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Boston Bowel Preparation Scale scores provide a standardized definition of “adequate” for describing bowel cleanliness

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Abstract

Background—Establishing a threshold of bowel cleanliness below which colonoscopies should be repeated at accelerated intervals is important, yet there are no standardized definitions for an “adequate” preparation.

Objective—To determine if Boston Bowel Preparation Scale (BBPS) scores could serve as a standard definition of adequacy.

Design—Cross-sectional observational analysis of colonoscopy data from 36 adult gastrointestinal endoscopy practices; prospective survey showing 4 standardized colonoscopy videos with varying degrees of bowel cleanliness.

Setting—The Clinical Outcomes Research Initiative.

Patients—Average risk patients attending screening colonoscopy.

Main Outcome Measurements—Recommended follow-up intervals among normal, average risk screening colonoscopies stratified by BBPS scores.

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Results—We evaluated 2516 normal screening colonoscopies performed by 74 endoscopists. If the BBPS score was ≥ 2 in all three segments (N=2295), follow-up was recommended in 10 years in 90% of cases. Examinations with total BBPS scores of 3–5 (N= 167) had variable recommendations. 96% of examinations with total BBPS scores of 0–2 (N=26) had recommended follow-up within 1 year. Similar results were noted among 167 participants in a video survey with pre-established BBPS scores.

Limitations—Retrospective study.

Conclusions—BBPS scores correlate with endoscopist behavior regarding follow-up intervals for colonoscopy. A total BBPS score ≥ 6 and/or all segment scores ≥ 2 provides a standardized definition of “adequate for 10-year follow-up” whereas total scores ≤ 2 indicate that a procedure should be repeated within 1 year. Future work should focus on finding consensus for management of examinations with total scores of 3 to 5.

Keywords

colonoscopy; provider recommendations; bowel preparation

Introduction and Background

Establishing a threshold of bowel cleanliness below which colonoscopies should be repeated promptly or at accelerated intervals has important implications for clinical outcomes such as missed polyps and cancers, and potentially unnecessary testing that leads to excess costs and exposure to avoidable risk.^{1, 2} Yet, despite the importance of bowel cleanliness for colonoscopy, there are no standardized, easily implemented definitions for an “adequate” preparation. The Quality Assurance Task Group of the National Colorectal Cancer Roundtable and the United States Multi-Society Task Force on Colorectal Cancer (USMSTF-CRC) have previously suggested “adequate” to be the ability to “detect polyps >5 mm in size.”³ However, there are no data indicating good inter- and intra-observer agreement with this definition of adequate. Similarly, the timing of repeat colonoscopy after an inadequately clean examination has not been standardized,⁴ although recently, the USMSTF-CRC suggested the following recommendation: “If the bowel preparation is poor, most cases should be repeated within 1 year...If the bowel preparation is fair but adequate (to detect lesions >5 mm) and if small (<10 mm) tubular adenomas are detected, follow-up at 5 years should be considered.”⁵ Unfortunately, this recommendation would require good agreement about definitions of “poor”, “fair”, and “adequate to detect lesions >5 mm”, yet such agreement has not been demonstrated.

We hypothesized that the Boston Bowel Preparation Scale (BBPS), because of its validity and reliability^{6, 7} and its use in clinical research studies evaluating efficacy of bowel purgatives and dietary modifications in bowel cleansing and adenoma detection rates,^{8–12} could provide a standardized way to define what level of bowel preparation cleanliness is appropriate for recommending a 10 year interval, what level of bowel preparation requires prompt (within 1 year) repeating, and what intermediate scores are associated with accelerated screening intervals. The aim of our study was to test the hypothesis that BBPS scores would correlate sufficiently with physician behavior (i.e. recommendations for

follow-up intervals) that they could serve as standardized definitions of “adequate for a 10-year interval” and “inadequate, requiring prompt repetition of the procedure.”

