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Original Article

Factors affecting outpatient bowel preparation for colonoscopy

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A B S T R A C T

Background: Colonoscopy remains one of the most effective methods to screen for colorectal cancer. However, the detection of colorectal polyps is dependent on the cleanliness of the colonic tract. The purpose of our retrospective chart review was to identify clinical factors that were associated with a lower Boston Bowel Preparation Scale (BBPS). Knowledge of these factors could identify which patients may benefit from increased pre-procedure guidance or more rigorous bowel preparation.

Methods: The charts of consecutive patients undergoing screening or surveillance colonoscopies over a one-year period were reviewed. Cases were defined as BBPS ≤ 5 while controls were patients with BBPS ≥ 6 . For each included patient, multiple characteristics were extracted. The chi-square analysis was performed for univariate analysis and a binomial logistic regression model for the multivariable analysis.

Results: One thousand and fifty-five colonoscopy reports with BBPS scores were retrieved with 189 cases (BBPS ≤ 5) and 866 controls (BBPS ≥ 6). Cases and controls were similar in age, sex, ethnicity, employment status, and marital status. Compared to patients with adequate bowel preparations, significantly more patients with inadequate bowel preparation had the following characteristics: diabetes, psychiatric illness, American Society of Anesthesiologists class ≥ 3 , history of inadequate bowel preparation, active smoker, opioid user, insulin user and Medicaid coverage. On multivariable logistic regression analyses, predictive factors of an inadequate bowel preparation were diabetes, psychiatric illness, opioid use, active tobacco use, history of inadequate bowel preparation, and Medicaid coverage.

Conclusion: This large retrospective case-control study identified independent predictive factors of an inadequate bowel preparation. Knowledge of these characteristics may aid both primary care providers and gastroenterologists in identifying patients who could benefit from an extended bowel preparation as well as enhanced education prior to their colonoscopy.

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Keywords: Boston Bowel Preparation Scale; Colorectal cancer; Increased pre-procedure guidance; Risk factors; Surveillance colonoscopy

Introduction

Colorectal cancer (CRC) is the second leading cause of cancer-related deaths in the United States, and the third most common cancer in men and in women. In 2013 alone, 51,813 people in the United States died from CRC.¹

Colonoscopy has become the most commonly used CRC screening and surveillance modality in the United States.² Allowing direct visualization of the colonic mucosa and the ability to biopsy or excise polyps and cancers, colonoscopy is considered the “preferred” screening test by the American College of Gastroenterology.²

A successful colonoscopy requires clear visualization of the mucosal surface of the colon. The adequacy of bowel cleansing is

a key factor in determining the efficacy, completeness, and most importantly, adenoma detection rate (ADR) of the examination. A recent systematic review and meta-analysis elucidated that ADRs were significantly higher with both intermediate-quality and high-quality preparation vs. low-quality preparation, with absolute risk increases of 5% for both.³ The lower ADRs of low-quality colonoscopy preparation prompt the need for early repeat colonoscopy,⁴ potentially leading to higher healthcare costs and increased risk of patient procedural complications.

Recent studies report a 10% to 30% occurrence rate of inadequate bowel preparations in colonoscopy.^{5,6} Various methods can be used to increase the quality of bowel preparation, including the addition of laxatives to standard bowel cleansing regimens, extending the bowel preparation length, and altering the timing

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of the preparation. For example, data now suggests that splitting the bowel preparation between the evening prior and the morning of the procedure results in cleaner preparations and greater endoscopic visualization.⁷ While there are retrospective studies⁸ and randomized trials looking at various bowel preparations, there are no specific guidelines or recommendations clarifying which patients should receive an intensified bowel preparation regimen, especially in the routine outpatient setting.

