HHS Public Access

Author manuscript

Gastrointest Endosc. Author manuscript; available in PMC 2020 October 01.

Published in final edited form as:

Gastrointest Endosc. 2019 October ; 90(4): 651–655.e3. doi:10.1016/j.gie.2019.06.004.

Improvement in Colonoscopy Quality Metrics in Clinical Practice from 2000 to 2014

Simon C. Mathews, MD[1,2], **Ni Zhao, PhD**[3], **Jennifer L. Holub, MA, MPH**[4], **David Lieberman, MD**[5]

[1]Johns Hopkins University School of Medicine, Department of Medicine, Division of Gastroenterology and Hepatology, Baltimore, MD [2]Johns Hopkins Medicine Armstrong Institute for Patient Safety and Quality, Baltimore, MD [3]Johns Hopkins University School of Public Health, Baltimore, MD [4]Clinical Outcomes Research Initiative (CORI), Portland, Oregon [5]Division of Gastroenterology and Hepatology, Oregon Health & Science University, Portland, Oregon

Abstract

Background and Aims—Tremendous growth in research focused on quality metrics in colonoscopy has occurred since 2000. However, whether national performance in colonoscopy quality outcomes have significantly changed since this time is not as well known.

Methods—We examined colonoscopy data collected prospectively through the Clinical Outcomes Research Initiative, which included 84 gastrointestinal practice sites from 2000 to 2014 for patients undergoing colonoscopy for multiple indications. Colonoscopy outcomes by indication were compared across three 5-year periods (2000–2004; 2005–2009; 2010–2014) using the following metrics: bowel prep quality (percent good/excellent), polyp finding, 2 or more polyp finding, and polyp finding >9 mm. Multivariate logistic regression was used to generate odds ratios and 95% confidence intervals for each time period while controlling for age, gender, and race/ethnicity.

Results—A total of 1,541,837 adults were included in the study across all indication groups. The average risk screening group (390,741 adults) demonstrated statistically significant improvement across all 4 quality metrics when comparing baseline period to the final time period. Bowel prep quality improved across all indications when comparing the baseline period with the final time period. Polyp finding, 2 or more polyp findings, and polyp finding >9 mm improved in average-

Corresponding Author: Simon C. Mathews, MD, Johns Hopkins Medicine, Divisions of Gastroenterology and Hepatology, Armstrong Institute for Patient Safety and Quality, 750 E. Pratt St., 15th Floor, Baltimore, MD 21202, Tel: 410-550-1793, smathel4@ihmi.edu.

Author Contributions:

Author (DL and JH) were responsible for generation, collection, and assembly of data Authors (DL and SCM) were responsible for concept and design; analysis, and interpretation of data; and drafting and revision of manuscript

Author NZ was responsible for review of statistical methods, interpretation of data, and revision of manuscript.

Disclosure statement:

The authors (SCM; NZ; JLH; DL) have no conflicts of interest to declare. SCM receives research funding from Genentech. The commercial entity had no involvement in this research.

risk screening; surveillance; and diagnostic indication groups when comparing the baseline period with final time period. The Increased Risk Screening and Inflammatory Bowel Disease indication groups did not see improvements beyond bowel prep quality when comparing baseline with final time period.

Conclusion—Colonoscopy outcomes as measured by bowel prep quality, polyp finding, 2 or more polyp findings, and polyp finding >9 mm improved significantly over the 15-year period between 2000 and 2014 with the largest and most consistent impact in the Average-Risk Screening indication group.

Introduction

Since the landmark publication of the Institute of Medicine's (IOM) *To Err is Human*[1] in 1999, the concept of quality improvement and safety has emerged as a growing priority in healthcare. This focus not surprisingly extended to gastroenterology and specifically endoscopic procedures. Early and ongoing efforts have often focused on colonoscopy given its ubiquitous use in clinical practice and its prominent role in colorectal cancer screening.

In 2002 a U.S. Multi-Society Task Force on Colorectal Cancer proposed initial consensus based standards.[2] This was followed by the publication of the American Gastroenterologic Association (AGA) Task Force on Quality in Practice in 2005 which specifically concluded that developing and implementing meaningful and quantifiable measures of quality needed to be a priority.[3] This was shortly followed by the 2006 publication of the joint Taskforce on Quality Endoscopy from the American College of Gastroenterology (ACG) and the American Society for Gastrointestinal Endoscopy (ASGE), which described specific endoscopic quality measures in a systematic way[4] and the 2007 publication of the Quality Assurance Task Force of the National Colorectal Cancer Roundtable which developed a standardized reporting and data system for colonoscopy.[5] Most recently, the joint ACG/ASGE Taskforce on Quality updated its guidelines[6] in 2015. During this 15-year period there has been tremendous progress in the research involving quality and colonoscopy. Notably Centers for Medicare and Medicaid Services (CMS) has also recognized the importance of quality in colonoscopy by incorporating measures into its quality reporting system.[7] Consequently, quality is now more directly tied to physician reimbursement.

