EFFECTS OF STOOL FORM ON ADEQUACY OF BOWEL PREPARATION DURING COLONOSCOPY: A PROSPECTIVE STUDY

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Significance: Early identification of adenomatous polyps is crucial in colorectal cancer prevention. Inadequate bowel preparation results in lower diagnostic yield and is affected by colonic transit. There are insufficient local studies correlating stool form with bowel preparation adequacy. Moreover, there's limited study correlating stool form with colonoscopy outcome. This study aims to test the association between BSFS, bowel preparation adequacy and colonoscopy outcome.

Method: We studied a prospective cohort of 260 consecutive outpatients at EAMC undergoing screening colonoscopy who were prescribed similar bowel preparation and diet. BSFS and comorbidities were collected prior to colonoscopy. Patients were grouped according to BSFS: Group 1 for type 1-2; Group 2 for type 3-5; Group 3 for type 6-7. An investigator, blinded to all information, recorded BBPS, PDR, cecal intubation and withdraw time for all patients. Chi-Square, ANOVA and logistic regression were the analysis used.

Results: 260 were included in analysis. Group 1 compared to Groups 2 and 3, was significantly associated with inadequate bowel preparation (24.3% vs 0% vs 9.1%; $p=0.004$), low cecal intubation rate (87% vs 100% vs 97%; $p<0.001$), low PDR (11% vs 32% vs 24%; $p=0.004$), and prolonged withdrawal time (9.41 minutes; $p<0.001$). Higher BSFS score (3-7) would have 157% higher odds of adequate bowel preparation. Diabetes have a likelihood of only 24% adequate bowel preparation.

Conclusion: It's important to identify patients with constipated stool form to guide proper bowel preparation regimen since they are significantly associated with inadequate bowel preparation, decreased cecal intubation rate, PDR, and increased withdrawal time.

Keywords: Prospective cohort, stool form, Bristol Stool Form Scale, adequacy bowel preparation, Boston Bowel Preparation Score, polyp detection rate, cecal intubation rate, withdrawal time

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INTRODUCTION

Colorectal cancer contributes significantly to mortality related cancer in the Philippines and ranks 6th overall (1). In an effort to reduce the risk of death associated with colorectal cancer, early identification and subsequent removal of adenomatous polyps are crucial (2). Colonoscopy is very important for the identification and removal of these precancerous polyps. However, the success of colonoscopy depends on multiple factors, a major factor of which being the quality of bowel preparation (3). Inadequate bowel preparation results in lower diagnostic yield, prolonged procedure time, increased rates of repeat colonoscopies, increased potential adverse events (4). There are several factors that influence the adequacy of bowel preparation independent of compliance to bowel preparation instructions, these include age over 60 years, inpatient status, history of constipation, previous appendectomy/hysterectomy, use of antidepressants, high body mass index and history of diabetes mellitus. A plausible explanation why these factors impact bowel cleansing is alterations in gastrointestinal motility and delayed colonic transit (5).

It has been shown that stool form is correlated with whole gut-transit (6). Bristol Stool Form Scale (BSFS) is currently used to rate stool form. It is a visual scale which allows the patients to classify the form of their stool into seven categories using images with written descriptions (7). Multiple international studies have demonstrated that BSFS was correlated with whole-gut and colonic transit (7-9).

Adequacy of bowel preparation should be properly documented and is recommended by the American Society of Gastrointestinal Endoscopy (10). Validated scoring systems have been devised to rate the quality of bowel preparation in clinical trials. The most extensively validated scale to assess the quality of bowel preparation with excellent intra- and inter-observer reliability is the Boston Bowel Preparation Score (BBPS) (11). This score uses a 10-point (0-9) summation score to assess the adequacy of bowel preparation and has been found to be both valid and reliable (12). 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 (13).

There are few local data in correlating patient's bowel habits and colonic transit using BSFS with the adequacy of bowel preparation using BBPS. Moreover, there is very limited study correlating patient's stool form with the outcome of colonoscopy. Thus the aim of this study was to test for an association between pre-preparation BSFS and the adequacy of bowel preparation during colonoscopy using BBPS.

OBJECTIVES

General Objective:

- To correlate Bristol Stool Form Scale with adequacy of bowel preparation using Boston Bowel Preparation score among outpatient population undergoing screening colonoscopy at East Avenue Medical Center.

Specific Objectives:

- To determine the stool type of outpatient population using Bristol Stool Form Scale undergoing screening colonoscopy at EAMC.
- To determine the adequacy of bowel preparation using the Boston Bowel Preparation Score in terms of per segment score and total score.
- To correlate the Bristol Stool Form Scale with the outcome of colonoscopy in terms of cecal intubation rate, withdrawal time, and polyp detection rate (PDR).

