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Patient compliance and suboptimal bowel preparation with split-dose bowel regimen in average-risk screening colonoscopy

Stacy B. Menees, MD, MS[1], **H. Myra Kim, ScD**[2], **Patricia Wren, PhD**[3], **Brian J. Zikmund-Fisher, PhD**[4,5], **Grace H. Elta, MD**[1], **Stephanie Foster, MPH**[1], **Sheryl Korsnes, MA**[1], **Brittany Graustein, BA**[1], and **Philip Schoenfeld, MD, MSEd, MSc (Epi)**[1,2]

[1]Division of Gastroenterology, University of Michigan Health System, Ann Arbor, Michigan, USA

[2]Division of Gastroenterology, Ann Arbor Veterans Administration Hospital, Ann Arbor, Michigan, USA

[3]School of Health Sciences, Oakland University, Rochester, Michigan, USA

[4]Department of Health Behavior and Health Education, University of Michigan, Ann Arbor, Michigan, USA

[5]Internal Medicine, University of Michigan, Ann Arbor, Michigan, USA

Abstract

Background—Although split-dose bowel regimen is recommended in colon cancer screening and surveillance guidelines, implementation in clinical practice has seemingly lagged because of concerns of patient compliance.

Objectives—To assess patient compliance with the split-dose bowel regimen and assess patient- and preparation process–related factors associated with compliance and bowel preparation adequacy.

Design—Prospective survey cohort.

Setting—Tertiary care setting.

Patients—Average-risk patients undergoing colonoscopy for colorectal cancer screening between August 2011 and January 2013.

Main Outcome Measurements—Split-dose bowel regimen patient-reported compliance and bowel preparation adequacy with the Boston Bowel Preparation Scale score.

Results—Surveys and Boston Bowel Preparation Scale score data were completed in 462 participants; 15.4% were noncompliant with the split-dose bowel regimen, and suboptimal bowel preparation (score < 5) was reported in 16% of all procedures. White (P = .009) and married (P = .01) subjects were least likely to be noncompliant, whereas Hispanic subjects and those who

Reprint requests: Stacy B. Menees, MD, 3912 Taubman Center, SPC 5362, Ann Arbor, MI 48109-5362.

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reported incomes of US$75,000 or less were most likely to be noncompliant (P = .004). Participants who were noncompliant with split-dosing were less likely to follow the other laxative instructions and more likely to have their colonoscopy appointment before 10:30 AM. Compliance differed by bowel preparation type (P = .003, χ^2 test), with those who used MiraLAX showing the highest compliance, followed by polyethylene glycol electrolyte solution and other bowel preparations. Noncompliance with split-dose bowel preparation (odds ratio 6.7; 95% confidence interval, 3.2–14.2) was the strongest predictor of suboptimal bowel preparation.

Limitations—Patient self-report, performed at tertiary care center.

Conclusions—Overall, 1 in 7 patients do not comply with a split-dose bowel regimen. Ensuring compliance with the split-dose bowel regimen will reduce the risk of a suboptimal bowel preparation. (Gastrointest Endosc 2014;79:811-20.)

Colonoscopy is the test of choice above all other modalities for both colorectal cancer screening and prevention as recommended by national multisociety guidelines.[1] Current guidelines recommend colonoscopy for colon cancer screening every 10 years in average-risk patients 50 years of age and older.[1] Ensuring that stool is adequately cleansed from the colon is crucial for colonoscopy effectiveness in identifying precancerous polyps and colon cancer. Suboptimal bowel preparation (qualified as fair, poor, inadequate, and unsatisfactory on endoscopy reports) is not only associated with increased costs because of rescheduling and wasted resources, but, more importantly, with missed colorectal cancers (CRCs) and decreased adenoma detection.[2–5]

Previous studies demonstrated as many as 30% of patients undergoing colonoscopy to have inadequate bowel preparations.[6–11] Risk factors for suboptimal colonoscopy preparation include diabetes, hypertension, cirrhosis, constipation, age, male sex, and the use of tricyclic antidepressants.[6,7,9] However, these data were acquired before the use of split-dose bowel preparation. The split-dosing regimen, in which patients take a portion of the laxative the evening before colonoscopy and the other half on the day of colonoscopy, improves the bowel preparation quality. Studies have consistently shown that the split-dose regimen is superior to administration of preparation on the day or night before the colonoscopy.[12–16] However, prospective studies have not assessed patient compliance with split-dose bowel regimen in the practical “real-world” setting. Unger et al[17] surveyed 300 patients undergoing EGD and the drivers of colonoscopy patients about the acceptance of split-dose bowel preparation. Of these patients, 85% would be willing to get up in the middle of the night for their second preparation dose. The aim of our study was to prospectively assess patient compliance with the split-dose bowel regimen and assess patient- and preparation process–related factors associated with compliance and bowel preparation adequacy. We hypothesized that patient failure to take the spilt-dose regimen largely accounts for suboptimal colonoscopy preparation in the average-risk colorectal cancer (CRC) screening population.