Given the significant evolution and growth of quality metrics in colonoscopy over time, we aimed to determine whether quality outcomes in colonoscopy have changed during the 15-year period between 2000 and 2014.

Methods

Colonoscopy data were collected prospectively at 84 gastrointestinal practice sites from 2000 to 2014, using an endoscopic report generator, from 1,541,837 adults who underwent colonoscopy. The practice sites include community practices and endoscopy centers (77.1%), academic centers (9%) and VA/military medical centers (13.8%). Indications for colonoscopy were used to divide this larger group into 5 broad categories including Average-Risk Screening; Increased Risk Screening; Surveillance; Inflammatory Bowel Disease; and Diagnostic. Increased Risk Screening included the indication groups "family history of

colorectal cancer;" "family history of polyps;" "positive fecal occult blood test;" "screening in hereditary nonpolyposis colorectal cancer syndrome;" "screening in familial adenomatous polyposis;" "polyps seen on barium enema;" "polyps seen on flexible sigmoidoscopy;" "other increased risk screening;" and "other risk factors." Surveillance included indication categories of "surveillance of adenomatous polyps;" surveillance of colorectal cancer;" and "polyps seen on prior colonoscopy." Inflammatory Bowel Disease included "established or surveillance of Crohns;" "established or surveillance of ulcerative colitis;" and "other surveillance." Diagnostic included all indications related to bleeding or any symptom as well as "other evaluation;" "other evaluation of suspected;" "abnormal studies/imaging (not including polyps);" "personal history of non-GI cancer;" and "therapeutic intervention."

Demographic characteristics collected included: age; sex; race/ethnicity; and ASA class. Primary outcomes included bowel prep quality (percent good/excellent), polyp finding, 2 or more polyp findings (2+ polyp finding), and polyp finding >9 mm (polyp >9). Of note, histology was not available for specimens removed; these metrics were consequently intended to approximate histologic risk.

Statistical Approach

Colonoscopy quality metrics were analyzed for patient groups based on indication, age, sex, and race/ethnicity and segmented into 5-year groupings: 2000 to 2004; 2005 to 2009; 2010 to 2014. Comparison of demographic data was performed by using chi-square tests and 1-way ANOVA. Cochran-Armitage test was used to measure trends in the data. Multivariate logistic regression was used to generate odds ratios and 95% confidence intervals for each time period while controlling for age, gender, and race/ethnicity. All analyses were performed with version 9.4 of SAS software (SAS Institute Inc, Cary, NC).

Results

Demographics

A complete breakdown of participants by indication, year period, age, sex, race/ethnicity, and ASA Class is provided in Table 1. A total of 1,541,837 adults were included in the study, with 390,741 in Average-Risk Screening; 199,226 in High-Risk Screening; 285,500 in Surveillance; 38,636 in Inflammatory Bowel Disease; and 627,734 in Diagnostic. Notably, there were statistical differences across nearly all demographic categories across all time periods across all indications (Table 1). As a result, the data was stratified by age and sex for each indication (Appendices 1–5) and further analyzed using multivariate logistic regression adjusting for differences in age, sex, and race/ethnicity (Table 2). The indication-specific, age and sex stratified results demonstrated significant heterogeneity across the various combination comparisons which are reported in Appendices 1 to 5. For a more global assessment of outcomes over time, the multivariate regression results are summarized below and in Table 2.

Average-Risk Screening Population

For the Average-Risk Screening group, there was a statistically significant improvement in all outcome measures (bowel prep quality, polyp finding, 2+ polyp finding, and polyp >9) over all 3 time periods when adjusted for age, sex, and race/ethnicity (Table 2).

Increased Risk Screening Population

For the Increased Risk Screening group, there was a statistically significant improvement in Bowel Prep Quality across all time periods. However, for the remainder of the metrics there was either no change (polyp finding) or a declining trend (2+ polyp finding, polyp>9) when comparing the final time period to the baseline (Table 2).

Surveillance Population

For the Surveillance group, bowel prep quality and polyp finding improved across all 3 time periods. Two+ polyp finding was unchanged in the middle time period but improved by the final time period. Polyp>9 was lower than baseline in the middle time period, but improved by the final time period. There was a statistically significant improvement across all outcome measures by the final time period (Table 2).

Inflammatory Bowel Disease Population

For the Inflammatory Bowel Disease group, there was no change in the Bowel Prep Quality during the middle time period, but improvement in the final period. Polyp finding and 2+ polyp finding were improved in the middle time period, but unchanged in the final time period. Polyp >9 was unchanged in the middle period and decreased in the final period. Results are presented in Table 2.

Diagnostic Population

For the Diagnostic group, bowel prep quality declined in the middle period but improved in the final time period. Polyp finding improved across all time periods. 2+ polyp finding was unchanged in the middle time period, but improved in the final time period. Polyp>9 declined in the middle period, but improved in the final time period. There was a statistically significant improvement across all outcome measures by the final time period (Table 2).

