HHS Public Access

Author manuscript

Clin Gastroenterol Hepatol. Author manuscript; available in PMC 2017 March 01.

Published in final edited form as:

Clin Gastroenterol Hepatol. 2016 March ; 14(3): 436–444.e1. doi:10.1016/j.cgh.2015.10.008.

Underuse and Overuse of Colonoscopy for Repeat Screening and Surveillance in the Veterans Health Administration

Caitlin C. Murphy, MPH[1], **Robert S. Sandler, MD, MPH**[1,2], **Janet M. Grubber, MSPH**[3,4], **Marcus R. Johnson, MPH, MBA, MHA**[3,5], and **Deborah A. Fisher, MD, MHS**[3,4]

[1]Department of Epidemiology, University of North Carolina at Chapel Hill, Chapel Hill, NC

[2]Center for Gastrointestinal Biology and Disease, University of North Carolina at Chapel Hill

[3]Durham VA Health Services Research and Development Center, Durham, NC

[4]Duke University Medical Center, Durham, NC

[5]VA Cooperative Studies Program Epidemiology Center, Durham, NC

Abstract

Background & Aims—Regular screening with colonoscopy lowers colorectal cancer incidence and mortality. We aimed to determine patterns of repeat and surveillance colonoscopy and identify factors associated with over- and underuse of colonoscopy.

Methods—We analyzed data from participants in a previous Veterans Health Administration (VHA) study who underwent outpatient colonoscopy at 25 VHA facilities between October 2007 and September 2008 (n=1455). The proportion of patients who received a follow-up colonoscopy was calculated for 3 risk groups, defined based on the index colonoscopy: no adenoma, low-risk adenoma, or high-risk adenoma.

Results—Colonoscopy was overused (used more frequently than intervals recommended by guidelines) by 16% of patients with no adenomas, 26% with low-risk adenomas, and 29% with high-risk adenomas. Most patients with high-risk adenomas (54%) underwent colonoscopy after the recommended interval or did not undergo colonoscopy. Patients who received a follow-up recommendation that was discordant with guidelines were more likely to undergo colonoscopy too

Correspondence: Caitlin C. Murphy, MPH, Department of Epidemiology, Gillings School of Public Health, The University of North Carolina at Chapel Hill, 135 Dauer Drive, 2101 McGavran-Greenberg Hall, CB #7435, Chapel Hill, NC 27599, caitlin_murphy@med.unc.edu.

Author conflicts of interest: none

Author financial disclosures: none

Author contributions:
Study concept and design: C.C. Murphy, R.S. Sandler, D.A. Fisher
Acquisition of data: J.M. Grubber, M.R. Johnson, D.A. Fisher
Analysis and interpretation of data: C.C. Murphy, R.S. Sandler, J.M. Grubber, D.A.
Fisher Drafting of the manuscript: C.C. Murphy
Critical revision of the manuscript: C.C. Murphy, R.S. Sandler, J.M. Grubber, M.R. Johnson, D.A. Fisher

early (no adenoma odds ratio [OR], 3.80; 95% CI, 2.31–6.25 and low-risk adenoma OR, 5.28; 95% CI, 1.88–14.83). Receipt of colonoscopy at non-academic facilities was associated with overuse among patients without adenomas (OR, 5.26; 95% CI, 1.96–14.29) or with low-risk adenomas (OR, 3.45; 95% CI, 1.52–7.69). Performance of colonoscopies by general surgeons vs gastroenterologists (OR, 2.08; 95% CI, 1.02–4.23) and female sex of the patient (OR, 3.28; 95% CI, 1.06–10.16) were associated with overuse of colonoscopy for patients with low-risk adenomas. No factors examined were associated with underuse of colonoscopy among patients with high-risk adenomas.

Conclusions—In an analysis of patients in the VHA system, more than a quarter of patients with low-risk adenomas received a follow-up colonoscopies too early, whereas more than half of those with high-risk adenomas did not undergo surveillance colonoscopy as recommended. Our findings highlight the need for system-level improvements to facilitate the appropriate delivery of colonoscopy based on individual risk.

Keywords

endoscopy; colon cancer; detection; tumor

Background

Colorectal cancer (CRC) screening is endorsed as an effective preventive service because it facilitates removal of adenomatous polyps and lowers CRC incidence and mortality.[1] In contrast to other cancer screening tests (e.g., mammography, prostate-specific antigen testing), where there is controversy regarding if and when to screen, the value of CRC screening is widely recognized.[2] Since the 1990s, both CRC incidence and mortality have declined,[3] and a substantial proportion of this improvement has been attributed to regular screening.[4] Cross-sectional data from both the National Health Interview Survey and Behavioral Risk Factor Surveillance System show an increase in overall screening use, from 43% in 2000 to 65% in 2010.[5–8] Most of the increase in CRC screening has been due to increased use of colonoscopy.[9]

