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Review Article

Optimizing Bowel Preparation in High-risk Patients Undergoing Colonoscopy: A Narrative Review

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Abstract

Identifying patients at high risk for poor bowel preparation preceding a colonoscopy is critical to successful colorectal cancer screening. High-risk patients, such as those who are obese, diabetic, opioid users, or former smokers, often have comorbidity, medication, and sociodemographic factors that lead to suboptimal bowel preparation even when following protocol. Suboptimal preparation results in missed lesions, longer procedure times, and increased healthcare costs. Optimal visualization of the colon mucosa is achieved through effective bowel preparation. Polyethylene glycol (PEG) solutions are preferred for their safety, especially in patients with kidney or cardiac disease. Split-dose PEG regimens with a low-residue diet are recommended by the American Gastroenterological Association to promote cleansing and patient tolerance. Tailored regimens can be employed in high-risk patients, including those with chronic constipation, opioid dependence, or diabetes. Educational interventions, such as written and verbal instructions, patient navigators, and mobile device reminders, improve compliance. Medical strategies include split-dose PEG-electrolyte lavage solution with bisacodyl, additional purgatives for select patients, and avoidance of sodium phosphate in elderly or renally impaired individuals. Open-access colonoscopy services have expanded following the COVID-19 pandemic to manage backlogs and improve access. Improving education, simplifying regimens, and targeting interventions can reduce repeat procedures and enhance colorectal cancer detection. This narrative review summarizes patient-, medication-, and system-level risk factors for inadequate bowel preparation in high-risk populations and synthesizes practical, evidence-based strategies to optimize colonoscopy quality, including in open-access settings.

Introduction

Colorectal cancer (CRC) remains the third leading cause of cancer mortality in the United States and the second worldwide. Screening has been shown to significantly reduce both the incidence and mortality associated with CRC. Colonoscopy, the gold standard for CRC screening, can reduce CRC-related mortality by up to 68% and incidence by as much as 60%.[1] Visualization of these internal structures allows for the identification and removal of premalignant lesions, such as polyps and adenomas, thereby interrupting the adenoma-carcinoma sequence. Timely and repeated screenings play a critical role in preventing CRCs. However, the diagnostic and therapeutic efficacy of colonoscopy is critically dependent on the quality of bowel preparation.

Bowel preparation is a pre-procedural regimen designed to cleanse the colon of fecal material prior to colonoscopy. The goal of bowel preparation is to facilitate unobstructed visualization of the colonic mucosa and the terminal ileum, enabling the detection of polyps and other abnormalities. Adequate bowel preparation is essential for early lesion detection and accurate diagnostic assessment, both of which are critical for reducing CRC–related morbidity and mortality.

Inadequate bowel preparation is one of the primary factors causing missed polyps, repeat colonoscopies, and delayed care, all of which contribute to poorer patient outcomes, such as elevated CRC risk.[2] Poor preparation leads to missed lesion detection, an increased need for repeat colonoscopies within a shortened interval (often less than three years), diagnostic delays, higher healthcare costs, and reduced procedural capacity, limiting the number of unique patients a practice can accommodate annually.[3]

Certain patient populations are at increased risk for inadequate bowel preparation, and recognizing these factors early allows for more intentional and preventative care. Advanced age, obesity, immobility, smoking, and neuromuscular conditions have all been as-

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sociated with impaired gastrointestinal motility and poorer bowel cleansing outcomes.[2] Several medical comorbidities, including diabetes mellitus, chronic constipation, renal insufficiency, cirrhosis, and prior stroke, further increase the likelihood of inadequate preparation.[4] Medication use is another important contributor, as drugs known to slow gastrointestinal motility, such as calcium channel blockers, anticholinergics, tricyclic antidepressants, opioids, and other psychotropic agents, are associated with reduced preparation quality.[4] In addition to these physiological contributors, behavioral and psychosocial factors, such as language barriers, limited health literacy, inadequate patient education, and poor adherence to instructions, may also compromise bowel preparation. Because these risks often cluster within the same patient, high-risk groups benefit from tailored bowel preparation regimens and targeted adherence support.

This review is organized around the practical reasons bowel preparation fails and how clinicians can prevent repeat inadequate examinations. We summarize patient-, medication-, and system-level predictors of poor preparation in high-risk groups and review the downstream consequences for detection, procedural efficiency, and cost. We then synthesize evidence-based regimen selection and escalation strategies, including adjunctive pharmacologic and nonpharmacologic approaches, followed by education, navigation interventions, and considerations unique to open-access colonoscopy models. Finally, we highlight gaps in the literature and future directions to improve preparation quality and colonoscopy outcomes. Overall, this review aims to identify predictors of inadequate bowel preparation in high-risk populations and to provide practical, evidence-supported strategies to optimize preparation quality, including within open-access colonoscopy workflows.

Determinants of inadequate bowel preparation in high-risk patients

Physiologic and comorbidity-related factors

Bowel preparation inadequacy is an issue with multiple contributing factors related to patient- and medication-related issues, along with the psychosocial aspects of the individual.

Standardized bowel preparation strategies provide adequate bowel visualization for many individuals. However, those who are at higher risk may need individualized strategies based on the underlying causes of limited gastrointestinal motility, reduced ability to adhere to prescribed bowel preparation, and intolerance to standard bowel preparations.[5]

The physiological and medical aspects are most commonly responsible for failure of bowel preparation. Obesity has also been shown to be consistently associated with suboptimal bowel cleansing, as obese patients have a slower GI tract transit time. Patients with diabetes mellitus have both autonomic dysfunction and gastroparesis that decrease their colonic motility and create an additional problem in preparing them for colonoscopy, especially if they are using insulin or oral hypoglycemic agents. Finally, chronic constipation increases the amount of stool burden and decreases the efficacy of traditional purgative protocols for bowel preparation, thus requiring a more intense or longer bowel preparation procedure.[3]

Medication-related factors

Medication use also negatively impacts bowel preparation quality. Opioid medications taken for chronic pain will reduce gastrointestinal motility and increase the risk for constipation, which may weaken the effectiveness of the standard bowel cleansing regimen.[6] The anticholinergic side effects of some antidepressants, such as tricyclics, can slow colonic motility and cause less effective bowel preparation results. According to a systematic review conducted by Beran *et al*.,[7] there was a strong relationship between tricyclic antidepressants and inadequate bowel preparation (odds ratio (OR): 3.85; 95% confidence interval (CI): 2.63–5.63). Although non-tricyclic antidepressants, such as selective serotonin reuptake inhibitors, did not produce the same strength of the relationship between their use and bowel preparation quality, they were still shown to be associated with poorer bowel preparation quality (OR: 1.69; 95% CI: 1.10–2.61).[5]

Beyond physiological and pharmacological contributors, comorbidities and polypharmacy present distinct challenges. Medications such as diuretics and antihypertensives may increase the risk of dehydration, which in turn can interfere with adequate purgative action and compromise adherence to the regimen.[6] These effects may be further compounded in elderly or frail populations with multiple comorbidities (Table 1). Together, these factors demonstrate the complexity of achieving optimal bowel preparation.

Psychosocial and adherence barriers

In addition to patient factors, psychosocial and demographic variables can influence how well a patient completes their preparation. Older adults, individuals with limited health literacy, those who speak a different language than the provider, and individuals with lower socioeconomic status are likely to follow bowel preparation instructions less frequently than other groups.[7] Anxiety, fear, embarrassment, and anticipated discomfort are additional psychological factors that may discourage completion of bowel preparation regimens for some patients, particularly for those who lack access to culturally sensitive care.[8]

Poor adherence to preparation regimens

Furthermore, the bowel preparation process itself poses intrinsic barriers. The taste, volume, and side effects (e.g., nausea, bloating) can overwhelm patients, especially when instructions are complex or poorly explained.[8] Acknowledging and addressing these barriers through personalized education and simplified regimens is essential for improving adherence and, ultimately, clinical outcomes.

