Optimizing Bowel Cleansing for Colonoscopy

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Abstract

Adequate bowel cleansing is essential for complete examination of the colon mucosa during colonoscopy. Suboptimal bowel preparation has potential adverse consequences, such as missed pathologic abnormalities, the need for repeated procedures, and increased procedure-related complications. Several factors can predict individuals at increased risk for inadequate bowel preparation. If predictors of inadequate bowel preparation are identified, then education should be intensified and a more aggressive bowel regimen recommended. On completion of this article, you should be able to (1) define the frequency of inadequate colon preparations, (2) identify predictors of poor bowel preparation, and (3) employ a more aggressive bowel regimen when clinically indicated.

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teronscopy is most often performed for colorectal cancer screening. For optimal performance and visualization of mucosal lesions and details, adequate bowel preparation is essential. The degree of bowel cleansing is a critical factor in diagnostic colonoscopy. However, bowel preparation is inadequate in up to 30% of cases and decreases diagnostic accuracy, prolongs the procedure time, decreases surveillance intervals, increases cost, and potentially results in procedure-related complications. In this article, the available bowel preparations are reviewed, considerations for colonic preparation are highlighted, and steps to optimize bowel preparation are outlined.

TYPES OF COLONIC PURGATIVES

The ideal bowel preparation should effectively clear the colon of stool and provide maximal visualization of mucosa, preserve the gross and microscopic integrity of the colon, and be easily administered, well tolerated, and safe. The ideal colonic purgative does not exist. Available colonoscopy preparations are of 2 broad categories: polyethylene glycol (PEG) based and hypertonic. Both types of preparations can produce...
adequate bowel cleansing but with variability in tolerance, preparation-induced mucosal changes, and adverse events.

Polyethylene Glycol
The PEG-electrolyte regimens are the most commonly administered preparations. A variety of PEG-based formulations are available, and they differ with respect to volume of solution, electrolyte content, requirement for adjunctive laxative, presence of artificial sweeteners, and efficacy. In general, PEG-based formulations include standard 4-L and reduced-volume 2-L preparations. The 2-L, low-volume PEG preparation is said to provide comparable colonic cleansing as 4-L formulations. However, note that clinical trials of colonoscopy purgatives are often designed as noninferiority studies and are not powered to demonstrate equivalence. In addition, patients with chronic constipation are often excluded from studies. Therefore, low-volume PEG formulations are not sufficient in all patient populations. In a recent meta-analysis, 4-L, split-dose PEG-electrolytes were found to be superior. Overall, PEG-based preparations are safe and well tolerated. The most common adverse events are nausea, abdominal pain, and bloating. Not surprisingly, the reduced volume regimens decrease nausea and abdominal bloating and may be better tolerated. The PEG preparations are iso-osmotic and are preferred in patients less likely to tolerate fluid shifts, such as those with renal insufficiency, congestive heart failure, or advanced liver disease. Because of their excellent safety profile, PEG-based agents are the most commonly used bowel colonoscopy purgatives.

Over-the-Counter PEG Product
MiraLAX (PEG 3350; Braintree Laboratories Inc) is an over-the-counter product for the treatment of constipation. As a colonoscopy bowel-cleansing regimen, 1 bottle (8.3 oz; 238 g) is mixed with 64 oz of Gatorade (PepsiCo) to create a nonosmotically balanced 2-L PEG formulation. Bisacodyl tablets or magnesium citrate are used in conjunction with the PEG 3350 powder. However, 4-L, split-dose PEG-electrolyte preparations seem to be more effective. In contrast, tolerability (taste and overall experience) is better with MiraLAX/Gatorade than with 4-L PEG-electrolytes. Despite MiraLAX/Gatorade being a hypotonic solution, hyponatremia is rare with the use of this over-the-counter formulation, which is an option in patients without congestive heart failure, liver disease with ascites, or chronic kidney disease.

Hyperosmotic Preparations
Hyperosmotic preparations contain poorly absorbed multivalent cations or anions with osmotic effects and increase intraluminal water, causing bowel distension and evacuation. The available hyperosmotic agents include sodium phosphate (NaP), sodium picosulfate, and magnesium citrate.

The NaP preparations are effective and may be better tolerated than PEG-based preparations because of lower volume. A meta-analysis found NaP to be more effective in bowel cleansing than standard PEG-electrolytes and comparable in terms of adverse events. However, most studies compared NaP with standard 4-L PEG-electrolytes. When both are administered in split-dose regimens, no difference in efficacy was seen, but split-dose PEG-electrolytes were better tolerated, with less nausea and vomiting. Therefore, when administered in split fashion, PEG formulations seem to be better tolerated than NaP, with equal cleansing efficacy.

