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Quality Indicators for Colonoscopy

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Colonoscopy is widely used for the diagnosis and treatment of colonic disorders. Properly performed, colonoscopy is generally safe, accurate, and well tolerated by most patients. Visualization of the mucosa of the entire large intestine and distal terminal ileum is usually possible at colonoscopy. In patients with chronic diarrhea, biopsy specimens can help diagnose the underlying condition. Polyps can be identified and removed during colonoscopy, thereby reducing the risk of colon cancer. Colonoscopy is the preferred method to evaluate the colon in most adult patients with bowel symptoms, iron deficiency anemia, abnormal radiographic studies of the colon, positive colorectal cancer screening tests, postpolypectomy and postcancer resection surveillance, surveillance in inflammatory bowel disease, and in those with suspected masses.

The use of colonoscopy has become accepted as the most effective method of screening the colon for neoplasia in patients over the age of 50 years and in younger patients at increased risk (1). The effectiveness of colonoscopy in reducing colon cancer incidence depends on adequate visualization of the entire colon, diligence in examining the mucosa, and patient acceptance of the procedure. Preparation quality affects the ability to perform a complete examination, the duration the procedure, and the need to cancel or reschedule procedures (2, 3). Ineffective preparation is a major contributor to costs (4). Longer withdrawal times have been demonstrated to improve polyp detection rates, (5–7) and conversely, rapid withdrawal may miss lesions and reduce the effectiveness of colon cancer prevention by colonoscopy. The miss rates of colonoscopy for large ($\geq$1 cm) adenomas may be higher than previously thought (8, 9) Thus, careful examinations are necessary to optimize the effectiveness of recommended intervals between screening and surveillance examinations. Finally, technical expertise will help prevent complications that can offset any cost benefit ratio gained by removing neoplastic lesions.

The following quality indicators have been selected to establish competence in performing colonoscopy and help define areas for continuous quality improvement. The levels of evidence supporting these quality indicators were graded according to Table 1.

PREPROCEDURE

The preprocedure period encompasses the time from first contact by the patient until administration of sedation or instrument insertion. The aspects of patient care addressed in prior documents apply here as well, including timely scheduling, patient preparation, identification, history and physical examination, appropriate choice of sedation and analgesia, evaluation of bleeding risk, etc. Because many examinations are currently being performed for colon cancer screening and are elective, care must be taken to be certain that all potential risks have been reduced to as low as practically achievable.

The American Society for Gastrointestinal Endoscopy (ASGE) (10) and the U.S. Multi-Society Task Force on Colon Cancer have published appropriate indications for colonoscopy (11) (Tables 2 and 3).

SPECIFIC QUALITY INDICATORS

1. Appropriate indication. The ASGE and the U.S. Multi Society Task Force on Colon Cancer have published appropriate indications for colonoscopy (Tables 2 and 3). An indication should be documented for each procedure, and when it is a nonstandard indication it should be justified in the documentation.

Discussion. The ASGE in 2000 published a list of accepted indications for endoscopic procedures (10). This list was determined by a review of published literature and expert consensus. Studies have shown that when esophago gastroduodenoscopy and colonoscopy are done for appropriate reasons significantly more clinically relevant diagnoses are made (12–14). In these studies, which divided indications into appropriate, uncertain, and inappropriate, and looked at high-volume European centers, 21% to 39% were classified as inappropriate. It is likely that this can be improved to less than a 20% inappropriate rate (15). The European Panel of Appropriateness of Gastrointestinal Endoscopy (EPAGE) Internet guideline is a useful decision support tool for determining the appropriateness of colonoscopy (15). The goal is

Table 1. Grades of Recommendation*

Grade of Recommendation	Clarity of Benefit	Methodologic Strength/Supporting Evidence	Implications
1A	Clear	Randomized trials without important limitations	Strong recommendation; can be applied to most clinical settings
1B	Clear	Randomized trials with important limitations (inconsistent results, nonfatal methodologic flaws)	Strong recommendation; likely to apply to most practice settings
1C +	Clear	Overwhelming evidence from observational studies	Strong recommendation; can apply to most practice settings in most situations
1C	Clear	Observational studies	Intermediate-strength recommendation; may change when stronger evidence is available
2A	Unclear	Randomized trials without important limitations	Intermediate-strength recommendation; best action may differ depending on circumstances or patients' or societal values
2B	Unclear	Randomized trials with important limitations (inconsistent results, nonfatal methodologic flaws)	Weak recommendation; alternative approaches may be better under some circumstances
2C	Unclear	Observational studies	Very weak recommendation; alternative approaches likely to be better under some circumstances
3	Unclear	Expert opinion only	Weak recommendation; likely to change as data become available

*Adapted from Guyatt G, Sinclair J, Cook D, et al. Moving from evidence to action: grading recommendations—a qualitative approach. In: Guyatt G, Rennie D, eds. Users' guides to the medical literature. Chicago: AMA Press; 2002. pp. 599–608.

