% of the retrieved polyps were sent for histopathological evaluation, which meets the requirement of 95% [6]. Perforations occurred in 1:7962 colonoscopies and 1:7225 colonoscopies with polypectomy. Bleedings occurred in 1:521 colonoscopies with polypectomy. Possible reasons for higher complication rates in procedures with sedation are a reduced perception of pain by patients and subsequent failure of the endoscopist to notice alert signals.

Regarding data quality, the percentage of correct data entry increased by 13 percentage points in the first 3 years after implementation of the quality assurance project, and was 94% in 2013. However, changes in the report form led to a deterioration in quality of data transmission. After the extension of the report form in 2013, which involved the inclusion of number of adenomas, resection technique (cold/high-frequency snare resection), and differentiation between screening and surveillance colonoscopy, the percentage of correct data entry decreased by 6%.

The percentages of contaminated endoscopes and washing machines were low. Overall, the rate of contaminated equipment decreased by 1.9%. Interestingly, in 2013, a year when many private practices joined the quality assurance project, the proportion of contaminated instruments increased by 3.1%; the following years, this rate was falling again.

The awareness of endoscopic CRC prevention in Austria compared with the EU average is relatively high [18]. Past experiences have not only emphasized the importance of application of quality criteria, but also of monitoring via an independent structure in order to reveal deficiencies and provide options for intervention in an adequate and effective manner. In 2004, a report was published that revealed poor performance in screening colonoscopy in the United Kingdom, which was attributed to inadequate training [19]. The cecum was reached in less than 80%, every fifth examination was performed with poor bowel preparation, only half of the patients recalled that they had been informed about possible adverse events before the procedure, and perforation occurred in 1:769 procedures [19]. As a consequence, public funding was provided to improve colonoscopy performance, not only by practical training, but also by the introduction of an Endoscopy Global Rating Score, a web-based self-assessment tool for use in endoscopy units [20], and a National Bowel Cancer Screening Program, which implemented quality standards and an accreditation test for participation [21]. As a result, an improvement in quality was demonstrated in 2013 [22]; for example, the adjusted CIR increased from 76.9% to 95.8% [19,22]. In the

present study, ADR and PDR increased in 2013/2014 compared with 2007/2008 by +2 percentage points and +5.3 percentage points, respectively. Unadjusted CIR increased by 2.8 percentage points.

A large study from Poland identified the gold standard of an ADR of ≥20% in screening colonoscopy. The authors showed that an ADR of ≥20% significantly decreased the risk for interval cancers, which are cancers that developed between a screening colonoscopy and the scheduled time of surveillance colonoscopy [8]. Data from Austria confirmed that required ADR standards of ≥20% [9] are met (currently 24.2%) and stressed the need for sex-specific screening recommendations [11]. In US studies, a target ADR of >15% in women and >25% in men was proposed [5]. Recently, even higher ADR standards of ≥20% for women and ≥30% for men have been suggested [10,23]. However, compared with most European studies, US guidelines are based on data from specialized centers and therefore applicability for outpatient clinics and office-based physicians is debatable.

A German study group recently published a study on trends in screening colonoscopy. Brenner et al. reported an increase in ADR (nonadvanced adenoma detection rate increased from 13.3% to 22.3% in men and from 8.4% to 14.9% in women) in a study population of 4.4 million patients between 2003 and 2012. Age-adjusted CIR was >98% in 2003 and changed little during the study period investigated. Age-adjusted bleeding and perforation rates were 0.5% and 0.1%, respectively. The authors argued that the increase in ADRs results, at least partly, from an innovation effect [24]. The present study cohort also showed an increase in ADR (average +1.5 percentage points per 2-years period overall, +1.6 percentage points in men, and +1.9 percentage points in women), as well as PDR (36.7% to 42.0%). Notably, also CIR increased significantly (from 94.2% to 97.0%).

