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Do indication and demographics for colonoscopy affect completion? A large national database evaluation

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Abstract

Background and aim—Indication for colonoscopy has not been examined as a predictor of colonoscopy completion. We hypothesized that colonoscopy conducted for colorectal cancer screening might have higher in completion rates than colonoscopy conducted for other indications.

Methods—The study design was a retrospective cohort. Colonoscopies recorded within the Clinical Outcomes Research Initiative database conducted between 1 January 2002 and 30 June 2003 were analyzed. Indication included: average-risk screening; surveillance; nonspecific abdominal symptoms; bleeding symptoms; or family history of colorectal carcinoma. Demographic factors and indication for colonoscopy were evaluated for the outcome of incomplete colonoscopy using logistic regression analysis.

Results—129,549 Colonoscopy procedures were analyzed. Average risk screening seemed to be protective for completion (relative risk: 0.69; 95% confidence interval: 0.63–0.75). Bleeding and nonspecific symptoms had higher risk of incomplete procedure compared to other indications. Males had higher completion rates compared to females (relative risk: 0.62; 95% confidence interval: 0.58–0.66). Community setting had higher completion rates compared to academic or Veteran's administration sites. Increasing age was associated with higher rate of incomplete colonoscopy.

Conclusion—Colonoscopy conducted for screening indication has comparable completion rates when compared with other indications. An overall completion rate of around 95% was noted in this study. This is the largest study to date verifying that completion rates are meeting recommended multisociety guidelines in the USA. Nonspecific abdominal symptoms in Caucasian population, female sex, advanced age, clinical setting, and ethnic groups African–American and Hispanic were found to have increased risk of incomplete procedure.

Keywords

cancer; colonoscopy; completion rate; screening; surveillance

Introduction

Overholt and Pollard [1] performed the first total colonoscopy using fiber optic colonoscope in 1966. Since then, colonoscopy is now one of the most common medical procedures in the USA. This is the only procedure that has potential for both finding and removing premalignant lesions throughout colon and rectum. The number of procedures performed is

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expected to increase as colonoscopy for screening of the asymptomatic population for colorectal cancer (CRC) increases. Starting in 2001, reimbursement for screening for Medicare beneficiaries has increased the number of procedures performed and is evidence that the procedure is now widely accepted as one of the best means to screen our aging population for CRC [2,3]. With increased utilization of colonoscopy for both diagnostic and therapeutic indications, there is increasing emphasis on the quality and completeness of the procedure [4,5]. Full colonoscopy has been shown to detect a significant number of lesions that would have been missed otherwise [6,7]. Also, completion rate is considered an important indicator of endoscopic competence. The US Multi-society Task Force on Colorectal Cancer recommended the target of 90% colonoscopy completion, 95% for screening examinations [4]. The task force recommended the goal of cecal intubation rates in all cases should be at least 90%.

The Clinical Outcomes Research Initiative (CORI) is a large multicenter endoscopic database utilized in many sites in the US Primary indication for each procedure is a required data entry field. In addition, in the case of colonoscopy, the endoscopist is asked for landmarks verifying cecal intubation. The database incorporates a variety of practice settings affording the opportunity to compare performance data between academic and nonacademic settings. With regard to indication for colonoscopy, bleeding indications, such as hematochezia and iron deficiency anemia, have a high positive predictive value for CRC, and large adenomas. Understanding of the positive predictive value of certain indications for identification of neoplasia by colonoscopists could affect their willingness to continue on with a difficult procedure and thus affect completion rates.

Few studies have focused on colonoscopy completion as the primary outcome. The aim of this study was to examine colonoscopy completion by indication for procedure. Second, the affect of demographics, procedure site, and presence of a trainee on completion were evaluated. We hypothesized that meaningful differences in colonoscopy completion exist based on indication of the procedure.

Methods

Clinical Outcomes Research Initiative

Based at Oregon Health and Science University, Portland, CORI was developed in 1995 and is a multicenter database with the goal to collect endoscopy data from diverse sites. During the study period, CORI was a consortium of 507 participating endoscopists at 61 practice sites. A computerized report generator is used to produce endoscopy reports and is electronically sent to a central data repository after removal of all identifiers. Colonoscopies conducted in adults, 20 years or more, between 1 January 2002 and 30 June 2003 with at least one of the indications of interest were eligible for analysis.

Study groups

We analyzed the data by using the following indication categories for colonoscopy: average risk screening, surveillance, nonspecific symptoms, bleeding, or family history. Colonoscopy has been recommended for these indications in practice [8].

