Quality Indicators for Colonoscopy

Douglas K. Rex, MD, Philip S. Schoenfeld, MD, MSEd, MSc (Epi), Jonathan Cohen, MD, Irving M. Pike, MD, Douglas G. Adler, MD, M. Brian Fennerty, MD, John G. Lieb II, MD, Walter G. Park, MD, MS, Maged K. Rizk, MD, Mandeep S. Sawhney, MD, MS, Nicholas J. Shaheen, MD, MPH, Sachin Wani, MD and David S. Weinberg, MD, MSc

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Colonoscopy is widely used for the diagnosis and treatment of colon disorders. Properly performed, colonoscopy is generally safe, accurate, and well-tolerated. Visualization of the mucosa of the entire large intestine and distal terminal ileum usually is possible during colonoscopy. Polyps can be removed during colonoscopy, thereby reducing the risk of colon cancer. Colonoscopy is the preferred method to evaluate the colon in most adult patients with large-bowel symptoms, iron deficiency anemia, abnormal results on radiographic studies of the colon, positive results on colorectal cancer (CRC) screening tests, postpolypectomy and post-cancer resection surveillance, and diagnosis and surveillance in inflammatory bowel disease. In addition, colonoscopy is the most commonly used CRC screening test in the United States (1). Based on 2010 data, over 3.3 million outpatient colonoscopies are performed annually in the United States, with screening and polyp surveillance accounting for half of indications (2).

Optimal effectiveness of colonoscopy depends on patient acceptance of the procedure, which depends mostly on acceptance of the bowel preparation (3). Preparation quality affects the completeness of examination, procedure duration, and the need to cancel or repeat procedures at earlier dates than would otherwise be needed (4,5). Ineffective preparation is a major contributor to costs (6). Meticulous inspection (7,8) and longer withdrawal times (9–14) are associated with higher adenoma detection rates (ADR). A high ADR is essential to rendering recommended intervals (15) between screening and surveillance examinations safe (16,17). Optimal technique is needed to ensure a high probability of detecting dysplasia when present in inflammatory bowel disease (17–21). Finally, technical expertise and experience will help prevent adverse events that might offset the benefits of removing neoplastic lesions (22).

Recent studies report that colonoscopy is less effective in preventing proximal colon cancer and cancer deaths (ie, colon cancer proximal to the splenic flexure) compared with distal cancer (ie, colon cancer at or distal to the splenic flexure) (23–28). Decreased protection against right-sided CRC is likely due to multiple factors. These include missed adenomas or incompletely resected adenomas; suboptimal bowel preparation; precancerous lesions that are endoscopically subtle or difficult to remove, such as sessile serrated polyps and flat and/or depressed adenomas, and differences in tumorigenesis between right-sided and left-sided cancers. Improving prevention of right-sided colon cancer is a major goal of colonoscopy quality programs.

Five studies have established that gastroenterologists are more effective than surgeons or primary care physicians at preventing CRC by colonoscopy (27,29–32). This most likely reflects higher rates of complete examinations (ie, cecal intubation) (30) and higher rates of adenoma detection among gastroenterologists (33,34). All endoscopists performing colonoscopy should measure the quality of their colonoscopy. Institutions where endoscopists from multiple specialties are practicing should reasonably expect all endoscopists to participate in the program and achieve recommended quality benchmarks.

The quality of health care can be measured by comparing the performance of an individual or a group of individuals with an ideal or benchmark (35). The particular parameter that is being used for comparison is termed a quality indicator. A quality indicator often is reported as a ratio between the incidence of correct performance and the opportunity for correct performance (4) or as the proportion of interventions that achieve a predefined goal (35). Quality indicators can be divided into 3 categories: (1) structural measures—these assess characteristics of the entire health care environment (eg, participation by a physician or other clinician in systematic clinical database registry that includes consensus endorsed quality measures), (2) process measures—these assess performance during the delivery of care (eg, ADR and adequate biopsy sampling during colonoscopy for chronic ulcerative colitis), (3) outcome measures—these assess the results of the care that was provided (eg, the prevention of cancer by colonoscopy and reduction in the incidence of colonoscopic perforation).

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METHODOLOGY

In 2006, the American Society for Gastrointestinal Endoscopy (ASGE)/American College of Gastroenterology (ACG) Task Force on Quality in Endoscopy published their first version of quality indicators for colonoscopy (36). The present update integrates new data pertaining to previously proposed quality indicators and new quality indicators for performing colonoscopy (36). Indicators that had wide-ranging clinical application, were associated with variation in practice and outcomes, and were validated in clinical studies were prioritized. Clinical studies were identified through a computerized search of Medline followed by review of the bibliographies of all relevant articles. When such studies were absent, indicators were chosen by expert consensus. Although feasibility of measurement was a consideration, it is hoped that inclusion of highly relevant, but not yet easily measurable indicators, would promote their eventual adoption. Although a comprehensive list of quality indicators is proposed, it is recognized that, ultimately, only a small subset might be widely used for continuous quality improvement, benchmarking, or quality reporting. As in 2006, the current task force concentrated its attention on parameters related to endoscopic procedures; whereas the quality of care delivered to patients is clearly influenced by many factors related to the facilities in which endoscopy is performed, characterization of unit-related quality indicators was not included in the scope of this effort.

The resultant quality indicators were graded on the strength of the supporting evidence (**Table 1**). Each quality indicator was classified as an outcome or a process measure. Although outcome quality indicators are preferred, some can be difficult to measure in routine clinical practice, because they need analysis of large amounts of data and long-term follow-up and may be confounded by other factors. In such cases, the task force deemed it reasonable to use process indicators as surrogate measures of high-quality endoscopy. The relative value of a process indicator hinges on the evidence that supports its association with a clinically relevant outcome, and such process measures were emphasized.

The quality indicators for this update were written in a manner that lends them to be developed as measures. Although they remain quality indicators and not measures, this document also contains a list of performance targets for each quality indicator. The task force selected performance targets from benchmarking data in the literature when available. When no data were available to support establishing a performance target level, "N/A" (not available) was listed. However, when expert consensus considered failure to perform a given quality indicator a "never event" such as monitoring vital signs during sedation, then the performance target was listed as >98%. It is important to emphasize that the performance targets listed do not necessarily reflect the standard of care but rather serve as specific goals to direct quality improvement efforts.

Quality indicators were divided into 3 time periods: pre-procedure, intraprocedure, and postprocedure. For each category, key relevant research questions were identified.

In order to guide continuous quality improvement efforts, the task force also recommended a high-priority subset of the indicators described, based on their clinical relevance and importance, evidence that performance varies significantly in clinical practice, and feasibility of measurement (a function of the number of procedures needed to obtain an accurate measurement with narrow confidence intervals and the ease of measurement). A useful approach for an individual endoscopist is to first measure their performances with regard to these priority indicators. Quality improvement efforts would move to different quality indicators

Table 1. Grades of recommendation[a]

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

[a]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, editors. Users' guides to the medical literature. Chicago: AMA Press; 2002. p. 599-608.

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if the endoscopists are performing above recommended thresholds, or the employer and/ or teaching center could institute corrective measures and remeasure performance of low-level performers.

Recognizing that certain quality indicators are common to all GI endoscopic procedures, such items are presented in detail in a separate document, similar to the process in 20 06 (37,38). The preprocedure, intraprocedure, and postprocedure indicators common to all endoscopy are listed in **Table 2**. Those common factors will be discussed in this document only insofar as the discussion needs to be modified specifically to relate to colonoscopy.