Discussion

Colonoscopy Quality Metrics

Colonoscopy outcomes as measured by bowel prep quality, polyp finding, 2+ polyp finding, and polyp>9 improved significantly over the 15-year period between 2000 and 2014. Notably, bowel prep quality improved across all indication groups when comparing the baseline period with the final time period. This positive trend across all indications was not uniformly distributed across all quality metrics for colonoscopy. However, the Average-Risk Screening population, arguably the benchmark setting for quality in colonoscopy, demonstrated the most convincing and consistent improvements in all quality parameters. In addition to Average Risk, the Surveillance and Diagnostic indication groups also saw significant improvements across all metrics in the final time period compared to baseline.

Increased Risk Screening population did not demonstrate similar improvements. One hypothesis may be that clinicians completed these examinations with a higher index of suspicion that resulted in sustained vigilance consistent across all time periods. This would explain the unchanged polyp finding though does not fully explain the declines in 2+ polyp finding and polyp >9. The indication group of Inflammatory Bowel Disease in particular did not as consistently demonstrate global improvement. This indication group as well as diagnostic represent clinical contexts in which other priorities such as assessment of disease activity or detection of bleeding may complicate a primary goal of colorectal cancer prevention. This is relevant because the quality metrics measured were principally developed to address this end.

Significance

This report is the largest and longest evaluation of colonoscopy quality outcomes to date. With its large and diverse sample size, there is higher confidence in the validity of the improvement demonstrated. This study also demonstrated the potential use of polyp >9 as a robust measurement of quality that has not been previously described. The progress in colonoscopy quality mirrors the growth in research and regulation around quality improvement more broadly as well as its increased importance within gastroenterology societies through publications and formal recommendations/guidelines. Other factors may have played role include: increased overall awareness by providers; improvements in colonoscope technology including image quality and processing; and improvements in bowel preparation agents as well as greater use of more effective protocols such as split-dosing. Although it is not possible to directly ascribe causation to these factors, these results do confirm that improvements in colonoscopy quality are taking place.

Limitations

There are several limitations to consider. First, the outcomes collected represent process or intermediary measures in the broader landscape of preventing colorectal cancer. To this end, adenoma detection rate (ADR) has been the current gold standard proxy for colorectal cancer prevention as demonstrated by two notable studies that showed that ADR performance was inversely associated with the risk of interval colorectal cancer.[8,9] However, the data collection infrastructure during the 15-year study period did not regularly document histology to calculate this endpoint reliably. Nevertheless, the correlation between ADR and PDR is established[10] and the latter has also been correlated with decreased incidence of CRC.[11] To further address this limitation, we also examined 2+ polyp finding that may approximate a higher-quality examination because ADR could be theoretically gamed by the removal of a single adenomatous polyp. We also examined polyp >9, which was intended to capture higher risk lesions due to known association of polyp size and risk for advanced neoplasia,[12] although these metrics are not as well established. In addition, although improvements in colonoscopy quality would be ideally tied to clinical outcomes for each of indication group, these data were not collected.

Summary

Colonoscopy quality broadly improved in the 15-year period between 2000 and 2014, most notably with the largest and most consistent gains in the Average-Risk Screening population.

This suggests that multifactorial efforts over the past decade are improving colonoscopy quality.

Funding declaration:

This project was supported with funding from NIDDK U01DK57132. In addition, the practice network (Clinical Outcomes Research Initiative) has received support from the following entities to support the infrastructure of the practice-based network: AstraZeneca, Novartis, Bard International, Pentax USA, ProVation, Endosoft, GIVEN Imaging, and Ethicon. The commercial entities had no involvement in this research.

Appendix

Appendix A.

Screening Colonoscopy Quality Metrics Over Time

Percent Good/Excellent Bowel Prep (when documented)								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
40–49	76.16	78.28	86	<.0001	80.00	78.65	88.82	<.0001
50–59	78.55%	78.59%	84.55%	<.0001	82.58%	82.30%	87.92%	<.0001
60–69	76.47%	75.87%	82.05%	<.0001	80.21%	80.90%	87.33%	<.0001
70–79	74.60%	73.67%	83.00%	<.0001	78.43%	78.56%	87.49%	<.0001
>79	74.62%	74.25%	82.87%	0.0007	78.61	78.69	87.28	<.0001
Colonoscopy Polyp Detection Rate								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
40–49	34.02	37.65	36.60	0.215	25.80	25.49	27.84	0.271
50–59	39.52	42.38	47.02	<.0001	28.37%	30.40%	33.99%	<.0001
60–69	44.52	47.71	52.48	<.0001	32.52%	34.43%	37.21%	<.0001
70–79	44.44	46.90	50.84	<.0001	33.51	35.57	38.54	<.0001
>79	42.69	46.19	43.72	0.383	33.01	36.21	37.95	0.020
Colonoscopy Polyp Detection Rate 2+								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
40–49	10.59	11.52	14.82	0.002	6.69	7.26	6.33	0.658
50–59	14.86	15.99	19.76	<.0001	8.24	8.37	11.19	<.0001
60–69	18.52	20.12	25.26	<.0001	10.52	10.70	13.19	<.0001
70–79	18.97	19.65	22.81	<.0001	11.29	12.06	13.72	<.0001
>79	17.67	19.70	19.84	0.177	11.56	12.64	11.07	0.98
Colonoscopy Polyp Detection Rate > 9mm								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
40–49	5.12	5.24	4.29	0.342	3.18	3.60	3.35	0.928
50–59	6.08	6.56	7.81	<.0001	3.65	4.23	5.37	<.0001
60–69	8.55	9.08	9.92	<.0001	5.11	5.54	6.10	0.000