Although a large research effort has focused on CRC screening initiation,[10] relatively little attention has been paid to patterns of repeat screening and surveillance. Many patients who undergo screening colonoscopy have low- or high-risk adenomas that require removal and surveillance colonoscopy.[11] Current guidelines[12] recommend surveillance colonoscopy at 3 years for high-risk adenomas (including size ≥10mm, high grade dysplasia, or ≥3 adenomas) and at 5–10 years for low-risk adenomas (1 or 2 adenomas each <10mm). For those with no or hyperplastic polyps, guidelines recommend continuing average-risk screening with the next colonoscopy in 10 years. Potential deviation from screening guidelines includes both over- and underuse of repeat colonoscopy. Overuse of colonoscopy is concerning because it can increase risk of adverse events (e.g., bleeding, perforation), increase healthcare costs, and reduce the capacity for appropriate colonoscopy in underscreened populations.[13–17] Underuse of surveillance colonoscopy for those at higher risk has only recently been recognized as a potential missed opportunity for CRC prevention.[18–20]

The economic and healthcare burden of CRC screening and surveillance is considerable. A greater effort is needed to ensure colonoscopy services are delivered at the appropriate intervals and to eligible patients. This is especially important as recent changes in healthcare policy place a higher emphasis on the value of preventive services.[21] The purpose of this study was to describe patterns of repeat screening and surveillance colonoscopy use in a population-based sample of veterans and to identify factors associated with over- and underuse of colonoscopy.

Methods

Patients and Procedures

Patients were identified from a larger study[22] on physician adherence to repeat colonoscopy guidelines for screening and polyp surveillance in a sample of medical facilities in the Veterans Health Administration (VHA). Details of the study have been previously reported.[25] Briefly, patients who underwent an outpatient screening colonoscopy between October 2007 and September 2008 were sampled from 25 medical facilities representative of the geographic distribution, academic affiliation, and complexity level (a VHA measure of facility resources and medical complexity of Veterans seen) of all eligible VHA facilities. Patients were sampled from strata of facility, race, and sex, with oversampling of women and minorities. All patients were age 50–64 years at the index colonoscopy and had no history of CRC, inflammatory bowel disease, or colonoscopy during the 10 years preceding the index screening. Patients with inadequate bowel preparation or piecemeal polyp resection were also excluded. Medical records were manually abstracted for pathology results of the index colonoscopy. Eligible patients (n=1,455) were classified into the following clinical risk groups: no polyps/normal tissue, hyperplastic polyps only, low-risk adenomas (1 or 2 adenomatous polyps each <10mm), and high-risk adenomas (including 3 or more adenomatous polyps, any adenomatous polyp ≥10mm, or any adenomatous polyp with high grade dysplasia). Villous architecture was not included in the definition of high-risk adenomas because patients underwent an index colonoscopy between 2007 and 2008, where the information and references included in the 2006 polyp guidelines were still relevant.[11] Further, in our pilot work,[22] we found the proportion of villous architecture was rarely included in pathology results.

Repeat colonoscopy recommendations, as documented by the treating endoscopist, were abstracted from patient medical records after pathology results from the index colonoscopy were recorded. VHA policy requires documentation of patient communication of pathology results within 14 days of the procedure; follow-up recommendations were included in a variety of locations, including the endoscopy report (if no tissue was removed), progress notes, patient follow-up letters, and addendums to the endoscopy report.[22]

To determine use of repeat colonoscopy after the index screening, the presence of a colonoscopy procedure code (Current Procedural Terminology© codes 44388, 44389, 44390, 44391, 44392, 44393, 44394, 44395, 44396, 44397, 45355, 45378, 45379, 45380, 45381, 45382, 45383, 45384, 45385, 45386, 45387, 45394, 45397, G0105, G0121; International Classification of Diseases, Ninth Edition codes V7641, V7650, V7651) from October 2008 through September 2014 was obtained from VHA administrative claims

databases. Algorithms using these codes have been shown to accurately capture utilization of colonoscopy in the VHA.[23,24] Colonoscopy receipt allow was classified as early (i.e., overuse), on time/appropriate, or late (i.e., underuse). We included a 2-month grace period around guidelines intervals when classifying colonoscopy (e.g., 4 years and 10 months to 5 years and 2 months instead of 5 years exactly) to allow for some flexibility in patient scheduling of follow-up exams. Among patients with no adenoma, early colonoscopy included any colonoscopy received during the study period (i.e., because the follow-up period was 6 years, a colonoscopy that occurred during the study period was before the recommended 10-year interval). In the low-risk adenoma group, early colonoscopy was defined as a colonoscopy within 4 years and 10 months of the index screening. On time colonoscopies included a colonoscopy received from 4 years and 10 months after the index screening through the end of the study period or no colonoscopy. For patients with high-risk adenomas, early colonoscopies were defined as a colonoscopy within 2 years and 10 months of the index screening. On time colonoscopies were considered those received from 2 years and 10 months to 4 years and 2 months after the index screening. A late colonoscopy was defined as a colonoscopy received later than 4 years and 2 months after the index screening or no colonoscopy.

Statistical Analysis

Descriptive statistics (frequencies, weighted proportions and means) were used to examine patient-, physician-, and system-level characteristics by clinical risk group. Proportions and means were estimated with stratum-specific sample weights to account for the complex survey design. Sample weights were calculated as the inverse of the sampling proportion for each sampling stratum. Standard errors were obtained using the Taylor linearization method for robust variance estimation of descriptive statistics and regression parameters.