Table 2. Colonoscopy Indications*

A. Evaluation on barium enema or other imaging study of an abnormality that is likely to be clinically significant, such as a filling defect or stricture
B. Evaluation of unexplained gastrointestinal bleeding
   1. Hematochezia
   2. Melena after an upper gastrointestinal source has been excluded
   3. Presence of fecal occult blood
C. Unexplained iron deficiency anemia
D. Screening and surveillance for colonic neoplasia
   1. Screening of asymptomatic, average-risk patients for colonic neoplasia
   2. Examination to evaluate the entire colon for synchronous cancer or neoplastic polyps in a patient with treatable cancer or neoplastic polyp
   3. Colonoscopy to remove synchronous neoplastic lesions at or around time of curative resection of cancer followed by Colonoscopy at 3 years and 3-5 years thereafter to detect metachronous cancer
   4. After adequate clearance of neoplastic polyp(s) survey at 3- to 5-year intervals
   5. Patients with significant family history
      a. Hereditary nonpolyposis colorectal cancer: Colonoscopy every 2 years beginning at the earlier of age 25 years or 5 years younger than the earliest age of diagnosis of colorectal cancer. Annual Colonoscopy should begin at age 40 years.
      b. Sporadic colorectal cancer before age 60 years: Colonoscopy every 5 years beginning at age 10 years earlier than the affected relative or every 3 years if adenoma is found
   6. In patients with ulcerative or Crohn's pancolitis 8 or more years' duration or left-sided colitis 15 or more years' duration every 1-2 years with systematic biopsies to detect dysplasia
E. Chronic inflammatory bowel disease of the colon if more precise diagnosis or determination of the extent of activity of disease will influence immediate management
F. Clinically significant diarrhea of unexplained origin
G. Intraoperative identification of a lesion not apparent at surgery (e.g., polypectomy site, location of a bleeding site)
H. Treatment of bleeding from such lesions as vascular malformation, ulceration, neoplasia, and polypectomy site (e.g., electrocoagulation, heater probe, laser or injection therapy)
I. Foreign body removal
J. Excision of colonic polyp
K. Decompression of acute nontoxic megacolon or sigmoid volvulus
L. Balloon dilation of stenotic lesions (e.g., anastomotic strictures)
M. Palliative treatment of stenosing or bleeding neoplasms (e.g., laser, electrocoagulation, stenting)
N. Marking a neoplasm for localization

*ASGE. Appropriate use of gastrointestinal endoscopy. Gastrointest Endosc 2000:52:831–7.

Table 3. Indications for Colonoscopy and Appropriate Intervals*

Indication	Interval*
Bleeding	
Positive FOBT	NR
Hematochezia	NR
Iron deficiency anemia	NR
Melena with negative esophagogastroduodenoscopy	NR
Screening	
Average risk	10 y (begin at age 50 y)
Single FDR with cancer (or adenomas) at age ≥60 y	10 y (begin at age 40 y)
≥2 FDRs with cancer (or adenomas) or 1 FDR diagnosed at age <60 y	5 y (begin at age 40 y or 10 y younger, whichever is earlier)
Prior endometrial or ovarian cancer diagnosed at age <50 y	5 y
HNPCC (begin age 20-25 y)	1-2 y
Abdominal pain, altered bowel habitf†	
Positive sigmoidoscopy (large polyp or polyp of <1 cm shown to be an adenoma)‡	
Postadenoma resection	
1-2 tubular adenomas of <1 cm	5-10 y
3-10 adenomas or adenoma with villous features, ≥1 cm or with HGD	3 y
>10 adenomas	<3 y
Sessile adenoma of ≥2 cm, removed piecemeal§	2-6 m
Postcancer resection	Clear colon, then in 1 y, then 3 y, then 5 y
Ulcerative colitis, Crohn's colitis surveillance after 8 y of pancolitis or 15 y of left-sided colitis	2-3 y until 20 y after onset of symptoms, then 1 y

FOBT = Fecal occult blood test; NR = interval not recommended; FDR = first-degree relative; *HNPCC* = hereditary nonpolyposis colorectal cancer; *HGD,* high-grade dysplasia.
*From: Rex DK, Bond JH, Winawer S, et al. Quality in the technical performance of colonoscopy and the continuous quality improvement process for colonoscopy: recommendations of the U.S. Multi-Society Task
Force on Colorectal Cancer. Am J Gastroenterol 2002;97:1296–308. Updated based on guideline revisions in press. Used with permission.
†If colonoscopy has negative results and symptoms are stable, repeat examination should be done according to screening recommendations.
‡See postadenoma resection recommendation.
§The goal is to reexamine the site for residual polyp; repeating a flexible sigmoidoscopy is adequate for a distal polyp.

to minimize as much as possible the number of inappropriate procedures (16–19).

In the average-risk population, colonoscopic screening is recommended in all current guidelines at 10-year intervals (20–22). Direct observational data to support this interval are lacking. However, in a cohort of average-risk persons who underwent an initial colonoscopy with negative results, a repeat colonoscopy 5 years later had a very low yield (23). Two studies of flexible sigmoidoscopy showed that the protective effect of endoscopy with polypectomy was present for intervals of 10 years and 16 years and could not exclude longer durations of effect (24, 25). Thus, although colonoscopy is not perfectly protective, its protective effect is prolonged. These data support the continued use of the 10-year interval.

2. Informed consent is obtained, including specific discussions of risks associated with colonoscopy.

Discussion. As with all other endoscopic procedures, consent must be obtained before the procedure from the patient or guardian on the same day (or as required by local law or per policy of the institution) as the procedure. Consent may be obtained in the procedure room. It must include a discussion of the risks, benefits, and alternatives to the procedure. The risks of endoscopy include bleeding, perforation, infection, sedation adverse events, missed diagnosis, missed lesions, and intravenous site complications.

