Defining and Applying Locally Relevant Benchmarks for the Adenoma Detection Rate

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INTRODUCTION: **The adenoma detection rate (ADR) is the best validated colonoscopy performance quality indicator. The ASGE/ACG Task Force on Colonoscopy Quality set an ADR benchmark of ≥25% in a mixed male/female population. We propose a novel means for defining locally relevant ADR benchmarks using data from the population of interest and for applying ADR benchmarks using 95% confidence intervals (CIs) of an endoscopist's ADR. We further propose that ADR benchmarks should be raised to reflect what can be achieved by high-performing endoscopists.**

METHODS: **We used endoscopists' performance in a baseline year to develop and apply benchmarks in an assessment year. We defined assessment year benchmarks (Minimally Acceptable, Standard of Care, and Aspirational) based on the average ADR of performance groups defined by baseline year ADR quartiles. We demonstrated the use of these benchmarks in endoscopists performing screening colonoscopies by determining if the upper bound of the 95% CI of the endoscopist's ADR included the ADR benchmark.**

RESULTS: **The study included 8,492 colonoscopies (mean ADR 29%) in 2014 and 5,193 colonoscopies (mean ADR 32%) in 2015, completed at a regional screening center in Calgary, Canada. The Minimally Acceptable, Standard of Care, and Aspirational benchmarks for 2015 were 25%, 30%, and 39%, respectively. The 95% CI of the ADR of 1 (3%), 3 (10%), and 12 (39%) endoscopists did not include the benchmark.**

DISCUSSION: **We have proposed methods for defining and applying benchmarks for ADR in average-risk patients that go beyond the "minimally acceptable" threshold currently recommended.**

SUPPLEMENTARY MATERIAL accompanies this study at http://links.lww.com/AJG/A49

Am J Gastroenterol 2019;114:1315–1321. https://doi.org/10.14309/ajg.0000000000000120

INTRODUCTION

The adenoma detection rate (ADR) is the best validated colonoscopy performance quality indicator (1–3). The ADR is the proportion of patients who underwent a colonoscopy who had 1 or more adenomas detected and can be defined for specific indications (e.g., average-risk screening colonoscopy) or all colonoscopies (4,5). In 2015, the American Society of Gastrointestinal Endoscopy (ASGE)/American College of Gastroenterology (ACG) Task Force on Quality in Endoscopy recommended a benchmark ADR of ≥ 30% in men and ≥20% in women or ≥25% in a mixed male/female population at average risk for colorectal cancer (CRC) (4). The expectation is that all endoscopists would have an ADR that meets or exceeds this benchmark.

In this study, we argue that the creation and application of ADR benchmarks should occur locally and should take into consideration the role of random variation in an endoscopist's measured ADR. There are several problems that must be considered when using the ADR and the ASGE/ACG benchmark to assess the performance of an endoscopist. First, the ADR reflects not only the performance of the endoscopist, but also the underlying adenoma prevalence of the population. There are marked geographic variations in CRC incidence rates even within the United States (6,7). Therefore, there are also presumably marked geographic variations in adenoma prevalence. Second, the measured ADR is an estimate of the endoscopist's ADR and, like any estimate, it is subject to random variation. Third, the ASGE/ACG ADR benchmark is based on historical detection

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Received June 11, 2018; accepted December 3, 2018; published online January 29, 2019

rates of U.S. endoscopists and does not reflect the current detection rates of many endoscopists (2).

To overcome the inherent problems of using the ADR and existing benchmarks to assess the performance of endoscopists, we propose the following principles:

1. Locally relevant ADR benchmarks should be developed from the population of interest.
2. Confidence intervals should be applied to an endoscopist's ADR to clearly demonstrate the precision of the estimated ADR and to determine if an endoscopist fails to achieve the benchmark.
3. Adenoma detection rate benchmarks should be raised to reflect what can be achieved by high-performing endoscopists, which all endoscopists can strive to attain, thereby driving broad improvement in the quality of colonoscopy.

