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Quality indicators for colorectal cancer screening for colonoscopy ”

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Abstract

The growing importance of colonoscopy in the prevention of colorectal cancer has stimulated an effort to identify and track quality indicators for this procedure. Several factors have been identified so far which are readily measurable and in many cases have been associated with improved patient outcomes. There is also ample evidence of variations in performance of this procedure. As a result, gathering data about quality indicators may play a vital role in the process of continuous quality improvement. Quality indicators for colonoscopy in colorectal cancer prevention are described along with the evidence that supports their use in benchmarking, quality reporting, and continuous quality improvement.

Keywords

Quality indicators; Colonoscopy; Colon cancer; Colon polyps; Screening; Surveillance

1. Introduction

Based on 2010 data, more than 3.3 million outpatient colonoscopies are performed annually in the United States, and colonoscopy for colorectal cancer (CRC) screening and colon polyp surveillance accounts for approximately 50% of colonoscopies [1]. The use of colonoscopy has become accepted as the most effective method of screening the colon for neoplasia in patients older than 50 years. A growing body of evidence demonstrating the benefit of colonoscopy along with variations in performance has driven a large effort to identify and track quality indicators for this procedure.

The ability to perform an effective colonoscopy starts before the procedure with bowel preparation because the entire colon needs to be adequately visualized. Suboptimal preparation often results in incomplete examinations such as the need to extend procedure duration or cancellation of procedures. Suboptimal bowel cleansing is a major contributor to increased costs as examinations may have to be repeated at earlier dates than would otherwise be needed [2,3]. A completely clean colon permits meticulous inspection of the mucosa [2,3], which combined with longer withdrawal times [4-9], is associated with higher adenoma detection rates (ADR). Full visualization of the colon lumen is crucial to

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recommend appropriate intervals [10] between examinations and promotes safety during procedures [11]. Optimal colon cleansing should be part of all colonoscopy quality programs.

CRC screening with colonoscopy in the proximal or right side of the colon (proximal to the splenic flexure) differs from that in the left side of the colon (distal to the splenic flexure). Recent studies demonstrate that colonoscopy is substantially less effective in preventing proximal colon cancer and cancer deaths compared with distal cancer [12-17]. This finding may be related to multiple factors that could potentially lead to missed precancerous adenomatous colon polyps (adenomas) or incompletely resected adenomas, including suboptimal bowel preparation, difficult to identify and completely remove adenomas, such as flat and depressed lesions and those located behind folds, and other precancerous colon lesions that may be endoscopically subtle, such as sessile serrated polyps. Improving right colon cancer protection is another major goal of colonoscopy quality programs.

Although gastroenterologists appear to be more effective as endoscopists compared with other physicians, they should nevertheless strive to improve the quality of colonoscopy performance for CRC screening. Five studies have established that gastroenterologists are more effective than surgeons or primary care physicians or both at preventing CRC by colonoscopy [16,18-21], reflecting their higher rates of “complete” examinations (ie, cecal intubation) [19] and adenoma detection [22,23]. All endoscopists, regardless of specialty, should measure their colonoscopy quality. Gastroenterologists who establish quality programs in institutions where multiple specialties practice colonoscopy should expect and insist that all endoscopists participate in the program and achieve recommended standards.

This review describes quality indicators to establish competence in performing colonoscopy and to define areas for continuous quality improvement (CQI) (Table 1). These quality indicators are based upon recommendations from the American College of Gastroenterology (ACG) and the American Society for Gastrointestinal Endoscopy (ASGE). The performance of individual endoscopists can be measured using these quality indicators. Measuring performance identifies endoscopists who exceed recommended thresholds whereas highlighting low-level performers, facilitating the institution of corrective measures and reassessment of their performance.

Among the many quality indicators for colonoscopy, priority indicators include the following: (1) ADR; (2) recommended intervals between colonoscopies performed for screening and surveillance of colorectal neoplasia; and (3) cecal intubation rate with photographic documentation. Each of these priority indicators is associated with important clinical outcomes, can be easily measured, and there is substantial variation in performance [24]. A crucial point in measuring quality indicators is to improve patient care by identifying low-level performers and retraining them or removing their privileges to perform colonoscopy if performance cannot be improved. With increased awareness of which factors define high-quality colonoscopy, one can also expect a growing interest among patients of how their endoscopists perform in regards to these quality indicators.