Preprocedure quality indicators

The preprocedure period includes all contacts between members of the endoscopy team and the patient before the administration

Table 2. Summary of proposed quality indicators common to all endoscopic procedures (38)[a]

Quality indicator	Grade of recommendation	Measure type	Performance target (%)
Preprocedure			
1. Frequency with which endoscopy is performed for an indication that is included in a published standard list of appropriate indications, and the indication is documented (priority indicator)	1C+	Process	>80
2. Frequency with which informed consent is obtained and fully documented	3	Process	>98
3. Frequency with which preprocedure history and directed physical examination are performed and documented	3	Process	>98
4. Frequency with which risk for adverse events is assessed and documented before sedation is started	3	Process	>98
5. Frequency with which prophylactic antibiotics are administered for appropriate indication (priority indicator)	Varies	Process	>98
6. Frequency with which a sedation plan is documented	Varies	Process	>98
7. Frequency with which management of antithrombotic therapy is formulated and documented before the procedure (priority indicator)	3	Process	N/A
8. Frequency with which a team pause is conducted and documented	3	Process	>98
9. Frequency with which endoscopy is performed by an individual who is fully trained and credentialed to perform that particular procedure	3	Process	>98
Intraprocedure			
10. Frequency with which photodocumentation is performed	3	Process	N/A
11. Frequency with which patient monitoring during sedation is performed and documented	3	Process	>98
12. Frequency with which the doses and routes of administration of all medications used during the procedure are documented	3	Process	>98
13. Frequency with which use of reversal agents is documented	3	Process	>98
14. Frequency with which procedure interruption and premature termination due to sedation-related issues is documented	3	Process	>98
Postprocedure			
15. Frequency with which discharge from the endoscopy unit according to predetermined discharge criteria is documented	3	Process	>98
16. Frequency with which patient instructions are provided	3	Process	>98
17. Frequency with which the plan for pathology follow-up is specified and documented	3	Process	>98
18. Frequency with which a complete procedure report is created	3	Process	>98
19. Frequency with which adverse events are documented	3	Process	>98
20. Frequency with which adverse events occur	3	Outcome	N/A
21. Frequency with which postprocedure and late adverse events occur and are documented	3	Outcome	N/A
22. Frequency with which patient satisfaction data are obtained	3	Process	N/A
23. Frequency with which communication with referring provider is documented	3	Process	N/A

N/A, not available.

[a]This list of potential quality indicators is meant to be a comprehensive list 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 adopted universally.

of sedation or insertion of the endoscope. Common issues for all endoscopic procedures during this period include: appropriate indication, informed consent, risk assessment, formulation of a sedation plan, management of prophylactic antibiotics and antithrombotic drugs, and timeliness of the procedure (38). Preprocedure quality indicators specific to performance of colonoscopy include the following:

1. Frequency with which colonoscopy is performed for an indication that is included in a published standard list of appropriate indications, and the indication is documented

Level of evidence: 1C+

Performance target: >80%

Type of measure: process

The ASGE has published appropriate indications for colonoscopy (**Table 3**) (39). An appropriate indication should be documented for each procedure, and when it is a nonstandard indication, it should be justified in the documentation. When performing colonoscopy for average-risk CRC screening or colon polyp surveillance, endoscopists should specifically document whether the patient had a colonoscopy previously, date of the last colonoscopy (or document that the date of that procedure is not available), and any histologic findings from polyps removed during that colonoscopy.

Discussion: In 2012, the ASGE updated its indications for endoscopic procedures (39). This list was determined by a review of published literature and expert consensus. Studies have shown that when colonoscopy is done for appropriate reasons, significantly more clinically relevant diagnoses are made (40–42). 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 a <20% inappropriate rate (43). The European Panel on the Appropriateness of Gastrointestinal Endoscopy Internet guideline is a useful decision support tool for determining the appropriateness of colonoscopy (43). The goal is to minimize the number of inappropriate procedures (44–46).

Table 3. Appropriate indications for colonoscopy (39)

Evaluation of an abnormality on barium enema or other imaging study that is likely to be clinically significant, such as a filling defect or stricture
Evaluation of unexplained GI bleeding
Hematochezia
Melena after an upper GI source has been excluded
Presence of fecal occult blood
Unexplained iron deficiency anemia
Screening and surveillance for colon neoplasia
Screening of asymptomatic, average-risk patients for colon neoplasia
Examination to evaluate the entire colon for synchronous cancer or neoplastic polyps in a patient with treatable cancer or neoplastic polyp
Colonoscopy to remove synchronous neoplastic lesions at or around the time of curative resection of cancer followed by colonoscopy at 1 year and, if examination normal, then 3 years, and, if normal, then 5 years thereafter to detect metachronous cancer
Surveillance of patients with neoplastic polyps
Surveillance of patients with a significant family history of colorectal neoplasia
For dysplasia and cancer surveillance in select patients with long-standing ulcerative or Crohn's colitis
For evaluation of patients with chronic inflammatory bowel disease of the colon, if more precise diagnosis or determination of the extent of activity of disease will influence management
Clinically significant diarrhea of unexplained origin
Intraoperative identification of a lesion not apparent at surgery (eg, polypectomy site, location of a bleeding site)
Treatment of bleeding from such lesions as vascular malformation, ulceration, neoplasia, and polypectomy site
Intraoperative evaluation of anastomotic reconstructions (eg, evaluation for anastomotic leak and patency, bleeding, pouch formation)
As an adjunct to minimally invasive surgery for the treatment of diseases of the colon and rectum
Management or evaluation of operative adverse events (eg, dilation of anastomotic strictures)
Foreign body removal
Excision or ablation of lesions
Decompression of acute megacolon or sigmoid volvulus
Balloon dilation of stenotic lesions (eg, anastomotic strictures)
Palliative treatment of stenosing or bleeding neoplasms (eg, laser, electrocoagulation, stenting)
Marking a neoplasm for localization

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2. Frequency with which informed consent is obtained, including specific discussions of risks associated with colonoscopy, and fully documented

Level of evidence: 1C

Performance target: >98%

Type of measure: process

In addition to the risks associated with all endoscopic procedures, the consent should address the relevant and substantial adverse events pertaining to each specific colonoscopy procedure.

Discussion: As with all other endoscopic procedures, consent must be obtained before the procedure from the patient or guardian (or as required by local law or per policy of the institution). It must include a discussion of the risks, benefits, and alternatives to the procedure. The most common risks of colonoscopy include bleeding, perforation, infection, sedation-related adverse events, missed lesions, and intravenous site adverse events.

3. Frequency with which colonoscopies follow recommended post-polypectomy and post-cancer resection surveillance intervals and 10-year intervals between screening colonoscopies in average-risk patients who have negative examination results and adequate bowel cleansing (priority indicator)

Level of evidence: 1A

Performance target: ≥90%

Type of measure: process

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 be effective in prevention of incident CRC only when the colon is effectively cleared of neoplasia. Therefore, detailed and effective examination of the colon, as discussed in the following, is critical to the effectiveness and safety of recommended intervals between colonoscopy. The recommended intervals assume cecal intubation, adequate bowel preparation, and careful examination. In the average-risk population (persons aged ≥50 years without other risk factors for CRC or who have only one first-degree relative with CRC and that cancer was diagnosed at age >60 years), colonoscopic screening is recommended in all past and current guidelines at 10-year intervals (15,47,48). A German case-control study found that a negative screening colonoscopy result was associated with >20 years of protection against colorectal cancer (49). In cohorts of average-risk persons who underwent an initial colonoscopy with a negative result, a repeat colonoscopy 5 years later had a very low yield (50,51). Two studies of flexible sigmoidoscopy found a protective effect of endoscopy with polypectomy lasting 10 years and 16 years and could not exclude longer durations of protection (52,53). Thus, although colonoscopy is not perfectly protective, its protective effect is prolonged. These data support the 10-year interval, but many American colonoscopists systematically perform screening colonoscopy at 5-year intervals in average-risk individuals (54). This practice is not cost-effective, exposes patients to excess risk, and cannot be justified.