Methods

This study was approved by the Institutional Review Boards at Boston Medical Center (IRB #H-29928) in November 2010 and Oregon Health & Science University (eIRB #7038) in February 2011 with waivers of informed consent. This specific study used a limited dataset and was therefore exempted from further IRB review.

Clinical Outcomes Research Initiative

Data was prospectively generated between October 2009 and May 2013 within the Clinical Outcomes Research Initiative (CORI). During the study period, CORI was a consortium of 61 adult gastrointestinal practices, including approximately 500 physicians in 18 states, using a specialized electronic health record to create their endoscopy reports. Within the CORI application, definitions of BBPS segment scores are provided using illustrative endoscopic images as a reference. Participating sites agree to use a structured computerized report generator to produce all endoscopic reports and comply with quality control requirements. The site's data files are transmitted electronically to a central data repository - the National Endoscopic Database. This data contains minimal patient or provider identifiers and therefore qualifies as a Limited Data Set under the Code of Federal Regulations Title 45, Section 164.514(e)(2). After completion of quality control checks, data from all sites were merged in the data repository for analysis. Practice sites contributing colonoscopy reports during the study period included private practice (73%), academic medical centers (9%), and Department of Veterans Affairs (VA) hospitals (18%).^{13, 14} Practice sites were selected to represent a complete spectrum of GI practices.

Colonoscopy reports with the indication of “average-risk screening” in which no polyps were found and with both a documented BBPS score and recommendation for timing of the next colonoscopy were included in the study. The recommendation for follow-up was obtained from a discrete data entry field or as free text in the assessment/plan. In cases where the recommendation was given as a range (e.g. 3–6 months), the mean time was used (e.g. 4.5 months). Patients with inflammatory bowel disease, history of colonic resection or prior removal of polyps or cancer, or family history of colon cancer were excluded. Incomplete examinations due to technical difficulty or patient intolerance were also excluded. Patient age and gender and a unique endoscopist CORI identification number and practice site were recorded.

Standardized video survey

We invited all participants of the Boston Bowel Preparation Scale Educational Program (BBPSEP) to complete a brief, online survey. The BBPSEP is a free 20-minute web-based program that teaches the BBPS and has been described in detail elsewhere (available online at <https://www.cori.org/bbps/login.php>).¹⁵ Four colonoscopy videos, each approximately 1-minute in length and designed to represent total BBPS scores of 2, 4, 6, and 8, were shown in random order. Based on the degree of bowel cleanliness observed in the video,

participants were asked to provide their recommendation for timing of the next colonoscopy for a hypothetical 60 year-old average-risk man (Figure 1). Choices were listed as 6 months, 1 year, 3 years, 5 years, 10 years, or other. Demographic information including specialty, years in practice, annual procedure volume, practice setting, and geographic location were collected.

Analysis

Clinical Outcomes Research Initiative—We determined the frequency of recommendations for specific follow-up intervals in percentages and compared frequencies using the Chi-square test of independence. We evaluated recommended follow-up intervals stratified by total and segment BBPS scores using medians and interquartile ranges (IQR). We compared follow-up recommendations by segment score grouped dichotomously (any segment with a score of 0 or 1 vs. all segments scoring 2 or 3). We also evaluated whether the location (right, transverse, left colon) of a particular segment score impacted follow-up recommendations. Comparisons were made using the Wilcoxon rank sum test.

Standardized video survey—For each video, we determined the frequency of follow-up interval responses in percentages. Median follow-up time recommended was not calculated because response choices were categorical rather than continuous. Differences in responses by video and by participant characteristics were evaluated using the chi-square test of independence. P-values <0.05 were considered significant.

Sample size calculation—For the primary endpoint examining the association between total BBPS scores and follow-up recommendations in the CORI data, we hypothesized *a priori* that BBPS total scores of 6, 7, 8, and 9 would have a higher proportion of recommendations for a 10 year interval of follow-up compared to BBPS total scores of 5. Assuming 90% of examinations with BBPS total scores 6 and 70% of examinations with BBPS total scores 5 were given 10-year follow-up, we would need 62 examinations in each group to have 80% power with an alpha of 0.05 to show a significant difference. In prior studies, the median BBPS score among a screening colonoscopy population was 6 with an approximate bell-shaped curve distribution⁷, so we estimated that ~600 examinations would give at least 62 examinations with a total score of 5.