METHODS

The study was conducted at the University of Michigan Health Systems in Ann Arbor at 2 outpatient endoscopic procedure units. With investigational review board approval, we

approached a prospective cohort of average-risk patients in the procedure waiting room before their colonoscopy appointments. We defined average risk as persons age 50 years of age and older without risk factors for CRC other than age. Participants 50 to 74 years of age were eligible for participation. Exclusion criteria included the following: patients unable to read, comprehend, or consent to their involvement in the study; patients with a family history of CRC in a first-degree relative or a history of polyps or colon cancer; or patients undergoing colonoscopy for hematochezia, abdominal pain, chronic change in bowel habits, or other GI symptoms. The ability to read and comprehend was assessed during the informed consent process. Our planned sample size was 450 patients; however, a total of 496 patients were recruited, including an additional 46 patients recruited to fulfill a separate aim of our funded grant. Sample size was calculated to have 90% power to detect a difference in the proportion of suboptimal preparation of 15% in those who are compliant with the split-dose bowel regimen versus 30% in those who are noncompliant, assuming that 30% of patients are noncompliant with preparation instructions and further assuming that about 10% may have incomplete data. If only 20% of subjects are noncompliant with the split-dose regimen, we would have 85% power to detect this difference.

Patients were asked to complete a 43-question survey instrument before their scheduled colonoscopy (Appendix 1, available online at www.giejournal.org). The survey was designed after an extensive literature review and with expert consultation (P.W. and B.Z.-F.). We assessed face and construct validity of the survey instrument and performed a pilot test with 20 patients. The survey instrument was then modified based on patient feedback. The survey assessed patient demographic factors and medical history while focusing on possible risk factors for suboptimal bowel preparation. Three areas related to preparation process were evaluated: (1) preparation information relayed to patients, (2) preparation activities on the day before colonoscopy, and (3) preparation activities on the day of the colonoscopy for all bowel preparation types. All colonoscopists were blinded to the results of the survey.

Colonoscopy bowel preparation

All patients are given the same bowel preparation instructions for the split-dose bowel regimen and fluid and dietary intake. On the day before their colonoscopy, the patient is instructed to take half of the bowel preparation. On the day of the colonoscopy, he or she is to take the second half of the bowel preparation starting 4 hours before the patient needs to leave for the appointment. Bowel preparation timing instructions will vary slightly by the prescribed bowel preparation. The following bowel preparations are the only ones used in the University of Michigan Health System: polyethylene glycol electrolyte (PEG-EL) formulations (NuLYTELY, Braintree Laboratories, Braintree, Mass; CoLyte, Alaven Pharmaceutical, Marietta, GA; GoLYTELY, Braintree Laboratories, Braintree, Mass; TriLyte, Kremers Urban Pharmaceuticals, Seymour, IN), PEG 3350/MiraLAX (MSD, Whitehouse Station, NJ) + Gatorade (PepsiCo, Purchase, NY), HalfLytely (Braintree Laboratories, Braintree, Mass), MoviPrep (Salix Pharmaceuticals, Raleigh, NC), OsmoPrep (Salix Pharmaceuticals, Raleigh, NC), Suprep (Braintree Laboratories, Braintree, Mass), and a preparation that involves 34 g MiraLAX in 16 oz of water 2 nights before the examination, 2 days of clear liquids, plus standard PEG-EL split-dose preparation (will be referred as 2-

day preparation). The bowel preparation prescribed is at the discretion of the referring physician.

Suboptimal bowel preparation

Bowel preparation findings at the time of colonoscopy were graded by the endoscopist by using the Boston Bowel Preparation Scale (BBPS), a valid and reliable instrument for colonoscopy-oriented research.[18,19] The BBPS score is a cumulative score based on a 4-point scoring system applied to each of the 3 broad regions of the colon: the right side of the colon (including the cecum and ascending colon), the transverse colon (including the hepatic and splenic flexures), and the left side of the colon (including the descending colon, sigmoid colon, and rectum). The BBPS scores can range from 0 to 9, with lower values corresponding to less optimal preparation. Colon preparation quality was considered suboptimal if the BBPS score was less than 5. A score of 5 or higher is associated with a higher polyp detection rate.[18]

Statistical analysis

The analytic goal was to assess the association between suboptimal bowel preparation and compliance with split-dose bowel preparation. To assess compliance to split-dose bowel regimen, we posed the following statement in our survey: “Please pick the sentence below that best describes how you took the liquid/pill laxative preparation.” The participants were given the following choices: “I took ALL of the liquid/pill laxative preparation YESTERDAY; I took SOME of the liquid/pill laxative preparation YESTERDAY and SOME of it TODAY; I took ALL of the liquid/pill laxative preparation TODAY; or I NEVER took my liquid/pill laxative preparation.” Participants who chose “I took SOME of the liquid/pill laxative preparation YESTERDAY and SOME of it TODAY” were considered compliant with the split-dose bowel regimen. We first calculated descriptive statistics of various demographic characteristics and other potential explanatory variables of suboptimal bowel preparation for the overall sample and separately by those compliant and noncompliant with split-dose bowel preparation, the primary predictor of interest. We then used multiple logistic regression analysis to assess the association between suboptimal preparation and compliance with split-dose bowel preparation, with a dummy variable indicating compliance with split-dose bowel preparation as the primary independent variable. Because the patient’s compliance with split-dosing may be associated with other characteristics that are also predictive of suboptimal bowel preparation such as the volume of fluid intake on the day of colonoscopy or the colonoscopy appointment time, we adjusted the model for these other potential confounders of the relationship between split-dosing and suboptimal preparation. The potential confounders included sociodemographic characteristics (eg, age, sex, race, marital status), current medications in use (eg, narcotics, tricyclic acid), self-reported health characteristics (eg, cirrhosis), GI health history (eg, history of constipation), and bowel preparation process–related variable (eg, whether any discussion was done regarding the use of laxatives, type of preparation, percentage of preparation ingested, and site and time of colonoscopy appointment). All covariates or potential confounders were carefully examined for collinearity and categorical variables; the categories were reduced when needed on examining their distribution and their association with split-dose bowel preparation. We used both forward and backward stepwise selection