Patient characteristics included sex (male vs. female), race/ethnicity (non-Hispanic white vs. other), age, and comorbidity. Comorbidity was scored using the Charlson comorbidity index with New Jersey Medicare Data weights.[25,26] Physician characteristics included specialty (gastroenterology, general surgery, internal medicine, other) and repeat colonoscopy recommendation at the index screening (adherent vs. non-adherent). Follow-up recommendations were considered non-adherent if the recommendation was for any interval other than 10 years for no adenomas, less than 5 years or greater than 10 years for low risk adenomas, and other than 3 years for high risk adenomas. System-level characteristics included academic affiliation (academic vs. non-academic), facility complexity level (high vs. medium/low), and geographic region (Northeast, Midwest, South, West). Facility complexity level was determined by characteristics of the patient population, clinical services offered, education and research missions, and administrative complexity, as described in the 2012 VHA Facility Quality and Safety Report.[27]

Within each clinical risk group, we described characteristics of patients who underwent colonoscopy early (i.e., overuse), on time (i.e., guideline adherent), and late (i.e., underuse). We then used logistic regression models with stratum-specific sample weights to identify factors associated with underuse and overuse of repeat colonoscopy. Separate regression models were developed for the no adenoma (n=1,096), low-risk adenoma (n=231), and high-

risk adenoma (n=128) groups. The no adenoma group combined patients with normal findings and hyperplastic polyps only on the index screening because the recommendation for repeat colonoscopy is the same for both risk groups. Overuse of colonoscopy was assessed as the dependent variable for the no adenoma and low-risk adenoma risk groups, and underuse was the dependent variable in the high-risk adenoma group. Associations between independent variables and colonoscopy overuse or underuse are reported as odds ratios (OR) and 95% confidence intervals (CI).

Secondary Analysis—To account for the possibility that colonoscopies may have been performed outside the VHA among Medicare-eligible patients, we conducted a secondary analysis that examined the proportion of patients who received a colonoscopy too early, on time, and too late in each clinical risk group by age. We compared colonoscopy use among patients tuning age 65 during the study period (i.e., were age 59–64 at the index colonoscopy) to those who remained younger than age 65 in all years of follow-up.

Statistical analyses were conducted using SAS version 9.2 (SAS Institute, Cary, NC) and SUDAAN version 11.0 (Research Triangle Institute, Raleigh, NC).

Results

Characteristics of the study population by clinical risk group are shown in Table 1. No adenoma, low risk adenoma, and high risk adenoma groups were similar with respect to age and comorbidity score. The majority of patients were male, and a greater proportion of males and non-Hispanic whites had high or low risk adenomas compared to females or other racial/ethnic groups. A larger proportion of low-risk (54.8%) and high-risk (49.2%) adenoma patients received non-adherent recommendations for follow-up after the index colonoscopy than did patients without adenomas (31.8%).

No Adenoma

Among patients with no adenomas, 208 (16.4%) received a repeat colonoscopy too early, and 888 (83.6%) did not receive a colonoscopy during the study period and were considered guideline adherent (Table 2). Patients who received a non-adherent recommendation for follow-up at the index colonoscopy (OR 3.80, 95% CI 2.31–6.25) or were treated in a non-academically affiliated facility (OR 5.26, 95% CI 1.96–14.29) had higher odds of receiving colonoscopy early (Table 3) compared to patients who received an adherent recommendation or were treated in an academically-affiliated facility.

Low-Risk Adenoma

Over one-quarter (26.4%) of low-risk adenoma patients received a follow-up colonoscopy less than five years after the index screening. The remaining proportion (73.6%) either received a follow-up colonoscopy more than five years after the index screening or did not receive a colonoscopy during the study period (Table 2). Patients who were female (OR 2.08, 95% CI 1.02–4.23), received a non-adherent recommendation for follow-up at the index colonoscopy (OR 5.28, 95% CI 1.88–14.33), or were treated in a non-academically affiliated facility (OR 3.45, 95% CI 1.52–7.69) were more likely to receive a follow-up

colonoscopy too early (Table 4). General surgery (vs. gastroenterology) physician specialty (OR 3.28, 95% CI 1.06–10.16) was also associated with colonoscopy overuse in the low-risk adenoma group.

High-Risk Adenoma

Of patients with high-risk adenomas, the majority (54.1%) received a follow-up colonoscopy greater than three years after the index screening or did not receive a follow-up colonoscopy. Only 17.3% of patients received a colonoscopy on time, and 28.7% received a colonoscopy too early (Table 2). No variables were significantly associated with underuse of colonoscopy in logistic models comparing patients who received colonoscopy late to patients who underwent colonoscopy on time (Table 5). Similar results were observed when underuse was compared to appropriate use and overuse combined (results not shown).

Results of the secondary analysis that examined the proportion of patients who received a colonoscopy too early, on time, and too late in each clinical risk group by age are shown in Supplementary Table 1. In the high-risk adenoma group, colonoscopy underuse was higher in the Medicare-eligible subgroup (59.5%) compared to patients younger than age 65 (47.5%), although the difference was not statistically significant (p=0.55). The proportion of patients who received a colonoscopy too early was similar among younger patients in both the no adenoma (age <65: 18.7% vs. age ≥65: 14.0%, p=0.12) and low-risk adenoma (age <65: 29.0% vs. age ≥65: 23.7%, p=0.55) groups.