1. Group 1: nonspecific abdominal symptoms. This group included patients with one or more of the following complaints: abdominal pain/bloating, diarrhea, constipation, and change in bowel habits as an indication were included. This excluded any procedures that also had bleeding as indication in this group. The clustering of symptoms into discrete groups has previously been used to examine colonic neoplasia in people with nonspecific gastrointestinal complaints, utilizing CORI data [9].

2. Group 2: routine/average risk asymptomatic screening colonoscopy. Patients who underwent colonoscopy only for indication of routine/average risk screening.
3. Group 3: surveillance for adenomatous polyps. This group included patients with prior history of adenomatous polyps and underwent colonoscopy as part of surveillance.
4. Group 4: family history of colorectal carcinoma. Patients with a family history of CRC as an indication for colonoscopy were included in this group.
5. Group 5: bleeding. Patients with anemia, iron deficiency without anemia, melena, hematochezia, or positive fecal occult blood test by either digital examination or standard home stool collection method were included in this group.

Data collection

CORI database was queried to identify colonoscopy procedures based on indication. For this study, data were collected between 1 January 2002 and 30 June 2003. A total of 129 549 colonoscopies were identified that fulfilled the criterion. The mandatory fields during data input in CORI included examination extent intended, extent reached, demographic data (age, sex, race/ethnicity), clinical setting (academic, community or veteran's hospital), and indication for the procedure. A complete examination was defined as one in which the cecum, terminal ileum, or ileum was reached. Exclusion criteria included lack of complete demographic data, and a prior intent by the endoscopist to reach a point anatomically distal to the cecum. We excluded 1071 patients from the dataset (n=881 in 2002 and n=190 in 2003, total n=1071) for which race or ethnicity data were not available. Overall, less than 2% procedures were excluded because of incomplete data entry with minimal loss of study data. This is similar to the prior rates observed using CORI database. Of note, multiple indications could be entered for the procedure but a primary indication was required.

Statistical analysis

We constructed a logistic regression model for the end- point of an incomplete colonoscopy. Backward stepwise selection was used with a retention criterion of 0.01. The adjusted relative risk (RR) of each outcome was calculated separately with 95% confidence intervals (CIs). We used the following hierarchy for multiple indications entered to calculate RR of incomplete colonoscopy: bleeding > family history > surveillance > screening > nonspecific symptoms. The quality of preparation for colonoscopy was also factored in the model. We grouped the preparation quality into four groups: excellent/good, fair, fair exam compromised/poor, and unknown based on defined CORI definitions. The significance of each predictor variable was assessed using a likelihood-ratio test statistic obtained from a logistic regression model. Pearson's χ^2 tests were used to calculate P values for descriptive data. All statistical analyses were performed with SAS v8.1 software (SAS Institute Inc., Cary, North Carolina, USA).

Results

Demographic data and clinical setting (Tables 1 and 2)

A total of 129,549 colonoscopies were identified during the study period. Table 1 shows the demographic characteristics of the study population based on colonoscopy indication. About 84.8% of the cohort was over the age of 50 years, and 53.5% were 60 years of age or older. Only 2% of the asymptomatic screening group was under 50 years of age. Sixty percent of the procedures conducted for family history of CRC were performed in patients under 60 years and 23.5% under 50 years of age. Among colonoscopies done for surveillance of adenomatous polyps, over 70% were done in patients 60 years or older. Twenty-one percent

of colonoscopies were performed for the indication of bleeding and 23% of colonoscopies for nonspecific abdominal complaints were performed in patients less than 50 years of age. Sex distribution in the study cohort was nearly equal with females comprising 48.3% of the cohort. Of those procedures with asymptomatic screening as an indication, 46% were female and 54% male. Among known polyp formers undergoing surveillance colonoscopy, 62.4% were male and 37.9% were females. Females comprised a higher percentage of the total number of procedures that were conducted for family history of CRC (55%), and those conducted for nonspecific abdominal symptoms (64%).

Ethnic distribution of the study cohort included Caucasian (86%), African–American (6.7%), Hispanic (5%), Asian/Pacific Islanders (1.3%), Native Americans (0.9%), and multiracial (0.2%). About 76.8% of procedures were conducted in the community setting, 13.7% academic centers, and 9.5% Veteran's administration (VA). A training fellow was present for 17,660 (13.7%) of the colonoscopies.