For the standardized video analysis, we used a convenience sample. Post-hoc calculations demonstrated greater than 99% power to detect a significant difference in the percentage of participants recommending 10 year follow-up for Case A compared to Case D with an alpha of 0.05 with the study sample size. We had greater than 95% power to detect a 25% difference (85 vs. 60%) in the percentage of US vs. international participants recommending 10 year follow for Case A with an alpha of 0.05 with the study sample size.

Results

Clinical Outcomes Research Initiative examinations

Between October 2009 and May 2013, 42,484 normal average-risk negative screening colonoscopies were performed in CORI, of which 3615 (8.5%) contained a BBPS score.

Among these, 2619 (72%) documented a follow-up recommendation (Figure 2). We excluded 103 examinations that included a recommendation to stop colorectal cancer screening due to advanced age, leaving 2516 examinations for analysis. These 2516 examinations were performed by 74 endoscopists from 36 practice sites. The median (IQR) number of examinations contributed by each endoscopist was 3 (1–13) and by each practice site was 16 (2–35). The median (IQR) patient age was 56 (51–62) years and 56% were women. The median (IQR) BBPS score was 8 (6–9). Among the normal average risk screening colonoscopy examinations with “good” or “excellent” preparation and a recommendation for follow-up (N=22,851), the median follow-up recommendation was 10 years by both CORI users who use the BBPS and CORI users who have never used the BBPS.

Figure 3 shows the percentage of examinations given a follow-up interval of 10 years among the different total BBPS scores. Follow-up was recommended in 10 years in 89% (2066/2323) of cases with total BBPS scores ≥ 6 , then decreased as BBPS scores decreased. Follow-up was recommended within 1 year in 96% (25/26) of cases where total BBPS scores were 0–2. The greatest variability in recommendations for follow-up was seen among total BBPS scores 3–5 (median recommendation 5 years), in which follow-up at 10 years was recommended only 34% (56/167) of the time. Examinations with any BBPS segment score of 0 (N=49) or 1 (N=221) were associated with a shorter median follow-up recommendation compared with examinations in which all BBPS segment scores were ≥ 2 (N=2295), even when total BBPS scores were high (total score 6 or 7) (Table 1). Whenever any colonoscopy contained a single segment score of 1 (N=101), the location of that segment had no significant effect on recommended follow-up intervals (right colon: 7.4 (IQR 5–10) years vs. transverse colon: 7.3 (IQR 5–10) years vs. left colon: 6.3 (IQR 3–10) years; $P=0.45$).

In a secondary analysis, we excluded endoscopists who contributed fewer than 10 colonoscopy examinations, leaving 23 endoscopists from 20 practice sites for analysis, and found very similar findings. For total BBPS scores 6–9, follow-up was recommended in 10 years in 89% of examinations and for total BBPS scores 0 to 2, follow-up was recommended within 1 year in 96% of examinations.

Standardized videos survey

Of the 207 eligible physicians (i.e. participated in the BBPSEP), 167 (81%) responded to the survey. They were predominantly gastroenterologists with diverse backgrounds (Table 2). In terms of geography, 66 were from outside the US including Canada, Europe (Austria, Belgium, Bulgaria, France, Germany, Greece, Italy, Netherlands, Norway, Spain, UK), South America (Argentina), Middle East (Israel, Lebanon), Asia (Singapore, Thailand), and Australia. Twenty three (14%) of the 167 survey respondents were CORI users who contributed colonoscopy examinations to the CORI analysis of follow-up recommendations.