Discussion

Our results suggest deviations from guideline recommendations for follow-up and surveillance colonoscopy include both under- and overuse of colonoscopy. For both the no adenoma and low-risk adenoma groups, patients who received a non-adherent recommendation for follow-up at the index screening were more likely to receive colonoscopy too early. Findings from our earlier study showed more than one-third of physicians recommend repeat colonoscopy be performed earlier than guidelines suggest.[22] Others similarly report only a minority of endoscopists give follow-up recommendations consistent with clinical guidelines,[14,16,28] with many instead favoring shorter follow-up intervals. In a survey[17] of a nationally representative sample of gastroenterologists and surgeons regarding their attitudes toward frequency of surveillance after polypectomy, physicians frequently recommended surveillance colonoscopy earlier than specified by guidelines. Other physician surveys[29–31] show many endoscopists either lack knowledge regarding follow-up recommendations or disagree with guidelines. Most of these studies focus exclusively on recommendations and lack follow-up data on whether patients undergo repeat exams, which precludes the ability to examine the association between physician recommendation and colonoscopy receipt. Our study extends the findings of previous research by demonstrating that, not only do physicians consistently deviate from guidelines when making recommendations, but that those recommendations are the primary driver of undergoing colonoscopy. Targeting endoscopists' recommendation for follow-up (e.g., by requiring clinical justification of intervals not aligned with guidelines) may be an effective strategy to improve appropriate receipt of colonoscopy.

Overuse of colonoscopy in the no adenoma and low-risk adenoma groups was also associated with non-academically affiliated facilities. Non-adherent physician recommendations, patient age, and comorbidity were similar across academic and non-academic facilities.[22] A non-academic affiliation also does not imply lower patient volume, and there is no financial incentive for colonoscopy in any VHA facility, regardless of academic affiliation. Rather, there may be important differences in the organization and delivery of healthcare in non-academic settings that contribute to inappropriate use of colonoscopy. One possibility is that primary care providers in the community are more likely to manage specialty care and have responsibility for a broader range of services.[32] In our study, gastroenterology was the predominant physician specialty in academic facilities (57%), whereas general surgery was more common in non-academic facilities (57%). This difference is also consistent with our finding that general surgery (vs. gastroenterology) was associated with colonoscopy overuse in the low-risk adenoma group. There are likely also differences in reminder and audit systems across academic and non-academic clinics in the VHA. Most VHA facilities have an average-risk CRC screening reminder, but only some have a colonoscopy reminder system for adenoma or cancer surveillance.

Although we observed some overuse of colonoscopy in normal and low-risk patients, a larger proportion of patients with high-risk adenomas did not receive follow-up colonoscopy at the recommended interval. More than half of patients with multiple or advanced adenomas either received surveillance colonoscopy too late or did not undergo colonoscopy up to six years after the index screening. Previous research[19] of participants in the Prostate, Lung, Colorectal, and Ovarian (PLCO) cancer screening trial shows 27% of trial participants with advanced adenomas did not undergo surveillance colonoscopy within seven years. The higher prevalence of colonoscopy underuse (54%) in our study may be due to differences in the patient populations, where patient motivation to participate in clinical trials such as PLCO is likely to positively affect adherence. In addition, none of the explanatory variables in our study were associated with underuse of colonoscopy among higher risk patients. Non-adherent physician recommendations for follow-up and treatment in non-academically affiliated clinics were associated with overuse only in the no and low-risk adenoma groups. There may be other reasons for underuse of surveillance colonoscopy among patients with high risk adenomas not captured in our data.

A limitation of the study is our inability to fully explain reasons for over- and underuse of colonoscopy during the study period that may be due to patient or physician preferences or inadequacies in the healthcare system. For example, the large number of patients with high-risk adenomas who did not receive colonoscopy may be related to a lack of systematic monitoring of when repeat colonoscopy should be performed. Although scheduling and wait times may prohibit some patients from obtaining colonoscopy on time, our data showed only a 5% increase in colonoscopy use among high-risk adenoma patients in the three years after it was due. This is likely not a problem of access or delayed care (i.e., where more colonoscopies would be expected in years 4–6) but could indicate patients are not in contact with the healthcare system regarding follow-up. Another possibility is that patients who turned 65 during the follow-up period may have received a colonoscopy covered under Medicare outside the VHA. This limitation highlights the difficulty of accurately assessing the number of individuals receiving any colonoscopy across healthcare systems. However,

results of our sensitivity analysis suggest underuse was still high (48%) among younger patients with high-risk adenomas (i.e., those age 50–58 at the index colonoscopy who did not become eligible for Medicare), and only a minority (24%) were classified as on time. There were also some older patients who underwent colonoscopy on time or early, suggesting many dual-eligible patients continue to seek care related to polyp surveillance in the VHA. Better measurement of colonoscopy use, especially among patients who are dual-eligible, may be facilitated by cross-talk of electronic health records between different healthcare systems. There may also be patient or physician preferences for early use of colonoscopy (e.g., patient symptoms) that account for some of the variation we observed in overuse. We were not able to distinguish between colonoscopies performed for diagnostic reasons and routine follow-up. Finally, characteristics of the VHA population (e.g., majority male, access to health benefits) may not be generalizable to other populations, and there may be different patterns of follow-up colonoscopy use in other clinical settings. Because there are no financial incentives to perform more frequent colonoscopies in the VHA, the results may underestimate the use of follow-up colonoscopy in systems where financial incentives influence colonoscopy performance.