Table 2 shows the demographic characteristics in relation to clinical setting where colonoscopy was performed. The demographic features were similar for the various site types. One main exception was the sex distribution at Veteran's Administration Medical Center (VAMC) hospital where the proportion of females having colonoscopy was much lower than the proportions for the other practice settings (7.2% at VAMC as compared with 53.5 and 47.2% in community and academic centers, respectively). Training fellow participation in colonoscopy was much more common at academic settings (42.9%) and VA settings (60.8%) as compared with those of community setting (2.6%). Caucasian population constituted the main ethnic group in all clinical settings (86.4% in community, 83.7% in academic, and 85.3% at VAMC hospitals). Other ethnic groups including African–American (6.2% community, 7.5% academic, and 9.9% VAMC), Hispanic (5% community, 6% academic, and 3.6% VAMC), Asian (1.2% community, 2.4% academic, and 0.8% VAMC), Native American (1% community, 0.4% academic, and 0.3% VAMC), and multiracial (0.2% community, 0.1% academic, and 0.1% VAMC) were nearly equally distributed in the clinical settings. Colonoscopy preparation was also similar with the exception of slightly higher percentage of missing or unknown preparation quality in academic setting (Table 2).

Completion rates (Tables 3 and 4)

The overall completion rate for the study cohort was 95.3%. Table 3 shows completion rates by patient demographics, site type, and presence/absence of a fellow. Colonoscopy completion decreased with advancing age (< 50 years, 96%; ≥70 years, 93.6%; $P < 0.001$). Males had higher completion rates than females (females, 94.6%; males 96%, $P < 0.001$). Caucasians had a higher completion rate than all other ethnic groups, except for the multiracial group that only included 199 procedures (Caucasians 95.6%; African–American 93.5%; Hispanic 93%; Native American 94.7%; Asian 95.9%; and multi-racial 97%). Community sites had a higher completion rate than both academic and veteran's affairs sites. Overall completion rate at community sites was 96% with academic centers and VAMC lagging behind (academic center 93.4% and VAMC 92.8%; $P < 0.001$). Colonoscopies conducted with the assistance of a training fellow in some capacity had lower completion rate than those without a fellow's presence (fellow present 92.7%; fellow absent 95.7%; $P < 0.001$).

Table 4 shows completion rates by indication for procedure. Community setting represented the largest colonoscopy group (77% of all procedures). Completion rates in this clinical setting reached 95% among all indications including screening (96.9% complete). Both academic and VAMCs, however, seem to be lagging behind in overall completion rates (93.4 and 92.8%, respectively) and in screening group (93.5 and 94.3%, respectively). Overall completion rates were highest for the group with family history of CRC (96.9%),

followed by surveillance for history of adenomatous polyps (96.3%) and screening of asymptomatic individuals (96.3%), nonspecific abdominal symptoms group (94.4%), and bleeding group (94.2%).

Relative risk of incomplete colonoscopy (Table 5)

Table 5 shows the adjusted RR of incomplete colonoscopy by the various characteristics we examined. Increasing age more than 60 years increased the risk of incomplete colonoscopy in comparison with those under the age of 60 years. Using age under 50 years as reference, we found adjusted RR of 1.37 (95% CI: 1.25–1.51) and 1.88 (95% CI:1.72–2.05) in age groups 60–69 years and 70 or older. Males had an adjusted RR of 0.62 (95% CI: 0.58–0.66) in comparison with females, hence at less risk for incomplete colonoscopy. African–Americans had an adjusted RR of 1.24 (95% CI: 1.13–1.36) and Hispanics had an adjusted RR of 1.22 (95% CI: 1.10–1.36) in comparison with Caucasians. Procedures conducted at academic sites and VAMCs had an increased risk of incompletion when compared with those conducted in community practices, RR 1.40 (95% CI: 1.29–1.52) and 1.92 (95% CI: 1.73–2.12), respectively. Endoscopic inexperience also increased the risk of incomplete procedure as evidenced by presence of training fellow in the model (RR: 1.22, 95% CI: 1.19–1.33).

Preparation quality was factored in the model with excellent/good group as reference. This confirmed the obvious effect of poor preparation on risk of incomplete procedure with increasing RR of 1.51 (95% CI: 1.39–1.63) and 9.86 (95% CI: 9.16–10.62) for fair preparation and fair, exam compromised/poor preparation groups, respectively. Using nonspecific symptom group as reference, average-risk screening, surveillance, and family history of CRC had higher completion rates with adjusted relative rate of 0.69 (95% CI: 0.63–0.75), 0.55 (95% CI: 0.50–0.60), and 0.61 (95% CI: 0.55–0.68), respectively. The effect of the bleeding as indication on colonoscopy completion did not show any increased or decreased RR when compared with the reference group (0.96, 95% CI: 0.89–1.03).

Discussion

Multiple factors influence successful completion of colonoscopy. Patient population, bowel preparation, endo- scopist experience, patient tolerance, and sedation among other factors can all have influence on the procedure. Multiple studies have reported overall colonoscopy completion rates ranging from 55 to 99% [10–18]. Marshall and Barthel [19] showed that cecal intubation rates above 90% can be consistently achieved by experienced endoscopists and intubation can be documented by high-quality picture.

