CME

Optimizing Bowel Preparation Quality for Colonoscopy: Consensus Recommendations by the US Multi-Society Task Force on Colorectal Cancer

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This document is an update to the 2014 recommendations for optimizing the adequacy of bowel cleansing for colonoscopy from the US Multi-Society Task Force on Colorectal Cancer, which represents the American College of Gastroenterology, the American Gastroenterological Association, and the American Society for Gastrointestinal Endoscopy. The US Multi-Society Task Force developed consensus statements and key clinical concepts addressing important aspects of bowel preparation for colonoscopy. The majority of consensus statements focus on individuals at average risk for inadequate bowel preparation. However, statements addressing individuals at risk for inadequate bowel preparation quality are also provided. The quality of a bowel preparation is defined as adequate when standard screening or surveillance intervals can be assigned based on the findings of the colonoscopy. We recommend the use of a split-dose bowel preparation regimen and suggest that a 2 L regimen may be sufficient. A same-day regimen is recommended as an acceptable alternative for individuals undergoing afternoon colonoscopy, but we suggest that a same-day regimen is an inferior alternative for individuals undergoing morning colonoscopy. We recommend limiting dietary restrictions to the day before a colonoscopy, relying on either clear liquids or low-fiber/low-residue diets for the early and midday meals. We suggest the adjunctive use of oral simethicone for bowel preparation before colonoscopy. Routine tracking of the rate of adequate bowel preparations at the level of individual endoscopists and at the level of the endoscopy unit is also recommended, with a target of >90% for both rates.

KEYWORDS: bowel preparation; colonoscopy; USMSTF

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INTRODUCTION

Colorectal cancer remains the second most common cause of cancer death in the United States (1), and colonoscopy is considered the gold standard for evaluating the colon, including assessing causes of colon-related signs or symptoms and the detection of precancerous lesions. It is well recognized that the adequacy of bowel preparation is essential for optimal colonoscopy performance (2,3).

The quality of colonoscopy is measured in several ways including objective metrics such as the adenoma detection rate (ADR) and the cecal intubation rate. While these factors are in part dependent on the endoscopist, the quality of the bowel preparation is also central to high performance. To date, there is no single accepted approach to this basic element of procedural preparation. For example, there are many options for colonic lavage with important variables including effectiveness, safety,

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Table 1. Terminology used throughout the document

Terminology	Definition
Bowel preparation process	All the steps communicated to an individual to prepare them for a colonoscopy. Includes instructions for what to expect, to arrange for an escort, how to modify their diet, what medications to hold, and what medications to take.
Bowel preparation regimen	The combination of medications and dietary modifications used to achieve a clean colon as preparation for colonoscopy.
Bowel preparation quality	The degree of cleanliness of the colon. The US Multi-Society Task Force on Colorectal Cancer recommends assessing and reporting this metric after all washing and suctioning maneuvers have been done during the colonoscopy.
Adequate bowel preparation quality	When the bowel preparation quality is such that a standard screening or surveillance interval can be assigned based on the findings of the colonoscopy.
Inadequate bowel preparation quality	When the bowel preparation quality is such that a standard screening or surveillance interval cannot be assigned based on the findings of the colonoscopy.
Purgative	The primary medication consumed by an individual to clean the colon of stool.
Adjunct	Any secondary medication or dietary supplement that might be included in a bowel preparation regimen other than the purgative.
Day prior regimen	A bowel preparation regimen wherein an individual consumes the entire purgative the day before their colonoscopy.
Split-dose regimen	A bowel preparation regimen wherein an individual consumes some portion (typically half) of the purgative the day before their colonoscopy and consumes the remainder of the purgative the day of their colonoscopy.
Same-day regimen	A bowel preparation regimen wherein an individual consumes the entire purgative on the day of their colonoscopy.
High-volume regimen	Use of ≥4 L of purgative in a bowel preparation regimen. A high-volume regimen can be part of a day prior, same-day, or split-dose regimen. This is sometimes referred to as "full volume" in the literature.
Low-volume regimen	Use of ≥2 to <4 L of a purgative in a bowel preparation regimen. A low-volume regimen can be part of a day prior, same-day, or split-dose regimen.
Ultra-low-volume regimen	Use of <2 L of a purgative in a bowel preparation regimen. An ultra-low-volume regimen can be part of a same-day or split-dose regimen.

palatability, and cost. There are also options for how a patient consumes the bowel purgative, which may include consumption of the entire purgative in one limited timeframe (e.g., the evening before or the morning of the colonoscopy) or consumed in a split-dose fashion. Split dose refers to a temporal separation of many hours when the patient consumes portions of the purgative. The most common convention is to administer half the purgative's volume the evening before the colonoscopy and the remaining half the morning of the colonoscopy, although other percentage splits have been reported (e.g., 75%/25%).

Similarly, there is no standard nomenclature for discussing bowel preparation, with terms such as "bowel preparation" used at times to describe the process (e.g., all the steps taken by a patient before colonoscopy including arranging for transportation), the regimen (e.g., the purgative consumed with or without additional adjuncts to clean the colon), or the quality of bowel preparation (e.g., how clean the colon is during colonoscopy). Table 1 reviews the terminology used throughout this document to avoid ambiguity.

The US Multi-Society Task Force on Colorectal Cancer (USMSTF) is composed of members with interest and expertise in topics pertaining to colonoscopy and colorectal cancer screening. The USMSTF has previously issued guidance on the topic of bowel preparation for colonoscopy, but this area continues to evolve, and updated recommendations are warranted.

SCOPE OF THE RECOMMENDATIONS AND METHODOLOGY

This set of clinical recommendations addresses the major issues related to bowel preparation for colonoscopy in outpatients at low risk for inadequate bowel preparation. Clinically relevant questions were developed by content experts whose clinical practice and research focus include colonoscopy and bowel preparation. Along with research librarians, the panel formulated 21 questions deemed clinically important using the PICO format: P, population in question; I, intervention; C, comparator; and O, outcomes of interest (Supplemental Table S1, http://links.lww.com/AJG/D523) (4) These questions were then investigated by performing a comprehensive literature search of EMBASE, PubMed, Cochrane Reviews, and the Cochrane Central Register of Controlled Clinical Trials from January 2013 through September 2023. We included only English language articles that focused on human subjects. Our original 21 PICO questions evolved into a final set of 25 recommendations organized relative to the colonoscopy procedure (before, during, and postcolonoscopy) based on practical considerations.

The USMSTF is composed of 9 members, with 3 members representing each of the 3 gastroenterological societies—the American College of Gastroenterology (ACG), the American Gastroenterological Association, and the American Society for Gastrointestinal Endoscopy (ASGE). After the development of draft documents and recommendation statements, the leadership of all 3 societies provided feedback on the content and the Task Force subsequently revised the document to address those comments. Final recommendations were approved independently by each organization's governing board. The document then moved to the publication phase without further peer review or comment.

The methods used by the USMSTF to develop recommendations are outlined by an agreed upon Charter from the 3 gastrointestinal (GI) societies and are entirely separate from processes used by the individual societies' Clinical Guidelines Committee, Practice Parameters Committee, or Standards of Practice Committee. Given these differences, the consensus statements developed are referred to as "Recommendations" and not "Guidelines" to distinguish these documents from those separately developed by the individual societies.

In brief, the Charter for document development requires a literature review lead by the primary author(s), with or without the assistance of research librarians, and the development of a draft article with evidence tables to be reviewed by the entire committee. For each recommendation, the quality of the evidence is assessed, applying agreed upon conventions (e.g. evidence from well-designed clinical trials and systematic reviews is of higher quality than observational studies) and codified by the consensus of the experts composing the committee. The evidence supporting each statement is assessed as "high," "moderate," "low," and "very low" using this process, and the relevant supporting literature is included in the narrative that follows each recommendation to provide context to the rating. To provide clinical guidance for the practitioner, the committee comes to a consensus recommendation for each statement using the terms "strong" and "weak". The strength of any recommendation was considered strong when consensus was that most patients should be managed according to the recommendation and weak when, in the opinion of the committee, there is more latitude in application of the recommendation. Weak recommendations are often made when the evidence is less robust (e.g. clinical trials are not available) and/or the degree of clinical impact is of smaller size and where other factors (e.g. the perspective of the patient or endoscopist) take on greater importance. Weak recommendations are phrased as "We suggest…" as opposed to "We recommend…" to highlight the potential for future data to alter the recommendation. The final recommendations of the USMSTF are given in Table 2.

The authors have also highlighted "key concepts" throughout the document (Table 3). Key concepts are statements to which a systematic evaluation of the strength of the supporting literature has not been applied and may include definitions and epidemiological statements rather than diagnostic or management recommendations. Finally, to aid the reader in more efficiently finding particular topics of interest, the recommendations have been grouped by topics related to 3 broad timeframes: before colonoscopy, during colonoscopy, and after colonoscopy.

An important caveat: In general, the majority of studies that support the USMSTF recommendations have been conducted among selected populations, either participating in controlled trials or with exclusion criteria that might affect generalizability. Many of the cited studies are limited to healthy ambulatory patients without prior gastrointestinal surgery and with limited risk factors for inadequate bowel preparation (5–9) (see Table 4: risk factors for inadequate bowel preparation), making it difficult to draw generalizable recommendations for all patients. Consideration is given to specific populations later in this document, but, our recommendations, unless otherwise stated, apply to ambulatory patients at low risk for inadequate bowel preparation.

RECOMMENDATIONS BEFORE COLONOSCOPY

TOPIC: PATIENT EDUCATION AND NAVIGATION

Question: Should patient navigators and electronic adjuncts (e.g., automated texting programs) be used to help prepare patients for colonoscopy?

Recommendations

- We recommend that individuals undergoing colonoscopy receive both verbal and written patient education instructions for all components of the colonoscopy preparation (strong recommendation, high-quality evidence).
- We suggest that individuals undergoing colonoscopy receive some form of patient navigation, including telephonic or virtual navigation using automated electronic messaging, to improve rates of adequate bowel preparation (weak recommendation, moderate-quality evidence).

The goals of patient education and navigation include increasing bowel preparation adequacy while enhancing the likelihood the patient will attend and safely undergo colonoscopy on the day that it is scheduled. Bowel preparation is a multistep process that includes arranging time off for the procedure, ensuring an escort for safe discharge according to standards of the endoscopy unit, proper management of medication regimen (with special emphasis on anticoagulation, anti-platelet agents, glucagon-like peptide-1 [GLP-1] receptor agonists, and diabetes and antihypertensive medications), compliance with dietary modifications, and the proper timing and complete ingestion of the specified bowel purgative and associated fluids. While not the focus of this study, the appropriate management of antithrombotic and anti-platelet medications in the periendoscopic period has recently been reviewed in separate guidelines (10,11). The management of anti-hyperglycemic and anti-hypertensive agents should be individualized with the assistance of the prescribing clinician based on the timing of the colonoscopy and is beyond the scope of this document.

The complexity of the bowel preparation process, variable health literacy and preferred languages, and potentially counterproductive information on the internet (12) are some factors that can negatively affect colonoscopy completion rates (13–15). The use of both verbal and detailed written instructions, effective across a range of health literacy and educational levels, has been associated with improved bowel preparation compared with written instructions alone (16–22). Videos when used to augment bowel preparation instructions have been shown in some randomized controlled trials to improve bowel preparation and the ADR (23,24). For example, the addition of virtual reality videos (compared with more conventional verbal and written materials) improved both the mean Boston Bowel Preparation Scale (BBPS)

Table 2. Recommendations of the US Multi-Society Task Force on Colorectal Cancer for optimizing bowel preparation quality

We recommend that individuals undergoing colonoscopy receive both verbal and written patient education instructions for all components of the colonoscopy preparation (strong recommendation, high-quality evidence).
We suggest that individuals undergoing colonoscopy receive some form of patient navigation, including telephonic or virtual navigation using automated electronic messaging to improve rates of adequate bowel preparation (weak recommendation, moderate-quality evidence).
We recommend limiting dietary modifications to the day before colonoscopy for ambulatory patients at low risk for inadequate bowel preparation (strong recommendation, high-quality evidence).
We recommend dietary modifications should include the use of low-residue and low-fiber foods or full liquids for the early and midday meals on the day before colonoscopy when using a split-dose bowel preparation regimen for ambulatory patients at low risk for inadequate bowel preparation (strong recommendation, high-quality evidence).
We do not recommend one bowel preparation purgative as superior to others about bowel preparation adequacy for ambulatory patients at low risk for inadequate bowel preparation (strong recommendation, high-quality evidence).
We suggest 2 L bowel preparation regimens instead of 4 L regimen preparation (weak recommendation, moderate-quality evidence).
We recommend the selection of a bowel preparation regimen that considers the individual's medical history, medications, and, when available, the adequacy of bowel preparation reported from prior colonoscopies (strong recommendation, moderate-quality evidence).
We recommend against the use of hyperosmotic regimens in individuals at risk for volume overload or electrolyte disturbances (strong recommendation, high-quality evidence).
We recommend a split-dose administration of bowel preparation purgatives for all patients, regardless of high-volume or low-volume preparation (strong recommendation, high-quality evidence).
We recommend that a same-day regimen is an acceptable alternative to split dosing for individuals undergoing an afternoon colonoscopy (strong recommendation, high-quality evidence).
We suggest that a same-day regimen is an inferior alternative to split dosing for individuals undergoing a morning colonoscopy (weak recommendation, low-quality evidence).
For individuals using a split-dose regimen for colonoscopy preparation, we recommend the consumption of the second portion begin 4–6 hr before the time of colonoscopy and be completed at least 2 hr before the procedure start (strong recommendation, moderate-quality evidence).
We suggest the adjunctive use of oral simethicone for bowel preparation before colonoscopy (weak recommendation, moderate-quality evidence).
We suggest against the routine use of nonsimethicone adjuncts for bowel preparation before colonoscopy (weak recommendation, low-quality evidence).
When patients report incomplete adherence to the bowel preparation regimen or offer statements suggesting that their bowel preparation may not be adequate (e.g., dark bowel effluent), we suggest insertion of the colonoscope to the sigmoid colon to confirm inadequacy before aborting the procedure (weak recommendation, low-quality evidence).
We recommend bowel preparation quality be assessed only after all washing and suctioning have been completed, using reliably understood descriptors that communicate the adequacy of the preparation (strong recommendation, moderate-quality evidence).
We recommend the term "adequate bowel preparation" be used to indicate that standard screening or surveillance intervals can be assigned based on the findings of the colonoscopy (strong recommendation, moderate-quality evidence).
We suggest the routine use of irrigation pumps to assist with bowel preparation during colonoscopy (weak recommendation, very low-quality evidence).
We suggest the use of same-day salvage maneuvers when feasible for inadequate bowel preparations (weak recommendation, moderate-quality evidence).
We recommend routine tracking of the rate of adequate bowel preparations at the level of individual endoscopists and at the level of the endoscopy unit (strong recommendation, moderate-quality evidence).
We recommend an endoscopy unit-level and individual endoscopist-level bowel preparation adequacy rate of $\geq$ 90% (strong recommendation, moderate-quality evidence).
When the bowel preparation is deemed inadequate to allow assigning standard screening or surveillance intervals, we recommend rescheduling a colonoscopy within 12 mo for screening or surveillance colonoscopies, and as soon as possible (i.e. generally within 3 mo) for those performed for an abnormal noncolonoscopic colorectal cancer screening test (strong recommendation, moderate-quality evidence).
In the setting of a previous inadequate bowel preparation, we recommend modifications to bowel preparation instructions to include 1 or more of the following: increased attention to communicating the bowel preparation regimen instructions; increased use of patient navigation; restricting the intake of vegetables and legumes for 2 to 3 d before colonoscopy; allowing only clear liquids on the day before colonoscopy; the addition of promotility agents; treatment of underlying constipation; temporary cessation of anticholinergic, opioid, or other constipating medications; and/or the use of high-volume bowel preparation regimens (strong recommendation, moderate-quality evidence).
We recommend individuals at high risk for inadequate bowel preparation quality be managed like individuals with a prior inadequate bowel preparation, with modifications to their bowel preparation regimen as previously described (strong recommendation, moderate-quality evidence).
We suggest the following bowel preparation regimen for individuals at high risk for inadequate bowel preparation quality: split-dose 4 L polyethylene glycol-electrolyte lavage solution + 15 mg bisacodyl the afternoon before the colonoscopy and a low-residue diet 3 and 2 d before colonoscopy changing to clear-liquid diet the day before colonoscopy (weak recommendation, low-quality evidence).

Table 3. Key concepts

The choice of bowel preparation regimen, including the purgative, should take into consideration patient preference, comorbidities, safety (see below), associated additional costs to the patient for both prescription and over the counter purgatives and adjuncts, and ease for the patient in obtaining and consuming any purgatives or adjuncts.
Individuals using a same-day bowel preparation regimen should begin drinking the purgative 4–6 hr before the time of colonoscopy and complete the purgative at least 2 hr before the procedure's start.
Given the lack of data to strongly support the timing of oral simethicone during the bowel preparation process, and limited data supporting a specific dose, the USMSTF recommends that if endoscopists opt to include simethicone in a bowel preparation regimen, a dose of at least 320 mg be used. The impact of simethicone on meaningful clinical outcomes and its efficacy when coupled with various bowel preparation regimens requires further study. Out of pocket cost to the patient should also be considered when adding simethicone to a regimen.
If a colonoscopy is being aborted because of inadequate bowel preparation quality, the endoscopist should photograph the segment(s) of colon that resulted in abortion of the procedure. This will aid in quality assurance efforts in the setting of variability in cancellation rates among an endoscopy unit's endoscopists.
When a screening/surveillance colonoscopy is performed, the assessment of bowel preparation quality should be based on all segments of the colon. When faced with a small region of colonic mucosa that cannot be cleared of residual stool, the endoscopist may exercise judgement in determining the adequacy of bowel preparation based on the overall likelihood of missing a clinically meaningful lesion.
The term "fair," when used to describe bowel preparation quality, should be accompanied by a statement of bowel preparation adequacy (i.e., whether standard screening or surveillance intervals can be assigned based on the findings of the colonoscopy).
When a nonscreening/surveillance colonoscopy is performed, the bowel preparation may be deemed adequate for the procedure's indication (e.g., diarrhea or hematochezia) even if it is not adequate for screening/surveillance purposes. In these situations, the preparation description should communicate this distinction to ensure appropriate screening or surveillance intervals are followed.
The USMSTF recognizes that there are occasions when bubbles in the visual field at the time of colonoscopy significantly affect visualization and, by extension, procedural quality. If simethicone is used in those circumstances, we suggest using the lowest possible dilution (for example, 0.5 mL simethicone in 99.5 mL water) and administering only through an instrument channel that is routinely brushed during endoscope reprocessing.
Individuals whose colonoscopies are cancelled for presumed inadequate preparation (i.e., before colonoscope insertion) should be included when calculating both endoscopy unit and endoscopist-level bowel preparation adequacy rates.
When significant variability in bowel preparation adequacy is seen between endoscopists in a practice with shared preparation processes, it suggests individual-level variation in either intraprocedural efforts at augmenting bowel preparation quality or in their assessment of adequacy.
If the descending colon, sigmoid colon, and rectum are well-visualized during an average risk screening colonoscopy with an otherwise inadequate bowel preparation (e.g., ascending or transverse colon bowel preparation quality is deemed inadequate), it is reasonable to revisit screening options with the patient and their referring practitioner. If the individual opts to consider their limited colonoscopy as a flexible sigmoidoscopy and prefers to not repeat the colonoscopy, they should be screened again by sigmoidoscopy or colonoscopy in 5 yr, or with the use of nonendoscopic screening tests recommended by the USMSTF and the US Preventive Services Task Force.