Our study also has several strengths. Few studies have been able to examine appropriate receipt of surveillance colonoscopy because it requires long periods of observation in a relatively closed healthcare system. We used a complex sampling strategy to obtain a representative sample of patients seeking care in an integrated delivery system and had follow-up data after the index screening. In addition, because there is no method or algorithm to identify the presence of adenoma in administrative data, claims-based analyses have been limited in their ability to classify patients by clinical risk group. Polypectomy is often used as a proxy measure for adenoma removal,[18] but this may not accurately capture the number of patients who are eligible for shorter follow-up intervals. We had detailed pathology reports at the index screening that allowed us to determine whether the timing of repeat colonoscopy was guideline-appropriate based on clinical risk. We also had information on physician recommendation for follow-up and were able to establish its importance in relation to receipt of colonoscopy. Although many studies report physicians frequently recommend follow-up intervals in excess of guidelines, the relevance of physician recommendation in predicting colonoscopy completion has not been extensively evaluated.

In summary, the results of this study paint a complex picture of colonoscopy overuse and underuse. Our findings highlight the need for system-level improvements that may facilitate appropriate delivery of repeat colonoscopy. Enhancing existing information systems to systematically track patients by clinical risk group could identify patients eligible for surveillance colonoscopy when testing is due. Reminder and recall systems can be set to guideline-recommended intervals that alert both physicians and patients to schedule colonoscopy. Other changes include computer prompts or lock-outs, which prohibit physicians from ordering inappropriate procedures without override. As healthcare reform continues to emphasize the value of preventive services, such as colonoscopy, these improvements are critical to maximizing the value and benefit of CRC surveillance strategies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Grant Support: National Institutes of Health Grant T32 DK07643

Abbreviations

CRC	colorectal cancer
VHA	Veterans Health Administration

References

1. Zauber AG, Lansdorp-Vogelaar I, Knudsen AB, et al. Evaluating test strategies for colorectal cancer screening: a decision analysis for the U.S. Preventive Services Task Force. Ann Intern Med. 2008; 149:659–69. [PubMed: 18838717]
2. Maciosek MV, Solberg LI, Coffield AB, et al. Colorectal cancer screening: health impact and cost effectiveness. Am J Prev Med. 2006; 31:80–9. [PubMed: 16777546]
3. Siegel R, Desantis C, Jemal A. Colorectal cancer statistics, 2014. CA Cancer J Clin. 2014; 64:104–17. [PubMed: 24639052]
4. Edwards BK, Ward E, Kohler BA, et al. Annual report to the nation on the status of cancer, 1975–2006, featuring colorectal cancer trends and impact of interventions (risk factors, screening, and treatment) to reduce future rates. Cancer. 2010; 116:544–73. [PubMed: 19998273]
5. Increased use of colorectal cancer tests–United States, 2002 and 2004. MMWR Morb Mortal Wkly Rep. 2006; 55:308–11. [PubMed: 16557215]
6. Shapiro JA, Seeff LC, Thompson TD, et al. Colorectal cancer test use from the 2005 National Health Interview Survey. Cancer Epidemiol Biomarkers Prev. 2008; 17:1623–30. [PubMed: 18628413]
7. Shapiro JA, Klabunde CN, Thompson TD, et al. Patterns of colorectal cancer test use, including CT colonography, in the 2010 National Health Interview Survey. Cancer Epidemiol Biomarkers Prev. 2012; 21:895–904. [PubMed: 22490320]
8. Seeff LC, Nadel MR, Klabunde CN, et al. Patterns and predictors of colorectal cancer test use in the adult U.S. population. Cancer. 2004; 100:2093–103. [PubMed: 15139050]
9. Klabunde CN, Cronin KA, Breen N, et al. Trends in colorectal cancer test use among vulnerable populations in the United States. Cancer Epidemiol Biomarkers Prev. 2011; 20:1611–21. [PubMed: 21653643]
10. Vernon SW. Participation in colorectal cancer screening: a review. J Natl Cancer Inst. 1997; 89:1406–22. [PubMed: 9326910]
11. Winawer SJ, Zauber AG, Fletcher RH, et al. Guidelines for colonoscopy surveillance after polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer and the American Cancer Society. Gastroenterology. 2006; 130:1872–85. [PubMed: 16697750]
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]
13. Warren JL, Klabunde CN, Mariotto AB, et al. Adverse events after outpatient colonoscopy in the Medicare population. Ann Intern Med. 2009; 150:849–57. w152. [PubMed: 19528563]
14. Goodwin JS, Singh A, Reddy N, et al. Overuse of screening colonoscopy in the Medicare population. Arch Intern Med. 2011; 171:1335–43. [PubMed: 21555653]