History of inadequate preparation

Among all variables studied, a prior history of inadequate preparation remains the most consistent factor hindering adequate bowel preparation. A comprehensive meta-analysis by Beran *et al*.[7] found that a history of inadequate bowel preparation was associated with a 1.92-fold increased risk of future inadequate preparation (OR: 1.92; 95% CI: 1.37–2.70). Similarly, a retrospective analysis identified prior inadequate preparation as the single strongest predictor of future inadequate preparation outcomes.[4,7] Patients who experience prior poor bowel preparation are more likely to have repeated suboptimal outcomes, delayed diagnoses, increased procedural burden, and increased avoidable healthcare costs. Prioritizing prevention through tailored education, reducing barriers to information, and providing anticipatory guidance at the first encounter are essential for reducing repeat inadequacies and improving the overall effectiveness of colonoscopy screening. Addressing all these factors requires a tailored, multidisciplinary approach that considers individual patient risk factors and potential barriers to adherence.

Table 1. Frequently identified risk factors of Inadequate Prep Across Studies

Category	Risk factors
Unmodifiable factors	Age over 65 years
Environmental	Smoking
Functional/Neuromuscular	Immobility
	Neuromuscular disabilities (MS, ALS, Parkinson's)
Obesity	BMI > 35
Medical comorbidities	Diabetes mellitus
	Chronic constipation
	Renal Insufficiency
	Cirrhosis
	Stroke
Medications	Calcium channel blockers
	Anticholinergics
	Antidepressants (TCA, SSRI)
	Opioids
Hospitalized patients	Inconsistent prep timing
	Limited mobility
	Polypharmacy
Behavioral/Psychosocial	Language barriers
	Insufficient patient education
	Low health literacy
	Poor adherence
History of poor bowel prep	Prior inadequate bowel prep (strongest indicator)

ALS, amyotrophic lateral sclerosis; BMI, body mass index; MS, multiple sclerosis; SSRI, Selective Serotonin Reuptake Inhibitors; TCA, tricyclic antidepressant.

Consequences of suboptimal bowel preparation

Missed lesions and adenomas

Suboptimal bowel preparation has been consistently associated with significantly lower detection rates for adenomas and advanced neoplasia, decreasing the effectiveness of CRC screening and surveillance. The Boston Bowel Preparation Scale (BBPS) is a current, widely accepted tool used to standardize the evaluation of bowel cleanliness. The BBPS is a 9-point scoring system. Each of the three colonic segments (ascending, transverse, and descending segments) is individually scored from 0 to 3.[2] This system allows physicians to quantify bowel preparation quality, maintain a reference standard across cases, and better predict the adequacy of visualization. Inadequate bowel preparation is defined as a score of 0 or 1 in any individual colonic segment or a total BBPS score of less than 5 across all segments. *Guo et al*.[9] analyzed over 14,000 bowel segments and found that segments with poor preparation (BBPS 0–1) had adenoma detection rates as low as 3%, in contrast to 11% in well-prepared segments. Notably, even with high total BBPS scores, poor preparation within a single segment reduced both adenoma detection rate and advanced adenoma detection rate.[9]

Sánchez et al.[10] similarly found that within a cohort of 413 patients undergoing repeat colonoscopy after an inadequate initial exam, the per-adenoma miss rate was 69%, and the advanced adenoma miss rate was 60%, results that are corroborated by other studies.[11,12] All four CRCs detected on repeat colonoscopy were missed on the initial exam, further demonstrating the significant risk of delayed cancer diagnosis due to poor bowel preparation.[10] Even segments scored as BBPS = 1 (considered by the BBPS as "suboptimal" but not entirely "inadequate") were associated with increased miss rates, supporting guidelines that recommend repeat colonoscopy when any segment scores below two.[10] Furthermore, the miss rate for serrated polyps was particularly high (84%), likely due to their flat morphology, which renders them particularly vulnerable to suboptimal visualization.[10]

Figure 1 illustrates the relationship between bowel preparation quality and lesion visibility, where lesions such as (1) flat; (2) depressed; (3) mucous cap; (4) sessile; (5) subpedunculated polyps; and (6) adenomas are at risk of being unidentified due to poor preparation conditions. These lesions rely on the detection of subtle mucosal or vascular changes and are often obscured by residual stool under poor preparation conditions.

Techniques such as narrow-band imaging enhance the visibility of features such as vascular patterns that help detect flat and other subtle lesions that may not be detected via standard white-light endoscopy. For example, sessile serrated lesions and flat, mucous-capped polyps can be better visualized with narrow-band imaging; however, under poor preparation conditions, these lesions are frequently missed. Figure 1 underscores the necessity of adequate

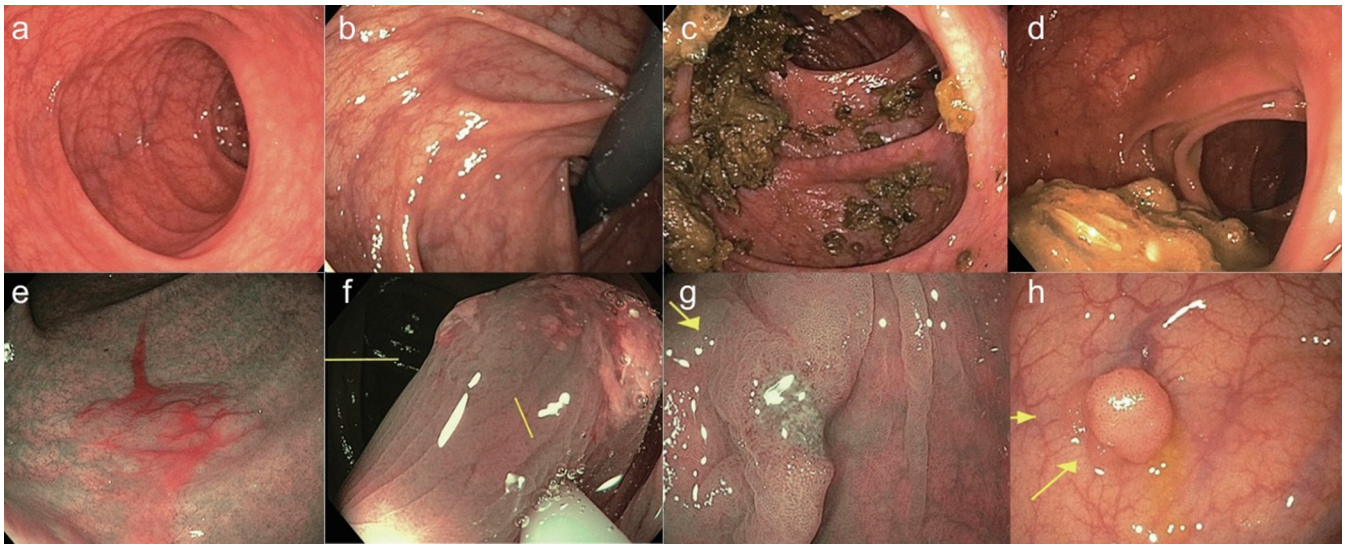

Fig. 1. Visualization of bowel preparation quality's impact on lesion detection: missed lesions in poor preparation scenarios. (a-d) Examples of descending BPPS that exemplify the importance of adequate bowel preparation and its ability to allow visualization of various lesions, polyps, and mucosal characteristics. (a) BBPS visualization score of 3; (b) BPPS visualization score of 3; (c) BBPS visualization score of 1; (d) BBPS Visualization score of 0. (e-h) Various lesions, polyps, or mucosal characteristics that can be difficult to visualize with inadequate preparation. (e) Flat, mucous capped polyp/sessile, serrated lesion seen with narrow band imaging. (f) Flat mucous capped polyp/sessile serrated lesions that demonstrates difficulty of visualization even with submucosal lift. (g) Polyp classified as a depressed adenoma via the Paris clarification with a flat elevation and central depression. (h) Subpedunculated polyp. BPPS, Boston Bowel Preparation Scales.

bowel preparation to reliably detect these lesions, given their subtle and often inconspicuous appearance.