To achieve these goals, we extended methods we have previously proposed for defining an ADR benchmark for colonoscopies performed on fecal immunochemical test (FIT) + patients (8). In this study, we first show the calculation and behavior of these benchmarks in two hypothetical examples, and then apply these methods to endoscopists providing screening colonoscopies at a regional colon cancer screening center in Canada.

METHODS

Study design and patients

This study was approved by the Health Research Ethics Board of Alberta (HREBA.CC 16-0884). The study was conducted at the Forzani & MacPhail Colon Cancer Screening Centre (CCSC) in Calgary, AB, Canada.

In this historical cohort study, we included 13,676 patients who underwent a screening colonoscopy at the CCSC in 2014 (year 0) and 2015 (year 1). To be included in the study, a patient had to have undergone a colonoscopy between the ages of 50 and 74 years with an indication of average risk for CRC (free of a personal or family history of colorectal cancer or adenomatous polyps). Patients with a positive FIT were excluded. Only colonoscopies reported by the endoscopist to be complete to the cecum and with a bowel preparation rated by the endoscopist as adequate to detect polyps greater than 5 mm were included (9). Procedures performed by endoscopists who performed fewer than 50 colonoscopies in a year were excluded.

Data sources and variables

We obtained data on colonoscopies from the endoscopy reporting program endoPRO (Pentax Medical). Data elements included age, sex, procedure date, indication, depth of endoscope insertion, bowel preparation quality, whether a polypectomy was performed, and withdrawal time. Pathology data were obtained from the CCSC Pathology Database, which includes a structured summary of the pathology report.

Statistical analysis

Statistical analysis was performed using Stata 15 (StataCorp LLP, College Station, TX). In calculating ADR, only polyps that were biopsied or resected and confirmed on pathological examination to be conventional adenomas were included. Cancers, sessile serrated adenomas, traditional serrated adenomas, and hyperplastic polyps of any size or location were not included. The

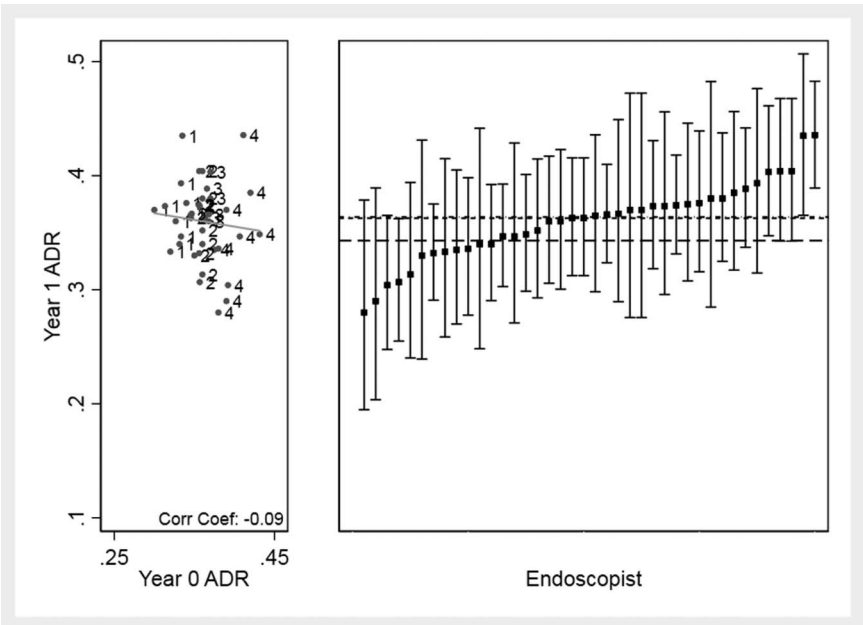

Figure 1. Benchmarking example No. 1–endoscopists' adenoma detection probability 90%. In example No. 1, all endoscopists have a 90% probability of detecting at least 1 adenoma if 1 or more is present in a given patient. When the true ADR of all endoscopists is identical and the only difference between endoscopists' measured ADR is due to random variation in the adenoma prevalence of their patients, there is a very poor correlation between endoscopists' year 0 and year 1 ADRs (left graph) and all three benchmarks are roughly equivalent, and in this example, do not follow the expected order of minimally Acceptable benchmark < Standard of Care benchmark < Aspirational benchmark. In the right graph, the upper bound of the 95% confidence interval of the measured ADR of all endoscopists encompasses all three benchmarks (horizontal lines). ADR, adenoma detection rate.