15. Partin MR, Powell AA, Bangerter A, et al. Levels and variation in overuse of fecal occult blood testing in the Veterans Health Administration. J Gen Intern Med. 2012; 27:1618–25. [PubMed: 22810358]
16. Kruse GR, Khan SM, Zaslavsky AM, et al. Overuse of Colonoscopy for Colorectal Cancer Screening and Surveillance. J Gen Intern Med. 2015; 30(3):277–83. [PubMed: 25266407]
17. Mysliwiec PA, Brown ML, Klabunde CN, et al. Are physicians doing too much colonoscopy? A national survey of colorectal surveillance after polypectomy. Ann Intern Med. 2004; 141:264–71. [PubMed: 15313742]
18. Cooper GS, Kou TD, Barnholtz Sloan JS, et al. Use of colonoscopy for polyp surveillance in Medicare beneficiaries. Cancer. 2013; 119:1800–7. [PubMed: 23436321]
19. Schoen RE, Pinsky PF, Weissfeld JL, et al. Utilization of surveillance colonoscopy in community practice. Gastroenterology. 2010; 138:73–81. [PubMed: 19818779]
20. Murphy CC, Lewis CL, Golin CE, et al. Underuse of surveillance colonoscopy in patients at increased risk of colorectal cancer. Am J Gastroenterol. 2015; 110(5):633–641. [PubMed: 25384901]
21. Koh HK, Sebelius KG. Promoting prevention through the Affordable Care Act. N Engl J Med. 2010; 363:1296–9. [PubMed: 20879876]
22. Johnson MR, Grubber J, Grambow SC, et al. Physician non-adherence to colonoscopy interval guidelines in the Veterans Affairs Healthcare System. Gastroenterology. 2015 Epub 26 June 2015.
23. El-Serag HB, Petersen L, Hampel H, et al. The use of screening colonoscopy for patients cared for by the Department of Veterans Affairs. Arch Intern Med. 2006; 166:2202–8. [PubMed: 17101937]
24. Fisher DA, Grubber JM, Castor JM, et al. Ascertainment of colonoscopy indication using administrative data. Dig Dis Sci. 2010; 55:1721–5. [PubMed: 20393875]
25. Gagne JJ, Glynn RJ, Avorn J, et al. A combined comorbidity score predicted mortality in elderly patients better than existing scores. J Clin Epidemiol. 2011; 64:749–59. [PubMed: 21208778]
26. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care. 2005; 43:1130–9. [PubMed: 16224307]
27. Department of Veteran Affairs. VHA Facility Quality and Safety Report 2012. 2012. http://www.va.gov/HEALTH/docs/2012_VHA_Facility_Quality_and_Safety_Report_FINAL508.pdf
28. Krist AH, Jones RM, Woolf SH, et al. Timing of repeat colonoscopy: disparity between guidelines and endoscopists' recommendation. Am J Prev Med. 2007; 33:471–8. [PubMed: 18022063]
29. Shah TU, Voils CI, McNeil R, et al. Understanding gastroenterologist adherence to polyp surveillance guidelines. Am J Gastroenterol. 2012; 107:1283–7. [PubMed: 22951869]
30. Saini SD, Nayak RS, Kuhn L, et al. Why don't gastroenterologists follow colon polyp surveillance guidelines?: results of a national survey. J Clin Gastroenterol. 2009; 43:554–8. [PubMed: 19542818]
31. Yabroff KR, Klabunde CN, Yuan G, et al. Are physicians' recommendations for colorectal cancer screening guideline-consistent? J Gen Intern Med. 2011; 26:177–84. [PubMed: 20949328]
32. Zapka JG, Lemon SC. Interventions for patients, providers, and health care organizations. Cancer. 2004; 101:1165–87. [PubMed: 15329892]

Table 1

Baseline characteristics of the study population by clinical risk group (n=1,455)

	No Adenoma (n=1,096)		Low Risk Adenoma (n=231)		High Risk Adenoma (n=128)	
	n	**wt %**	**n**	**wt %**	**n**	**wt %**
Age (mean, SE)	57.4 (0.26)		57.5 (0.26)		58.0 (0.50)	
Sex						
Male	851	92.3	202	95.6	117	95.9
Female	245	7.8	29	4.4	11	4.2
Race						
Non-Hispanic white	866	72.5	181	76.6	106	81.4
Other	230	27.5	50	23.4	22	18.6
Comorbidity score (mean, SE)	1.2 (0.07)		1.0 (0.11)		1.1 (0.15)	
Physician[1] Specialty						
Gastroenterology	530	64.3	132	66.8	69	62.1
General Surgery	279	15.4	27	4.9	12	7.3
Internal Medicine	111	9.2	40	21.3	21	15.9
Other	176	11.1	32	7.1	26	14.8
Physician[1] years in practice (mean, SE)	25.1 (1.30)		22.0 (1.38)		21.9 (1.96)	
Follow-up Recommendation						
Adherent	737	68.3	124	45.2	62	50.8
Non-adherent	359	31.8	107	54.8	66	49.2
Academic affiliation						
Academic	925	93.7	204	96.2	113	94.8
Non-academic	171	6.3	27	3.8	15	5.2
Complexity level[2]						
Low/medium	558	28.5	84	17.8	56	24.4
High	538	71.5	147	82.2	72	75.7
Geographic region						
Midwest	272	21.1	67	31.8	45	41.0
Northeast	187	12.7	70	21.0	32	17.5

Clin Gastroenterol Hepatol. Author manuscript; available in PMC 2017 March 01.

