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Quality Metrics and Indicators in Colonoscopy

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Abstract

Colonoscopy is the preferred method for colorectal cancer screening. However, despite significant advances, the examination remains subject to limitations and variability amongst different practitioners. This calls for the need for objective quality indicators to ensure the optimal use of the modality. Three major priority quality measures have been identified that include adenoma detection rate (ADR), cecal intubation, and adherence to surveillance guidelines. ADR is the best-studied metric correlating with outcomes including post-colonoscopy colon cancer, but has inherent limitations such as the potential for corruptibility. Other important quality indicators include the quality of bowel preparation and colonoscopy withdrawal time. All these quality measures are interrelated and an improvement in any of them would help in increasing the power of colonoscopy as a screening tool, as well as decreasing its economic burden and potentially improving adherence to screening guidelines.

Keywords: Colonoscopy, Quality Indicator, Quality Metrics, Quality, Screening, Colorectal Cancer, Polyps

1. Context

Colonoscopy is the method of choice for screening and diagnosing colorectal cancer (CRC) allowing both direct visualization of the colonic mucosa and the ability of sampling and removal of suspicious lesions. According to the American College of Gastroenterology, colonoscopy every 10 years starting from the age of 50 is the test of choice for CRC screening (1). Colonoscopy also serves as a CRC prevention tool if precancerous polyps are removed and proper surveillance guidelines are followed (2). Since colonoscopy has a time-sensitive and operator-dependent nature, it requires quality indicators to ensure consistency in quality health care standards and disease diagnosis and prevention (3). The American Society for Gastrointestinal Endoscopy (ASGE)/American College of Gastroenterology (ACG) Task Force on Quality in Endoscopy published their first recommendations on quality indicators for colonoscopy in 2006 (4), followed by an update in 2015 (5). The Task Force established three categories for colonoscopy quality indicators: structural, process, and outcome measures. It also identified three priority measures of performance for colonoscopy: adenoma detection rate (ADR) on screening exams, the rate of cecal intubation, and adherence to post-colonoscopy surveillance guidelines. In this paper, we discuss these three parameters and present new evidence on the subject.

2. Adenoma Detection Rate (ADR)

ADR is defined as the fraction of screening colonoscopies that detect at least one adenoma (6). ADR is the most commonly used and validated quality measure in screening colonoscopy. Although CRC prevention remains the optimal quality measure, we resort to surrogate measurements due to its low frequency of detection and lag time between screening and diagnosis. ADR is an effective and easy way to measure the quality of colonoscopy, as well as CRC prevention and polyp detection. Evidence has shown an inverse relationship between ADR and risk of colorectal cancer (7) leading to its adoption as the primary quality indicator in colonoscopy (8). Recent guidelines have set a goal of 30% ADR in males and 20% in females (5). A microsimulation modeling study estimated that for every 5% increase in ADR, CRC incidence would decrease by 11.4% and mortality by 12.8% with no subsequent higher overall costs (9).

With ADR being dependent on technology and operator performance, several studies have attempted to improve adenoma detection rates by boosting these factors. In 2013, Kahi et al. showed increased adenoma detection rates with the implementation of a quarterly colonoscopy report card (10). Another study found that distributing colonoscopy quality report cards and implementing institutional standards of practice ($\geq$ 5 min withdrawal time,

ADR $\geq$ 20%) significantly improved ADRs (11). There are other studies suggesting the ways and methods of improving gastroenterologists' ADRs. For example, Abdul-Baki et al. showed that public reporting of colonoscopy quality using ADR led to improved adenoma detection rates for the endoscopist (12). However, as pointed out by Lieberman and Mascarenhas these before-after types of studies are subject to biases because of the lack of control and the possibility of confounders due to improving technical abilities (13). With these limitations in mind, it is important to understand the value of obtaining a reliable ADR per examiner calculated from a large number of primary screening colonoscopies (14). In 2013, a study on 12, 134 subjects showed that ADR was not affected by the colonoscopy volume (15). However, a more recent study on 18, 456 Canadian subjects concluded that ADR is affected by annual colonoscopies done, with physicians having a lower volume of annual colonoscopies reporting higher ADR than their colleagues with more procedures per year (16). This indicates that ADR may not be reliable when comparing physicians with the discrepancy in the volume of colonoscopies.