ADR for each endoscopist was calculated as the percentage of colonoscopies in which at least 1 adenoma was detected. Exact binomial 95% confidence intervals (CIs) were calculated for each endoscopist's ADR.

We developed three benchmarks: (1) Minimally Acceptable, (2) Standard of Care, and (3) Aspirational. To calculate the benchmarks, we used 2 years of data. Data from a baseline year (year 0) were used to classify the endoscopists into performance groups. Data from the assessment year (year 1) were used to set the benchmarks. We used the ADRs measured in the assessment year of the performance groups defined in the baseline year to calculate the benchmarks. In this way, performance in 1 set of patients (year 0) was used to develop and apply benchmarks in an independent set of patients (year 1). This limits the risk that the benchmarks are merely the result of random variation in endoscopists' ADR as could occur if performance groups were identified and benchmarks were defined in the same set of patients.

To classify endoscopists into performance groups, year 0 ADRs were divided into quartiles (see Figure 1, Supplemental Digital Content, http://links.lww.com/AJG/A49). Those endoscopists in the middle two quartiles were classified as Average Detectors. Those endoscopists in the highest quartile were classified as High Detectors. The three ADR benchmarks were then based on the year 1 performance of these groups as described below.

The Minimally Acceptable benchmark was defined as the mean of the year 1 ADRs of the lower two quartiles. The rationale for this benchmark is that it best approximates the intent of the ASGE/ACG Task Force benchmark. All endoscopists are expected to at least achieve the ASGE/ACG Task Force benchmark, although it is recognized that many endoscopists will have an ADR that greatly exceeds it.

The Standard of Care benchmark was defined as the average of the year 1 ADRs of those endoscopists in quartiles two and three (Average Detectors). The Standard of Care benchmark represents an estimate of the readily detectable adenomas prevalent in the population. An endoscopist's observed performance (measured ADR) should not be inconsistent with the overall adenoma prevalence.

The Aspirational benchmark was defined as the average of the year 1 ADRs of those endoscopists in quartile four (High Detectors). The rationale for this benchmark is that those endoscopists with a high ADR in an independent set of observations may represent a group of endoscopists who are especially adept at detecting adenomas. The observed prevalence of adenomas in patients seen in those achieving the Aspirational benchmark is more likely to reflect the true adenoma prevalence in the population than the observed adenoma prevalence in the Average Detectors.

The benchmarks were first applied in two hypothetical examples (methods described in Supplementary Document, Supplemental Digital Content, http://links.lww.com/AJG/A49). These two examples demonstrate how the benchmarks perform when all endoscopists perform at a uniformly high level and when there is variation in endoscopists' performance.

Application to study sample

The ADRs of endoscopists who performed screening colonoscopies in year 0 (2014) and year 1 (2015) were used to define the three benchmarks. The benchmarks were then applied to all endoscopists who performed colonoscopies in year 1. The year-over-year correlation of the endoscopists' ADRs was calculated. The performance of endoscopists was evaluated by comparing