The association between total and segment BBPS scores and recommended follow-up time in the video survey paralleled that observed in the CORI analysis. Recommended follow-up time decreased significantly as BBPS scores decreased ($P<.001$; Table 3). Seventy six percent of participants recommended 10 year follow-up for Video A (total BBPS 8), in

which all segment scores were 2 or 3, compared to only 29% for Video B (total BBPS 6), which contained a segment score of 1. Eighty four percent of participants recommended immediate follow-up within 1 year for Video D (total BBPS 2). US participants (87% vs. 60%, $P=.0002$), those working in an ambulatory endoscopy center (92% vs. 74%, $P=.04$) or non-academic setting (82% vs. 69%; $P=0.05$) were more likely to recommend a 10 year follow-up for Video A (BBPS 8) than their counterparts. A secondary analysis limited to survey respondents who did not contribute any colonoscopy examinations to the CORI analysis ($N=144$) showed similar results with 72% recommending 10 year follow-up for Video A, 26% recommending 10 year follow-up for Video B, and 85% recommending follow-up within 1 year for Video D. US participants (82%) were more likely to recommend 10 year follow-up for Video A compared to those outside the US (60%; $P=0.005$).

Discussion

In this study, BBPS scores from real-world screening colonoscopies performed by a diverse group of providers correlated with provider behavior regarding recommendations for follow-up intervals after colonoscopy. Total BBPS scores ≥ 6 in which all segment scores were ≥ 2 were considered adequate to recommend a 10 year follow-up interval. Conversely, there appeared to be agreement that total scores ≤ 2 were considered completely inadequate, requiring prompt follow-up within 1 year. Total BBPS scores in the intermediate range (3–5) were given variable follow-up recommendations, suggesting lack of uniformity in our current management of these “middling” preparation qualities. The location of the worst segment score did not change follow-up recommendations in a significant way. US participants were more likely to recommend 10 year follow-up for a standardized video designed to have a BBPS score of 8 compared to international participants, perhaps due to variation in national guidelines and practice patterns by country.¹⁶

A clear and universally accepted definition of the term “adequacy” for bowel preparation cleanliness that is amendable to use in clinical practice is vital to ensuring efficient use of colonoscopy resources. Adequacy to allow for a 10 year follow-up interval and inadequacy to warrant prompt (within 1 year) follow-up can be reasonably well defined using the BBPS. Intermediate preparations that fall into the middle or “fair” category continue to present management challenges. Our findings indicate the utility of the BBPS for future research addressing intermediate bowel cleanliness as we define rational, accelerated follow-up intervals. Providing evidence-based recommendations for accelerated follow-up intervals may help increase patient adherence with attending repeat colonoscopy after less-than-adequate bowel preparation, which is currently poor. For example, one single center study found that fewer than 36% of patients returned for a repeat colonoscopy after inadequate bowel preparation.¹⁷

The use of BBPS scores to define “adequate,” “inadequate,” and “in need of an accelerated follow up” may also help us begin to understand the impact of various bowel preparations (including purgatives and dietary instructions) on resource utilization. By knowing the distribution of BBPS scores in a typical screening population, we can perform modeling studies to evaluate the frequency and thus costs of accelerated follow-up intervals. Accountable care organizations, for example, may decide to pay for a more costly bowel

purgative regimen if it increases the number of examinations that achieve a total BBPS score of at least 6, allowing for more 10-year follow-up intervals.

Prior studies have examined the association between bowel cleanliness and endoscopist recommendations for follow-up and found great variability among physician responses. In a study of 78 gastroenterologists in a single country, there was considerable inter-observer variability in recommended follow-up, ranging from immediate to 5 years for identical cases represented with photographs.¹⁸ The physicians in that study, however, were not asked to directly assess the bowel preparation quality or its adequacy. In another study of 239 gastroenterologists evaluating photographs, the timing of follow-up when the colonoscopy was imperfect was highly variable. No associations were observed between personal or practice characteristics and follow-up recommendations.¹⁹ In a survey of 288 members of the American College of Gastroenterology presented with six written scenarios with either suboptimal (defined as “fair, poor, or inadequate”) or optimal (defined as “adequate, good, or excellent”) bowel preparation and varying findings (normal, small adenoma, large adenoma), suboptimal preparations were associated with shorter intervals compared to optimal preparations in every scenario.²⁰ However, our study distinguishes itself by identifying thresholds of cleanliness below which physician behavior changes, thereby suggesting the appropriateness of BBPS scores for clinical use in suggesting screening intervals.