Potential adverse effects of NaP preparations include fluid shifts, hyperphosphatemia, electrolyte abnormalities, tonic-clonic seizures, mucosal damage, and acute renal failure (acute phosphate nephropathy). Acute phosphate nephropathy is characterized by precipitation of calcium phosphate crystals in the renal tubules, which may cause chronic irreversible kidney injury even in patients with previously normal renal function. Previous renal insufficiency and medications that impact renal function, such as diuretics, angiotensin-converting enzyme inhibitors, and angiotensin receptor blockers, predispose to complications of NaP. Although the incidence of acute phosphate nephropathy is low, the Food and Drug Administration issued a black box warning for acute phosphate nephropathy in those with advanced age, preexisting renal disease, decreased intravascular volume, and use of medications that affect renal perfusion or function. Because of these concerns, routine use of NaP as a bowel preparation is not recommended. Despite this statement, a recent large, retrospective cohort study found no increased risk of acute kidney injury with the use of oral NaP compared with PEG even in high-risk clinical subgroups.
adverse renal effects from oral NaP preparations are rare. If considered for use, oral NaP preparations are best for otherwise healthy patients, who should be instructed on how to maintain adequate hydration during preparation and after the procedure.

Sodium sulfate is an alternative osmotic bowel purgative with similar effectiveness and tolerance as PEG formulations. Sodium sulfate solutions do not cause significant electrolyte or fluid shifts in individuals without cardiac, renal, or liver disease. Sodium sulfate—based preparations have not been tested in patients at risk for electrolyte abnormalities or intravascular volume shifts; therefore, they are not recommended for use in such patients.

A newer dual-action hyperosmotic preparation contains sodium picosulfate and magnesium. Sodium picosulfate acts as a stimulant laxative, and magnesium acts as an osmotic agent. Sodium picosulfate is better tolerated than and produces a similar degree of cleansing as NaP and PEG preparations. However, sodium picosulfate preparations can precipitate severe hyponatremia in older adults.

Commonly used bowel preparations and comments on their use are summarized in Table 1.

**TABLE 1. Commonly Used Bowel Preparations**

<table>
<thead>
<tr>
<th>Type</th>
<th>Products</th>
<th>Comments on use</th>
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<tbody>
<tr>
<td>Polyethylene glycol</td>
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</tr>
<tr>
<td>4-L PEG-ELS</td>
<td>GoLYTELY and Colyte</td>
<td>4 L is the gold standard for efficacy</td>
</tr>
<tr>
<td>4-L SF PEG</td>
<td>NuLYTELY and TriLyte</td>
<td>4 L is the gold standard for efficacy</td>
</tr>
<tr>
<td>2-L PEG-ELS and bisacodyl</td>
<td>Halfltyly</td>
<td>Preferable option if history of poor tolerability of the 4-L PEG preparation and medical/patient predictors of poor preparation are absent</td>
</tr>
<tr>
<td>2-L PEG with ascorbate</td>
<td>MoviPrep</td>
<td>Alternative to 4-L PEG if no medical/patient predictors of poor preparation</td>
</tr>
<tr>
<td>MiraLAX and Gatorade</td>
<td>OTC</td>
<td>Inferior to PEG in preparation quality and may precipitate severe hyponatremia because not osmotically balanced</td>
</tr>
<tr>
<td>Sodium phosphate tablet</td>
<td>OsmoPrep</td>
<td>Avoid in individuals with cardiac, renal, or liver disease</td>
</tr>
<tr>
<td>Sodium picosulfate</td>
<td>Prepopik</td>
<td>Better tolerated than PEG preparations; avoid in individuals with cardiac, renal, or liver disease</td>
</tr>
<tr>
<td>Sodium sulfate</td>
<td>Suprep</td>
<td>Similar efficacy and tolerability as PEG formulation; avoid in individuals with cardiac, renal, or liver disease</td>
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</table>

ELS = electrolyte lavage solution; OTC = over the counter; PEG = polyethylene glycol; SF = sulfate free.

A general preparation is defined as one that allows endoscopic visualization of polyps larger than 5 mm throughout the colorectum. This operational definition allows the detection of clinically significant lesions and is accompanied by the expectation that screening and surveillance intervals available in established guidelines are followed. Inadequate preparations result in examinations being repeated sooner, which increases the cost and potential risks of colonoscopy. Literature has emerged defining patients who are at risk for inadequate bowel cleansing (Table 2). There are 2 sets of predictors of inadequate preparation: medical factors and patient factors.