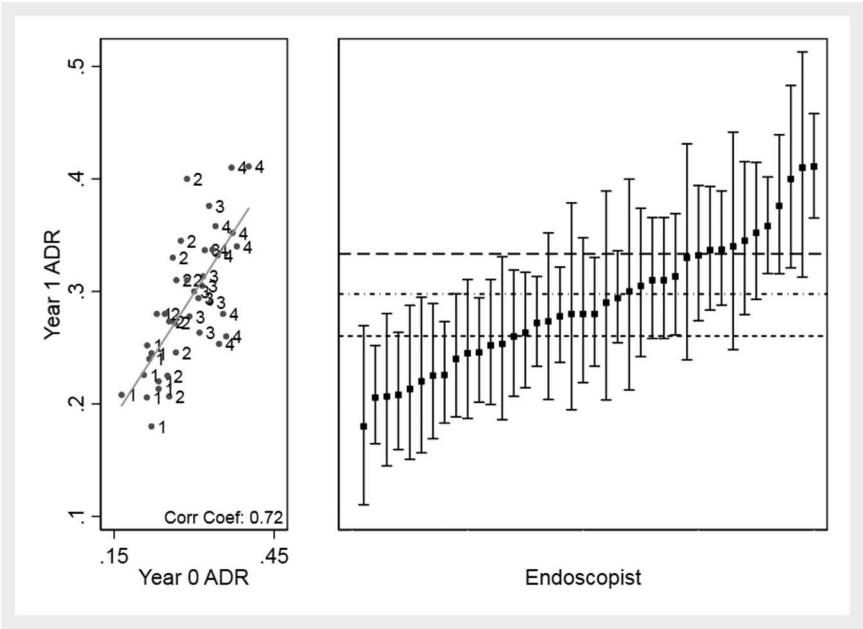

Figure 2. Benchmarking example No. 2–endoscopists' adenoma detection probability 50%—90%. In example No. 2, there is a variation in the ability of endoscopists to detect adenomas. The probability that the endoscopists will detect at least 1 adenoma if 1 or more is present varies from 50% to 90%. In example No. 2, more of the variation in endoscopists measured ADR is due to a true difference in performance. Therefore, there is a strong correlation in endoscopists' year 0 and year 1 ADRs (left graph) and the benchmarks (horizontal lines in right graph) are ordered as expected: Minimally Acceptable benchmark < Standard of Care benchmark < Aspirational benchmark. In the right graph, the upper bound of the 95% confidence interval of the measured ADR of lower performing endoscopists do not encompass the Standard of Care benchmark (middle horizontal lines) and approximately half of endoscopists do not achieve the Aspirational benchmark (upper horizontal line). ADR, adenoma detection rate.

Table 1. Characteristics of the study sample

	Year 0 (2014)	Year 1 (2015)
Patient characteristics	(n = 8,492)	(n = 5,193)
Sex		
Male	4,295 (51%)	2,561 (49%)
Female	4,197 (49%)	2,632 (51%)
Age group		
50–64	7,206 (85%)	4,358 (84%)
65–75	1,286 (15%)	835 (16%)
Fecal immunochemical test		
Not done	7,159 (84%)	3,139 (61%)
Negative	1,333 (16%)	2,054 (39%)
Any polyp	4,140 (49%)	2,686 (52%)
Any adenoma	2,477 (29%)	1,649 (32%)
Any advanced adenoma	426 (5%)	243 (5%)
Endoscopist characteristics	(n = 40)	(n = 31)
Specialty		
Gastroenterology	33 (83%)	26 (84%)
Colorectal surgery	7 (18%)	5 (16%)
Procedure volume		
≤100	13 (33%)	8 (26%)
101–200	9 (23%)	12 (39%)
201–400	11 (28%)	11 (36%)
≥401	7 (18%)	0 (0%)
Withdrawal time (min)		
≤7	17 (43%)	8 (25%)
7.1–9	16 (40%)	17 (55%)
≥9.1	7 (18%)	6 (19%)

their observed ADR and associated 95% CIs to each of the three benchmarks.

RESULTS

Hypothetical application of benchmarks

In the hypothetical situation where all endoscopists have a 90% probability of detecting at least 1 adenoma, there was little correlation between endoscopists' year 0 and year 1 ADRs (Figure 1—left graph) because variation among endoscopists is primarily due to the random variation in the adenoma prevalence in their patients in the two observation periods. The upper bound of the 95% CI of the measured ADR of all endoscopists encompasses all three benchmarks (Figure 1—right graph).

In the hypothetical situation, where there is significant variation in the probabilities that the endoscopists will detect at least 1 adenoma, there was a strong correlation between endoscopists' year 0 and year 1 ADRs (Figure 2—left graph). The upper bound of the 95% CI of the endoscopist with the second lowest ADR does not even achieve the Minimally Acceptable benchmark (lowest horizontal line); several endoscopists do not achieve the Standard of Care benchmark and nearly half of endoscopists do not achieve the Aspirational benchmark (Figure 2—right graph).