DEFINITION OF TERMS

1. Colonoscopy - a nonsurgical procedure used to examine a person's colon using a video scope that is inserted through the rectum and advanced to the other end of the large intestine.
2. Screening Colonoscopy - a service performed on an asymptomatic person for the purpose of testing for the presence of colorectal cancer or colorectal polyps
3. Bowel Preparation – cleansing of the intestines from fecal matter and secretion which is usually done before a diagnostic or treatment procedure can be initiated for certain colorectal diseases.
4. Bristol Stool Form Scale (BSFS) - a visual scale which allows the patients to classify the form of their stool into seven categories.
5. Boston Bowel Preparation Score (BBPS) – a bowel cleanliness rating scale originally designed and validated for use during colonoscopy-oriented research. It relies on the summation of three individual colonic segment scores (from the right, transverse and left colons) to indicate the degree of bowel visualization.

DIAGRAM OF STUDY FLOW

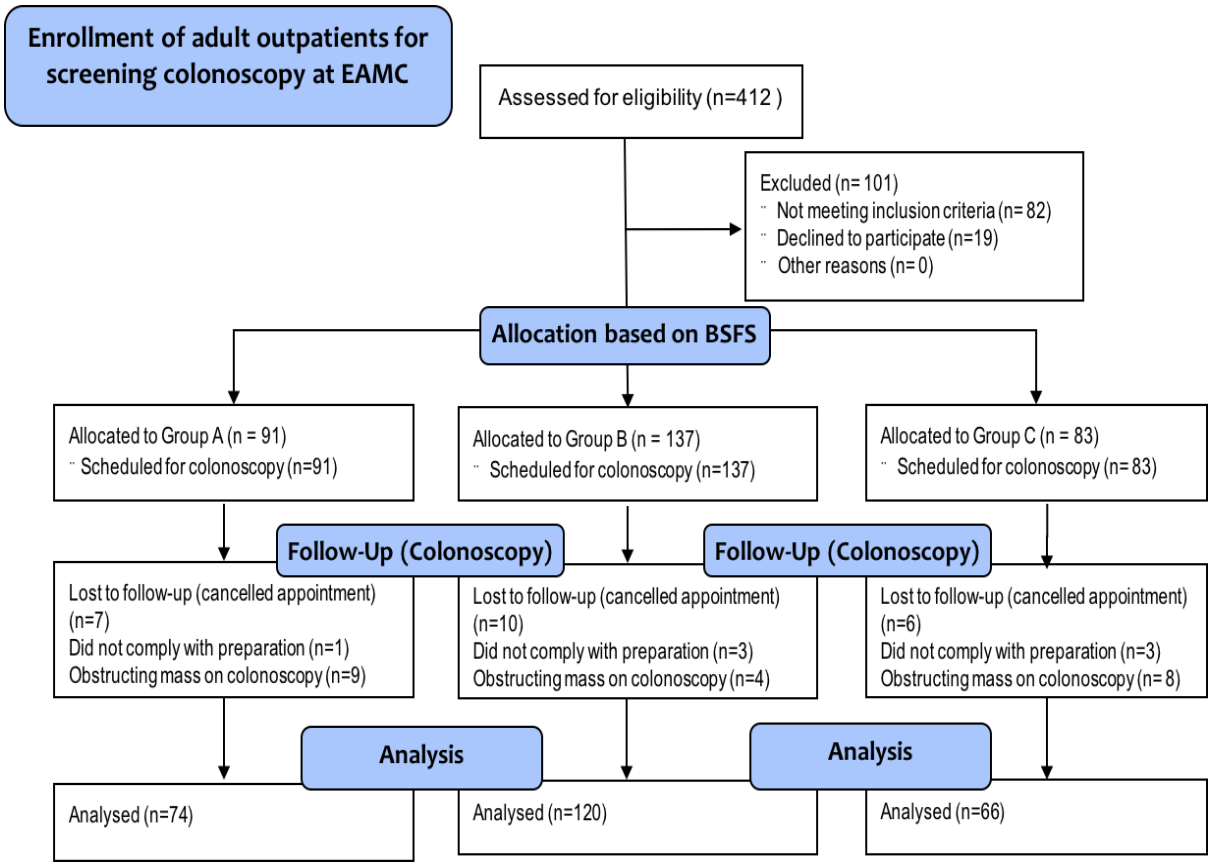


Figure 1. Diagram of the study flow.

METHODOLOGY

Research Design

This is a prospective cohort study.

IRB approval and informed consent

This study was approved by the Institutional Review Boards of EAST AVENUE MEDICAL CENTER. No subject participated in this study without written documentation of informed consent.

Participants/ Population of Interest

Participants were all adult consecutive outpatients undergoing screening colonoscopy at East Avenue Medical Center from March 2017 to November 2017.

Study Population

Inclusion criteria were as follows:

- Outpatients 18 years old and above
- Undergoing screening colonoscopy

Exclusion criteria were as follows:

- History of colorectal surgery
- Known or suspected bowel obstruction or perforation
- Patients found to have obstructing mass on colonoscopy
- History of inflammatory bowel disease
- Severe congestive heart disease (NYHA class III or IV)
- Chronic renal failure stage IV or V
- Pregnancy or lactation
- Unable to give informed consent

Patient Selection and Interview

At the beginning of the study, adult patients at the Outpatient Department of East Avenue Medical Center that will undergo screening colonoscopy were shown BSFS chart with seven corresponding images and descriptions (see Appendix A). Each patient was asked to report the main stool form he/she defecated in last 7 days according to the BSFS chart. Patients were then grouped according to the stool scale: Group 1 (Constipated) for type 1-2; Group 2 (Normal) for type 3-5; Group 3 (Diarrheic) for type 6-7. Written informed consent was obtained from all the patients.

