SUPPLEMENTARY MATERIALS

The study population included patients from four large healthcare systems (i.e., Kaiser Permanente Northern California [KPNC], Kaiser Permanente Southern California [KPSC], Kaiser Permanente Washington [KPWA], and Parkland Hospital/University of Texas Southwestern [UTSW]) who had a colorectal cancer (CRC)-negative colonoscopy (i.e., a colonoscopy with no CRC detected at or within 6 months (i.e.,182 days) after the procedure) performed between January 2011 through June 2019. Combined, these systems include approximately one of every 30 people in the United States. Patients with a prior CRC diagnosis or history of lower gastrointestinal surgery (e.g., colectomy) were excluded. Patients from the three Kaiser Permanente systems had ≥1 year of health plan enrollment prior to their CRC-negative colonoscopy for ascertainment and recording of clinical history data. Patients were further restricted to those whose physician performed ≥100 total colonoscopy examinations during the calendar year prior to the CRC-negative colonoscopy; this excluded physicians who infrequently performed colonoscopies.

Data on colonoscopy procedures, cancer diagnoses and deaths, and patient and physician characteristics were obtained from clinical and administrative databases. Colonoscopy procedures were identified using Current Procedural Terminology codes, International Classification of Disease procedure codes, Healthcare Common Procedure Coding System codes, and site-specific codes. All sites linked to cancer registries reporting to the Surveillance, Epidemiology, and End Results (SEER) program. CRC was defined as an adenocarcinoma within the colon or rectum using registry cancer site group codes 21040 and 21050, the International Classification of Diseases for Oncology, third edition (ICD-O-3) site (topography) codes: C18.0, C18.2-C18.9, C19.9, and C20.9, and ICD-O-3 histology (morphology) codes for adenocarcinoma. CRC diagnoses were available through December 31, 2019.

Adenoma detection used manually validated methods from systematized nomenclature of medicine (SNOMED) coding in electronic pathology databases (KPNC and KPSC) and either chart abstraction and/or natural language processing of pathology reports (KPWA and UTSW). For KPNC and KPSC, colonoscopy indication was ascertained via a modified validated algorithm that incorporates pre-procedure administrative and clinical data and was designed to minimize misclassification of screening examinations. KPWA and UTSW used either chart abstraction and/or natural language processing of colonoscopy reports with comparable performance (unpublished internal validation). KPNC validation studies confirmed that the indications identified differed somewhat using different approaches (e.g., indication from colonoscopy report vs. more comprehensive methods with medical records, the latter being more accurate); by indication, surveillance examinations were the most susceptible to misclassification. Colonoscopies following a positive fecal test were classified as diagnostic.

For ADR calculations, we collected data on colonoscopies performed between 2010-2018 by endoscopists who performed ≥100 colonoscopies (irrespective of indication) during the calendar year. We calculated annual overall ADRs for all colonoscopies regardless of indication, and ADRs for each indication (i.e., screening, surveillance, and diagnostic) for physicians who performed ≥25 colonoscopies of the specific indication per year. As noted in the **Supplementary Table**, 363,429 screening colonoscopies performed by 474 physicians in 2010-2018 served as the basis for annual screening ADR calculations. Each physician's screening ADR value for a given year was then applied to all colonoscopies performed by this physician the following year; thus, screening ADRs were applied to 1,031,896 colonoscopies performed in 2011-2019 by 474 physicians to evaluate associations with PCCRC risk among those colonoscopies. Similarly, 1,032,350 diagnostic colonoscopies performed by 486 physicians in

2010-2018 served as a basis for calculating the annual diagnostic ADRs, these diagnostic ADRs were then applied to 1,045,119 total colonoscopies performed by these 486 physicians in 2011-2019. Likewise, 174,280 surveillance colonoscopies performed by 438 physicians in 2010-2018 served as a basis for annual surveillance ADR calculations, and surveillance ADRs were applied to 913,099 total colonoscopies performed by these 438 physicians in 2011-2019. Finally, 1,703,723 total colonoscopies performed by 487 physicians in 2010-2018 served as a basis for annual overall ADR calculations, and overall ADRs were applied to 1,046,916 total colonoscopies performed by these 487 physicians in 2011-2019.

