Does Colonoscopy Work?

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Key Words
Colonoscopy, colorectal cancer, screening, prevention, adenoma, polyp

Abstract
Through its impact on the adenoma-carcinoma sequence, colonoscopy has a central role in the detection and prevention of colorectal cancer (CRC). Observational data support a protective effect of colonoscopy and polypectomy on CRC incidence and mortality. However, recent studies suggest that the degree of CRC protection afforded by colonoscopy is dependent on the effectiveness of identification of prevalent cancers or their precursors, particularly in the proximal colon. Biologic variation in tumor genetics and growth likely contribute to diminished protection in the proximal colon. Operator variability is known to be a key factor predicting adenoma detection. Evidence supports the immediate adoption of specific quality improvement initiatives to reduce the failure rate of colonoscopy. Further interventions should target individual, organizational, and health system factors which influence physician behavior. (JNCCN 2010;8:67–77)

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Learning Objectives
Upon completion of this activity, participants will be able to:
• Specify the effectiveness of other screening modalities in the prevention of colorectal cancer
• Describe outcomes of research examining the use of colonoscopy after adenoma removal
• Identify the anatomic area for which colonoscopy screening is least effective
• List reasons why colonoscopy may not be effective in detecting lesions and means to improve the quality of colonoscopy

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Colonoscopy has a central role in the detection and prevention of colorectal cancer (CRC). This is based on the recognition that most CRC develops within precursor adenomatous polyps, and this adenoma–carcinoma sequence allows for interventions (polypectomy) that target the premalignant stages of the pathway and therefore prevent the development of CRC.

In the United States, colonoscopic screening is widely recommended by professional societies, public advocacy groups, and policy makers. An estimated 15 million colonoscopies are performed each year in the United States, and the use of colonoscopy for screening has increased steadily over the past decade, largely replacing other imaging tests used for screening. In some countries, fecal occult blood testing (FOBT) is the primary screening modality, but effective colonoscopy is still essential for accurate evaluation of positive tests.

The potential advantages of colonoscopy include visualization of the full colon, a high level of comfort if effective sedation is used, longer protective intervals than other tests, and single test diagnosis and treatment. However, colonoscopy is invasive and has defined risks, including perforation and those relating to sedation. Recent studies have questioned the effectiveness of CRC prevention, particularly in the proximal colon. This article reviews the evidence regarding colonoscopy use as a CRC prevention strategy and considers how it might be improved.

Impact of Colonoscopy on CRC Incidence and Mortality

No randomized controlled trials have tested whether colonoscopy reduces the incidence of CRC. Support for the role of colonoscopy in CRC prevention derives from indirect evidence and observational studies.

Indirect Evidence of the Effectiveness of Colonoscopy

Population-level cancer statistics show a decline in overall cancer incidence, with an important contributor being reductions in CRC incidence attributed to endoscopic screening. Furthermore, the emergence of Medicare-funded colonoscopic screening led to a shift in CRC diagnosis to earlier, more favorable stages.

The results of sigmoidoscopy have often been extrapolated to support the effectiveness of colonoscopy, because both technologies are endoscopic. Although this extrapolation has its limitations, evidence suggests that this more limited structural examination is effective in reducing CRC. Case-control studies of sigmoidoscopy have shown a 49% to 76% reduction in distal CRC incidence and 60% to 79% reduction in mortality.

The Telemark Polyp Study, a controlled trial in which participants underwent flexible sigmoidoscopy screening followed by colonoscopy if polyps were found, showed an 80% reduction in CRC incidence, although this was based on only 10 control and 2 screening CRC cases. Screened subjects had a higher overall mortality (relative risk [RR], 1.57; 95% CI, 1.03–2.4), although no reduction in CRC mortality was seen.