Preparation Regimens

Patients were instructed to take low residue diet the day before colonoscopy and kept fasting the day of colonoscopy. Patients were then asked to drink 14 sachets of PEG3350 (Polyethylene glycol 3350) powder (Surelax, Westmont Pharma Philippines) dissolved in 2 L of sports drink (250 ml every 30 min). 1L taken 12 hours before colonoscopy and another 1L taken 4 hours before colonoscopy. Patients were asked to take two 5mg tablets of Bisacodyl (Buscolax enteric-coated tablet, Kauffman Pharma Philippines) at bedtime the day before colonoscopy. A pamphlet with printed instructions regarding bowel preparation including dietary advice were given to each patient (see Appendices B & C). Additionally, a telephone number was given to patients, and were encouraged to dial it if they have any questions about bowel preparation.

Data collection and colonoscopy

Baseline demographic and clinical characteristics of all patients were recorded at the time of appointment for colonoscopy. On the day of colonoscopy, before their scheduled procedures, patients were interviewed by one investigator who was not involved in the

endoscopic procedure. The bowel preparation time, the food type and the compliance to bowel preparation were recorded to evaluate compliance. Non-compliance was defined as the admitted failure to follow the prescribed instructions or failure to finish drinking at least 75% of the preparation volume and were excluded from the study.

Two gastroenterologist who were blinded to the pre-colonoscopy BSFS performed the colonoscopy. One investigator who was blinded to all information, recorded the quality of bowel preparation using the BBPS, detection of at least one polyp, cecal intubation and time of withdrawal for all patients. Before study initiation, this investigator was educated by the Boston Bowel Preparation Scale Educational Program (BBPSEP) online (available at http:// www.cori.org/bbps/login.php) and performed a calibration exercise on 30 colonoscopies according to BBPS, to achieve a satisfactory level of consistency in the assessment of bowel preparation quality.

Patients with incomplete colonoscopy due to an obstructing mass lesion were excluded from the study. All procedures were conducted with either sedation or awake, according to patients' willingness.

Outcome measures

Blinded investigator evaluated the preparation quality by using the BBPS. This assesses each colon segment (right, transverse, and left colon) by using a 4-point scale (0–3) (see Appendix D) Scores of all segments were added up as the total BBPS scores, ranging from 0 to 9. If the endoscopist aborts the procedure due to an inadequate preparation, then any non-visualized proximal segments were assigned a score of 0. Adequate preparation was defined as BBPS score >=2 in all colon segments or a total BBPS score >= 6.

The primary study endpoint was the rate of adequate bowel preparation based on the total BBPS score and the BBPS score on each segment. Secondary endpoints included cecal intubation rate, withdrawal time, and PDR.

Statistical analysis

Sample size calculated was 126 assuming a level of significance of 5%, proportion of colon cancer of 9% and a margin of error of 0.015.

Test for associations were done with the baseline demographics using Chi-Square Test. Test for comparison of means using ANOVA was done in Age. Logistic Regression with coded variables was used to test significant difference in the proportion of adequate bowel preparation. Chi square was used to check if there is an association of inadequacy in bowel preparation, cecal intubation rate and polyp detection rate. One-way ANOVA was used for average withdrawal time. Multivariate binary logistic regression using variables with a p value of <0.1 at univariate analysis to evaluate risk drivers for adequate bowel preparation was used. A p-value of < 0.05 was considered significant.

RESULTS

From March to November 2017, 412 eligible outpatients were assessed for inclusion: 101 were excluded (82 met exclusion criteria and 19 declined to participate in the study). 91 patients with BSFS 1 and 2 were assigned to group A (n = 91), 137 patients with BSFS 3 to 5 were assigned to group B (n = 137). 83 patients with BSFS 6 and 7 were assigned to group C (n = 83). The following patients were excluded from the final analysis due to cancelled appointments, did not comply with prescribed diet and/or bowel preparation, or an obstructing mass lesion on colonoscopy: 17 patients for group A, 17 patients for group B, 17 patients for group C. The final number of patients for group A, B and C that was included in the analysis were 74 (28%), 120 (46%), and 66 (25%) respectively (Figure 1).

Baseline characteristics are summarized in Table 1. At a 95% level of confidence, the presence of diabetes (p-value <0.001) and age (p-value <0.001) are significantly different among the three groups. The proportion of patients with diabetes in Group 1 is significantly higher compared to other two Groups. The age of patients in group 1 (60.8 +/- 10.6) is also significantly higher compared to the age of patients in other groups (54.2 +/- 8.3 and 54.4 +/- 10.2). Other factors such as sex, smoking history, thyroid disease, neurologic disease and hypertension were not statistically different among the three groups.