70–79	9.52	9.91	10.36	0.093	6.25	7.07	7.11	0.040
>79	10.79	11.23	8.53	0.233	7.25	7.05	10.26	0.061

Appendix B.

Increased Risk Screening Colonoscopy Quality Metrics Over Time

Percent Good/Excellent Bowel Prep (when documented)								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	80.5	83.76	87.22	0.000	80.81	84.79	90.19	<.0001
40–49	80.61	82.36	86.72	<.0001	82.17	84.21	90.12	<.0001
50–59	78.03	77.41	83.68	<.0001	81.36	82.34	86.60	<.0001
60–69	76.09	75.71	81.74	<.0001	80.00	82.52	87.84	<.0001
70–79	73.52	74.56	82.65	<.0001	78.03	80.06	85.95	<.0001
>79	73.92	71.43	77.38	0.598	74.04	79.26	83.48	<.0001
Colonoscopy Polyp Detection Rate								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	34.61	32.39	28.23	0.007	26.85	23.09	25.99	0.372
40–49	41.95	40.17	42.13	0.664	30.91	27.55	31.65	0.609
50–59	51.38	46.55	50.09	<.0001	35.79	31.91	36.81	0.960
60–69	56.73	51.18	55.45	0.003	40.02	35.14	38.64	0.008
70–79	55.74	51.43	53.54	0.002	41.64	35.64	39.16	0.000
>79	52.6	48.09	47.83	0.019	39.23	35.68	39.83	0.549
Colonoscopy Polyp Detection Rate 2+								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	11.75	10.00	10.00	0.1787	7.16	5.47	7.30	0.7548
40–49	15.74	14.26	16.28	0.9526	9.52	7.61	9.71	0.4441
50–59	24.73	20.06	23.64	<.0001	12.46	9.59	12.67	0.2886
60–69	30.24	23.79	28.82	0.0001	16.06	11.59	13.75	<.0001
70–79	29.51	25.31	26.70	<.0001	16.75	11.59	14.01	<.0001
>79	25.93	22.31	25.06	0.2153	17.61	10.88	16.23	0.0087
Colonoscopy Polyp Detection Rate > 9mm								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	7.51	5.64	5.81	0.0907	5.28	3.38	4.38	0.1644
40–49	7.91	6.27	7.06	0.0294	5.28	3.92	4.97	0.1254
50–59	11.75	9.6	11.35	0.0120	6.67	4.59	5.77	<.0001
60–69	16.34	12.87	15.48	0.0065	9.27	5.83	6.60	<.0001

70–79	19.76	14.78	16.23	<.0001	11.91	7.21	8.74	<.0001
>79	20.79	18.23	17.14	0.0432	16.58	12.51	20.78	0.5934

Appendix C.

Surveillance of CRC/polyps Colonoscopy Quality Metrics Over Time

Percent Good/Excellent Bowel Prep (when documented)								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
20–39	76.2	77.5	86.3	0.001	77.4	82.1	87.9	0.000
40–49	74.2	76.9	84.3	<.0001	77.1	78.9	85.4	<.0001
50–59	74.1	76.0	82.3	<.0001	76.6	78.7	86.1	<.0001
60–69	74.5	75.2	81.0	<.0001	77.8	79.9	86.4	<.0001
70–79	73.3	73.7	80.4	<.0001	77.3	78.6	86.2	<.0001
>79	73.2	74.1	81.3	<.0001	76.2	77.3	86.0	<.0001
Colonoscopy Polyp Detection Rate								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
20–39	43.4	39.7	38.6	0.161	29.9	32.3	36.2	0.058
40–49	46.3	46.0	47.3	0.584	37.5	36.4	40.1	0.187
50–59	53.1	52.3	58.4	<.0001	42.6	42.5	46.4	<.0001
60–69	54.4	55.6	61.1	<.0001	44.5	45.5	49.6	<.0001
70–79	54.0	55.6	60.8	<.0001	43.5	46.5	51.4	<.0001
>79	51.8	54.8	57.5	<.0001	44.3	46.9	50.9	<.0001
Colonoscopy Polyp Detection Rate 2+								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
20–39	13.0	12.1	13.6	0.864	8.4	9.6	12.4	0.065
40–49	17.7	17.3	19.1	0.360	12.5	11.8	14.7	0.11
50–59	23.7	22.6	27.8	<.0001	16.2	14.3	18.5	0.0001
60–69	25.5	25.6	32.2	<.0001	17.1	16.7	20.0	<.0001
70–79	25.4	26.1	31.8	<.0001	16.2	17.5	22.0	<.0001
>79	23.0	24.3	29.1	<.0001	16.8	17.7	21.4	0.0002
Colonoscopy Polyp Detection Rate > 9mm								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p	2000–2004	2005–2009	2010–2014	trend p
20–39	5.5	7.5	5.3	0.983	4.5	4.8	4.5	0.999
40–49	6.3	5.9	7.5	0.120	5.0	5.2	6.3	0.151
50–59	8.1	7.8	8.8	0.040	6.7	6.0	6.9	0.684
60–69	9.4	8.9	10.4	0.000	8.1	7.5	7.9	0.588