Early results were reported recently from the Norwegian Colorectal Cancer Prevention randomized controlled trial of flexible sigmoidoscopy screening for CRC. Participants underwent once-only flexible sigmoidoscopy (subsequent colonoscopy was performed in 21%), and no reduction in CRC incidence or mortality was shown at 6 to 7 years of follow-up (incidence, 134.5 vs. 131.9 cases per 100,000 person-years; hazard ratio [HR] for mortality, 0.73; 95% CI, 0.47–1.13). However, these are interim findings, and longer follow-up is required. The trial also set a high bar for showing a reduction in CRC incidence through including prevalent cancers detected at initial sigmoidoscopy, reporting nondistal CRC incidence and an intention-to-treat analysis. Per protocol analysis showed that screen-adherent subjects had a 59% reduction in cancer mortality (HR, 0.41; 95% CI, 0.21–0.82).

Other indirect evidence comes from the Minnesota randomized controlled trial of FOBT, which showed a 20% reduction in cancer incidence in screened subjects, attributed to colonoscopic resection of large polyps detected by FOBT.

CRC Incidence After Adenoma Removal

The first of the adenoma cohort studies (see Table 1) was the National Polyp Study (NPS), which reported a 76% to 90% reduction in the incidence of CRC in patients with adenomas who underwent colonoscopy and polypectomy, compared with 3 selected reference cohorts. No CRC mortality was reported. This study adopted stringent criteria for inclusion, excluding patients with sessile adenomas.
larger than 3 cm, and 13% of the cohort had more than one colonoscopy at baseline. Long-term follow-up evaluation showed a sustained impact on CRC incidence and mortality, mostly believed to be attributable to the baseline colonoscopy rather than subsequent surveillance procedures.26,27
An Italian prospective cohort study, conducted in standard clinical practice, also assessed the impact of colonoscopic polypectomy on cancer incidence.28 Six cases of CRC were observed during follow-up compared with 17.7 cases expected from the reference population, representing an incidence ratio of 0.34, which is equivalent to that seen in the NPS.

These studies have been widely cited to support the contention that colonoscopy with polypectomy can prevent approximately 80% of CRC, and the data were used to drive policy formation culminating in legislation that funded colonoscopic screening for Medicare patients.

However, not all adenoma cohort studies have shown such high-level reductions in CRC incidence. Two trials of dietary fiber in patients with colorectal adenomas (the Wheat Bran Fiber Trial29 and Polyp Prevention Trial30) showed rates of incident CRC after “clearing” colonscopy 3 to 4 times higher than those seen in the NPS. The Funen Adenoma Follow-up Study,31 which consisted of a prospective randomized examination of surveillance intervals in patients with adenomas, did not show any difference in CRC incidence between the adenoma cohort and general population (RR, 1.26; 95% CI, 0.60–2.31), although a difference was seen in CRC mortality (RR, 0.13; 95% CI, 0.00–0.74). Additionally, a study combining the results of 3 adenoma chemoprevention trials (testing the impact of calcium, folic acid, antioxidants, and aspirin on recurrent colorectal adenomas after colonoscopy and polypectomy) did not report any significant effects on the rate of incident CRC when compared with a SEER reference cohort (standardized incidence ratio for CRC, 0.98; 95% CI, 0.63–1.54).32

What explains these apparent conflicting findings regarding CRC incidence after colonoscopy and polypectomy in cohort studies? Much of the variation can be attributed to methodologic differences, driven by natural evolution in the essential research questions informing each study. As a result, direct comparisons between studies are necessarily complicated.

For example, the duration and definition of follow-up was different between studies. The NPS and Italian cohort study followed up patients for an average of 5.9 and 10.5 years, respectively, whereas follow-up in the Funen Adenoma study, dietary intervention, and chemoprevention trials was 3 to 4 years. Shorter follow-up potentially allows the impact of missed cancers to dominate, because these cancers are expected to become clinically evident during the first few years of follow-up. Censure time also differed, with some studies terminating person-years of follow-up at the time of the last study colonoscopy and others at the most recent annual cancer update.33,34 Furthermore, differences in the rates and timing of colonoscopic follow-up could explain some of the variable reductions in CRC incidence. For example, more complete colonoscopic surveillance was performed in the chemoprevention studies,32 whereas 20% of the NPS cohort and 26% of the Italian cohort did not have a scheduled follow-up colonoscopy.