Table 1. Baseline Characteristics

Baseline Demographics		Group			p-value
		1 (n=74)	*2 (n=120)*	*3 (n=66)*	
Sex	F	28 (38%)	44 (37%)	28 (42%)	0.213
	M	46 (62%)	76 (63%)	38 (58%)	
Smoking	No	46 (62%)	90 (75%)	52 (79%)	0.06
	Yes	28 (38%)	30 (25%)	14 (21%)	
Age	Average (SD)	60.8 (10.6)	54.2 (8.3)	54.4 (10.2)	0.001
Diabetes	Yes	18 (24%)	8 (7%)	5 (8%)	0.001
Thyroid Disease	Yes	4 (5%)	0 (0%)	3 (5%)	.044
Hypertension	Yes	24 (32%)	22 (18%)	20 (30%)	0.051
Intake of Antidepressant	Yes	74 (100%)	120 (100%)	66 (100%)	N/A
Neurologic Disease	Yes	2 (3%)	4 (3%)	0 (0%)	0.338

Values are mean +/- SD, % or number.

Bowel preparation quality

Proportion of adequate bowel preparation based on BBPS is summarized in Table 2. Adequate bowel preparation was defined as a BBPS total score of ≥ 6 and/or a scores of ≥ 2 in each of the segment (right, transverse, and left). At a 95% level of confidence, proportion of adequate bowel preparation in each of the segment is not significantly different for all groups (p-value: 0.997). However, group 1 patients have the lowest proportion among the other groups and in a test for association, inadequate bowel preparation is significantly associated with Group 1 (p-value: 0.004).

Table 2. Proportion of Adequate Bowel Preparation

	Group 1 (n=74)	*Group 2 (n=120)*	*Group 3 (n=66)*	*p-value*
Right colon	62 (84%)	120 (100%)	62 (94%)	0.997
Transverse colon	68 (92%)	120 (100%)	62 (94%)	
Left colon	74 (100%)	120 (100%)	66 (100%)	
Total Score	75.7%	100.0%	90.9%	0.004

Outcomes of colonoscopy

The outcomes of colonoscopy are shown in Table 3 and Figure 2. In group 2, successful cecal intubation rate was 100% which was significantly higher than both group 1 (87%) and group 3 (97%) (p-value <0.001). The PDR was also significantly higher with group 2 (32%) than groups 1 (11%) and 3 (24%) (p-value <0.004). Average withdrawal time was fastest with group 2 (6.38 minutes) compared with groups 1 (9.41 minutes) and 3 (8.58 minutes) and is also statistically significant (p-value <0.001).

Table 3. Outcomes of Colonoscopy

	Group 1 (n=74)	*Group 2 (n=120)*	*Group 3 (n=66)*	*p-value*
Cecal Intubation rate	64 (87%)	120 (100%)	64 (97%)	0.000
Polyp detection rate	8 (11%)	38 (32%)	16 (24%)	0.004
Average Withdrawal Time	9.41	6.38	8.58	0.000

Risk Drivers for Adequate Bowel Preparation

The risk drivers for adequate bowel preparation were analyzed by logistic regression as shown in Table 4. These factors including age, smoking, diabetes, thyroid disease, neurologic disease, hypertension, gender, and BSFS were analyzed. Looking at the baseline characteristics at what drives adequate bowel preparation, only BSFS score (p-value 0.003) appeared significant and diabetes (p-value 0.062) only appeared as a slightly significant driver. Patients with higher BSFS score have 157% higher odds of having adequate bowel preparation while patients with diabetes tend to have a likelihood of having adequate bowel preparation at only 24% of the time compared to non-diabetic patients.

Table 4. Initial model: Risk Drivers for Adequacy of Bowel Preparation

Risk Drivers	*B*	*S.E.*	*Wald*	*p-value*	*Odds Ratio*
Age	-.004	.031	.015	.904	100%
Smoking	1.072	.681	2.478	.115	292%
Diabetes	-1.434	.768	3.490	.062	24%
Thyroid disease	-.230	1.300	.031	.860	79%
Neurologic disease	19.371	15562.180	.000	.999	258%
Hypertension	.784	.767	1.043	.307	219%
Male	-.407	.518	.616	.433	67%
BSFS	.450	.154	8.599	.003	157%
Constant	1.003	1.879	.285	.594	273%