70–79	10.8	10.4	11.3	0.257	8.8	9.1	9.4	0.177
>79	12.6	12.4	11.9	0.390	10.7	10.7	11.2	0.646

Appendix D.

IBD Colonoscopy Quality Metrics Over Time

Percent Good/Excellent Bowel Prep (when documented)								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	trend p-value	2000–2004	2005–2009	2010–2014	trend p-value
20–39	82.5	80.8	84.6	0.160	82.3	83.5	83.7	0.428
40–49	82.4	79.4	86.0	0.053	82.7	85.3	86.7	0.018
50–59	80.3	75.5	84.6	0.018	83.0	82.7	86.2	0.053
60–69	76.8	77.7	81.0	0.004	80.2	80.8	85.4	0.006
70–79	75.5	72.8	81.8	0.013	81.8	80.4	88.4	0.030
>79	76.1	75.9	83.5	0.226	84.7	78.4	88.4	0.764
Colonoscopy Polyp Detection Rate								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	13.0	12.8	13.2	0.903	9.5	9.8	8.0	0.220
40–49	17.1	19.4	19.7	0.100	13.7	15.9	13.8	0.771
50–59	25.1	28.5	26.4	0.262	18.4	21.1	19.4	0.494
60–69	28.4	36.3	31.5	0.111	23.8	23.4	22.9	0.661
70–79	33.3	34.7	31.7	0.631	23.2	24.4	25.6	0.412
>79	31.2	33.7	33.0	0.679	25.7	24.4	21.7	0.542
Colonoscopy Polyp Detection Rate 2+								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	3.5	2.7	2.5	0.179	2.4	2.0	1.7	0.287
40–49	3.6	5.2	4.6	0.216	3.3	3.1	3.0	0.700
50–59	8.3	10.1	8.7	0.519	5.1	5.9	5.5	0.663
60–69	10.7	15.1	12.7	0.137	6.3	7.4	6.7	0.779
70–79	13.4	13.8	11.8	0.440	7.2	8.3	6.6	0.897
>79	13.7	9.9	13.0	0.653	7.4	8.0	5.8	0.778
Colonoscopy Polyp Detection Rate > 9mm								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	2.8	3.1	1.4	0.028	1.7	1.6	0.9	0.123
40–49	3.9	3.1	2.7	0.113	2.7	2.1	1.9	0.220

50–59	4.4	3.8	3.7	0.357	3.0	3.2	2.9	0.941
60–69	5.0	6.8	4.7	0.652	4.8	4.4	3.0	0.076
70–79	7.0	6.6	6.5	0.691	5.6	4.2	3.3	0.089
>79	9.3	8.6	7.0	0.526	5.9	5.2	0.0	0.088

Appendix E.

Diagnostic Colonoscopy Quality Metrics Over Time

Percent Good/Excellent Bowel Prep								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	79.8	78.8	85.2	<.0001	81.8	82.0	86.7	<.0001
40–49	77.0	76.8	83.1	<.0001	79.3	79.2	83.9	<.0001
50–59	75.8	73.4	78.6	<.0001	79.3	77.3	81.1	0.016
60–69	72.0	70.6	76.5	<.0001	77.4	76.5	81.6	<.0001
70–79	70.1	68.0	75.5	<.0001	75.6	73.9	80.6	<.0001
>79	67.3	66.1	73.7	<.0001	70.5	70.4	79.2	<.0001
Colonoscopy Polyp Detection Rate								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	18.3	17.8	18..9	0.331	12.8	12.7	13.8	0.036
40–49	31.0	31.6	34.7	<.0001	21.4	22.7	23.9	<.0001
50–59	37.2	38.6	41.9	<.0001	25.4	26.5	31.2	<.0001
60–69	40.4	41.2	45.7	<.0001	29.1	29.9	33.7	<.0001
70–79	39.5	40.1	45.2	<.0001	29.5	30.5	34.9	<.0001
>79	37.1	37.4	39.4	0.029	29.5	30.4	33.5	<.0001
Colonoscopy Polyp Detection Rate 2+								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	4.4	3.9	4.4	0.912	2.3	2.2	2.7	0.136
40–49	10.1	9.9	11.9	<.0001	5.6	5.5	6.3	0.014
50–59	14.3	14.7	17.5	<.0001	7.4	7.3	9.5	<.0001
60–69	16.6	16.6	20.9	<.0001	9.2	9.0	11.1	<.0001
70–79	16.9	16.8	20.5	<.0001	9.7	9.7	12.1	<.0001
>79	15.0	14.6	16.0	0.329	9.7	10.3	11.9	0.000
Colonoscopy Polyp Detection Rate > 9mm								
	Male				**Female**			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
20–39	3.7	2.7	3.0	0.009	2.0	1.9	1.9	0.603
40–49	6.3	6.0	6.5	0.758	3.9	3.9	4.2	0.208