3. Use of recommended postpolypectomy and post-cancer resection surveillance intervals (Tables 2 and 3).

Discussion. For colonoscopy to be both effective and cost-effective and to minimize risk, the intervals between examinations should be optimized. Intervals between examinations can only be effective in prevention of incident colorectal cancer when the colon is effectively cleared of neoplasia. Therefore, detailed and effective examination of the colon, as discussed below, is critical to the effectiveness of recommended intervals between colonoscopies. The recommended intervals assume cecal intubation, adequate bowel preparation, and careful examination.

Colonoscopy, even when performed carefully, is not expected to prevent all incident colorectal cancers. Some colorectal cancers arise because of genetic factors that make the adenoma-to-carcinoma sequence faster (26). In addition, in some instances, colonoscopic polypectomy may not be effective in eradicating polyps (27). Because colonoscopy can be an expensive procedure and is associated with a low risk of serious consequences, intervals between examinations are recommended on the basis of the best available evidence and experience that indicates a balance between the protective effect of high-quality clearing colonoscopy with the risks and cost of colonoscopy

Recent evidence from 4 surveys indicated that postpolypectomy surveillance colonoscopy in the United States is frequently performed at intervals that are shorter than those recommended in guidelines (28–31) These surveys underscore the importance of measuring intervals between examinations in continuous quality improvement programs. Some

endoscopists in these studies performed colonoscopy in patients with only small hyperplastic polyps or a single tubular adenoma at 1 year, an interval abandoned in guidelines after publication of the National Polyp Study randomized trial in 1993 (32). Surgeons were more likely than gastroenterologists to use short intervals (28). These data underscore the need for endoscopic leaders to promote continuous quality improvement among all specialties practicing colonoscopy in a given community.

Diminutive hyperplastic polyps, when found only in the rectosigmoid colon, can be considered normal. The presence of small distal hyperplastic polyps only should not alter the recommended interval for surveillance. Appropriate intervals in patients with large hyperplastic polyps located in the proximal colon, or in patients who have many hyperplastic polyps (30 or more) are not yet established, but close follow-up may be appropriate (33–34).

Patients who have evidence of colonic bleeding that occurs after a colonoscopy with negative results may need repeat examinations at intervals shorter than those recommended in Tables 2 and 3. However, the use of fecal occult blood testing for the first *5* years after a colonoscopy is discouraged because the positive predictive value of guaiac-based fecal occult blood testing during that interval is extremely low (35). Additional study of fecal immunochemical testing for blood in this setting as an adjunct to colonoscopy is warranted (36).

4. The use of recommended ulcerative colitis and Crohn's colitis surveillance.

Discussion. In ulcerative colitis and Crohn's colitis, surveillance refers to interval examinations of patients with long-standing disease who have undergone an initial examination in which dysplasia is not detected. The term is also used when patients who are asymptomatic are prospectively entered into interval colonoscopy programs on the basis of their duration of disease. Surveillance does not refer to diagnostic examinations or examinations in previously diagnosed patients to assess symptoms. Both ulcerative colitis and Crohn's colitis of long duration are associated with an increased risk of colorectal cancer (37, 38).

There are no randomized trials to support the effectiveness of surveillance colonoscopy in ulcerative colitis or Crohn's colitis, but case control studies in ulcerative colitis suggest a survival benefit for patients who participate in surveillance (39, 40). Surveys of practitioners in the United States (41) and the United Kingdom (42) demonstrate that many practitioners are not familiar with surveillance recommendations, have a poor understanding of dysplasia, and make inappropriate recommendations in response to findings of dysplasia (41, 42).

Patients should be encouraged to undergo surveillance colonoscopy, and surveillance has emerged as a standard of medical care in the United States. The onset of disease is timed to the onset of symptoms for the purpose of timing the initiation of surveillance in both ulcerative colitis and Crohn's colitis. Because the yield of ulcerative colitis in surveillance for cancer and severe dysplasia is relatively low, (43, 44) it is important to not overuse surveillance colonoscopy during the first 20 years because overuse is not cost-effective (45). Shorter intervals between examinations are indicated for patients with long-duration disease and may be initiated earlier in the course of disease in patients with established risk modifiers, such as a family history of colorectal cancer or a personal history of primary sclerosing cholangitis (46, 47). Persons with primary sclerosing cholangitis who are discovered to have asymptomatic ulcerative colitis should begin surveillance at the time ulcerative colitis is diagnosed.

5. Preparation: in every case the procedure note should document the quality of preparation.

Discussion. In each colonoscopy, the colonoscopist should document the quality of the bowel preparation. In clinical trials of bowel preparation, terms used to commonly characterize bowel preparation include "excellent," "good, " "fair," and "poor. " In clinical practice, these terms do not have standardized definitions. In clinical trials on the effectiveness of various laxative regimens for bowel preparation, excellent is typically defined as no or minimal solid stool and only small amounts of clear fluid requiring suctioning. "Good" is typically no or minimal solid stool with large amounts of clear fluid requiring suctioning. "Fair" refers to collections of semisolid debris that are cleared with difficulty. "Poor" refers to solid or semisolid debris that cannot be effectively cleared. These terms can be interpreted as having more to do with retained intraluminal contents that often can be removed by suctioning rather than the quality of inspection allowed after suctionable material has been fully removed; however, these terms are probably reasonable guides to the appropriate use of bowel descriptors.