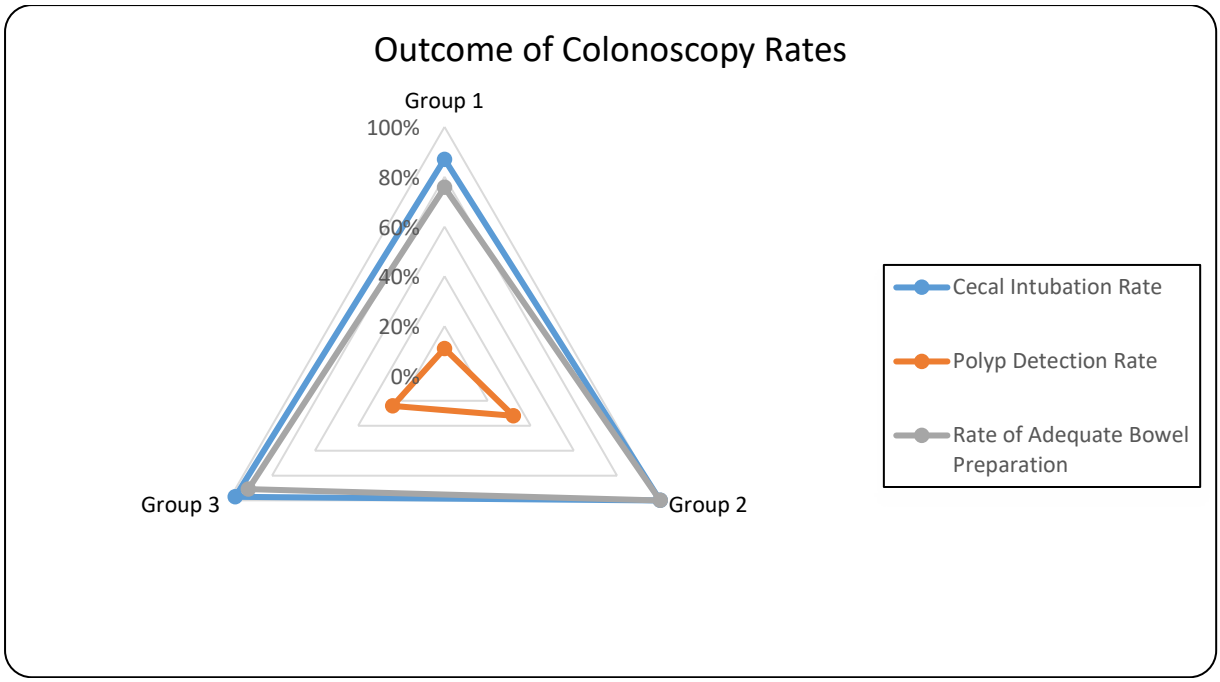


Figure 2. Outcome of colonoscopy rates based on cecal intubation, polyp detection and adequate bowel preparation. Group 1 (constipated) with BSFS 1 and 2. Group 2 (normal) with BSFS 3, 4 and 5. Group 3 (Diarrheic) with BSFS 6 and 7.

DISCUSSION

Effective colonoscopy starts before the procedure with bowel preparation because the entire colon needs to be adequately visualized. This study examined the relationship between the effect of stool form using BSFS and the adequacy of bowel preparation using BBPS as an objective scale. Inadequate bowel preparation was hypothesized to be related to slowed colonic transit and BSFS score correlates with colonic motility as was shown in a previous study in which a BSFS score below 3 predicted delayed whole-gut transit with a sensitivity of 85% and specificity of 82% and delayed colonic transit with a sensitivity of 82% and specificity of 83% (6). In line with these findings, our study showed that Group 1 (constipated) patients were significantly associated with inadequate bowel preparation at a rate of 24.3% using standard bowel preparation techniques and is consistent with previous studies (15-16). Moreover, in our study it showed that group 1 has a higher proportion of diabetics and is older compared to group 2 (normal) and group 3 (diarrheic). Colonic transit is influenced by multiple factors, it has been shown that advancing age and diabetes increases colonic transit time (5-6, 8, 17), thus possibly contributing to the constipated stool form and subsequently, inadequate bowel preparation. Hassan, et al. identified such factors and found that older age (OR, 1.01) and diabetes (OR, 1.8) are associated with inadequate bowel preparation (5). However, in our study, using logistic regression analysis, diabetes appeared only as a slightly significant driver with a 76% likelihood of having inadequate bowel preparation compared to non-diabetic patients. While stool form, which is a reflection of colonic transit, appeared as a significant predictor of adequate bowel preparation with patients of higher BSFS score having 157% higher odds of having adequate bowel preparation.

Quality indicators recommended by the American College of Gastroenterology (ACG) and the American Society for Gastrointestinal Endoscopy (ASGE) includes a cecal intubation rate of >95% for screening colonoscopy, a mean withdrawal time of 6 minutes for normal colonoscopy and adenoma detection rate (ADR) of 15-25% (18). These indicators are in place due to the following factors: low cecal intubation rates have been associated with higher rates of interval proximal colon cancer (19); longer withdrawal times are associated with higher detection rate (20) but with the drawback of prolonged procedure time and increased potential adverse events (4); low ADR has a higher likelihood to fail in preventing colorectal cancer (21). PDR was used as a surrogate for the adenoma detection rate. PDR has the advantage of not requiring manual entry of pathology data and correlates well with ADR in several studies (22-23). Group 1 has a cecal intubation rate of only 87%, a PDR of only 11%, and an average withdrawal time of 9.41 minutes. All of which fails the recommended quality indicator by ACG and ASGE. This is in contrast to the cecal intubation rate achieved with Groups 2 and 3 at 100% and 97% respectively. PDR is also significantly higher with Groups 2 and 3 at 32% and 24% respectively. Group 2 has a shorter withdrawal time of 6.38 minutes, still within the recommended quality indicator. The prolonged average withdrawal time with Groups 1 and 3 (8.58 minutes) is due to the requirement of more suctions and washes in the withdraw procedure, consequently more time was needed.