Financial considerations are a by-product of quality initiatives. Currently, the Center for Medicare and Medicaid Services offers a small bonus, 1.5%, for reporting quality indicators through the Physician Quality Reporting System. Based upon current guidance, Center for Medicare and Medicaid Services will start penalizing endoscopists in 2014 with a 2.0% reduction in procedure reimbursement if they do not report colonoscopy quality indicators. In 2015, a quality index (formula to be determined) will be implemented. This is expected to be a budget-neutral system where physicians who demonstrate success at multiple quality indicators will receive higher reimbursement per colonoscopy, whereas reimbursement will

be less for low-level performers. Other insurers are expected to implement similar protocols that reward documented high-quality endoscopists and penalize low-level performers.

2. Preprocedure quality indicators

The first measurable quality indicator for colonoscopy is providing the appropriate indication for screening or surveillance for colorectal neoplasia.

2.1. Appropriate indication

The ASGE has published appropriate indications for colonoscopy [25]. When such indications are met, significantly more clinically relevant diagnoses are made [26-28]. In a study of high-volume European centers, 21%-39% of colonoscopies were classified as inappropriate [29] for not meeting proper indications. The European Panel on the Appropriateness of Gastrointestinal Endoscopy internet guideline is a useful decision support tool for determining the appropriateness of colonoscopy [29]. Minimizing the number of inappropriate procedures is an important goal for a quality program, with a reduction target to <20% of cases [30-32].

This review focuses on the appropriate indications for CRC screening and colon polyp surveillance (Table 2). The timing of colonoscopy for screening and surveillance should adhere to current national guideline recommendations. Whenever possible, endoscopists should document whether the patient has undergone prior colonoscopy, the date of their last examination, and polyp histology results, if any were removed during that procedure (stated later).

2.2. Informed consent should include specific discussions of risks associated with colonoscopy

As with all endoscopic procedures, informed consent must be obtained prior to the procedure from the patient or their guardian (or as required by local law or per policy of the institution). Discussion of potential risks, benefits, and alternatives to the procedure should be included as part of the informed consent process. Colonoscopy-associated risks may include bleeding, perforation, infection, sedation-related adverse events, splenic injury, missed lesions, and intravenous site complications. At this time, adequate data are not available to provide numerical benchmark targets for the expected frequency of each of these potential adverse events.

2.3. Use of recommended postpolypectomy and post-cancer resection surveillance intervals and 10-year intervals between screening colonoscopies in average-risk patients (Table 2)

For colonoscopy to be both effective and cost-effective and to minimize risk, the intervals between colonoscopy screening and surveillance examinations should be optimized. Effective follow-up intervals between examinations are dependent on the colon being entirely cleared of neoplasia. Therefore, detailed and complete examination of the colon, as discussed later, is critical to the effectiveness and safety of recommended intervals between colonoscopy procedures. The recommended intervals also rely upon successful cecal intubation, adequate bowel preparation, and careful examination.

In the average-risk population, colonoscopy screening for CRC is recommended in current guidelines at 10-year intervals [10,33,34]. A case-control study demonstrates that a negative screening colonoscopy is associated with more than 20 years of protection against CRC [35]. After a normal screening colonoscopy, 3% of average-risk patients have advanced adenomas detected when surveillance colonoscopy is repeated in 5 years [36,37]. Flexible

sigmoidoscopy with appropriate follow-up colonoscopy or polypectomy protects against CRC for up to 10-16 years or longer [38,39]. These data support the 10-year follow-up interval. Repeat screening colonoscopy should not be performed at 5-year intervals in average-risk patients, although this practice may still occur frequently [40]. The 5-year interval is not cost-effective, exposes patients to additional risk, and is not supported. Thus, whenever possible, endoscopists should document whether the patient underwent prior colonoscopy, the date of that last examination, and polyp histology results if removed during that procedure under “indication” for procedure. Based on this documentation, endoscopists should be able to justify that colonoscopy for CRC screening or colon polyp surveillance is being performed at an appropriate interval.

There is a need to measure follow-up intervals between colonoscopy procedures as part of a quality improvement program. Surveys suggest that postpolypectomy surveillance colonoscopy in the United States is frequently performed at shorter intervals than is recommended in guidelines [41-46]. Furthermore, these surveys indicate that physician knowledge of guideline recommendations is high and thus unlikely to account for overuse of colonoscopy. An assessment of Medicare colonoscopy codes demonstrated systematic overuse of colonoscopy for screening by some endoscopists [40] who systematically performed colonoscopy sooner than every 5 years among patients with 1-2 small (<10 mm) tubular adenomas, or sooner than every 3 years for patients with 3 adenomas, a large (<1 cm) adenoma, an adenoma with villous features or high-grade dysplasia. Notably, surgeons were more likely to use shorter surveillance follow-up intervals than gastroenterologists [41], demonstrating the need for all specialists performing colonoscopy to participate in quality programs. In addition to overuse of surveillance examinations in average-risk patients, there is also an underuse in high-risk patients [47].