Poor bowel preparation is a major impediment to the effectiveness of colonoscopy Poor preparation prolongs cecal intubation time and withdrawal time and reduces detection of both small (2) and large (2, 3) polyps. In every colonoscopic practice, some colonoscopies must be repeated at intervals shorter than those recommended in Table 3 because of inadequate preparation. The task force recommends that the procedure be considered adequate if it allows (within the technical limitations of the procedure) detection of polyps 5 mm or larger (11). The economic burden of repeating examinations because of inadequate bowel preparation is substantial (4). No thresholds are recommended by the committee for the percentage of examinations that are repeated for poor preparation because the percentage of patients requiring repeat examination may depend mostly on patient population characteristics. However, measurement of individual practitioners' percentage of examinations requiring repeat because of preparation is recommended. Individual endoscopists may compare their percentages to others within the same practice or to other endoscopists practicing in the same hospital. This can allow identification of outliers within that hospital for whom corrective measures should be taken.

Preprocedure Research Questions

- What are the most effective methods to disseminate guidelines and educate physicians on quality recommendations?
- Why do physicians fail to follow recommended guidelines for screening and surveillance intervals? Do they know the guidelines? Are they concerned about missed lesions?
- Which hyperplastic polyps in the proximal colon are clinically important? What are cost-effective intervals for follow-up after removal of large hyperplastic polyps?
- What is the current understanding among clinicians of surveillance guidelines for ulcerative colitis and Crohn's colitis?
- Can patients with ulcerative colitis be triaged on the basis of endoscopic findings into low- and high-risk groups for surveillance intervals?
- What method would allow same-day bowel preparation in the endoscopy unit in patients with poor preparation? Would this prevent patients with poor preparation from being lost to follow-up?
- What bowel preparation is the best combination of safety, effectiveness, and tolerability?

INTRAPROCEDURE

Quality evaluation of the colon consists of intubation of the entire colon and a detailed mucosal inspection. Cecal intubation improves sensitivity and reduces costs by eliminating the need for radiographic procedures or repeat colonoscopy to complete examination. Careful mucosal inspection is essential to effective colorectal cancer prevention and reduction of cancer mortality. The detection of neoplastic lesions is the primary goal of most colonoscopic examinations.

Cost-benefit analyses of colonoscopy for the detection of neoplastic lesions are well within acceptable rates (approximately $20,000 per year of life saved) (20–22). However, complications, repeat procedures, and inappropriate surgical intervention for endoscopically removable polyps can significantly reduce this benefit. It is incumbent on endoscopists to evaluate their practices and seek to make improvements wherever possible to reduce the costs associated with neoplasia detection.

6. Cecal intubation rates: visualization of the cecum by notation of landmarks and photodocumentation of landmarks should be documented in every procedure.

Discussion. In the United States, colonoscopy is generally undertaken with the intent to intubate the cecum. Cecal intubation is defined as passage of the colonoscope tip to a point proximal to the ileocecal valve so that the entire cecal caput, including the medial wall of the cecum between the ileocecal valve and appendiceal orifice, is visible. The need for cecal intubation is based on the persistent finding that a substantial fraction of colorectal neoplasms are located in the proximal colon, including the cecum (48). Techniques of cecal intubation are discussed elsewhere (49). Cecal intubation should be documented by naming the identified cecal landmarks. Most important, these include the appendiceal orifice and the ileocecal valve. In cases where there is uncertainty as to whether the cecum has been entered, visualization of the lips of the ileocecal valve (ie, the orifice) or intubation of the terminal ileum will be needed. Experienced colonoscopists can verify cecal intubation in real time in 100% of cases, (50) because there is no other portion of the gastrointestinal tract with a similar appearance. It can be helpful to document other landmarks, such as the cecal sling fold or intubation of the terminal ileum.

Photography of the cecum is also recommended. Still photography of the cecum may not be convincing in all cases because of variations in cecal anatomy (50) Thus, the ileocecal valve may not be notched or may not have a lipomatous appearance; however, still photography is convincing in a substantial majority of cases, and its use allows verification of cecal intubation rates of individual endoscopists in the continuous quality improvement program. The best photographs of the cecum to prove intubation are of the appendiceal orifice, taken from a distance sufficiently far away that the cecal strap fold is visible around the appendix, and a photograph of the cecum taken from distal to the ileocecal valve (50). Photographs of the terminal ileum are sometimes convincing if they show villi, circular valvulae connivente, and lymphoid hyperplasia, but they are less likely to be effective compared with the above-mentioned photographs (50). Videotaping of the cecum is not necessary in clinical practice because its feasibility remains low at this time; however, the appearance of the cecum is unmistakable in real time and videotaping of the cecum can be a very effective way of documenting cecal intubation for an examiner whose rates of cecal intubation require verification (50).

Effective colonoscopists should be able to intubate the cecum in $\geq$90% of all cases (51) and in $\geq$95% of cases when the indication is screening in a healthy adult (52). All colonoscopy studies done for screening have reported cecal intubation rates of 97% or higher (52–61). Cases in which procedures are aborted because of poor preparation or severe colitis need not be counted in determining cecal intubation rates. It is also not necessary to count cases in which the initial intent of the procedure is colonoscopic treatment of a benign or malignant stricture or a large polyp (provided that complete colonic imaging by some method has been previously performed). All other colonoscopies, including those in which a previously unknown benign or malignant stricture is encountered, should be counted.