One of the downfalls of ADR as a quality measurement is its potential to corruption, as it does not account for the number of adenomas per colonoscopy and may be susceptible to the so-called "one-and-done" phenomenon where an endoscopist may not proceed with the same level of inspection after having found the first adenoma (since it would not add a value to ADR) (17). Such concerns have triggered the search for other quality measures. One such measure is the ADR-plus, which also takes into account the number of adenomas detected after the first one. In a study comparing ADR and ADR-plus between teaching and non-teaching groups, ADRs were found to be similar in both groups whereas ADR-plus and the mean number of adenomas detected were significantly higher in the teaching group. This shows that despite some endoscopists meeting the required ADR values, they might still be missing adenomas during their examinations (18).

3. Adenoma per Colonoscopy (APC)

Another proposed quality indicator is the adenoma per colonoscopy, which accounts for the total number of adenomas and is a more objective measure with less potential for corruptibility. It is, however, more labor-intensive and may result in increased cost with the added amount of samples sent to pathology (5). In a recent comparative study, APC was not superior to ADR, and even its use as an adjunctive measure to ADR showed no added benefit (19).

4. Proximal Serrated Polyp Detection Rate (PSP-DR)

Around one-third of CRC arises from serrated lesions (20). These lesions include hyperplastic polyps, traditional serrated adenomas, and sessile serrated adenomas. Therefore, PSP-DR was suggested as a quality measurement. Some studies have shown a strong correlation between PSP-DR and ADR (21, 22). But, this correlation has been contested by Occhipinti et al. who failed to find such an association despite the correlation between ADR and total serrated lesions detection (23). PSP-DR has also been found to strongly correlate with another quality measure defined as the detection rate of clinically relevant serrated polyps (RSP-DR) although PSP-DR in that study was only moderately correlated with ADR ($P = 0.03$) (24).

5. Advanced Adenoma Detection Rate (AADR)

Adenoma per positive participant is obtained by dividing the number of adenomas detected by the number of colonoscopies in which at least one adenoma is found (19). This quality measure was introduced due to its added value of taking into account adenoma numbers compared to ADR. In fact, APP was shown to identify those endoscopists who miss adenomas despite meeting the ADR recommendations. However, this might not be of clinical importance since these endoscopists maintained a high AADR. The AADR is defined as the percentage of colonoscopies in which at least one advanced adenoma (villous or tubulovillous or tubular with diameter > 10 mm or high-grade dysplasia) could be detected (19).

6. Cecal Intubation Rates

Cecal intubation is defined as crossing the ileocecal valve with the scope in order to visualize the caput of the cecum. This is especially important due to colonoscopy's limitation in right colon cancer prevention (3, 25-27). The ACG guidelines require cecal intubation documentation by landmarks description and photography (1). The US Multi-Society Task Force on Colorectal Cancer (USMSTF) and the ACG/ASGE Task Force recommend a minimum of 90% cecal intubation for all colonoscopies and a 95% rate for screening colonoscopies (4, 5). Interval cancer risk decreased when endoscopists had > 85% completion rates (28). A similar British study showed that cecal intubation rates correlated with ADR (29).

7. Colonoscopy Withdrawal Time (WT)

Colonoscopy withdrawal time is the time spent on inspecting colonic mucosa during the withdrawal of the colonoscope not including time spent on washing, suctioning, or taking biopsies. Although WT is easily measured, it does not provide direct information on the quality of the examination. However, in a retrospective study conducted on 76, 816 screening colonoscopies, ADR was shown to increase by 3.6% for every minute increase in WT (mean ADRs 25% $\pm$ 9% and mean WT 8.6 $\pm$ 1.7 minutes). In addition, the incidence of interval colorectal cancer within 5.5 years was inversely proportional to the mean withdrawal time, even when adjusted for ADR, sex, age, and quality of colon preparation (30). However, other studies did not show a correlation between WT and ADR (15, 31-33).