USMSTF, US Multi-Society Task Force on Colorectal Cancer.

score (7.6 vs 7.0; $P = 0.002$) and the detection of adenomas (33% vs 22%) in a single-center, 2-arm, randomized controlled trial (N = 346) (23). However, when baseline bowel preparation adequacy rates are already quite high, there may be a ceiling effect, whereby additional education measures offer no benefit (25,26). Comparing several studies of enhanced bowel preparation instructions (i.e., more details provided in written and/or verbal and/or video format), significant improvements in bowel preparation adequacy seem difficult to achieve when the control population's rate of bowel preparation adequacy already exceeds 89% (27–32).

The use of trained patient navigators has been associated with improved bowel preparation adequacy rates (21,33,34) and screening colonoscopy completion rates (33,35–37). For example, in one randomized controlled trial of 605 patients, a telephone call to review instructions the day before colonoscopy improved bowel preparation adequacy from 70% to 82% (27). In another randomized controlled trial of 399 subjects, a patient's own self-selected contact, such as a friend or family member, voluntarily served as a navigator receiving only basic pre-colonoscopy instructions (37). Use of these voluntary navigators was associated with a modest increase in the adequate bowel preparation rate (89% vs 81%; relative risk [RR] = 1.1; 95% confidence interval [CI] 1.0–1.2; P value = 0.046).

Mobile telephone apps and web-based software systems have also been used to send automated instructions, videos, and text message reminders to help guide patients through the bowel preparation process (17,28,31,38–43). One meta-analysis of 5 studies found that smartphone app use was associated with a higher rate of adequate bowel preparation compared with standard preparation instructions alone (88% vs 78%; pooled odds ratio [OR] 2.67; 95% CI 1.00–7.13; $P = 0.05$), although significant heterogeneity was observed across the studies in part due to methodologic variation (44). When the analysis was limited to studies using the BBPS to grade bowel preparation adequacy (n = 3 studies), smartphone users (n = 235 subjects) had higher mean scores compared with standard written instructions (n = 240 subjects), with mean BBPS scores ranging from 7.5 to 8.1 compared with a range of 6.3–7.2. This yielded a statistically significant absolute mean score difference of 0.9 points ($P < 0.01$) across the 3 studies. Importantly, the delivery of instructions in patients' preferred language, when not English, is associated with

Table 4. Risk factors for inadequate bowel preparation quality (5–9)

Risk factor	Magnitude of risk [odds ratio (95% confidence interval)][a]
Cirrhosis	3.4 (1.5–7.9)
Parkinson disease	3.2 (1.2–9.3)
Dementia	3.0 (1.2–7.5)
Tricyclic antidepressant use	2.0 (1.4–2.9)
Diabetes	1.8 (1.5–2.1)
Opioid use	1.7 (1.4–2.1)
Gastroparesis	1.6 (1.2–2.3)
Previous colorectal surgery	1.6 (1.2–2.2)
Lower level of education	1.5 (1.3–1.8)
Body mass index >30 kg/m^2	1.5 (1.2–1.8)
Inpatient status	1.5 (1.1–2.1)
Hypertension	1.3 (1.2–1.4)
Tobacco use	1.3 (1.1–1.5)
Constipation	1.3 (1.0–1.6)
Medicaid vs private insurance	1.3 (1.1–1.6)
Medicare vs private insurance	1.2 (1.1–1.3)
Male sex	1.2 (1.1–1.3)
Age >65	1.1 (1.1–1.2)
Body mass index (each unit)	1.1 (1.0–1.1)

[a]Representative odds ratio selected among the references.

improved colonoscopy completion rates and improved bowel preparation quality (45).

TOPIC: DIET DURING THE BOWEL PREPARATION PROCESS

Question: When and how should diets be altered before colonoscopy?

Recommendations

- We recommend limiting dietary modifications to the day before colonoscopy for ambulatory patients at low risk for inadequate bowel preparation (strong recommendation, high-quality evidence).
- We recommend dietary modifications should include the use of low-residue and low-fiber foods or full liquids for the early and midday meals on the day before colonoscopy when using a split-dose bowel preparation regimen for ambulatory patients at low risk for inadequate bowel preparation (strong recommendation, high-quality evidence).

Dietary modification as a method to improve bowel preparation adequacy should be balanced against patient experience and compliance with the overall preparation regimen. Historically, patients were limited to ingesting only clear liquids on the day before colonoscopy, with additional restrictions varying widely in both specifically prohibited foods (e.g., seeds, vegetables, and legumes) and number of days during which modifications were required (46). Recent randomized trials, meta-analyses, and prospective dietary studies have demonstrated the utility of simpler, patient-centered dietary regimens, particularly when split dosing the bowel preparation purgative.

Several randomized controlled trials have examined whether alteration in diet is required for more than 1 day before colonoscopy. Additional days of dietary restrictions confer no benefit in bowel preparation adequacy when comparing a low-residue diet 1 day vs 2 or 3 days before colonoscopy (47–50). Patients found the 1-day diet restriction more tolerable and easier to comply with compared with longer durations of diet restrictions (48,49). However, diet instructions do not always equate to compliance with dietary restrictions, making it difficult to discern which specific dietary components correlate with bowel preparation adequacy. One prospective study with 201 subjects used food diaries and detailed nutritionist-led interviews to determine the macronutrients and micronutrients consumed during the 3 days before colonoscopy (51). Dietary information was then compared with bowel preparation adequacy in the setting of a 4 L, split-dose, polyethylene glycol (PEG) purgative and confirmed that foods consumed 2 and 3 days before colonoscopy have no impact on bowel preparation. Bowel preparation quality was positively associated with the intake of gelatin and inversely associated with intake of red meat, poultry, and vegetables on the day before colonoscopy, further supporting the use of low-residue, full-liquid, or clear-liquid diets during bowel preparation.

One problem with the recommendation of a low-residue diet is the lack of a standardized definition (52). A low-residue diet is meant to limit foods and beverages that result in the undigested material remaining in the gastrointestinal lumen and that is eventually passed in feces. While dietary fiber contributes to colonic residue, other dietary items such as milk may also contribute to residue if consumed in large quantity (53). A low-residue diet attempts to limit high-fiber foods such as cereals, beans, peas, nuts, seeds, and raw or dried fruits and vegetables (54). The term low-fiber diet is occasionally used interchangeably with low-residue diet, but much of the literature specifically describes assigning patients to low-residue or low residual diets. A list of low-residue foods associated with adequate bowel preparation quality in several randomized trials comparing low-residue with full-liquid or clear-liquid diets is provided in Table 5 (55–60).

Several meta-analyses and randomized controlled trials demonstrate that bowel preparation adequacy is not inferior when comparing low-residue diets with clear-liquid diets before colonoscopy (61–65). The largest and most recent systematic review and meta-analysis included 20 randomized controlled trials with 4,323 patients (65). There was significant heterogeneity across the included studies in bowel purgative used and whether low-residue foods were permitted for 1, 2, or 3 meals on the day before colonoscopy. Analysis of secondary endpoints found no differences in adenoma and advanced ADRs, but patients allowed a low-residue diet were more willing to repeat the preparation (71% vs 62%; $P = 0.005$), found the diet easier to comply with (52% vs 39%; $P = 0.01$), and experienced less hunger (25% vs 44%; $P < 0.001$) and nausea (18% vs 23%; $P = 0.02$) (65).

For patients at high risk for inadequate bowel preparation quality, routine use of a 1-day, low-residue diet may not be appropriate, and clinicians should offer diet recommendations on a case-by-case basis. However, for the majority of individuals, an approach that uses only 1 day vs 2 or 3 days of dietary restrictions,

Table 5. Low-residue foods and sample meals reported in the literature (quantities included when reported in primary source) [55–60]

Breakfast options
2 eggs (fried, over easy, scrambled, or boiled) with or without condiments
2 white bread slices or 1 plain bagel with butter, jelly, or cream cheese
2⁄3 cup yogurt (no seeds, berries, nuts), 1 banana
30 g of cheese, or 2 eggs (fried/boiled) + ½ cup of milk + ¼ loaf of white bread + 1 tbsp olive oil or butter
Scrambled eggs: 1 egg with 2 teaspoons of oil. Two slices of ham. Accompany with 2 pieces of white bread and a glass of apple juice (without pulp)
Chicken burrito: ½ portion of shredded chicken breast (40 g), divided into 2 wheat tortillas. A glass of yogurt or a cup of milk.
Lunch options
1 plain chicken or Turkey sandwich on white bread with condiments only: no lettuce or tomato
Chicken breast (120 g) or ham (120 g) with white bread
1 chicken breast (skinless)—pan fried or baked
90 g of meat (beef, chicken or fish) + ½ cup of cooked white rice + ½ cup of ice cream + 2 Tbsp olive oil
Lean meat: beef (100 g) or pork or poultry (160 g) or fish (200 g) or 2 eggs
1 cup macaroni and cheese
1 baked potato (no skin) with butter or sour cream
Chicken rice soup (250 g)
Miso soup (7 g)
Cottage cheese (1 c)
White rice (130 g) or plain white pasta (200 g) or peeled potatoes (fried, baked, or boiled; 300 g)
Rice noodles
Snack/dessert options
Pretzels (handful)
Jello (1 c)
Plain or vanilla yogurt (1/2 c)
Apple sauce (113 g)
Vanilla shake (58 g) or vanilla ice cream
Plain rice crackers

and more patient-acceptable diets (e.g., low-residue vs strict clear) seems warranted.

TOPIC: CHOICE OF BOWEL PREPARATION PURGATIVE

Question: Is there a specific FDA-approved bowel preparation purgative that is superior to others, including non-FDA-approved purgatives, in bowel preparation adequacy?

Recommendation

- We do not recommend 1 bowel preparation purgative as superior to others about bowel preparation adequacy for ambulatory patients at low risk for inadequate bowel preparation (strong recommendation, high-quality evidence).

In the last version of the USMSTF recommendations, we did not recommend a specific bowel preparation purgative as superior to others in bowel preparation quality adequacy rate (66,67). The USMSTF remains unable to recommend 1 specific bowel preparation as superior despite numerous studies in the field. There are very few recent head-to-head comparisons of bowel preparations where the endpoint is superior to one preparation compared with another. Noninferiority designs are more common in the era of split-dosing preparations given the high (>90%) baseline level of cleanliness achieved by most preparations currently in use (68). Extremely large numbers of individuals would be needed to demonstrate superiority in a randomized controlled trial, and there exists the possibility that small, statistically significant differences would not translate into clinically significant differences sufficient to alter patient and/or physician and/or insurer preferences. Therefore, we do not anticipate the generation of definitive data identifying one "best" preparation.

For commercial entities seeking approval of new purgatives by the Food and Drug Administration (FDA), available FDA guidance requires efficacy of colon cleansing be assessed "during insertion of the colonoscope (i.e., before washing and suctioning) to ensure the effect measured is attributable to the bowel preparation purgative, not to intraprocedural preparation efforts of the colonoscopist". Thus, the clinical effectiveness, that is, how clean a colon is during the final inspection phase of the procedure, of 2 or more preparations being compared, would remain a secondary endpoint for FDA approval. Furthermore, the endoscopist's ability to clean the colon during the procedure confounds the ability to prove one preparation superior to another (68,69).

One large retrospective study of more than 150,000 outpatient screening or surveillance colonoscopies performed in the Cleveland Clinic health system between January 2011 and June 2017 found that NuLYTELY (OR 0.66; 95% CI 0.60–0.72) and SuPREP (OR 0.53; 95% CI 0.40–0.69) were associated with reduced inadequate bowel preparation rates compared with GoLYTELY (69). However, there was no observed difference in ADRs, and the authors concluded choice of purgative should be based on other factors such as tolerability, cost, or safety. Another large study examined the bowel preparation quality for more than 4,000 colonoscopies performed by 75 endoscopists using several commonly used regimens including oral sodium sulfate, PEG-3350 with sports drink, 4 L of PEG, magnesium citrate, low-volume PEG-electrolyte lavage solution (ELS) with ascorbic acid or anhydrous citric acid, sodium picosulfate, and magnesium oxide (70). They observed that oral sodium sulfate, PEG-3350 with sports drink, and low-volume PEG-ELS with ascorbic acid had superior preparation quality and tolerability as compared with high-volume PEG. It should be noted that despite the large sample of patients and physicians from these 2 studies, the data are retrospective and from single organizations, potentially limiting generalizability. Moreover, because these were not randomized trials, there may be selection biases related to the choice of bowel preparation for each patient studied.

Key Concept
The choice of bowel preparation regimen, including the purgative, should take into consideration patient preference, comorbidities, +safety (see below), associated additional costs to the patient for both prescription and over-the-counter purgatives and adjuncts, and ease for the patient in obtaining and consuming any purgatives or adjuncts.

Question: Are high-volume bowel preparation regimens superior to low-volume bowel preparation regimens in bowel preparation adequacy?

Recommendation
- We suggest 2 L bowel preparation regimens instead of 4 L regimens for ambulatory patients at low risk for inadequate bowel preparation (weak recommendation, moderate-quality evidence).

In the last version of the USMSTF recommendations, we did not specifically comment on the volume of bowel purgative consumed by patients (66). It is important to note that the term "low volume" applies to the purgative used but does not account for the large quantities of water or other fluids recommended for consumption during the bowel preparation process. Subsequently published data suggest low-volume regimens may provide similar bowel preparation quality with superior tolerance (Table 6). Since tolerability is an important factor about patient experience and compliance with bowel preparation, it is reasonable to assume that regimens with a lower volume (e.g., $\leq$2 L compared with 4 L) may be associated with higher compliance (71). The FDA has approved the use of PEG-based low-volume bowel preparations: 2 L PEG + ascorbate; 2 L PEG-3350 + sodium sulfate, potassium chloride, magnesium sulfate, and sodium chloride; and 1 L PEG + ascorbate (71,72). A recent meta-analysis with data from 17 studies compared low-volume and high-volume bowel preparation (73). They observed that both low-volume and high-volume bowel preparations were similar in efficacy of cleaning. However, tolerability was superior for the low-volume groups. Findings were similar for the PEG (PEG with ascorbic acid and PEG with glycol citrate) and non-PEG (oral sulfate solution and sodium picosulfate with magnesium citrate) low-volume regimens. One important caveat is that all bowel preparations were administered in split doses. The investigators also excluded non-FDA-approved regimens commonly used in clinical practice, such as sodium phosphate and PEG-3350 with sports drink.

In a large (n = 2,314) multicenter randomized controlled trial comparing 4 L split-dose PEG with 2 L split-dose PEG + bisacodyl, investigators found the low-volume arm to be noninferior to the high-volume arm in rates of bowel preparation adequacy (74). While the *a priori* established noninferior margin of 10% was not exceeded, the frequency of adequate bowel preparation (based on BBPS segment scores of at least 2 in each of 3 segments) was slightly higher with the 4 L dosing compared with the 2 L dosing (90% vs 89%; $P = 0.02$). This difference was no longer significant when adjusting for multiple variables including time of day of colonoscopy. In the high-volume arm, symptoms of nausea and pain were reported more frequently, and patient willingness to repeat the preparation was significantly lower compared with the low-volume arm (66.9% vs 91.9%; $P < 0.01$).

One meta-analysis examined the efficacy of ultra-low-volume ($\leq$1 L) bowel preparation regimens and observed the bowel preparation adequacy rate was unacceptably low for $\leq$1 L sodium picosulfate/magnesium citrate regimens (75% adequacy rate; 19 trials; n = 10,287), 1 L PEG with ascorbate regimens (83% adequacy rate; 10 trials; n = 1,717), and <1 L sodium phosphate regimens (82% adequacy rate; 2 trials; n = 621) (75). However, use of a $\leq$1 L split-dose oral sulfate solution regimen (3 trials; n = 597) was associated with a 92% rate of adequate bowel preparation. The results of this meta-analysis suggest that ultra-low-volume bowel preparation regimens are not ready for general use but should also be interpreted with caution, given significant heterogeneity in study design and variables among the included studies (I^2 range 86%–98%).

A recent randomized controlled trial of 548 ambulatory subjects undergoing afternoon colonoscopy for any indication compared an ultra-low-volume regimen combining 1 L PEG + 290 mcg of linaclotide with same-day 2 L PEG and observed that the 1 L PEG + linaclotide regimen was not inferior to the 2 L PEG regimen about quality of bowel preparation, cecal intubation rate, and ADR (76). The 290 mcg linaclotide was taken the evening before colonoscopy and again the morning of the colonoscopy coupled with the 1 L PEG as a same-day preparation between 10 AM and 11 AM. The 2 L PEG was taken between 9 AM and 11 AM the day of the procedure, and all colonoscopies were afternoon cases. All patients were instructed to consume a low-residue diet the day before colonoscopy. In the intention-to-treat analysis, adequate bowel preparation was observed among 91.6% of subjects randomized to 2 L PEG and 90.5% of subjects randomized to 1 L PEG + linaclotide ($P = 0.64$). There were fewer reports of nausea and vomiting and a higher rate of patients willing to repeat the bowel preparation in the lower volume arm (95.2% vs 82.2%; $P < 0.01$).