50–59	8.5	4.0	9.1	0.184	4.8	4.8	5.5	0.002
60–69	11.2	9.8	11.6	0.826	6.6	5.9	6.9	0.667
70–79	12.1	11.1	13.4	0.084	8.1	7.8	8.7	0.239
>79	14.0	12.7	14.1	0.573	11.1	10.6	12.2	0.189

Acronyms and Abbreviations

IOM	Institute of Medicine
AGA	American Gastroenterologic Association
ACG	American College of Gastroenterology
ASGE	American Society for Gastrointestinal Endoscopy
CMS	Centers for Medicare and Medicaid Services
ASA	American Society of Anesthesiologists
ANOVA	Analysis of Variance
ADR	Adenoma Detection Rate
PDR	Polyp Detection Rate
CRC	Colorectal Cancer

References

1. KohnL LT, Corrigan JM, Donaldson MS (Institute of Medicine) To err is human: building a safer health system. Washington, DC: National Academy Press, 2000
2. 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 Gastroenterol 2002;97:1296–308. [PubMed: 12094842]
3. Brotman M, Allen JI, Bickston SJ, et al. AGA Task Force on Quality in Practice: a national overview and implications for GI practice. Gastroenterology. 2005;129:361–9. [PubMed: 16012961]
4. Rex DK, Petrini JL, Baron TH, et al. Quality indicators for colonoscopy. Am J Gastroenterol. 2006;101:873–85. [PubMed: 16635231]
5. Lieberman D, Nadel M, Smith R, et al. Standardized colonoscopy reporting and data system (CO-RADS): report of the Quality Assurance Task Group of the National Colorectal Cancer Roundtable. Gastrointest Endosc 2007;65:757–66. [PubMed: 17466195]
6. Rex DK, Schoenfeld PS, Cohen J, et al. Quality indicators for colonoscopy. Gastrointest Endosc. 2015;81:31–53. [PubMed: 25480100]
7. Centers for Medicare and Medicaid Services. Measure Codes. https://www.cms.gov/medicare/quality-initiatives-patient-assessment-instruments/pqrs/measurescodes.html. Accessed August 20, 2015.
8. Kaminski MF, Regula J, Kraszewska E, et al. Quality indicators for colonoscopy and the risk of interval cancer. N Engl J Med 2010;362: 1795–803. [PubMed: 20463339]
9. Corley D, Jensen CD, Marks AR, et al. Adenoma detection rate and risk of colorectal cancer and death. N Engl J Med 2014;370: 1298–306. [PubMed: 24693890]

10. Schramm C, Scheller I, Franklin J, et al. Predicting ADR from PDR and individual adenoma-to-polyp-detection-rate ratio for screening and surveillance colonoscopies: A new approach to quality assessment. United European gastroenterology journal. 2017;5:742–9. [PubMed: 28815039]

11. Baxter N, Sutradhar R, Forbes DD, et al. Analysis of administrative data finds endoscopist quality measures associated with post-colonoscopy colorectal cancer. Gastroenterology 2011;140:65–72. [PubMed: 20854818]

12. Lieberman DA, Rex DK, Winawer SJ, et al. Guidelines for colonoscopy surveillance after screening and polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer. Gastroenterology. 2012;143:844–57. [PubMed: 22763141]

Table 1.