Prior studies have identified risk factors found to negatively affect quality of bowel preparation, including those related to immobilization (including hospitalization, older age, and obesity), those related to inhibition of bowel motility (including chronic constipation, diabetes, previous intra-abdominal surgery, opioid use, or tricyclic antidepressant use), and certain socioeconomic factors (Medicaid, unmarried status).^{4,9-13}

The Boston Bowel Preparation Scale (BBPS) is a validated and reliable measure of bowel preparation, reflecting the colon's cleanliness during the inspection phase of colonoscopy.¹⁴ The aim of our study was to identify factors that are associated with lower BBPS scores in a population undergoing screening or surveillance colonoscopy in the outpatient setting. Knowledge of these factors could ideally identify which patients may benefit from increased pre-procedure guidance or more rigorous bowel preparation.

Methods

Location and definitions of study variables

This was a retrospective case-control study that was conducted at Yale New Haven Hospital's outpatient endoscopy center in New Haven, CT, USA. We submitted this research study for institutional review board (IRB) exemption to the Yale University IRB and were granted exemption from complete IRB review (protocol no. 1508016323).

The BBPS scoring system was used. The BBPS determines a score of 0 to 3 for each segment of the colon: left colon, transverse colon, and right colon. The aggregate score per colonoscopy is therefore from 0 to 9 depending on the cleanliness of the tract. The BBPS was developed to create a standardized scale that could be discussed universally for every colonoscopy, used during the withdrawal portion of the colonoscopy. The cleanliness of the tract is judged after the endoscopist has attempted to clean the colonic tract.

Table 1 outlines the scoring criteria for each segment of the colonic tract.¹⁵

Cases were defined as patients who had BBPS scores less than or equal to 5. Prior data has suggested this score as representative of an inadequate bowel preparation and that repeat of colonos-

copy is suggested within a year.¹ Controls were those patients who had an adequate bowel preparation, defined as a BBPS score of greater than or equal to 6. The colonoscopies were performed by six endoscopists. All six were experienced in use of the BBPS BBPS.

In order for a colonoscopy to be included in this retrospective analysis, it had to have been performed by one of the six endoscopists, had to have utilized the split dose preparation, and had to have a BBPS score.

All patients were given a split dose bowel preparation using the polyethylene glycol split-dose preparation (MoviPrep; Salix Pharmaceuticals, Raleigh, NC, USA). All followed standard practice split dose instructions with the first half of the preparation night prior to procedure and second half the morning of the procedure.

Clinical and socioeconomic factors were extracted from the patient history and electronic medical record. The following socioeconomic factors were collected and retrospectively analyzed: age, sex, body mass index, number of medications, use of tricyclic antidepressants, use of opioids, previous colonoscopies, American Society of Anesthesiologists (ASA) score (1–6), diabetes, hemoglobin A1c, insulin, chronic constipation, psychiatric illness (including depression, bipolar disorder, anxiety disorders, and schizophrenia), liver cirrhosis, history of inadequate bowel preparation, hypertension, history of debilitating neurologic disease (including Alzheimer disease, Huntington disease, and dementia), previous surgery, current tobacco use, and later time of procedure (1 p.m. or later). The following clinical factors were evaluated: ethnicity, Medicaid, married, and employed.

Statistical analysis

The chi-square analysis was used for univariate analysis and binomial logistic regression model was used for multivariable analysis. Student *t* test was used to compare age in the two cohorts. Statistical analysis was performed using SPSS 23.0 (IBM Corp., Armonk, NY, USA) and significance level was set at $P < 0.05$.

Results

One-thousand and fifty-five colonoscopy reports with BBPS scores were retrieved from September 1st, 2014 to September 1st, 2015. Of these, 189 patients (17.9%) had BBPS scores less than or equal to 5 and were defined as cases while 866 patients (82.1%) had BBPS scores greater than or equal to 6 and defined as controls.