methods with age, sex, and race locked in variable selection. The final logistic regression model, however, was determined by carefully examining the variables selected or removed for their magnitude of the estimates as well as the significance level.

A second logistic regression model explored whether the observed association between compliance with split-dose preparation and suboptimal bowel preparation remained even after adjusting for measures reflecting post-laxative experiences. The set of post-laxative experience–related variables included measures regarding the bowel movement or GI experiences in response to laxatives and thus are potentially affected by split-dosing such as time to clear bowel movement and the look of last bowel movement. We report adjusted odd ratios and their 95% confidence intervals to describe the influence of compliance with split-dose bowel preparation as well as other predictors of suboptimal preparation. Statistical analysis was performed by using Stata version 12.1 (StataCorp, College Station, Tex).

RESULTS

A total of 462 participants had completed surveys and BBPS data. Thirty-four patients (7%) either failed to return or to complete the survey. An additional 181 patients were approached during the study period, of whom 158 (87.4%) met exclusion criteria and 23 (12.6%) declined to participate. Demographic and bowel preparation characteristics did not differ significantly from those of the patients who remained in our study. Study participants had a mean age of 56.8 years, and approximately 50% were male. Table 1 shows sociodemographic and health characteristics of the participants. Seventy-one participants (15.4%) were noncompliant with the split-dose bowel regimen, whereas 391 (84.6%) were compliant. Race, ethnicity, marital status, and income differed between those compliant versus noncompliant with split-dose bowel preparation. Approximately 87% of participants were white, but a smaller percentage of patients noncompliant with split-dose preparation were white than those compliant ($P = .009$). Compared with participants compliant with split-dose preparation, a larger percentage of noncompliant participants were Hispanic ($P < .001$) and had an annual income of $75,000 or less ($P = .004$). More than half (66%) of the study participants reported being in very good or excellent health, and this and other health-related measures did not differ between those compliant versus noncompliant with split-dose bowel preparation.[18]

Table 2 shows the distribution of the various bowel preparation characteristics. The index colonoscopy was the first colonoscopy for 62% of the participants. Almost half of the participants (48%) reported not having any discussion about liquid laxatives with any of the medical staff, including pharmacists. Recentness in preparation, in terms of when the instructions were looked at or liquid or pill laxatives purchased, was not different between those compliant and noncompliant with split-dose bowel preparation. Compliance differed by bowel preparation type ($P = .003$, χ^2 test), where a larger than expected percentage of MiraLAX users were compliant. Participants non-compliant with split-dosing were less likely to have followed the laxative instructions exactly, were more likely to have had no glasses of fluid in addition to the laxative preparation either the day before or the day of the procedure, were more likely to have had their colonoscopy appointment before 10:30 AM, and

were less likely to have taken more than 90% of liquid or pill laxatives (although this latter effect was only marginally significant).

Table 3 shows the distribution of patient experiences after using laxatives. Although 34.5% of patients were nauseous or sick to their stomachs from laxatives and 4.8% experienced vomiting in the past 24 hours, no differences were seen by compliance with split-dose bowel preparation. With regard to bowel movements after laxatives, a significantly smaller percentage of noncompliant patients reported taking more than 12 hours until getting a bowel movement or never getting clear bowel movement after taking laxatives.

Suboptimal bowel preparation (BBPS score <5) was reported in 16% (75/462) of the overall study participants. Suboptimal bowel preparation, however, was seen in 36.6% (26/71) of those noncompliant with split-dose bowel preparation versus 12.5% (49/391) of those compliant, corresponding to a crude odds ratio (OR) of 4.0 (95% confidence interval, = 2.3–7.1, $P < .001$) for the association between suboptimal bowel preparation and noncompliance with split-dose bowel preparation. After adjusting for various patient characteristics, the association remained significant with an OR of 4.3 ($P < .001$) (Table 4). No demographic variables were associated with suboptimal bowel preparation after adjusting for split-dose bowel preparation, but those with private insurance, those whose endoscopies done at a hospital rather than an ambulatory surgery center, and those who last ate before noon the day before were less likely to have suboptimal bowel preparation. On the other hand, those with a history of constipation and those typically never being nauseous were more than 2 times more likely to be associated with suboptimal bowel preparation. The type of bowel preparation used by the participant was not associated with suboptimal bowel preparation. When post-laxative experience measures were included, the adjusted OR associated with noncompliance with split-dose bowel preparation was even greater (OR 6.7). Of the post-laxative measures, those who reported that it took more than 12 hours or never until there was a clear bowel movement were 2.4 times more likely to have suboptimal bowel preparation, and those whose last bowel movement was watery with flecks of particulates were nearly 3 times more likely to have suboptimal bowel preparation than those with a watery or clear last bowel movement.