Colonoscopy, even when performed carefully, is not expected to detect or prevent all incident or interval CRCs and thus informed consent may include discussion of “missed lesions” being a potential risk or adverse event associated with colonoscopy. An interval CRC is defined as one diagnosed after a colonoscopy but before repeat colonoscopy as indicated based on guideline recommendations. It is believed that interval CRCs may occur for several reasons. One reason is related to genetic factors that are associated with a more rapid polyp-to-carcinoma sequence [48]. Most of these rapidly developing CRCs are believed to result from mutations in mismatch repair genes. Approximately 30% of postcolonoscopy CRCs have these mutations detected, and more than 80% of these interval cancers are right sided [49,50]. Another potential reason for interval CRCs is that colonoscopic polypectomy may have been inadequate to completely resect the polyp [51]. This may occur more frequently with large flat adenomas in the right side of the colon. Interval CRCs may also be associated with potentially missed lesions, which may be related to suboptimal bowel cleansing that limits visualization or flat lesions. These factors are most likely to affect adenoma detection in the right side of the colon, and may be particularly common with sessile serrated polyps.

Serrated colon polyps include hyperplastic polyps, sessile serrated polyps (synonymous with sessile serrated adenomas), and traditional serrated adenomas. Recommended postpolypectomy surveillance intervals for sessile serrated polyps and traditional serrated adenomas are currently based on limited evidence and will likely be revised as new studies are published [10]. Serrated lesions, particularly the sessile serrated polyp, which may account for a substantial portion of proximal CRCs are hypermethylated and frequently carry mutations in the BRAF gene [48]. These CRCs carry the CpG island methylator phenotype and about half demonstrate microsatellite instability (MSI). About 80% of all MSI-high CRCs arise through this pathway. Currently, recommendations for timing of

postpolypectomy surveillance colonoscopy for sessile serrated polyps are the same as those for adenomas and are based upon size and number of lesions [10].

Symptomatic patients with rectal bleeding after a negative colonoscopy may need to undergo a repeat colonoscopy for clinical evaluation, even if the interval is shorter than that recommended for routine screening or surveillance follow-up (Table 2). The positive predictive value of a positive fecal occult blood testing during the first 5 years after a negative colonoscopy is extremely low [52], and thus should not be recommended. Additional study of a more sensitive alternative fecal occult blood testing, that is, fecal immunochemical test as an adjunct to colonoscopy in this setting is warranted [53].

Quality measures that address the issue of reducing overuse of resources carry a high priority with national quality organizations such as the National Quality Forum. Measures based on appropriate recommendations for screening and surveillance intervals have already been endorsed by the National Quality Forum and incorporated into physician measure reporting via the national Physician Quality Reporting System.

3. Intraprocedure quality indicators

Quality evaluation of the colon consists of intubation of the entire colon, a detailed mucosal inspection to identify adenomas, and prevention of CRC. The detection and concurrent removal of adenomas is a primary goal of colonoscopy screening and polyp surveillance.

Cost-benefit analysis of colonoscopy for the detection of adenomas is approximately \$20,000 per year of life saved [54]. However, complications, repeat procedures, and inappropriate surgical intervention for endoscopically removable polyps raise costs and mitigate the favorable cost-benefit of colonoscopy as a screening and surveillance procedure.

3.1. Preparation

The colonoscopy procedure report should always document the quality of the bowel preparation [55,56]. Quality is based upon the endoscopist's ability to visualize the mucosa after retained stool and fluid have been suctioned out. Terms commonly used to characterize bowel preparation include "excellent," "good," "fair," and "poor." In clinical practice these terms do not have standardized definitions amongst endoscopists [57], although standardized definitions do exist for clinical trials of bowel preparation [58]. In addition, some practitioners may use the terms "adequate" or "inadequate" to describe bowel preparation for procedures. The ASGE/ACG Quality Indicator Task Force has recommended that a colonoscopy bowel preparation be considered adequate if it allows (within the technical limitations of the procedure) detection of polyps >5 mm in size [59]. Another option is to use independently validated bowel preparation scores, such as the Boston Bowel Preparation Scale [60] or the Ottawa Bowel Preparation Scale [61]. These scales account for retained stool or liquid that can be removed during the colonoscopy, and the quality of bowel preparation (and mucosal inspection) should be based on the appearance of colonic mucosa after the retained material has been washed and suctioned out.

