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Importance of endoscopist quality metrics for findings at surveillance colonoscopy: The detection-surveillance paradox

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Abstract

Background: Guidelines recommend surveillance colonoscopies based exclusively on findings at baseline colonoscopy. This recommendation leads to the paradox that the higher the baseline colonoscopy quality, the more surveillance colonoscopies will be indicated according to current guidelines.

Objective: The aim of this study was to evaluate the effect on follow-up findings of different quality metrics of the endoscopist performing the baseline colonoscopy.

Methods: This retrospective cohort study included individuals with advanced adenomas at baseline colonoscopy. Adenoma detection rate (ADR) and adenomas per colonoscopy rate (APCR) were determined for 44 endoscopists. Surveillance colonoscopies were checked after systematic tracking.

Results: A total of 574 individuals were diagnosed with advanced adenomas, of whom 270 received a surveillance colonoscopy. Patients whose baseline colonoscopy endoscopist had an ADR lower than the median of 33.8% had significantly higher rates of advanced neoplasia at follow-up (13.1% vs 4.0%; $p = 0.001$). On univariate analysis, high-risk advanced adenomas at baseline (HR 0.43; 95% CI 0.19–0.97) and ADR (HR 0.94; 95% CI 0.89–0.99) showed a significant relationship with advanced neoplasia at surveillance. In a multivariate Cox model, the ADR of the endoscopist who performed the baseline colonoscopy was the only independent predictor of risk for developing advanced neoplasia at follow-up (HR 0.94; 95% CI 0.89–0.99).

Conclusions: Our results suggest that the risk of identifying advanced adenomas at follow-up is closely related to the quality metrics of the endoscopist who performs the baseline colonoscopy.

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Key summary

Summarize the established knowledge on this subject

- Surveillance after polyp excision is based on an estimation of risk of metachronous advanced neoplasia.
- Surveillance recommendations are made depending on size, number and pathology of polyps found at baseline.
- Quality of baseline colonoscopy could influence findings at follow-up.

What are the significant and/or new findings of the study?

- Having advanced adenomas at follow-up is closely related to the quality metrics of the endoscopist who performs the baseline colonoscopy.
- Baseline adenoma detection rate remained the only quality-related independent risk factor for advanced neoplasia at follow-up.

Introduction

Patients with colorectal adenomas are at risk of developing metachronous adenomas or colorectal cancer (CRC), which provides the rationale for surveillance colonoscopies in this group. The indication for and timing of the colonoscopies are based on a risk estimation, and different guidelines recommend follow-up schedules depending on findings at baseline, specifically the size and number of adenomas.[1–3] However, the evidence supporting these recommendations is of low to moderate quality.[2] On the other hand, colonoscopy quality varies considerably among endoscopists, with important variations in fulfillment of quality indicators, such as adenoma detection rate (ADR) or adenomas per colonoscopy rate (APCR).[4–6] This variation suggests that the existence of multiple adenomas in a particular patient depends not only on putative biological factors that would put this patient at risk of developing future lesions but also on the ability of the endoscopist who performs the colonoscopy to detect adenomas. This association gives rise to the paradox that higher-quality baseline colonoscopies would lead to the indication for more surveillance colonoscopies according to current guidelines. The corollary is that with lower ADR (implying more missed lesions), fewer surveillance colonoscopies will be indicated, putting these patients at a higher risk of developing interval cancer.

The aim of this study was to investigate in part this potential paradox in a cohort of advanced adenoma patients with endoscopic surveillance by evaluating the effect of different baseline endoscopist quality metrics on findings at follow-up.

Materials and methods

Study characteristics and population

A retrospective cohort study nested in the COLONPREV study was performed. The COLONPREV study is a randomized trial aimed at comparing the efficacy of one-time colonoscopy vs a biennial fecal immunochemical test (FIT) for reducing CRC-related mortality in asymptomatic healthy individuals aged 50–69 years.[7] COLONPREV was approved by the ethical review board of each participating center, and written informed consent was obtained from each patient included in the study. Ethical board approval of the COLONPREV study was granted January 15, 2009. The trial was registered in ClinicalTrials.gov#NCT00906997. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a prior approval by the institution's human research committee.