When performing colonoscopy for CRC screening, endoscopists should document under "indication for procedure" whether the patient previously had a colonoscopy, date of the last colonoscopy, and any histologic findings from polyps removed during that colonoscopy if that information is available. This documentation should demonstrate that colonoscopy for CRC screening or colon polyp surveillance is being performed at an appropriate interval.

Evidence from surveys indicates that post-polypectomy surveillance colonoscopy in the United States is frequently performed at intervals that are shorter than those recommended in guidelines (55–60), that knowledge of guideline recommendations is high, and lack of guideline awareness is unlikely to account for overuse of colonoscopy. Assessments of actual practice identified both overuse of surveillance examination in low-risk patients and underuse in high-risk patients (61).

An assessment of Medicare colonoscopy codes demonstrated systematic overuse of colonoscopy for screening and post-polypectomy surveillance by some physicians (54). These surveys underscore the importance of measuring intervals between examinations in continuous quality improvement programs. Surgeons were more likely to use short intervals than were gastroenterologists (55), emphasizing the need for all specialties practicing colonoscopy to participate in quality programs. Primary care and other referring physicians can reasonably expect surveillance recommendations to reflect post-polypectomy surveillance recommendations or to be accompanied by an explanation indicating why the recommended interval differs from the guideline.

Intervals between examinations are recommended based on 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. Intervals are determined by the numbers, size, and specific histology of precancerous lesions (15). Patients with sessile polyps >2 cm in size that are removed piecemeal have a high risk for residual polyp at the polypectomy site and require short-term follow-up at 3 to 6 months (15) and a second examination a year later to rule out a late recurrence of polyp at the site (62). Recommended post-polypectomy surveillance intervals for sessile serrated polyps (also called sessile serrated adenomas) and traditional serrated adenomas currently are based on limited evidence and will be subject to updating as new evidence appears (15). Serrated lesions include hyperplastic polyps, sessile serrated polyps, and traditional serrated adenomas. Serrated lesions, particularly the sessile serrated polyp, are considered the precursors of a substantial group of CRCs that arise predominantly in the proximal colon. At this time, consensus post-polypectomy surveillance intervals for sessile serrated polyps are similar to recommended intervals for adenomas and are based on size and number of lesions (15). Serrated lesions of all types should be counted to identify patients who meet the criteria for serrated polyposis, formerly known as hyperplastic polyposis syndrome, for which colonoscopy is recommended at 1 to 2-year intervals (15).

Patients who have suspected colon bleeding after a negative colonoscopy result may require repeat examinations at intervals shorter than those recommended.

However, the use of fecal occult blood testing by using guaiac-based tests for the first 5 years after a colonoscopy is inappropriate because the positive predictive value of guaiac-based fecal occult

blood testing during that interval is extremely low (63). Additional study of fecal immunochemical testing for blood in this setting as an adjunct to colonoscopy is warranted (64).

Colonoscopies performed for screening or surveillance at intervals shorter than those recommended in guidelines and without an appropriate explanation for the shortened interval should be considered to have an inappropriate indication.

4. Frequency with which ulcerative colitis and Crohn's colitis surveillance is recommended within proper intervals

Level of evidence: 2C

Performance target: ≥90%

Type of measure: process

Discussion: In ulcerative colitis and Crohn's colitis, surveillance refers to interval examinations in patients with long-standing disease who have undergone an initial examination in which dysplasia was not detected. The term also is used when patients who are asymptomatic are prospectively entered into interval colonoscopy programs based on the 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 (65,66). Surveillance colonoscopy often is recommended beginning 7 to 10 years after the onset of symptoms when ulcerative colitis extends beyond the rectum or in Crohn's disease when more than one third of the colon is involved. 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 indicate a survival benefit for patients who participate in surveillance (67,68). Surveys of practitioners in the United States (69) and the United Kingdom (70) 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 (69,70).

Patients should undergo surveillance colonoscopy, which has emerged as a standard of medical care in the United States. The onset of disease is considered to be the onset of symptoms for the purpose of initiating surveillance for both ulcerative colitis and Crohn's colitis. Because the yield of dysplasia or cancer during ulcerative colitis surveillance is relatively low and not cost-effective (71), it is important to avoid overuse of surveillance colonoscopy during the first 20 years (72). At between 7 and 20 years of disease, intervals of 2 to 3 years are generally adequate, assuming the absence of primary sclerosing cholangitis and a colon that is without severe scarring (71). Indeed, recent studies continue to indicate that the risk for CRC in chronic ulcerative colitis has been overestimated in previous decades (18,73). 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 CRC or a personal history of primary sclerosing cholangitis (71). Persons with primary sclerosing cholangitis who are discovered to have asymptomatic ulcerative colitis should begin surveillance at the time ulcerative colitis is diagnosed. Patients with endoscopically abnormal colons (eg, endoscopic scarring, pseudopolyp formation or cobblestoning, chronic severe inflammation) are at increased risk for development of cancer, compared with patients with endoscopically normal colons (74). Thus, patients with endoscopically normal colons, or with only mild abnormalities, can be triaged to longer intervals of surveillance of at least 2 to 3 years, at least during the interval from 7 to 20 years after the onset of symptoms, and assuming the absence of primary sclerosing cholangitis (74).

Preprocedure research questions

1. Why do physicians fail to follow recommended guidelines for screening and surveillance intervals? Are they concerned about missed lesions? Is there fear of litigation? What interventions will maximize adherence to guideline recommendations?
2. Which serrated lesions in the proximal colon are clinically important? What are cost-effective intervals for follow-up after removal of sessile serrated polyps and large (>10 mm) hyperplastic polyps?
3. Does the incidence of splenic injury during colonoscopy warrant inclusion in the informed consent process?
4. What is the current understanding among clinicians of surveillance guidelines for ulcerative colitis and Crohn's colitis?
5. How will new reimbursement models affect compliance with recommended surveillance intervals?
6. Can and should surveillance interval recommendations be adjusted for endoscopists with high-level versus low-level baseline ADRs? Does the presence of 3 small adenomas warrant high-risk surveillance for endoscopists with high ADRs?

Intraprocedure quality indicators

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 the examination. Careful mucosal inspection is essential to effective CRC 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) (75). However, adverse events, repeat procedures, and inappropriate surgical intervention for endoscopically removable polyps can reduce this benefit significantly. It is incumbent on endoscopists to evaluate their practices and make improvements wherever possible to reduce the costs associated with neoplasia detection.

The intraprocedure period extends from the administration of sedation, or insertion of the endoscope when no sedation is given, to the removal of the endoscope. This period includes all the technical aspects of the procedure including completion of the examination and of therapeutic maneuvers. Common to most endoscopic procedures is the provision of sedation and need for

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patient monitoring (38). Intraprocedure quality indicators specific to performance of colonoscopy include the following:

5. Frequency with which the procedure note documents the quality of preparation

Level of evidence: 3

Performance target: ≥98%

Type of measure: process

Quality of bowel preparation is based on ability to visualize the mucosa after retained stool and fluid have been suctioned away.

Discussion: The endoscopist should document the quality of the bowel preparation in each colonoscopy (76,77). Terms commonly used to characterize bowel preparation include *excellent, good, fair,* and *poor.* In clinical practice, these terms do not have standardized definitions (78). They are given standardized definitions in clinical trials of bowel preparation (79), but these trials often take into account retained fluid, which is of little interest to the examination because it can be readily suctioned. Some practitioners use the terms *adequate* or *inadequate.* The ASGE/ACG task force recommends that the examination be considered adequate if it allows detection of (within the technical limitations of the procedure) polyps >5 mm in size (80). Another option is to use independently validated preparation scores, such as the Boston Bowel Preparation Scale (81) or the Ottawa Bowel Preparation Scale (82). However, the Ottawa scale also takes into account retained material that can be removed before examination. Regardless of the scoring system used, endoscopists should document the quality of bowel preparation based on ability to identify polyps after retained fluid or stool has been suctioned.