Univariate analysis

Table 2 shows the results of the univariate analysis. Diabetes (39.7% vs 15.8%), psychiatric illness (31.2% vs 16.6%), use of insulin (15.3% vs 4.8%), use of opioids (28.6% vs 16.6%), use of tobacco (37.6% vs 19.1%), history of inadequate bowel preparation (4.8% vs 0.5%), procedure after 1 p.m. (25.4% vs 32.4%), Medicaid (52.4% vs 32.7%), and ASA class ≥ 3 (53.4% vs 39.3%) were found to be factors that were significantly different between those who had inadequate bowel preparation and those with adequate preparation. Cases and controls were found to be statistically non-significant in terms of sex (female; 57.7% vs 55.3%), employment status (35.8% vs 33.9%), and marital status (39.3% vs 36.5%). In addition, cases and controls were matched in age (55.9 years vs 55.9 years) and statistically non-significant.

Table 1 Boston Bowel Preparation Scale Criteria for Each Portion of the Colonic Tract

Scale	Criteria guidelines
0	Unprepared colon segment with mucosa not seen due to solid stool that cannot be cleared.
1	Portion of mucosa of the colon segment seen, but other areas of the colon segment not well seen due to staining, residual stool and/or opaque liquid.
2	Minor amount of residual staining, small fragments of stool and/or opaque liquid, but mucosa of colon segment seen well.
3	Entire mucosa of colon segment seen well with no residual staining, small fragments of stool or opaque liquid.

Table 2 Univariate Analysis of Factors Affecting Bowel Preparation

Factor	Inadequate preparation (n = 189)	Adequate preparation (n = 866)	P-value
Comorbidities			
Chronic constipation	11 (5.8)	48 (5.5)	NS
Diabetes	75 (39.7)	137 (15.8)	< 0.01
Hypertension	68 (36.0)	267 (30.9)	NS
Liver cirrhosis	2 (1.1)	9 (1.0)	NS
Neurologic disease	1 (0.5)	17 (2.0)	NS
Psychiatric illness	59 (31.2)	144 (16.6)	< 0.01
Medications			
More than 5 medications	58 (30.7)	310 (35.8)	NS
Insulin	29 (15.3)	42 (4.8)	< 0.01
Opioids	54 (28.6)	144 (16.6)	< 0.01
Tricyclic antidepressants	7 (3.7)	27 (3.1)	NS
Remaining factors			
Tobacco use	71 (37.6)	165 (19.1)	< 0.01
History of inadequate bowel preparation	9 (4.8)	4 (0.5)	< 0.01
Prior colonoscopy	33 (17.5)	151 (17.4)	NS
Procedure time after 1 p.m.	48 (25.4)	281 (32.4)	< 0.05
Married	69 (36.5)	334 (38.6)	NS
Medicaid	99 (52.4)	283 (32.7)	< 0.01
Reported employment	64 (33.9)	308 (35.6)	NS
ASA class ≥ 3	101 (53.4)	340 (39.3)	< 0.05
Age*			NS

Values are presented as number (%).

NS, not significant; ASA, American Society of Anesthesiologists.

*The mean age for two groups was 55.9 years.

Multivariate analysis

On multivariate logistic regression analysis, it was found that diabetes, psychiatric illness, opioids, tobacco use, history of inadequate bowel preparation, and Medicaid coverage significantly predicted lower bowel preparation scores. Table 3 provides the results of the multivariate logistic regression analysis.

Discussion

This retrospective case-control study aimed to identify independent predictive factors for an inadequate bowel preparation in patients undergoing screening or surveillance colonoscopy in the outpatient setting, using BBPS scores as a standardized measure of bowel preparation. This is the largest case-control study to date evaluating these factors, albeit the retrospective design. Inadequate bowel preparation leads to lower ADRs, with prior studies showing that ADRs were significantly higher with both intermediate-quality and high-quality preparation versus low-quality preparation: odds ratio = 1.39 (1.08–1.79) and 1.41 (1.21–1.64).³ Lower ADRs have been shown to be the most important independent predictor of interval colon cancer.^{15,16} Lower ADR due to inadequate bowel preparation also prompts endoscopists to repeat colonoscopy earlier.^{17,18} Optimizing bowel preparation in targeted individuals with known predictive factors is crucial