Quality metrics were measured among endoscopists with at least 20 colonoscopies performed in the COLONPREV study;[6,8] therefore, only baseline procedures completed by these endoscopists were included. Individuals were included in this analysis if an advanced adenoma was detected at their baseline colonoscopy. Those participating in centers that did not report surveillance data were excluded. Ultimately, patients from 12 of the 15 centers participating in the COLONPREV study were included.

Variables

Patients were classified according to the most advanced lesion found, as described in the COLONPREV study.[7]

In brief, polyps were categorized as non-neoplastic or neoplastic. Adenomas were defined as advanced when they were 10 mm or larger or had villous architecture, high-grade dysplasia, or intramucosal carcinoma, or when three or more adenomas were found.[1–3]

Advanced adenomas at baseline were classified as intermediate risk or high risk according to the European Guidelines of Surveillance.[1] Intermediate risk was considered in patients with any adenoma between 10 and 19 mm or three or four adenomas of any size or the presence of high-grade dysplasia or a villous component also in polyps of any size. High risk was considered in patients with adenomas 20 mm or larger or with 5–10 adenomas of any size. At the time of patient inclusion in the COLONPREV study, European Guidelines of Surveillance[1] were not yet published, and surveillance recommendations in Spain were following local guidelines.[9] These recommendations were very close to those of the United States task force:[2] colonoscopy at three years for patients with advanced adenomas and at 5–10 years for those with low-risk adenomas.

Factors regarding the quality of baseline colonoscopy and endoscopist quality metrics have been previously studied.[6,8] For the purposes of this study, endoscopist quality metrics and other demographic characteristics (age, years as physician, years as specialist, exclusive dedication to endoscopy, total lifelong number of colonoscopies, number of colonoscopies the previous year, weekly hours dedicated to endoscopy, and number of formative activities the previous year) were assessed. The ADR was defined as the percentage of colonoscopies performed by each endoscopist in which at least one adenoma was found. The APCR was defined as the mean number of adenomas found per colonoscopy for each endoscopist. The colonoscopy withdrawal time was calculated from the moment of cecal intubation until the extraction of the colonoscope through the anus. Mean withdrawal time was calculated for each endoscopist, taking into account only colonoscopies without polyps. Only patients with baseline procedures with cecal intubation and excellent or good colonic cleansing were included in the study.

Surveillance colonoscopies were checked after systematic tracking that included information regarding the first surveillance: date, quality of colonoscopy, and characteristics of detected adenomas; if CRC was detected, date and location with respect to splenic flexure were recorded as well. The information was gathered from the screening program's information system (Spanish network of CRC screening programs, database of the COLONPREV study) and clinical records.

Statistical analysis

Continuous variables are reported as mean (standard deviation), discrete variables as median (25th–75th percentiles), and categorical variables as frequency or percentage. The primary outcome variable was advanced neoplasia detection at surveillance colonoscopy. Basal adenoma characteristics and endoscopist factors were analyzed using the Chi square test for categorical data and the Mann–Whitney *U* test for quantitative data. The time to adenoma detection was assessed using Kaplan–Meier curves. The effect of endoscopist quality metrics as possible predictors of adenoma detection was analyzed by classifying them into dichotomous variables according to the median values.

Variables significantly associated with adenoma detection in the univariate analysis were included in a forward stepwise conditioned Cox proportional-hazards regression, and hazard ratios (HRs) with 95% confidence intervals (CIs) for overall survival were computed. Age and quality indicators were considered as continuous variables for this multivariate analysis

All reported p values are two sided, and $p < 0.05$ was considered to indicate statistical significance. All calculations were performed using SPSS 19.0 software (SPSS Inc, Chicago, IL, USA).

Results

A total of 5722 individuals underwent a colonoscopy in the 15 centers that participated in the COLONPREV study. For these patients, 3454 procedures were performed by 44 endoscopists in 12 centers that provided data on surveillance.

Of the 574 individuals diagnosed with advanced adenomas at baseline in these centers, 270 underwent a surveillance colonoscopy (Figure 1). The group of 574 patients with advanced adenomas did not differ from the 270 patients with subsequent surveillance colonoscopy in terms of baseline sex, age, colon cleansing quality, cecal intubation rate, mean withdrawal time in normal colonoscopies, or proximal and distal adenomas (Table 1).

Table 2 lists the characteristics of participant endoscopists and their quality indicators. Mean ADR was 33%, and the median was 33.8%. Mean APCR was 0.68 adenomas per colonoscopy and a median 0.69.