Application to study sample

Characteristics of the patients and endoscopists included in the study sample are shown in Table 1. The average ADR in year 0 (2014) was 30.2% (95% CI 27.9%–32.4%), and in year 1 (2015), it was 31.8% (95% CI 29.2%–34.3%). Twenty-nine of the 40 endoscopists present in year 0 also completed at least 50 procedures each in year 1. The performance of these 29 endoscopists, as shown in Table 2, was used to define the year 1 benchmarks. There was a strong correlation (Pearson correlation coefficient 0.77, 95% CI 0.56–0.89) between these endoscopists' year 0 and year 1 ADRs as shown in Figure 3. Notably, the eight endoscopists classified as High Detectors (Quartile No. 4) in year 0 continued to have high ADRs in year 1. The mean year 1 ADR of the year 0 High Detectors was 39.0% (95% CI 35.1%–42.9%) compared with 29.9% (95% CI 27.7%–32.2%) for the year 0 Average Detectors.

The calculated benchmarks for year 1 were as follows: Minimally Acceptable 25%, Standard of Care 30%, and Aspirational 39%. Figure 4 shows how each endoscopist's year 1 ADR and associated 95% CI compared to the three benchmarks. When based on the upper bound of the 95% CI of the ADR, 1 (3%) endoscopist did not achieve the Minimally Acceptable benchmark, 2 (7%) endoscopists achieved the Minimally Acceptable but did not achieve the Standard of Care benchmark, and 9 (29%) endoscopists achieved the Standard of Care but did not achieve the Aspirational benchmark.

DISCUSSION

In this study, we have attempted to overcome inherent limitations in the current ASGE/ACG Task Force ADR benchmark and how it is applied to assess the performance of endoscopists.

Table 2. Year 0 and year 1 performance of endososcopists classified into performance groups based on year 0 ADR

	Year 0			Year 1	
	ADR quartiles	n	ADR range	n	ADR mean (range)
Performance groups					
Low detectors	1	10	0.17–0.22	5	0.25 (0.16–0.33)
Average detectors	2 and 3	20	0.26–0.33	16	0.30 (0.23–0.36)
High detectors	4	10	0.34–0.44	8	0.39 (0.32–0.47)

ADR, adenoma detection rate.

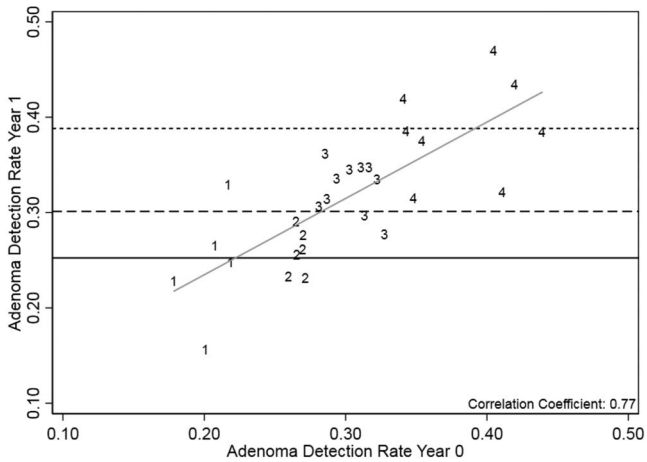

Figure 3. Year-to-year correlation in endoscopists' adenoma detection rate. Correlation between each endoscopist's year 0 and year 1 ADR is shown. The marker for each endoscopist (1–4) reflects their year 0 performance quartile. The year 1 benchmarks are shown as horizontal lines: Solid horizontal line: Minimally Acceptable benchmark (25%). Long dashed line: Standard of care benchmark (30%). Short dashed line: Aspirational benchmark (39%). ADR, adenoma detection rate.