Two centers separately reported fecal immunochemical test (FIT) results (KPNC and KPSC), allowing separate calculation of ADR distributions and associations between a FIT-positive colonoscopy ADR and PCCRC. At KPNC and KPSC, FIT kits (OC FIT-Chek, Polymedco) were mailed and/or handed out to health plan members who then mailed completed kits to regional laboratories where they were analyzed using OC-Sensor Diana (Polymedco; positive result, ≥100 ng/mL of hemoglobin [20 µg of hemoglobin per gram of stool]).

Consistent with World Endoscopy Organization PCCRC definitions, the primary outcome was a colorectal adenocarcinoma occurring ≥6 months after a CRC-negative colonoscopy; cancers diagnosed <6 months after the colonoscopy were considered detected cancers by that colonoscopy. For each eligible colonoscopy, PCCRC follow-up ended at the earliest of 1) subsequent CRC-negative colonoscopy; 2) health plan disenrollment; 3) PCCRC diagnosis; 4) death; or 5) end of the study period (12/31/2019). Patients with a subsequent CRC-negative colonoscopy were followed, as a separate observation, from the subsequent colonoscopy date.

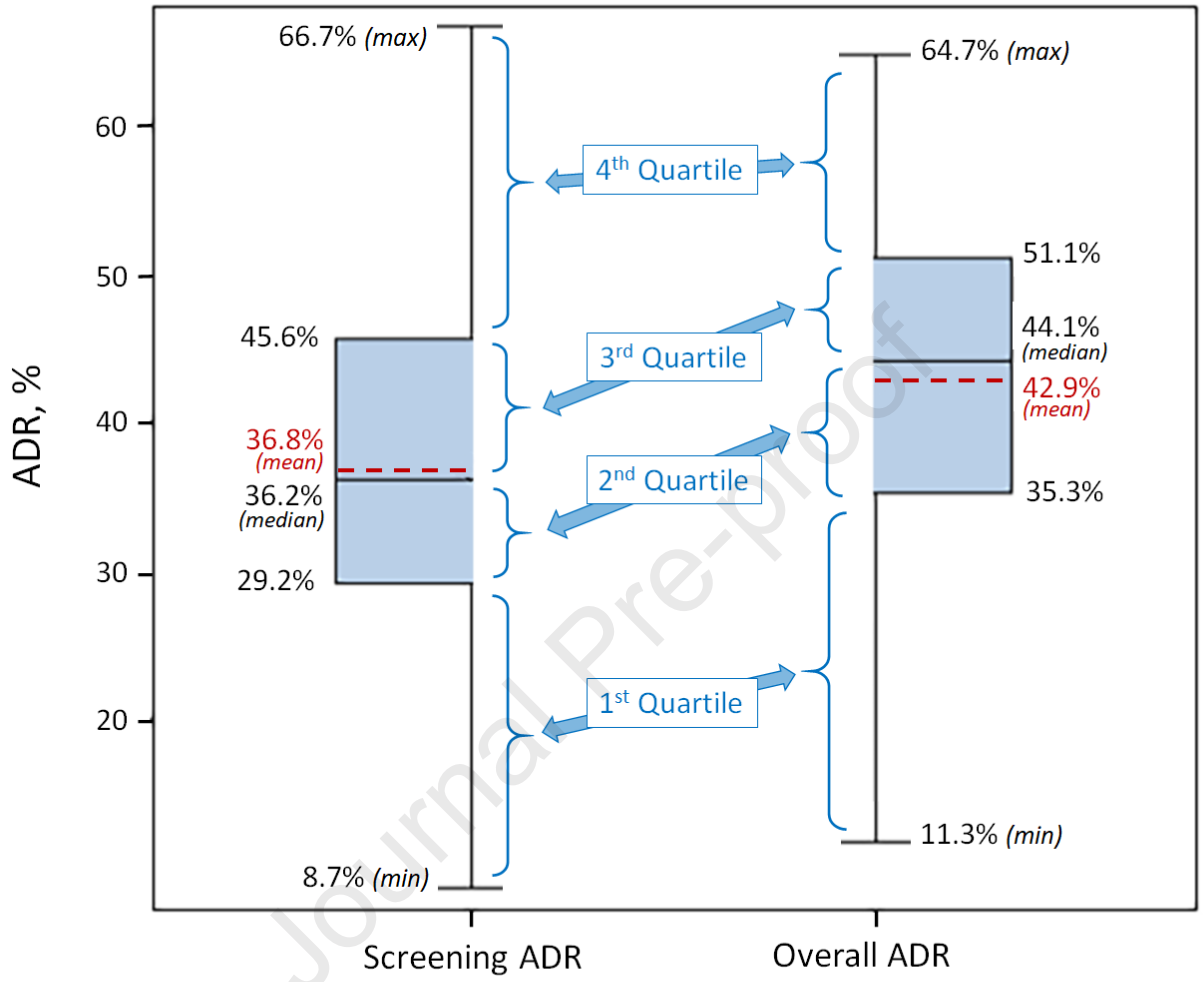
The Wilcoxon matched pairs signed-ranks test was used to estimate the statistical significance of differences in medians of paired observations of overall ADR vs. screening ADR. Among patients with a CRC-negative colonoscopy, associations between physician ADR by indication and overall ADR in the calendar year before the negative colonoscopy and patient's risk of PCCRC were evaluated using Cox proportional hazards regression. ADRs by indication and overall ADR were modeled as ADR categories (i.e., <25, 25-29.9. 30-34.9, 35-39.9, 40-44.9, and ≥45%) and by ADR quartiles. The lowest group (i.e., ADR <25% and 1st ADR quartile, respectively) served as the referent. Clustering of patients within physicians was accounted for using the robust sandwich covariance estimator. Model covariates included health system (KPNC, KPSC, KPWA, UTSW); sex (male, female); self-reported race and ethnicity (non-Hispanic Asian or Pacific Islander, non-Hispanic Black, Hispanic, other [Native American, Alaska Native, multiracial or other race or ethnicity, or not otherwise specified], and non-Hispanic White); age, body mass index (<25, 25-29.9, ≥30 kg/m^2), Charlson comorbidity score (0, 1, ≥2, unknown) in the calendar year prior to the CRC-negative colonoscopy; and colonoscopy year to account for temporal trends. All statistical tests were two-sided; a p-value of <0.05 was considered statistically significant. Analyses used SAS/STAT software, version 9.4 (SAS Institute Inc., Cary, NC, USA).