DISCUSSION

Current American College of Gastroenterology and Multi-Society Task Force CRC Screening and Surveillance Guidelines state that the impact of colonoscopy on CRC prevention is critically dependent on high-quality baseline examinations.[20,21] When a high-quality colonoscopy is performed and no polyps are identified, repeat examination is not recommended for 10 years. However, the guidelines also note that inadequate bowel preparation is common and is associated with a reduction in the detection of small and large polyps. The guidelines state that splitting the dose of bowel preparation, with half of the preparation given on the day of the procedure, leads to higher likelihood of excellent bowel cleansing and increased adenoma detection rates. The American College of Gastroenterology guideline also identified the split-dose bowel regimen as one of the “key measures for improving the quality and cost-effectiveness of colonoscopy as a CRC screening test.”[21] Our study is the first to prospectively assess the compliance of average-

risk patients undergoing screening colonoscopy with split-dose bowel preparation and to assess predictors associated with noncompliance and suboptimal bowel preparation. We found that non-Hispanic white and married participants were most likely to be compliant, whereas those of Hispanic/Latino ethnicity and those an annual income of $75,000 or less were more likely to be noncompliant. Key behavioral or procedural characteristics associated with noncompliance with the split-dose bowel regimen included the following: not following instructions exactly, no additional glasses of fluid in addition to the laxative preparation, colonoscopy appointment before 10:30 AM, and those less likely to have taken more than 90% of liquid or pill laxatives. Subjects who ingested MiraLAX/PEG 3350 + Gatorade were most likely to be compliant compared with those who took the PEG-EL or other preparations. Lastly, subjects who reported that it was more than 12 hours before a clear bowel movement occurred were most likely to be compliant with split-dose bowel preparation.

Implementation of split-dose bowel preparations has been slow in endoscopy centers. As of March 2012, more than 66% of the Veterans Affairs Medical Centers at which colonoscopies are performed and more than 50% of gastroenterology fellowship programs have not implemented split-dose bowel preparation as their routine bowel preparation regimen (Douglas J. Robertson, MD, personal correspondence). Additionally, Lin and Schembre[22] did an informal survey of physicians at a recent meeting of the Pacific Northwest Gastroenterology Society representing 10 academic or community gastroenterology practices in the greater Seattle area. They found that only 20% used a split-dose bowel regimen for all colonoscopies, and an additional 40% of practices used the split-dose bowel regimen for afternoon only colonoscopies. Practitioners express concern about patient noncompliance with waking early on the day of the colonoscopy to take the second half of the bowel preparation. We did find that colonoscopy appointments earlier than 10:30 AM support these practitioners' concern; however, 78.5% (172 of 219) of those with an appointment at 10:30 AM or earlier still reported complying with the split-dose regimen.

Through our study, it is clear that the use of split-dose bowel preparation is well accepted by average-risk patients undergoing screening colonoscopy. The majority of our patients complied with the instructions for the split-dose bowel regimen. We were pleasantly surprised with our results because we did expect a larger percentage to be noncompliant with split-dose bowel preparation based on conversations with other GI physicians and patients. However, the findings of our study are similar to findings by Unger et al[17]; they found that 85% of potential colonoscopy patients would be willing to take the second half of their split-dose bowel preparation during the night. Patients, by report, are largely compliant with the split-dose bowel regimen, and, thus, it should be used by endoscopy practices as recommended by national guidelines, regardless of the time of the procedure.

Patients who were noncompliant with the split-dose bowel regimen also failed to follow other sections of the bowel preparation instructions and were less likely to be compliant with the more traditional PEG-EL bowel preparations compared with MiraLAX/PEG 3350 + Gatorade preparation. Noncompliant participants were less likely to follow the laxative instructions exactly, were more likely to have drunk no additional glasses of fluid along with the laxative preparation either the day before or the day of the procedure, and were less

likely to have taken more than 90% of liquid or pill laxatives. Based on these findings, one would have thought that factors that would correspond to patient education (ie, previous discussion with a physician or nurse about the bowel preparation) might be significantly associated with noncompliance in this population. However, none of these or actual patient education level were significant. Contrary to our findings, Chan et al[23] found that lower education levels were associated with poor bowel preparation. Furthermore, the data on patient education for bowel preparation have been inconsistent in the improvement on bowel preparation efficacy.[24–27] We agree that further examination of the reasons that patients deviate from multiple areas of the colonoscopy preparation instructions are needed. We have already conducted preliminary qualitative research on this topic. In the future, we plan prospective studies with tools to minimize noncompliance, and these tools will be based on data gathered from our qualitative research.