Patient Demographics By Indication and Time Period (Total N = 1,541,837)

Patient Demographics	Screening (n = 390,741)				Increased Risk Screening (n = 199,226)				IBD (n = 38,636)				Surveillance of CRC/polyps (n = 285,500)				Diagnostic (n = 627,734)			
	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value	2000–2004	2005–2009	2010–2014	p-value
	82,000	197,704	111,037		79,708	80,340	39,178		11,648	16,949	10,039		82,474	122,318	80,708		235,834	269,374	122,526	
Age																				
20–39	139 (0.2)	295 (0.2)	225 (0.2)	<.0001	2577 (3.2)	2560 (3.2)	1305 (3.3)	<.0001	2105 (18.1)	2659 (15.7)	2292 (22.8)	<.0001	896 (1.1)	1091 (0.9)	680 (0.8)	<.0001	22237 (9.4)	31647 (11.8)	16663 (13.6)	<.0001
40 – 50	1742 (2.1)	3686 (1.9)	2309 (2.1)		11677 (14.7)	12259 (15.3)	5247 (13.4)		2351 (20.2)	2847 (16.8)	1725 (17.2)		4453 (5.4)	5546 (4.5)	2851 (3.5)		37387 (15.9)	46966 (17.4)	21011 (17.2)	
50 – 59	35417 (43.2)	103507 (52.4)	56458 (50.9)		29732 (37.3)	32354 (40.3)	15306 (39.1)		3125 (26.8)	4709 (27.8)	2399 (23.9)		17392 (21.1)	29148 (23.8)	18460 (22.9)		65537 (27.8)	71062 (26.4)	29656 (24.2)	
60 –69	26748 (32.6)	61657 (31.2)	39182 (35.3)		20165 (25.3)	21190 (26.4)	12355 (31.5)		2306 (19.8)	4057 (23.9)	2491 (24.8)		26106 (31.7)	42585 (34.8)	34378 (42.6)		50435 (21.4)	57316 (21.3)	29187 (23.8)	
70 –79	15379 (18.8)	24731 (12.5)	11604 (10.5)		12391 (15.6)	9474 (11.8)	4112 (10.5)		1442 (12.4)	2161 (12.8)	963 (9.6)		25542 (31.0)	33731 (27.6)	20112 (24.9)		42702 (18.1)	41727 (15.5)	18032 (14.7)	
> 80	2575 (3.1)	3828 (1.9)	1259 (1.1)		3166 (4.0)	2503 (3.1)	853 (2.2)		319 (2.7)	516 (3.0)	169 (1.7)		8085 (9.8)	10217 (8.4)	4227 (5.2)		17536 (7.4)	20656 (7.7)	7977 (6.5)	
Mean (SD)	61.9 (9.0)	59.9 (8.4)	59.5 (8.2)	<.0001	59.0 (11.4)	58.0 (10.7)	58.1 (10.4)	<.0001	53.5 (14.5)	54.9 (14.3)	52.2 (14.9)	<.0001	66.1 (10.7)	65.4 (10.2)	64.8 (9.3)	<.0001	58.7 (14.5)	57.5 (15.0)	56.9 (15.3)	<.0001
Sex																				
% Male	44437 (54.2)	105850 (53.5)	62815 (56.6)	<.0001	43068 (54.0)	40958 (51.0)	19688 (50.3)	<.0001	6721 (57.7)	9657 (57.0)	5880 (58.6)	0.037	51132 (62.0)	74918 (61.3)	52467 (65.0)	<.0001	108442 (46.0)	121422 (45.1)	58110 (47.4)	<.0001
% Female	37563 (45.8)	91854 (46.5)	48222 (43.4)		36640 (46.0)	40958 (49.0)	19490 (49.8)		4927 (42.3)	7292 (43.0)	4159 (41.4)		31342 (38.0)	47400 (38.8)	28241 (35.0)		127392 (54.0)	147952 (54.9)	64416 (52.6)	
Race/Ethnicity																				
% White	69763 (85.1)	166589 (84.3)	86319 (77.7)	<.0001	67520 (84.7)	68918 (85.8)	30996 (79.1)	<.0001	10334 (88.7)	15086 (89.01)	8495 (84.6)	<.0001	72058 (87.4)	107657 (88.0)	68383 (84.7)	<.0001	191129 (81.0)	219521 (81.5)	87882 (71.7)	<.0001
% Black	5289 (6.5)	10108 (5.1)	8048 (7.3)		5280 (6.6)	3833 (4.8)	2020 (5.2)		604 (5.2)	784 (4.6)	491 (4.9)		4192 (5.1)	5444 (4.5)	3885 (4.8)		16666 (7.1)	16486 (6.1)	8547 (7.0)	
% Hispanic	4517 (5.5)	15730 (8.0)	10876 (9.8)		2386 (3.0)	5530 (6.9)	4051 (10.3)		321 (2.8)	779 (4.6)	713 (7.1)		2955 (3.6)	6686 (4.5)	5513 (6.8)		14309 (6.1)	25356 (9.4)	19732 (16.1)	
% Other	1705 (2.1)	5091 (2.6)	5709 (5.1)		2009 (2.5)	1957 (2.4)	2080 (5.3)		180 (1.6)	278 (1.6)	333 (3.3)		1354 (1.5)	2345 (1.9)	2881 (3.6)		6674 (2.8)	7667 (2.9)	6297 (5.1)	
% Unknown	726 (0.9)	186 (0.1)	85 (0.1)		2513 (3.2)	102 (0.1)	31 (0.1)		209 (1.8)	22 (0.1)	7 (0.1)		1915 (2.3)	186 (0.2)	46 (0.1)		7056 (3.0)	344 (0.1)	68 (0.1)	
ASA Class																				
I	28931 (35.3)	53269 (26.9)	22196 (20.0)	<.0001	30824 (38.7)	22514 (28.0)	7058 (18.0)	<.0001	3557 (30.5)	3287 (19.4)	869 (8.7)	<.0001	22963 (27.8)	24700 (20.2)	6796 (8.4)	<.0001	82626 (35.0)	70456 (26.2)	19166 (15.6)	<.0001
II	49445 (60.3)	136266 (68.9)	80927 (72.9)		44605 (56.0)	53385 (66.5)	28758 (73.4)		7416 (63.7)	12543 (74.0)	8118 (80.9)		53229 (64.5)	88514 (72.4)	63805 (79.1)		130679 (55.4)	172500 (64.0)	82333 (67.2)	
III	3566 (4.4)	8002 (4.1)	7665 (6.9)		4168 (5.2)	4316 (5.4)	3275 (8.4)		652 (5.6)	1093 (6.5)	1034 (10.3)		6170 (7.5)	8912 (7.3)	9936 (12.3)		21434 (9.1)	25332 (9.4)	20010 (16.3)	
IV or greater/ missing*	58 (0.1)	167 (0.1)	249 (0.2)		111 (0.1)	125 (0.2)	87 (0.2)		23 (0.2)	26 (0.2)	18 (0.2)		112 (0.1)	192 (0.2)	171 (0.2)		1095 (0.5)	1086 (0.4)	1017 (0.8)	
*n = 68 total missing																				