Supplementary Table. The number of endoscopists and colonoscopies used for adenoma detection rate (ADR) calculations and distributions of colonoscopy indications.

Colonoscopy Indication	Colonoscopies* n	Endoscopists# n	Number of Colonoscopies per Endoscopist per Year Used for Annual ADR Calculations, Median (Interquartile Range)	
All	1,703,723	487	Overall ADR	628 (397-821)
Screening	363,429	474	Screening ADR	119 (72-180)
Diagnostic	1,032,350	486	Diagnostic ADR	402 (238-512)
Surveillance	174,280	438	Surveillance ADR	61 (42-92)
Unknown	133,664	-		

*Included outpatient colorectal cancer-negative colonoscopies performed by 487 endoscopists in 2010-2018.
#Endoscopists were considered eligible for calculation of indication-specific ADRs when they performed ≥100 colonoscopies overall and ≥25 indication-specific colonoscopies per year.

Supplementary Figure. Distributions and quartile interchange between screening and overall adenoma detection rate (ADR) measures for 293 endoscopists among colonoscopies performed in 2017-2018.



Screening ADR Quartile	Overall ADR Quartile				
	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile	Total
1st Quartile	62	11	0	0	73
2nd Quartile	10	47	16	0	73
3rd Quartile	1	13	41	19	74
4th Quartile	0	2	17	54	73
Total	73	73	74	73	293

The data in the figure represent the distributions of screening and overall ADRs for 293 endoscopists who performed at least 25 screening and at least 100 total colonoscopies per year in 2017-2018. When both screening and overall ADR measures were calculated for each individual endoscopist, 204 of 293 (69.6%) remained in the same ADR quartile (green cells); 86 endoscopists (29.4%) changed by one ADR quartile up or down (blue cells); 3 endoscopists (1%) changed by two ADR quartiles (red cells).