The probability that an endoscopist will detect an adenoma in a given patient is the product of two independent probabilities: the probability of that patient having at least 1 adenoma and the probability that the endoscopist will detect at least 1 adenoma if 1 is present. There are marked geographic variations in CRC incidence rates even within the United States (6,7). Is an ADR benchmark of ≥25% appropriate for all states? CRC incidence rates and, presumably, adenoma prevalence rates are affected by many factors that may vary between settings and populations, including standard epidemiological risk factors for CRC and the availability and use of other screening tests, such as the FIT.

The US Multi-Society Task Force on Colorectal Cancer in 2002 set the initial ADR benchmark of 20% based on the range of adenoma prevalence reported in cross-sectional screening colonoscopy studies (10). In 2015, ASGE/ACG Task Force on Quality in Endoscopy recommended increasing the ADR benchmark to 25% based on the recognition that many endoscopists achieve an ADR much higher than 20% and evidence that the greater the ADR, the greater the protection against CRC incidence and mortality (4). The decision by the ASGE/ACG Task Force to set the new ADR benchmark 5% higher than the original ADR benchmark of the US Multi-Society Task Force was largely arbitrary, and the benchmark is not clearly linked to either the adenoma prevalence in the population or to achieving maximal reductions in CRC incidence. Data on over 300,000 colonoscopies examined by Corley et al.(2) indicate that there may not be a simple threshold effect to the protection from CRC afforded by colonoscopy. These investigators showed that the risk of advanced-stage or fatal colorectal cancer decreased with increasing ADR. Therefore, it may no longer be reasonable to continue to advocate the use of the ASGE/ACG Task Force's benchmark as a quality improvement tool.

In our study, we defined three different thresholds that represent "minimally acceptable," "standard of care," and "aspirational" benchmarks. The Minimally Acceptable benchmark is based on the performance of endoscopists with overall below standard performance. Therefore, the Minimally Acceptable benchmark is not linked to the underlying adenoma prevalence in the population and is unlikely to be associated with high levels of protection against CRC.

Our Standard of Care benchmark reflects the performance of typical endoscopists. Our Aspirational benchmark is the average performance among high-performing endoscopists. Therefore, both measures are more clearly linked to the population's adenoma prevalence and because measures of colonoscopy performance theoretically have greater validity than the Minimally Acceptable benchmark. Therefore, we propose that the Standard of Care and Aspirational benchmarks be used in quality improvement activities.

We would argue that the Standard of Care rather than the Minimally Acceptable benchmark is the most useful single measure of endoscopist's performance based on ADR. It has a theoretical underpinning that is linked to the adenoma prevalence in the population and is based on the principle that all endoscopists performing screening colonoscopy should at least be "average" performers. In our setting, it identified a small group of underperforming endoscopists.

However, the goal of a quality improvement program should be to move performance toward excellence and not merely toward the Minimally Acceptable or average. Therefore, we would argue that the Aspirational benchmark is most useful to drive improvement toward excellence. In our sample, the group of endoscopists, classified as High Detectors based on their 2014 performance, continued to demonstrate excellent performance in 2015. Therefore, this group truly does appear to be adept at identifying adenomatous polyps. The overall adenoma prevalence in their patients is likely more representative of the true adenoma prevalence in the population. There is a large gap in performance between the High Detectors and the average detectors. It is the performance of this high-performing group of endoscopists that the other endoscopists should be striving to match to best achieve the goals of reducing CRC incidence and