If bowel cleansing is inadequate to identify polyps >5 mm in size, and the procedure is being performed for CRC screening or colon polyp surveillance, then the procedure should be repeated in 1 year or less (15). Adequate preparation carries the implication that the recommended interval before the next colonoscopy will be consistent with guidelines (15).

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 (4) and large (4,5,83) polyps. In every colonoscopic practice, some colonoscopies must be repeated at intervals shorter than those recommended (15,84) based on inadequate preparation. The economic burden of repeating examinations because of inadequate bowel preparation is substantial (6).

6. Frequency with which the bowel preparation is adequate to allow the use of recommended surveillance or screening intervals

Level of evidence: 3

Performance target: ≥85% of outpatient examinations

Type of measure: process

We recommend that the percentage of outpatient examinations with inadequate bowel preparation that require repeat colonoscopy in ≤1 year should not exceed 15% (5). Measurement of an individual practitioner's percentage of examinations requiring repetition because of inadequate preparation is recommended. Endoscopists who have >15% of examinations with inadequate bowel preparation should re-examine their bowel preparation protocols, including patient education, choice of purgative, and protocol for administering the purgative, including use of the split-dose protocol. Recent clinical trials of even low-volume preparations (which have lower effectiveness than 4-liter preparations) suggest that these rates of adequate preparation are readily achievable in outpatients by using split-dose preparation (85,86). Socioeconomic factors and language barriers in some patient populations may require increased educational efforts before the colonoscopy to achieve this level of success.

The most important determinant of preparation quality is the interval between the end of the preparation ingestion and the start of the procedure (87). Quality diminishes as the interval increases, and the right side of the colon is particularly affected. We recommend that all patients be prescribed split-dosing of bowel preparations, meaning that half the preparation is given on the day of the examination (87). For afternoon colonoscopies, the entire preparation can be ingested on the day of examination (88). According to fasting guidelines of the American Society of Anesthesiologists, patients should have nothing by mouth for 2 h after ingestion of clear liquids (89). We recommend that rule be followed for ingestion for split-dose and same-day preparations. This recommendation is supported by prospective observational studies that demonstrate that residual volume of liquid in the stomach is minimal (<25 ml) and similar whether patients split the bowel preparation or consume all of the bowel preparation on the evening before the procedure (90). However, because this study (90) excluded patients with gastroparesis, longer intervals may be prudent in those with conditions such as gastroparesis or achalasia (increased risk of larger volumes of retained fluid), those with central nervous system dysfunction that might be more inclined to aspirate, or in those with cardiac, pulmonary, or immunologic disease in whom a small aspiration event might be devastating.

Patients should receive instruction to begin the second half of split-dose preparations 4 to 5 h before their scheduled procedure start time, and they should be finished with ingestion by at least 2 h before that time (89). Because the quality of preparation deteriorates as the preparation-to-procedure interval increases, patients scheduled in the early morning (before 9 AM) who refuse to begin ingestion 4 to 5 h before the scheduled time can begin ingestion of the second half of the preparation late on the evening before (after 11 PM) and maintain reasonable preparation quality, although true split dosing is preferred.

7. Frequency with which visualization of the cecum by notation of landmarks and photodocumentation of landmarks is documented in every procedure (priority indicator)

Level of evidence: 1C

Performance targets: cecal intubation rate with photography (all examinations), ≥90% cecal intubation rate with photography (screening), ≥95%

Type of measure: process

Discussion: In the United States, colonoscopy is almost always 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. Low cecal intubation rates have been associated with higher rates of interval proximal colon cancer (30). Techniques of cecal intubation are discussed elsewhere (91). Cecal intubation should be documented by naming the identified cecal landmarks. Most importantly, these include the appendiceal orifice and the ileocecal valve. For cases in which 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 their cases (92), because there is no other portion of the GI tract with 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 mandated. Still photography of the cecum may not be convincing in all cases because of variations in cecal anatomy (92). Thus, the ileocecal valve may not be notched or may not have a lipomatous appearance. Nevertheless, 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 (92). Photographs of the terminal ileum are sometimes convincing if they show villi, circular valvulae conniventes, and lymphoid hyperplasia, but they are less likely to be effective compared with the earlier-mentioned photographs (92). 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 (92). Effective colonoscopists should be able to intubate the cecum in ≥90% of all cases (93) and ≥95% of cases when the indication is screening in a healthy adult.(94–106) Colonoscopy studies in screening patients in the United States, and at times from outside the United States, have reported cecal intubation rates of 97% or higher (94–106).

Cases in which procedures are aborted because of poor preparation or severe colitis need not be counted in determining cecal intubation rates, provided that photo-documentation is provided to support the decision to abort the examination. 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 in the colon distal to the cecum (provided that complete colon imaging by some method has been performed previously). All other colonoscopies, including those in which a previously unknown benign or malignant stricture is encountered, should be counted.

8. Frequency with which adenomas are detected in asymptomatic, average-risk individuals (screening) (priority indicator)

Level of evidence: 1C

Performance targets: ADR for male/female population, ≥25% (for men ≥30%, for women ≥20%)

Type of measure: outcome

Discussion: An enormous amount of literature has identified evidence of failed detection by colonoscopists including failure to detect adenomas in tandem colonoscopy studies (107) and in CT colonography studies that used segmental unblinding (108,109). Colonoscopy fails to prevent all CRC in colonoscopy cohorts followed for up to 3 years after the procedure (23–28), with most of the post-colonoscopy cancers attributable to missed lesions (110), and contributions from incomplete polypectomy (111) as well as variation in growth patterns and rates (112,113). There is evidence of marked variation in the detection of adenomas by colonoscopists within practice groups (114–117). This variation became the rationale for the creation of targets for adenoma detection, originally proposed in 2002 (80) and largely adopted by the ASGE/ACG task force in 2006 (36,118). The proposed measure for detection was the fraction of patients undergoing screening colonoscopy who had one or more adenomas detected, now known as the adenoma detection rate or ADR (36,80,118). The recommended targets for ADR were based on screening colonoscopy studies and were set at levels slightly below the mean detection rates of adenomas in those studies (80). Thus, the recommendation has previously been that individual colonoscopists should identify one or more adenomas in at least 25% of men and 15% of women aged ≥50 years undergoing screening colonoscopy (36,80,118). The rationale to set these targets below the mean prevalence of adenomas and well below the true prevalence of adenomas (as defined by autopsy studies and high-level detectors during colonoscopy) was very limited, and these initial targets reflected a clear bias that the greatest contributors to failure to prevent cancer are endoscopists with very low ADRs. In 2010, a Polish study of screening colonoscopy provided validation for the targets, finding that patients undergoing colonoscopy by physicians with ADRs below 20% had hazard ratios for development of post-colonoscopy cancer>10 times higher than patients of physicians with ADRs above 20% (16). However, this study had limited power to establish that cancer protection continues to improve when ADRs rise above 20%. One other study found that physicians with high polypectomy rates protected patients from right-sided cancer better than physicians with low polypectomy rates (30). Recent studies report ADRs that are much higher than the original targets and have, in some cases, exceeded 50% (119,120). There had been evidence that individual examiners reach ADRs above 40% (114,115). These observations suggest that raising the ADR target above 20% for a male/female population might have benefit, but evidence that increasing the target results in either improved cancer prevention or increased detection of advanced lesions has been lacking. Recently, Corley *et al* (121) presented the association of ADR in 223,842 patients undergoing 264,792 colonoscopies by 136 gastroenterologists. Patients were followed from their baseline examinations for either 10 years or until they