The definitions of (and therefore distinction between) prevalent and incident cancers in the study and reference populations differed.35 The NPS and Italian study attempted to adjust for latent prevalent cases in the comparison population (which would be counted as “incident” cases when detected subsequently) by excluding patient-years at risk during the first 2 years after the index colonoscopy; however, this approach has limitations.36 Inclusion and exclusion criteria differed. The NPS and Italian studies excluded patients with adenomas larger than 3 cm and those with a history of adenomas, whereas other studies included patients with any-sized adenomas or a history of adenomas.

Additional insights can be gained by exploring the characteristics of the cancers detected in the adenoma cohort studies (see Table 1). The NPS followed up patients for 6 years; among the 5 cancers detected, 3 lesions were found at 3 years, all of which were larger than 1 cm and proximal to the splenic flexure. These findings suggest that the 3 early (and larger) cancers may have been lesions missed at clearing colonoscopy, whereas the later lesions were true incident cancers, as acknowledged by the authors.

In the Italian adenoma cohort study, 9 cancers were detected, of which 3 were excluded because they were detected within the first 2 years of follow-up. Of the remaining 6, 3 were detected within 5 years and likely represent missed cancers during the index examination; these 3 patients died of CRC during follow-up. The other 3 cancers were found later and were smaller in size.

In the Polyp Prevention Trial, CRC was diagnosed during follow-up in 13 subjects. A subsequent analysis of these cases showed that the mean detec-
tion interval was 22 months and 6 were detected at the 1 year colonoscopy. Most cancers were proximal, and an adjudication algorithm suggested that only 3 cases represented new cancer diagnoses (all proximal to the splenic flexure), compared with 3 missed cancers (all in the cecum or at flexures), 4 incompletely removed lesions (rectosigmoid), and 3 failed biopsy detections (sigmoid colon).

During follow-up in the Wheat Bran Fiber Trial, 9 cancers were found, all within the 3-year trial follow-up period. In the Funen Adenoma Follow-up Trial, in which no difference in CRC incidence was found, 10 cancers were detected. Five cancers were detected at or within 4 years of follow-up (2 cecum, 3 rectosigmoid). Previous piecemeal polypectomy had been performed at the cancer site in 3 patients.

In the combined chemoprevention trials, patients with an adenoma of any size were followed up for a mean of 3.7 years, including colonoscopic surveillance. In these trials, 19 cancers were found, of which 17 were detected within 4 years of index-clearing colonoscopy (and 6 within 2 years), 10 were proximal to the hepatic flexure, and 5 had a 1 cm or greater adenoma removed from the same segment of colon; 2 patients died of CRC. To adjust for missed prevalent cancers, the authors calculated separate CRC incidence rates for subjects who had surveillance colonoscopies at 1 year, and found significantly different CRC incidence rates between the first follow-up interval (clearing to year 1 colonoscopy, 3.79 per 1000 person-years) and the second (year 1–4 colonoscopy, 0.96 per 1000 person-years).

This analysis begins to highlight the variation in cancer protection afforded by colonoscopy. The appearance of early (and often proximal) interval cancers after colonoscopy may counteract the long-term protective effect of polypectomy on long-term CRC incidence. Recent evidence shows that most interval cancers are believed to be caused by missed or incompletely resected lesions, and the degree of CRC protection seems dependent on the effectiveness of identifying prevalent cancers or their precursors, particularly in the proximal colon.