The positive effect of specific interventions on ADRs has been reported in several studies [25,26]. Therefore, if studies on new benchmark requirement and/or new guidelines on screening are published, these publications are communicated to participating endoscopists by information letters. However, the positive trend in ADR in the present study might have resulted from many factors, such as: increasing awareness about the importance of ADR not related to the quality assurance program; possible changes in training and experience of participating endoscopists; possible changes in equipment and bowel preparation; differences in performance of incoming, leaving and continuing endoscopists; and trends in demographics and risk of screening participants. Constant audit and feedback in the form of benchmarking has certainly contributed to the strong increase in ADR in the present study population. In order to assess the amount of this increase that can be attributed to the quality assurance interventions, a comparison with endoscopies performed outside of the screening program is inevitable. However, like most other countries, in Austria there is no obligatory quality control program and therefore no universal assessment of ADR or other metrics. In order to make general statements on the trends in ADR and other quality parameters from a nationwide perspective, provision of colonoscopy reports and their assessment by an independent authority are mandatory, which underlines the strong need for respective guidelines comparable to the Germen model [24].

Another interesting finding was that although the ADR significantly increased over the investigated time period, the AADR decreased. AADR is known to be associated with sex and age [8,11]. However, AADR in the present study cohort was presented separately for men and women (both decreased) and adjusted for age; age did not differentiate between the investigated time periods. Notably, there was wide variation in the detection of advanced adenomas as a proportion of all adenomas detected per endoscopists (median 25.6%, interquartile range 16.7%–38.3%). Big differences in the percentage of individuals with advanced adenomas have been noted in other average-risk populations [27]. A possible explanation for the negative trend might lie in potential overdiagnosis of advanced adenomas in the earlier certification periods; overdiagnosis might have been due to the definition of advanced adenomas – a combination of a clinical (size, estimated by the endoscopist) and histopathological (amount of villous component, set by the pathologist) diagnosis – rather than higher prevalence rates. It has been shown that endoscopists tend to overestimate the size of a lesion [28], which in combination with a villous histology of an adenoma leads to overdiagnosis of advanced adenomas. Moreover, to our knowledge there are no data on the accuracy of the diagnosis of a villous adenoma made by pathologists, which has major impact on the AADR.

To date, approximately half of all endoscopy units in Austria participate voluntarily in the quality assurance project, which is an encouraging result. However, efforts to ensure more comprehensive coverage in the future are required, for example, by making participation in the quality assurance project a condition of participation in the national screening program, and providing appropriate financial reward for endoscopists. However, the implementation of the present quality assurance project was a milestone towards comprehensive assessment and objective demonstration of trends in adenoma, advanced adenoma, and polyp detection rates. The acquired database provides the unique opportunity to analyze trends in effectiveness of screening colonoscopy, which impacts on patient benefit and safety as well as cost-effectiveness. Therefore, publication of these data is expected to give an important impulse to negotiations in this matter.

Limitations of this study include participation in the quality assurance project, which was on a voluntary basis; even though participation shows interest in and willingness to improve individual performance, it constitutes a possible bias by including particularly well trained endoscopists with above-average performance. A further limitation is the method of determining accuracy of the data captured in the database. Three randomly selected colonoscopy reports per endoscopist per year might be an insufficient number to monitor such a large data transfer. In the current form, the probability of missing incorrect data is rather high. However, the current personal and financial resources permit only this small sample test to be performed. Therefore, a future goal of the project is to acquire more resources in order to improve this very important issue. In addition, we did not assess colonoscope withdrawal time, which should be at least 6 minutes in screening colonoscopy [29]. However, inclusion of withdrawal time into the report form is a future goal of the project. Another limitation, which applies to most quality record forms, is the lack of assessment of patient comfort, despite this measure being recommended as an auditable outcome in screening colonoscopy in the EU guidelines [30]. In addition, complications are assessed solely in the electronic report form; there is no long-term follow-up (e.g. contacting patients after 30 days). Finally, although participants are obliged contractually to provide reports of all screening colonoscopies performed (provided the screened individuals have given written informed consent), and the count of screening colonoscopy is assessed twice a year in the benchmark reports, a certain selection bias cannot be excluded with absolute certainty.

In summary, screening colonoscopy in the present study cohort revealed high quality standards and showed positive trends during the investigated study period. Detection rates of adenomas, advanced adenomas, and proximal lesions in both men and women increased significantly during the study period, whereas AADR decreased.

Competing interests: None.