If bowel cleansing is "inadequate" to identify polyps >5 mm in size during a colonoscopy that is being performed for CRC screening or polyp surveillance then the procedure is considered suboptimal and should be repeated in 1 year or less [10]. Adherence to recommended follow-up intervals consistent with national guidelines requires that bowel preparation be adequate at the time of colonoscopy [10].

Poor bowel preparation is a major impediment to the effectiveness of colonoscopy and unfortunately still occurs often. Poor bowel preparation prolongs cecal intubation and withdrawal time and reduces detection of both small [62] and large [62-64] colon polyps. The economic burden of repeating colonoscopy procedures because of inadequate bowel preparation is substantial [65]. It is recommended that the percentage of examinations with “inadequate” bowel preparation that require repeat colonoscopy in 1 year not exceed 10% [63]. Measurement of individual endoscopists’ percentage of examinations requiring repeat examinations because of inadequate preparation is recommended. Endoscopists who have >10% of examinations with “inadequate” bowel preparation should re-examine their bowel preparation protocols, including factors such as patient education, choice of purgative, and protocol for administering the purgative, that is, possible use of a split-dose protocol.

The most important determinant of bowel preparation quality is the interval between the end of the preparation ingestion and the start of the colonoscopy procedure [66]. Quality of colon cleansing diminishes as this interval increases, and the right side of the colon is particularly affected. An optimal bowel preparation protocol may use split dosing of the purgative, meaning that the second half of the preparation is taken on the day of the examination [66]. For afternoon colonoscopy procedures, the entire bowel preparation can be ingested early on the morning of the examination [67]. As per fasting guidelines of the American Society of Anesthesiologists, patients should refrain from drinking clear liquids for a minimum of 2 hours prior to undergoing sedation for colonoscopy [68]. Notably, prospective observational studies 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 [69].

3.2. Cecal intubation rates

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. Cecal intubation is mandatory for CRC screening examinations because low cecal intubation rates have been associated with higher rates of interval proximal colon cancer [19]. (*Note:* discussion of endoscopic techniques to maximize success of cecal intubation is beyond the scope of this report, but is discussed elsewhere [70].) Cecal intubation should be documented by stating that the appendiceal orifice and ileocecal valve were visualized and by providing photodocumentation of these landmarks in the procedure report. In cases where there is uncertainty as to whether the cecum has been entered, intubation of the terminal ileum with photodocumentation may be needed. Experienced endoscopists should be able to verify cecal intubation in real-time in 100% of cases [71] because no other portion of the gastrointestinal tract has landmarks with similar appearance.

Photography of the cecal landmarks is mandatory in all cases, although the quality of this photodocumentation may vary because of variations in cecal anatomy [71]. Ideally, endoscopists should photograph the appendiceal orifice with the cecal strap fold visible around the appendix and the cecum distal to the ileocecal valve with the lips of the ileocecal valve visible [71]. If the cecal landmarks cannot be verified during the colonoscopy, the terminal ileum may be intubated and photos can be taken that demonstrate small bowel villi, circular valvulae connivente, and lymphoid hyperplasia [71].

Effective endoscopists should achieve successful intubation of the cecum during colonoscopy in 90% of all cases [72], and 95% of procedures for CRC screening or colon polyp surveillance [73-85]. Cases in which procedures are aborted because of poor or inadequate bowel cleansing should not be counted in calculations of cecal intubation rates. Also, cases that are performed to complete resection of large polyps or to treat colonic

strictures do not require cecal intubation as long as a complete colonoscopic examination has been performed recently in a separate examination.

3.3. Detection of adenomas (ADR)

Tandem colonoscopy studies [86] and computed tomographic colonography studies using segmental unblinding [87,88] have demonstrated that endoscopists may sometimes miss adenomas. Studies have reported failure of colonoscopy to prevent all CRCs in cohorts followed for up to 3 years [12-17], with most interval CRCs attributed to potential missed adenomas at time of initial colonoscopy [89]. There is evidence of significant variation in the detection of adenomas by endoscopists within practice groups [90-93], which was 1 factor that led to the creation of targets for adenoma detection, originally proposed in 2002 [59], and largely adopted by the ACG/ASGE Task Force in 2006 [94,95]. The proposed measure for adenoma detection was the fraction of patients undergoing screening colonoscopy who had ≥ 1 adenomas detected, now known as the ADR [59,94,95]. 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 [59]. Thus, recommendations are that individual endoscopists should identify ≥ 1 adenoma in at least 25% of men and 15% of women at age ≥ 50 years undergoing screening colonoscopy [59,94,95]. In 2010, a Polish study of screening colonoscopy provided validation for the ADR targets, finding that patients undergoing procedures performed by endoscopists with ADRs $<20\%$ had hazard ratios for the development of postcolonoscopy interval CRCs >10 times higher than patients whose endoscopists had ADRs $>20\%$ [11]. Of note, however, this study had limited power to establish that CRC protection continues to improve when ADRs rise above 20%. Another study demonstrated that endoscopists with high polypectomy rates protected patients from right-sided colon cancer better than those with low polypectomy rates [19]. Therefore, based on limited evidence, current ADR targets appear appropriate, but future research may lead to changes in these target ADRs.