Table 2.

Comparison of Colonoscopy Metrics Over Time By Indication

AVERAGE RISK SCREENING			
Outcome	**2000–2004**	**2005–2009**	**2010–2014**
Good/excellent bowel preparation	1.0 (reference)	1.01 (.99–1.04)	1.64 (1.60 – 1.68)
Polyp Finding	1.0 (reference)	1.12 (1.10 – 1.14)	1.33 (1.30 – 1.35)
2 or more polyp finding	1.0 (reference)	1.08 (1.05 – 1.10)	1.41 (1.38 – 1.45)
Polyp finding > 9mm	1.0 (reference)	1.09 (1.05 – 1.13)	1.25 (1.21 – 1.30)
INCREASED RISK SCREENING			
Outcome	**2000–2004**	**2005–2009**	**2010–2014**
Good/excellent bowel preparation	1.0 (reference)	1.06 (1.03 – 1.09)	1.62 (1.57 – 1.68)
Polyp Finding	1.0 (reference)	0.83 (0.81 – 0.85)	0.97 (0.95 – 1.00)
2 or more polyp finding	1.0 (reference)	0.75 (0.73 – 0.77)	0.95 (0.92 – 0.98)
Polyp finding > 9mm	1.0 (reference)	0.73 (0.70 – 0.75)	0.88 (0.85 – 0.92)
SURVEILLANCE			
Outcome	**2000–2004**	**2005–2009**	**2010–2014**
Good/excellent bowel preparation	1.0 (reference)	1.09 (1.07 – 1.12)	1.69 (1.65 – 1.74)
Polyp Finding	1.0 (reference)	1.05 (1.03 – 1.07)	1.28 (1.26 – 1.31)
2 or more polyp finding	1.0 (reference)	1.01 (0.98 – 1.03)	1.34 (1.31 – 1.37)
Polyp finding > 9mm	1.0 (reference)	0.96 (0.93 – 0.99)	1.06 (1.02 – 1.10)
IBD EXAMS			
Outcome	**2000–2004**	**2005–2009**	**2010–2014**
Good/excellent bowel preparation	1.0 (reference)	0.94 (0.88 – 1.00)	1.34 (1.25 – 1.45)
Polyp Finding	1.0 (reference)	1.16 (1.10 – 1.23)	1.05 (0.98 – 1.12)
2 or more polyp finding	1.0 (reference)	1.19 (1.09 – 1.31)	1.03 (0.92 – 1.15)
Polyp finding > 9mm	1.0 (reference)	0.99 (0.88 – 1.12)	0.77 (0.67 – 0.89)
DIAGNOSTIC			
Outcome	**2000–2004**	**2005–2009**	**2010–2014**
Good/excellent bowel preparation	1.0 (reference)	0.95 (0.94 – 0.97)	1.43 (1.40 – 1.45)
Polyp Finding	1.0 (reference)	1.04 (1.03 – 1.06)	1.24 (1.22 – 1.26)
2 or more polyp finding	1.0 (reference)	1.00 (0.98 – 1.02)	1.29 (1.27 – 1.32)
Polyp finding > 9mm	1.0 (reference)	0.92 (0.90 – 0.94)	1.08 (1.05 – 1.11)

* models are controlled for gender, age and race/ethnicity