Colonoscopy completion rate in our study cohort was 95.3%, which is comparable with other previously published rates. Church [11] reported crude and adjusted completion rates of 93.6 and 98.8%, respectively. Waye and Bashkoff [12] reported an overall completion rate of 95.9% in 1351 consecutive procedures. In subgroup analysis of 865 colonoscopies, conducted to evaluate whether previous pelvic surgery adversely affected ability to complete colonoscopy, total colonoscopy was pre- formed in 98% of cases when obstructing lesions were excluded from analysis. Nelson et al. [18] reported an overall completion rate of 97.2% in the VA Cooperative, a study of success and safety of screening colonoscopy in a group of over 3000 veterans.

By using a large multicenter database consisting primarily of patients in the community setting, we were better able to estimate ‘true’ completion rates in clinical practice. We were also able to compare academic, VA and community practices, and examine variance across a spectrum of patients. Indication for doing a procedure can potentially have an impact on completion of that procedure. We hypothesized that procedures done for screening might

have lower completion rates due to the unwillingness of endoscopists to persevere in a difficult procedure. RR of less than 1 indicated a higher completion rate than reference group and hence, was considered as protective or at least not contributing to incompletion of the procedure. Our results suggest that colonoscopy conducted for screening indication did not show increased risk for incomplete colonoscopy when compared with those conducted for surveillance of adenomatous polyps, or other indications we examined. In fact, average-risk screening, surveillance of adenomatous polyps, and family history of CRC had increased completion rates in our analysis (RR: 0.69, 0.55, and 0.61, respectively). We grouped nonspecific abdominal symptoms, which may be compatible with the irritable bowel syndrome (IBS) complex, into one symptom cluster for ease of analysis. It is worth noting that nonspecific abdominal symptoms group, used as reference in our model, had a relatively lower completion rate compared with other indications, followed only by the bleeding group. Incomplete procedure was consistently seen in group with bleeding indication. A confounding factor, however, may be acuity of need for procedure for this indication which may have influence on completion. Church reported data regarding indication for pro- cedure and colonoscopy completion in a cohort of 2907 consecutive colonoscopies. This author found the lowest rates when abdominal pain (95.3%), change in bowel habits (95.7%), and constipation (96%) were the indications for colonoscopy [11]. Potential explanations for lower completion rate in nonspecific abdominal symptoms group are many, and include differences in pain threshold in comparing patients suffering from IBS type symptoms, or IBS proper, and others. Difficulty in sedation of patients who might be using chronic opioid medications might also be a contributor. Finally, the low pretest probability of neoplasm in examinations conducted for nonspecific GI complaints might affect the tenacity of the endoscopists in completing a difficult procedure.

Several demographic factors have been examined in relation to colonoscopy completion including age, sex, ethnicity, body mass index, prior surgery or other medical condition, endoscopist experience, patient discomfort, bowel preparation among others [12,17–18,20–22]. Higher completion rates in men than in women have been noted [20–22]. Higher rate of incomplete colonoscopies has been noted in women particularly those with lower body mass index [21]. Lee et al. [23] analyzed the effect of various prior surgeries on colonoscopy performance and concluded that hysterectomy and gastrectomy are most correlated with procedural incompleteness.

Sex seemed to be predictive of complete colonoscopy in this study; we found a higher completion rate among males than females (96.0 vs. 94.6%), and this persisted even after adjustment in our logistic regression model. The observed difference might be explained in part by purely anatomical differences, and particularly among women with prior abdominopelvic surgery, such as total abdominal hysterectomy [20,23]. Anderson et al. [21] hypothesized a difference in intra-abdominal fat content to contribute to the lower completion rate among thin females. We were not able to assess comorbidity factors such as prior surgery or body mass index as these data were not routinely collected in CORI database.

Advancing age was associated with decreasing completion rates in this study. This might be a result of combination of various factors such as increased prevalence of cardiopulmonary comorbidities, poor mobility, and difficulty with laxative preparation, prior abdominal surgeries, which might on the ease of completing colonoscopy. Prior history of abdominal hysterectomy is generally accepted as a risk factor for a difficult colonoscopy. Waye and Bashkoff [12], however, found previous total abdominal hysterectomy to be insignificant in their subgroup analysis of 865 colonoscopies. In contrast, Cirocco and Rusin [22] analyzed the factors predicting incomplete colonoscopy in a prospective manner, among 1047

patients. They found that women with prior total abdominal hysterectomy had lower cecal intubation rates.