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had another colonoscopy with negative results, left the health care system, or were diagnosed with CRC. The ADRs of the gastroenterologists ranged from 7.4% to 52.5% and were arranged in quintiles for study purposes. The patients ultimately developed 712 interval cancers. The unadjusted risks for interval cancer in the ADR quintiles from highest to lowest were 4.8, 7.0, 8.0, 8.6, and 9.8 cases per 10,000 person-years of follow-up. Patients of physicians in the highest ADR quintile had an adjusted risk of interval cancer of 0.52 (95% CI, 0.39–0.69) compared with patients of physicians in the lowest ADR quintile. There was a 3% reduction in CRC incidence and a 5% reduction in cancer mortality for each 1% increase in ADR. Higher ADRs were associated with a reduced risk of both proximal and distal cancer and reduced risk in both men and women (121). Based on this new evidence, the task force now recommends a new minimum target for overall ADR (ADR in a male/female population aged ≥50 years undergoing screening colonoscopy) of at least 25%. Because some endoscopists perform colonoscopy for primarily male or female patients (eg, endoscopists in Veterans Affairs hospitals or female endoscopists with largely female patient populations), an ADR target of 30% is recommended for men and 20% for women. Colonoscopy programs may choose to calculate individual colonoscopists' ADRs for male and female patients separately in some instances. Data from a registry of screening patients indicate that these targets are at the mean level of performance in current gastroenterology practice (Irving Pike, personal communication based GIQuIC registry) and, thus, are already achieved by many endoscopists in routine colonoscopic practice. All colonoscopists should have their ADRs measured, and colonoscopists with ADRs below 25% overall must take steps to improve performance. Although these new targets represent current understanding of ADR performance needed to optimize CRC prevention, they should not be considered a standard of care. Rather, they should be used as performance targets in the quality improvement process.

The principal factors that determine adenoma prevalence are age and sex; both are accounted for in the recommended targets (ADR should be measured in patients aged ≥50 years, and there are separate targets for men and women). Other influences on adenoma prevalence include cigarette smoking, obesity, and diabetes mellitus (47). Adjustment of the target ADR for different prevalences of these factors is not currently recommended.

ADR is considered the primary measure of the quality of mucosal inspection and the single most important quality measure in colonoscopy. There is a substantial interaction between ADR and recommended intervals for screening and surveillance, so that optimal patient safety cannot be correctly predicted without knowledge of both an adequate ADR and adherence to recommended intervals. Colonoscopists with high ADRs clear colons better and bring patients back at shorter intervals because the recommended intervals are shorter when precancerous lesions are detected. Colonoscopists with low ADRs fail to identify patients with precancerous lesions and find fewer patients with multiple lesions, putting patients at risk for cancer by failure to clear the colon and recommending inappropriately long intervals between examinations. This interaction emphasizes the essential nature of knowing the ADR of individual colonoscopists to ensure adequate patient protection (122).

One issue regarding ADR is whether it represents the best overall measure of the quality of mucosal inspection with regard to discrimination of quality, feasibility of measurement, and resistance to gaming (induction of behaviors directed toward meeting the target but not toward optimizing detection of precancerous lesions and cost effectiveness). ADR does require manual entry of pathology data in most instances, which requires additional work for the endoscopist or endoscopy unit. A second problem is that it rewards a "one and done" approach to colonoscopy: after identifying one polyp with the endoscopic appearance of an adenoma, the endoscopist stops examining the remaining mucosa as carefully. In some cases one and done results from reimbursement policies that typically pay for only one polypectomy regardless of the number of polypectomies performed. Several alternatives to ADR have been proposed, and two deserve mention here.

The polyp detection rate (PDR) is the number of patients with ≥1 polyp removed during screening colonoscopy in patients aged ≥50 years. PDR has the advantage of not requiring manual entry of pathology data and correlates well with ADR in several studies (123–126). Conversion rates for PDR to ADR have been proposed (123). A Canadian study demonstrated a correlation between polypectomy rates and cancer protection (30). However, whether PDR remains an accurate correlate to ADR when used prospectively in quality improvement programs has not been studied. Furthermore, PDR could be susceptible to gaming, in that it includes removal of the only class of colorectal polyps not considered to have a risk of becoming cancer (ie, distal colon diminutive hyperplastic polyps). Unlike ADR, PDR can be measured by using claims data by payers or others outside the institution performing colonoscopy. Given the ease of application of PDR, prospective studies of its use are desirable and considered necessary to establish its appropriateness. Until these studies are performed, PDR is not endorsed as a quality indicator to be used independently of ADR.

A second measure that warrants consideration is the adenoma per colonoscopy (APC) rate, which is now commonly used in clinical trials of detection (119,120). APC reflects inspection over the entire length of the colon better than ADR and provides greater separation between endoscopists (114). APC might lead to increased pathology costs if colonoscopists were expected or inclined to put each polyp in a different container to prove APC, but this problem could be overcome by use of photography to prove detection of multiple adenomas. APC also overcomes the problem of "one and done." Currently, APC is considered to be the most promising alternative to ADR, and additional study is recommended to identify best thresholds and establish mechanisms to ensure that it does not lead to increased costs.

In the future, ADR may be stratified based on size of adenoma (ADR for adenomas ≥1 cm), location of adenoma (ADR for right-sided versus left-sided adenomas), or polyp histology. The importance of separate targets for serrated lesions deserves particular attention. Targets for ADR were established by using studies reporting detection of conventional adenomas and do not apply to serrated lesions (80). Certainly, the terminology is confusing (eg,

a sessile serrated polyp/adenoma is not an adenoma—the great majority of these lesions have no dysplasia). These lesions are in a separate class from conventional adenomas and should not be counted toward the ADR. Recent evidence has shown that there is more variation between members of the same gastroenterology group in detection of these lesions (127,128) than is seen for conventional adenomas (114–117), indicating that missing polyps is a greater problem for these lesions than it is for conventional adenomas. Additional support for the concept that missed serrated lesions are important is the finding that post-colonoscopy cancers are more likely to be CIMP-high, MSI-high, and located in the proximal colon (112,113). Whether there should be a separate detection target for serrated lesions is the subject of current investigation, with one study suggesting a target of 5% for all serrated lesions (hyperplastic plus sessile serrated polyps) in the proximal colon (129). A new target may not be needed if ADR and proximal colon serrated lesion detection are sufficiently correlated (127,128). Further, the target would need to be set for proximal serrated lesions because targeting distal colon hyperplastic lesions is undesirable. A proximal colon target would be subject to substantial problems with lesion location and perhaps gaming of location. The best target would be sessile serrated polyps, but the pathologic distinction between sessile serrated polyp and hyperplastic polyp is subject to marked interobserver variation in pathologic interpretation (130,131), making sessile serrated polyps nonviable as a detection target. Finally, although ADR and PDR have been shown to correlate with colon cancer protection, this has not yet been demonstrated for other proposed markers.

Future approaches to measurement of the quality of mucosal inspection may have to account for an evolving approach to diminutive polyp management called "resect and discard" (132,133). Resect and discard means that endoscopists would estimate the pathology of diminutive polyps based on visual examination by using image enhancement and then resect and dispose of the lesions without submitting tissue to pathology for histologic evaluation. Under these circumstances, a high-quality endoscopic image would serve as the record of the polyp and the endoscopic estimation of its pathologic type.