**CRC Incidence in Screening Cohorts**

Two studies have addressed the incidence of CRC in screening colonoscopy cohorts. Lieberman et al. reported 5-year follow-up data for the VA Cooperative Study (No. 380), comprising surveillance colonoscopy findings in average- and above-average-risk patients. Among 1193 previously screened patients having colonoscopy within 5.5 years, 15 interval cancers and 7 lesions with high-grade dysplasia were found (6 of these patients were diagnosed with CRC at baseline). Most of these cancers (n = 15) were detected within 36 months of the index colonoscopy. Of the 9 interval cancers occurring in patients without a baseline cancer diagnosis, 6 were found proximal to the splenic flexure and 5 were found within 36 months of the index examination.

A recent study examined a screening cohort of average-risk persons followed up for up to 16 years. The cohort comprised 715 patients with 10,492 person-years of follow-up. The study compared observed CRC rates with SEER rates, finding 12 cases of CRC; 5 at baseline and 7 after a median follow-up of 8 years. The RR reduction in CRC incidence was 48% for all observed CRC cases. When the first 2 years of follow-up (and 5 prevalent cancers) were excluded, the RR reduction was 67%. Only 3 patients died, representing a CRC mortality reduction of 65%. Of the 7 cancers detected, 6 were located at or proximal to the hepatic flexure.

**CRC Incidence After Negative Colonoscopy**

The potential protective effect of colonoscopy on CRC development can be further examined through studies of patients with a history of negative colonoscopy. These patients appear to have a low risk for subsequent CRC. In 2 prospective cohort studies, both from Indiana, asymptomatic average-risk subjects with no neoplasia on screening colonoscopy underwent repeat colonoscopy at 5 years (n = 154 and n = 1256). No cancers were found on re-screening in either cohort.

A German population-based case-control study found that patients who had a previous negative colonoscopy had a 74% lower risk for developing CRC than those who had no previous colonoscopy. Control subjects without CRC were 3.5 times as likely to have had a previous negative colonoscopy (adjusted odds ratio, 0.26; 95% CI, 0.16–0.40), and the risk reduction conferred by negative colonoscopy extended beyond 20 years. This study also examined the distribution of cancers, finding risk reductions to be most evident for patients with rectosigmoid cancers and less so (although still significant) for those with proximal cancers. The difference in risk reduction became less obvious after correction for
incomplete examinations.

Using billing claims data, Singh et al.\(^4^4\) retrospectively analyzed a population-based cohort of 32,203 patients from Manitoba with negative colonoscopy findings (for both diagnostic and screening indications), and compared the incidence of CRC with that of the general population. Standardized incidence ratios were 0.66 at 1 year, 0.55 at 5 years, and 0.28 at 10 years, again supporting a reduction in CRC incidence that increases with time, after missed cancers have emerged. However, the investigators also found that of the incident cancers detected, more were located in the proximal colon than in the distal colon (47% vs. 28%; \(P < .001\)). Cancers were also more likely to be right-sided in patients diagnosed within 2 years of the index colonoscopy than those diagnosed past 5 years (57% vs. 38%), although this difference was not statistically significant.

These studies, combined with the observations in the adenoma cohorts, suggest that colonoscopy-related cancer protection is higher in the distal colon. More recent reports have tried to clarify this issue.

Lakoff et al.\(^4^5\) conducted a retrospective analysis of a large Canadian cohort of 111,402 patients with a previous negative complete colonoscopy (for diagnosis or screening) and found a decreased risk for CRC in each of the 14 years of follow-up after the first year, compared with the Ontario population (year 2: RR, 0.80; 95% CI, 0.66–0.93; year 14: RR, 0.25; 95% CI, 0.12–0.37). The risk for distal cancers was lower than the overall risk throughout the years of follow-up; however, the reduction in risk for proximal cancers was not as pronounced and only evident during the latter half of the follow-up period, mostly after year 7 (year 8: distal RR, 0.30 vs. proximal RR, 0.68).