Previous researches showed that split-dose regimen demonstrated an increase in ADR (24). Thus a standard split-dose bowel preparation and low residue diet prior to colonoscopy was used in this study. All patients that did not comply were eliminated from the analysis, hence eliminating the risk of inadequate bowel preparation due to non compliance. Identifying stool forms of patients using BSFS is easy and not time-consuming. Our study showed that we should tailor our bowel preparation strategy according to patient's stool form. Cecal intubation rate and PDR were substantially decreased in those with BSFS 1 and 2, therefore giving a more aggressive bowel preparation regimen to these patients is essential. BSFS 1 and 2 having greater inadequate bowel preparation rate is not surprising as this result concurs with several previous studies (5, 9, 15-16), but this is the first study to correlate the degree of constipation in a more objective manner using BSFS as well as correlating it with the cecal intubation rate and PDR.

There are certain limitations in the study. First, instead of the ADR (adenoma detection rate), we only calculated the PDR. We acknowledge that PDR is not currently endorsed as a quality indicator and needs further validation in prospective studies, but we failed to obtain the pathologic information in a significant proportion of the subject population since these were outpatient colonoscopies and patients either failed to follow-up with the result or had the histopathology done in another institution. Second, data regarding the total number of polyps for each examination were not included, which could influence the risk for future polyps. Nevertheless, we suspect that finding any polyp is likely more significant than the number of polyps seen with inadequate preparation in predicting missed polyps. Finally, the study may have been limited by the clinical setting in which the observations were made since this was done in a single institution, thereby potentially limiting the generalizability of the data.

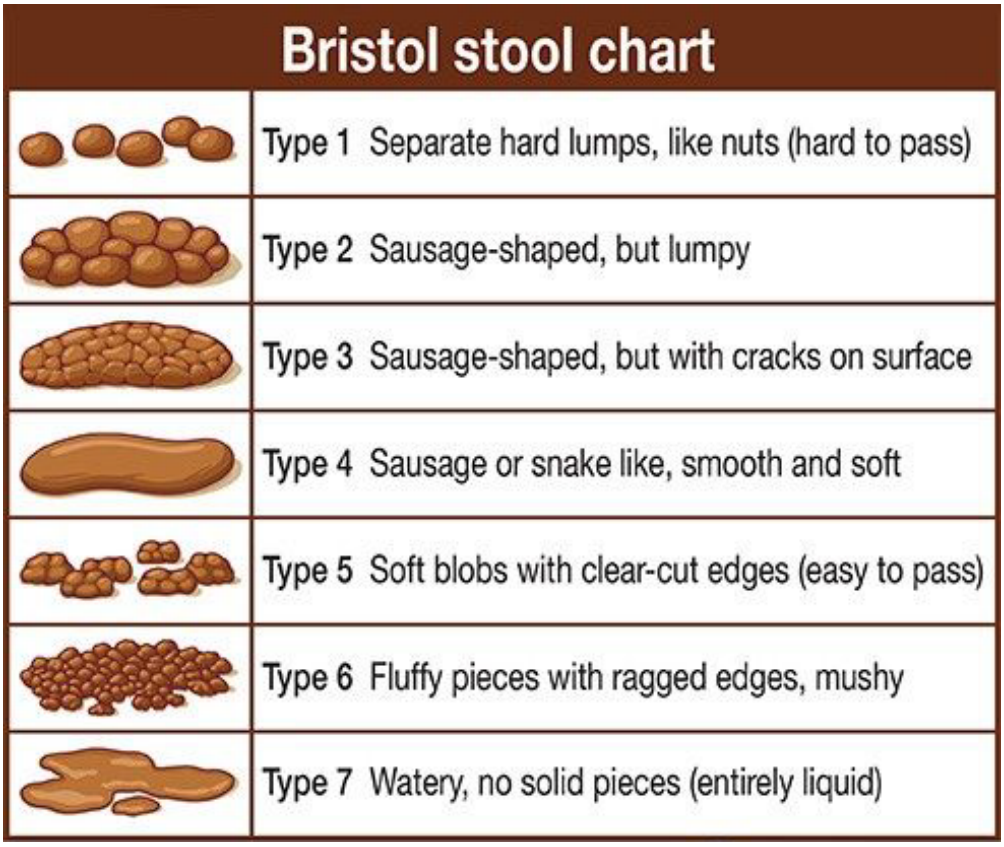
It is the authors' suggestions that future research be focused towards optimizing the bowel preparation for constipated patients with BSFS 1 and 2 and/or diabetic patients. Although Li Y. et al. has already done a randomized control trial comparing 2 L PEG-ELP vs 10 mg bisacodyl plus 2 L PEG-ELP with promising results (9), our study which also used 10mg bisacodyl plus 2L PEG but at a split dose regimen failed to show improved bowel preparation. Other areas of future study may also focus on modifying the diet to improve adequacy of bowel preparation like extending the days of low-residue diet prior to colonoscopy.