The goal of most colonoscopies is the detection and prevention of CRC. ADR is now designated an outcome measure because of the extensive evidence that it correlates directly with CRC and predicts effective prevention of CRC (16,30,121). This correlation is partly because colonoscopists with higher ADRs are more likely to be accurate when they designate patients as having polyp-free colons. In addition, however, adenoma detection and resection directly prevent CRC and CRC mortality (30,134). Because CRC prevention is an ideal outcome, and because effective polyp detection or resection are clearly established as the mechanism by which colonoscopy produces prevention, ADR is now designated an outcome measure.

9a. Frequency with which withdrawal time is measured

Level of evidence: 2C

Performance target: >98%

Type of measure: process

9b. Average withdrawal time in negative-result screening colonoscopies

Level of evidence: 2C

Performance target: ≥6 min average

Type of measure: process

Withdrawal time should be measured in all colonoscopy examinations, with the performance target being a ≥6 min average withdrawal time in negative-result screening colonoscopies.

Discussion: Studies have demonstrated increased detection of significant neoplastic lesions in colonoscopic examinations in which the average withdrawal time is ≥6 min. We recommend that mean withdrawal time should be ≥6 min in normal-result colonoscopies performed for CRC screening in average-risk patients with intact colons. However, withdrawal time is secondary to ADR as a quality measure. Reporting mean withdrawal times to colonoscopists with ADRs above targets may not be essential or useful. The primary utility of withdrawal time may be in correcting performance of colonoscopists with substandard ADRs (135). Retrospective studies, which are of substantial value in understanding behaviors associated with detection, clearly demonstrate an association between longer withdrawal time and higher detection rates (7–14). Careful examination of the colon takes time, which is why studies show an association between time and detection. Any colonoscopist may benefit from education regarding withdrawal technique, and better technique is likely to be accompanied by increased withdrawal time. Therefore, we recommend that the withdrawal phase of colonoscopy in patients without previous surgical resection, and in whom no biopsies or polypectomies are performed, should last ≥6 min on average. Each of the previous recommendations has specified that the application of this standard to an individual case is not appropriate (36,80,118), because colons differ in length, and in some instances a very well-prepared colon of relatively short length and without prominent haustral markings can be carefully examined in <6 min. This caveat is reiterated here, but colonoscopists should be aware that anecdotal cases abound where the 6-minute standard has been applied to medicolegal cases involving a post-colonoscopy cancer and alleged negligent performance of colonoscopy.

10. Frequency with which biopsy specimens are obtained when colonoscopy is performed for an indication of chronic diarrhea

Level of evidence: 2C

Performance target: >98%

Type of measure: process

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 biopsies is not established, but ≥8 are recommended. Inclusion of samples from the proximal colon improves the sensitivity for collagenous colitis (17,136).

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11. Frequency of recommended tissue sampling when colonoscopy is performed for surveillance in ulcerative colitis and Crohn's colitis

Level of evidence: 1C

Performance target: >98%

Type of measure: process

Performance of pancolonic chromoendoscopy with targeted biopsies or 4 biopsies per 10-cm section of involved colon (or approximately 32 biopsies in cases of pan-ulcerative 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. Recent randomized controlled trials have established that pancolonic chromoendoscopy with targeted biopsies results in fewer biopsies and better identification of dysplasia (19–21). Alternatively, a systematic biopsy protocol can be used (74). The recommended protocol includes biopsies in 4 quadrants from each 10 centimeters of the colon, which typically results in 28 to 32 biopsies. The procedure report in ulcerative colitis surveillance examinations should note the number and locations of biopsies from flat mucosa and the location and endoscopic appearance of any mass or suspicious polypoid lesions that called for biopsy or removal.

12. Frequency with which endoscopic removal of pedunculated polyps and sessile polyps <2 cm is attempted before surgical referral

Level of evidence: 3

Performance target: >98%

Type of measure: outcome

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 other more experienced endoscopists for endoscopic resection is encouraged.

In some centers, polyps <2 cm in size have been referred for surgical resection (137), but such are almost invariably endoscopically resectable, if not in routine colonoscopic practice then by expert colonoscopists (138). 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 another, more experienced endoscopist may be appropriate.

Endoscopists should not attempt removal of polyps they consider beyond their skills or comfort levels and should feel comfortable in referring such polyps to other endoscopists for a second opinion (eg, review of photographs) or endoscopic resection. Many sessile polyps >2 cm in size are removable endoscopically, depending on their location within the colon, their size, and the ability to access them endoscopically (139,140). Endoscopic resection is more cost effective and safer than surgical resection (137). If referral to another endoscopist is anticipated for resection of a large sessile lesion, then the endoscopist should avoid snare resection of any part of the polyp if possible, because such a partial resection will result in a false-positive non-lifting sign that can make the subsequent attempt at endoscopic resection more difficult. Essentially all mucosa-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. Both benign and malignant lesions sent for surgical resection that are not in an area that can be indentified with certainty by endoscopy (eg, the cecum and proximal ascending colon where the cecum is still endoscopically visible and the rectum) should be marked with ample submucosal injection of carbon black in 3 to 4 quadrants to ensure resection of the correct segment. If the tattoo cannot be located during surgery, intraoperative colonoscopy is needed to resolve the correct location.

Intraprocedure research questions

1. What is the most clinically relevant rating system for bowel preparation quality?
2. What tools can improve patient and physician awareness and use of split-dose and same-day dosing of bowel preparation?
3. What factors are associated with an increased risk of having an inferior bowel preparation, and what interventions can overcome such variations?
4. Can PDR replace ADR when used prospectively without distorting behaviors (eg, increasing resection of distal colon hyperplastic polyps or normal polypoid tissue)?
5. Does improving ADR (or PDR) as part of a quality improvement effort result in lower CRC rates?
6. Is there significant interobserver variation when photo-documentation of cecal landmarks is reviewed?
7. Is APC a practical and cost-effective measure of the quality of mucosal inspection?
8. Are ADR and proximal serrated lesions correlated? Is a separate detection target for proximal colon serrated lesions necessary and practical to implement?
9. Should surveillance follow-up recommendations be altered when colonoscopy is performed by endoscopists with high ADRs? For example, would patients in this category with 3 or more adenomas, all of which are diminutive tubular adenomas, still require follow-up colonoscopy in 3 years?
10. Does detection of advanced lesions continue to increase as the overall ADR increases?
11. For screening programs that use fecal occult blood or immunochemistry testing to select patients for colonoscopy, can ADR be used as a quality metric and at what benchmarks?

12. Which technical adjuncts or imaging tools, if any, improve adenoma detection, especially by colonoscopists with low ADRs?
13. What is the optimal duration of the withdrawal phase by using white-light colonoscopy (ie, at what duration does detection of clinically significant neoplasms plateau)?
14. Does chromoendoscopy improve targeted biopsies over high-definition white-light colonoscopy in chronic ulcerative colitis?
15. What is the degree of adherence to recommended biopsy protocols or use of chromoendoscopy for inflammatory bowel disease in community practice?
16. How often are patients with polyps <2 cm inappropriately undergoing surgical rather than endoscopic resection?
17. How are large (>2 cm) colon polyps managed in community practice, and does this management differ among colonoscopists in different specialties (eg, gastroenterologists vs surgeons)?
18. What is the success rate of endoscopic resection of large sessile polyps (>2 cm) in community practice?
19. What polypectomy methods optimize completeness of resection of serrated lesions?
20. How will the need to document ADR for quality reporting influence the development of optical biopsy for the interpretation of small polyps?