In a case-control study in the California Medicaid population involving 4458 cancer cases and 43,815 controls, Singh et al.\(^4^6\) identified a 45% reduction in CRC incidence after colonoscopy (adjusted RR, 0.55; 95% CI, 0.46–0.65). Overall, the risk for right-sided tumors after negative colonoscopy was considerably higher (0.67) than that for left-sided tumors (0.16). Although both sexes had an 84% reduction in left-sided cancers, the reduction in right-sided cancers was 62% in men and only 18% in women.

The observation of reduced and delayed protection against proximal cancers is intriguing and suggests that colonoscopy either tends to miss lesions in the proximal colon, which then present as cancer within the first 8 years of follow-up, or that the biology of right-sided cancers is different. This raises the question of how often this occurs. Bressler et al.\(^4^7\) analyzed miss rates of right-sided colon cancer in a population-based cohort study of 4920 patients with right-sided CRC who underwent surgical resection. They found that 105 patients (4.0%) had a colonoscopy within 6 to 36 months of their cancer diagnosis.

Two studies of interval cancers provide further information. A description of 37 interval cancers from the Mayo Clinic in Jacksonville\(^4^8\) found that 76% were right-sided, 4 were in patients who did not present for follow-up, 2 patients had evidence of incomplete polypectomy, and 7 patients had poor bowel preparation on the index colonoscopy. Investigators suggested that correctable factors were present in approximately one third of the interval cancers. Farrar et al.\(^4^9\) reported an analysis of 45 cancers found within 5 years of a complete colonoscopy, in which interval cancers were 3 times more likely to occur in the right colon compared with sporadic cancers.

Other Canadian work has helped clarify some of the factors contributing to missed cancers. First, Bressler et al.\(^5^0\) conducted a population-based cohort study of 12,496 patients with CRC who had undergone colonoscopy within 3 years of diagnosis. Patients were regarded as having a missed cancer if the colonoscopy was performed 6 to 36 months before the date of diagnosis, of which the rates were higher for right-sided CRC (5.9%) than for left-sided. Independent predictors of missed CRC were right-sided CRC, older age, history of diverticular disease, specialty of the proceduralist, and office-based procedure.

Second, a large case-control study recently evaluated the association between colonoscopy (screening or diagnostic) and death from CRC using administrative claims data.\(^5^1\) Patients with CRC were less likely to have undergone complete colonoscopy (OR, 0.63). However, complete colonoscopy was associated with fewer deaths from left-sided CRC but not right-sided (adjusted OR, 0.33 vs. 0.99). For deaths from right-sided cancers, the apparent protective effect of colonoscopy was stronger when it was performed 6 to 24 months before diagnosis (OR, 1.32) than when performed more than 24 months before (OR, 0.92).
Does Colonoscopy Fail?

Based on the available data reviewed earlier, colonoscopy has a greater protective effect on distal CRC than proximal. Table 2 outlines potential reasons for the failure of colonoscopy to protect against CRC. In broad terms, failures may be related to patient, colonoscopist, system, or technical factors.

Although the explanation for lower protection in the proximal colon is uncertain, at least 3 factors may specifically impede right colon protection compared with left colon, each of which is probably largely or partly correctable. One is failed intubation of the cecum. When intubation fails and is not recognized by the operator, it represents inadequate training, because the cecum is anatomically unmistakable in real-time video, and it is universally accepted that the definition of cecal intubation involves entry of the colonoscope into the cecal caput so that the medial wall of the cecum is visualized.32 A second factor is that bowel preparation is typically worse in the right colon than the left if patients take the entire preparation the day before colonoscopy.1 This effect can be largely overcome by split-dosing, in which patients take half of the preparation a few hours before the colonoscopy.3 A third factor is altered tumor biology, which is discussed below. A fourth potential factor is a higher prevalence of flat lesions in the right colon, although whether this prevalence difference is correct is unclear.