Table 6. A comparison of high-volume, low-volume, and ultra-low-volume bowel preparations [73–75]

Outcome	High-volume (4 L) preparations	Low-volume (2 L) preparations	Ultra-low-volume (≤1 L) preparations	Magnitude of effect
PEG and non-PEG regimens				
Adequate bowel cleanliness overall, % (95% CI)	87.4% (84.1–90.7)	86.1% (82.6–90)	Sodium picosulfate with magnesium citrate: 75.2% (67.6–81.4) 1 L PEG with ascorbic acid: 82.9% (74.4–90.2) Oral sulfate solution: 92.1% (79.7–97.2) Sodium phosphate: 81.9% (36.8–97.2)	Relative risk high vs low volume 1.00 (0.98–1.02)
Adequate bowel cleanliness, right colon, % (95% CI)	89.6% (87.3–92.0)	91.2% (89.1–93.3)	NA	Relative risk high vs low volume 1.01 (0.99–1.03)
Patient adherence to regimen, % (95% CI)	86.8% (82.1–91.4)	92.8% (89.6–96.1)	NA	Relative risk high vs low volume 1.06 (1.02–1.10)
Tolerability, % (95% CI)	49.6% (28.8–70.5)	72.5% (56.4–88.7)	NA	Relative risk high vs low volume 1.39 (1.12–1.74)
Patient willingness to repeat preparation, % (95% CI)	61.9% (47.8–76.1)	89.5% (80.3–98.7)	NA	Relative risk high vs low volume 1.41 (1.20–1.66)
Adenoma detection rate, % (95% CI)	28.7% (26.1–31.4)	27.6% (25.0–30.2)	Sodium picosulfate with magnesium citrate: 31.1% (25.6–36.7) 1 L PEG with ascorbic acid: 32.4% (26.6–38.4) Oral sulfate solution: 40.9% (28.3–54.2) Sodium phosphate: 30.4% (20.6–41.2)	Relative risk high vs low volume 0.96 (0.87–1.08)
PEG + ascorbic or citric acid regimens				
Adequate bowel cleanliness overall, % (95% CI)	86.3% (82.0–90.5)	84.9% (80.8–89.0)	1 L PEG with ascorbic acid: 82.9% (74.4–90.2)	Relative risk high vs low volume 1.00 (0.96–1.02)
Adequate bowel cleanliness, right colon, % (95% CI)	88.4% (85.0–91.9)	90.5% (87.3–93.6)	NA	Relative risk high vs low volume 1.01 (0.98–1.04)
Patient adherence to regimen, % (95% CI)	88.2% (87.0–89.4)	93.4% (92.5–94.3)	NA	Relative risk high vs low volume 1.08 (1.03–1.14)
Tolerability, % (95% CI)	78.5% (76.9–80.2)	83.1% (81.5–84.6)	NA	Relative risk high vs low volume 1.18 (0.99–1.42)
Patient willingness to repeat preparation, % (95% CI)	66.0% (60.5–71.3)	89.0% (85.0–92.3)	NA	Relative risk high vs low volume 1.46 (1.15–1.86)
Non-PEG regimens[a]				
Adequate bowel cleanliness overall, % (95% CI)	91% (87.8–94.2)	89.5% (83.6–95.4)	Sodium picosulfate with magnesium citrate: 75.2% (67.6–81.4) Oral sulfate solution: 92.1% (95% CI, 79.7–97.2) Sodium phosphate: 81.9% (95% CI, 36.8–97.2)	Relative risk high vs low volume 1.00 (0.96–1.04)
Adequate bowel cleanliness, right colon, % (95% CI)	91.4% (87.9–94.9)	92.2% (88.8–95.6)	NA	Relative risk high vs low volume 1.01 (0.96–1.06)
Patient adherence to regimen, % (95% CI)	89.4% (86.3–92.4)	90.2% (86.7–93.0)	NA	Relative risk high vs low volume 1.01 (0.98–1.04)

Table 6. (*continued*)

Outcome	High-volume (4 L) preparations	Low-volume (2 L) preparations	Ultra-low-volume (≤1 L) preparations	Magnitude of effect
Tolerability, % (95% CI)	48.5% (43.4–53.7)	85.8% (81.7–89.1)	NA	Relative risk high vs low volume 1.87 (1.11–3.16)
Patient willingness to repeat preparation, % (95% CI)	67.7% (57.4–76.9)	92.8% (85.7–97.1)	NA	Relative risk high vs low volume 1.37 (1.18–1.59)

Tolerability defined as palatability or acceptability.
Adenoma detection rate = Number of colonoscopies with at least 1 adenoma detected.
CI, confidence interval; PEG, polyethylene glycol; NA, not available.
[a]Non-PEG bowel preparation regimens include sodium picosulfate with magnesium citrate and oral sulfate solution.

Question: Should selection of a bowel preparation regimen consider the patient's medical history?

Recommendations

- We recommend the selection of a bowel preparation regimen that considers the individual's medical history, medications, and, when available, the adequacy of bowel preparation reported from prior colonoscopies (strong recommendation, moderate-quality evidence).
- We recommend against the use of hyperosmotic regimens in individuals at risk for volume overload or electrolyte disturbances (strong recommendation, high-quality evidence).

In the last version of the USMSTF recommendations, we recommended that selection of a bowel preparation regimen should take into consideration the patient's medical history, medications, and, when available, the adequacy of bowel preparation reported from prior colonoscopies (strong recommendation, moderate-quality evidence) (66).

Hyperosmolar purgatives for bowel preparation should be avoided in individuals at risk of clinical consequences from fluid shifts, such as renal insufficiency, or cardiac conditions, such as congestive heart failure. One large meta-analysis of various bowel preparation regimens highlighted that most preparations can cause abdominal pain and abdominal distention, anal irritation, nausea, headache, dizziness, and malaise (75). It is important to highlight that in this analysis, the investigators included studies that enrolled outpatient patients with various indications for colonoscopy, i.e., screening, surveillance, and diagnostic. They excluded those studies with patients who had commonly accepted contraindications for colonoscopy and contraindications for bowel preparation. The authors point out that their study did not include those patients with serious systemic illnesses.

Participants receiving sodium picosulfate + magnesium citrate experienced elevated serum magnesium levels, hyponatremia, and hyperkalemia; those receiving PEG + ascorbate were more likely to experience hypernatremia; and those receiving oral sulfate solution were more likely to experience metabolic derangements including transient diminished renal function (75). However, these changes were transient and were of low clinical significance.

What follows is a discussion of the most frequently prescribed purgatives for bowel preparation, their advantages and disadvantages (including when patient-related factors are considered), and whether they have been approved by the FDA for use as part of a bowel preparation regimen. Details of the bowel preparation regimens associated with each purgative are provided in Table 7.

Polyethylene glycol-electrolyte lavage solution

PEG-ELS is available in high-volume (4 L) or low-volume (≤2 L) doses or sometimes is used as an adjunct with other bowel cleansing agents in various doses (e.g. 1 L). PEG-ELS is an iso-osmolar and isotonic agent making it relatively safe for patients with significant comorbidities. Since the last version of the USMSTF recommendations, a meta-analysis of 6 trials demonstrated that high-volume, split-dose PEG-ELS (>3 L total volume) was superior to lower volume, split-dose (<3 L total volume) PEG-ELS about quality of bowel preparation (OR 1.89; 95% CI 1.01–3.46) (77). Regarding willingness to repeat the regimen, high-volume split-dose PEG-ELS was rated significantly lower than lower volume, split-dose PEG-ELS in 3 trials (OR 0.20; 95% CI 0.09–0.45). The results demonstrate that the quality of bowel preparation was marginally better with higher volume PEG-ELS, but the tolerance was significantly greater with lower volume PEG-ELS. These data indicate that low-volume PEG (<4 L) is preferred by patients compared with high-volume PEG because of improved tolerability. Physicians considering only bowel preparation adequacy may still prefer high-volume PEG-based preparations. Since this meta-analysis, as highlighted above, other 2 L PEG-based regimens have demonstrated similar quality of bowel preparation compared with 4 L regimens with better tolerability. This purgative is approved by the FDA for use as a bowel preparation regimen.

PEG-ELS (2 L) + ascorbate

Two liter PEG-ELS + ascorbate, an osmotically active purgative, is a low-volume bowel preparation. One meta-analysis of 11 studies showed a noninferior efficacy for bowel preparation quality but greater compliance with 2 L PEG-ELS + ascorbate compared with 4 L PEG-ELS (78). Ascorbate is contraindicated in patients with phenylketonuria or glucose-6-phosphate dehydrogenase deficiency (79,80). In addition, this purgative should not be used in patients with reduced creatinine clearance (<30 mL/min) or in those with congestive heart failure. Since this purgative is hypertonic, hydration with additional water is recommended (79). Two liter PEG-ELS + ascorbate is approved by the FDA for use as a bowel preparation regimen.

PEG-ELS (1 L) + ascorbate

One liter PEG-ELS + ascorbate is an osmotically active purgative which uses an ultra-low-volume PEG solution. One randomized

Table 7. Commonly used bowel preparation regimens

Bowel preparation regimen	Active compounds	FDA-approved	Mechanism of action	Tonicity	Volume to be consumed	Standard regimen approach	Side effects	Contraindications
High-volume FDA-approved regimens								
Polyethylene glycol electrolyte solution (PEG-ELS) (GoLYTELY CoLyte)	PEG-3350, sodium sulfate, sodium bicarbonate, sodium chloride, potassium chloride	Yes	Poorly absorbed polymer (large volume)	Isotonic	4 L of purgative	2 L night before and same dose on examination day	Nausea, bloating/ abdominal cramps/anal irritation	Bowel obstruction, ileus, allergy/hypersensitivity to ingredients
Sulfate-free PEG-ELS (NuLytely TriLyte)	PEG-3350, sodium sulfate, sodium bicarbonate, sodium chloride, potassium chloride	Yes	Poorly absorbed polymer (large volume)	Isotonic	4 L of purgative	2 L night before and same dose on examination day	Nausea, bloating/ abdominal cramps/anal irritation	Bowel obstruction, ileus, allergy/hypersensitivity to ingredients
Low-volume FDA-approved agents								
2 L PEG-ELS plus ascorbate (MoviPrep)	PEG-3350, sodium sulfate, sodium chloride, potassium chloride, ascorbic acid	Yes	Poorly absorbed polymer (low volume)/osmotic action of ascorbate	Isotonic	2 L of purgative	16 oz clear liquids per 500 cc night before and same dose on examination day	Nausea, bloating/ abdominal cramps/anal irritation, hemolysis in patients with glucose-6-phosphate dehydrogenase	Bowel obstruction, ileus, allergy/hypersensitivity to ingredients
1 L PEG plus ascorbate (PLENVU)	PEG-3350, sodium sulfate anhydrous, sodium ascorbate, ascorbic acid	Yes	Poorly absorbed polymer (low volume)/osmotic properties of ascorbate	Isotonic	1 L	16 oz clear liquids per 500 cc night before and same dose on examination day	Nausea, bloating/ abdominal cramps/anal irritation	Bowel obstruction, ileus, allergy/hypersensitivity to ingredients
Oral sodium sulfate (tablets: SUTAB Liquid: SUPREP)	Sodium sulfate, potassium sulfate, magnesium sulfate (and tabs which have potassium chloride instead of sulfate)	Yes	Osmotic agent	Hypertonic	12 oz of purgative and 2.5 L H_2O Or 24 tablets and 2 L H_2O	6 oz or 12 tablets night before and same dose on day of examination	Nausea, bloating/ abdominal cramps/anal irritation, vomiting	Bowel obstruction, ileus, allergy/hypersensitivity to ingredients
Sodium picosulfate, magnesium oxide, anhydrous citric acid (CLENPIQ)	Sodium picosulfate, magnesium oxide, anhydrous citric acid	Yes	Osmotic agent	Hypertonic	10 oz of purgative and 2 L H_2O	5 oz and 1 L night before and same dose day of examination	Nausea, bloating/ abdominal cramps/anal irritation, vomiting	Chronic or acute kidney disease, bowel obstruction, ileus, allergy/hypersensitivity to ingredients

Table 7. (*continued*)

Bowel preparation regimen	Active compounds	FDA-approved	Mechanism of action	Tonicity	Volume to be consumed	Standard regimen approach	Side effects	Contraindications
Sodium phosphate tablets (OsmoPrep)	Sodium phosphate	Yes	Osmotic agent	Hypertonic	32 tablets and 2 L H_2O	16 tablets and 1 L night before and same dose on examination day	Nausea, bloating/ abdominal cramps/anal irritation, vomiting	Chronic or acute kidney disease, bowel obstruction, ileus, allergy/hypersensitivity to ingredients
Non-FDA-approved regimens								
PEG-3350/sports drink (MiraLAX/ Gatorade)	PEG-3350/sports drink	No	Poorly absorbed polymer (low volume)	Hypotonic without sports drink	238 g PEG-3350 in 2 L sports drink	1 L night before and same dose on examination day	Nausea, bloating/ abdominal cramps/anal irritation, hypocalcemia, hyponatremia, hypokalemia	Bowel obstruction, ileus, allergy/hypersensitivity to ingredients, chronic or acute kidney disease, seizures
Magnesium citrate (Generic)	Magnesium citrate	No	Osmotic agent	Hypertonic	2 bottles (12 oz of purgative each) plus 2 L H_2O	Split-dose, 1 bottle night before and 1 bottle day of examination each with 1 L H_2O	Nausea, bloating/ abdominal cramps/anal irritation, hypermagnesemia	Chronic or acute kidney disease
Bisacodyl (Generic)	Bisacodyl	No		N/A	4 tablets (20 mg) plus 2–3 L H_2O		Nausea, bloating/ abdominal cramps/anal irritation, ischemic colitis	

FDA, Food and Drug Administration; PEG-ELS, polyethylene glycol-electrolyte lavage solution.

controlled trial compared a regimen consisting of 1 L PEG + ascorbate (NER1006L; PEG-3350, sodium sulfate anhydrous, sodium ascorbate, and ascorbic acid) both as a split-dose (n = 283) and as a same-day (n = 283) dose with split-dose 2 L PEG-ELS + ascorbate (n = 283) (81). Both 1 L regimens were associated with reasonable rates of adequate bowel preparation using the Harefield Cleansing Scale (split-dose: 92.0% and same-day: 89.1%) and were noninferior to the 2 L PEG-ELS group (87.5%). There was a greater proximal colon polyp detection rate in the 1 L split-dose group. Higher rates of vomiting were observed among individuals receiving the same-day 1 L regimen compared with those receiving the split-dose 2 L PEG-ELS + ascorbate regimen. There were no differences for other outcomes such as adherence, patient tolerance, and safety (81). A meta-analysis of 9 studies demonstrated that using 1 L PEG-ELS + ascorbate was associated with higher rates of adequate bowel preparation quality for the entire colon (OR = 1.50; 95% CI = 1.25–1.81) and the right colon (OR = 1.67; 95% CI = 1.21–2.31) when compared with other preparations such as 2 L PEG-ELS + ascorbate, 4 L PEG-ELS, and a regimen using both sodium picosulfate + magnesium citrate (82). Despite differences in the quality of bowel preparation observed, the ADR was similar across bowel preparations (OR = 0.99; 95% CI = 0.84–1.18). One liter PEG-ELS + ascorbate is approved by the FDA for use as a bowel preparation regimen.

PEG-ELS (2 L) + citrate

Two liter PEG-ELS + citrate is a regimen based on the concept that sodium citrate and citric acid are not absorbed in the gastrointestinal lumen and thus can act as osmotic agents. Osmotic agents allow for the use of reduced purgative volume for cleansing and improve the tolerability because of improved taste (83). One study randomized patients to either 4 L PEG-ELS (n = 209) or 2 L PEG + citrate (n = 213; PEG 4000, sodium sulphate, citric acid, sodium citrate, sodium chloride, potassium chloride, and simethicone) and observed that both groups had similar bowel preparation quality, safety profile, and adherence (83). However, patient tolerance and acceptability were greater with 2 L PEG + citrate (83). Specifically, those who received 2 L PEG + citrate were more likely to report no distress during the preparation (2 L PEG + citrate 72.8% vs PEG 4 L 63%, $P = 0.0314$) and willingness-to-repeat the process (93.9% vs 82.2%, $P = 0.0002$). In another study which compared this regimen with 2 L PEG + ascorbate, outcomes were equivalent for quality of bowel preparation, patient adherence to the regimen, safety, and willingness to repeat the regimen (84). 2 L PEG-ELS + citrate is approved by the FDA for use as a bowel preparation regimen.

PEG-3350 (2 L) + bisacodyl

Bisacodyl, which is used as an adjunct in various bowel preparation regimens, acts as a stimulant promoting motility and peristalsis while increasing the water content of the stool. All recent studies comparing various doses of bisacodyl and 4 L PEG-ELS have observed no difference in bowel preparation quality but demonstrated superior tolerability compared with regimens using larger volumes of PEG (85–87). One safety concern with this regimen is that bisacodyl has been associated with rare occurrences of ischemic colitis (88–91). In addition, it is important to mix a sports drink with the PEG-3350 because this bowel purgative is iso-osmotic but not isotonic. This regimen using over-the-counter PEG-3350 (e.g., Miralax), though widely used, is not approved by the FDA for use as a bowel preparation regimen.

Sodium picosulfate + magnesium citrate

Sodium picosulfate + magnesium citrate acts through a combination of mechanisms. While magnesium citrate is an osmotic laxative, picosulfate acts as a stimulant. Picosulfate is a prodrug which is metabolized by gut bacteria to form desacetyl bisacodyl which acts as the stimulant. One meta-analysis of 25 randomized controlled trials observed a trend toward superior quality of bowel preparation with regimens using 1 L, 2 L, and 4 L PEG-ELS compared with sodium picosulfate + magnesium citrate (RR 0.93; 95% CI 0.86–1.01; $P = 0.07$) but no difference in adenoma or polyp detection (92). However, the tolerability was higher for sodium picosulfate + magnesium citrate as evidenced by a higher proportion of patients completing the sodium picosulfate + magnesium citrate regimen and willing to repeat this regimen. A subsequent meta-analysis, which included 13 randomized controlled trials, demonstrated that sodium picosulfate + magnesium citrate was associated with a higher rate of adequate bowel preparation quality compared with PEG, which was used as part of different regimens within each included study (93). However, when restricting the comparison with 4 L PEG-based regimens, sodium picosulfate + magnesium citrate was no longer associated with superior bowel preparation quality. In addition, the analysis observed that sodium picosulfate + magnesium citrate was tolerated better than PEG-ELS. Sodium picosulfate + magnesium citrate performed similarly to sodium phosphate about efficacy and tolerability. While vomiting was observed more often with PEG-ELS, dizziness was observed more often with sodium picosulfate + magnesium citrate (risk ratio = 0.62; 95% CI: 0.38, 1.00). These data suggest that sodium picosulfate + magnesium citrate has a superior efficacy to PEG-ELS for volumes <4 L.

Sodium picosulfate + magnesium citrate as a bowel preparation regimen is contraindicated in patients with congestive heart failure, hypermagnesemia, and severe renal impairment because of its hyperosmolar nature. In patients with normal baseline renal function, serum magnesium imbalances are transient and of little clinical concern (92,94). Another potential electrolyte imbalance, hyponatremia, has been observed in patients 65 years or older (95). Sodium picosulfate was associated with a higher risk of hospitalization with hyponatremia (absolute risk increase: 0.05%, 95% CI: 0.04%–0.06%; RR: 2.4, 95% CI: 1.5–3.9), but it was not linked with a need for urgent CT of the head (RR: 1.1, 95% CI: 0.7–1.4) or death (RR: 0.9, 95% CI: 0.7–1.3). Sodium picosulfate + magnesium citrate is approved by the FDA for use as a bowel preparation regimen.