Table 3 shows the findings for the surveillance colonoscopies. Mean time to follow-up endoscopy was 3.36 years, and the majority of surveillance colonoscopies were performed in the third year of follow-up. Advanced adenomas were found in 23 (8.5%) cases, and one CRC (0.4%) was detected in these surveillance colonoscopies.

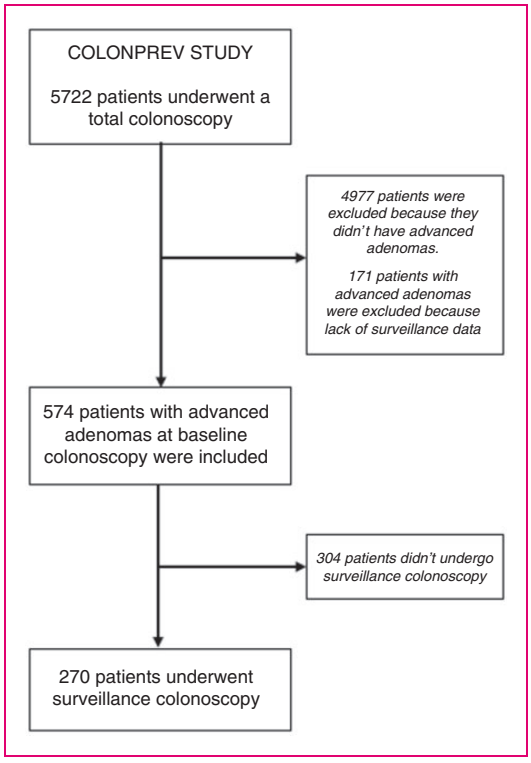

Figure 1. Flow diagram of the study.

Table 1. Characteristics of patients and baseline colonoscopies.

		Patients with advanced adenomas at baseline $n = 574$	Patients with follow-up $n = 270$
Sex	Male	389 (67.8)	183 (67.8)
	Female	185 (32.2)	87 (32.2)
Age (years)		60 ± 6	61 ± 6
Screening method	FIT	149 (26)	86 (32)
	Colonoscopy	425 (74)	184 (68)
Number of adenomas		2.5 (1.7)	2.4 (1.7)
Mean withdrawal time (minutes)		8.8 ± 4.0	8.3 ± 3.8
Proximal adenomas		354 (61.7%)	172 (63.7%)
Intermediate risk		129 (22.5%)	55 (20.4%)
High risk		20 (3.5%)	11 (4.1%)
Distal adenomas		345 (60.1%)	171 (63.3%)
Intermediate risk		224 (39.0%)	108 (40.0%)
High risk		85 (14.8%)	46 (17.0%)

Categorical data are represented as number (%) and continuous variables as mean ± SD.
No significant differences were found between any of the variables (Chi square; Student's *t*).
FIT: fecal immunochemical test.

Table 2. Endoscopist characteristics and quality indicators.

Characteristics		*N* (%)
Number of endoscopists		44
Sex	Male	27 (61.4)
	Female	17 (38.6)
Age (years)		40 ± 8
Adenoma detection rate	Mean ± SD	33 ± 11
	Median; P25–P75	33.8; 22.9–37.5
Adenomas per colonoscopy rate	Mean ± SD	0.68 ± 0.25
	Median; P25–P75	0.69; 0.48–0.98
Mean withdrawal time (minutes)		7.9 ± 2.5
Years as physician		15 ± 8
Years as specialist		10 ± 8
Exclusive dedication to endoscopy		11 (23%)
Total lifelong case volume		7042 ± 5299
Last year case volume		766 ± 595
Weekly hours dedicated to colonoscopy		16.5 ± 9.9
Educational activities in the last year		3.2 ± 2.3

Categorical data are represented as number (%) and continuous variables as mean ± SD.
P25: 25th percentile; P75: 75th percentile.

The quality metrics of the endoscopists who performed the baseline colonoscopies did not differ in number of surveillance colonoscopies performed or mean follow-up time (Table 4). As Table 4 shows, both ADR and APCR appeared to influence the rate of advanced neoplasia at follow-up. Patients whose baseline colonoscopy endoscopist had an ADR lower than the median had an advanced neoplasia frequency of 13.1% at follow-up whereas if ADR was higher than 33.8%, advanced neoplasia was present in only 4% of cases ($p = 0.001$; log rank 0.02) (Figure 2(a)).