Noncompliance with the split-dose bowel regimen was significantly associated with suboptimal bowel preparation. This was our strongest predictor of suboptimal bowel preparation. This finding corresponds to data from randomized, controlled trials showing the efficacy of split-dose bowel regimen.[13–16] Other positive predictors of suboptimal bowel preparation before adjusting for bowel movement variables included constipation and lack of nausea history. History of constipation is a well-established predictor of suboptimal bowel preparation; however, personal nausea history has not been looked at.[6] We were surprised with this finding because we had hypothesized that participants with a nausea history would be more likely to ingest less of the bowel preparation, thus leading to a worse bowel preparation than those without a history of nausea. However, we did not find that a history of nausea was associated with noncompliance, and we found that the lack of a history of nausea was independently associated with suboptimal bowel preparation after adjusting for noncompliance with split-bowel preparation. We did not ask whether patients had used antiemetics prophylactically, and it is possible that those who had a history of nausea had prepared themselves, allowing them to take the full bowel preparation. Endoscopy performed at a hospital compared with an ambulatory surgical center (ASC) was protective against suboptimal bowel preparation. Bowel preparation instructions do not vary between the sites and, generally, this may point to a difference in the patient population that decides to have their procedure at the hospital versus those who go to an ASC. However, none of the health related variables including the overall health of the patients were associated with the site of endoscopy, and the relationship between the site of endoscopy and sub-optimal bowel preparation remained significant even after adjusting for the overall health of patients. Last, stool characteristics of the participant's last rectal effluent and the onset to first bowel movement positively predicted suboptimal bowel preparation. Fatima et al[11] found that patients with a brown liquid or solid stool had a 54% chance of having fair or poor preparation. We even found that patients with watery stool with flecks of particulates had an almost threefold risk of suboptimal bowel preparation.

We are aware of some limitations of this study. Although it was prospective in design, it relied on patient self-report for the compliance rate with the split-dose bowel preparation. Participants may have wanted to present themselves in the best light, which may have thus increased reports of compliance. Also, the subject's ability to read and comprehend was assessed during the informed consent process; however, there was no formal evaluation for

functional health literacy to gauge patient understanding of instructions. Additionally, this survey was administered at a tertiary care setting, which may limit the generalizability. However, for open-access colonoscopy, we do have some outside referring physicians not directly associated with the university, and thus this patient population is perhaps more representative than one might expect of a tertiary care setting. However, we did find a significant association with Hispanic/Latino participants and noncompliance with the split-dose bowel regimen. This finding should be interpreted with caution, and further studies need to be done on larger populations of Hispanic/Latino participants because our small population may not be representative. Last, assessing bowel preparation quality is subjective, and there is wide interpretation between endoscopists. To counter this, we used the BBPS score, which is a validated measure for colonoscopy-oriented research.

In conclusion, our data suggest that practitioners can be reassured that the majority of average-risk patients undergoing screening colonoscopy will comply with the split-dose regimen. However, 1 in 7 patients may not comply with this regimen and continued strategies to reduce this noncompliance are needed. It is critical that the split-dose regimen is used to combat suboptimal bowel preparation, thus reducing the additional costs of this preventive procedure.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

ASC	ambulatory surgical center
BBPS	Boston Bowel Preparation Scale
CRC	colorectal cancer
OR	odds ratio
PEG-EL	polyethylene glycol electrolyte

REFERENCES

1. Levin B, Lieberman DA, McFarland C, et al. American Cancer Society Colorectal Advisory Group; US Multi-Society Task Force; American College of Radiology Colon Cancer Committee. Screening and surveillance for the early detection of colorectal cancer and adenomatous polyps, 2008: a joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. CA Cancer J Clin. 2008; 58:130–160. [PubMed: 18322143]
2. Harewood GC, Sharma VK, de Garmo P. Impact of colonoscopy preparation quality on detection of suspected colonic neoplasia. Gastrointest Endosc. 2003; 58:76–79. [PubMed: 12838225]