Sodium picosulfate + magnesium oxide + citrate

This low-volume preparation includes the osmotically active agents magnesium oxide and citrate as adjuncts. Recent trials comparing split-dose sodium picosulfate + magnesium oxide + citrate with split-dose 2 L PEG-ELS + ascorbate observed similar rates of adequate bowel preparation quality (96–98). An important concern when selecting sodium picosulfate + magnesium oxide + citrate is the potential for fluid and electrolyte shifts. One study performed a post hoc analysis on data from a randomized trial and observed that tolerability, safety, and efficacy were similar for all patients, regardless of the presence of diabetes or renal insufficiency (99). Sodium picosulfate + magnesium oxide + citrate is approved by the FDA for use as a bowel preparation regimen.

Oral sulfate solution

A meta-analysis which included 7 studies (2,049 participants) observed no difference between oral sulfate solution and low-volume PEG-ELS + ascorbate about quality of bowel preparation (100). However, use of oral sulfate solution was associated with an increased risk of nausea (RR 1.35 [1.03–1.77]; $P = 0.03$) and more than twice the risk of vomiting (RR 2.30 [1.63–2.23]; $P < 0.05$). Another meta-analysis demonstrated an increase in ADR for patients using oral sulfate solution compared with 2 L PEG-ELS regimens (OR = 1.17; 95% CI 1.03–1.33) (101). Oral sulfate solution is approved by the FDA for use as a bowel preparation regimen.

TOPIC: DOSING AND TIMING OF BOWEL PREPARATION REGIMENS

Question: Should a split-dose bowel preparation be used for both high-volume and low-volume bowel preparation regimens?

Recommendation

- We recommend a split-dose administration of bowel preparation purgatives for all patients, regardless of high-volume or low-volume preparation (strong recommendation, high-quality evidence).

In the last version of the USMSTF recommendations, the use of a split-dose bowel preparation regimen was strongly recommended (strong recommendation and high-quality evidence) for elective colonoscopy (66). The rationale for a split-dose regimen is that the first dose cleans out solid stool and the second dose clears chyme that enters the large bowel overnight after the first dose has been finished (71,79,102,103). Studies that conducted surveys of patients undergoing colonoscopy have observed that a majority of patients were willing to have split-dose preparation for their examinations (104,105). One study observed that compliance with split preparation was directly associated with bowel preparation quality (105).

While high-quality evidence to support the use of split-dose regimens existed at the time of our prior recommendations (106–109), an important outcome subsequently confirmed was an increased ADR among individuals who use a split-dose bowel preparation regimen (79,110,111). One meta-analysis observed that split-dose regimens, whether 3 L or 4 L PEG-based, sodium phosphate-based, or picosulfate-based were all associated with a better quality of bowel preparation than day prior bowel preparation regimens (77). In addition, a higher percentage of patients were willing to repeat split-dose vs same-day regimens. There have been other randomized controlled trials which support the use of split-dose preparation when using various purgatives, such as picosulfate + magnesium citrate and PEG, demonstrating improvement in bowel preparation quality with split dosing as compared with day before dosing (112–114). A randomized controlled trial examining split dose vs day prior dosing of 2 L PEG + ascorbate showed that split dosing was associated with higher adenoma detection per colonoscopy (53.0% vs 40.9%; 95% CI 1.03–1.46); higher advanced adenoma detection per colonoscopy (26.4% vs 20.0%; 95% CI 1.06–1.73), and a greater number of both adenomas and advanced adenomas per patient (1.15 vs 0.8; $P < 0.001$; 0.36 vs 0.22; $P < 0.001$, respectively) (115). There is evidence that split dosing may also increase the rate of detection of sessile serrated lesions (116).

Important factors to consider when using split dose are potential barriers to implementing these regimens. A multicenter nonrandomized prospective study surveyed 1,447 patients having a colonoscopy between 8 AM and 2 PM (117). The patients were offered a choice of split dose and day prior regimens with both written instructions and verbal instructions provided by secretarial staff. The results showed that colonoscopies before 10 AM, travel of >1 hour, lower educational level, and female sex were inversely associated with compliance with split-dose preparations. However, the split-dose regimen was not associated with significant disruption in travel or fecal incontinence en route to the endoscopy unit and was an independent predictor of adequate colon preparation and polyp detection after adjustment for other factors. One trial among 341 patients undergoing ambulatory colonoscopy randomized subjects to either single-dose day prior or split-dose 2 L PEG-ELS + ascorbate (116). The authors found that split dosing significantly decreased the duration and intensity of bowel movements, decreased nocturnal waking for bowel movements, and did not increase the need to stop en route to the endoscopy unit for bathroom use. These patient-friendly outcomes were accompanied by a greater frequency of excellent or good bowel preparations (95.6 vs 85.5%; $P < 0.001$). A prospective study including 641 subjects found that 17% of individuals traveling more than 1 hour to their colonoscopy had to stop for bathroom use for a bowel movement, but this was not different among 6 different bowel preparation regimens including a mix of high-volume and low-volume split-dose PEG-based bowel preparation regimens (118). Only 0.6% of individuals reported an episode of incontinence during travel.

While patient-specific considerations (e.g., those with incontinence traveling long distances for their colonoscopy or those traveling by public transportation who may not have bathroom access) are important and may require modification of the preparation regimen, the strength of evidence supporting split-dose regimens makes this the preferred approach for most individuals attending colonoscopy.

Question: Can a same-day bowel preparation regimen be used in lieu of split-dose preparation regimen?

Recommendations

- We recommend that a same-day regimen is an acceptable alternative to split dosing for individuals undergoing an afternoon colonoscopy (strong recommendation, high-quality evidence).
- We suggest that a same-day regimen is an inferior alternative to split dosing for individuals undergoing a morning colonoscopy (weak recommendation, low-quality evidence).

In the last version of the USMSTF recommendations, a same-day bowel preparation regimen was given a strong recommendation with high-quality evidence as an acceptable alternative to a split-dose regimen, especially for afternoon colonoscopies (66). Since those recommendations were published, several studies, mostly meta-analyses, support the recommendation (Table 8). Two studies examined same-day dosing compared with split dosing of purgatives for afternoon colonoscopies and observed similar quality of bowel preparation, tolerability, and willingness of patients to repeat the regimen (119,120). Not surprisingly, one study showed better sleep quality with same-day regimens (119). A recent meta-analysis demonstrated similar bowel preparation

Table 8. A comparison of split-dose vs same-day bowel preparation regimens

Outcome	Split-dose subjects (n)	Same-day subjects (n)	Measurement of effect comparing same-day with split-dose (95% confidence interval)	Reference
Adequate bowel preparation quality				
All subjects	984	952	Pooled relative risk: 0.95 (0.90–1.00)	Avalos (119)
	1,036	926	Adequacy rate: 79.4% (same-day) vs 81.7% (split-dose) Pooled odds ratio: 0.92 (0.62–1.36)	Cheng (120)
	717	667	Adequacy rate: 85.3% (same-day) vs 86.3% (split-dose) Pooled weighted rate difference: 2% (−6% to 1%)	Bucci (121)
AM procedure	193	202	Pooled relative risk: 0.95 (0.90–1.00)	Avalos (119)
PM procedure	213	222	Pooled relative risk: 0.87 (0.70–1.07)	Avalos (119)
Adenoma detection rate	598	600	Pooled relative risk: 0.97 (0.79–1.20)	Avalos (119)
	681	688	Adenoma detection rate: 26.7% (same-day) vs 29.4% (split-dose) Odds ratio: 0.87 (0.67–1.13)	Cheng (120)
Tolerance/compliance	798	806	Pooled relative risk: 1.00 (0.96–1.04)	Avalos (119)
Willingness to repeat	436	437	Pooled relative risk: 1.17 (0.95–1.44)	Avalos (119)
	1,251[a]		Willingness to repeat: 75.1% (same-day) vs 72.3% (split-dose) Odds ratio: 1.08 (0.45–2.61)	Cheng (120)
Sleep disturbance	546	547	Pooled relative risk: 0.56 (0.31–1.01)	Avalos (119)
	1,489[a]		Sleep disturbance: 22.3% (same-day) vs 37.4% (split-dose) Odds ratio: 0.44 (0.24–0.82)	Cheng (120)

[a]Number in split-dose vs same-day arms was not provided.

quality for same-day and split dosing but did not specifically examine the timing of the examination, including the impact on morning colonoscopies (121). This study demonstrated better sleep quality but more side effects, such as nausea, in the same-day group (121). A recent randomized controlled study of 1,750 patients undergoing colonoscopy after 10 AM compared 2 L PEG on the day of the colonoscopy (plus 15 mg bisacodyl the day prior) with split-dose 2 L PEG (plus 15 mg bisacodyl the day prior) and split-dose 4 L PEG (122). No difference in quality of bowel preparation was observed. Therefore, our recommendation remains strong that same-day dosing is an acceptable alternative for patients with an afternoon colonoscopy.

The use of same-day dosing for morning colonoscopies may be an option for patients, but the available data are limited. A few randomized controlled trials have compared same-day dosing to split-dosing regimens for morning examinations. One randomized trial of 200 patients compared split dosing with same-day dosing and observed better bowel preparation quality with split dosing using the Ottawa Bowel Preparation Score (mean 5.52; SD ± 1.23 vs 6.02; SD ± 1.34; $P = 0.017$), although this may not be a clinically meaningful difference (123). The purgative used was 1 packet of PEG dissolved in 2 L of water (concentration not specified) given as a split-dose (1 L between 6 PM and 7 PM the evening prior and the other half between 6 AM and 7 AM on the morning of the procedure) or as a same-day dose (2 L consumed between 5 AM and 7 AM the morning of the procedure). There was no difference in compliance or tolerability of the 2 regimens, and ADR was not reported. Another study randomized 120 hospitalized patients to receive 4 L of PEG either on the morning of colonoscopy or as a split dose (124). The split-dose regimen instructed patients to consume 2 L of PEG (Golytely) between 7 PM and 9 PM the day before colonoscopy and the remaining half between 7 AM and 9 AM the day of colonoscopy. The same-day regimen instructed patients to consume all 4 L of PEG between 5 AM and 9 AM on the day of colonoscopy. Bowel preparation quality was not significantly different between the 2 arms as measured by the Ottawa Bowel Preparation score (split-dose arm: 7.38; SD ±3.65 vs morning-only regimen 7.15; SD ±3.58; $P = 0.75$). There were no significant differences between the 2 arms in symptoms such as nausea or pain, but the subjects in the split-dose arm reported a greater willingness to repeat the same regimen (88.5% vs 70.6%; $P = 0.02$). ADR was not reported. Another study randomized 295 patients to 2 L same day or 2 L split dose of PEG-ELS and observed a statistically significant, but not clinically significant, improvement in BBPS score with split dosing (median BBPS 6; interquartile range [IQR] 6–8 vs 6; IQR 6–7; $P = 0.038$) (125). The group receiving 2 L PEG as a same-day regimen ingested the purgative between 5 AM and 6 AM the day of colonoscopy and the split-dose group finished 1 L of PEG between 8 PM and 8:30 PM the night before and the other 1 L between 5:30 AM and 6 AM the day of the examination. Both groups of patients were also administered 10 mg of bisacodyl on each of the 2 nights

before colonoscopy. Both the total number of adenomas detected and preparation tolerability were better with the split-dose regimen.

Taken together, the current evidence comparing split-dose preparations vs same-day preparations for morning procedures generally favors the split-dose approach. Patients undergoing later day colonoscopy may consider a same-day approach as an alternative.

Question: Is there an optimal timing for starting and completing the bowel purgative?

Recommendation

- For individuals using a split-dose regimen for colonoscopy preparation, we recommend the consumption of the second portion begin 4–6 hours before the time of colonoscopy and be completed at least 2 hours before the procedure start (strong recommendation, moderate-quality evidence).

The length of time between ingestion of the final dose of a bowel purgative and colonoscope insertion correlates inversely with the quality of bowel preparation (102,126–128). In one study of non-split-dose, day prior preparations, every additional hour between the last purgative ingestion and the start of colonoscopy was associated with a 10% decrease in the likelihood of having a good or excellent bowel preparation (127). In another study of same-day morning preparations, patients who finished their PEG-based purgative within 4 hours of the start of colonoscopy had better bowel preparation quality than those finishing the purgative more than 4 hours before colonoscope insertion ($P = 0.02$) (126). A systemic review and meta-analysis of 29 randomized controlled trials comparing split dose with day prior regimens found that as the time between purgative completion and colonoscopy increased, the superiority of split dose over non-split-dose regimens decreased (128). The improvement in preparation quality of the split-dose regimen was maintained within 3 hours from the end of the purgative, progressively decreased after 4–5 hours, and was no longer present after 5 hours. The authors highlighted that the meta-analysis included a variety of regimens for bowel preparation, making the timing more relevant than the actual purgative.

The 2023 American Society of Anesthesiologists (ASA) updated practice guidelines for preoperative fasting for healthy patients undergoing elective procedures recommends that patients may consume clear liquids, including up to 400 mL of clear liquids containing simple or complex carbohydrates, up to 2 hours before the use of anesthesia or procedural sedation (129). However, not all anesthesiologists consider the purgatives used for bowel preparation to be clear liquids and therefore may prefer longer intervals before initiating sedation (130). Evidence from observational studies of patients undergoing esophagogastroduodenoscopy (EGD) before their colonoscopy has demonstrated no excess gastric volumes when comparing split-dose bowel preparations and day prior preparations (131–133). It should be noted that patients in those studies had completed their split-dose regimens no earlier than 2 hours before their endoscopy, in compliance with ASA guidelines.

For example, in one single-center study, the residual gastric fluid volume was measured among 305 outpatients undergoing both EGD and colonoscopy (131). A split-dose regimen was used by 157 patients, and a day prior regimen was used by 148 patients. Patients using a day prior regimen were permitted the ingestion of clear liquids until 11:30 PM of the day before the procedure, and patients using a split-dose regimen were permitted the ingestion of clear liquids until 7:30 AM on the day of the procedure. Endoscopies occurred between 9:30 AM and 3:00 PM, and the minimum fasting time was 2 hours. The residual gastric fluid volume was significantly lower in the split-dose group of patients (11 mL vs 19 mL; $P < 0.001$). The pH of residual fluid did not vary significantly based on the regimen (pH 2 for both groups).

In the timing for same-day preparations, there are no studies specifically determining the ideal times of ingestion relative to the procedure time. However, it is our opinion that a similar recommendation can be made regardless of whether the patient is ingesting an entire preparation the day of their procedure or just the second half of a split-dose preparation.

It is important to highlight that the ASA guidelines describe "healthy patients" as "those without coexisting diseases or conditions that may increase the risk for aspiration, including esophageal disorders such as significant uncontrolled reflux disease, hiatal hernia, Zenker diverticulum, achalasia, stricture, previous gastric surgery (for example, gastric bypass), gastroparesis, diabetes mellitus, opioid use, gastrointestinal obstruction or acute intraabdominal processes, pregnancy, obesity, and emergency procedures." (129) Clinical judgement is recommended for patients meeting any of the above criteria.

Newer agents such as GLP-1 receptor agonists that delay gastric emptying may also affect the timing of when to cease drinking a bowel preparation purgative. The ASA advises that these agents be stopped for 1–7 days (depending on the agent) before an elective procedure to limit aspiration risk during sedation (134). When the agents have not been stopped, the advisement is to proceed but with the assumption that the stomach is full. The American Gastroenterology Association position is that the decision to continue or withhold these medications should be made on a case-by-case basis (135). Regardless, the approach to individuals using GLP-1 receptor agonists is likely to change as newer information emerges from well-conducted research studies.

Key Concept

Individuals using a same-day bowel preparation regimen should begin drinking the purgative 4–6 hours before the time of colonoscopy and complete the purgative at least 2 hours before the procedure's start.

TOPIC: ADJUNCTS TO HELP WITH BOWEL PREPARATION

Question: Are there adjuncts to the bowel preparation regimen that can improve bowel preparation adequacy?

Recommendations

- We suggest the adjunctive use of oral simethicone for bowel preparation before colonoscopy (weak recommendation, moderate-quality evidence).
- We suggest against the routine use of nonsimethicone adjuncts for bowel preparation before colonoscopy (weak recommendation, low-quality evidence).

Simethicone is a mixture of silicon dioxide and viscoelastic silicon oil consisting of polymers of polydimethylsiloxane with

antifoaming properties due to its ability to lower the surface tension of bubbles (136). In the last version of the USMSTF recommendations, the routine use of adjuncts, including simethicone, for bowel preparation before colonoscopy was not recommended, a weak recommendation based on moderate-quality evidence (66). However, since that publication, evidence specifically supporting the use of oral simethicone has strengthened. A prospective, multicenter, endoscopist-blind trial in which 583 patients were randomized to 2 L PEG or 2 L PEG mixed with 30 mL simethicone (no concentration provided), with assigned regimen administered 6–8 hours before colonoscopy, showed an increased ADR in the simethicone group (21.0% vs 14.3%; $P = 0.04$) (137). The percentage of patients with a BBPS score $\geq$6 was also higher when oral simethicone was added to the regimen (88.3% vs 75.2%; $P < 0.001$).

A meta-analysis which examined data from the aforementioned trial and 5 other studies also found an increase in ADR when simethicone was included in the bowel preparation regimen (27.9% vs 23.3%; $P = 0.02$) (138). However, the included studies varied in regimens, including the type and volume of purgative, and in the dose of simethicone used (with some studies failing to report the concentration). Two additional randomized controlled trials reported a significant decrease in visualized bubbles when simethicone was added to a bowel preparation regimen (139,140). In one of these trials, the addition of 400 mg of simethicone to the final 500 mL of consumed clear liquid during a 2 L PEG + ascorbate regimen significantly improved the percentage of patients with a BBPS score $\geq$6 (99% vs 84%; $P < 0.05$) (139). In the other trial, the addition of 1,200 mg of simethicone to a single-dose 2 L PEG regimen also significantly improved the percentage of patients with a BBPS score $\geq$6 (88.2% vs 76.6%; $P < 0.001$) (140).

A recent meta-analysis which included these studies observed no difference in overall adenoma detection or quality of bowel preparation, but an improvement in adenoma detection for studies in which the baseline examinations had an ADR of <25% (141). Another meta-analysis of 18 randomized controlled trials with 7,187 patients demonstrated improvement in bowel preparation quality, but there was significant heterogeneity in preparation regimen and bowel preparation quality scoring (142). Moreover, the use of simethicone failed to improve ADRs. A more recent meta-analysis of 38 trials with 10,505 patients observed that oral simethicone use, particularly with a dose of 320 mg or higher, was associated with improved bowel preparation quality and fewer bubbles, but no improvement in ADR (143). The addition of simethicone to a PEG-based bowel preparation regimen reduces the intraprocedural use of simethicone from 49% of colonoscopies to 2% of colonoscopies ($P < 0.05$) (144).