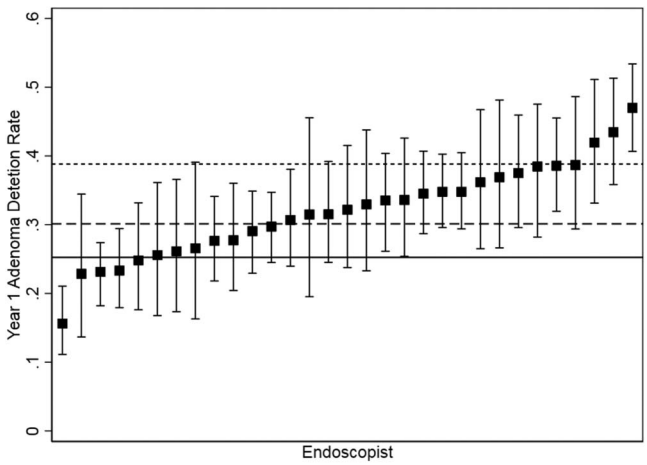

Figure 4. Year 1 ADR and 95% confidence interval for each endoscopist. The year 1 ADR of each endoscopist is shown as a black box with whiskers extending to its 95% confidence interval. The year 1 benchmarks are shown as horizontal lines: Solid horizontal line: Minimally Acceptable benchmark (25%). Long dashed line: Standard of care benchmark (30%). Short dashed line: Aspirational benchmark (39%). ADR, adenoma detection rate.

mortality through screening. Several studies, using a variety of interventions, have demonstrated that endoscopists can improve their ability to detect adenomatous polyps (11–13). Therefore, greater emphasis should be placed on showing endoscopists their potential for improvement.

Because of the methods used to calculate the Standard of Care and Aspirational benchmarks, many endoscopists' observed ADRs are expected to fall below the benchmarks, even if all endoscopists perform at a uniformly excellent level (as shown in Figure 1). Therefore, it is important when applying these benchmarks to calculate a CI of the endoscopist's ADR to determine if the endoscopist's performance is consistent or inconsistent with the benchmark. It is extraordinarily difficult to confidently conclude that an endoscopist's performance is not consistent with the ASGE/ACG Task Force benchmark unless the endoscopist has performed many hundreds, or even thousands, of procedures (14). As shown in Figure 4, low-volume endoscopists have very wide CIs for their ADR, which makes it difficult to confidently make any assessment of their performance. We chose to use 95% confidence intervals. However, a quality improvement program could elect to use a different value, say 90%, which would provide narrower intervals, but a higher risk of falsely concluding that endoscopist was not achieving a benchmark.

Important underlying assumptions of these methods are that there is true variation in endoscopists' performance. Consider the situation where these two assumptions are not true, where all endoscopists are performing at a similar high level. As shown in Figure 1, any variation among endoscopists would be due to variation in the adenoma prevalence in the set of patients seen by each endoscopist. There would be little correlation between the year-to-year performance of endoscopists and little difference in the ADRs of each of the performance groups used to define the benchmarks. Therefore, each of the three benchmarks would be approximately the same. This pattern would also be seen if all endoscopists are performing at a uniformly low level. Therefore, a quality assurance program faced with this set of results (limited year to year correlation in ADRs, small differences between the benchmarks and lower than expected benchmarks) would need to consider other information (CRC rates in the population and postcolonoscopy cancers rate) before concluding that all endoscopists were performing at an acceptable level.

Our study was conducted at a single site with subspecialist endoscopists. However, the methods we propose to establish the benchmarks are broadly applicable. Apart from the unlikely situation where all endoscopists perform at a uniformly poor level, our methods would also fail if the practices of individual endoscopists are so different that systematic, rather than only random, variation in adenoma prevalence would be expected.

In conclusion, we have proposed methods for defining locally relevant benchmarks for ADR in average risk patients that go beyond the currently recommended "minimally acceptable" threshold. These new benchmarks are derived from the assessment year results obtained by peers and by a group of expert adenoma detectors defined in an independent patient cohort (baseline year). To apply these benchmarks, we have recommended the use of CIs to account for expected variation in a measured ADR and to more confidently identify endoscopists not achieving a benchmark. These benchmarks are appropriately applied at a screening program or regional level, but not at an institutional level where there are only a small number of endoscopists (<20). These benchmarks support the goal of improving the performance of all endoscopists and lowering CRC incidence and mortality through screening.

Study Highlights

WHAT IS KNOWN

- ✓ The Adenoma Detection Rate (ADR) is the best validated colonoscopy quality indicator.
- ✓ The ADR benchmark is based on historical estimates of adenoma prevalence in the United States.
- ✓ An endoscopist's measured ADR is subject to random variation because it is estimated from a limited number of colonoscopies.