A retrospective chart review of 373 patients with poor bowel preparation during initial colonoscopy found that a quarter of patients later identified with high-risk lesions (defined as ≥3 adenomas, lesions ≥1 cm, or those with villous features or high-grade dysplasia) had no polyps detected during their initial examination, further emphasizing the significant impact of inadequate preparation on risk reduction.[11]

Increased procedure times and complications

Poor bowel preparation impairs mucosal visualization, making cecal intubation more challenging for endoscopists; thus, cecal intubation time can be a valuable indicator of procedural difficulty associated with inadequate preparation. Longer cecal intubation times have been associated with reduced detection rates of both small and advanced colorectal adenomas, which may significantly impact patient outcomes.[13] Notably, longer withdrawal times have been shown to offset some of the decline in adenoma detection associated with prolonged cecal intubation times, suggesting a potential protective procedural mechanism.[14]

Beyond increased cecal intubation time, other factors can increase procedure time, such as the need for therapeutic procedures during endoscopy. One study found that endoscopic resection of larger polyps is associated with significantly longer procedural times compared to smaller ones.[15] Because resection of larger polyps is associated with an increased risk of post-procedure bleeding, it can be reasonably inferred that procedures requiring more time may carry a higher risk of complications such as bleeding.[16] However, evidence specifically examining whether longer procedural times alone, separate from procedural complexity, lead to a higher risk of adverse outcomes remains limited. Additional research is needed to better define the relationship between procedural time and complication rates following colonoscopy.

Elevated healthcare costs

Extensive research over the past several decades has shown that inadequate bowel preparation significantly increases healthcare costs.[17] Although colonoscopy is considered the most accurate and preferred first-line screening tool for CRC, a cost-effectiveness modeling study found that colonoscopy is not the most cost-effective option compared to sigmoidoscopy, stool DNA testing, or fecal immunochemical testing when more than 13% of procedures require repeat colonoscopy due to poor bowel preparation.[18] This is particularly concerning given that a systematic review reported repeat colonoscopy rates due to inadequate bowel preparation ranging from 24.5% in the United Kingdom to 63% in Spain.[16] The same study developed an analytical model incorporating data from five different countries, finding that achieving adequate bowel preparation prior to the initial colonoscopy substantially reduces the need for repeat procedures and leads to cost savings.[16] These findings emphasize the importance of ensuring high-quality bowel preparation when aiming to optimize both clinical outcomes and healthcare resource utilization.

Poor patient outcomes

Colonoscopy remains one of the most effective tools for CRC screening, allowing for both early detection of adenomas and the opportunity for preventive intervention. However, its effectiveness is limited by the quality of bowel preparation, and one of the most concerning consequences of inadequate bowel preparation is a significant reduction in the efficacy of CRC screening, which may lead to missed lesions and increased mortality. According to a study that used the Aronchick Bowel Preparation Scale, fair, poor, and insufficient bowel preparation were all associated with higher CRC-related mortality rates, with 10-year CRC mortality increasing from 0.14% among patients with good or excellent preparation to 0.41% among those with suboptimal preparation.[17] Inadequate and fair bowel preparation is also associated with reduced

adenoma detection rates, particularly for high-grade polyps.[17] Notably, a meta-analysis found that while poor and inadequate bowel preparation were associated with reduced adenoma detection, the detection rate in patients with fair bowel preparation was not significantly different from that in patients with good or excellent preparation. This discrepancy between studies may reflect variability in endoscopist technique and interpretation, as bowel preparation grading remains subjective and may vary among endoscopists.[18]

Similarly, one study in patients with Lynch syndrome reported that adequate bowel preparation was associated with more than twice the odds of adenoma detection compared to inadequate preparation.[19] Considering these findings, adequate bowel preparation must be prioritized to improve long-term patient outcomes in CRC screening.

Evidence-based bowel preparation regimens for high-risk patients

Standard bowel preparation strategies

Bowel preparation regimens can be broadly thought of in three ways: (1) high-volume; (2) low-volume; and (3) non–United States Food and Drug Administration (FDA)-approved regimens. Each has its own mechanism of action, tolerability, and clinical considerations based on the patient's comorbidities. These regimens constitute the foundation of colonoscopy preparation, and while each has its strengths and weaknesses, the optimal regimen is often individualized based on risk factors and patient preference.

High-volume polyethylene glycol electrolyte lavage solutions (PEG-ELS), such as GoLYTELY and CoLyte, remain among the most commonly prescribed standard bowel preparations. These isotonic solutions contain PEG-3350 and electrolytes (sodium sulfate, bicarbonate, and chloride; potassium chloride), acting as poorly absorbed polymers that draw water into the bowel via osmotic action. While these solutions are considered safe for patients with renal or cardiac disease, the need for 4 L of fluid can hinder tolerability. Many patients report feeling nauseated and bloated, while others report cramping and anal irritation. Due to this, a split-dose approach—the consumption of 2 L the evening before the colonoscopy and then 2 L on the morning of the procedure—has been used. The use of split-dose PEG-ELS has been shown to result in significantly improved bowel cleansing, approximately 30% better in the proximal colon, and increased rates of polyp detection. The rationale behind split dosing is that the initial dose eliminates residual stool, and the second dose removes overnight accumulations of chyme, resulting in better visualization during the procedure. In 2011, Kilgore *et al*.[20] conducted and published a systematic review and meta-analysis, concluding that "split-dose PEG resulted in significantly improved satisfactory bowel preparations as compared to non-split-dose (OR: 3.70; 95% CI: 2.79–4.91), and increased patients' willingness to repeat the same bowel preparation (OR: 1.76; 95% CI: 1.06–2.91)".

Additional studies support these findings, such as the meta-analysis study by Martel *et al*.,[21] which demonstrated that split-dose PEG regimens resulted in better cleansing and improved patient preference compared to day-before preparation. The requirement for patients to take the second dose on the day of the procedure can be inconvenient, as it often requires patients to wake around 2 a.m., disrupting sleep.

Sulfate-free PEG-ELS agents such as NuLYTELY and TriLyte offer comparable efficacy with fewer metallic taste and gastrointestinal side effects. However, their 4-L volume requirement still poses adherence challenges.

Low-volume PEG-based regimens have gained traction in terms of tolerability. MoviPrep is made with PEG-3350 and ascorbic acid, functioning as an osmotic agent that requires only 2 L of total fluid consumption. The FDA-approved PLENVU preparation uses PEG-3350 and high-dose ascorbate to reduce the total volume of preparation to 1 L, supplemented with additional clear fluids. This tolerance scheme is certainly more appealing to patients, but nausea, bloating, and abdominal discomfort are still reported with both regimens.[22] Other examples of low-volume FDA-approved solutions include oral sulfate preparations such as SUPREP (liquid) and SUTAB (tablet formulation). These agents consist of (1) sodium; (2) potassium; and (3) magnesium sulfate salts that exert an osmotic effect. Patients consume 12–24 oz of the purgative, followed by 2–2.5 L of clear liquids to complete preparation. Although tolerability is improved and the preparation volume is reduced, these hypertonic agents are not without risk, particularly in patients with renal insufficiency, congestive heart failure, and disturbances in electrolyte balance.[23]

Sodium picosulfate-based regimens (e.g., CLENPIQ) and sodium phosphate tablets (OsmoPrep) are also hypertonic osmotic agents with good efficacy but may induce a greater risk of volume depletion and electrolyte derangements. As noted in the prior section on bowel preparation regimens, these types are generally avoided in patients with chronic kidney disease, bowel obstruction, or heart failure.[24]

There are also many non-FDA-approved regimens that are commonly utilized, given their favorable tolerability profile and convenience of administration. The most widely utilized is the MiraLAX/Gatorade regimen, which consists of 238 g of PEG-3350 dissolved in 2 L of a sports drink such as Gatorade. MiraLAX/Gatorade is hypotonic, generally better tolerated, and efficacious for many average-risk patients, although less safety profile data are available in patients with significant comorbidities. While early studies raised concerns regarding electrolyte derangements and decreased efficacy, more recent studies have demonstrated that MiraLAX/Gatorade achieves comparable bowel cleanliness to PEG-ELS preparations when used in sufficiently large amounts (e.g., extended dosing time or higher doses), with minimal laboratory derangements.[8,25] Two commonly used over-the-counter alternatives include magnesium citrate (two bottles of 0.355 L each) and bisacodyl (usually 20 mg orally), often used in combination regimens, especially for patients with constipation or those struggling to tolerate high volumes of solution.[22]

All preparation agent types require consideration of multiple patient-related factors, including (1) renal function; (2) comorbid conditions; (3) medication burden; and (4) previous preparation quality. In high-risk populations, standard regimens often result in suboptimal bowel preparation, which has prompted growing interest in adjunctive therapies to improve cleansing quality and increase the likelihood of a sufficient colonoscopy.