Similar values were obtained for APCR. Patients whose endoscopists at baseline colonoscopy scored lower than the median of 0.69 adenomas per colonoscopy showed advanced neoplasia in 13.0% of cases at surveillance; those with endoscopists scoring higher than the median had advanced neoplasia at follow-up in only 2.8% of cases ($p = 0.001$; log rank 0.01) (Figure 2(b)).

Table 5 shows the relationships among patient characteristics, quality indicators of the endoscopist who performed the baseline colonoscopy, and the rate of advanced neoplasia at follow-up. In the univariate analysis (Table 5(a)), only having high-risk advanced adenomas at baseline (HR 0.43; 95% CI 0.19–0.97) and ADR of the endoscopist (HR 0.94; 95% CI 0.89–0.99) showed a significant relationship with advanced neoplasia at surveillance, whereas APCR of the

endoscopist showed a value near statistical significance (HR 0.14; 95% CI 0.02–1.01). A multivariate Cox model, adjusted for patient age and sex, showed that the ADR of the endoscopist who performed the baseline colonoscopy was the only independent predictor of the risk of developing advanced neoplasia at follow-up (HR 0.94; 95% CI 0.89–0.99) (Table 5(b)), which means a 6% of reduction in the risk of advanced neoplasia at surveillance per each 1% of increase in endoscopist's ADR.

Table 3. Characteristics and findings at surveillance colonoscopies.

Characteristics		*N* (%)
Number of surveillance colonoscopies		270 (100)
Time of follow-up (years): mean ± SD		3.36 ± 0.41
Year of follow-up	2	46 (17.0)
	3	206 (76.3)
	4	18 (6.7)
Advanced neoplasia		24 (8.9)
Advanced adenoma		23 (8.5)
Colorectal cancer		1 (0.4)
Adenomas		95 (35.2)

Categorical data are represented as number (%) and continuous variables as mean ± SD.

Discussion

Our results support the hypothesis that the risk of having advanced adenomas at follow-up is closely related to the quality metrics of the endoscopist who performs the baseline colonoscopy. Endoscopists with higher ADR or APCR detect and remove lesions more appropriately at baseline; thus, their patients have a lower risk of advanced adenomas at follow-up. The reverse is also the case: Endoscopists with lower-quality metrics have patients at higher risk for advanced adenomas in surveillance colonoscopy because low ADR or APCR indicates that overlooked lesions have progressed to advanced lesions at follow-up. In the current multivariate analysis, baseline ADR remained the only quality-related independent risk factor for advanced neoplasia at follow-up, showing better performance than APCR.

Variation among endoscopists in quality metrics has been reported extensively,[4,10,11] and studies have demonstrated that the individual endoscopist is an independent predictive factor for adenoma detection.[4,11] The relationship between quality indicators at baseline colonoscopy and risk of future lesions already has been demonstrated in terms of interval cancer. Two pivotal studies[12,13] have shown how the ADR influences the risk of interval cancer, suggesting that low ADR leads to missed lesions that will grow and progress to CRC. Such studies have established a linear

Table 4. Findings of surveillance colonoscopies according to baseline colonoscopy endoscopist ADR and APCR with different cut-offs (25th percentile (P25), median (P50), and 75th percentile (P75)).

	Categorized according to P25		Categorized according to P50 (median)		Categorized according to P75	
According to endoscopist ADR[b]	ADR < 22.9	ADR > 22.9	ADR < 33.8	ADR > 33.8	ADR < 37.5	ADR > 37.5
Number of colonoscopies	84 (31.1)	186 (68.9)	145 (53.7)	125 (46.3)	212 (78.5)	58 (21.5)
Time to follow-up	3.36 ± 0.38	3.35 ± 0.43	3.37 ± 0.41	3.34 ± 0.42	3.34 ± 0.41	3. 42 ± 0.43
Advanced neoplasia	11 (13.1)	13 (7.0)	19 (13.1)	5 (4.0)[a]	21 (9.9)	3 (5.2)
Advanced adenomas	11 (13.1)	12 (6.5)	19 (13.1)	4 (3.2)[a]	21 (9.9)	2 (3.4)
Adenomas	34 (40.5)	65 (32.8)	57 (39.3)	38 (30.4)	77 (36.3)	18 (31.0)
According to endoscopist APCR	APCR < 0.48	APCR > 0.48	APCR < 0.69	APCR > 0.69	APCR < 0.98	APCR > 0.98
Number of colonoscopies	96 (35.6)	174 (64.4)	161 (59.6)	109 (40.4)	220 (81.5)	50 (18.5)
Time of follow-up	3.34 ± 0.42	3.37 ± 0.41	3.36 ± 0.43	3.35 ± 0.39	3.34 ± 0.41	3.43 ± 0.40
Advanced neoplasia	13 (13.5)	11 (6.3)[a]	21 (13.0)	3 (2.8)[a]	23 (10.5)	1 (2.0)
Advanced adenomas	13 (13.5)	10 (5.7)[a]	21 (13.0)	2 (1.8)[a]	22 (10.0)	1 (2.0)
Adenomas	38 (39.6)	57 (32.8)	62 (38.5)	33 (30.3)	75 (34.1)	20 (40.0)