Our study has several strengths. First, we used a large, national repository of endoscopy reports from endoscopists from diverse practice settings and geographic regions which lends some generalizability to our findings. Second, we evaluated the behavior of endoscopists in terms of follow-up recommendations in routine clinical practice rather than a study setting and were able to capture “real-world” behavior. Third, we confirmed our findings by also conducting an international survey using standardized video cases, which further lends generalizability to our findings.

Despite these strengths, we acknowledge certain limitations. As with any retrospective study, we were limited by the availability and quality of documentation. However documentation within the CORI system was generated prospectively, was subject to quality control and has been shown to be fairly robust.²¹ There may have been selection bias limiting complete generalizability of our findings; participants in CORI may differ than general endoscopists outside of CORI and participants in CORI who opt to use the BBPS may differ from those who do not, including a possible greater likelihood of following current screening colonoscopy interval guidelines. However, we found that among normal average risk screening colonoscopy examinations with “good” or “excellent” preparation, the median follow-up recommendation was 10 years by both CORI users who use the BBPS and CORI users who have never used the BBPS. Survey participants may also be a select group having completed the web-based tutorial. Interestingly, nearly all of the survey respondents had either fewer than 5 years of experience or more than 20 years of experience, suggesting possible selection bias based on duration of time in practice. We excluded 28% of examinations due to lack of documentation of follow-up. However, many of these excluded examinations (N=453) were performed by endoscopists whose behavior was already captured in the study based on examinations that did contain documented follow-up

recommendations, leaving only 5 endoscopists without follow-up recommendation data. Our study does not provide data on the relationship between BBPS scores and follow-up intervals in the setting of finding 1 or more adenomas, an area that should be evaluated in future studies. Last, although it would have been interesting to look at the relationship between other bowel preparation scales, such as the Ottawa scale, and endoscopists' behavior regarding follow-up intervals, these data were not available to us.

In summary, BBPS scores correlated with endoscopist behavior regarding recommended follow-up intervals after screening colonoscopy. The BBPS appears to be a reasonable standardized tool for determining if bowel cleanliness is adequate for recommending a 10 year screening interval (total score ≥ 6 and/or all segment scores ≥ 2) or inadequate requiring repeat examination within 1 year (total scores ≤ 2). Future research should determine how to manage intermediate BBPS scores of 3–5.

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Acronyms

ACG	American College of Gastroenterology
ASGE	American Society of Gastrointestinal Endoscopy
BBPS	Boston Bowel Preparation Scale
CORI	Clinical Outcomes Research Initiative
CRC	Colorectal cancer
GI	Gastroenterology
IQR	Interquartile range
US	United States
USMSTF-CRC	United States Multi-Society Task Force on Colorectal Cancer
VA	Veteran's Affairs

Take-Home Message

- Boston Bowel Preparation Scale (BBPS) scores correlate with endoscopist behavior regarding follow-up intervals, such that colonoscopies with total BBPS scores ≥ 2 necessitate repeat examination within 1 year.
- The use of the BBPS can help inform management of colonoscopies with less than perfect bowel cleanliness.

Boston University School of Medicine

CLINICAL OUTCOMES RESEARCH INITIATIVE

The Boston Bowel Preparation Scale Educational Program

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Case #1

Transverse colon

Right	Transverse	Left
☐ NA	☐ NA	☐ NA
☐ 0	☐ 0	☐ 0
☐ 1	☐ 1	☐ 1
☐ 2	☐ 2	☐ 2
☐ 3	☐ 3	☐ 3

Total Score: 0

Optional question: For a 60 year-old average-risk man undergoing screening colonoscopy with this bowel cleanliness in which no polyps are found, when would you recommend his next colonoscopy?