7. Detection of adenomas in asymptomatic individuals (screening).

Discussion. Among healthy asymptomatic patients undergoing screening colonoscopy, adenomas should be detected in $\geq$25% of men and $\geq$15% women more than 50 years old. Measuring adenoma detection rates of individual colonoscopists is a priority in the quality improvement process for colonoscopy for multiple reasons. First, the fundamental goal

of colonoscopy for most indications is detection of neoplastic lesions in the colon. Second, although early studies in the 1990s indicated that colonoscopy and polypectomy prevented 76% to 90% of incident cancers and provided an even higher level of mortality reduction, (62–64) recent studies of adenoma cohorts have demonstrated incident cancer rates after clearing colonoscopy that are substantially higher than those identified in the earlier studies (65–67) and suggest that colonoscopy may provide a lower protection level against incident cancers. Analysis of individual cases in one of these trials suggested that at least a portion of the incident cancers were related to missed lesions (27). Third, recent data from two U.S. practice groups, one in private practice (6) and one in academia, (68) have indicated large disparities between practicing gastroenterologists in their rates of detection of both small and large adenomas. Thus, suboptimal performance of colonoscopy by some practitioners, as evidenced by variable performance, may be a fundamental obstacle to colonoscopy's ability to provide near-complete protection against incident colorectal cancers.

The evolution of evidence regarding missed lesions during colonoscopy is as follows. First, tandem colonoscopy studies in the mid 1990s demonstrated miss rates during colonoscopy for adenomas $\geq$1 cm of 0% to 6%, 12% to 13% for adenomas 6 to 9 mm in size, and 15% to 27% for adenomas $\leq$5 mm in size (69, 70). A tandem study that used flexible sigmoidoscopy confirmed these findings (71). Subsequently, citing the obvious defect of studies using colonoscopy as its own gold standard, (8, 9) centers of excellence in computed tomography (CT)-colonography measured miss rates of conventional colonoscopy of adenomas $\geq$ 1 cm in size of 12% (8) and 17% (9). In these studies, conventional colonoscopy comparisons used the technique of "segmental unblinding." (72) CT-colonography thus far is not usable as a method of measuring miss rates for conventional colonoscopy for adenomas $<$1 cm in size because the sensitivity of CT-colonography is falling more precipitously for polyps $<$ 1 cm than is that of conventional colonoscopy; however, the results of these CT-colonography studies (8, 9) indicate that miss rates calculated by tandem endoscopic studies probably substantially underestimate the miss rates of colonoscopy and sigmoidoscopy for polyps of all sizes. In addition, miss rates of colonoscopy for colorectal cancer have also been identified in two large studies as 5% (73) and 4% (74).

Studies demonstrating variable sensitivity among endoscopists constitute the evidence indicating suboptimal performance as an important factor in the failure of colonoscopy to identify and prevent colorectal cancers. With regard to cancer detection, one study demonstrated miss rates of 3% for gastroenterologists versus 13% for nongastroenterologists; however, miss rates for cancer were 5% for one group of gastroenterologists compared with 1% for all other gastroenterologists studied (73). In a recent study in Canada, higher miss rates for cancer were associated with lesions in the right colon and were higher when colonoscopy was performed by internists or family physicians and when colonoscopy was performed in an office setting (75).

With regard to variable detection of adenomas, a large tandem colonoscopy study involving 26 colonoscopists demonstrated a range of miss rates from 17% to 48% (69). A comparison of withdrawal techniques between the two examiners in this study at the extremes of adenoma detection showed that higher sensitivity was associated with longer examinations, superior examination of mucosa proximal to folds and flexures, better colonic distention, and better cleaning of debris and fluid from the colon (5). A flexible sigmoidoscopy screening study involving 12 endoscopists in the United Kingdom demonstrated a range of detection of adenomas from 21 per 100 examinations to 11 per 100 examinations (76). A private practice group of 12 gastroenterologists in the United States performing screening colonoscopy in adults aged 50 years and older described a range of adenoma detection from $>$100 adenomas per 100 colonoscopies for the highest performer to $<$10% this rate for the lowest performer. Detection of small adenomas correlated with detection of large adenomas. Persons who spent longer than 6 minutes of withdrawal time had a detection rate of adenomas $\geq$1 cm of 6.6% compared with 3% for persons who averaged less than 6 minutes of withdrawal time. A group of 9 academic gastroenterologists in the United States were shown to have detection rates of adenomas during colonoscopy in persons aged 50 years and older that ranged from 86 adenomas per 100 colonoscopies to 21 adenomas per 100 colonoscopies, and a range of prevalences of adenomas $\geq$1 cm of 5.5% to 1.5% (68).

There is a strong interaction between the quality with which the colon is cleared of neoplasia and the effectiveness of recommended intervals for surveillance. Thus, suboptimal performers with low detection rates for large adenomas and for multiple adenomas have recently been demonstrated (6, 68) These individuals will recommend that fewer persons undergo surveillance colonoscopy at 3 years, rather than at 5-year intervals, on the basis of large adenomas or the presence of 3 or more adenomas, although these same colonoscopists have been less effective at clearing the colon of neoplasia. Recommended intervals for surveillance and screening can only have adequate effectiveness when the current disparities between examiners in clearing the colon of neoplasia are improved.