Categorical data are represented as number (%) and continuous variables as mean ± SD. Number of adenomas given as median (p25–p75).
[a]$P < 0.05$ (Chi square test for categorical data and Mann–Whitney U test for quantitative data). [b]Advanced, proximal, and distal ADR were available for 253 surveillance colonoscopies.
ADR: adenoma detection rate; APCR: adenomas per colonoscopy rate.

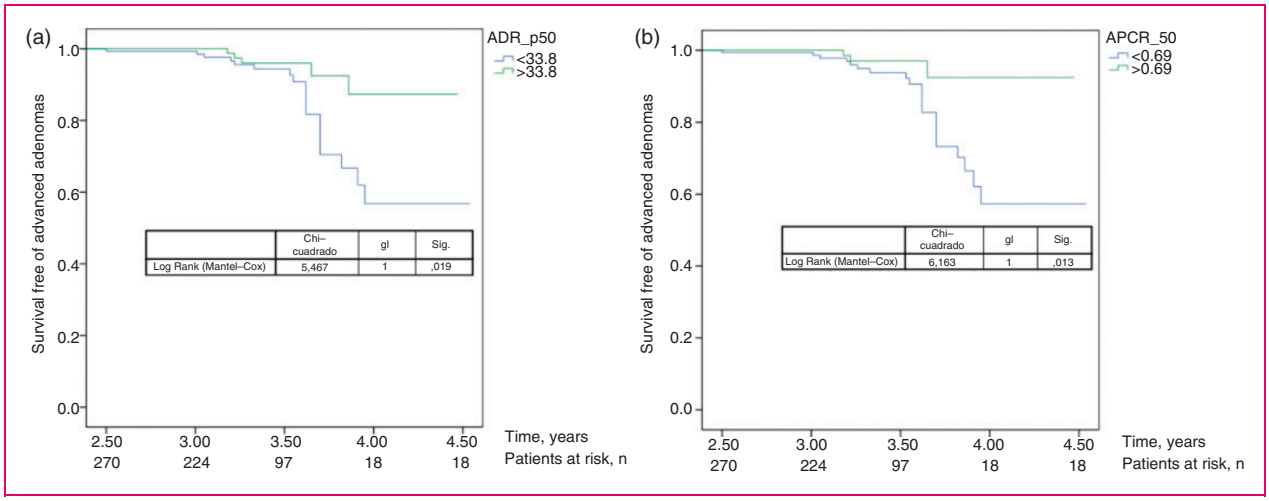

Figure 2. Development of advanced neoplasia at surveillance depending on the ADR (a) or on the APCR (b) of the endoscopist who performed the baseline colonoscopy.

Table 5. Univariate and multivariate analyses of quality indicators at baseline and their influence on advanced neoplasia at follow-up.

Variable	HR	(95% CI)	*p value*
(a) Univariate analysis			
Sex of patient (male/female)	1.17	(0.49–2.84)	0.72
Age of patient	0.99	(0.93–1.07)	0.89
Risk (intermediate/high)	0.43	(0.19–0.97)	0.04
Mean withdrawal time longer than 8 minutes (no/yes)	3.25	(0.97–10.91)	0.056
ADR	0.94	(0.89–0.99)	0.02
APCR	0.14	(0.02–1.01)	0.05
(b) Multivariate analysis			
ADR	0.94	(0.89–0.99)	0.02
Risk (intermediate/high)	2.22	(0.97–5.08)	0.06
APCR	0.44	(0.01–15.08)	0.97

ADR: adenoma detection rate; APCR: adenoma per colonoscopy rate; CI: confidence interval.

relationship between ADR and future interval cancer. On the other hand, a number of reports have described how a quality improvement program can increase ADR[14] and decrease interval cancer.[15] Nevertheless, this knowledge about the link between quality indicators at baseline and findings at follow-up has not produced any variation in surveillance recommendations, which do not take into account the characteristics of the endoscopist performing the baseline procedure. Our study demonstrates huge differences in terms of advanced neoplasia at surveillance depending on the quality metrics of the endoscopist who performs the baseline colonoscopy, supporting the notion that periodically establishing these quality metrics would be of great value and aid in designing a follow-up strategy accordingly.