African–Americans and Hispanics seem to be at increased risk of an incomplete examination, compared to Caucasians. African–Americans undergo colonoscopy for screening purposes less frequently than Caucasians, and when CRC is diagnosed it is often at a more advanced stage, negatively affecting morbidity and mortality. Effect of the preprocedural conditioning is, however, unknown. Preprocedural conditioning includes not only laxative preparation, but also counseling which might impact on the patient's willingness to go forward with an uncomfortable procedure. Further study is warranted to delineate the reasons for the apparent ethnic differences in procedural completion.

Procedures conducted at academic or VA centers are less likely to be complete than those conducted at community settings. Screening completion rates seem to be lagging behind with rates less than 95%. The involvement of trainees (i.e. gastroenterology fellows) might explain some of the observed difference. Completion rates above 90% are now a goal of training programs in colonoscopy within the United States. Recently published data from the UK supports that endoscopy training affects the success of colonoscopy completion [17]. Church et al. [5] followed 18 trainees and concluded that at least 100 cases are needed to gain a level of proficiency that enables completion in two-thirds of cases whereas 125 cases lead to an average completion rate of 75%. This would support our hypothesis that some of the difference in completion rate between academic and community sites is due to the experience, or lack thereof, of the endoscopist. Positive correlation between cecal intubation rates with endoscopist experience was also demonstrated in a study by Harewood [24]. Other factors influencing different completion rates based on clinical settings may be due to difference in the population characteristics. Academic centers usually have patient bias with more complex profile with regard to comorbidity, prior surgery, and ability to comply with preparation instructions.

A limitation of this study is the lack of photodocumentation of cecal intubation in all cases. Owing to the large number of procedures included and the number of sites, reviewing the records to obtain such documentation was not feasible. This could have led to overestimation of cecal intubation in our study. A validation study, reviewing images obtained from the cecal cap, would be useful. Another potential weakness is the fact that the endoscopist enters data regarding indication for procedure after the procedure has been completed. This has the potential to affect that accuracy of the data. Site relation bias is another concern with possibility that certain sites are more interested in quality; some may even use the CORI system to assess their individual quality in completion. This could lead to overestimation of completion rates in comparison with other sites. In this large cohort of patients, the differences noted in colonoscopy completion based on the indication for the procedure are small in magnitude, and are therefore unlikely to impact on clinical decision making. Similarly, differences based on demographic factors and site-type is small in magnitude, considering the very large number of procedures analyzed.

In conclusion, this is the largest study to date, to our knowledge, on evaluating the influence of primary indication on completion rates. The most salient observation was that colonoscopy done for screening indication had a comparable rate compared with overall completion rates. Academic and VAMCs, however, seem to be lagging behind community centers in overall completion rates and in screening groups. In addition, surveillance colonoscopy also did not show any increased risk of incomplete procedure. Nonspecific abdominal symptoms population was at relatively higher risk of incomplete procedure. Female sex, advancing age, academic clinical setting, and specific populations of African–American, Hispanic, and native Indian were all found to increase risk of incomplete

colonoscopy. In addition, overall completion rate of colonoscopy based on a large database are about 95%, based on a broad base of patient population and clinical setting. This is the largest study to date, verifying that completion rates are meeting recommended multisociety guidelines in the USA.

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References

1. Overholt BF, Pollard HM. Cancer of the colon and rectum. Current procedures for detection and diagnosis. Cancer. 1967; 20:445–450. [PubMed: 6021499]
2. Harewood GC, Lieberman DA. Colonoscopy practice patterns since introduction of medicare coverage for average-riskscreening. Clin Gastroenterol Hepatol. 2004; 2:72–77. [PubMed: 15017635]
3. Prajapati DN, Saeian K, Binion DG, Staff DM, Kim JP, Massey BT, Hogan WJ. Volume and yield of screening colonoscopy at a tertiary medical center after change in Medicare reimbursement. Am J Gastroenterol. 2003; 98:194–199. [PubMed: 12526957]
4. Rex DK, Bond JH, Winawer S, Levin TR, Burt RW, Johnson DA, 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; 97:1296–1308. [PubMed: 12094842]
5. Church J, Oakley J, Milsom J, Strong S, Hull T. Colonoscopy training: the need for patience (patients). ANZ J Surg. 2002; 72:89–91. [PubMed: 12074082]
6. Imperiale TF, Wagner DR, Lin CY, Larkin GN, Rogge JD, Ransohoff DF. Risk of advanced proximal neoplasms in asymptomatic adults according to the distal colorectal findings. N Engl J Med. 2000; 343:169–174. [PubMed: 10900275]
7. Lieberman DA, Weiss DG, Bond JH, Ahnen DJ, Garewal H, Chejfec G. Use of colonoscopy to screen asymptomatic adults for colorectal cancer. Veterans Affairs Cooperative Study Group 380. N Engl J Med. 2000; 343:162–168. [PubMed: 10900274]
8. Winawer SJ, Fletcher RH, Miller L, Godlee F, Stolar MH, Mulrow CD, et al. Colorectal cancer screening: clinical guidelines and rationale. Gastroenterology. 1997; 112:594–642. [PubMed: 9024315]
9. Lieberman DA, de Garmo PL, Fleischer DE, Eisen GM, Chan BK, Helfand M. Colonic neoplasia in patients with nonspecific GI symptoms [see comment]. Gastrointest Endosc. 2000; 51:647–651. [PubMed: 10840294]
10. Aldridge MC, Sim AJ. Colonoscopy findings in symptomatic patients without X-ray evidence of colonic neoplasms. Lancet. 1986; 2:833–834. [PubMed: 2876280]
11. Church JM. Complete colonoscopy: how often? And if not, why not? Am J Gastroenterol. 1994; 89:556–560. [PubMed: 8147359]
12. Waye JD, Bashkoff E. Total colonoscopy: is it always possible? Gastrointest Endosc. 1991; 37:152–154. [PubMed: 2032598]
13. Webb WA. Colonoscoping the difficult colon. Am Surg. 1991; 57:178–182. [PubMed: 2003705]
14. Gelfand DW, Wu WC, Ott DJ. The extent of successful colonoscopy: its implication for the radiologist. Gastrointest Radiol. 1979; 4:75–78. [PubMed: 761748]
15. Obrecht WF Jr, Wu WC, Gelfand DW, Ott DJ. The extent of successful colonoscopy: a second assessment using modern equipment. Gastrointest Radiol. 1984; 9:161–162. [PubMed: 6745595]