3. Froehlich F, Wietlisbach V, Gonvers JJ, et al. Impact of colonic cleansing on quality and diagnostic yield of colonoscopy: the European Panel of Appropriateness of Gastrointestinal Endoscopy European multicenter study. Gastrointest Endosc. 2005; 61:378–384. [PubMed: 15758907]
4. Lebwohl B, Kastrinos F, Glick M, et al. The impact of suboptimal bowel preparation on adenoma miss rates and the factors associated with early repeat colonoscopy. Gastrointest Endosc. 2011; 73:1207–1214. [PubMed: 21481857]
5. Menees SB, Kim HM, Elliott EE, et al. The impact of fair colonoscopy preparation on colonoscopy use and adenoma miss rates in patients undergoing outpatient colonoscopy. Gastrointest Endosc. 2013; 78:510–516. [PubMed: 23642491]
6. Ness RM, Manan R, Hoen H, et al. Predictors of inadequate bowel preparation for colonoscopy. Am J Gastroenterol. 2001; 96:1797–1802. [PubMed: 11419832]
7. Chung YW, Han DS, Park KH, et al. Patient factors predictive of inadequate bowel preparation using polyethylene glycol: a prospective study in Korea. J Clin Gastroenterol. 2009; 43:448–452. [PubMed: 18978506]
8. Rex DK, Imperiale TF, Latinovich TR, et al. Impact of bowel preparation on efficiency and cost of colonoscopy. Am J Gastroenterol. 2002; 97:1696–1700. [PubMed: 12135020]
9. Govani SM, Elliot E, Menees SB, et al. Predictors of sub-optimal bowel preparation for screening colonoscopy. Gastroenterology. 2011; 140:S560.
10. Sanaka MR, Shah N, Mullen KD, et al. Afternoon colonoscopies have higher failure rates than morning colonoscopies. Am J Gastroenterol. 2006; 101:2726–2730. [PubMed: 17227519]
11. Fatima H, Johnson CS, Rex DK. Patients' description of rectal effluent and quality of bowel preparation at colonoscopy. Gastrointest Endosc. 2010; 71:1244.e2–1252.e2. [PubMed: 20362286]
12. Parra-Blanco A, Nicolas-Perez D, Gimeno-Garcia A, et al. The timing of bowel preparation before colonoscopy determines the quality of cleansing, and is a significant factor contributing to the detection of flat lesions: a randomized study. World J Gastroenterol. 2006; 12:6161–6166. [PubMed: 17036388]
13. Aoun E, Abdul-Baki H, Azar C, et al. A randomized single-blind trial of split-dose PEG-electrolyte solution without dietary restriction compared with whole dose PEG-electrolyte solution with dietary restriction for colonoscopy preparation. Gastrointest Endosc. 2005; 62:213–218. [PubMed: 16046981]
14. Rostom A, Jolicoeur E, Dubé C, et al. A randomized prospective trial comparing different regimens of oral sodium phosphate and polyethylene glycol-based lavage solution in the preparation of patients for colonoscopy. Gastrointest Endosc. 2006; 64:544–552. [PubMed: 16996347]
15. El Sayed AM, Kanafani ZA, Mourad FH, et al. A randomized single-blind trial of whole versus split-dose polyethylene glycol-electrolyte solution for colonoscopy preparation. Gastrointest Endosc. 2003; 58:36–40. [PubMed: 12838218]
16. Park SS, Kanafani ZA, Mourad FH, et al. Efficacy and tolerability of split-dose magnesium citrate: low-volume (2 liters) polyethylene glycol vs. single- or split-dose polyethylene glycol bowel preparation for morning colonoscopy. Am J Gastroenterol. 2010; 105:1319–1326. [PubMed: 20485282]
17. Unger RZ, Amstutz SP, Seo da H, et al. Willingness to undergo split-dose bowel preparation for colonoscopy and compliance with split-dose instructions. Dig Dis Sci. 2010; 55:2030–2034. [PubMed: 20082216]
18. Lai EJ, Calderwood AH, Doros G, et al. The Boston bowel preparation scale: a valid and reliable instrument for colonoscopy-oriented research. Gastrointest Endosc. 2009; 69(3 Pt 2):620–625. [PubMed: 19136102]
19. Mittal S. The Boston bowel preparation scale: reliable not only for colonoscopy-oriented research but clinical practice also. Gastrointest Endosc. 2010; 71:221. [PubMed: 20105483]
20. Lieberman DA, Rex DK, Winawer SJ, et al. United States Multi-Society Task Force on Colorectal Cancer. Guidelines for colonoscopy surveillance after screening and polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer. Gastroenterology. 2012; 143:844–857. [PubMed: 22763141]

21. Rex DK, Johnson DA, Anderson JC, et al. American College of Gastro-enterology guidelines for colorectal cancer screening 2009 [corrected]. Am J Gastroenterol. 2009; 104:739–750. [PubMed: 19240699]

22. Lin OS, Schembre DB. Are split bowel preparation regimens practical for morning colonoscopies? Implications of the new American College of Gastroenterology colon cancer screening guidelines for real-world clinical practice. Am J Gastroenterol. 2009; 104:2627–2678. author reply 2628–9. [PubMed: 19806092]

23. Chan WK, Saravanan A, Manikam J, et al. Appointment waiting times and education level influence the quality of bowel preparation in adult patients undergoing colonoscopy. BMC Gastroenterol. 2011; 11:86. [PubMed: 21798022]

24. Tae JW, Lee JC, Hong SJ, et al. Impact of patient education with cartoon visual aids on the quality of bowel preparation for colonoscopy. Gastrointest Endosc. 2012; 76:804–811. [PubMed: 22840295]

25. Modi C, Depasquale JR, Digiacomo WS, et al. Impact of patient education on quality of bowel preparation in outpatient colonoscopies. Qual Prim Care. 2009; 17:397–404. [PubMed: 20051190]

26. Abuksis G, Mor M, Segal N, et al. A patient education program is cost-effective for preventing failure of endoscopic procedures in a gastro-enterology department. Am J Gastroenterol. 2001; 96:1786–1790. [PubMed: 11419830]

27. Calderwood AH, Lai EJ, Fix OK, et al. An endoscopist-blinded, randomized, controlled trial of a simple visual aid to improve bowel preparation for screening colonoscopy. Gastrointest Endosc. 2011; 73:307–314. [PubMed: 21168840]

Take-home Message

- Prospectively, 1 in 7 average-risk patients do not comply with the split-dose bowel regimen. Predictors of noncompliance included Hispanic ethnicity, income of $75,000 or less, and poor adherence to bowel preparation instructions.
- Noncompliance with the split-dose bowel regimen was the strongest predictor of suboptimal bowel preparation.