The principal demographic features that predict adenomas at colonoscopy are age and sex and, to a lesser extent, family history of colorectal neoplasia. The indication for the procedure is not a strong predictor of the presence of adenomas (43). Screening colonoscopy studies in the United States have identified adenomas in 25% to 40% of patients more than 50 years old (52–61). The best established neoplasia-related quality indicator is the actual prevalence of adenomas detected. Prevalence rates of adenomas in colonoscopy screening studies have been consistently over 25% in men and 15% in women more than 50 years old (52–61). Although detection of overall numbers of adenomas per colonoscopy could

prove to be the ideal measure of adenoma detection, there are currently insufficient data to establish acceptable compliance rates for this threshold. Overall adenoma prevalence rates correlate with detection rates of large adenomas, (6, 68) are easier to measure and have better established thresholds for acceptable compliance rates. Individuals who reach the primary goals for prevalence rates of adenomas are likely to have a satisfactory withdrawal technique. For these examiners, secondary measures, such as the time taken for withdrawal (see below), are of less importance.

8. Withdrawal times: studies have demonstrated increased detection of significant neoplastic lesions in colonoscopic examinations where the withdrawal time is 6 minutes or more. Mean withdrawal time should be $\geq$6 minutes in colonoscopies with normal results performed in patients with intact colons.

Discussion. In instances of low detection rates of adenomas, measurement of withdrawal time is appropriate as a quality indicator. To measure withdrawal time, the time at which the cecum is reached and the time at which the scope is withdrawn from the anus must be noted. Some electronic report-generating systems allow the time to be noted electronically when cecal photographs are taken. On the basis of the mean withdrawal times of an examiner with very low miss rates (5) and previously cited evidence that the detection rate of large adenomas was greater for examiners who took longer than 6 minutes for withdrawal during screening colonoscopy it is recommended that the withdrawal phase of colonoscopy in patients without previous surgical resection should last at least 6 minutes on average. Application of this standard to an individual case is not appropriate because colons differ in length and in some instances a very well prepared colon of relatively short length and with nonprominent haustral markings can be carefully examined in less than 6 minutes. Further, recent evidence suggests that colonoscopes with a wide angle of view allow quicker examination without increasing miss rates for polyps (77).

9. Biopsy specimens should be obtained from the colon in patients with chronic diarrhea.

Discussion. Patients with microscopic colitis (collagenous and lymphocytic colitis) may have normal-appearing mucosa at colonoscopy. The diagnosis requires biopsy of otherwise unremarkable-appearing colon. All patients undergoing colonoscopy for the evaluation of chronic diarrhea should have biopsy specimens obtained. The optimal number and location of biopsy specimens is not established. Inclusion of samples from the proximal colon improves the sensitivity for collagenous colitis (78, 79).

10. Number and distribution of biopsy samples in ulcerative colitis and Crohn's colitis surveillance. Goal: 4 per 10-cm section of involved colon or approximately 32 biopsy specimens in cases of panulcerative colitis.

Discussion. Systematic biopsy of the colon and terminal ileum can assist in establishing the extent of ulcerative colitis and Crohn's disease and in differentiating ulcerative colitis from Crohn's disease. During surveillance, a systematic biopsy protocol is needed to maximize the sensitivity of surveillance for dysplasia (80). The recommended protocol includes biopsies in all 4 quadrants from each 10 cm of the colon. This typically results in 28 to 32 biopsy samples as a minimum. The procedure report in ulcerative colitis surveillance examinations should note the number and locations of specimens from flat mucosa and the location and endoscopic appearance of any mass or suspicious polypoid lesions that were sampled or removed.

Recent studies have reported that patients with endoscopically abnormal colons (e.g., endoscopic scarring, pseudopolyp formation, or cobblestoning) are at increased risk for development of cancer compared with those with colons that are endoscopically normal (81). Thus, patients with endoscopically normal colons might be triaged to longer intervals of surveillance than those with scarred or endoscopically abnormal colons (81). Recent studies have reported that panchromoscopy of the colon and targeted biopsies results in a higher yield of dysplasia than systematic 4-quadrant biopsies in non-dye-sprayed colons (82, 83) This intriguing observation deserves additional consideration and evaluation.

11. Mucosally based pedunculated polyps and sessile polyps $<$2 cm in size should not be sent for surgical resection without an attempt at endoscopic resection or documentation of endoscopic inaccessibility.

Discussion. Colonoscopists should be able to perform biopsy and routine polypectomy Consistent referral of small "routine" colorectal polyps identified during diagnostic colonoscopy for repeat colonoscopy and polypectomy by others is unacceptable. On the other hand, referral of technically difficult polyps to more experienced endoscopists for endoscopic resection is encouraged (see below).

Patients with sessile polyps $<$2 cm in size should seldom be referred for surgical resection because these polyps are readily resectable in most cases by competent colonoscopists. Consistent referral of sessile polyps $<$2 cm in size for surgical resection is inappropriate. In some cases, these polyps may be difficult to access or properly position for polypectomy, and referral to a more experienced endoscopist may be appropriate.

Certainly endoscopists should not attempt removal of polyps they consider beyond their skill or comfort level, and they should feel comfortable in referring such polyps to other endoscopists for a second opinion (e.g., review of photographs) or endoscopic resection. Many sessile polyps $>$2 cm in size are also removable endoscopically, depending on their location within the colon, their size, and the ability to access them endoscopically. Essentially all mucosally based pedunculated polyps can be removed endoscopically. All polyps referred for surgical resection should be photographed to document the need for surgical resection in the continuous quality improvement process. Review of photographs by a second, more experienced endoscopist can

be useful to ensure the appropriateness of surgical referral. When surgical referral is pursued, correlation of photographs and endoscopic and pathologic measurements of polyp size should be undertaken to confirm the appropriateness of surgical referral.