WHAT IS NEW HERE?

- ✓ Locally relevant ADR benchmarks are defined using contemporary data that reflect the performance of typical and high-performing endoscopists.
- ✓ Application of ADR benchmarks takes into consideration random variation by calculating 95% CIs for the measured ADRs.
- ✓ These proposed benchmarks support the goal of improving the performance of all endoscopists.

CONFLICTS OF INTEREST

Guarantor of the article: Robert J. Hilsden, MD, PhD.
Specific author contributions: R.J.H.: all aspects of the study, including drafting of the manuscript. S.M.R.: statistical analysis, interpretation of the data, and critical revision of the manuscript. C.D.: planning/conduct of the study, interpretation of the data, and critical revision of the manuscript. A.R.: planning/conduct of the study, collection of data, interpretation of the data, and critical revision of the manuscript. R.B.: planning/conduct of the study, interpretation of the data, and critical revision of the manuscript. S.E.M.: planning/conduct of the study, interpretation of the data, and critical revision of the manuscript. D.R.B.: interpretation of the data and critical revision of the manuscript. S.J.H.: planning/conduct of the study, interpretation of the data, and critical revision of the manuscript.
Financial Support: None.
Potential competing interests: None.

REFERENCES

1. Kaminski MF, Regula J, Kraszewska E, et al. Quality indicators for colonoscopy and the risk of interval cancer. New Engl J Med 2010;362:1795–803.
2. Corley DA, Jensen CD, Marks AR, et al. Adenoma detection rate and risk of colorectal cancer and death. New Engl J Med 2014;370:1298–306.
3. Hilsden RJ, Dube C, Heitman SJ, et al. The association of colonoscopy quality indicators with the detection of screen-relevant lesions, adverse events and post-colonoscopy cancers in an asymptomatic Canadian colorectal cancer screening population. 2015. Gastrointest Endosc [Epub ahead of print.]
4. Rex DK, Schoenfeld PS, Cohen J, et al. Quality indicators for colonoscopy. Gastrointest Endosc 2015;81:31–53.
5. Rex DK, Ponugoti PL. Calculating the adenoma detection rate in screening colonoscopies only: Is it necessary? Can it be gamed? Endoscopy 2017;28:28.
6. Arnold M, Sierra MS, Laversanne M, et al. Global patterns and trends in colorectal cancer incidence and mortality. Gut 2017;66:683–91.

7. Siegel RL, Miller KD, Fedewa SA, et al. Colorectal cancer statistics, 2017. CA Cancer J Clin 2017;67:177–93.
8. Hilsden RJ, Bridges R, Dube C, et al. Defining benchmarks for adenoma detection rate and adenomas per colonoscopy in patients undergoing colonoscopy due to a positive fecal immunochemical test. Am J Gastroenterol 2016;111:1743–9.
9. Lieberman D, Nadel M, Smith RA, et al. Standardized colonoscopy reporting and data system: Report of the quality assurance task group of the national colorectal cancer roundtable. Gastrointest Endosc 2007;65:757–66.
10. Rex DK, Bond JH, Winawer S, et al. Quality in the technical performance of colonoscopy and the continuous quality improvement process for colonoscopy: Recommendations of the US Multi-Society Task Force on colorectal cancer. Am J Gastroenterol 2002;97:1296–308.
11. Coe SG, Crook JE, Diehl NN, et al. An endoscopic quality improvement program improves detection of colorectal adenomas. Am J Gastroenterol 2013;108:219–26; quiz 227.
12. Barclay RL, Vicari JJ, Greenlaw RL. Effect of a time-dependent colonoscopic withdrawal protocol on adenoma detection during screening colonoscopy. Clin Gastroenterol Hepatol 2008;6: 1091–8.
13. Kahi CJ, Ballard D, Shah AS, et al. Impact of a quarterly report card on colonoscopy quality measures. Gastrointest Endosc 2013;77: 925–31.
14. Do A, Weinberg J, Kakkar A, et al. Reliability of adenoma detection rate is based on procedural volume. Gastrointest Endosc 2013;77: 376–80.