Several studies have attempted to determine an ideal WT. The USMSTF recommends a withdrawal time of at least 6 minutes (4). However, data from the New Hampshire colonoscopy registry suggested that by every one minute increase in WT above six minutes, both ADR and serrated polyps detection increase, reaching a cap at nine-minute WT (34). Lee et al. also demonstrated this "ceiling effect" by showing that increasing WT above 10 minutes had no added benefit (35). A more recent study recommended a WT of three minutes in the right colon and a total WT of at least nine minutes (36).

8. Quality of Bowel Preparation

Since colonoscopy is mainly a visual examination, bowel preparation remains a crucial part of the process. An inadequate bowel preparation could affect the overall quality of the examination and has been shown to be associated with longer cecal intubation time, longer withdrawal time, decreased detection of adenomas, increased cost, and earlier repeat colonoscopy (37, 38). An adenoma miss rate of up to 43% may ensue (39). One study estimated that for every one percent of exams requiring earlier repeat due to bad preparation, there is a one percent increase in colonoscopy costs (40). With that being said, it is important to note that up to one-quarter of bowel preparations is considered inadequate (41). The USMTF recommends that at least 85% of the colonoscopies should have adequate preparation, defined as the ability to identify polyps that are as small as 5 mm in size (37). In a systematic review and meta-analysis, it was argued that surveillance interval does not require to be shortened in patients with fair (intermediate quality) preparation compared to those with excellent/good preparation. This was due to that no significant difference in ADR was found between the two groups. However, ADR was significantly lower in patients with poor bowel preparation, which led the authors to recommend shorter surveillance intervals in those patients (42). Anderson et al. corroborated the similar ADR in excellent and fair preparations (43). In a retrospective cohort of 2519 patients, there were no significant differences in ADR despite the levels of quality in bowel preparation ranging from excellent to poor. However, the quality had an effect on colonoscopy completion rate, dropping from 99% in excellent/good preparations to 75.4% and 72% in fair and poor preparations, respectively (44). As discussed earlier, ADR has some inherent limitations and it is conceivable that a fair preparation may be associated with a lower adenoma per colonoscopy (45). A fair preparation remains the most important reason for guideline-inconsistent surveillance recommendations after a screening examination (46).

Adherence to instructions is crucial to obtain adequate bowel preparation. This may be a challenge to patients who have a hard time tolerating large volume preparations or the taste of the cathartic solution. Studies have shown that a split-dose regimen is better tolerated, more effective, (47, 48) and results in increased ADR (49). The USMSTF recommends split-dosing preparation with the second dose administered on the day of examination (37). Another issue is palatability and taste, and despite attempts to integrate flavored options, it has been shown that this issue could be simply managed with the additional use of commercially available sugar-free mentholyptus candy drops taken with the PEG-electrolyte solutions (50-52). Another major reason for bowel preparation non-adherence is unclear or forgotten instructions; this has led several investigators to come up with and test ways to improve patient compliance. A prospective randomized controlled study randomized 605 patients to a control group and a group that would receive phone-call re-education about the preparation. The preparation was significantly better in the telephone re-education group (81.6% vs. 70.3%) as was the polyp detection rate (38% vs. 24.7%) (53). Lorenzo-Zuniga et al. tested the effect of instructions delivery method by randomizing 260 patients to phone application based instructions or written instructions with visual aids; the application group had better bowel preparation quality and improved patient accessibility (54). Another study with a similar design noted a vast-majority of favorable reviews from all users despite not finding any significant difference with the control group (55). A more recent study showed that patients who received bowel preparation education via a smartphone

application had better bowel cleansing despite no change in polyps detected or examination duration (56). A 2018 study showed that SMS text patient education in four days leading up to the colonoscopy improved bowel cleanliness, adenoma detection in the right colon, and reduced patient discomfort (57).

9. Adherence to Surveillance Guidelines

Increasing surveillance intervals may result in missing cancerous or pre-cancerous lesions whereas shortening the intervals leads to increased cost and risk of adverse events and complications (3). Therefore adherence to surveillance intervals is a major quality indicator for colonoscopy. The ACG/ASGE recommends endoscopists have a > 90% adherence to the surveillance guidelines (4). One study on 1455 patients demonstrated non-adherence in one-third of patients among salaried-physicians (28% in normal colonoscopies and 45% - 53% in the presence of adenomatous or hyperplastic polyps). Most of the non-followed recommendations instructed for shorter surveillance intervals (58). In 2015, Skinner et al. published their experience on developing the Parkland-UT Southwestern colonoscopy reporting system (CoRS), which is a reporting system that gives surveillance recommendations based on colonoscopy findings. CoRS was well received by physicians and resulted in improved quality performance (17).