TABLE 1

Study participant characteristics by compliance status to split-dosing recommendations (N = 462)

Patient characteristics	Split-dosing recommendation		Total	*P* value*
	Compliant (n = 391)	Noncompliant (n = 71)		
Demographic				
Age, y, mean (SD)	56.5 (6.7)	58.2 (7.8)	56.8 (6.9)	.07
Male	192 (49.2)	39 (56.5)	231 (50.3)	.26
White	345 (88.5)	53 (76.8)	398 (86.7)	.009
Hispanic or Latino	5 (1.3)	6 (8.7)	11 (2.4)	<.001
Married	288 (74.4)	41 (59.4)	329 (72.2)	.01
BMI, kg/m^2, mean (SD)	28.9 (5.8)	28.7 (5.7)	28.9 (5.8)	.85
High school education or less	61 (15.7)	13 (18.8)	74 (16.2)	.51
Full-time employment	223 (57.3)	40 (58.0)	263 (57.4)	.92
On Medicare	55 (14.5)	15 (22.1)	70 (15.6)	.11
On Medicaid or no insurance	17 (4.5)	3 (4.3)	20 (4.4)	.95
≤$75,000 annual income	145 (39.1)	39 (58.2)	184 (42.0)	.004
Health-related measures				
Very good or excellent health	260 (67.0)	43 (62.3)	303 (66.3)	.45
History of stroke	9 (2.3)	3 (4.4)	12 (2.6)	.33
History of cirrhosis	3 (0.9)	1 (1.5)	4 (0.9)	.58
On prescription pain pills	28 (7.2)	3 (4.4)	31 (6.8)	.39
On tricyclic antidepressant†	6 (1.6)	0 (0)	6 (1.3)	.30
History of constipation	73 (18.9)	10 (14.5)	83 (18.2)	.39
Never nauseous	65 (16.6)	13 (18.3)	78 (16.9)	.73

All values are number (percentage) of those split-dose compliant or split-dose noncompliant, unless otherwise specified. The total number of patients for each characteristic may not add to total (N = 462) because of missing data.

SD, Standard deviation; *BMI*, body mass index.

*From testing differences in the distribution of the patient characteristics between patients compliant and noncompliant with split-dose guidelines; based on a *t* test for continuous variables and χ^2 test for categorical variables. No adjustments for multiple testing were done as the tests were not meant to be inferential, but to identify variables that are potentially associated with compliance to split-dose preparation.

†Taking Tofranil, Mallinckrodt Pharmaceuticals, Hazelwood, MO, (imipramine hydrochloride), Elavil, AstraZeneca, London, UK, (amitriptyline), Norpramin, Sanofi Aventis, Paris, France, (desipramine hydrochloride), Sinequan, Pfizer, New York, NY, (doxepin hydrochloride), or Pamelor, Mallinckrodt Pharmaceuticals, Hazelwood, MO, (nortriptyline hydrochloride).

TABLE 2

Distribution of bowel preparation process–related variables, by compliance status to split-dosing recommendations (N = 462)

	Split dosing			
Bowel preparation characteristics	**Compliant (n = 391)**	**Noncompliant (n = 71)**	**Total**	***P* value***
First colonoscopy	248 (63.4)	38 (55.1)	286 (62.2)	.19
Endoscopy at academic hospital unit†	221 (56.5)	33 (46.5)	254 (55.0)	.12
No one talked about liquid laxative‡	193 (49.4)	28 (39.4)	221 (47.8)	.12
No discussion about food before preparation	244 (62.9)	48 (67.6)	292 (63.6)	.45
No handout about how to prepare	113 (29.2)	23 (32.9)	136 (29.8)	.54
Looked at instructions for the preparation				
Yesterday	24 (6.2)	6 (8.5)	30 (6.6)	
2–6 days ago	124 (32.0)	124 (33.8)	148 (32.3)	
7–14 days ago	86 (22.2)	17 (23.9)	103 (22.5)	
15–21 days ago	36 (9.3)	5 (7.0)	41 (9.0)	
>21 days ago or never	117 (30.2)	19 (26.8)	136 (29.7)	.88
Bought liquid/pill laxatives to prepare				
Yesterday	40 (10.3)	8 (11.3)	48 (10.4)	
2–6 days ago	237 (60.9)	35 (49.3)	272 (59.1)	
7–14 days ago	57 (14.7)	14 (19.7)	71 (15.4)	
15–21 days ago	9 (2.3)	2 (2.8)	11 (2.4)	
>21 days ago or never	46 (11.8)	12 (16.9)	58 (12.6)	.45
Followed laxative instructions exactly	265 (67.8)	39 (54.9)	304 (65.8)	.04
Bowel preparation type				
PEG-EL	133 (34.2)	37 (52.1)	170 (37.0)	
MiraLAX PEG 3350 + Gatorade	237 (60.9)	28 (39.4)	265 (57.6)	
Other§	19 (4.9)	6 (8.5)	25 (5.4)	.003
Last time ate/drank was before noon yesterday	325 (83.6)	56 (80.0)	381 (83.0)	.47
No. of glasses of fluid drank yesterday ‖				
0	20 (5.2)	9 (13.0)	29 (6.4)	
1–6	178 (46.5)	42 (60.9)	220 (48.7)	
>6	185 (48.3)	18 (26.1)	203 (44.9)	.001
No. of glasses of fluid drank today ‖				
0	119 (30.6)	38 (55.1)	157 (34.3)	
1–6	248 (63.8)	28 (40.6)	276 (60.3)	
>6	22 (5.7)	3 (4.4)	25 (5.5)	<.001
Amount of liquid or pill laxative taken, %				
>90	355 (90.8)	58 (82.9)	413 (89.6)	