☐ ≤6 months
 ☐ 1 year
 ☐ 3 years
 ☐ 5 years
 ☐ 10 years
 ☐ Other

Please Wait...

A score for all segments is required.

For technical support, please contact CORI support at 888-786-2674. For questions regarding the content of this program, please contact Audrey Calderwood at audrey.calderwood@bmc.org or 617-638-8211.

Figure 1.
Sample video case asking participants to provide a recommendation for timing of next colonoscopy based on bowel cleanliness observed.

Figure 2.

Flow diagram showing the colonoscopy examinations included in the analysis of the association between Boston Bowel Preparation Scale scores and timing of the next colonoscopy recommended.

* Recommendation for no further colonoscopies due to age

Figure 3.

Percentage of normal colonoscopy examinations in which 10-year follow-up was recommended stratified by total Boston Bowel Preparation Scale score.

Table 1

Impact of Boston Bowel Preparation Scale segment scores on follow-up recommendations.

	N	Follow-up recommended, years		P-value
		Median	IQR	
All total scores:				<.0001
All segments 2	2295	10	10, 10	
Any segment 1	221	5	1, 10	
Any segment 0	49	0.25	0, 1	
Total scores 6 and 7:				<.001
All segments 2	874	10	10, 10	
Any segment 1	28	5	3, 10	

Table 2

Characteristics of the endoscopists who participated in the standardized video survey.

Characteristic	N (%)
Total	167
Specialty ^a	
Gastroenterology	134 (81)
Family medicine	5 (3)
Surgery	17 (10)
Other	9 (5)
Years in practice ^b	
<5	56 (60)
5–10	1 (1)
11–20	1 (1)
>20	36 (38)
Annual colonoscopy volume ^c	
<100	23 (14)
100–250	34 (21)
251–500	49 (30)
501–1000	36 (22)
>1000	21 (13)
Practice setting	
Ambulatory center	29 (17)
Hospital	68 (41)
Academic center	68 (41)
VA	17 (10)
Region	
US ^a	101 (60)
North East	21 (21)
South East	18 (18)
North Central	14 (14)
South Central	3 (3)
North West	27 (27)
South West	16(16)
Outside the US	66 (40)

^a missing 2

^b missing 73

^c missing 4

Table 3

Recommended follow-up interval for next colonoscopy for video cases among endoscopists who agreed on the Boston Bowel Preparation Scale score for each video for (A) all participants, (B) U.S. participants, and (C) international participants.

A. All participants (N=167)							
	BBPS score, total (R-T-L)	Follow-up recommended, %					
		6 mo	1 yr	3 yr	5 yr	10 yr	Other
Video A	8 (2-3-3)	0	1	3	18	76	0
Video B	6 (1-2-3)	9	14	14	30	29	3
Video C	4 (0-2-2)	20	19	19	25	15	2
Video D	2 (0-1-1)	61	23	7	7	2	0

B. US participants (N=101)							
	BBPS score, total (R-T-L)	Follow-up recommended, %					
		6 mo	1 yr	3 yr	5 yr	10 yr	Other
Video A	8 (2-3-3)	0	2	1	9	87 ^a	1
Video B	6 (1-2-3)	7	17	8	28	36	3
Video C	4 (0-2-2)	21	18	11	31	17	1
Video D	2 (0-1-1)	63	18	7	10	2	0

C. International participants (N=66)							
	BBPS score, total (R-T-L)	Follow-up recommended, %					
		6 mo	1 yr	3 yr	5 yr	10 yr	Other
Video A	8 (2-3-3)	0	0	5	31	60 ^a	5
Video B	6 (1-2-3)	13	11	22	33	19	3
Video C	4 (0-2-2)	19	21	30	16	11	3
Video D	2 (0-1-1)	58	31	6	2	3	0

Global P<.001

^a Comparison between the percentage of US vs. international participants recommending 10 year follow-up for Video A was significantly different using Chi-square test of independence (P=.0002).