Institutions
[1] Department of Internal Medicine III, Division of Gastroenterology and Hepatology, Medical University of Vienna, Vienna, Austria
[2] Austrian Society of Gastroenterology and Hepatology (OEGGH) Quality assurance Working Group, Vienna, Austria
[3] Center for Medical Statistics, Informatics and Intelligent Systems, Section for Clinical Biometrics, Medical University of Vienna, Vienna, Austria
[4] Main Association of the Austrian Social Insurance Institutions, Vienna, Austria

Acknowledgments

We thank S. Pramhas, C. Wiener, C. Reinhart, C. Bannert, O. Gal, and P. Salzl for their input in implementation of the certificate. We also thank W. Vogel, P. Knoflach, and W. Petritsch for their thoughtful support in the project. The Austrian Society for Gastroenterology and Hepatology, the Main Association of the Austrian Social Insurance Institutions, and the Austrian Cancer Aid, particularly D. Kiefhaber and J. Probst, supported and founded the quality assurance project. In particular, we thank all endoscopists who participate and have formerly participated at the "quality certificate for colorectal cancer prevention" for the excellent cooperation and data contribution. A list of current participants is available at http://www.vorsorgekoloskopie.at. Finally, we thank everyone who supported the quality certificate for screening colonoscopy, and generally, projects on CRC awareness and prevention.

The project "Quality Certificate for Screening Colonoscopy" was established in cooperation with the Main Association of the Austrian Social Security Institution and supported by fund §447h ASVG (Fund for preventive check-ups and health promotion), the Austrian Cancer Aid and the Austrian Society of Gastroenterology and Hepatology.