16. Parry BR, Williams SM. Competency and the colonoscopist: a learning curve. Aust N Z J Surg. 1991; 61:419–422. [PubMed: 2059173]
17. Bowles CJA, Leicester R, Romaya C, Swarbrick E, Williams CB, Epstein O. A prospective study of colonoscopy practice in the UK today: are we adequately prepared for national colorectal cancer screening tomorrow? [see comment]. Gut. 2004; 53:277–283. [PubMed: 14724164]
18. Nelson DB, McQuaid KR, Bond JH, Lieberman DA, Weiss DG, Johnston TK. Procedural success and complications of large-scale screening colonoscopy. Gastrointest Endosc. 2002; 55:307–314. [PubMed: 11868001]
19. Marshall JB, Barthel JS. The frequency of total colonoscopy and terminal ileal intubation in the 1990s. Gastrointest Endosc. 1993; 39:518–520. [PubMed: 8365599]
20. Saunders BP, Fukumoto M, Halligan S, Jobling C, Moussa ME, Bartram CI, Williams CB. Why is colonoscopy more difficult in women? Gastrointest Endosc. 1996; 43:124–126. [PubMed: 8635705]
21. Anderson JC, Gonzalez JD, Messina CR, Pollack BJ. Factors that predict incomplete colonoscopy: thinner is not always better [see comment]. Am J Gastroenterol. 2000; 95:2784–2787. [PubMed: 11051348]
22. Cirocco WC, Rusin LC. Factors that predict incomplete colonoscopy. Dis Colon Rectum. 1995; 38:964–968. [PubMed: 7656745]
23. Lee SK, Kim TI, Shin SJ, Kim BC, Kim WH. Impact of prior abdominal or pelvic surgery on colonoscopy outcomes. J Clin Gastroenterol. 2006; 40:711–716. [PubMed: 16940884]
24. Harewood GCMM. Relationship of colonoscopy completion rates and endoscopist features. Dig Dis Sci. 2005; 50:47–51. [PubMed: 15712636]