About timing of the ingestion of simethicone, one study randomized 440 patients to 200 mg oral simethicone ingested either during the first 1 L dose of a split-dose 2 L PEG regimen or during the second 1 L dose (145,146). The authors found the timing of simethicone did not affect BBPS scores or ADR. Secondary analyses found that the earlier dosing of simethicone was associated with a shorter cecal intubation times (3.80; SD $\pm$ 1.81 minutes vs 4.42; SD $\pm$ 2.03 minutes; $P < 0.001$), fewer bubbles, and higher detection of diminutive right-sided adenomas (145). Another randomized trial of 240 patients observed fewer bubbles in patients who had taken an evening dose of simethicone as compared with morning (147), but another trial with 204 patients observed fewer bubbles when simethicone was ingested on the day of the colonoscopy (148).

Key Concept
Given the lack of data to strongly support the timing of oral simethicone during the bowel preparation process, and limited data supporting a specific dose, the USMSTF recommends that if endoscopists opt to include simethicone in a bowel preparation regimen, a dose of at least 320 mg be used. The impact of simethicone on meaningful clinical outcomes and its efficacy when coupled with various bowel preparation regimens requires further study. Out of pocket cost to the patient should also be considered when adding simethicone to a regimen.

Beyond oral simethicone, there have been many medications, foods, and dietary supplements studied as potential adjuncts for bowel preparation. One meta-analysis included 77 studies which examined many of the adjuncts which are discussed in various sections throughout this document including ascorbate, simethicone, prokinetics, and food products (149). The heterogeneity was very high ($I^2 = 85\%$) and likely demonstrates the variability in adjuncts for bowel preparation.

In food, chewing gum has been studied in one randomized controlled trial and was observed to improve patient satisfaction with the bowel preparation regimen (97.4% vs 90.7% among those assigned to not chew gum, $P = 0.015$) but had no impact of quality of bowel preparation (150). Gum chewing was performed after completion of a 2 L PEG regimen. A meta-analysis of 6 studies observed that various adjuncts were associated with better palatability, acceptability, willingness to repeat bowel preparation, less frequent reports of bloating, and better quality of bowel preparation (151). The 6 studies included were all small randomized controlled trials which included no more than 150 patients per arm. The interventions were diverse and included drinking orange juice along with PEG (152), using a diet cola instead of water for PEG solution (153), chewing gum every 2 hours (150), simethicone (139), menthol candy drops (154), and citrus peel tablets in between PEG (155). Not surprisingly, the heterogeneity for the quality of bowel preparation was quite high ($I^2 = 81\%$). Thus, the data from these small randomized controlled trials are not sufficient to support any recommendation for an adjunct to improve bowel preparation aside from simethicone. Adjuncts may be reasonable additions to bowel preparation regimens if seeking to improve the patient experience, but data are insufficient to recommend any one specific adjunct for this purpose.

The 2023 ASA practice guidelines for preoperative fasting for healthy patients undergoing elective procedures make a conditional suggestion based on very low-quality evidence to not delay elective procedures requiring general anesthesia, regional anesthesia, or procedural sedation in healthy adults (as defined previously) who are chewing gum (129). This opens the possibility to study the addition of gum chewing as a means of improving the tolerability of bowel preparation purgatives. Patients must remove any gum from their mouths before their procedure.

A cross-sectional study including data from 15 centers and 39,042 patients undergoing screening colonoscopy observed the addition of bisacodyl (dose and timing of bisacodyl administration not defined) greatly improved bowel preparation quality when using $\leq$1 L bowel preparation regimens but not when using larger

volume regimens (156). More than 99% of regimens were split dose, and the ≤1 L volume preparation regimens included 1 L PEG + sodium sulfate + ascorbate, sodium picosulfate + magnesium citrate, or oral sulfate solution. Bisacodyl use was associated with a higher level of patient discomfort.

Lubiprostone, a chloride-2 channel activator, has been studied as a means to improve bowel preparation quality, particularly with the use of ≤2 L bowel preparation regimens (157–161). One trial randomized 442 patients to 24 mcg of lubiprostone or placebo at the start of a same-day 2 L PEG-ELS bowel preparation regimen. The addition of lubiprostone significantly decreased the number of patients deemed to have a poor bowel preparation quality (9.5% vs 16.7%; $P < 0.01$).

Mosapride citrate, a selective 5-hydroxytryptamine-4 receptor agonist, was studied in a randomized trial among 257 patients aged ≥65 undergoing screening or surveillance colonoscopy. All patients received a split-dose 2 L PEG and ascorbate purgative and either no adjunct or a 15 mg dose of mosapride citrate when consuming each of the two 1 L doses of PEG. There was no difference in the rate of adequate bowel preparation as determined by BBPS scores ≥6 (98.4% vs 98.5%; $P = 0.97$) (162).

RECOMMENDATIONS DURING COLONOSCOPY

TOPIC: ASSESSING BOWEL PREPARATION

Question: Should a colonoscopy be cancelled when patients report incomplete adherence to the bowel preparation regimen or offer statements suggesting their bowel preparation may not be adequate (e.g., dark bowel effluent)?

Recommendation

- When patients report incomplete adherence to the bowel preparation regimen or offer statements suggesting their bowel preparation may not be adequate (e.g., dark bowel effluent), we suggest insertion of the colonoscope to the sigmoid colon to confirm inadequacy before aborting the procedure (weak recommendation, low-quality evidence).

Patient-reported assessment of their own bowel preparation adequacy is unreliable (163,164). Prospective studies of outpatients undergoing colonoscopy have shown poor correlation between a patient's perceived bowel cleanliness based on rectal effluent and the endoscopist's determination of adequacy at colonoscopy. In one study of 429 patients, bowel preparation quality at the end of all washing and suctioning was deemed adequate (rating of excellent or good) by the endoscopist among 42% of the 52 patients reporting brown liquid or solid stool just before the colonoscopy (163). Despite the evidence that patient self-report of preparation adequacy is unreliable, 97% of academic medical center GI fellowship program directors responding to a survey (n = 76/78) reported their hospital's endoscopy unit policies allowed for cancellation of colonoscopies during the preprocedure phase based on patient-reported preparation quality (165). Reliance on precolonoscopy preparation predictions ignores the endoscopist's ability to perform cleansing maneuvers to assist in ensuring adequacy of bowel preparation, which may mitigate unnecessary cancellation of procedures, thereby decreasing inconvenience to patients and their escorts, inefficient use of endoscopy resources, and failure of patients to return in a timely manner for a repeat procedure (165).

Given the evidence, when a bowel preparation is presumed to be inadequate based on patient self-report of bowel effluent or nonadherence to dietary modifications and/or consumption of the purgative, colonoscope insertion to the sigmoid colon allows for a more accurate determination whether the procedure should continue and is the recommended approach in such circumstances.

Key Concept

If a colonoscopy is being aborted because of inadequate bowel preparation quality, the endoscopist should photograph the segment(s) of colon that resulted in abortion of the procedure. This will aid in quality assurance efforts in the setting of variability in cancellation rates among an endoscopy unit's endoscopists.

Question: How should bowel cleanliness be assessed and described in the endoscopy report?

Recommendations

- We recommend bowel preparation quality be assessed after all washing and suctioning have been completed, using reliably understood descriptors that communicate the adequacy of the preparation (strong recommendation, moderate-quality evidence).
- We recommend the term "adequate bowel preparation" be used to indicate that standard screening or surveillance intervals can be assigned based on the findings of the colonoscopy (strong recommendation, moderate-quality evidence).

The ACG/ASGE previously recommended documentation of bowel preparation quality in the endoscopy report in at least 98% of cases (166). In the last version of the USMSTF recommendations, bowel preparation adequacy was defined as a degree of cleanliness that allows a recommendation of a screening or surveillance interval appropriate to the findings of the examination (66). It has been suggested that a crucial aspect of any definition of bowel preparation adequacy or any categorical scales used to measure bowel preparation quality is reliability, or the consistent assignment of the scale's scoring by both the same endoscopist and among different endoscopists (167). Validity of a scale refers to the ability of that scale to measure the outcome which it was designed to assess, and this is also important.

There are several scales in use to assess the quality of bowel preparation including the Aronchick Scale, Harefield Preparation Scale (168), Chicago Bowel Preparation Scale (169), Ottawa Bowel Preparation Scale (170), and Boston Bowel Preparation Scale (171). However, there is variability in both their reliability and validity. The New Hampshire Colonoscopy Registry, which uses a simple scale with explicit descriptors based on the terms excellent, good, fair, and poor (similar to the Aronchick Scale), has observed that a "fair" bowel preparation quality is associated with similar ADRs and screening/surveillance interval recommendations compared with an "excellent" or "good" preparation quality (172,173). This highlights the nebulous meaning of "fair" unless it has a standardized definition with clear descriptors as in the New Hampshire Colonoscopy Registry scale. Even if "fair" is defined with clear descriptors, its use in a report should be

accompanied by a statement of bowel preparation adequacy (i.e., whether standard screening or surveillance intervals can be assigned based on the findings of the colonoscopy).

One large systematic review of various bowel preparation scales concluded that the Boston Bowel Preparation Scale was the most reliable and thoroughly validated (174). One prospective study conducted in male veterans observed that patients with BBPS segment scores of 2 or 3 for all colonic segments had an adequate bowel preparation as defined by the ability to detect adenomas larger than 5 mm (175). These data helped to further validate the BBPS and also support a recommendation to consider a BBPS score <6 due to any segment score <2 as inadequate, requiring a repeat colonoscopy as soon as feasible within 12 months.

- When a screening/surveillance colonoscopy is performed, the assessment of bowel preparation quality should be based on all segments of the colon. When faced with a small region of colonic mucosa that cannot be cleared of residual stool, the endoscopist may exercise judgement in determining the adequacy of bowel preparation based on the overall likelihood of missing a clinically meaningful lesion.
- The term "fair", when used to describe bowel preparation quality, should be accompanied by a statement of bowel preparation adequacy (i.e., whether standard screening or surveillance intervals can be assigned based on the findings of the colonoscopy).
- When a nonscreening/surveillance colonoscopy is performed, the bowel preparation may be deemed adequate for the procedure's indication (e.g., diarrhea or hematochezia) even if it is not adequate for screening/surveillance purposes. In these situations, the preparation description should communicate this distinction to ensure appropriate screening or surveillance intervals are followed.

TOPIC: IMPROVING BOWEL PREPARATION QUALITY AFTER COLONOSCOPE INSERTION

Question: Should an irrigation pump be used to improve bowel preparation adequacy during colonoscopy?

Recommendation

- We suggest the routine use of irrigation pumps to assist with bowel preparation during colonoscopy (weak recommendation, very low-quality of evidence).

Despite the well-documented efficacy of bowel purgatives to adequately cleanse the colon in the majority of patients, there remains a frequent need for additional washing of colonic mucosa to clear stool, food debris, mucoadhesive film, and bubbles to maximize visualization. Commercially available irrigation pumps, typically operated by a foot pedal, propel a stream of water through a colonoscope's dedicated water jet channel or through an adapter connected to the colonoscope's suction channel. The use of irrigation pumps supplants the need to use water-filled hand operated syringes for additional preparation. While many endoscopist rely heavily on this technology to improve visualization, there is a paucity of data on the use of these pumps to improve colonoscopy-related endpoints such as bowel preparation, ADR, and procedure time. One retrospective study of 1,037 outpatient colonoscopies compared outcomes before (n = 328) and after (n = 709) the introduction of irrigation pumps in a single endoscopy unit (176). All patients received a 4 L PEG-ELS + 15 mg of bisacodyl bowel preparation regimen the evening before colonoscopy. Compared with historical controls, use of an irrigation pump was associated with a lower rate of inadequate bowel preparation (10% vs 24%; $P < 0.01$) but no significant change in ADR. Procedure times were not reported.

Given the paucity of evidence, our suggestion to use irrigation pumps is conditional. However, efforts to improve the quality of the bowel preparation during a colonoscopy are often needed, and this technology greatly facilitates that aim, especially when compared with the alternative of repeated flushes with a syringe.

Dilute simethicone is often administered directly into the colon during colonoscopy in the form of flushes through the irrigation channel or accessory channel to clear bubbles and improve visualization (136). Unfortunately, simethicone can form crystals in the endoscope's water or instrument channels and make colonoscope cleaning difficult because it is not water soluble (177). This is particularly problematic when the simethicone is added to an irrigation pump's water bottle, causing a sticky residue in the water channel that can be associated with development of a biofilm (136,178). One study used 3 simethicone concentrations (0.5%, 1%, and 3%) and observed that the lowest concentration (0.5%) was associated with the least residue in the accessory channel (178). This concentration was achieved by using 0.5 mL simethicone (20 mg/0.3 mL) in 99.5 mL of water.

Endoscopists should be aware that in response to guidance from the FDA, endoscope manufacturers have recommended against the administration of simethicone into endoscope accessory channels.

Key Concept

The USMSTF recognizes there are occasions when bubbles in the visual field at the time of colonoscopy significantly affect visualization and, by extension, procedural quality. If simethicone is used in those circumstances, we suggest using the lowest possible dilution (for example, 0.5 mL simethicone in 99.5 mL water) and administering only through an instrument channel that is routinely brushed during endoscope reprocessing (79,179–181).

Question: Should salvage maneuvers be performed for patients with inadequate bowel preparation on the day of colonoscopy?

Recommendation

- We suggest the use of same-day salvage maneuvers when feasible for inadequate bowel preparations (weak recommendation, moderate-quality evidence).

Some bowel preparations initially deemed inadequate may be salvaged with additional efforts. One prospective study of 525 patients found that 75% of patients with poor (n = 11) or fair (n = 33) bowel preparation on insertion of the colonoscope could be converted to a good or excellent bowel preparation with concerted efforts at washing and suctioning (182). This is made easier with the use of irrigation pumps (see above) (182). However, in some cases, the endoscopist may deem the preparation too poor for simple washing maneuvers to salvage. In these situations,

instillation of enemas into the right colon may be used to complete the procedure later that day. After instillation of the enema with the patient in the right lateral decubitus position, the colonoscope is withdrawn and the patient is allowed to recover from sedation. After subsequent spontaneous evacuation, the patient can then undergo repeat colonoscopy. Both PEG (500 mL–1,000 mL) and bisacodyl (10 mg) enemas have been shown to achieve adequate bowel preparations; however, success rates range from 53% to 100% (183–185).

Another salvage option includes waking the patient entirely from sedation and continuing with further oral ingestion of purgative with same-day (allowing for 2 hours from the last dose of purgative) or next-day colonoscopy (which is often the more feasible approach). In a randomized trial of patients with inadequate bowel preparation, the oral ingestion of an additional 2 L of PEG after recovering from sedation was superior to 1 L PEG enema in achieving an adequate preparation (82% vs 53%) (185). Obviously, any of these salvage options requires considerable time and space in the endoscopy unit with the need to accommodate a repeat, unexpected colonoscopy and/or open schedule time on the day following the planned procedure. However, when feasible, these options should be considered.

RECOMMENDATIONS POSTCOLONOSCOPY

TOPIC: BOWEL PREPARATION ADEQUACY RATE AS A QUALITY MEASURE

Question: Should bowel preparation adequacy rates be routinely measured at the level of individual endoscopists and the endoscopy unit?

Recommendation

- We recommend routine tracking of the rate of adequate bowel preparations at the level of individual endoscopists and at the level of the endoscopy unit (strong recommendation, moderate-quality evidence).

Bowel preparation adequacy rates reflect more than patient-related factors, such as compliance with diet instructions and quantity of ingested purgative. Many policies and procedures established by an endoscopy unit's leadership also affect these rates. Endoscopy unit-level variables include the quality and understandability of the written and verbal instructions patients are given, the specific purgative(s) prescribed, the use and education of nurses and navigators assisting with the preparation, and the availability of irrigation pumps. This suggests that measuring the rate of adequate bowel preparation at the level of the endoscopy unit may offer insights into potential policy changes needed to improve these rates. Targeted quality improvement projects may use this rate as a primary endpoint, including over several cycles of an iterative improvement effort (21). Sharing of unit-level bowel preparation adequacy rates may allow for the identification of benchmarks and best practices (186). However, case-mix adjustment may be required when comparing benchmarks across different endoscopy units. For example, in the Dutch Gastrointestinal Endoscopy Audit, a national registry of colonoscopy data in the Netherlands, unadjusted bowel preparation adequacy rates ranged between 90% and 99% among 51 endoscopy units (187). After accounting for each unit's case-mix of patient ages, sex, American Society of Anesthesiologist classifications, and colonoscopy indications, several units' performance changed significantly relative to the benchmark (187).

While objective assessments of bowel preparation adequacy may become feasible using artificial intelligence platforms (188,189), currently an individual endoscopist must render a subjective determination that mucosal visualization is sufficiently adequate for the procedure's indication. This introduces another source of variability because endoscopists may have different thresholds for considering a bowel preparation adequate and expend different degrees of effort in intraprocedural washing. In one retrospective study of ambulatory colonoscopies performed by 11 endoscopists at a university medical center, the frequency of "poor/unsatisfactory" or "fair" bowel preparations ranged from 3% to 40% with a mean value of 22% (190).

When unit-level and endoscopist-level bowel preparation adequacy rates are calculated, efforts should be taken to include all patients whose colonoscopy is cancelled for any bowel preparation-related reason. This complicates the calculation but more accurately represents the magnitude of shortcomings in the preparation process and better aids in identifying remediable factors.

Key concept

Individuals whose colonoscopies are cancelled for presumed inadequate preparation (i.e., before colonoscope insertion) should be included when calculating both endoscopy unit and endoscopist-level bowel preparation adequacy rates.

Question: Is there a standard minimum bowel preparation adequacy rate that should be achieved?

Recommendation

- We recommend an endoscopy unit-level and individual endoscopist-level bowel preparation adequacy rate of $\geq$ 90% (strong recommendation, moderate-quality evidence).

The ASGE/ACG recommends bowel preparation adequacy as a priority quality indicator for colonoscopy, with a performance target of 90% adequacy (191). One report, appearing in abstract form, from the GIQuIC consortium, a data registry of endoscopy and colonoscopy outcomes jointly sponsored by the ACG and the ASGE, analyzed 3,773,519 screening and surveillance colonoscopies between 2010 and 2017 (192). Among those examinations, inadequate bowel preparation was reported in 5.3%. While the definition of bowel preparation adequacy is not a standardized defined endpoint across the over 700 endoscopy practices participating GIQuIC, this value, coupled with the data from the Dutch Gastrointestinal Endoscopy Audit (see above), suggests that an endoscopy unit-level and individual endoscopist-level bowel preparation adequacy rate of at least 90% is a reasonable benchmark.

Key Concept

When significant variability in bowel preparation adequacy is seen between endoscopists in a practice with shared preparation processes, it suggests individual-level variation in either intraprocedural efforts at augmenting bowel preparation quality or in their assessment of adequacy.