Strategies for high-risk patients

Before performing colonoscopy in patients deemed high risk, bowel preparation should be tailored to their past medical history, tolerability, and risk factors. According to the American Gastroenterological Association and the United States Multi-Society Task Force on Colorectal Cancer (2021), the recommended regimen for high-risk patients consists of a split-dose 4-L PEG-ELS combined with 15 mg of bisacodyl, administered after a low-residue diet (LRD) for two to three days and a clear-liquid diet on the day

Table 2. Optimizing bowel preparation in high-risk patients: Strategies and regimen comparisons

Prep therapy	Components	Advantages	Disadvantages/ Limitations	Ideal patient populations
Split-dose high-volume PEG-ELS	4L PEG-electrolyte solution split into 2 doses	Best cleansing quality, higher polyp detection rates, endorsed by AGA and US Multi-Society Task Force	Sleep disruption (second dose ~2am), complicated schedule	General use, high-risk patients, elderly, frail patients
Low-volume PEG + Ascorbate (MoviPrep, PLENVU)	1–2L PEG + ascorbate	Good efficacy, better tolerability, fewer adverse events (nausea, bloating)	Still requires significant fluid intake; may need adjuncts for severe constipation	Elderly, frail, renal/ cardiac comorbidities
Miralax + Gatorade ("Bright Bar" prep)	PEG 3350 powder + Gatorade	Well tolerated, palatable	Potential risk of hypotonicity, not FDA-approved, lower cleansing efficacy, potential electrolyte disturbances	Low-risk patients if no renal/cardiac issues (caution advised)
PEG + Adjunctive Stimulant Laxatives	PEG + Bisacodyl or Sodium Picosulfate	Enhances peristalsis, reduces volume burden	Risk of diarrhea, abdominal pain, contraindicated in obstruction/inflammation	Severe constipation, opioid users (with caution)
PEG + Osmotic agents (e.g., magnesium citrate)	PEG + magnesium citrate	Further enhances bowel movement	Risk of hypermagnesemia, avoid in renal insufficiency	Young, otherwise healthy patients
PEG + prokinetic agents (e.g., metoclopramide)	PEG + metoclopramide	May reduce nausea, improve gastric emptying	Limited effectiveness, extrapyramidal side effects	Rarely needed; selective cases with significant nausea
PEG + PAMORAs (e.g., Methylnaltrexone, Naloxegol)	PEG + Opioid antagonists	Useful for opioid-induced constipation without affecting analgesia	Diarrhea, abdominal pain, contraindicated in bowel obstruction	Chronic opioid users
LRD + split-dose PEG	Dietary restriction + split purgative	Improves tolerability, compliance, and similar or better prep vs clear liquid diet	Requires patient education and adherence	High-risk patients, general population
Sodium sulfate-based Preps (e.g., SUTAB, SUPREP)	Sodium sulfate, potassium sulfate, magnesium sulfate (tablets or liquid)	Lower volume, good efficacy	Hypertonic, risk of dehydration/electrolyte shifts, not for renal impairment	Patients intolerant to PEG, low-risk populations
Sodium picosulfate + Mag Oxide + Citric Acid (CLENPIQ)	Sodium picosulfate, magnesium oxide, citric acid	Palatable, lower volume	Hypertonic, not for renal/ cardiac patients, expensive	Select patients needing low-volume alternative with good compliance
Sodium Phosphate Tablets (OsmoPrep)	Sodium phosphate	Tablet form, avoids large fluid volume	Risk of nephropathy, electrolyte imbalance, contraindicated in renal impairment	Only in healthy, young patients without comorbidities

AGA, American Gastroenterological Association; FDA, U.S. Food and Drug Administration; LRD, low-residue diet; PAMORAs, peripherally acting μ-opioid receptor antagonists; PEG, polyethylene glycol; PEG-ELS, polyethylene glycol electrolyte solution.

preceding colonoscopy. The split-dose regimen has been shown to improve bowel cleansing by more effectively removing residual stool and chyme, allowing for clearer visualization. This approach is especially important in patients with a history of poor preparation or chronic constipation.[8] For patients with renal insufficiency or heart conditions, isotonic high-volume PEG solutions should be used to minimize shifts in fluids and electrolytes.[12] For patients unable to tolerate high-volume preparations, low-volume regimens containing ascorbate, such as MoviPrep or PLENVU, may be considered. Both regimens have demonstrated equivalent efficacy and tolerability.[26–28] Overall, bowel preparation should be individualized, with selection guided by the patient's medical history and risk factors to enhance preparation quality and compliance,[22,29,30] as detailed in Table 2.

Adjunctive medications

Adjunctive medications can maximize the effectiveness and tolerability of bowel preparation, especially in high-risk patients with (1) chronic constipation; (2) diabetes; (3) a history of opioid use; (4) obesity; or (5) a history of poor bowel preparation.

Table 3. Adjunctive therapies and medications to optimize bowel preparation

Category	Strategy	Description & Indications	Cautions / Side effects
Adjunctive medications	Bisacodyl	Stimulant laxative used with PEG to enhance peristalsis and bowel cleansing	Diarrhea, abdominal pain; avoid in ileus, obstruction, dehydration, IBD
	Sodium Picosulfate + Mg citrate	Stimulant plus osmotic combo that enhances cleansing and decreases prep volume	GI discomfort; avoid in renal insufficiency
	Magnesium citrate	Osmotic agent retaining fluid to stimulate movement; lowers prep volume	Avoid in renal failure due to hypermagnesemia
	Simethicone	Reduces bloating and gas for better patient tolerability Often added to PEG	Well tolerated, minimal side effects
	Metoclopramide	Prokinetic that improves gastric emptying and may reduce nausea	EPS, tardive dyskinesia; use limited
	Loperamide (Imodium)	May improve cecal/ascending colon cleansing *after* lavage Used post-prep only	Contraindicated during prep; can worsen constipation if misused
	Methylnaltrexone / Naloxegol	PAMORAs used for opioid-induced constipation without reducing pain control	Abdominal pain, diarrhea; contraindicated in bowel obstruction
	Psyllium (Fiber Supplement)	Used days before prep to improve stool consistency/ frequency Beneficial in chronic constipation	Combine with PEG for best results; needs >10g/day for ≥4 weeks
Adjunctive therapies	Double prep	Full prep regimen is repeated twice Improves prep quality and detection, especially in high-risk or previously inadequate preps	More burdensome for patients; used selectively
	Low-volume Prep (Miralax + Gatorade)	17g Miralax mixed with electrolyte drink like Gatorade to increase tolerability and reduce volume burden	Avoid in renal/cardiac patients if not properly monitored
	LRD	2–3 days of low-residue food before procedure improves prep and compliance vs clear liquid diet	Avoid high-fiber foods, seeds, nuts, fruits/vegetables
	Dietary fiber (long-term)	Incorporating dietary fiber long before procedure can help keep regularity in chronically constipated patients	Ineffective short-term; not a substitute for PEG-based prep

EPS, extrapyramidal symptoms; GI, gastrointestinal; IBD, inflammatory bowel disease; LRD, low-residue diet; Mg, magnesium; PAMORAs, peripherally acting μ-opioid receptor antagonists; PEG, polyethylene glycol.