	No Adenoma (n=1,096)		Low Risk Adenoma (n=231)		High Risk Adenoma (n=128)	
	n	wt %	n	wt %	n	wt %
South	433	48.0	50	23.4	37	33.4
West	204	18.2	44	23.7	14	8.1

NOTE: Proportions weighted by sampling fraction; column percentages displayed in table

Abbreviations: wt, weighted; SE, standard error

[1]There were 149 unique physicians that performed the 1,455 colonoscopies across 25 VHA facilities

[2]Complexity level was determined by characteristics of the patient population, clinical services offered, education and research missions, and administrative complexity[27]

Table 2

Receipt of follow-up colonoscopy by clinical risk group and study year (n=1,455)

Clinical Risk Group	Colonoscopy ≤ 1 year	Colonoscopy at Year 2	Colonoscopy at Year 3	Colonoscopy at Year 4	Colonoscopy at Year 5	Colonoscopy at Year 6	No Colonoscopy
Normal/Hyperplastic Only (n=1,096) Due in 10 years	46 (2.9%)	23 (1.9%)	31 (2.4%)	36 (2.7%)	53 (4.6%)	19 (1.9%)	888 (83.6%)
Low Risk Adenoma (n=231) Due in 5–10 years	21 (7.8%)	14 (5.8%)	28 (10.5%)	10 (2.3%)[1]	38 (16.2%)[2]	13 (6.9%)	107 (50.5%)
High Risk Adenoma (n=128) Due in 3 years	29 (22.6%)	5 (6.1%)[1]	24 (17.3%)[3]	8 (4.9%)[4]	10 (7.0%)	1 (0.9%)	51 (41.3%)

NOTE: Clinical risk group based on index colonoscopy; proportions weighted by sampling fraction

[1] Excludes colonoscopies performed in the 11th and 12th month of the year; these are included in the next year's cell count based on the definition of on time/appropriate colonoscopy for the risk group (see "Methods")

[2] Includes colonoscopies performed in the 11th and 12th month of Year 4 based on the definition of on time/appropriate colonoscopy for the low risk adenoma group

[3] Includes colonoscopies performed in the 11th and 12th month of Year 2 through the 1st and 2nd month of Year 4 based on the definition of on time/appropriate colonoscopy for the high risk adenoma group

[4] Excludes colonoscopies performed in the 1st and 2nd month of Year 4 based on the definition of on time/appropriate colonoscopy for the high risk adenoma group

Overuse

Appropriate Use

Underuse

Table 3

Factors associated with overuse of colonoscopy for patients with no adenomas[1] at baseline (n=1,096)

	Appropriate Use[2] (n=888)		Overuse[3] (n=208)		OR (95% CI)
	n	wt %	n	wt %	
Age (mean, SE)	57.5 (0.29)		56.9 (0.42)		0.97 (0.91—1.03)
Sex					
Male	678	83.4	173	16.6	1.00
Female	210	84.9	35	15.1	0.89 (0.38—2.09)
Race					
Non-Hispanic white	697	82.3	169	17.7	1.00
Other	191	86.9	39	13.1	0.70 (0.36—1.35)
Comorbidity score (mean, SE)	1.1 (0.08)		1.3 (0.10)		1.09 (0.99—1.19)
Physician Specialty					
Gastroenterology	439	84.8	91	15.3	1.00
General surgery	227	82.2	52	17.8	1.21 (0.48—3.02)
Internal medicine	89	81.7	22	18.3	1.25 (0.60—2.60)
Other	133	80.1	43	19.9	1.38 (0.63—3.04)
Provider years in practice (mean, SE)	2	4.7 (1.35)		27.2 (1.76)	1.01 (0.99—1.04)
Follow-up recommendation					
Adherent	638	89.9	99	10.1	1.00
Non-adherent	250	70.0	109	30.0	3.80 (2.31—6.25)
Academic affiliation					
Academic	772	85.6	153	14.4	1.00
Non-academic	116	53.4	55	46.6	5.26 (1.96—14.29)
Complexity level					
High	455	85.4	83	14.6	1.00
Low/medium	433	78.9	125	21.1	1.57 (0.74—3.33)
Geographic region					
Midwest	221	85.1	51	14.9	1.00
Northeast	146	74.4	41	25.6	1.97 (0.59—6.56)
South	354	86.5	79	13.5	0.89 (0.31—2.58)

	Appropriate Use[2] (n=888)		Overuse[3] (n=208)		OR (95% CI)
	n	wt %	n	wt %	
West	167	80.3	37	19.8	1.41 (0.55—3.57)

Abbreviations: wt, weighted; OR, odds ratio (unadjusted); SE, standard error

NOTE: Proportions weighted by sampling fraction; row percentages displayed in table

[1] No adenomas includes normal findings or hyperplastic polyps only on the index colonoscopy

[2] Appropriate use defined as no receipt of follow-up colonoscopy during the 6-year study period

[3] Overuse defined as any receipt of colonoscopy during the 6-year study period

Clin Gastroenterol Hepatol. Author manuscript; available in PMC 2017 March 01.