As mentioned earlier, adherence to surveillance guidelines can also be affected by the quality of bowel preparation. In fact, a fair preparation was found to be the strongest predictor of deviations from guidelines (OR 12.7; 95% CI, 7.3 - 22.4) in average-risk individuals. In a cohort of 1387 patients, a 75% non-adherence to guidelines was recorded in patients with a fair bowel preparation compared to 15.3% for excellent/good preparation (59) and an adenoma miss rate of 28% was reported in patients with fair bowel preparation returning for a three-year interval repeat of colonoscopy (46). There is a clear need to establish surveillance guidelines better tailored for people with a fair bowel preparation, with the first step probably being a clearer and more universal definition of “fair/adequate” preparation (60).

10. Colonoscopy Technique and Maneuvers

As previously discussed, many quality indicators depend on the endoscopist’s technique, withdrawal time, thorough inspection, residual debris cleansing, and good luminal distention (61, 62). Technique involves certain maneuvers that may be used to obtain a better examination. It is believed that repositioning the patient during withdrawal can result in better visualization of the mucosa due to shifting of debris and residual fluids, as well as improved luminal distention. This, in turn, results in a better detection of polyps (63). The benefits of repositioning have been controversial with some showing that it had no effect on ADR and polyps detection rate while others showing effectiveness in the transverse colon (64) and in the right colon (65).

Another important maneuver is retroflexion in the right colon. Hewett and Rex showed a per-patient adenoma miss rate of 4.4% identified by repeat examination with retroflexion (66). Other studies have shown the same results but when the colon is examined twice in forwarding view, (67, 68) suggesting a confounder of the number of examinations rather than technique. In a direct comparison between retroflexion and a second forward examination in the right colon, Kushnir et al. showed similar ADRs (47% and 46%, respectively), as well as a similar number of adenomas (69).

Being a technology-assisted examination, colonoscopy qualities depend on the platform used. For example, dye chromoendoscopy has been shown to increase ADR in some studies while others have failed to show a consistent benefit of electronic chromoendoscopy when compared to standard white light examination (70, 71). Cap-assisted endoscopy allows for better mucosal inspection and shorter cecal intubation time due to flattening of the folds but does not consistently result in a higher ADR (72). However, when comparing standard colonoscopy with Endocuff-assisted endoscopy, the latter had a higher polyps detection rate (56% vs. 42%) with similar cecal and ileum intubation rates, procedure time, withdrawal time, and adverse events (73). Similar results were reported in a large RCT of Endocuff-assisted endoscopy vs. standard colonoscopy (35.4% vs. 20.7%) (74).

11. Conclusions

Optimizing colonoscopy is an important step of providing high quality-healthcare to patients. The colonoscopy’s quality depends on several parameters and factors. Several quality measures have been suggested and studied with all having advantages and limitations compared to one another (Table 1). However, these metrics are related and they serve to complement each other for the benefit of the patient and the healthcare system as a whole. These quality measures should be integrated into routine colonoscopy reporting and be the subject of quality improvement projects.

Table 1. Colonoscopy Quality Metrics

Metric	Values and Advantages	Drawbacks and Limitations
Adenoma detection rate (ADR)	Proven inverse relation to interval colorectal cancer incidence	Large colonoscopy volume required to measure
	Reliable and practical to measure	Potentially corruptible ("one-and-done")
Cecal intubation	Hallmark of a complete examination	Insufficient measure to use as a stand-alone quality indicator
	Proven correlation with ADR	
	Easy to document	
Withdrawal time	Positive correlation with ADR	Ceiling effect
		Not an independent quality indicator
		Missing detailed breakdown by colonic segment
Bowel preparation	Higher quality associated with increased ADR and shorter examinations	Subjective in nature
	Split-dosing increases examination quality	Low-to-moderate concordance of bowel scales between examiners
	Easily improved with better patient educations and reminders	Time spent washing and suctioning not accounted for in quality scoring

Footnote

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