Postprocedure quality indicators

The postprocedure period extends from the time the endoscope is removed to subsequent follow-up. Postprocedure activities include providing instructions to the patient, documentation of the procedure, recognition and documentation of adverse events, pathology follow-up of, communication with referring physicians, and assessing patient satisfaction (38). Postprocedure quality indicators specific to performance of colonoscopy include the following:

13. Incidence of perforation by procedure type (all indications versus CRC screening/polyp surveillance) and post-polypectomy bleeding

Level of evidence: 1C

Performance targets:

Incidence of perforation—all examinations, <1:500

Incidence of perforation—screening, <1:1000

Incidence of post-polypectomy bleeding, <1%

Type of measure: outcome

Perforation rates also may be stratified based on use of therapeutic polypectomy with snare or application of cautery with forceps versus cold biopsy forceps only.

Discussion: Perforation is generally considered the most serious adverse event presenting in the short term during or after colonoscopy. About 5% of colonoscopic perforations are fatal. Published rates of colonoscopic perforation vary widely (141–154), and few studies on this topic have been reported in the past 5 years. A population-based study of Medicare patients reported an overall risk of perforation of 1 in 500, but risk of less than 1 in 1000 screening patients (145). Expected perforation rates in screening patients are lower because the patients are generally healthy and tend not to have associated colon conditions that have been associated with perforation, including pseudoobstruction, ischemia, severe colitis, radiation, stricture formation, bulky colorectal cancers, more severe forms of diverticular disease, and chronic corticosteroid therapy.

Considering all of the available data, perforation rates >1 in 500 overall or >1 in 1000 in screening patients should initiate review by an endoscopy unit medical director or another expert to determine whether insertion or polypectomy practice are inappropriate.

Technical factors that result in perforation as well as those steps that prevent perforation are not fully understood or proven effective. Generally accepted advice includes the following. The colonoscopist should not continue to push against fixed resistance. Loops and bends in the insertion tube should be removed as soon as possible. Consider use of a more flexible instrument (eg, pediatric colonoscope or up per endoscope) when there is severe diverticular disease, sigmoid fixation, radiated colon, Crohn's colitis, or otherwise significantly diseased colon. Avoidance of electrocautery in resection of diminutive polyps and some small (6–9 mm) polyps, in favor of cold resection techniques (particularly cold snaring), has proven remarkably safe (155,156). Submucosal injection likely reduces risk during EMR. A guidewire passed through strictures before an attempt to push an endoscope through can prevent the instrument tip from sliding off the stricture and dissecting the adjacent colon wall. Caution should be used in dilating long strictures. In general, graded dilation with inspection of strictures before increasing dilator size can help control the depth of tear created. Insufflation of carbon dioxide rather than air may reduce the risk of barotrauma perforations, particularly in patients with partial obstruction or with pseudoobstruction. Perforations that are recognized during the procedure may be effectively closed by the use of metallic hemostatic clips (157) or by large clips that are mounted over the end of the endoscope for application (158).

Perforation rates can be very difficult to track over time, especially in colonoscopists with low procedure volumes. An alternative approach is to have the circumstances of all perforations reviewed and tracked by the endoscopy unit medical director or by an outside expert. This "sentinel event" approach can lead to changes in systems and changes in physician practice that reduces patient risk in future examinations.

Bleeding is the most common adverse event of polypectomy (141–143,159,160). Bleeding can be 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 (161,162). In clinical practice, the use of pure low-power coagulation or blended current are both common, and the use of pure cutting current for polypectomy is rare (163).

Endoscopic series suggests that the overall risk of post-polypectomy bleeding should be <1% (141,142,159,160).

Overall, bleeding rates that exceed 1% 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 polyp size, proximal colon location, anticoagulation, and use of antiplatelet agents such as clopidogrel

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(164). For polyps >2 cm in size, particularly in the proximal colon, bleeding rates may exceed 10% (62,138,159,160,165).

Technical measures that help reduce immediate bleeding include epinephrine injection for sessile or pedunculated polyps (166,167) and detachable loops for pedunculated polyps (167,168). Cold resection techniques have not been associated with delayed hemorrhage from diminutive polyps and some small (6–9 mm) polyps. Effective methods of reducing delayed bleeding from large sessile and flat lesions remains uncertain but, as noted earlier, the risk may be related to cautery type. Some experts advocate the use of microprocessor-controlled alternating coagulation and/or cutting currents to limit thermal injury and reduce the delayed bleeding risk when these lesions are resected (140), but controlled evidence is lacking.

14. Frequency with which post-polypectomy bleeding is managed without surgery

Level of evidence: 1C

Performance target: ≥90%

Type of measure: outcome

In ongoing bleeding, repeat colon examination and endoscopic treatment of polypectomy sites results in successful hemostasis.

Discussion: In general, >90% of post-polypectomy bleeding can be managed without surgery. Immediate post-polypectomy bleeding can generally be treated effectively by endoscopic means and should seldom require operative treatment. Immediate bleeding from the stalk of a pedunculated polyp after transection can be treated by re-grasping the stalk and holding it for 10 or 15 min. This causes spasm in the bleeding artery. Immediate bleeding also can be treated by application of clips or by injection of epinephrine (169), followed by application of multipolar cautery (170). Immediate bleeding is not considered an adverse event unless it results in hospitalization, transfusion, or surgery.

Risk factors for delayed bleeding include large polyp size, proximal colon location, anticoagulation, and possibly the use of low-power coagulation current for electrocautery (159,160). Delayed bleeding frequently stops spontaneously (170). 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 who present with delayed bleeding and are continuing to pass bright red blood usually are having an ongoing arterial hemorrhage. Prompt repeat colonoscopy, which may be performed without bowel preparation (170), is warranted. Treatment can be by application of clips (169) or injection in combination with multipolar cautery (170). Multipolar cautery is generally applied at low power, without forceful tamponade (especially in the proximal colon) and is 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. Repeat bleeding seldom occurs after postpolypectomy bleeding has stopped spontaneously or from endoscopic therapy.

15. Frequency with which appropriate recommendation for timing of repeat colonoscopy is documented and provided to the patient after histologic findings are reviewed

Level of evidence: 1A

Performance standard: ≥90%

Type of measure: process

Discussion: Colonoscopic screening is recommended in all current guidelines at 10-year intervals in the average-risk population (15,47,48,171), at 5 to 10-year intervals among patients with 1 or 2 small (<10 mm) tubular adenomas, at 5-year intervals when there is a history of advanced adenomas on previous colonoscopies, and at 3-year-intervals for patients with>3 small adenomas, an adenoma with villous features or high-grade dysplasia, or an adenoma>1 cm in size. However, assessments of Medicare colonoscopy codes demonstrated systematic overuse of colonoscopy for screening and polyp surveillance by some physicians (54). This practice is not cost effective and it exposes patients to excess risk, and its systematic performance cannot be justified.

Endoscopists should specifically document a recommendation for a repeat colonoscopy at 10-year intervals after a normal screening colonoscopy in an average-risk patient. If polyps are removed, then the pathology data should be used to document recommendations regarding timing for repeat colonoscopy.

Post-procedure research questions

1. How many perforations are avoidable by improved training, altered technique, or new or improved technology?
2. Do perforation rates vary in clinical practice by specialty or by extent of training or duration of experience?
3. Do different types of electrocautery used for polypectomy current definitely affect adverse event rates and to what extent?
4. Does prophylactic clipping of non-bleeding, large polypectomy sites prevent delayed adverse events?
5. Does cold snare resection definitely reduce adverse events from resection of small polyps?
6. Does submucosal injection definitely reduce large sessile polyp perforation rates?
7. Which polypectomy maneuvers can be performed safely in patients who must continue to take anticoagulants or antiplatelet agents?
8. Are delayed bleeding rates reduced by the use of clips or loops after polypectomy among patients who need to resume anticoagulation therapy?
9. Does application of cautery to the edge of large, piecemeal-resected polyps reduce the incidence of incomplete polypectomy?
10. Does the application of chromoendoscopy or optical contrast endoscopy reduce the incidence of incomplete polypectomy?
11. Can software programs be developed to reliably integrate pathology data fields directly into the endoscopy database and eliminate the need for manual entry?