Higher ADR may lead to more frequent surveillance; however, we did not find this relationship in the current analysis, and the number of surveillance colonoscopies was not related to the endoscopist quality indicators. An explanation may be that in this study, we included only patients with advanced adenomas at baseline, and the recommendation was the same for all of them: surveillance colonoscopy at three years. Nevertheless, although increased detection of lesions might be expected in patients undergoing enhanced surveillance, we found fewer advanced lesions in patients of physicians with higher ADR. When we compared the more often used quality indicators, we found that the ADR of the endoscopist who performed the baseline colonoscopy was the main independent predictor of advanced neoplasia at follow-up. The very low rate of advanced neoplasia found in the group of high baseline ADR (>33.8%) is clinically rewarding and, if it is confirmed in larger studies, suggests the possibility of enlarging the surveillance interval when a high-quality endoscopist has performed the baseline colonoscopy. The relationship between ADR and APCR is not always linear,[6] and the same endoscopist could show good performance for one indicator and poor performance for another. The vast majority of studies focused on quality indicators have used ADR, and controversies have arisen regarding which quality indicator more appropriately reflects good endoscopy practice.[16] However, the relationship between these and other indicators must be evaluated in a larger prospective study to establish the real link between these metrics and lesion characteristics at follow-up.

The main limitation of our study is the low number of procedures evaluated, which make it difficult to draw strong conclusions about the independent importance of the different quality indicators. Moreover, that precluded obtaining the optimal cut-off for appropriately separated low and high detectors. That said, we were able to show different trends quite nicely depending on quality metrics at baseline. Higher numbers would be needed to build receiver operating characteristic curves to obtain adequate thresholds. Ideally, it should be possible to adjust surveillance intervals to the quality metrics of the endoscopist who performs the baseline colonoscopy, allowing the best endoscopists to have longer follow-up intervals. Prospective studies with a larger number of patients are needed to establish such a relationship.

Surveillance leads to a high burden of colonoscopies, which is especially important in screening programs, in which endoscopic capacity is currently challenged. Work-up colonoscopies after a positive FIT lead to high adenoma detection in organized programs, and surveillance colonoscopies secondary to that detection also occupy an important part of the endoscopy workload. For this reason, it is very important to validate the indication of these follow-up colonoscopies.[17] On the other hand, organized screening programs can help with monitoring the quality indicators of participant endoscopists to allow for ideal scheduling of future surveillance intervals. Currently recommended surveillance colonoscopy intervals are based on very weak evidence,[2] and removal of polyps at a high-quality baseline colonoscopy is plausibly much more important than follow-up.[18] Our results have demonstrated the importance of endoscopist quality metrics in surveillance outcomes. Finally, we would like to remark that our study was performed in a context of high quality, as demonstrated by the low number of advanced neoplasia found at follow-up, especially if compared with previous studies.[19]

In summary, in this small study, we found that in patients with advanced adenomas, quality metrics of the endoscopists who perform the baseline colonoscopy are related to the frequency of advanced neoplasia at surveillance. This result seems to confirm the paradox of detection and surveillance in which patients whose endoscopists have a higher detection ability should need less surveillance instead of more, as current guidelines recommend. Given the small size of our sample, these results are, at the moment, hypothesis generating and should be confirmed in a larger sample.

Acknowledgments

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Declaration of conflicting interests

None declared.

Ethics approval

COLONPREV was approved by Comité Ètic d'Investigació Clínic de l'Hospital Clínic de Barcelona, who gave prior approval and by the ethical review board of each participating center. The ethical board approval of COLONPREV study was granted in January 15th, 2009. The trial was registered in ClinicalTrials.gov#NCT00906997. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a prior approval by the institution's human research committee.

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Informed consent

Written informed consent was obtained from each patient included in this study.

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