Intraprocedure Research Questions

- Can electronic report generating systems automate collection of intraprocedural quality indicator data?
- What technical improvements could improve the ease, speed, and safety of colonoscopy?
- Can physicians already in practice with low cecal intubation rates improve? What are effective measures and teaching methods that produce improvement?
- Can physicians with low adenoma detection rates improve? What is needed to produce improvement (i.e., Is slowing down enough? Is additional training needed?)
- What are the key elements of examination by endoscopists with high adenoma detection rates? How can these elements be taught to other colonoscopists? Can such information improve suboptimal performance?
- What technical improvements in colonoscopy can reduce variation between endoscopists in adenoma detection rates (e.g., chromoendoscopy? autofluorescence? narrow-band imaging?)?
- What is the optimal duration of the withdrawal phase with white-light colonoscopy (i.e., at what duration does detection of clinically significant neoplasms plateau?)?
- What technical advances would allow reliable and efficient detection of flat dysplastic tissue without chromoscopy or other practices that reduce efficiency?
- How is dysplasia in flat mucosa, dysplasia associated lesion or mass (DALM), and sporadic adenoma managed in community practice?
- What is the degree of adherence to recommended biopsy protocols for irritable bowel disease in community practice?
- How are large (>2 cm) colon polyps managed in community practice, and does this management differ among colonoscopists in different specialties (e.g., gastroenterologists vs surgeons)?
- What is the success rate of endoscopic resection of large sessile polyps (>2 cm) in community practice?
- What is the optimal biopsy protocol for detection of microscopic colitis?

POSTPROCEDURE

The aspects of postprocedure care that have been discussed in previous sections also apply here. A complete and accurate report, describing the procedure and findings, must be completed immediately after the procedure. The report should include photo documentation of abnormalities and identification of any biopsy specimens obtained. Expectations for follow-up care and determination of who will provide the follow-up should be specified.

The postprocedure interval also provides an opportunity to determine the safety of the procedure as performed by any given endoscopist. Although some complications are discovered immediately, each practitioner should establish a system to contact patients after a period of time to determine whether any delayed complications have occurred. Methods to report and evaluate these complications should be in place so that systematic errors can be discovered and corrected.

12. Incidence of perforation by procedure type (all indications vs screening) is measured.

Discussion. Perforation is the most serious complication in the short term during or after colonoscopy. About 5% of colonoscopic perforations are fatal (84–86) The rates of colonoscopic perforation vary widely in the medical literature. One study from an established endoscopic center reported an overall perforation rate of 1 in 500 in the 1990s (87). A population-based study of Medicare patients reported an overall risk of perforation of 1 in 500 but a risk of less than 1 in 1,000 screening patients (88). A review of screening colonoscopy studies revealed no perforations in the first 6,000 reported cases (11). Expected perforation rates in screening patients are lower because the patients are generally healthy and tend not to have associated colonic conditions that have been associated with perforation, including pseudoobstruction, ischemia, severe colitis, radiation-induced changes, stricture formation, bulky colorectal cancers, more severe forms of diverticular disease, and chronic corticosteroid therapy.

Considering all the available data, perforation rates greater than 1 in 500 overall or greater than 1 in 1,000 in screening patients should raise concerns as to whether inappropriate practices are the cause of the perforations.

Perforations are of two general types. Diagnostic perforations occur as a result of insertion of the colonoscope. They are most commonly mechanical and caused by rupture of the side of the instrument through the rectosigmoid region. They typically result in large rents in the colon that may be recognized during the procedure. Mechanical perforations can also result from barotraumas (89). Barotrauma perforations are the result of pneumatic pressures in the cecum that exceed its bursting pressure. They are most likely to occur when the colonoscope has passed either a stricture or severe diverticular disease and the patient has an ileocecal valve that is competent to air. Barotrauma perforations can probably be avoided in most cases by judicious use of air during insufflation, particularly after passing strictures, perhaps by insufflation of carbon dioxide rather than air, and by ensuring that the air pump and the light source will not continue to insufflate air when intraluminal pressures exceed the bursting pressure of the colon (89). Mechanical perforations can also occur during attempts to pass benign or malignant strictures.

Perforations may also result from polypectomy. In virtually every case, they are the result of the electrocautery burn. The

risk of perforation is greatest with large polyps in the proximal colon. Submucosal saline solution injection polypectomy is now frequently used by gastroenterol-ogists, (90) although no standardized guidelines regarding the size and location of polyps that require submucosal saline solution injection have been developed. In experimental models, injection reduces the chance of electro-cautery damage to the muscularis propria, (91) but no randomized controlled clinical trial has been performed that demonstrates reduction of risk of perforation or post-polypectomy syndrome by injection. Therefore, colonoscopists should be familiar with and comfortable with the technique of submucosal saline solution injection, but clinical judgment is necessary in determining which polyps should undergo submucosal injection.

Anecdotal reports have suggested an increased risk of complications associated with the use of hot biopsy forceps, (92) and forceps removal of small polyps reduces the chance of complete removal (93). Cold snaring is attractive for the removal of small polyps because it effectively removes small polyps and has been associated with exceedingly low risks of complications (94–96). Cold snaring often results in immediate bleeding that is of no clinical significance and allows effective retrieval of polyps (9).

13. Incidence of postpolypectomy bleeding is measured.

Discussion. Bleeding is the most common complication of polypectomy (84–86, 97, 98) Bleeding can be either immediate (during the procedure) or delayed. In general, the use of blended or cutting current is associated with an increased risk of immediate bleeding, whereas pure low-power coagulation is associated with a greater risk of delayed bleeding (99, 100). In clinical practice, the use of pure low-power coagulation or blended current is common, and the use of pure cutting current for polypectomy is rare (90).