Table 3 summarizes key adjunctive medications and therapies, their indications, and potential cautions. Stimulant laxatives such as bisacodyl are commonly used adjunctively with PEG-ELS to enhance bowel cleansing efficacy. Bisacodyl acts by stimulating colonic peristalsis and secretion, thereby decreasing the volume of solution needed. While generally well tolerated, bisacodyl can cause adverse effects including diarrhea, abdominal pain, and, rarely, ischemic colitis. Bisacodyl is contraindicated in patients with ileus, intestinal obstruction, severe dehydration, or acute inflammatory diseases.[22,31] Sodium picosulfate is another stimulant laxative that promotes colonic peristalsis and is typically administered in combination with magnesium citrate to enhance efficacy. Similar to bisacodyl, sodium picosulfate can cause diarrhea and abdominal pain and has similar contraindications.[31,32] Osmotic agents can also be used as adjunctive medications to improve bowel preparation effectiveness. For example, magnesium citrate osmotically draws fluid into the colonic lumen, stimulating peristalsis, potentially decreasing the total preparation volume required. However, its use is contraindicated in patients with renal insufficiency or chronic kidney disease due to the risk of hypermagnesemia. Simethicone is an anti-foaming agent sometimes included in PEG solutions to reduce bloating and gas and improve patient comfort. It is generally well tolerated with minimal side effects.[8]

Prokinetic agents such as metoclopramide may be used during bowel preparation to improve gastric emptying and possibly reduce nausea; however, their effectiveness is limited. Prokinetics can produce extrapyramidal symptoms or tardive dyskinesia and therefore should not be routinely used for bowel preparation. Loperamide (Imodium), an inhibitor of gut motility, is generally contraindicated during bowel preparation, as it slows gastrointestinal movement and can worsen constipation. However, Church *et al*.[33] found that when loperamide is used after completing bowel preparation, it can improve cleansing, particularly in the cecum and ascending colon. In a randomized trial, the authors found that patients who received 4 mg of loperamide after completing their PEG bowel preparation the night before had a significantly lower incidence of a dirty or bile-coated cecum (2.0% vs. 12.7% with placebo; $P = 0.0041$), without significantly delaying the time to the first bowel movement ($P = 0.72$). This suggests that loperamide may improve preparation quality in select patients when used following completion of the lavage.[31,33]

Peripherally acting μ-opioid receptor antagonists, such as methylnaltrexone and naloxegol, offer efficacy comparable to standard treatments for opioid-induced constipation, with the key advantage of preserving central analgesia. They are useful for patients receiving chronic opioid therapy. Common adverse effects include (1) abdominal pain; (2) diarrhea; and (3) flatulence.[34] They are contraindicated in patients with known or suspected mechanical gastrointestinal obstruction.

Table 4. Educational and supportive interventions

Intervention type	Description	Key outcomes
Oral and written instructions	Use of verbal + written instructions, including booklets, infographics, and video. Most effective when culturally and linguistically appropriate.	Improved adherence and reduced poor bowel prep; lower repeat colonoscopy rates
Audiovisual tools	Supplemental AV re-education (e.g., smartphone video). Improves bowel prep score, adherence, and patient satisfaction.	Statistically higher BBPS scores, higher AS, improved satisfaction
Virtual reality tools	Use of VR-based educational video. Shown to improve BBPS scores and adenoma detection rates.	Higher patient-reported BBPS scores and higher adenoma detection rates
Patient navigation	Trained individuals guide patients through the process, assist with logistics, and provide culturally competent, personalized support.	Higher adequate prep rates, fewer missed appointments, lower cancellations, improved equity in screening

AS, adherence score; AV, audiovisual; BBPS, Boston Bowel Preparation Scale; VR, virtual reality.

Non-pharmacologic adjunctive strategies

Double bowel preparation, in which patients complete a full preparation regimen twice prior to colonoscopy, is used to enhance mucosal visualization in high-risk populations or in patients with a history of inadequate bowel preparation. This strategy has demonstrated improved rates of adequate bowel preparation. In a prospective study, patients undergoing an intensive regimen consisting of a low-fiber diet for 72 h, a liquid diet for 24 h, bisacodyl, and split-dose PEG achieved adequate bowel cleansing in 90.2% of repeat colonoscopies. This approach was also associated with increased polyp detection and a mean BBPS score of 7.43.[35]

For patients who struggle with high-volume preparations, MiraLAX-PEG may be considered. This low-volume regimen consists of 17 g of MiraLAX with Gatorade (as a replacement for PEG) and is used as an alternative to traditional high-volume PEG solutions to improve tolerability while still achieving adequate bowel cleansing. This approach can also be used in patients at risk for fluid overload or those who struggle to consume large volumes of liquid.[36]

Dietary modifications can greatly influence the efficacy of bowel preparation, particularly in high-risk patients. Unlike laxatives, dietary fiber increases stool bulk and promotes regular bowel habits by incorporating water and bacterial mass into the stool. Psyllium, a soluble fiber, has been shown to improve stool frequency and consistency, especially when administered at dosages greater than 10 g/day for at least four weeks.[37] However, fiber may need to be combined with osmotic or stimulant laxatives to achieve satisfactory bowel preparation, particularly in patients with severe or opioid-induced constipation. For instance, PEG can be used with psyllium to soften stool and improve regular bowel habits.[37]

In addition to fiber supplementation, implementation of an LRD is recommended. The American Gastroenterological Association and the United States Multi-Society Task Force on Colorectal Cancer recommend an LRD for 2–3 days before the procedure in combination with a split-dose purgative regimen. This diet has demonstrated better patient compliance and comparable, if not superior, bowel cleansing compared with a traditional clear liquid diet.[8,38] A low-residue diet restricts the intake of high-fiber and other bulk-forming foods to decrease colonic residue. Examples include (1) cereals; (2) beans; (3) nuts; (4) seeds; (5) raw or dried fruits; and (6) vegetables.[38] Recent studies comparing an LRD with a clear liquid diet for bowel preparation have shown that an LRD is at least as effective in achieving adequate bowel preparation, with the added benefits of improved patient tolerability and fewer gastrointestinal side effects.[22] Importantly, patients on an LRD reported improved satisfaction, reduced hunger, and decreased nausea and bloating compared with those on a clear liquid diet.[22]

Educational and supportive interventions

Oral and written instructions

The American Gastroenterological Association recommends that patients undergoing colonoscopy receive an educational process that uses both verbal and written instructions covering all aspects of the bowel preparation process. This recommendation by the American Gastroenterological Association is based on extensive evidence demonstrating that multimodal educational approaches improve patient understanding and adherence, decrease the occurrence of poor bowel preparation, and reduce the likelihood of repeat colonoscopies.[22] Standardized educational formats such as (1) booklets or leaflets; (2) animated videos; and (3) infographics tend to be particularly effective. When developed and formatted to account for health literacy and the educational diversity of patient populations, standardized education can be universally applied and is practical for all patients. In addition, it is important to account for language barriers by providing educational materials in other languages, such as Spanish. Notably, combining detailed written instructions with verbal education in the form of videos has demonstrated an independent association with adequate bowel preparation quality.[22,39,40] By providing individualized guidance through clear and repeatable educational efforts, a meaningful impact on colonoscopy outcomes can be achieved. A concise summary of these educational and supportive interventions is provided in Table 4.

Audiovisual (AV) tools

AV tools are a powerful supplement to support patient education and knowledge retention regarding bowel preparation. A randomized controlled trial involving 283 patients evaluated the modified use of AV re-education delivered through smartphones in combination with standard Solaris instructions for bowel preparation. The AV intervention significantly improved mean BBPS scores, with the AV group achieving a mean score of 7.53 compared with 6.29 in the standard re-education group ($P < 0.001$), indicating that increased patient education is correlated with improved bowel preparation quality. The AV group demonstrated better adherence

to the bowel preparation regimen, as reflected by a higher adherence score, which quantifies patient compliance with the regimen. Patient satisfaction was assessed using a visual analog scale and indicated significantly greater perceived helpfulness and clarity of AV content compared with traditional education.[41] In conclusion, AV re-education demonstrates substantial utility in communicating bowel preparation instructions to patients, resulting in greater adherence to bowel preparation regimens and improved patient satisfaction. Clinically, these factors promote clearer visualization of the bowel, allowing for reduced rates of repeat colonoscopies and missed lesions.

New technologies also provide a promising direction for educational interventions. In one clinical trial, a virtual reality video-based educational intervention resulted in significantly higher BBPS scores (mean 7.61 vs. 7.04, $P = 0.002$) and higher adenoma detection rates (32.6% vs. 22.1%, $P = 0.03$) compared with standard instruction.[42] While these findings are encouraging, the incremental benefit of virtual reality may be limited in settings where baseline adequacy rates are already high, and its feasibility is constrained by cost, equipment, and staff training requirements.[43] Thus, although guided visual tools show promise for enhancing patient knowledge and mucosal visualization, their scalability and cost-effectiveness remain uncertain for routine clinical use.