Table 1

Demographic data

	Colonoscopy Indication					
Demographic factor	**Screening[a] (n = 26 956)**	**Family history[b] (n = 15 333)**	**Nonspecific symptoms[c] (n = 24 965)**	**Surveillance[d] (n = 21 501)**	**Bleeding[e] (n = 40 794)**	**Total (n = 129 549)**
Age (years)						
< 50	609 (2.3)	3599 (23.5)	5728 (22.9)	1348 (6.3)	8440 (20.7)	19 724 (15.2)
50–59	10 884 (40.4)	5659 (36.9)	7159 (28.7)	4660 (21.7)	12 164 (29.8)	40 526 (31.3)
60–69	8754 (32.5)	3691 (24.1)	5910 (23.7)	6934 (32.2)	9203 (22.6)	34 492 (26.6)
≥70	6709 (24.9)	2384 (15.5)	6168 (24.7)	8559 (39.8)	10 987 (26.9)	34 807 (26.9)
Sex						
Female	12 490 (46.3)	8451 (55.1)	15902 (63.7)	8091 (37.6)	17 577 (43.1)	62 511 (48.3)
Male	14 466 (53.7)	6882 (44.9)	9063 (36.3)	13 410 (62.4)	23 217 (56.9)	67 038 (51.7)
Ethnicity						
Caucasian	23 266 (86.3)	13912 (90.7)	21264 (85.2)	19 419 (90.3)	33 494 (82.1)	111 355 (86.0)
African–American	1837 (6.8)	845 (5.5)	1389 (5.6)	1025 (4.8)	3612 (8.9)	8708 (6.7)
Hispanic	1315 (4.9)	364 (2.4)	1547 (6.2)	775 (3.6)	2445 (6.0)	6446 (5.0)
Asian	368 (1.4)	140 (0.9)	282 (1.1)	175 (0.8)	752 (1.8)	1717 (1.3)
Native American	128 (0.5)	58 (0.4)	445 (1.8)	76 (0.4)	417 (1.0)	1124 (0.9)
Multiracial	42 (0.2)	14 (0.1)	38 (0.2)	31 (0.1)	74 (0.2)	199 (0.2)
Clinical setting						
Community	20 848 (77.3)	12602 (82.2)	20 985 (84.1)	15 729 (73.2)	29 396 (72.1)	99 560 (76.9)
Academic	4810 (17.8)	1601 (10.4)	2922 (11.7)	3249 (15.1)	5122 (12.6)	17 704 (13.7)
VAMC	1298 (4.8)	1130 (7.4)	1058 (4.2)	2523 (11.7)	6276 (15.4)	12 285 (9.5)
Fellow						
Present[f]	3073/26 895	1847/15 302	2167/24 906	2933/21 461	7640/40 719	17 660/129 283

n, number of colonoscopies for specified indication; the numbers in brackets represent percentages. VAMC, Veteran's Administration Medical Center.

[a] Asymptomatic average-risk patient.

[b] Family history of colorectal cancer.

[c] Abdominal pain/bloating, diarrhea, constipation, change in bowel habits excluding bleeding.

[d]Undergoing surveillance for history of adenomatous polyp.

[e]Anemia, iron deficiency without anemia, melena, hematochezia, positive fecal occult blood test.

[f]Number of colonoscopies with fellow/total colonoscopies, which documented fellow attendance.

Table 2

Demographic characteristics and clinical setting

Demographic characteristics	Community (n = 99 560)	Academic (n = 17 704)	VAMC (n = 12 285)	Total (n = 129 549)
Age (years)				
< 50	15 490(15.6)	2968(16.8)	1266(10.3)	19 724(15.2)
50–59	30 838(31.0)	5642(31.9)	4046(32.9)	40 526(31.3)
60–69	26 462(26.6)	4534(25.6)	3496(28.5)	34 492(26.6)
≥70	26 770(26.9)	4560(25.8)	3477(28.3)	34 807(26.9)
Sex				
Female	53 273(53.5)	8353(47.2)	885(7.2)	62 511(48.3)
Male	46 287(46.5)	9351(52.8)	11 400(92.8)	67 038(51.7)
Ethnicity				
Caucasian	86 055(86.4)	14 824(83.7)	10 476(85.3)	111 355(86.0)
African–American	6175(6.2)	1319(7.5)	1214(9.9)	8708(6.7)
Hispanic	4946(5.0)	1057(6.0)	443(3.6)	6446(5.0)
Asian	1198(1.2)	425(2.4)	94(0.8)	1717(1.3)
Native American	1021(1.0)	62(0.4)	41(0.3)	1124(0.9)
Multiracial	165(0.2)	17(0.1)	17(0.1)	199(0.2)
Fellow[b]				
Present	2619/99 333	7575/17676	7466/12 274	17660/129 283
Prep[a]				
Excellent/good	14 422(14.5)	3367(19.0)	2130(17.3)	19 919(15.4)
Fair	67 545(67.8)	9140(51.6)	7877(64.1)	84 562(65.3)
Fair, exam compromised/poor	4007(4.0)	1193(6.7)	741(6.0)	5941(4.6)
Unknown/missing	13 586(13.7)	4004(22.6)	1537(12.5)	19 127(14.8)

n, total number of colonoscopies in specified clinical setting; numbers in bracket represent percentage. VAMC, Veteran's Administration Medical Center.

[a] Colonoscopy preparation results.

[b] Presence of training fellow, number of colonoscopies with training fellow/total colonoscopies, which documented fellow attendance, 266 procedures were missing data regarding fellow's presence.