Bowel preparation characteristics	Split dosing		Total	*P* value*
	Compliant (n = 391)	Noncompliant (n = 71)		
75–90	21 (5.4)	9 (12.9)	30 (6.5)	
50–75	15 (3.8)	3 (4.3)	18 (3.9)	.06
Colonoscopy appointment was before 10:30 AM	172 (44.0)	47 (66.2)	219 (47.4)	.001

All values are number (percentage) of those split-dose compliant or noncompliant), unless otherwise specified.

PEG-EL, Polyethylene glycol electrolyte.

*From testing differences in the distribution of the patient characteristics between patients compliant and noncompliant with split-dose guidelines; based on a *t* test for continuous variables and χ^2 test for categorical variables. No adjustments for multiple testing were done as the tests were not meant to be inferential, but to identify variables that are potentially associated with compliance to split-dose bowel preparation.

†Versus ambulatory surgery centers.

‡Patients responded having talked to no one about laxatives, including doctor, nurse or medical assistant, and pharmacist.

§Includes sodium phosphate/OsmoPrep, Half-Lytely, Moviprep, and 2-day preparation.

‖In addition to liquid laxative preparation.

TABLE 3

Participants' experiences from colonoscopy preparation by compliance status to split-dosing recommendations (N = 462)

	Split dosing			
Colonoscopy preparation experiences	**Compliant (n = 391)**	**Noncompliant (n = 71)**	**Total**	***P* value***
Nauseous or sick to stomach from laxative	139 (35.6)	20 (28.2)	159(34.5)	.22
Any vomiting in 24 h	18 (4.6)	4 (5.6)	22 (4.8)	.71
Bowel movement after taking laxatives				
>6 h to first bowel movement	30 (10.0)	5 (7.0)	44 (9.5)	.22
>12 h before clear bowel movement	161 (41.7)	10 (14.1)	171 (37.4)	<.001
Last bowel movement was solid or brown liquid	25 (6.4)	4 (5.6)	29 (6.3)	.80
>3 bathroom stops on way to colonoscopy appointment	7 (1.8)	4 (5.6)	11 (2.4)	.05

All values are number (%) of those split-dose compliant or noncompliant, unless otherwise specified.

*From testing differences in the distribution of the patient characteristics between patients compliant and noncompliant with split-dose guidelines; based on a *t* test for continuous variables and χ^2 test for categorical variables. No adjustments for multiple testing were done as the tests were not meant to be inferential, but to identify variables that are potentially associated with compliance to split-dose bowel preparation.

TABLE 4

Adjusted odds ratios (95% confidence intervals) based on logistic regression models for suboptimal preparation defined based on Boston Bowel Preparation Scale Scores less than 5

	Model 1: not adjusting for bowel movement variables			Model 2: after adjusting for bowel movement variables		
Characteristics	**AOR**	**95% CI**	***P* value**	**AOR**	**95% CI**	***P* value**
Noncompliant with split-dose bowel preparation	4.31	2.28–8.12	<.001	6.74	3.20–14.21	<.001
Age	0.98	0.94–1.02	.38	1.00	0.95–1.04	.84
Male	0.90	0.50–1.63	.74	1.03	0.54–1.95	.94
White	1.26	0.55–2.89	.58	1.21	0.50–2.94	.67
Private insurance*	0.47	0.23–0.98	.05	0.50	0.23–1.09	.08
Endoscopy performed at a hospital†	0.48	0.27–0.84	.01	0.33	0.18–0.63	.001
History of constipation	2.11	1.07–4.16	.03	2.06	0.99–4.27	.05
Typically never nauseous	2.53	1.31–4.86	.01	3.47	1.70–7.09	.001
Last ate before noon yesterday	0.48	0.25–0.92	.03	0.56	0.28–1.11	.10
Taken >12 h or never until clear BM	—	—	—	2.42	1.23–4.74	.01
Last BM watery with flecks of particulates‡	—	—	—	2.98	1.55–5.71	.001
Last BM solid or brown liquid‡	—	—	—	6.54	2.43–17.64	<.001

AOR, Adjusted odds ratio; *CI*, confidence interval; *BM*, bowel movement.

*Versus Medicare, Medicaid, or no insurance.

†Versus ambulatory surgery centers.

‡Versus watery or clear.