CONCLUSION

In conclusion, although majority of our patients that come for screening colonoscopy has normal stool form (BSFS 3-5), it is important to identify patients with constipated stool form (BSFS 1 and 2) since not only are these patients associated with inadequate bowel preparation, but they also have a significantly decreased cecal intubation rate and PDR, and a substantially increased colonoscopy withdrawal time using standard bowel preparation. This work further highlights the importance of recognizing patients with constipated stool forms using BSFS to guide in tailoring a proper bowel preparation regimen.

Appendix A

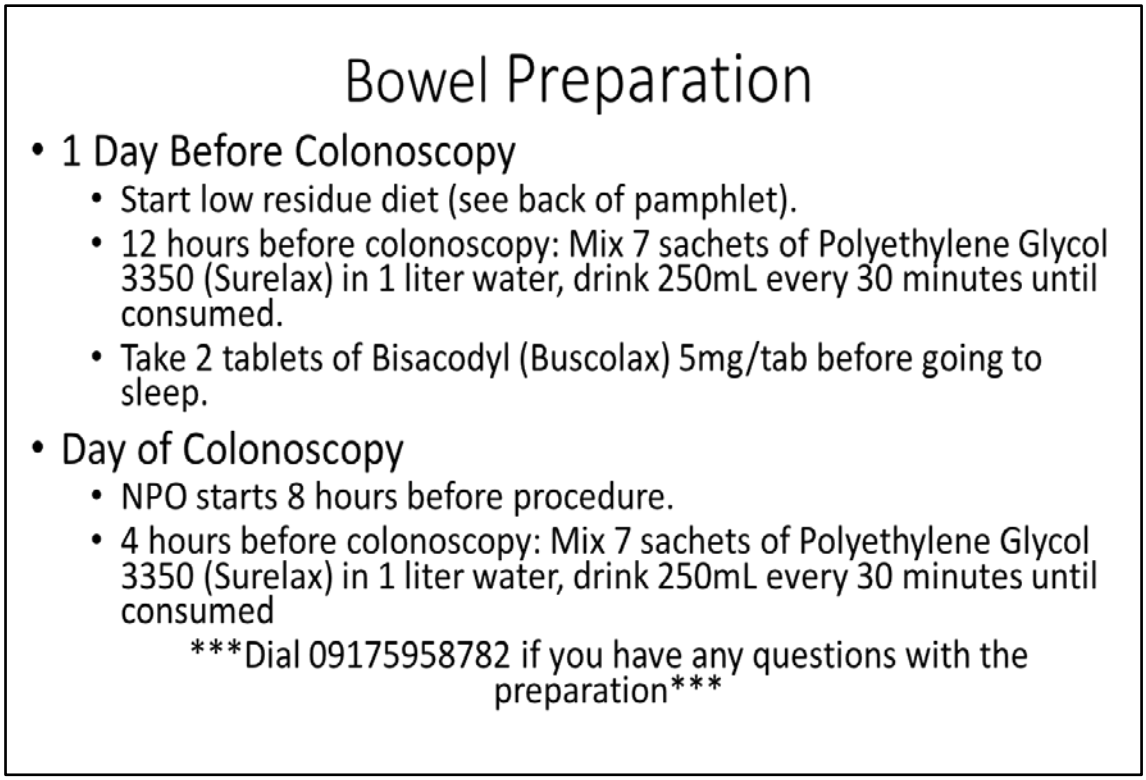
Bristol Stool Form Scale*



*Adopted from Lewis SJ, Heaton KW. Stool form scale as a useful guide to intestinal transit time. Scand J Gastroenterol. 1997;32(9):920-4