Age and gender are the only factors that affect adenoma prevalence which are accounted for in the recommended target ADRs. Nevertheless, other factors may also affect adenoma prevalence including family history of colon cancer, tobacco use, obesity, and diabetes mellitus [33]. Adjustment of the target ADR for these factors is not recommended currently, but future research may change this recommendation.

Several issues about target ADRs should be discussed in more detail. First, target ADRs may need to be raised in the future because the true prevalence of adenomas probably exceeds 50% [96,97]. However, before raising target ADRs, research should demonstrate that raising ADRs above current targets will lead to lower CRC levels. At a minimum, research should demonstrate that raising ADRs leads to increased detection of advanced adenomas. There is already some evidence that higher ADR is associated with better detection of large adenomas [90,91] and of multiple adenomas [90,91], but whether detection of advanced adenomas levels off at some level of overall ADR is not known.

ADR has limitations. It requires manual entry of pathology data postprocedure because the histology report follows by days the completion of the colonoscopy report. It also rewards a “one and done” approach to colonoscopy: after identifying 1 polyp with the endoscopic appearance of an adenoma, the endoscopist stops examining the remaining mucosa as carefully as before. Therefore, polyp detection rate (PDR) and adenomas per colonoscopy (APC) have been proposed as possible alternative quality measures.

The PDR is defined as the number of patients with ≥ 1 polyp removed during a screening colonoscopy at age ≥ 50 years. PDR has the advantage of not requiring manual entry of pathology data and correlates well with ADR in several studies [98-100]. Conversion rates

for PDR to ADR have been proposed [98]. However, PDR has not yet been shown to correlate with ADR in prospective studies. Furthermore, PDR would be very susceptible to gaming in that it may reward removal of a class of colorectal polyps not considered at risk of progressing to cancer, that is, distal colon diminutive hyperplastic polyps. Therefore, PDR is not currently endorsed as a quality indicator.

The APC rate have been used in multiple clinical polyp detection trials [96,97]. APC may reflect inspection of the entire colon better than ADR, and provides greater separation between endoscopists [90]. APC might incentivize increased pathology costs if endoscopists were expected or inclined to submit each resected polyp in a different specimen container to prove APC, but this problem could potentially be overcome by the use of photography to prove detection of multiple adenomas or by the advent of global pathology reimbursement per procedure replacing the fee per specimen container model currently in routine practice. APC also overcomes the problem of “one and done” approach.

In the future, ADR may be stratified based upon adenoma size (ADR for adenomas ≥ 1 cm), location (ADR for right-sided vs left-sided adenomas), or polyp histology.

The importance of separate targets for serrated colon polyp lesions also deserves particular attention. Targets for ADR were established using studies reporting detection of conventional adenomas and thus do not directly apply to serrated lesions [59]. Currently, the terminology regarding serrated lesions is confusing (eg, a sessile serrated polyp or adenoma is not an adenoma—the majority of these lesions have no dysplasia). One study has recently shown that there is greater variation among members of the same group of endoscopists in detection of these serrated lesions [101,102] than is seen for conventional adenomas [90-93], indicating that missing these lesions may be a potentially greater issue for serrated lesions. Additional support for the concept that missed serrated lesions are important is the finding that postcolonoscopy interval CRCs are more likely to be CpG island methylator phenotype high, MSI high, and located in the proximal colon [49,50]. How we should account for serrated lesions within ADR is unclear, but it may be appropriate to quantify serrated lesion detection rate and ADR separately [103], and even to have different postpolypectomy surveillance guidelines for identification of serrated lesions. However, a new target may not be needed if ADR and proximal colon serrated lesion detection are sufficiently correlated [101,102]. 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 [104,105], which could make it difficult to use sessile serrated polyps as a detection target.