Priority indicators for colonoscopy

For colonoscopy, the recommended priority indicators are (1) ADR, (2) use of recommended intervals between colonoscopies performed for average-risk CRC screening and colon polyp surveillance, and (3) cecal intubation rate with photographic documentation (**Table 5**). For each of these indicators, reaching the recommended performance target is considered strongly associated with important clinical outcomes. These indicators can

Table 4. Summary of proposed quality indicators for colonoscopy[a]

Quality indicator	Grade of recommendation	Measure type	Performance target (%)
Preprocedure			
1. Frequency with which colonoscopy is performed for an indication that is included in a published standard list of appropriate indications, and the indication is documented	1C+	Process	>80
2. Frequency with which informed consent is obtained, including specific discussions of risks associated with colonoscopy, and fully documented	1C	Process	>98
3. Frequency with which colonoscopies follow recommended post-polypectomy and post-cancer resection surveillance intervals and 10-year intervals between screening colonoscopies in average-risk patients who have negative examination results and adequate bowel cleansing (priority indicator)	1A	Process	≥90
4. Frequency with which ulcerative colitis and Crohn's colitis surveillance is recommended within proper intervals	2C	Process	≥90
Intraprocedure			
5. Frequency with which the procedure note documents the quality of preparation	3	Process	>98
6. Frequency with which bowel preparation is adequate to allow the use of recommended surveillance or screening intervals	3	Process	≥85 of outpatient examinations
7. Frequency with which visualization of the cecum by notation of landmarks and photodocumentation of landmarks is documented in every procedure (priority indicator)	1C	Process	
Cecal intubation rate with photography (all examinations)			≥90
Cecal intubation rate with photography (screening)			≥95
8. Frequency with which adenomas are detected in asymptomatic average-risk individuals (screening) (priority indicator)	1C	Outcome	
Adenoma detection rate for male/female population			≥25
Adenoma detection rate for male patients			≥30
Adenoma detection rate for female patients			≥20
9a. Frequency with which withdrawal time is measured	2C	Process	>98
9b. Average withdrawal time in negative-result screening colonoscopies	2C	Process	≥6 min
10. Frequency with which biopsy specimens are obtained when colonoscopy is performed for an indication of chronic diarrhea	2C	Process	>98
11. Frequency of recommended tissue sampling when colonoscopy is performed for surveillance in ulcerative colitis and Crohn's colitis	1C	Process	>98
12. Frequency with which endoscopic removal of pedunculated polyps and sessile polyps <2 cm is attempted before surgical referral	3	Outcome	>98
Postprocedure			
13. Incidence of perforation by procedure type (all indications vs colorectal cancer screening/polyp surveillance) and post-polypectomy bleeding	1C	Outcome	
Incidence of perforation—all examinations			<1:500
Incidence of perforation—screening			<1:1000
Incidence of post-polypectomy bleeding			<1%
14. Frequency with which post-polypectomy bleeding is managed without surgery	1C	Outcome	≥90
15. Frequency with which appropriate recommendation for timing of repeat colonoscopy is documented and provided to the patient after histologic findings are reviewed	1A	Process	≥90

[a]This list of potential quality indicators is 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 adopted universally.

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be measured readily in a manageable number of examinations and, for each, there is evidence of substantial variation in performance (122). In addition, there is evidence for both ADR and the use of recommended screening and surveillance intervals that simple educational and corrective measures can improve performance (172).

Correction of poor performance

The primary purpose of measuring quality indicators is to improve patient care by identifying poor performers and retraining them or removing privileges to perform colonoscopy if performance cannot be improved. When individual colonoscopists have ADRs below the recommended threshold, they must demonstrate improvement. Corley (172) recently reviewed the developing literature on improving detection. Retrospective studies provide overwhelming evidence that withdrawal time is positively associated with detection (7–14), but forcing colonoscopists to observe longer withdrawal times is generally not effective in improving detection (172), probably because studies with negative results typically have not included specific instruction about how the increased time should be used (173).

If endoscopists with low ADRs are not using split-dose preparation, they should immediately switch to split dosing. The two most effective interventions regarding colonoscopy skills for improving ADR have both involved education (135,174), which should include information on the spectrum of precancerous lesions. The task force recommends instruction in the Paris classification (175) to emphasize the importance of flat and depressed lesions and review of photographs of flat and depressed conventional adenomas (176) and serrated lesions (177). Education also should include instruction in withdrawal technique that has been repeatedly associated with improved detection, including probing the proximal sides of folds, cleaning up pools of retained fluid and mucus, and ensuring adequate distention of the entire colon (7,178).

Finally, technical adjuncts to imaging can be considered (179). Electronic chromoendoscopy (Olympus narrowband imaging, Fujinon Intelligent Chromo Endoscopy, Pentax i-scan) has been ineffective in improving detection, but the investigators were typically endoscopists with high ADRs (179). One study suggested that narrowband imaging induced a learning effect that improved white-light detection in endoscopists with low ADRs (180). Conventional chromoendoscopy has produced gains in detection of tiny adenomas and, in a large recent randomized trial, produced a nearly significant increase in detection of advanced adenomas (181). A recent meta-analysis indicated that cap-fitted colonoscopy produces small gains in detection of small adenomas (182). A tandem study found improved detection with the Third-Eye Retroscope, but failed to control withdrawal times in the two study arms (183). These technologies should be tested specifically for their capacity to improve detection by endoscopists with low ADRs. Pending such studies, even case studies of their effect on endoscopists with low ADRs would be of interest.

Colonoscopists who cannot improve their detection rates to reach recommended ADR thresholds through education and technical measures should have their colonoscopy privileges removed, because current evidence indicates that low-level detection endangers patients (16). This recommendation holds for colonoscopists of all specialties.

Table 5. Priority quality indicators for colonoscopy[a]

Frequency with which adenomas are detected in asymptomatic average-risk individuals (screening)
Frequency with which colonoscopies follow recommended post-polypectomy and post-cancer resection surveillance intervals and 10-year intervals between screening colonoscopies in average-risk patients who have negative examination results and adequate bowel cleansing
Frequency with which visualization of the cecum by notation of landmarks and photodocumentation of landmarks is documented in every procedure

[a]See text for specific targets and discussion.

CONCLUSION

Reduction in variation in 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 created a comprehensive list of potential quality indicators along with a set of performance targets based on benchmarking data where available. These proposals reflect a significant evolution from the first set of indicators described in 2006 (36), both in terms of what is feasible to measure and in terms of evidence about best practices and association with outcome. For the first time, the task force recommends 3 priority quality indicators that every colonoscopy practice should track (**Table 5**). Practices that are initiating the quality process should focus on the priority indicators first. The performance of high-quality colonoscopy and its documentation in a quality improvement program is the most important role of the colonoscopist in the multi-specialty effort to reduce CRC incidence and mortality.

ABBREVIATIONS

ACG, American College of Gastroenterology; ADR, adenoma detection rate; APC, adenoma per colonoscopy; ASGE, American Society for Gastrointestinal Endoscopy; CRC, colorectal cancer; PDR, polyp detection rate

CONFLICT OF INTEREST

Dr Rex has been a member of the Speaker's Bureaus for Olympus, Braintree, and Boston Scientific, received research support grants from Given Imaging, Olympus, and Braintree, has been a member of the Scientific Advisory Boards for Given Imaging, American BioOptics, CheckCap, Epigenomics, and Exact Sciences, and has been a consultant for EndoAid, Ltd. Dr Shaheen received research grant support from Covidien Medical, CSA Medical, and Takeda Pharmaceuticals. All other authors disclosed no financial relationships relevant to this publication.

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