Table 3

Colonoscopy completion by patient demographics, site type, and training fellow presence

Demographic characteristic	Completion rate, % (n/N)[a]	P value χ^2 test
Entire cohort	95.3(123 473/129,549)	
Age (years)		
< 50	96.0(18, 941/19,724)	< 0.001
50–59	96.4(39, 056/40,526)	
60–69	95.4(32,906/34,492)	
≥70	93.6(32,570/34,807)	
Sex		
Female	94.6(59, 147/62,511)	< 0.001
Male	96.0(64, 326/67,038)	
Ethnicity		
Caucasian	95.6(106, 431/111,355)	< 0.001
African–American	93.5(8,141/8,708)	
Hispanic	93.0(5,998/6,446)	
Asian/Pacific Islander	95.9(1,646/1,717)	
Native American	94.7(1,064/1,124)	
Multiracial	97.0(193/199)	
Clinical setting		
Community	96.0(95,551/99,560)	< 0.001
Academic	93.4(16,527/17,704)	
VAMC	92.8(11,395/12,285)	
Fellow		
Present[b]	92.7(16,374/17,660)	< 0.001
Absent	95.7(106,842/111,623)	

VAMC, Veteran's Administration Medical Center.

[a] Percent complete (number of complete colonoscopies/total number of colonoscopies in that cohort): colonoscopy was considered complete if cecum or terminal ileum was reached.

[b] Presence of training fellow: number of colonoscopies with fellow present/total colonoscopies, which documented training fellow attendance, 266 procedures lacked data on the presence of a training fellow.

Table 4

Colonoscopy completion by indication for procedure

	Clinical setting			
Indication	**VAMC, n/N (%)**	**Academic, n/N (%)**	**Community, n/N (%)**	**Total, n/N (%)**
Screening[a]	1213/1298 (93.5)	4534/4810 (94.3)	20 203/20 848(96.9)	25 950/26 956 (96.3)
Surveillance[b]	2382/2523 (94.4)	3100/3249 (95.4)	15 231/15 729(96.8)	20 713/21 501 (96.3)
Bleeding[c]	5795/6276 (92.3)	465/5122 (90.9)	27966/29 396 (95.1)	38 418/40794 (94.2)
Nonspecific symptoms[d]	934/1058 (88.3)	2701/2922 (92.4)	19 897/20 985(94.8)	23 532/24 965 (94.3)
Family history[e]	1071/1130 (94.8)	1535/1601 (95.9)	12 254/12 602(97.2)	14 860/15 333 (96.9)

n/N (%): number of complete examinations/total number of colonoscopies in the specified group (percent), colonoscopy was considered complete if cecum or terminal ileum was reached.

VAMC, Veteran's Administration Medical Center.

[a] Asymptomatic, average-risk.

[b] Colonoscopy in patient known history of adenomatous polyps.

[c] History of anemia, iron deficiency without anemia, melena, hematochezia, or positive fecal occult blood test.

[d] Abdominal pain, bloating, diarrhea, constipation, changes in bowel habits excluding bleeding.

[e] Family history of colorectal cancer.

Table 5

Adjusted relative risk for incomplete colonoscopy based on demographics and indications

Demographic characteristics	Adjusted relative risk	95% confidence interval
Age (years)		
< 50	1.0 (reference)	
50–59	1.04	0.95–1.14
60–69	1.37	1.25–1.51
≥70	1.88	1.72–2.05
Sex		
Female	1.0 (reference)	
Male	0.62	0.58–0.66
Ethnicity		
Caucasian	1.0 (reference)	
African–American	1.24	1.13–1.36
Hispanic	1.22	1.10–1.36
Asian	0.83	0.65–1.06
Native American	0.86	0.66–1.13
Multiracial	0.56	0.24–1.29
Clinical setting		
Community	1.0 (reference)	
Academic	1.40	1.29–1.52
VAMC	1.92	1.73–2.12
Indication		
Symptoms[a]	1.0 (reference)	
Screening[b]	0.69	0.63–0.75
Surveillance[c]	0.55	0.50–0.60
Family history[e]	0.61	0.55–0.68
Bleeding[d]	0.96	0.89–1.03
Prep results		
Excellent/good	1.0 (reference)	
Fair	1.51	1.39–1.63
Fair, exam compromised/poor	9.86	9.16–10.62
Unknown/missing	2.09	1.95–2.25
Fellow[f]		
Absent	1.0 (reference)	
Present	1.22	1.19–1.33

VAMC, Veteran's Administration Medical Center.

[a] Nonspecific symptoms: abdominal pain, bloating, diarrhea, constipation, changes in bowel habits excluding bleeding.

[b] Asymptomatic, average-risk.

[c] Colonoscopy in patient known history of adenomatous polyps.

[d] History of anemia, iron deficiency without anemia, melena, hematochezia or positive fecal occult blood test.

[e] Family History of colorectal cancer.

[f] Presence of training fellow, 266 procedures were missing data regarding fellow's presence.