When individual endoscopists have ADRs below the recommended threshold, they should demonstrate improvement [106] following remediation. Withdrawal time is positively associated with detection [2-9], but forcing longer withdrawal times may not be very effective in improving detection [106] unless specific instruction is provided about how the increased time should be utilized [107].

Endoscopists who are not currently using split-dose bowel preparation should consider switching to such regimens for low-level adenoma detection. The 2 most effective interventions for improving ADR have involved endoscopist education [108] (Coe S, Crook JE, Diehl NN, Wallace MB. An endoscopic quality improvement program (EQUIP) improves detection of colorectal adenomas. *Am J Gastroenterol*, in press.), that is, including providing information on the spectrum of precancerous colorectal polyp lesions. Instruction on the Paris classification of polyps [109] would emphasize awareness and characterization of flat and depressed polyp lesions and provide review of endoscopic photographs of flat

and depressed conventional adenomas [110,111]. Education should also include instruction in optimal colonoscope withdrawal technique that has been repeatedly associated with improved polyp detection, including probing the proximal sides of folds, suctioning out pools of retained fluid and mucus, and ensuring adequate distention of the entire colon [2,112]. One successful improvement strategy involved endoscopist education and increased withdrawal time with use of a timer that sounded every 2 minutes, with a target of examining approximately one-quarter of the colon every 2 minutes for a total minimum withdrawal time of 8 minutes [108]. Another successful program involved a short but comprehensive educational session. (Coe S, Crook JE, Diehl NN, Wallace MB. An endoscopic quality improvement program (EQUIP) improves detection of colorectal adenomas. *Am J Gastroenterol*, in press.) Both programs produced gains in polyp detection across the all endoscopists in their institutions. Finally, endoscopic technology, including chromoendoscopy, narrow band imaging and cap-fitted colonoscopy, may improve detection [113-116]. Endoscopists, regardless of specialty, who cannot improve their detection rates to reach recommended ADR thresholds through education and technical measures should have their colonoscopy privileges removed, as current evidence indicates that low-level detection may endanger patient care [11].

3.4. Withdrawal times

Withdrawal time should be documented for all colonoscopies performed for CRC screening and polyp surveillance. Studies have demonstrated increased detection of significant neoplastic lesions in colonoscopic examinations where the withdrawal time is ≥ 6 minutes. Mean withdrawal time should be ≥ 6 minutes in normal colonoscopies, but withdrawal time should be considered secondary to ADR as a quality measure. Retrospective studies demonstrate that longer withdrawal are associated with higher detection [2-9], and endoscopists may benefit from education regarding withdrawal technique, as better technique is likely to be accompanied by increased withdrawal time. However, each colonoscopy procedure does not require 6 minutes or more for withdrawal time [59,94,95] because colons differ in length and a well-cleansed colon with nonprominent haustral markings can be carefully examined in <6 minutes.

3.4.1. 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—Patients with sessile colorectal polyps <2 cm in size should seldom be referred for surgical resection, because these polyps are usually readily resectable in most cases by competent endoscopists. Consistent referral by some endoscopists of sessile polyps <2 cm in size for surgical resection is inappropriate. In some cases, these polyps may be difficult to access or properly positioned for polypectomy, and in such cases, referral to a more experienced endoscopist may again be appropriate and encouraged.

Certainly, endoscopists should not attempt removal of colorectal polyps that they consider beyond their skill or comfort level, and should feel comfortable in referring such polyps to other endoscopists for a second opinion (eg, review of photographs) and possible attempt at endoscopic resection. Furthermore, many large sessile polyps >2 cm in size may be removable endoscopically, depending on their location within the colon, their size, and the ability to access them endoscopically [117,118]. Endoscopic resection is both more cost-effective and safer than surgical resection [119]. Essentially, almost 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 CQI 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. Inability to endoscopically remove polyps <2 cm may also be an appropriate quality indicator in the future.

3.4.2. Rate of incomplete polypectomy following piecemeal resection of sessile polyps >2 cm is measured on repeat examination within 6 months—

Apart from missed lesions, another postulated major cause of interval CRC following colonoscopy is incomplete polypectomy. Often, when endoscopists believe they have completely removed a large polyp lesion with no evidence of high-grade dysplasia at histology, they may not bring the patient back for a repeat examination for 3 years, as per current surveillance guidelines; as such, it is difficult to determine the rate of potential residual polyp following colonoscopic removal of a large polyp. However, following endoscopic piecemeal resection of large adenomas given that recommendations suggest follow-up endoscopic assessment within 6 months, an opportunity would exist to record rates of potential residual polyp at the polypectomy site. In contrast, large polyp lesions incompletely removed at colonoscopy would be so recorded at the time of initial examination and typically scheduled for a short-interval repeat colonoscopy to complete the resection, potentially, if felt necessary, with a more experienced endoscopist at a referral center.