Table 4

Factors associated with overuse of colonoscopy for patients with low risk adenomas at baseline (n=231)

	Appropriate Use[1] (n=158)		Overuse[2] (n=73)		OR (95% CI)
	n	wt %	n	wt %	
Age (mean, SE)		57.7 (0.35)		56.9 (0.76)	0.96 (0.85—1.08)
Sex					
Male	141	74.3	61	25.7	1.00
Female	17	58.1	12	41.9	2.08 (1.02—4.23)
Race					
Non-Hispanic white	119	73.2	62	26.8	1.00
Other	39	74.6	11	25.4	0.93 (0.30—2.94)
Comorbidity score (mean, SE)		0.9 (0.11)		1.1 (0.17)	1.09 (0.90—1.33)
Physician Specialty					
Gastroenterology	98	78.2	34	21.8	1.00
General surgery	13	52.2	14	47.8	3.28 (1.06—10.16)
Internal medicine	27	67.3	13	32.7	1.74 (0.81—3.74)
Other	20	63.4	12	36.6	2.07 (0.66—6.46)
Provider years in practice (mean, SE)		22.3 (1.33)		21.2 (2.07)	0.99 (0.97—1.02)
Follow-up recommendation					
Adherent	105	87.4	19	12.6	1.00
Non-adherent	53	56.8	54	43.3	5.28 (1.88—14.83)
Academic affiliation					
Academic	146	74.6	58	25.4	1.00
Non-academic	12	46.3	15	53.7	3.45 (1.52—7.69)
Complexity level					
High	107	75.2	40	24.8	1.00
Low/medium	51	66.1	33	33.9	1.55 (0.57—4.23)
Geographic region					
Midwest	47	69.5	20	30.5	1.00
Northeast	49	68.4	21	31.6	1.05 (0.39—2.84)
South	29	68.9	21	31.1	1.03 (0.30—3.50)

	Appropriate Use[1] (n=158)		Overuse[2] (n=73)		OR (95% CI)
	n	wt %	n	wt %	
West	33	88.1	11	11.9	0.31 (0.11—0.90)

Abbreviations: wt, weighted; OR, odds ratio (unadjusted); SE, standard error

NOTE: Proportions weighted by sampling fraction; row percentages displayed in table

[1] Appropriate use defined as receipt of follow-up colonoscopy ≥5 years after index colonoscopy or no receipt of colonoscopy during the 6-year study period

[2] Overuse defined as receipt of follow-up colonoscopy <5 years after index colonoscopy

Clin Gastroenterol Hepatol. Author manuscript; available in PMC 2017 March 01.

Table 5

Factors associated with underuse of colonoscopy for patients with high risk adenomas at baseline (n=128)

	Underuse[2] (n=70)		Appropriate Use[3] (n=24)		Overuse[4] (n=34)		OR (95% CI)[5]
	n	wt %	n	wt %	n	wt %	
Age (mean, SE)	58.7(0.45)		57.5 (0.75)		56.9(1.35)		1.08 (0.93—1.26)
Sex							
Male	63	53.1	23	17.7	31	29.2	1.00
Female	7	75.7	1	7.3	3	17.0	3.45 (0.37—32.07)
Race							
Non-Hispanic white	56	55.0	21	18.5	29	26.5	1.00
Other	14	49.7	3	12.1	5	38.1	1.36 (0.21—8.68)
Comorbidity score (mean, SE)	1.0 (0.21)		0.8 (0.18)		1.3 (0.37)		1.13 (0.78—1.62)
Physician Specialty							
Gastroenterology	40	61.1	14	14.1	15	24.8	1.00
General surgery	7	33.9	1	7.4	4	58.7	1.05 (0.09—11.89)
Internal medicine	13	48.8	4	28.6	4	22.6	0.39 (0.11—1.42)
Other	10	39.7	5	23.4	11	37.0	0.39 (0.09—1.75)
Provider years in practice (mean, SE)	22.5 (2.54)		21.3 (3.48)		21.0 (2.65)		1.01 (0.94—1.08)
Follow-up recommendation							
Adherent	40	56.0	17	25.9	5	18.1	1.00
Non-adherent	30	52.0	7	8.4	29	39.6	2.85 (0.56—14.51)
Academic affiliation							
Academic	66	55.6	21	17.3	26	27.1	1.00
Non-academic	4	24.7	3	17.9	8	57.4	0.43 (0.10—1.89)
Complexity level							
High	43	58.3	13	17.6	16	24.1	1.00
Low/medium	27	40.8	11	16.3	18	42.9	0.75 (0.15—3.87)
Geographic region							
Midwest	27	60.3	6	15.4	12	24.3	1.00
Northeast	18	59.0	8	25.0	6	16.0	0.60 (0.07—5.14)
South	17	41.2	7	16.6	13	42.2	0.63 (0.08—5.24)

	Underuse[2] (n=70)		Appropriate Use[3] (n=24)		Overuse[4] (n=34)		OR (95% CI)[5]
	n	wt %	n	wt %	n	wt %	
West	8	64.2	3	13.3	3	22.5	1.23 (0.12—13.19)

Abbreviations: wt, weighted; OR, odds ratio (unadjusted); SE, standard error

NOTE: Proportions weighted by sampling fraction

[1] Unadujsted logistic regression compares underuse (n=70) to appropriate use (n=24); similar results were observed when overuse and appropriate use were combined in the analysis (not shown in table)

[2] Underuse defined as receipt of follow-up colonoscopy >3 years after index colonoscopy or no receipt of colonoscopy during the 6-year study period

[3] Appropriate use defined as receipt of follow-up colonoscopy 3 years after index colonoscopy

[4] Overuse defined as receipt of follow-up colonoscopy <3 years after index colonoscopy

[5] OR compares underuse of colonoscopy to appropriate use; similar results were observed when underuse was compared to appropriate use and overuse combined.