TOPIC: MANAGEMENT OF THE PATIENT WITH AN INADEQUATE AND NONSALVAGEABLE BOWEL PREPARATION

Question: How should inadequate bowel preparations be managed when not salvageable?

Recommendations

- When the bowel preparation is deemed inadequate to allow assigning standard screening or surveillance intervals, we recommend completing a colonoscopy within 12 months for screening or surveillance colonoscopies (strong recommendation, moderate-quality evidence).
- In the setting of a previous inadequate bowel preparation, we recommend modifications to bowel preparation instructions to include 1 or more of the following: increased attention to communicating the bowel preparation regimen instructions; increased use of patient navigation; restricting the intake of vegetables and legumes for 2 to 3 days before colonoscopy; allowing only clear liquids on the day before colonoscopy; the addition of promotility agents; treatment of underlying constipation; temporary cessation of anticholinergic, opioid, or other constipating medications; and/or the use of high-volume bowel preparation regimens (strong recommendation, moderate-quality evidence).

The ability to detect adenomas and advanced adenomas is significantly hampered by inadequate bowel preparation. A systematic review and meta-analysis of 11 studies with more than 55,000 colonoscopies examined that the impact bowel preparation quality had on ADR (193). While there were methodological differences among the studies regarding bowel preparation scoring, the study demonstrated a 5% absolute lower ADR and a 1%–2% absolute lower advanced ADR in the setting of inadequate preparations compared with adequate or intermediate (defined as some semisolid stool that could be suctioned or washed away but >90% of mucosal surface seen) preparations. Summary ADRs were not reported, but the OR for detecting at least 1 adenoma comparing high-quality bowel preparation adequacy with low-quality bowel preparation adequacy was 1.41 (95% CI 1.21–1.64) (193). Other studies (see below) have found adenoma and advanced adenoma miss rates in the 15%–40% range, depending on the clinical indication for colonoscopy (194,195). The lower efficacy of colonoscopy as a cancer-prevention tool when the bowel preparation is not adequate makes it logical to repeat the procedure within a limited timeframe.

Despite this, there is significant variation among endoscopists in the recommendations for when to repeat a colonoscopy after an inadequate bowel preparation (196,197). Among 260,314 screening or surveillance colonoscopies with inadequate bowel preparation in the GIQuIC registry, only 32% were accompanied by a recommendation to repeat the procedure within a year (196). Patients with advanced adenomas or serrated polyps were more likely to be instructed to repeat the procedure within the year (52%) as were those in whom the endoscopist failed to reach the cecum (15% failure to reach cecum; 61% recommendation to repeat within a year).

In one single-center study of 3,047 patients with an inadequate bowel preparation (defined as fair or poor), repeat colonoscopy was performed within 3 years for only 505 (17%) patients (195). Given that these were patients with an inadequate preparation, it may not be surprising that only 216 had an adequate bowel preparation at their repeat procedure. Nonetheless, among those patients, 83 previously unseen adenomas were found, yielding an adenoma miss rate of 42% (95% CI 35–49). The advanced adenoma miss rate was 27% (95% CI 17–41). For colonoscopies repeated within 1 year, the adenoma and advanced adenoma miss rates were 35% and 36%, respectively. While no cancers were missed in this study, suboptimal bowel preparation therefore substantially decreases colonoscopy effectiveness and indicates the need for an early follow-up examination (195).

A single-center study from Spain reported the outcomes from 248 subjects who had a positive screening fecal immunochemical testing but "suboptimal" bowel preparation at subsequent colonoscopy (194). Suboptimal bowel preparation was defined as a BBPS segment score of 1 in at least 1 segment, and patients with a completely unprepared bowel preparation (BBPS segment score of 0 in at least 1 segment) were excluded from analysis. The mean period between the index colonoscopy and the repeat colonoscopy was 352 days. The primary finding was that subjects with suboptimal preparation had a large number of lesions found during repeat colonoscopy, with an ADR and advanced ADR of 39% and 15%, respectively.

Key Concept

When the bowel preparation is deemed inadequate to allow assigning standard screening or surveillance intervals, and the indication is for alarm symptoms (e.g., GI blood loss) or a positive nonendoscopic colorectal cancer screening test (e.g., fecal immunochemical test), a colonoscopy with adequate bowel preparation should occur as soon as possible. The timing of the repeat colonoscopy should consider the date of onset of symptoms or the date when a nonendoscopic screening test was found to be positive.

Relatively small, single-center studies have also shown that patients are more likely to attend next-day colonoscopies than non-next-day colonoscopies when repeating the procedure because of inadequate bowel preparation, and that loss to follow-up is not uncommon (197,198). Previous US-based and European-based guidelines have recommended repeating the colonoscopy within 1 year after a screening or surveillance procedure with inadequate bowel preparation (66,79).

As previously noted (195), patients who return for a repeat colonoscopy because of inadequate bowel preparation have a high likelihood of having a second inadequate bowel preparation. To mitigate this risk, modifications to a standard bowel preparation have been studied. In one single-centered, blind, randomized controlled trial, 256 subjects with previous inadequate bowel preparation (BBPS score $\leq$5) were randomized to a 4 L split-dose PEG regimen or a 2 L split-dose PEG + ascorbic acid regimen for their repeat colonoscopy (199). All individuals underwent a 3-day low-residue diet and received 10 mg of bisacodyl on the day before colonoscopy. Of note, all colonoscopies were performed during a morning endoscopy session. In an intention-to-treat analysis, patients randomized to 4 L PEG had a greater percentage

of adequate bowel preparation (BBPS score $\geq$6) than those randomized to the lower-volume preparation (81% vs 67%; OR 2.07; 95% CI 1.16–3.69).

In a multicenter, blind, randomized controlled trial, subjects who had previous inadequate bowel preparation (defined as inability to detect polyps <5 mm and assignment of a shorter interval than recommended by guidelines) were randomized to a 4 L split-dose PEG regimen or a 6 L split-dose PEG regimen (4 L/2 L) (200). With both regimens, subjects also ingested 15 mg bisacodyl early in the afternoon the day before colonoscopy. All subjects were assigned a low-fiber diet 3 and 2 days before colonoscopy and a clear-liquid diet the day before colonoscopy. Among 196 subjects included in an intention-to-treat analysis, subjects randomized to the 4 L regimen had a similar rate of bowel preparation adequacy (defined as BBPS score $\geq$6 with all segment scores $\geq$2) as subjects randomized to the 6 L regimen (91% vs 88%; $P = 0.44$). There were likewise no differences in ADR. However, those randomized to the 4 L regimen were more willing to repeat the bowel preparation (92% vs 66%; $P < 0.001$).

Key Concept

If the descending colon, sigmoid colon, and rectum are well-visualized during an average risk screening colonoscopy with an otherwise inadequate bowel preparation (e.g., ascending or transverse colon bowel preparation quality is deemed inadequate), it is reasonable to revisit screening options with the patient and their referring practitioner. If the individual opts to consider their limited colonoscopy as a flexible sigmoidoscopy and prefers to not repeat the colonoscopy, they should be screened again by sigmoidoscopy or colonoscopy in 5 years, or with the use of nonendoscopic screening tests recommended by the USMSTF (201) and the US Preventive Services Task Force (202).

When a bowel preparation is inadequate for colorectal cancer screening in an average risk person, it may be reasonable to offer acceptable alternative methods of screening, including flexible sigmoidoscopy, FIT, and stool-based DNA testing (202). In a survey of more than 1,000 randomly selected, diverse US adults aged 45–75 years at average risk for colorectal cancer, 59% preferred a stool-based test (FIT or stool-based DNA testing) as the salvage method of screening compared with repeating a colonoscopy when presented with the theoretical scenario of having an inadequate bowel preparation at screening colonoscopy (203). Even among those who had actually undergone at least 1 colonoscopy during their lifetime (n = 486), this preference for stool-based testing was 51%. This suggests that average-risk patients with inadequate bowel preparation may warrant a discussion of alternative screening options other than relying on a repeated attempt at colonoscopy. It is important to highlight that finding adenomas during the index colonoscopy would exclude someone from being average-risk, and therefore, repeat colonoscopy to exclude synchronous lesions is recommended.

TOPIC: BOWEL PREPARATION REGIMEN FOR INDIVIDUALS AT HIGH RISK FOR INADEQUATE BOWEL PREPARATION

Question: What bowel preparation regimen should be used for the individual at high risk for inadequate bowel preparation?

Recommendations

- We recommend individuals at high risk for inadequate bowel preparation quality be managed like individuals with a prior inadequate bowel preparation, with modifications to their bowel preparation regimen as previously described (strong recommendation, moderate-quality evidence).
- We suggest the following bowel preparation regimen for individuals at high risk for inadequate bowel preparation quality: split-dose 4 L PEG-ELS + 15 mg bisacodyl the afternoon before the colonoscopy, and a low-residue diet 3 and 2 days before colonoscopy, changing to clear-liquid diet the day before colonoscopy (weak recommendation, low-quality evidence).

In the last version of the USMSTF recommendations, we made a weak recommendation based on low-quality evidence to consider using additional bowel purgatives for individuals with risk factors for inadequate bowel preparation quality (66). Patient-related risk factors for inadequate bowel preparation quality are presented in Table 4 and may have an additive effect. For example, in one study of 1,588 ambulatory colonoscopies, the risk of inadequate bowel preparation increased linearly with the number of risk factors present, plateauing at 98% likelihood once 7 risk factors were present (6).

Modified bowel preparations may therefore be an option for patients identified as being at risk for inadequate bowel preparation quality during the scheduling process. Predictive models based on known risk factors have been published but yield modest positive predictive values ranging from 29% to 41% (8,204–206). Use of predictive models has not yet been proven to improve bowel preparation quality, and an efficient process to flag these patients during scheduling has not been demonstrated. It is possible that artificial intelligence-based algorithms may expedite the identification of patients at risk for inadequate bowel preparation. One potential solution may be artificial intelligence systems that evaluate pictures of feces in the toilet and suggest bowel preparation modifications to individuals because they undergo the bowel preparation process (207).

Based on data referenced earlier regarding individuals repeating colonoscopy after a failed bowel preparation, the USMSTF suggests that individuals considered high risk for having an inadequate bowel preparation use a regimen that includes split-dose 4 L PEG-ELS + 15 mg bisacodyl the afternoon before the colonoscopy, and a low-fiber diet 3 and 2 days before colonoscopy, changing to a clear-liquid diet the day before colonoscopy (200). Future research should focus on efficient methods for identifying individuals at high risk of inadequate bowel preparation quality and maximizing their bowel preparation regimen.

CONFLICTS OF INTEREST

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REFERENCES

1. Siegel RL, Miller KD, Wagle NS, et al. Cancer statistics, 2023. CA Cancer J Clin 2023;73(1):17–48.
2. Anderson R, Burr NE, Valori R. Causes of post-colonoscopy colorectal cancers based on World Endoscopy Organization system of analysis. Gastroenterology 2020;158(5):1287–99.e2.
3. Leung LJ, Lee JK, Merchant SA, et al. Post-colonoscopy colorectal cancer etiologies in a large integrated US Health Care setting. Gastroenterology 2023;164(3):470–2.e3.
4. Richardson WS, Wilson MC, Nishikawa J, et al. The well-built clinical question: A key to evidence-based decisions. ACP J Club 1995;123:A12–3.
5. Fayad NF, Kahi CJ, Abd El–Jawad KH, et al. Association between body mass index and quality of split bowel preparation. Clin Gastroenterol Hepatol 2013;11:1478–85.
6. Borg BB, Gupta NK, Zuckerman GR, et al. Impact of obesity on bowel preparation for colonoscopy. Clin Gastroenterol Hepatol 2009;7(6):670–5.
7. Garber A, Sarvepalli S, Burke CA, et al. Modifiable factors associated with quality of bowel preparation among hospitalized patients undergoing colonoscopy. J Hosp Med 2019;14(5):278–83.
8. Hassan C, Fuccio L, Bruno M, et al. A predictive model identifies patients most likely to have inadequate bowel preparation for colonoscopy. Clin Gastroenterol Hepatol 2012;10(5):501–6.
9. Gandhi K, Tofani C, Sokach C, et al. Patient characteristics associated with quality of colonoscopy preparation: A systematic review and meta-analysis. Clin Gastroenterol Hepatol 2018;16(3):357–69.e10.
10. Abraham NS, Barkun AN, Sauer BG, et al. American College of Gastroenterology-Canadian Association of Gastroenterology Clinical Practice Guideline: Management of anticoagulants and antiplatelets during acute gastrointestinal bleeding and the periendoscopic period. Am J Gastroenterol 2022;117(4):542–58.
11. ASGE Standards of Practice Committee, Acosta RD, Abraham NS, Chandrasekhara V, et al. The management of antithrombotic agents for patients undergoing GI endoscopy. Gastrointest Endosc 2016;83(1):3–16.
12. Basch CH, Hillyer GC, Reeves R, et al. Analysis of YouTube(TM) videos related to bowel preparation for colonoscopy. World J Gastrointest Endosc 2014;6(9):432–5.
13. Kunnackal John G, Thuluvath AJ, Carrier H, et al. Poor health literacy and medication burden are significant predictors for inadequate bowel preparation in an urban tertiary care setting. J Clin Gastroenterol 2019;53(9):e382–6.
14. Davis TC, Hancock J, Morris J, et al. Impact of health literacy-directed colonoscopy bowel preparation instruction sheet. Am J Health Behav 2017;41(3):301–8.
15. Tian C, Champlin S, Mackert M, et al. Readability, suitability, and health content assessment of web-based patient education materials on colorectal cancer screening. Gastrointest Endosc 2014;80(2):284–90.
16. Jung DH, Gweon TG, Lee S, et al. Combination of enhanced instructions improve quality of bowel preparation: A prospective, colonoscopist-blinded, randomized, controlled study. Dis Colon Rectum 2022;65(1):117–24.
17. Solonowicz O, Stier M, Kim K, et al. Digital navigation improves no-show rates and bowel preparation quality for patients undergoing colonoscopy: A randomized controlled quality improvement study. J Clin Gastroenterol 2022;56(2):166–72.
18. Janahiraman S, Tay CY, Lee JM, et al. Effect of an intensive patient educational programme on the quality of bowel preparation for colonoscopy: A single-blind randomised controlled trial. BMJ Open Gastroenterol 2020;7(1):e000376.
19. Guo X, Li X, Wang Z, et al. Reinforced education improves the quality of bowel preparation for colonoscopy: An updated meta-analysis of randomized controlled trials. PLoS One 2020;15(4):e0231888.
20. Alvarez-Gonzalez MA, Pantaleón Sánchez M, Bernad Cabredo B, et al. Educational nurse-led telephone intervention shortly before colonoscopy as a salvage strategy after previous bowel preparation failure: A multicenter randomized trial. Endoscopy 2020;52(11):1026–35.
21. Calderwood AH, Mahoney EM, Jacobson BC. A plan-do-study-act approach to improving bowel preparation quality. Am J Med Qual 2017;32(2):194–200.
22. Shieh TY, Chen MJ, Chang CW, et al. Effect of physician-delivered patient education on the quality of bowel preparation for screening colonoscopy. Gastroenterol Res Pract 2013;2013:570180.
23. Chen G, Zhao Y, Xie F, et al. Educating outpatients for bowel preparation before colonoscopy using conventional methods vs virtual reality videos plus conventional methods: A randomized clinical trial. JAMA Netw Open 2021;4(11):e2135576.
24. Pillai A, Menon R, Oustecky D, et al. Educational colonoscopy video enhances bowel preparation quality and comprehension in an inner city population. J Clin Gastroenterol 2018;52(6):515–8.
25. MacArthur KL, Leszczynski AM, Jacobson BC. Enhancing bowel preparation instructions: Is the bang worth the buck, or are we stuck with the muck? Gastrointest Endosc 2017;85(1):98–100.
26. Walker TB, Hengehold TA, Garza K, et al. An interactive video educational tool does not improve the quality of bowel preparation for colonoscopy: A randomized controlled study. Dig Dis Sci 2022;67(6):2347–57.
27. Liu X, Luo H, Zhang L, et al. Telephone-based re-education on the day before colonoscopy improves the quality of bowel preparation and the polyp detection rate: A prospective, colonoscopist-blinded, randomised, controlled study. Gut 2014;63(1):125–30.
28. Kang X, Zhao L, Leung F, et al. Delivery of instructions via mobile social media app increases quality of bowel preparation. Clin Gastroenterol Hepatol 2016;14(3):429–35.e3.
29. Lorenzo-Zúñiga V, Moreno de Vega V, Marín I, et al. Improving the quality of colonoscopy bowel preparation using a smart phone application: A randomized trial. Dig Endosc 2015;27:590–5.
30. 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(4):804–11.
31. Lee YJ, Kim ES, Choi JH, et al. Impact of reinforced education by telephone and short message service on the quality of bowel preparation: A randomized controlled study. Endoscopy 2015;47(11):1018–27.
32. 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(2):307–14.
33. Seoane A, Font X, Pérez JC, et al. Evaluation of an educational telephone intervention strategy to improve non-screening colonoscopy attendance: A randomized controlled trial. World J Gastroenterol 2020;26(47):7568–83.
34. Miller SJ, Itzkowitz SH, Shah B, et al. Bowel prep quality in patients of low socioeconomic status undergoing screening colonoscopy with patient navigation. Health Educ Behav 2016;43(5):537–42.
35. DeGroff A, Gressard L, Glover-Kudon R, et al. Assessing the implementation of a patient navigation intervention for colonoscopy screening. BMC Health Serv Res 2019;19(1):803.
36. DeGroff A, Schroy PC 3rd, Morrissey KG, et al. Patient navigation for colonoscopy completion: Results of an RCT. Am J Prev Med 2017;53(3):363–72.
37. Laiyemo AO, Kwagyan J, Williams CD, et al. Using patients' social network to improve compliance to outpatient screening colonoscopy appointments among blacks: A randomized clinical trial. Am J Gastroenterol 2019;114(10):1671–7.
38. Mahmud N, Asch DA, Sung J, et al. Effect of text messaging on bowel preparation and appointment attendance for outpatient colonoscopy: A randomized clinical trial. JAMA Netw Open 2021;4(1):e2034553.
39. Wang SL, Wang Q, Yao J, et al. Effect of WeChat and short message service on bowel preparation: An endoscopist-blinded, randomized controlled trial. Eur J Gastroenterol Hepatol 2019;31(2):170–7.