Appendix B

Bowel Preparation Instruction



Appendix C

Low Residue Diet Instruction*

Low Residue Diet

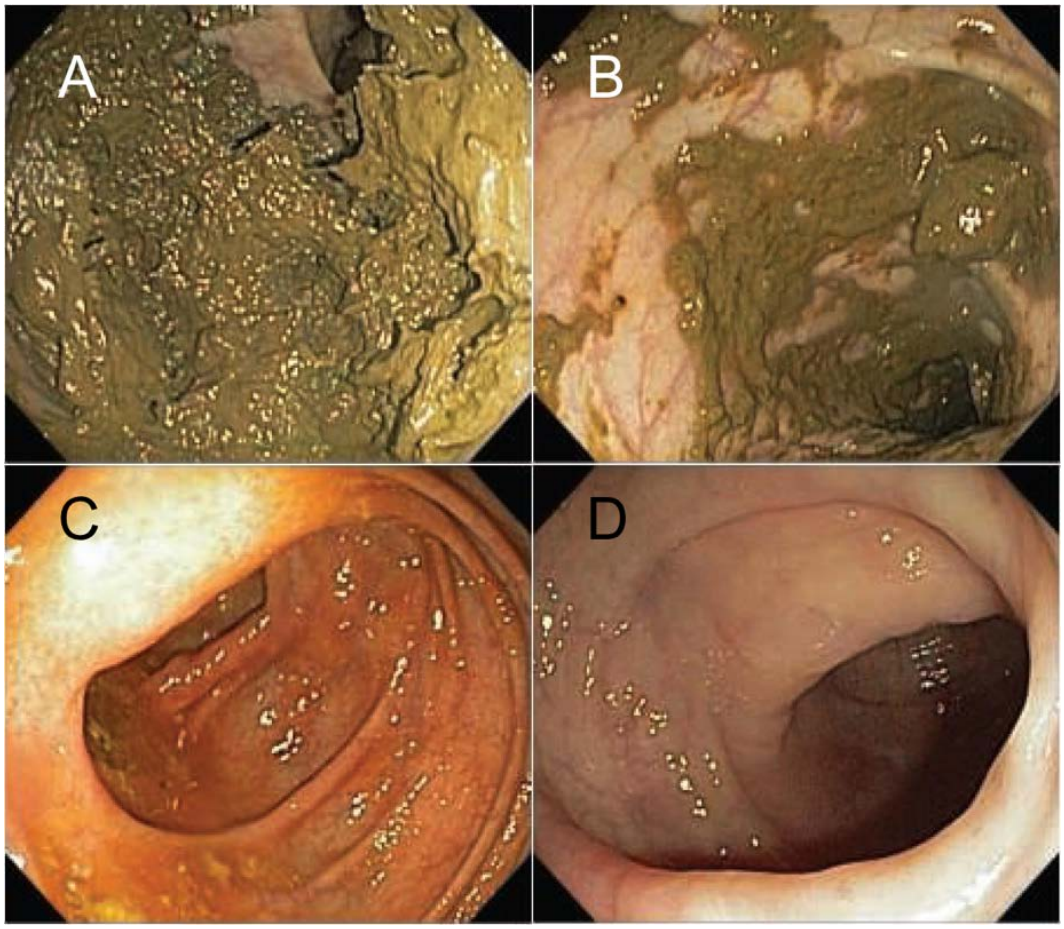
	Foods Allowed	Foods to Avoid
Starchy foods 	• White bread/flour • White pasta • White rice • Cous cous • Pastry (white flour)	• Wholemeal or Granary bread/flour • Wholemeal pasta • Brown rice • Pearl barley • Quinoa
Breakfast cereals 	• Cornflakes • Rice krispies • Frosted Flakes	• All wholewheat cereals (e.g., Branflakes, Weetabix, Shreddies etc) • Porridge & Muesli • All containing dried fruit/nuts
Dairy 	• Milk • Yoghurts (smooth) • Cheese	• Yoghurts or cheeses containing fruit/nut pieces
Meat, fish & eggs 	• All tender meat, fish and poultry • All eggs	• Tough, gristly meat • Skin and bones of fish • Pies/egg dishes containing vegetables as listed
Vegetables 	1-2 portions daily: • Peeled, well-cooked, soft/mashable vegetables • Potatoes (not skins) • Crisps	• Raw vegetables/salad • Baked beans • Split peas/lentils • Peas, sweetcorn, celery • All seeds, pips, tough skins • Potato skins

	Foods Allowed	Foods to Avoid
Fruit 	1-2 portions daily: • Soft/ripe peeled fruit without pips or seeds e.g. tinned fruit, peaches, plums, melon, apricots, nectarines, ripe bananas, apples, pears	• All dried fruit • Citrus fruit • Berries e.g. strawberries, raspberries blackberries • Prunes • Smoothies & fruit juices with bits
Nuts 	• Nil	• Avoid all, including coconut and almond
Desserts & sweets 	• Sponge cakes (without fruit/nuts) • Custard • Ice cream • Jelly • Semolina, rice pudding • Chocolate (without fruit/nuts) • Seedless jam • Plain biscuits	• Puddings/cakes/biscuits made with wholemeal flour, dried fruit or nuts (e.g mince pies, fruit crumble etc) • Chocolate/toffee/fudge with dried fruit or nuts • Marmalade with peel and jam with seeds • Popcorn • Marzipan • Digestive biscuits
Fats 	• All ok in moderation	• Nil
Other	• Clear soups • Spices, pepper • Stock cubes • Tea, coffee, squash	• Lentil/vegetable soups • Pickles/Chutneys • Horseradish • Relish

*Adopted from Low Residue Diet. Nutrition & Dietetics Department, The Great Western Hospital, Marlborough Road, Swindon, Wiltshire, United Kingdom. May 2012.

Appendix D

Boston Bowel Preparation Scale*



A, segment score 0: unprepared colon segment with mucosa not seen due to solid stool that cannot be cleared. **B,** segment score 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. **C,** segment score 2: minor amount of residual staining, small fragments of stool and/or opaque liquid, but mucosa of colon segment seen well. **D,** segment score 3: entire mucosa of colon segment seen well with no residual staining, small fragments of stool and/or opaque liquid.

*Adopted from Lai EJ, et al. The Boston Bowel Preparation Scale: A Valid and Reliable Instrument for Colonoscopy-Oriented Research. Gastrointest Endosc. 2009; 69:620-625.

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