References

1 *Zauber AG, Winawer SJ, O'Brien MJ* et al. Colonoscopic polypectomy and long-term prevention of colorectal-cancer deaths. N Engl J Med 2012; 366: 687 – 696
2 *Winawer SJ, Zauber AG, Ho MN* et al. Prevention of colorectal cancer by colonoscopic polypectomy. The National Polyp Study Workgroup. N Engl J Med 1993; 329: 1977 – 1981
3 *Altobelli E, Lattanzi A, Paduano R* et al. Colorectal cancer prevention in Europe: burden of disease and status of screening programs. Prev Med 2014; 62: 132 – 141
4 *Jover R, Herraiz M, Alarcon O* et al. Clinical practice guidelines: quality of colonoscopy in colorectal cancer screening. Endoscopy 2012; 44: 444 – 451
5 *Rex DK, Petrini JL, Baron TH* et al. Quality indicators for colonoscopy. Gastrointest Endosc 2006; 63: 16 – 28
6 *Rex DK, Bond JH, Winawer S* et al. Quality in the technical performance of colonoscopy and the continuous quality improvement process for colonoscopy: recommendations of the U.S. Multi-Society Task Force on Colorectal Cancer. Am J Gastroentoerl 2002; 97: 1296 – 1308
7 *Segnan N, Patnick J, von Karsa L* et al. European guidelines for quality assurance in colorectal cancer screening and diagnosis – first edition. Luxembourg: Publications Office of the European Union. 2010: Available at: http://www.kolorektum.cz/res/file/guidelines/CRC-screening-guidelines-EC-2011-02-03.pdf Accessed: 11 July 2016
8 *Regula J, Rupinski M, Kraszewska E* et al. Colonoscopy in colorectal-cancer screening for detection of advanced neoplasia. N Engl J Med 2006; 355: 1863 – 1872
9 *Kaminski MF, Regula J, Kraszewska E* et al. Quality indicators for colonoscopy and the risk of interval cancer. N Engl J Med 2010; 362: 1795 – 1803
10 *Corley DA, Jensen CD, Marks AR* et al. Adenoma detection rate and risk of colorectal cancer and death. N Engl J Med 2014; 370: 1298 – 1306
11 *Ferlitsch M, Reinhart K, Pramhas S* et al. Sex-specific prevalence of adenomas, advanced adenomas, and colorectal cancer in individuals undergoing screening colonoscopy. JAMA 2011; 306: 1352 – 1358
12 *Bannert C, Reinhart K, Dunkler D* et al. Sedation in screening colonoscopy: impact on quality indicators and complications. Am J Gastroenterol 2012; 107: 1837 – 1848
13 *Reinhart K, Bannert C, Dunkler D* et al. Prevalence of flat lesions in a large screening population and their role in colonoscopy quality improvement. Endoscopy 2013; 45: 350 – 356
14 *Waldmann E, Britto-Arias M, Gessl I* et al. Endoscopists with low adenoma detection rates benefit from high-definition endoscopy. Surg Endosc 2015; 29: 466 – 473
15 *Ferlitsch M, Heinze G, Salzl P* et al. Sex is a stronger predictor of colorectal adenoma and advanced adenoma than fecal occult blood test. Med Oncol 2014; 31: 151
16 *Jeschek P, Ferlitsch A, Salzl P* et al. A greater proportion of liver transplant candidates have colorectal neoplasia than in the healthy screening population. Clin Gastroenterol Hepatol 2015; 13: 956 – 962
17 *Kozbial K, Reinhart K, Heinze G* et al. High quality of screening colonoscopy in Austria is not dependent on endoscopist specialty or setting. Endoscopy 2015; 47: 207 – 216
18 *Stock C, Brenner H.* Utilization of lower gastrointestinal endoscopy and fecal occult blood test in 11 European countries: evidence from the Survey of Health, Aging and Retirement in Europe (SHARE). Endoscopy 2010; 42: 546 – 556
19 *Bowles CJ, Leicester R, Romaya C* et al. A prospective study of colonoscopy practice in the UK today: are we adequately prepared for national colorectal cancer screening tomorrow? Gut 2004; 53: 277 – 283
20 British Society of Gastroenterology. Endoscopy Global rating Scale. Available from: http://www.bsg.org.uk/clinical-guidance/endoscopy/endoscopy-global-rating-scale.html Accessed 11 July 2016
21 *Chilton A, Rutter M.* Quality assurance guidelines for colonoscopy. Sheffield: NHS Cancer Screening Programmes. 2011: Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/427591/nhsbcsp06.pdf Accessed: 11 July 2016
22 *Gavin DR, Valori RM, Anderson JT* et al. The national colonoscopy audit: a nationwide assessment of the quality and safety of colonoscopy in the UK. Gut 2013; 62: 242 – 249
23 *Rex DK, Schoenfeld PS, Cohen J* et al. Quality indicators for colonoscopy. Gastrointest Endosc 2015; 81: 31 – 53
24 *Brenner H, Altenhofen L, Kretschmann J* et al. Trends in adenoma detection rates during the first 10 years of the German Screening Colonoscopy Program. Gastroenterology 2015; 149: 356 – 366
25 *Kahi CJ, Ballard D, Shah AS* et al. Impact of a quarterly report card on colonoscopy quality measures. Gastrointest Endosc 2013; 77: 925 – 931
26 *Coe SG, Crook JE, Diehl NN* et al. An endoscopic quality improvement program improves detection of colorectal adenomas. Am J Gastroenterol 2013; 108: 219 – 226
27 *Pox CP, Altenhofen L, Brenner H* et al. Efficacy of a nationwide screening colonoscopy program for colorectal cancer. Gastroenterology 2012; 142: 1460 – 1467
28 *Anderson BW, Smyrk TC, Anderson KS* et al. Endoscopic overestimation of colorectal polyp size. Gastrointest Endoc 2016; 83: 201 – 208
29 *Barclay RL, Vicari JJ, Doughty AS* et al. Colonoscopic withdrawal times and adenoma detection during screening colonoscopy. N Engl J Med 2006; 355: 2533 – 2541
30 European Colorectal Cancer Screening Guidelines Working Group. *von Karsa L, Patnick J* et al. European guidelines for quality assurance in colorectal cancer screening and diagnosis: overview and introduction to the full supplement publication. Endoscopy 2013; 45: 51 – 59

Correction

Elisabeth Waldmann, Irina Gessl, Daniela Sallinger et al. Trends in quality of screening colonoscopy in Austria. Endoscopy 2016, 48: 1102 – 1109

Figs. 5 and 6: the graphs in these figures were inadvertently transposed in the e-first publication. This has now been corrected.