40. Jung JW, Park J, Jeon GJ, et al. The effectiveness of personalized bowel preparation using a smartphone camera application: A randomized pilot study. Gastroenterol Res Pract 2017;2017:4898914.
41. Nayor J, Feng A, Qazi T, et al. Impact of automated time-released reminders on patient preparedness for colonoscopy. J Clin Gastroenterol 2019;53(10):e456–62.
42. Back SY, Kim HG, Ahn EM, et al. Impact of patient audiovisual re-education via a smartphone on the quality of bowel preparation before colonoscopy: A single-blinded randomized study. Gastrointest Endosc 2018;87(3):789–99.e4.
43. Walter B, Klare P, Strehle K, et al. Improving the quality and acceptance of colonoscopy preparation by reinforced patient education with short message service: Results from a randomized, multicenter study (PERICLES-II). Gastrointest Endosc 2019;89(3):506–13.e4.
44. Desai M, Nutalapati V, Bansal A, et al. Use of smartphone applications to improve quality of bowel preparation for colonoscopy: A systematic review and meta-analysis. Endosc Int Open 2019;7(2):E216–24.
45. Zapata MC, Ha JB, Hernandez-Barco YG, et al. Using a customized SMS program to promote colonoscopy adherence and support bowel cleanliness for Spanish-speaking patients. J Health Care Poor Underserved 2022;33(2):1069–82.
46. Ton L, Lee H, Taunk P, et al. Nationwide variability of colonoscopy preparation instructions. Dig Dis Sci 2014;59(8):1726–32.
47. Gimeno-García AZ, de la Barreda Heuser R, Reygosa C, et al. Impact of a 1-day versus 3-day low-residue diet on bowel cleansing quality before colonoscopy: A randomized controlled trial. Endoscopy 2019;51(7):628–36.
48. Jiao L, Wang J, Zhao W, et al. Comparison of the effect of 1-day and 2-day low residue diets on the quality of bowel preparation before colonoscopy. Saudi J Gastroenterol 2020;26(3):137–43.
49. Machlab S, Martínez-Bauer E, López P, et al. Comparable quality of bowel preparation with single-day versus three-day low-residue diet: Randomized controlled trial. Dig Endosc 2021;33(5):797–806.
50. Taveira F, Areia M, Elvas L, et al. A 3-day low-fibre diet does not improve colonoscopy preparation results compared to a 1-day diet: A randomized, single-blind, controlled trial. United Eur Gastroenterol J 2019;7(10):1321–9.
51. Leszczynski AM, MacArthur KL, Nelson KP, et al. The association among diet, dietary fiber, and bowel preparation at colonoscopy. Gastrointest Endosc 2018;88(4):685–94.
52. Vanhauwaert E, Matthys C, Verdonck L, et al. Low-residue and low-fiber diets in gastrointestinal disease management. Adv Nutr 2015;6:820–7.
53. Weinstein L, Olson RE, Van Itallie TB, et al. Diet as related to gastrointestinal function. JAMA 1961;176:935–41.
54. Ozer Etik D, Suna N, Gunduz C, et al. Can a 1-day clear liquid diet with a split -dose polyethylene glycol overcome conventional practice patterns during the preparation for screening colonoscopy? Turk J Gastroenterol 2019;30(9):817–25.
55. Butt J, Bunn C, Paul E, et al. The White Diet is preferred, better tolerated, and non-inferior to a clear-fluid diet for bowel preparation: A randomized controlled trial. J Gastroenterol Hepatol 2016;31(2):355–63.
56. Dwyer JP, Tan JYC, Paul E, et al. White Diet with split-dose Picosalax is preferred, better tolerated, and non-inferior to day-before clear fluids with polyethylene glycol plus sodium picosulfate-magnesium citrate for morning colonoscopy: A randomized, non-inferiority trial. JGH Open 2017;1:38–43.
57. Delegge M, Kaplan R. Efficacy of bowel preparation with the use of a prepackaged, low fibre diet with a low sodium, magnesium citrate cathartic vs. a clear liquid diet with a standard sodium phosphate cathartic. Aliment Pharmacol Ther 2005;21(12):1491–5.
58. Lee JW, Choi JY, Yoon H, et al. Favorable outcomes of prepackaged low-residue diet on bowel preparation for colonoscopy: Endoscopist-blinded randomized controlled trial. J Gastroenterol Hepatol 2019;34(5):864–9.
59. Sipe BW, Fischer M, Baluyut AR, et al. A low-residue diet improved patient satisfaction with split-dose oral sulfate solution without impairing colonic preparation. Gastrointest Endosc 2013;77:932–6.
60. Soweid AM, Kobeissy AA, Jamali FR, et al. A randomized single-blind trial of standard diet versus fiber-free diet with polyethylene glycol electrolyte solution for colonoscopy preparation. Endoscopy 2010;42:633–8.
61. Ahumada C, Pereyra L, Galvarini M, et al. Efficacy and tolerability of a low-residue diet for bowel preparation: Systematic review and meta-analysis. Surg Endosc 2022;36(6):3858–75.
62. Alvarez-Gonzalez MA, Pantaleon MA, Flores-Le Roux JA, et al. Randomized clinical trial: A normocaloric low-fiber diet the day before colonoscopy is the most effective approach to bowel preparation in colorectal cancer screening colonoscopy. Dis Colon Rectum 2019;62(4):491–7.
63. Gómez-Reyes E, Tepox-Padrón A, Cano-Manrique G, et al. A low-residue diet before colonoscopy tends to improve tolerability by patients with no differences in preparation quality: A randomized trial. Surg Endosc 2020;34(7):3037–42.
64. Stolpman DR, Solem CA, Eastlick D, et al. A randomized controlled trial comparing a low-residue diet versus clear liquids for colonoscopy preparation: Impact on tolerance, procedure time, and adenoma detection rate. J Clin Gastroenterol 2014;48(10):851–5.
65. Zhang X, Wu Q, Wei M, et al. Low-residual diet versus clear-liquid diet for bowel preparation before colonoscopy: meta-analysis and trial sequential analysis of randomized controlled trials. Gastrointest Endosc 2020;92(3):508–18.e3.
66. Johnson DA, Barkun AN, Cohen LB, et al. Optimizing adequacy of bowel cleansing for colonoscopy: Recommendations from the US multi-society task force on colorectal cancer. Gastroenterology 2014;147(4):903–24.
67. Johnson DA, Barkun AN, Cohen LB, et al. Optimizing adequacy of bowel cleansing for colonoscopy: Recommendations from the US Multi-Society Task Force on Colorectal Cancer. Am J Gastroenterol 2014;109(10):1528–45.
68. Jacobson BC, Calderwood AH. Measuring bowel preparation adequacy in colonoscopy-based research: Review of key considerations. Gastrointest Endosc 2020;91(2):248–56.
69. Sarvepalli S, Garber A, Burke CA, et al. Comparative effectiveness of commercial bowel preparations in ambulatory patients presenting for screening or surveillance colonoscopy. Dig Dis Sci 2021;66(6):2059–68.
70. Gu P, Lew D, Oh SJ, et al. Comparing the real-world effectiveness of competing colonoscopy preparations: Results of a prospective trial. Am J Gastroenterol 2019;114(2):305–14.
71. Oldfield EC, Johnson DA, Rex DK. Prescribing colonoscopy bowel preparations: Tips for maximizing outcomes. Am J Gastroenterol 2023;118(5):761–4.
72. Sharma P, Burke CA, Johnson DA, et al. The importance of colonoscopy bowel preparation for the detection of colorectal lesions and colorectal cancer prevention. Endosc Int Open 2020;8(5):E673–83.
73. Spadaccini M, Frazzoni L, Vanella G, et al. Efficacy and tolerability of high- vs low-volume split-dose bowel cleansing regimens for colonoscopy: A systematic review and meta-analysis. Clin Gastroenterol Hepatol 2020;18(7):1454–65.e14.
74. Barkun AN, Martel M, Epstein IL, et al. The bowel CLEANsing national initiative: High-volume split-dose vs low-volume split-dose polyethylene glycol preparations: A randomized controlled trial. Clin Gastroenterol Hepatol 2022;20(6):e1469–77.
75. van Riswijk MLM, van Keulen KE, Siersema PD. Efficacy of ultra-low volume (<1 L) bowel preparation fluids: Systematic review and meta-analysis. Dig Endosc 2022;34(1):13–32.
76. Zhang C, Chen X, Tang B, et al. A novel ultra-low volume regimen combining 1 L polyethylene glycol and linaclotide versus 2 L polyethylene glycol for colonoscopy cleansing in low-risk individuals: A randomized controlled trial. Gastrointest Endosc 2023;97(5):952–61.e1.
77. Martel M, Barkun AN, Menard C, et al. Split-dose preparations are superior to day-before bowel cleansing regimens: A meta-analysis. Gastroenterology 2015;149(1):79–88.
78. Xie Q, Chen L, Zhao F, et al. A meta-analysis of randomized controlled trials of low-volume polyethylene glycol plus ascorbic acid versus standard-volume polyethylene glycol solution as bowel preparations for colonoscopy. PLoS One 2014;9(6):e99092.
79. Hassan C, East J, Radaelli F, et al. Bowel preparation for colonoscopy: European Society of Gastrointestinal Endoscopy (ESGE) guideline - update 2019. Endoscopy 2019;51(8):775–94.
80. Mehta JB, Singhal SB, Mehta BC. Ascorbic-acid-induced haemolysis in G-6-PD deficiency. Lancet 1990;336(8720):944.
81. Bisschops R, Manning J, Clayton LB, et al. Colon cleansing efficacy and safety with 1 L NER1006 versus 2 L polyethylene glycol + ascorbate: A randomized phase 3 trial. Endoscopy 2019;51:60–72.
82. Maida M, Ventimiglia M, Facciorusso A, et al. Effectiveness and safety of 1-L PEG-ASC versus other bowel preparations for colonoscopy: A meta-analysis of nine randomized clinical trials. Dig Liver Dis 2023;55(8):1010–8.

83. Spada C, Cesaro P, Bazzoli F, et al. Evaluation of Clensia®, a new low-volume PEG bowel preparation in colonoscopy: Multicentre randomized controlled trial versus 4L PEG. Dig Liver Dis 2017;49(6):651–6.
84. Kump P, Hassan C, Spada C, et al. Efficacy and safety of a new low-volume PEG with citrate and simethicone bowel preparation for colonoscopy (Clensia): A multicenter randomized observer-blind clinical trial vs. a low-volume PEG with ascorbic acid (PEG-ASC). Endosc Int Open 2018;6(8):E907–13.
85. Tae CH, Jung SA, Na SK, et al. The use of low-volume polyethylene glycol containing ascorbic acid versus 2 L of polyethylene glycol plus bisacodyl as bowel preparation for colonoscopy. Scand J Gastroenterol 2015;50(8):1039–44.
86. Brahmania M, Ou G, Bressler B, et al. 2 L versus 4 L of PEG3350 + electrolytes for outpatient colonic preparation: A randomized, controlled trial. Gastrointest Endosc 2014;79(3):408–16.e4.
87. Kang SH, Jeen YT, Lee JH, et al. Comparison of a split-dose bowel preparation with 2 liters of polyethylene glycol plus ascorbic acid and 1 liter of polyethylene glycol plus ascorbic acid and bisacodyl before colonoscopy. Gastrointest Endosc 2017;86:343–8.
88. Baudet JS, Castro V, Redondo I. Recurrent ischemic colitis induced by colonoscopy bowel lavage. Am J Gastroenterol 2010;105(3):700–1.
89. Lopez Morra HA, Fine SN, Dickstein G. Colonic ischemia with laxative use in young adults. Am J Gastroenterol 2005;100(9):2134–6.
90. Shamatutu C, Chahal D, Tai IT, et al. Ischemic colitis after colonoscopy with bisacodyl bowel preparation: A report of two cases. Case Rep Gastrointest Med 2020;2020:8886817.
91. Tomer O, Shapira Y, Kriger-Sharabi O, et al. An Israeli national survey on ischemic colitis induced by pre-colonoscopy bowel preparation (R1). Acta Gastroenterol Belg 2022;85(1):94–6.
92. Jin Z, Lu Y, Zhou Y, et al. Systematic review and meta-analysis: Sodium picosulfate/magnesium citrate vs. polyethylene glycol for colonoscopy preparation. Eur J Clin Pharmacol 2016;72(5):523–32.
93. van Lieshout I, Munsterman ID, Eskes AM, et al. Systematic review and meta-analysis: Sodium picosulphate with magnesium citrate as bowel preparation for colonoscopy. United Eur Gastroenterol J 2017;5(7):917–43.
94. Bertiger G, Jones E, Dahdal DN, et al. Serum magnesium concentrations in patients receiving sodium picosulfate and magnesium citrate bowel preparation: An assessment of renal function and electrocardiographic conduction. Clin Exp Gastroenterol 2015;8:215–24.
95. Weir MA, Fleet JL, Vinden C, et al. Hyponatremia and sodium picosulfate bowel preparations in older adults. Am J Gastroenterol 2014;109(5):686–94.
96. Seo SI, Kang JG, Kim HS, et al. Efficacy and tolerability of 2-L polyethylene glycol with ascorbic acid versus sodium picosulfate with magnesium citrate: A randomized controlled trial. Int J Colorectal Dis 2018;33(5):541–8.
97. Mathus-Vliegen EMH, van der Vliet K, Wignand-van der Storm IJ, et al. Split-dose bowel cleansing with picosulphate is safe and better tolerated than 2-l polyethylene glycol solution. Eur J Gastroenterol Hepatol 2018;30(7):709–17.
98. Choi HS, Chung JW, Lee JW, et al. Polyethylene glycol plus ascorbic acid is as effective as sodium picosulfate with magnesium citrate for bowel preparation: A randomized trial. J Dig Dis 2016;17(4):268–73.
99. Mankaney GN, Ando M, Dahdal DN, et al. Safety and efficacy of sodium picosulfate, magnesium oxide, and citric acid bowel preparation in patients with baseline renal impairment or diabetes: Subanalysis of a randomized, controlled trial. Therap Adv Gastroenterol 2021;14:17562848211024458.
100. Ali IA, Roton D, Madhoun M. Oral sulfate solution versus low-volume polyethylene glycol for bowel preparation: Meta-analysis of randomized controlled trials. Dig Endosc 2022;34(4):721–8.
101. Chen C, Shi M, Liao Z, et al. Oral sulfate solution benefits polyp and adenoma detection during colonoscopy: Meta-analysis of randomized controlled trials. Dig Endosc 2022;34(6):1121–33.
102. Seo EH, Kim TO, Park MJ, et al. Optimal preparation-to-colonoscopy interval in split-dose PEG bowel preparation determines satisfactory bowel preparation quality: An observational prospective study. Gastrointest Endosc 2012;75(3):583–90.
103. Shaukat A, Malhotra A, Greer N, et al. Systematic review: Outcomes by duration of NPO status prior to colonoscopy. Gastroenterol Res Pract 2017;2017:3914942.
104. Shafer LA, Walker JR, Waldman C, et al. Predictors of patient reluctance to wake early in the morning for bowel preparation for colonoscopy: A precolonoscopy survey in city-wide practice. Endosc Int Open 2018;6:E706–13.
105. Menees SB, Kim HM, Wren P, et al. Patient compliance and suboptimal bowel preparation with split-dose bowel regimen in average-risk screening colonoscopy. Gastrointest Endosc 2014;79(5):811–20.e3.
106. Marmo R, Rotondano G, Riccio G, et al. Effective bowel cleansing before colonoscopy: A randomized study of split-dosage versus non-split dosage regimens of high-volume versus low-volume polyethylene glycol solutions. Gastrointest Endosc 2010;72(2):313–20.
107. Kilgore TW, Abdinoor AA, Szary NM, et al. Bowel preparation with split-dose polyethylene glycol before colonoscopy: A meta-analysis of randomized controlled trials. Gastrointest Endosc 2011;73(6):1240–5.
108. Cohen LB. Split dosing of bowel preparations for colonoscopy: An analysis of its efficacy, safety, and tolerability. Gastrointest Endosc 2010;72(2):406–12.
109. Enestvedt BK, Tofani C, Laine LA, et al. 4-Liter split-dose polyethylene glycol is superior to other bowel preparations, based on systematic review and meta-analysis. Clin Gastroenterol Hepatol 2012;10(11):1225–31.
110. Gurudu SR, Ramirez FC, Harrison ME, et al. Increased adenoma detection rate with system-wide implementation of a split-dose preparation for colonoscopy. Gastrointest Endosc 2012;76(3):603–8 e1.
111. Jover R, Zapater P, Polania E, et al. Modifiable endoscopic factors that influence the adenoma detection rate in colorectal cancer screening colonoscopies. Gastrointest Endosc 2013;77(3):381–9.e1.
112. Mohamed R, Hilsden RJ, Dube C, et al. Split-dose polyethylene glycol is superior to single dose for colonoscopy preparation: Results of a randomized controlled trial. Can J Gastroenterol Hepatol 2016;2016:3181459.
113. Kiesslich R, Schubert S, Mross M, et al. Efficacy and safety of PICOPREP tailored dosing compared with PICOPREP day-before dosing for colon cleansing: A multi-centric randomised study. Endosc Int Open 2017;5(4):E282–90.
114. Schulz C, Müller J, Sauter J, et al. Superiority of a split-dose regimen of sodium picosulfate/magnesium citrate (SPMC) in comparison to a prior-day schedule (AM/PM) for colonoscopy preparation. A randomized single-blinded study. J Gastrointestin Liver Dis 2016;25(3):295–302.
115. Radaelli F, Paggi S, Hassan C, et al. Split-dose preparation for colonoscopy increases adenoma detection rate: A randomised controlled trial in an organised screening programme. Gut 2017;66(2):270–7.
116. Horton N, Garber A, Hasson H, et al. Impact of single- vs. split-dose low-volume bowel preparations on bowel movement kinetics, patient inconvenience, and polyp detection: A prospective trial. Am J Gastroenterol 2016;111(9):1330–7.
117. Radaelli F, Paggi S, Repici A, et al. Barriers against split-dose bowel preparation for colonoscopy. Gut 2017;66(8):1428–33.
118. Tse C, Barkun A, Martel M, et al. Sleep disturbances, bowel movement kinetics, and travel interruption with bowel preparation: A bowel CLEANsing national initiative substudy. Am J Gastroenterol 2023;118(1):87–94.
119. Avalos DJ, Castro FJ, Zuckerman MJ, et al. Bowel preparations administered the morning of colonoscopy provide similar efficacy to a split dose regimen: A meta analysis. J Clin Gastroenterol 2018;52(10):859–68.
120. Cheng YL, Huang KW, Liao WC, et al. Same-day versus split-dose bowel preparation before colonoscopy: A meta-analysis. J Clin Gastroenterol 2018;52(5):392–400.
121. Bucci C, Zingone F, Schettino P, et al. Same-day regimen as an alternative to split preparation for colonoscopy: A systematic review with meta-analysis. Gastroenterol Res Pract 2019;2019:7476023.
122. Barkun AN, Martel M, Epstein IL, et al. The bowel CLEANsing national initiative: A low-volume same-day polyethylene glycol (PEG) preparation vs low-volume split-dose PEG with bisacodyl or high-volume split-dose PEG preparations-A randomized controlled trial. Am J Gastroenterol 2020;115(12):2068–76.
123. Shah H, Desai D, Samant H, et al. Comparison of split-dosing vs non-split (morning) dosing regimen for assessment of quality of bowel preparation for colonoscopy. World J Gastrointest Endosc 2014;6(12):606–11.