With regard to altered biology of right colon tumors, an alternative polyp–cancer sequence now implicates a subset of hyperplastic polyps as premalignant lesions.53 This serrated pathway of carcinogenesis (in which the sessile serrated adenoma/polyp is the dominant precursor54) is characterized by BRAF oncogene mutations, gene promoter hypermethylation (the CpG island methylator phenotype [CIMP]), and possible rapid progression to cancer in those who develop the mutator phenotype (MSI-H) caused by inactivation of a DNA mismatch repair gene (methylation of MLH1 manifest as MSI-H).53,55 Molecular analyses have shown proximal location, CIMP, and microsatellite instability to be more prevalent in interval cancers than in those discovered at an initial colonoscopy.56,57

Evidence of a predisposing epigenetic field effect is also emerging,58,59 with studies showing significantly higher MLH1 methylation in the normal proximal colon among older women.60,61 Sessile serrated adenomas are more common in the right colon than the left, and are typically subtle and difficult to detect because they are larger than 5 mm, flat, pale, and covered with a fine layer of adherent mucus.54 Given these morphologic characteristics, variation in the ability of colonoscopists to detect these may be significant, although this has not been evaluated.

With regard to the overall protective effect of colonoscopy against CRC, marked operator dependency of detection has emerged as a potentially dominant contributor; operator variability is a key factor in predicting adenoma detection. A 4- to 10-fold variation in adenoma detection is also present among colonoscopists in the same group.62-64 However the various factors contributing to this variation have not been examined empirically. Instrument withdrawal time is known to correlate with adenoma detection; however, this measure is only a surrogate for other performance metrics and does not tap the actual skills required to detect polyps. Conceptually, performance deficits may be explained by variation in colonoscopists’ 1) procedural skills (e.g., insertion and withdrawal technique, ineffective polypectomy technique); 2) perceptual abilities affecting recognition and identification of colonic lesions (e.g., color, stereoscopic vision); 3) personality charac-

### Table 2 Possible Reasons for Why Colonoscopy Protection is Imperfect

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<thead>
<tr>
<th>Category</th>
<th>Reason</th>
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<tbody>
<tr>
<td>Patient</td>
<td>• Poor bowel preparation</td>
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<tr>
<td></td>
<td>• Tumor biology (including genetic factors and environmental factors, such as diet/smoking)</td>
</tr>
<tr>
<td>Colonoscopist</td>
<td>• Procedural/motor skill deficits (e.g., incomplete colonoscopy, incomplete/inadequate polypectomy, withdrawal technique)</td>
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<tr>
<td></td>
<td>• Perceptual factors (e.g., variation in color and depth perception)</td>
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<td>• Personality characteristics (e.g., conscientiousness, obsessiveness, impulsivity)</td>
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<td></td>
<td>• Knowledge and attitude deficits (e.g., awareness and appearance of flat lesions)</td>
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<td>System</td>
<td>• Financial factors (e.g., reimbursement disincentives)</td>
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<td></td>
<td>• Organizational factors (e.g., workload pressures, level of training)</td>
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<tr>
<td>Technical</td>
<td>• Inadequate equipment (e.g., poor image resolution)</td>
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teristics (e.g., conscientiousness, obsessiveness, impulsivity); 4) colorectal knowledge (e.g., knowledge of new concepts in colorectal biology and colonscopic correlates, recommendations regarding colonscopy performance and quality indicators); or 5) motivation to perform at a high level (e.g., perverse reimbursement incentives, organizational pressures to increase throughput). This last factor represents external structural variables at a health system or organizational level that act as external disincentives on individual colonoscopists to prevent or preclude best practice.

Finally, technical factors may play a role, such as inadequate or outdated equipment. Dramatic improvements in colonscopic imaging have occurred in the past decade, and instruments are now available with high-definition and image enhancement capabilities that may help detect small or subtle lesions, or reduce operator variability. Additional improvements in technology, such as dye-spray colonscopy, cap-fitted colonscopy, and the Third-Eye Retroscope, continue to improve the ability of colonscopy to see hidden or flat lesions. The pace of change in colonscopic technology makes the adoption of new features challenging and financially prohibitive to smaller endoscopy units.