Patient navigation

Patient navigation programs, comprised of trained personnel who assist patients throughout the colonoscopy process, have been associated with improved bowel preparation quality, reduced rates of incomplete procedures, and increased equitable access to CRC screening—especially in the high-risk populations previously mentioned (obese and diabetic patients, individuals with low health literacy, and patients with language barriers).

Navigators help improve bowel preparation quality by (1) providing individualized education; (2) reviewing bowel preparation protocols; and (3) ensuring that patients understand and follow the necessary preparation steps. One study found that navigated patients were 5.9 times more likely to achieve adequate bowel preparation compared with patients who did not receive navigation support.[44]

One of the most beneficial aspects of patient navigation is the reduction in incomplete procedures. Navigators assist with (1) scheduling appointments; (2) sending reminders; and (3) arranging transportation, all of which drastically decrease rates of no-shows and cancellations. In one study, 0% of patients with navigators missed their appointments, compared with 15.6% in the control group. Additionally, navigated patients were 24.8 times more likely to avoid cancellations within 24 h of their scheduled procedure.[44]

Navigators have been shown to be especially useful in addressing the multifactorial barriers that high-risk patients often face:

- *Logistical:* (1) scheduling conflicts; (2) transportation issues; or (3) preparation timing challenges.
- *Sociodemographic:* (1) older age; (2) low health literacy; (3) language barriers; or (4) limited socioeconomic resources.
- *Psychosocial:* (1) anxiety about the procedure; (2) fear of discomfort; or (3) cultural misunderstandings regarding screening.

For example, culturally competent navigation programs have been shown to significantly improve colonoscopy completion rates among Hispanic patients and to eliminate gender disparities in screening service utilization.[45] Furthermore, navigators can provide valuable emotional and peer support for patients. Access to such support can reduce feelings of isolation that may lead to missed appointments and can increase patient engagement in anxiety-inducing situations or when anticipating the procedure itself.[46] Additionally, use of a patient's preferred language has been shown to improve understanding of and adherence to bowel preparation instructions.[22] Overall, patient navigation (1) optimizes bowel preparation; (2) decreases procedural failure rates; and (3) reduces health disparities by delivering individualized and culturally competent, patient-centered services throughout the colonoscopy process.

Addressing challenges in OAC services

Risks associated with open-access models

The COVID-19 pandemic has significantly disrupted healthcare systems worldwide, causing a backlog of patients requiring essential preventive care services such as colonoscopies. To mitigate these delays, many institutions expanded the use of OAC systems, which are models that allow primary care physicians (PCPs) to directly refer patients for colonoscopy without requiring a pre-procedure consultation with a gastroenterologist.[47] This backlog, which has particularly impacted individuals from minority populations and low socioeconomic backgrounds, poses a considerable challenge to public health. OACs increase healthcare access by removing barriers and streamlining the process for patients, particularly benefiting individuals from underserved communities who may face additional hurdles in accessing specialized healthcare services. While OACs offer numerous advantages to patients, they are not without quality concerns.

One of the most pressing issues associated with OACs is the increased risk of suboptimal bowel preparation. Studies have demonstrated that open-access referrals are correlated with higher rates of inadequate bowel preparation, incomplete procedures, and inappropriate screening intervals.[48] A critical driver of this issue is the absence of direct gastroenterologist–patient interaction, during which detailed instructions, clarification of expectations, and assessment of individual risk factors for poor preparation would typically occur.[49,50] Without the pre-procedural visit, patients may receive inadequate education and counseling on CRC and colonoscopy from their PCPs.

Referring PCPs, often outside the gastroenterology specialty, may lack familiarity with the nuances of bowel preparation regimens, particularly in high-risk populations such as patients with (1) constipation; (2) diabetes; (3) opioid use; or (4) prior inadequate preparation. As a result, these patients may receive incomplete or inconsistent preparation instructions, exacerbated by variation in written materials, literacy barriers, or language differences. These communication gaps are further widened among patients from marginalized communities, where limited health literacy and complex social needs intersect to reduce the likelihood of adequate bowel preparation and follow-through.[42] Importantly, there is a significant lack of research addressing the quality of bowel preparation education delivered by non-gastroenterologists in open-access settings.

Few studies have examined the knowledge gaps that may exist among referring PCPs regarding appropriate preparation instructions, particularly for high-risk patients.

Given the potential for compromised colonoscopy outcomes, further research is urgently needed to characterize these deficiencies and to develop targeted interventions that ensure high-quality preparation guidance is consistently provided.

Strategies for improvement

To address these limitations while preserving the access benefits of OAC models, targeted interventions are essential. Improved communication between referring PCPs and gastroenterology teams is a foundational step toward enhancing the functionality of OAC models and achieving adequate bowel preparation. Standardized bowel preparation protocols, including (1) culturally tailored written materials; (2) videos; and (3) mobile applications, should be integrated into referral workflows to ensure consistent messaging.[42] The inclusion of patient navigators has shown promise in bridging communication gaps and improving preparation adherence. These individuals can guide patients through the colonoscopy process, reinforce key preparation steps, and offer personalized support for overcoming logistical barriers. Navigation support may be particularly effective for patients with prior preparation failures or those identified as high risk based on medical or social history.

Finally, incorporating a feedback loop, such as notifying primary care teams of inadequate preparations and offering retraining or supplemental resources, can help close knowledge gaps and improve future referrals. By enhancing provider education, patient engagement, and system-wide coordination, OAC models can retain their strengths in expanding access while minimizing the risk of compromised bowel preparation and poor procedural quality.

Future directions

Enhanced education and technology

Patient-related barriers remain a dominant contributor to inadequate bowel preparation, emphasizing the need for targeted strategies that reduce disparities and improve patient outcomes. As discussed earlier, patient navigator programs have shown significant promise, not only in increasing bowel preparation quality but also in expanding access to colonoscopy for underserved populations.[44] Furthermore, studies have shown that digital health interventions, including short message service reminders, offer potential for improving patient adherence and bowel preparation quality in a simple yet effective way. These tools have been associated with both reduced no-show rates for colonoscopy procedures and improved bowel preparation outcomes.[45]

Medical interventions

Future research is needed to explore the role of MiraLAX–Gatorade regimens as an alternative to traditional PEG–electrolyte solutions for patients who struggle with high-volume preparations. While existing evidence suggests that MiraLAX–Gatorade regimens have comparable efficacy and improved tolerability, more studies are necessary to determine which patient populations may benefit the most. Additionally, the development of standardized dosing protocols for the non-FDA-approved PEG + Gatorade regimens may help ensure safety and effectiveness. Additionally, further research is needed to confirm the efficacy of post-lavage loperamide administration in improving mucosal visualization, especially given its traditionally contraindicated use due to constipating effects. While a randomized controlled trial demonstrated reduced coated cecum rates, this intervention is not currently recommended by the US Multi-Society Task Force.[22] Concerns also remain regarding patient adherence, potential side effects, and overall cost-effectiveness, which limit its feasibility for routine incorporation into bowel preparation protocols.[22] Studies are needed to define optimal timing, dosing, and patient selection criteria for its safe and effective incorporation into bowel preparation protocols.

Conclusions

Adequate bowel preparation is essential for effective colorectal cancer screening, yet remains a frequent challenge in patients at high risk for suboptimal cleansing. Inadequate preparation is associated with reduced lesion detection, increased procedural complexity, higher healthcare costs, and poorer patient outcomes. Optimizing bowel preparation in high-risk populations requires an individualized, patient-centered, and multifactorial approach. Evidence supports the use of tailored bowel preparation regimens, dietary modifications, adjunctive pharmacologic agents, and structured patient education to improve preparation quality and adherence. By aligning preparation strategies with patient-specific risk factors and workflow considerations, clinicians can enhance colonoscopy quality and maximize the preventive impact of colorectal cancer screening.

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Conflict of interest

Each author certifies that there are no funding or commercial associations (consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article, related to the author or any immediate family members.