Endoscopic series suggests that the overall risk for postpolypectomy bleeding should be less than 1% (84–86, 97, 98). Overall, bleeding rates for polypectomy that exceed this rate should prompt review by experts from within or outside the institution regarding whether polypectomy practices are appropriate. In general, the risk of bleeding increases with the size of the polyps and with a more proximal colonic location. For polyps larger than 2 cm, particularly in the proximal colon, bleeding rates may exceed 10% (97, 98, 101, 102).

Inclusion of epinephrine in submucosal injection fluid has been shown to reduce the risk of immediate bleeding (103, 104) but not delayed bleeding. Because the overall risk of immediate bleeding with pure low-power coagulation current is low and immediate bleeding can generally be treated successfully by experienced endoscopists, there is no mandate to include epinephrine in injection fluid. Many experts prefer pretreatment of pedunculated polyps with thick stalks by epinephrine injection or placement of detachable snares. Two trials have demonstrated benefit from the use of detachable snares (104, 105). However, the clinical benefit may be marginally significant, and therefore the use of detachable snares in clinical practice for pedunculated polyps is not mandated.

14. Postpolypectomy bleeding should be managed nonoperatively. In the presence of continuous bleeding, repeat colon examination and endoscopic treatment of polypectomy sites results in successful hemostasis.

Discussion. In general, >90% of postpolypectomy bleeding can be managed nonoperatively. Immediate postpolypectomy bleeding can generally be treated effectively by endoscopic means and should seldom require operative treatment. After transection, immediate bleeding from the stalk of the pedunculated polyp can be treated by regrasping the stalk and holding it for 10 to 15 minutes. This causes spasm in the bleeding artery. Immediate bleeding can also be treated by application of clips (106) or by injection of epinephrine, followed by application of multipolar cautery (107).

Delayed bleeding frequently stops spontaneously (107). In-hospital observation may be appropriate if the patient has comorbidities or lives far from the treating physician. Repeat colonoscopy in patients who have stopped bleeding is optional and should be performed at the discretion of the colonoscopist. Patients seen for delayed bleeding who are continuing to pass bright red blood are usually having an arterial hemorrhage. Prompt repeat colonoscopy, which may be performed without bowel preparation, (107) is warranted. Treatment can be either by application of clips (106) or by injection in combination with multipolar cautery (107). Multi-polar cautery is generally applied at low power, without forceful tamponade (especially in the proximal colon), and continued until there is subjective cessation of bleeding. Findings in the base of the bleeding polypectomy site can include an actively bleeding visible vessel, a non-bleeding visible vessel, an apparent clot without bleeding, or an apparent clot with bleeding. Rebleeding seldom occurs after postpolypectomy bleeding has either stopped spontaneously or from endoscopic therapy.

Postprocedure Research Questions

- What are the causes of colonoscopic perforations in population-based studies? How many perforations are avoidable by improved training, altered technique, or new or improved techniques?
- Do perforation rates vary in clinical practice by specialty or by extent of training or duration of experience?
- Can efficient methods for endoscopic removal of large sessile polyps be developed that substantially reduce or eliminate the risk of bleeding or perforation?
- Does cold resection definitely reduce small polypectomy complications?
- Does submucosal injection definitely reduce large sessile polyp perforation rates?

Table 4. Summary of Proposed Quality Indicators for Colonoscopy*

Quality indicator	Grade of Recommendation
1. Appropriate indication	1C +
2. Informed consent is obtained, including specific discussion of risks associated with colonoscopy	3
3. Use of recommended postpolypectomy and postcancer resection surveillance intervals	1A
4. Use of recommended ulcerative colitis/Crohn's disease surveillance intervals	2C
5. Documentation in the procedure note of the quality of the preparation	2C
6. Cecal intubation rates (visualization of the cecum by notation of landmarks and photo documentation of landmarks should be present in every procedure)	1C
7. Detection of adenomas in asymptomatic individuals (screening)	1C
8. Withdrawal time: mean withdrawal time should be >6 minutes in colonoscopies with normal results performed in patients with intact anatomy	2C
9. Biopsy specimens obtained in patients with chronic diarrhea	2C
10. Number and distribution of biopsy samples in ulcerative colitis and Crohn's colitis surveillance. Goal: 4 per 10-cm section of involved colon or approximately 32 specimens per case of pancolitis	1C
11. Mucosally based pedunculated polyps and sessile polyps < 2 cm in size should be endoscopically resected or documentation of unresectabiltiy obtained	3
12. Incidence of perforation by procedure type (all indications vs screening) is measured	2C
13. Incidence of postpolypectomy bleeding is measured	2C
14. Postpolypectomy bleeding managed nonoperatively	1C

*This list of potential quality indicators was meant to be a comprehensive listing of measurable end points. It is not the intention of the task force that all end points be measured in every practice setting. In most cases, validation may be required before a given end point may be universally adopted.

CONCLUSION

Reduction in variation of quality has emerged as an important priority for colonoscopy practice. The continuous quality improvement process should be instituted and embraced in all colonoscopy practices. This article summarizes current evidence and expert consensus on quality indictors to be used in this process (Table 4). The task force has attempted to create a comprehensive list of potential quality indicators. We recognize that not every indicator will be applicable to every practice setting. Facilities should select the subset most appropriate to their individual needs.

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