Improving the Effectiveness of Colonscopy

Although improvements in colonscopic technology may enhance lesion detection, their impact is modest compared with the potential improvements from removing individual variation among colonoscopists. Physician behavior is a key determinant of gaps in health care quality between best evidence and routine clinical practice. However, human behavior and behavior change is a complex process, and quality improvement efforts must consider the different levels at which health care interventions can operate, including individual, health care groups/teams, organizations providing care, and the larger health care environment or system. Within each of these levels, interventions requiring a change in physician behavior should be based on relevant behavioral therapy.

Evidence supports the immediate adoption of specific quality improvement initiatives that should reduce the failure rate of colonscopy. These include the use of split-dose bowel preparation administration, documentation of cecal intubation, and measurement of and reporting on colonscopy quality indicators in routine practice. The U.S. Multi-Society Task Force on Colorectal Cancer has published continuous quality improvement targets for colonscopy. These targets should be incorporated into Continuous Quality Improvement programs with a goal of standardizing withdrawal technique at a minimum level associated with high detection rates. Further initiatives that deserve evaluation include those that may motivate changes in physician behavior, such as systematic video recording of all colonscopy procedures, audit of colonscopist performance, review and feedback, review of regulation and reimbursement for colonscopy services by government and the insurance industry, and publication of performance measures.

Colonoscopy is an operator-dependent procedure and provides better protection against left-sided CRC than right-sided. Given the documented variation among operators, the most significant improvements in the effectiveness of colonscopy will come not from technical improvements but from quality interventions that seek to standardize and enhance the performance of individual physicians responsible for CRC prevention.

References

Does Colonoscopy Work?


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Colonoscopy Efficacy

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1. Which of the following statements about the efficacy of other screening methods for colorectal cancer beside colonoscopy is most accurate?
   A. Case-control studies have demonstrated that sigmoidoscopy is ineffective
   B. The Norwegian Colorectal Cancer Prevention trial demonstrated that sigmoidoscopy reduced colorectal cancer incidence in the overall study cohort
   C. The Norwegian Colorectal Cancer Prevention trial demonstrated that sigmoidoscopy reduced colorectal cancer mortality in the overall study cohort
   D. Fecal occult blood testing has been demonstrated to reduce the incidence of colorectal cancer

2. Which of the following statements best characterizes research of colonoscopy after adenoma removal?
   A. All research has demonstrated that colonoscopy reduces colorectal cancer incidence
   B. No research has yet demonstrated that colonoscopy improves colorectal cancer outcomes
   C. Only some research has demonstrated that colonoscopy improves colorectal cancer outcomes
   D. Studies with longer follow-up times have demonstrated lower efficacy of colonoscopy

3. Screening colonoscopy appears to be least effective in reducing the risk for which of the following types of colorectal cancer?
   A. Cancer of the right colon
   B. Cancer of the transverse colon
   C. Cancer of the descending colon
   D. Rectal cancer

4. Which of the following statements with regard to factors that influence the quality of colonoscopy is most accurate?
   A. Split-dose bowel preparation should be avoided
   B. Intubation of the cecum is generally unnecessary
   C. Pedunculated adenomas are more common in the right colon
   D. Dye-spray and cap-fitted colonoscopy can help operators visualize flat lesions

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Activity Evaluation

1. The activity supported the learning objectives.
   Strongly Disagree Strongly Agree
   1 2 3 4 5

2. The material was organized clearly for learning to occur.
   Strongly Disagree Strongly Agree
   1 2 3 4 5

3. The content learned from this activity will impact my practice.
   Strongly Disagree Strongly Agree
   1 2 3 4 5

4. The activity was presented objectively and free of commercial bias.
   Strongly Disagree Strongly Agree
   1 2 3 4 5