124. Kotwal VS, Attar BM, Carballo MD, et al. Morning-only polyethylene glycol is noninferior but less preferred by hospitalized patients as compared with split-dose bowel preparation. J Clin Gastroenterol 2014; 48(5):414–8.
125. Chan WK, Azmi N, Mahadeva S, et al. Split-dose vs same-day reduced-volume polyethylene glycol electrolyte lavage solution for morning colonoscopy. World J Gastroenterol 2014;20(39):14488–94.
126. Eun CS, Han DS, Hyun YS, et al. The timing of bowel preparation is more important than the timing of colonoscopy in determining the quality of bowel cleansing. Dig Dis Sci 2011;56(2):539–44.
127. Siddiqui AA, Yang K, Spechler SJ, et al. Duration of the interval between the completion of bowel preparation and the start of colonoscopy predicts bowel-preparation quality. Gastrointest Endosc 2009;69(3 Pt 2): 700–6.
128. Bucci C, Rotondano G, Hassan C, et al. Optimal bowel cleansing for colonoscopy: Split the dose! A series of meta-analyses of controlled studies. Gastrointest Endosc 2014;80(4):566–76.e2.
129. Joshi GP, Abdelmalak BB, Weigel WA, et al. 2023 American Society of Anesthesiologists practice guidelines for preoperative fasting: Carbohydrate-containing clear liquids with or without protein, chewing gum, and pediatric fasting duration-A modular update of the 2017 American Society of Anesthesiologists Practice Guidelines for Preoperative Fasting. Anesthesiology 2023;138(2):132–51.
130. Agrawal D, Marull J, Tian C, et al. Contrasting perspectives of anesthesiologists and gastroenterologists on the optimal time interval between bowel preparation and endoscopic sedation. Gastroenterol Res Pract 2015;2015:497176.
131. Prieto-Frias C, Munoz-Navas M, Betes MT, et al. Split-dose sodium picosulfate-magnesium citrate colonoscopy preparation achieves lower residual gastric volume with higher cleansing effectiveness than a previous-day regimen. Gastrointest Endosc 2016;83(3):566–73.
132. Huffman M, Unger RZ, Thatikonda C, et al. Split-dose bowel preparation for colonoscopy and residual gastric fluid volume: An observational study. Gastrointest Endosc 2010;72(3):516–22.
133. Agrawal D, Elsbernd B, Singal AG, et al. Gastric residual volume after split-dose compared with evening-before polyethylene glycol bowel preparation. Gastrointest Endosc 2016;83(3):574–80.
134. Joshi GP, Abdelmalak BB, Weigel WA, et al. American Society of Anesthesiologists consensus-based guidance on preoperative management of patients (adults and children) on glucagon-like peptide-1 (GLP-1) receptor agonists. 2023. https://www.asahq.org/about-asa/newsroom/news-releases/2023/06/american-society-of-anesthesiologists-consensus-based-guidance-on-preoperative. Accessed July 23, 2024.
135. Hashash JG, Thompson CC, Wang AY. AGA rapid clinical practice update on the management of patients taking GLP-1 receptor agonists prior to endoscopy: Communication. Clin Gastroenterol Hepatol 2024; 22(4):705–7.
136. Speer T, Vickery K, Alfa M, et al. Minimizing the risks of simethicone in endoscope reprocessing. J Clin Gastroenterol 2023;57(2):153–8.
137. Bai Y, Fang J, Zhao SB, et al. Impact of preprocedure simethicone on adenoma detection rate during colonoscopy: A multicenter, endoscopist-blinded randomized controlled trial. Endoscopy 2018;50(2): 128–36.
138. Pan P, Zhao SB, Li BH, et al. Effect of supplemental simethicone for bowel preparation on adenoma detection during colonoscopy: A meta-analysis of randomized controlled trials. J Gastroenterol Hepatol 2019; 34(2):314–20.
139. Yoo IK, Jeen YT, Kang SH, et al. Improving of bowel cleansing effect for polyethylene glycol with ascorbic acid using simethicone: A randomized controlled trial. Medicine (Baltimore) 2016;95(28):e4163.
140. Zhang S, Zheng D, Wang J, et al. Simethicone improves bowel cleansing with low-volume polyethylene glycol: A multicenter randomized trial. Endoscopy 2018;50(4):412–22.
141. Yeh JH, Hsu MH, Tseng CM, et al. The benefit of adding oral simethicone in bowel preparation regimen for the detection of colon adenoma: A systematic review and meta-analysis. J Gastroenterol Hepatol 2019;34(5):830–6.
142. Liu X, Yuan M, Li Z, et al. The efficacy of simethicone with polyethylene glycol for bowel preparation: A systematic review and meta-analysis. J Clin Gastroenterol 2021;55(6):e46–55.
143. Cao RR, Wang L, Gao C, et al. Effect of oral simethicone on the quality of colonoscopy: A systematic review and meta-analysis of randomized controlled trials. J Dig Dis 2022;23(3):134–48.
144. Moraveji S, Casner N, Bashashati M, et al. The role of oral simethicone on the adenoma detection rate and other quality indicators of screening colonoscopy: A randomized, controlled, observer-blinded clinical trial. Gastrointest Endosc 2019;90(1):141–9.
145. Wu ZW, Zhan SG, Yang MF, et al. Optimal timing of simethicone supplement for bowel preparation: A prospective randomized controlled trial. Can J Gastroenterol Hepatol 2021;2021:4032285.
146. Zhang Z. Is polyethylene glycol superior to miralax-gatorade in bowel preparations for colonoscopy? Am J Gastroenterol 2015;110(4):596–7.
147. Kim H, Ko BM, Goong HJ, et al. Optimal timing of simethicone addition for bowel preparation using polyethylene glycol plus ascorbic acid. Dig Dis Sci 2019;64(9):2607–13.
148. Jung W, Oh GM, Kim JH, et al. When should patients take simethicone orally before colonoscopy for avoiding bubbles: A single-blind, randomized controlled study. Medicine (Baltimore) 2023;102(19): e33728.
149. Restellini S, Kherad O, Menard C, et al. Do adjuvants add to the efficacy and tolerance of bowel preparations? A meta-analysis of randomized trials. Endoscopy 2018;50(2):159–76.
150. Fang J, Wang SL, Fu HY, et al. Impact of gum chewing on the quality of bowel preparation for colonoscopy: An endoscopist-blinded, randomized controlled trial. Gastrointest Endosc 2017;86(1):187–91.
151. Kamran U, Abbasi A, Tahir I, et al. Can adjuncts to bowel preparation for colonoscopy improve patient experience and result in superior bowel cleanliness? A systematic review and meta-analysis. United Eur Gastroenterol J 2020;8(10):1217–27.
152. Choi HS, Shim CS, Kim GW, et al. Orange juice intake reduces patient discomfort and is effective for bowel cleansing with polyethylene glycol during bowel preparation. Dis Colon Rectum 2014;57(10):1220–7.
153. Seow-En I, Seow-Choen F. A prospective randomized trial on the use of Coca-Cola Zero(®) vs water for polyethylene glycol bowel preparation before colonoscopy. Colorectal Dis 2016;18(7):717–23.
154. Sharara AI, El-Halabi MM, Abou Fadel CG, et al. Sugar-free menthol candy drops improve the palatability and bowel cleansing effect of polyethylene glycol electrolyte solution. Gastrointest Endosc 2013;78(6): 886–91.
155. Lan HC, Liang Y, Hsu HC, et al. Citrus reticulata peel improves patient tolerance of low-volume polyethylene glycol for colonoscopy preparation. J Chin Med Assoc 2012;75(9):442–8.
156. Theunissen F, Lantinga MA, Ter Borg PCJ, et al. Efficacy of different bowel preparation regimen volumes for colorectal cancer screening and compliance with European Society of Gastrointestinal Endoscopy performance measures. United Eur Gastroenterol J 2023;11(5):448–57.
157. Banerjee R, Chaudhari H, Shah N, et al. Addition of lubiprostone to polyethylene glycol(PEG) enhances the quality & efficacy of colonoscopy preparation: A randomized, double-blind, placebo controlled trial. BMC Gastroenterol 2016;16(1):133.
158. Grigg E, Schubert MC, Hall J, et al. Lubiprostone used with polyethylene glycol in diabetic patients enhances colonoscopy preparation quality. World J Gastrointest Endosc 2010;2:263–7.
159. Li P, He XQ, Dong J, et al. A meta-analysis of randomized controlled trials of the addition of lubiprostone to bowel preparation before colonoscopy. Medicine (Baltimore) 2020;99(8):e19208.
160. Sirinawasatien A, Sakulthongthawin P, Chanpiwat K, et al. Bowel preparation using 2-L split-dose polyethylene glycol regimen plus lubiprostone versus 4-L split-dose polyethylene glycol regimen: A randomized controlled trial. BMC Gastroenterol 2022;22(1):424.
161. Sofi AA, Nawras AT, Pai C, et al. Lubiprostone plus PEG electrolytes versus placebo plus PEG electrolytes for outpatient colonoscopy preparation: A randomized, double-blind placebo-controlled trial. Am J Ther 2015;22(2):105–10.
162. Lee J, Jeong SJ, Kim TH, et al. Efficacy of mosapride citrate with a split dose of polyethylene glycol plus ascorbic acid for bowel preparation in elderly patients: A randomized controlled trial. Medicine (Baltimore) 2020;99(2):e18702.
163. Fatima H, Johnson CS, Rex DK. Patients' description of rectal effluent and quality of bowel preparation at colonoscopy. Gastrointest Endosc 2010;71(7):1244–52.e2.
164. Harewood GC, Wright CA, Baron TH. Assessment of patients' perceptions of bowel preparation quality at colonoscopy. Am J Gastroenterol 2004;99(5):839–43.
165. Hopkins RL, Parsons D, Hoyo L, et al. Evaluating the practice of canceling colonoscopies for presumed inadequate bowel preparation. Gastrointest Endosc 2020;92(2):382–6.

166. Rex DK, Schoenfeld PS, Cohen J, et al. Quality indicators for colonoscopy. Gastrointest Endosc 2015;81(1):31–53.
167. Kastenberg D, Bertiger G, Brogadir S. Bowel preparation quality scales for colonoscopy. World J Gastroenterol 2018;24(26):2833–43.
168. Halphen M, Heresbach D, Gruss HJ, et al. Validation of the Harefield Cleansing Scale: A tool for the evaluation of bowel cleansing quality in both research and clinical practice. Gastrointest Endosc 2013;78(1):121–31.
169. Gerard DP, Holden JL, Foster DB, et al. Randomized trial of gatorade/polyethylene glycol with or without bisacodyl and NuLYTELY for colonoscopy preparation. Clin Transl Gastroenterol 2012;3(6):e16.
170. Rostom A, Jolicoeur E. Validation of a new scale for the assessment of bowel preparation quality. Gastrointest Endosc 2004;59(4):482–6.
171. Calderwood AH, Schroy PC 3rd, Lieberman DA, et al. Boston Bowel Preparation Scale scores provide a standardized definition of adequate for describing bowel cleanliness. Gastrointest Endosc 2014;80(2):269–76.
172. Butterly LF, Nadel MR, Anderson JC, et al. Impact of colonoscopy bowel preparation quality on follow-up interval recommendations for average-risk patients with normal screening colonoscopies: Data from the New Hampshire Colonoscopy Registry. J Clin Gastroenterol 2020;54(4):356–64.
173. Anderson JC, Butterly LF, Robinson CM, et al. Impact of fair bowel preparation quality on adenoma and serrated polyp detection: Data from the New Hampshire colonoscopy registry by using a standardized preparation-quality rating. Gastrointest Endosc 2014;80(3):463–70.
174. Parmar R, Martel M, Rostom A, et al. Validated scales for colon cleansing: A systematic review. Am J Gastroenterol 2016;111(2):197–205; quiz 205.
175. Clark BT, Protiva P, Nagar A, et al. Quantification of adequate bowel preparation for screening or surveillance colonoscopy in men. Gastroenterology 2016;150(2):396–405; quiz e14–5.
176. Ravi S, Sabbagh R, Antaki F. Use of automated irrigation pumps improves quality of bowel preparation for colonoscopy. World J Gastrointest Endosc 2016;8(6):295–300.
177. Ofstead CL, Wetzler HP, Johnson EA, et al. Simethicone residue remains inside gastrointestinal endoscopes despite reprocessing. Am J Infect Control 2016;44(11):1237–40.
178. Barakat MT, Huang RJ, Banerjee S. Simethicone is retained in endoscopes despite reprocessing: Impact of its use on working channel fluid retention and adenosine triphosphate bioluminescence values (with video). Gastrointest Endosc 2019;89(1):115–23.
179. Beilenhoff U, Biering H, Blum R, et al. Reprocessing of flexible endoscopes and endoscopic accessories used in gastrointestinal endoscopy: Position statement of the European Society of Gastrointestinal Endoscopy (ESGE) and European Society of Gastroenterology Nurses and Associates (ESGENA) - update 2018. Endoscopy 2018;50(12):1205–34.
180. Day LW, Muthusamy VR, Collins J, et al. Multisociety guideline on reprocessing flexible GI endoscopes and accessories. Gastrointest Endosc 2021;93(1):11–33.e6.
181. Olympus. Use of simethicone and other non-water soluble additives with Olympus flexible endoscopes, 2018. https://medical.olympusamerica.com/customer-resources/cleaning-disinfection-sterilization/alerts-statements
182. MacPhail ME, Hardacker KA, Tiwari A, et al. Intraprocedural cleansing work during colonoscopy and achievable rates of adequate preparation in an open-access endoscopy unit. Gastrointest Endosc 2015;81(3):525–30.
183. Horiuchi A, Nakayama Y, Kajiyama M, et al. Colonoscopic enema as rescue for inadequate bowel preparation before colonoscopy: A prospective, observational study. Colorectal Dis 2012;14(10):e735–9.
184. Sohn N, Weinstein MA. Management of the poorly prepared colonoscopy patient: Colonoscopic colon enemas as a preparation for colonoscopy. Dis Colon Rectum 2008;51(4):462–6.
185. Yang HJ, Park DI, Park SK, et al. A randomized controlled trial comparing colonoscopic enema with additional oral preparation as a salvage for inadequate bowel cleansing before colonoscopy. J Clin Gastroenterol 2019;53(8):e308–15.
186. Nass KJ, van der Schaar PJ, van der Vlugt M, et al. Continuous monitoring of colonoscopy performance in The Netherlands: First results of a nationwide registry. Endoscopy 2022;54(5):488–95.
187. Nass KJ, van der Vlugt M, Elfrink AKE, et al. Case-mix adjustment to compare colonoscopy performance between endoscopy centers: A nationwide registry study. Endoscopy 2022;54(5):455–62.
188. Lee JY, Calderwood AH, Karnes W, et al. Artificial intelligence for the assessment of bowel preparation. Gastrointest Endosc 2022;95(3):512–8.e1.
189. Zhou J, Wu L, Wan X, et al. A novel artificial intelligence system for the assessment of bowel preparation (with video). Gastrointest Endosc 2020;91(2):428–35.e2.
190. Mahadev S, Green PH, Lebwohl B. Rates of suboptimal preparation for colonoscopy differ markedly between providers: Impact on adenoma detection rates. J Clin Gastroenterol 2015;49(9):746–50.
191. Rex DK, Anderson JC, Butterly LF, et al. Quality indicators for colonoscopy. Gastrointest Endosc 2024;100(3):352–81.
192. Greenwald DA, Eisen G, Bernstein BB, et al. Recommendations for follow up interval after colonoscopy with inadequate bowel preparation: An analysis from the GI QUality Improvement Consortium (GIQuIC). Gastrointest Endosc 2018;87:AB113 [Abstract].
193. Clark BT, Rustagi T, Laine L. What level of bowel prep quality requires early repeat colonoscopy: Systematic review and meta-analysis of the impact of preparation quality on adenoma detection rate. Am J Gastroenterol 2014;109(11):1714–24; quiz 1724.
194. Baile-Maxia S, Mangas-Sanjuan C, Medina-Prado L, et al. Diagnostic yield of early repeat colonoscopy after suboptimal bowel preparation in a fecal immunochemical test-based screening program. Endoscopy 2020;52(12):1093–100.
195. 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(6):1207–14.
196. Calderwood AH, Holub JL, Greenwald DA. Recommendations for follow-up interval after colonoscopy with inadequate bowel preparation in a national colonoscopy quality registry. Gastrointest Endosc 2022;95(2):360–7.e2.
197. Chokshi RV, Hovis CE, Colditz GA, et al. Physician recommendations and patient adherence after inadequate bowel preparation on screening colonoscopy. Dig Dis Sci 2013;58(8):2151–5.
198. Murphy CJ, Jewel Samadder N, Cox K, et al. Outcomes of next-day versus non-next-day colonoscopy after an initial inadequate bowel preparation. Dig Dis Sci 2016;61(1):46–52.
199. Gimeno-García AZ, Hernandez G, Aldea A, et al. Comparison of two intensive bowel cleansing regimens in patients with previous poor bowel preparation: A randomized controlled study. Am J Gastroenterol 2017;112(6):951–8.
200. Sey MSL, Von Renteln D, Sultanian R, et al. A multicenter randomized controlled trial comparing two bowel cleansing regimens for colonoscopy after failed bowel preparation. Clin Gastroenterol Hepatol 2022;20(6):e1283–91.
201. Rex DK, Boland CR, Dominitz JA, et al. Colorectal cancer screening: Recommendations for physicians and patients from the U.S. Multi-society task force on colorectal cancer. Gastroenterology 2017;153(1):307–23.
202. US Preventive Services Task Force. Screening for colorectal cancer: US Preventive Services Task Force recommendation statement. JAMA 2021;325:1965–77.
203. Platt KD, Kurlander JE, Zikmund-Fisher BJ, et al. Rethinking the re-prep: Attitudes toward noninvasive colorectal cancer screening tests after inadequate bowel preparation. Am J Gastroenterol 2019;114(10):1685–7.
204. Dik VK, Moons LM, Hüyük M, et al. Predicting inadequate bowel preparation for colonoscopy in participants receiving split-dose bowel preparation: Development and validation of a prediction score. Gastrointest Endosc 2015;81(3):665–72.
205. Gimeno-García AZ, Baute JL, Hernandez G, et al. Risk factors for inadequate bowel preparation: A validated predictive score. Endoscopy 2017;49(6):536–43.
206. Berger A, Cesbron-Métivier E, Bertrais S, et al. A predictive score of inadequate bowel preparation based on a self-administered questionnaire: PREPA-CO. Clin Res Hepatol Gastroenterol 2021;45(4):101693.
207. Zhu Y, Zhang DF, Wu HL, et al. Improving bowel preparation for colonoscopy with a smartphone application driven by artificial intelligence. NPJ Digit Med 2023;6(1):41.