4. Postprocedure quality indicators

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, should be completed shortly after the procedure [55]. Complications should also be recorded. Although some complications are detected during or immediately following the procedure, complications may also occur after the patient has adequately recovered and left the endoscopy site. Each endoscopist should establish a system to recontact patients after a period of time to determine if delayed complications may have occurred. In most practices, these contacts are typically made on the first working day following the procedure, which allows identification of most perforations but may miss delayed bleeding, which can occur up to several weeks after the procedure. Methods to evaluate and report delayed complications should be considered, although this would place a significant burden on the endoscopist and their staff.

4.1. Incidence of perforation by procedure type (all indications vs CRC screening or polyp surveillance) and postpolypectomy bleeding are measured

Perforation rates related to colonoscopy may be stratified based upon use of therapeutic polypectomy with snare and forceps, with or without application of cautery. Perforation is considered a significant complication presenting in the short-term detected during or soon after colonoscopy. About 5% of colonoscopic perforations may be fatal [120-122]. Published rates of colonoscopic perforation vary widely [120-133], and few recent studies on this topic have been reported in the past 5 years. A population-based study of Medicare patients undergoing colonoscopy reported an overall risk of perforation of 1 in 500, with a risk of less than 1 in 1000 when limited to those undergoing screening examinations [124]. Expected perforation rates in screening patients are typically lower as these patients are generally healthy and tend not to have associated colonic conditions that may be associated with potential increased risk of perforation, including pseudoobstruction, ischemia, severe colitis, radiation, stricture formation, bulky CRCs, severe diverticular disease, and chronic corticosteroid therapy. Endoscopists with colonoscopy perforation rates >1 in 500 overall or >1 in 1000 in screening patients should be considered for review by the endoscopy unit medical director or another appropriate member of the faculty or staff to determine if

colonoscopy insertion technique or polypectomy practice require re-education and further evaluation. However, most endoscopists should demonstrate much lower rates.

As perforation rates can be difficult to track over time, especially in low-volume endoscopists, an alternative approach may be 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 potentially lead to changes in the system and the physician practice that may help to reduce patient risk during future examinations.

Bleeding is the most common complication of polypectomy [120-122,134,135]. 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 [136,137]. Endoscopic series suggest that the overall risk of postpolypectomy bleeding should be <1% [120,121,134,135]. In general, the risk of bleeding increases with polyp size, proximal colon location, anticoagulation, and use of antiplatelet agents such as clopidogrel [138]. For polyps >2 cm in size, particularly in the proximal colon, bleeding rates may exceed 10% [134,135,139-141].

Technical measures that may help reduce immediate postpolypectomy bleeding include diluted epinephrine injection for sessile or pedunculated polyps [142,143] and detachable loops for pedunculated polyps [143,144]. Cold resection techniques are considered by some endoscopists to decrease the risk of delayed hemorrhage from diminutive polyps and some small (6-9 mm) polyps. Some experts advocate the use of microprocessor-controlled alternating coagulation or cutting currents to limit thermal injury and reduce delayed bleeding risk when resecting large flat lesions [118], though the placement of prophylactic metal clips to close defects following polypectomy in some cases, high-risk patients who must resume anticoagulation, may be helpful. However, confirmation of the potential effectiveness of each of these interventions awaits appropriate research studies.

4.2. Postpolypectomy bleeding should be managed nonoperatively

In ongoing bleeding, repeat colon examination and endoscopic treatment of polypectomy sites results in successful hemostasis. In general, >90% of postpolypectomy bleeding can be managed nonoperatively. Immediate bleeding from the stalk of pedunculated polyp after transection can be treated by regrasping the stalk and holding it for approximately 10-15 minutes. This causes spasm in the bleeding artery. Immediate bleeding can also be treated by application of clips [145] or by injection of epinephrine, followed by application of multipolar cautery [146]. Immediate bleeding is not considered a complication unless it results in hospitalization, transfusion, or operation.