Author contributions

Study concept and design (TA, MT), acquisition of data (TA, LAR, SM, AJ), analysis and interpretation of data (TA, LAR, SM, AJ), drafting of the manuscript (TA, LAR, SM, AJ), critical revision of the manuscript for important intellectual content (MT), administrative, technical, or material support (TA), and study supervision (MT). All authors have made significant contributions to this study and have approved the final manuscript.

Ethical statement

All endoscopic images included in this review were de-identified and obtained from institutional archives with approval from the institutional review board, and it conformed to the Declaration of Helsinki (as revised in 2024). The requirement for individual informed consent was waived due to the retrospective and non-interventional nature of this review.

References

[1] Pan J, Xin L, Ma YF, Hu LH, Li ZS. Colonoscopy Reduces Colorectal Cancer Incidence and Mortality in Patients With Non-Malignant

Findings: A Meta-Analysis. Am J Gastroenterol 2016;111(3):355–365. doi:10.1038/ajg.2015.418, PMID:26753884.
[2] Lai EJ, Calderwood AH, Doros G, Fix OK, Jacobson BC. The Boston bowel preparation scale: a valid and reliable instrument for colonoscopy-oriented research. Gastrointest Endosc 2009;69(3 Pt 2):620–625. doi:10.1016/j.gie.2008.05.057, PMID:19136102.
[3] Agha OQ, Alsayid M, Brown MD. Bowel preparation in diabetic patients undergoing colonoscopy. Ann Gastroenterol 2021;34(3):310–315. doi:10.20524/aog.2021.0599, PMID:33948054.
[4] Ness RM, Manam R, Hoen H, Chalasani N. Predictors of inadequate bowel preparation for colonoscopy. Am J Gastroenterol 2001;96(6):1797–1802. doi:10.1111/j.1572-0241.2001.03874.x, PMID:11419832.
[5] Fayad NF, Kahi CJ, Abd El-Jawad KH, Shin AS, Shah S, Lane KA, *et al*. Association between body mass index and quality of split bowel preparation. Clin Gastroenterol Hepatol 2013;11(11):1478–1485. doi:10.1016/j.cgh.2013.05.037, PMID:23811246.
[6] Nusrat S, Mahmood S, Bitar H, Tierney WM, Bielefeldt K, Madhoun MF. The impact of chronic opioid use on colonoscopy outcomes. Dig Dis Sci 2015;60(4):1016–1023. doi:10.1007/s10620-015-3639-3, PMID:25822037.
[7] Beran A, Abourshed T, Ali AH, Albunni H, Mohamed MF, Vargas A, *et al*. Risk Factors for Inadequate Bowel Preparation in Colonoscopy: A Comprehensive Systematic Review and Meta-Analysis. Am J Gastroenterol 2024;119(12):2389–2397. doi:10.14309/ajg.0000000000003073, PMID:39225554.
[8] Johnson DA, Barkun AN, Cohen LB, Dominitz JA, Kaltenbach T, Martel M, *et al*. Optimizing adequacy of bowel cleansing for colonoscopy: recommendations from the US multi-society task force on colorectal cancer. Gastroenterology 2014;147(4):903–924. doi:10.1053/j.gastro.2014.07.002, PMID:25239068.
[9] Guo R, Wang YJ, Liu M, Ge J, Zhang LY, Ma L, *et al*. The effect of quality of segmental bowel preparation on adenoma detection rate. BMC Gastroenterol 2019;19(1):119. doi:10.1186/s12876-019-1019-8, PMID:31286888.
[10] Pantaleón Sánchez M, Gimeno Garcia AZ, Bernad Cabredo B, García-Rodríguez A, Frago S, Nogales O, *et al*. Prevalence of missed lesions in patients with inadequate bowel preparation through a very early repeat colonoscopy. Dig Endosc 2022;34(6):1176–1184. doi:10.1111/den.14278, PMID:35189669.
[11] Chokshi RV, Hovis CE, Hollander T, Early DS, Wang JS. Prevalence of missed adenomas in patients with inadequate bowel preparation on screening colonoscopy. Gastrointest Endosc 2012;75(6):1197–1203. doi:10.1016/j.gie.2012.01.005, PMID:22381531.
[12] Lebwohl B, Kastrinos F, Glick M, Rosenbaum AJ, Wang T, Neugut AI. The impact of suboptimal bowel preparation on adenoma miss rates and the factors associated with early repeat colonoscopy. Gastrointest Endosc 2011;73(6):1207–1214. doi:10.1016/j.gie.2011.01.051, PMID:21481857.
[13] Blanks RG, Nickerson C, Patnick J, Rees C, Rutter M. Evaluation of colonoscopy performance based on post-procedure bleeding complications: application of procedure complexity-adjusted model. Endoscopy 2015;47(10):910–916. doi:10.1055/s-0034-1392263, PMID:26070007.
[14] Fritz CDL, Smith ZL, Elsner J, Hollander T, Early D, Kushnir V. Prolonged Cecal Insertion Time Is Not Associated with Decreased Adenoma Detection When a Longer Withdrawal Time Is Achieved. Dig Dis Sci 2018;63(11):3120–3125. doi:10.1007/s10620-018-5100-x, PMID:29721773.
[15] Overhiser AJ, Rex DK. Work and resources needed for endoscopic resection of large sessile colorectal polyps. Clin Gastroenterol Hepatol 2007;5(9):1076–1079. doi:10.1016/j.cgh.2007.04.022, PMID:17625979.
[16] Murphy D, Jenks M, McCool R, Wood H, Young V, Amlani B. A systematic review and cost analysis of repeat colonoscopies due to inadequate bowel cleansing in five European countries. Expert Rev Pharmacoecon Outcomes Res 2019;19(6):701–709. doi:10.1080/14737167.2019.1597709, PMID:30938201.
[17] Zessner-Spitzenberg J, Waldmann E, Rockenbauer LM, Klinger A, Klenske E, Penz D, *et al*. Impact of Bowel Preparation Quality on Colonoscopy Findings and Colorectal Cancer Deaths in a Nation-Wide Colorectal Cancer Screening Program. Am J Gastroenterol 2024;119(10):2036–2044. doi:10.14309/ajg.0000000000002880, PMID:39007693.
[18] 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):1714–1723. doi:10.1038/ajg.2014.232, PMID:25135006.
[19] Sánchez A, Roos VH, Navarro M, Pineda M, Caballol B, Moreno L, *et al*. Quality of Colonoscopy Is Associated With Adenoma Detection and Postcolonoscopy Colorectal Cancer Prevention in Lynch Syndrome. Clin Gastroenterol Hepatol 2022;20(3):611–621.e9. doi:10.1016/j.cgh.2020.11.002, PMID:33157315.
[20] Kilgore TW, Abdinoor AA, Szary NM, Schowengerdt SW, Yust JB, Choudhary A, *et al*. Bowel preparation with split-dose polyethylene glycol before colonoscopy: a meta-analysis of randomized controlled trials. Gastrointest Endosc 2011;73(6):1240–1245. doi:10.1016/j.gie.2011.02.007, PMID:21628016.
[21] Martel M, Barkun AN, Menard C, Restellini S, Kherad O, Vanasse A. Split-Dose Preparations Are Superior to Day-Before Bowel Cleansing Regimens: A Meta-analysis. Gastroenterology 2015;149(1):79–88. doi:10.1053/j.gastro.2015.04.004, PMID:25863216.
[22] Jacobson BC, Anderson JC, Burke CA, Dominitz JA, Gross SA, May FP, *et al*. Optimizing Bowel Preparation Quality for Colonoscopy: Consensus Recommendations by the US Multi-Society Task Force on Colorectal Cancer. Gastroenterology 2025;168(4):798–829. doi:10.1053/j.gastro.2025.02.002, PMID:40047732.
[23] DailyMed. SUPREP BOWEL PREP- sodium sulfate, potassium sulfate, magnesium sulfate solution, concentrate. Available from: https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=2f5f06de-ee98-44c0-be7e-9a998d1e5c16. Accessed January 28, 2026.
[24] DailyMed. CLENPIQ- sodium picosulfate, magnesium oxide, and anhydrous citric acid liquid. Available from: https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=e95fff66-4ec0-4001-a727-33e66a5ec7d5. Accessed January 28, 2026.
[25] Samarasena JB, Muthusamy VR, Jamal MM. Split-dosed MiraLAX/Gatorade is an effective, safe, and tolerable option for bowel preparation in low-risk patients: a randomized controlled study. Am J Gastroenterol 2012;107(7):1036–1042. doi:10.1038/ajg.2012.115, PMID:22565162.
[26] Repici A, Spada C, Cannizzaro R, Traina M, Maselli R, Maiero S, *et al*. Novel 1-L polyethylene glycol + ascorbate versus high-volume polyethylene glycol regimen for colonoscopy cleansing: a multicenter, randomized, phase IV study. Gastrointest Endosc 2021;94(4):823–831.e9. doi:10.1016/j.gie.2021.04.020, PMID:33940043.
[27] van Riswijk MLM, Indemans FA, Hawinkels K, Schreuder RM, Wildeman L, Tan ACITL, *et al*. Comparing low volume versus intermediate volume bowel preparation and their impact on work and tolerability: an open-label, noninferiority randomized controlled trial. Endoscopy 2026;58(2):151–162. doi:10.1055/a-2695-0994, PMID:40902625.
[28] Xie Q, Chen L, Zhao F, Zhou X, Huang P, Zhang L, *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. doi:10.1371/journal.pone.0099092, PMID:24902028.
[29] Shahini E, Sinagra E, Vitello A, Ranaldo R, Contaldo A, Facciorusso A, *et al*. Factors affecting the quality of bowel preparation for colonoscopy in hard-to-prepare patients: Evidence from the literature. World J Gastroenterol 2023;29(11):1685–1707. doi:10.3748/wjg.v29.i11.1685, PMID:37077514.
[30] Occhipinti V, Soriani P, Vavassori S, Annunziata ML, Bagolini F, Cavallaro F, *et al*. Risk factors for inadequate bowel preparation in patients using high- and low-volume cleansing products. Eur J Gastroenterol Hepatol 2023;35(2):159–166. doi:10.1097/MEG.0000000000002467, PMID:36574306.
[31] Chang L, Chey WD, Imdad A, Almario CV, Bharucha AE, Diem S, *et al*. American Gastroenterological Association-American College of Gastroenterology Clinical Practice Guideline: Pharmacological Management of Chronic Idiopathic Constipation. Gastroenterology 2023;164(7):1086–1106. doi:10.1053/j.gastro.2023.03.214, PMID:37211380.
[32] DailyMed. SODIUM PICOSULFATE, MAGNESIUM OXIDE AND ANHYDROUS CITRIC ACID- sodium picosulfate, magnesium oxide and anhy-