Table 3 Multivariate Analysis of Factors Affecting Bowel Preparation

Factor	Odds ratio (95% CI)
Diabetes	2.9 (1.8–4.6)
Psychiatric illness	2.0 (1.3–2.9)
Opioids	1.7 (1.1–2.6)
Tobacco use	2.1 (1.4–3.1)
History of inadequate bowel preparation	7.2 (1.8–28.9)
Medicaid	2.0 (1.4–2.9)

CI, confidence interval.

to preventing the costly and clinically dangerous consequences of inadequate bowel preparation. Our findings showed that patients with psychiatric illness, opioid use, active tobacco use, and Medicaid insurance have an approximately two-fold increase in inadequate bowel preparation. Patients with diabetes yielded an approximately three-fold increase, while patients with a history of inadequate bowel preparation showed an approximately seven-fold increase in inadequate bowel preparation. Unlike prior studies, we did not find that patient age,¹⁰ sex,¹² or ethnicity¹⁹ were predictors of inadequate bowel preparation.

We can postulate the reasons these particular factors contribute towards poorer bowel preparations for patients. Factors that potentially reduce colonic motility, such as opioid use and diabetes, would result in poorer bowel preparation. Colonic motility may also be slower in patients with psychiatric illnesses if they are on tricyclic antidepressants. These patients may also less ability to follow bowel preparation instructions. Medicaid insurance may be a surrogate for lower socioeconomic status and patients from lower socioeconomic classes may have poorer medical literacy and therefore also find bowel preparation instructions challenging. Patients who have a history of inadequate bowel preparation may continue to repeat their predisposition to poorer bowel preparations due to multiple reasons, including inability to tolerate the full bowel preparation, poor understanding of instructions, or ongoing underlying reduced colonic motility. It is unclear how active tobacco use contributes to a poorer bowel preparation, but perhaps this is also a surrogate marker of lower socioeconomic status, or of noncompliance with medical instructions. Given the retrospective nature of our study, we can only theorize on why these factors were statistically significant. We hope to further evaluate these correlations with prospective analysis.

Our study has several limitations. One limitation is the retrospective nature of the study, thus relying on prior medical records for documentation of patients' potential predictive factors and recorded BBPS. Furthermore, another limitation that we acknowledge is the lack of breakdown of several predictive factor categories (psychiatric illness, neurologic disease, and prior surgery) into further subsets. For example, further sub-categorization of prior surgical history may have elucidated whether prior history of gastrointestinal or genitourinary would have a negative effect on bowel preparation.

While there were limitations, several advantages to our study methodology also exist to distinguish it from prior studies. Our study used the BBPS scale, a standardized tool that is both validated and reliable, to reflect the colon's cleanliness during the inspection phase of colonoscopy. This aimed to remove any subjective determination of suboptimal preparation by our endoscopists. All patients were average risk when undergoing screening or surveillance colonoscopies. Therefore, this study can be applied to the average-risk asymptomatic patient undergoing screening or

surveillance colonoscopy in the typical outpatient setting. In addition, the location of the study was a single outpatient procedure center affiliated with a tertiary care hospital, which makes this generalizable to the community setting, as it would be potentially equivalent to any ambulatory procedure center.

We conclude that our retrospective case-control study identified patients with psychiatric illness, opioid use, active tobacco use, Medicaid insurance, diabetes, and history of inadequate bowel preparation to be at increased risk for inadequate bowel preparation when undergoing screening or surveillance colonoscopy in the outpatient setting. These patients may benefit from increased pre-procedure guidance or more rigorous bowel preparation. Further studies may be helpful to clarify best interventions to improve bowel preparation in these populations.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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