Delayed bleeding frequently stops spontaneously [146]. Repeat colonoscopy in patients who have stopped bleeding spontaneously is optional and may be performed at the discretion of the endoscopist. Patients who present with delayed bleeding and are continuing to pass bright red blood per rectum may be having an ongoing arterial hemorrhage. In such cases, prompt repeat colonoscopy which may be performed without bowel preparation [146] is warranted. Treatment can be either by application of clips [145] or by injection of epinephrine in combination with multipolar cautery [146]. Rebleeding seldom occurs after postpolypectomy bleeding has either stopped spontaneously or as a result of endoscopic therapy.

4.2.1. Appropriate recommendation for timing of repeat colonoscopy should be documented and provided to the patient after histologic findings are reviewed—As already discussed, current guidelines recommend colonoscopic screening at 10-year intervals in the average-risk population [10,33,34,147], at 5-year intervals among

patients with 1-2 small (<10 mm) tubular adenomas or a personal history of adenomas on previous colonoscopies, and at 3-year intervals for patients with 3 small adenomas, a large (>1 cm) adenoma, or an adenoma with villous features or high-grade dysplasia. However, assessments of Medicare colonoscopy codes have demonstrated systematic overuse of colonoscopy for screening and polyp surveillance by some physicians [40]. This practice is not cost-effective, may expose patients to additional risk, and is not justified.

Endoscopists should specifically document plan for repeat colonoscopy at a 10-year follow-up interval after a normal screening colonoscopy in an average-risk patient. If polyps are removed, then pathology data should be entered into the endoscopist or endoscopy unit's reporting system, if such a system is in use, and recommendations to the patient regarding the timing of the next follow-up surveillance colonoscopy should be documented.

5. Conclusion

Reduction in variation in quality has emerged as an important priority for colonoscopy practice. The CQI process should be instituted and embraced in all colonoscopy practices, regardless of specialty. There should be only 1 standard of quality performance of colonoscopy regardless of where the procedure is performed and who is performing the examination. This paper summarizes current literature and expert consensus on the quality indicators to be used in this process. Such evidence formed the basis for the comprehensive list of potential quality indicators first proposed by the ASGE/ACG task force in 2006 and currently being updated. Tracking quality indicators serve as both the vehicle for improvement in patient care and demonstration to payers, and more importantly to patients themselves of objective factors closely linked to good colonoscopy outcomes.

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Table 1

Summary of proposed quality indicators for colonoscopy.

Quality indicator	Target
1. Appropriate indication	80%
2. Informed consent is obtained, including specific discussion of risks associated with colonoscopy	100%
3. Use of recommended postpolypectomy and post-cancer resection surveillance intervals, and appropriate intervals after normal screening colonoscopy in average-risk individuals	90%
4. The use of recommended UC or Crohn's surveillance intervals	90%
5. Documentation of the quality of the preparation in the procedure note *	100%
6. Cecal intubation rate with photography (all examinations)	90%
Cecal intubation rate with photography (screening examinations)	95%
7. Adenoma detection rate in males	25%
Adenoma detection rate in females	15%
8. Documentation of withdrawal time	100%
9. Mean withdrawal time in patients with normal colonoscopies	6 min
10. Mucosally based pedunculated polyps and sessile polyps < 2 cm in size should be endoscopically resected, or convincing documentation of endoscopic unresectability	100%
11. Complications:	
Incidence of perforation (all examinations)	<1 in 500
Incidence of perforation (screening examinations)	<1 in 1000
Postpolypectomy bleeding	<1%
12. Postpolypectomy bleeding managed nonoperatively	90%
13. Appropriate timing of repeat colonoscopy following polypectomy should be documented after review of histologic results	95%

* Excellent cleansing of colon is associated with higher adenoma detection rates. The frequency of inadequate preparation that requires repeat colonoscopy should be <10%.

Table 2

Appropriate indications for colonoscopy for screening and surveillance of colonic neoplasia.*

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1. Screening of asymptomatic, average-risk patients for colonic neoplasia every 10 y
 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 the time of curative resection of cancer followed by colonoscopy at 1 y and, if normal, then 3 y, and, if normal, then 5 y thereafter to detect metachronous cancer
 4. Colonoscopy for surveillance following resection of neoplastic polyps: in 5 y when 1-2 small (< 10 mm) adenomas, or in 3 y when 1 large (≥ 10 mm) adenoma, or ≥ 3 small adenomas, or an adenoma with villous histology or high-grade dysplasia
 5. Repeat screening colonoscopy within 1 y if the bowel preparation is inadequate
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* This list does not include indications for screening colonoscopy among individuals with a family history of colon cancer, family history of colon adenomas, history of hereditary nonpolyposis colorectal cancer (HNPCC), or individuals who require repeat colonoscopy to insure complete resection of large flat adenomas.