drous citric acid powder, metered. Available from: https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=b759dc12-2dc1-4ef4-a375-1a61630d54d6. Accessed January 28, 2026.
[33] Church J, Bast J, Elayi E, Xhaja X. Keeping the cecum clean: a randomized, prospective, placebo-controlled trial of loperamide as part of preparation for colonoscopy. Dis Colon Rectum 2013;56(1):120–125. doi:10.1097/DCR.0b013e3182707d27, PMID:23222289.
[34] Crockett SD, Greer KB, Heidelbaugh JJ, Falck-Ytter Y, Hanson BJ, Sultan S, American Gastroenterological Association Institute Clinical Guidelines Committee. American Gastroenterological Association Institute Guideline on the Medical Management of Opioid-Induced Constipation. Gastroenterology 2019;156(1):218–226. doi:10.1053/j.gastro.2018.07.016, PMID:30340754.
[35] Ibáñez M, Parra-Blanco A, Zaballa P, Jiménez A, Fernández-Velázquez R, Fernández-Sordo JO, *et al*. Usefulness of an intensive bowel cleansing strategy for repeat colonoscopy after preparation failure. Dis Colon Rectum 2011;54(12):1578–1584. doi:10.1097/DCR.0b013e31823434c8, PMID:22067188.
[36] Siddique S, Lopez KT, Hinds AM, Ahmad DS, Nguyen DL, Matteson-Kome ML, *et al*. Miralax with gatorade for bowel preparation: a meta-analysis of randomized controlled trials. Am J Gastroenterol 2014;109(10):1566–1574. doi:10.1038/ajg.2014.238, PMID:25135007.
[37] van der Schoot A, Drysdale C, Whelan K, Dimidi E. The Effect of Fiber Supplementation on Chronic Constipation in Adults: An Updated Systematic Review and Meta-Analysis of Randomized Controlled Trials. Am J Clin Nutr 2022;116(4):953–969. doi:10.1093/ajcn/nqac184, PMID:35816465.
[38] Zhang X, Wu Q, Wei M, Ding Y, Gu C, Liu S, *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):508–518.e3. doi:10.1016/j.gie.2020.04.069, PMID:32376331.
[39] Brach C, editor. AHRQ Health Literacy Universal Precautions Toolkit. 3rd ed. Rockville (MD): Agency for Healthcare Research and Quality; 2024.
[40] Losurdo G, Martino ML, De Bellis M, Celiberto F, Rizzi S, Principi M, *et al*. Effect of Visual Booklets to Improve Bowel Preparation in Colonoscopy: Systematic Review with Meta-Analysis. J Clin Med 2023;12(13):4377. doi:10.3390/jcm12134377, PMID:37445412.
[41] Back SY, Kim HG, Ahn EM, Park S, Jeon SR, Im HH, *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):789–799.e4. doi:10.1016/j.gie.2017.09.007, PMID:28939500.
[42] Chen G, Zhao Y, Xie F, Shi W, Yang Y, Yang A, *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. doi:10.1001/jamanetworkopen.2021.35576, PMID:34807255.
[43] Ganayem R, Alamour O, Cohen DL, Ealiwa N, Abu-Freha N. Enhancing Patient Education for Colonoscopy Preparation: Strategies, Tools, and Best Practices. J Clin Med 2025;14(12):4375. doi:10.3390/jcm14124375, PMID:40566123.
[44] Rice K, Gressard L, DeGroff A, Gersten J, Robie J, Leadbetter S, *et al*. Increasing colonoscopy screening in disparate populations: Results from an evaluation of patient navigation in the New Hampshire Colorectal Cancer Screening Program. Cancer 2017;123(17):3356–3366. doi:10.1002/cncr.30761, PMID:28464213.
[45] Winkler CS, Hardaway JC, Ceyhan ME, Espat NJ, Saied Calvino A. Decreasing colorectal cancer screening disparities: A culturally tailored patient navigation program for Hispanic patients. Cancer 2022;128(9):1820–1825. doi:10.1002/cncr.34112, PMID:35128638.
[46] Rohan EA, Slotman B, DeGroff A, Morrissey KG, Murillo J, Schroy P. Refining the Patient Navigation Role in a Colorectal Cancer Screening Program: Results From an Intervention Study. J Natl Compr Canc Netw 2016;14(11):1371–1378. doi:10.6004/jnccn.2016.0147, PMID:27799508.
[47] Manem N, Donovan K, Miller D, Yodice M, Wang K, Balogun K, *et al*. Open-access colonoscopy quality indicators and patient perception using split-dose bowel preparation. JGH Open 2021;5(5):563–567. doi:10.1002/jgh3.12532, PMID:34013055.
[48] Ghaoui R, Ramdass S, Friderici J, Desilets DJ. Open access colonoscopy: Critical appraisal of indications, quality metrics and outcomes. Dig Liver Dis 2016;48(8):940–944. doi:10.1016/j.dld.2016.04.005, PMID:27160698.
[49] Russell L, Mathura P, Lee A, Dhaliwal R, Kassam N, Kohansal A. Patient-centered approaches to targeting incomplete bowel preparations for inpatient colonoscopies. Ann Gastroenterol 2021;34(4):547–551. doi:10.20524/aog.2021.0623, PMID:34276194.
[50] Donovan K, Manem N, Miller D, Yodice M, Kabbach G, Feustel P, *et al*. The Impact of Patient Education Level on Split-Dose Colonoscopy Bowel Preparation for CRC Prevention. J Cancer Educ 2022;37(4):1083–1088. doi:10.1007/s13187-020-01923-x, PMID:33405208.