Medical predictors include previous failed bowel preparation, chronic constipation, use of constipating medications, diabetes mellitus, obesity, and previous colonic resection. Medical predictors of inadequate preparation can be easily identified by providers. Patient factors associated with inadequate bowel preparation relate to predictors of not following preparation instructions and include Medicaid insurance, English not being the patient’s first language, lower educational level, low health literacy, low patient activation (how engaged a patient is in his or her health care), and a longer waiting time between the date the procedure is scheduled and the day of the procedure. Patient factors are difficult to assess in clinical practice. Two useful surrogates for not following bowel preparation instructions are Medicaid insurance and English not being the patient’s first language. It is important to identify medical and patient predictors so that measures can be taken to overcome them.
ADDITIONAL FACTORS INFLUENCING CLEANSING

Additional factors that may influence the quality of bowel preparation include split-dose administration, timing, dietary factors, and use of adjunctive agents. Traditionally, a large volume of iso-osmotic PEG-electrolyte solution was given 1 day before colonoscopy. The main disadvantages of this preparation are large volume and poor palatability. Poor adherence prompted refinements such as split-dose administration. Dose splitting consists of taking half the preparation the evening before and the remainder the morning of the examination. Meta-analyses show that split-dosing regimens are more effective, irrespective of the type of bowel preparation used, which is due to improved tolerance and adherence to preparation regimens, with subsequent improvement in quality of bowel cleansing. Because split-dose preparation regimens are associated with better colonic cleansing (particularly in the right colon), increased patient satisfaction, and improved polyp detection rates, it is considered the standard for patients undergoing colonoscopy. Time between bowel preparation and the start of colonoscopy is also important in determining bowel preparation quality. A shorter interval between the last dose of bowel preparation and the colonoscopy procedure is associated with improved bowel preparation quality. To maximize preparation quality, colonoscopy should be performed within 3 to 5 hours of the last dose of preparation. Every hour by which the interval is extended is associated with a 10% decrease in adequate bowel preparation. An interval of more than 5 hours from the last purgative dose allows new small intestinal effluent to coat the right colonic mucosa, which impairs mucosal visualization. Sessile serrated polypos are more commonly located in the right colon and are likely even more vulnerable to underdetection than adenomas in persons with suboptimal preparations. Consideration should be given to not performing colonoscopies with a preparation-to-colonoscopy interval greater than 7 hours because of significant worsening in bowel preparation quality.

In addition to an active cleansing agent, bowel preparation typically consists of a restrictive diet. However, there is a paucity of data regarding the role of dietary factors in the quality of bowel preparation. Refraining from seeds and corn is recommended for several days before colonoscopy, and only clear fluids are permitted on the day preceding the procedure. Consumption of solid, low-residue food before colonoscopy does not affect the efficacy of colon cleansing and can enhance tolerance compared with a clear liquid diet. In addition to being better tolerated, a low-residue diet results in more adequate bowel cleanliness than a clear liquid diet on the day preceding colonoscopy. The importance of adherence to a low-residue diet was highlighted in a large retrospective cohort study, and ingestion of a prescribed low-residue diet for 2 days preceding colonoscopy was an independent predictor of adequate bowel preparation.

ADJUNCTS TO COLON CLEANSING

Adjunctive agents, such as enemas, prokinetics, and simethicone, are variably used to improve bowel preparation, but routine use of such adjuncts is not necessary and does not improve bowel preparation. Adjunctive enema decreases patient acceptability. Prokinetic agents, such as metoclopramide, have not shown improvement in tolerability or quality of bowel cleansing and are not recommended. Bubbles and foam encountered during colonoscopy can decrease mucosal visualization. Simethicone reduces the surface tension of air bubbles and is inexpensive; however, its addition to oral lavage preparations does not improve colon cleanliness.

SELECTING A BOWEL PREPARATION

Many providers prescribe the same bowel preparation for all procedures, irrespective of patient characteristics. Given the high rate of inadequate cleansing, identifying patients at higher risk for poor bowel cleansing is important.
bowel preparation is often predictable based on 2 categories of factors: medical predictors and other patient issues, such as socioeconomic status, educational level, insurance type, and health literacy. If any of these predictive factors of inadequate preparation are present, a more individualized and aggressive preparation regimen should be instituted.

An evidence-based strategy for how to respond to medical predictors of inadequate preparation is not available. Common strategies in clinical practice include using a standard 4-L preparation “plus” or a “2-day” preparation. The standard preparation plus strategy is used in individuals with medical factors predictive of inadequate preparation. The standard 4-L PEG formulation is prescribed in a split dose with the addition of a stimulant laxative (3-12 tablets of low-dose senna or 10 mg of bisacodyl) to increase the cleansing effect. The 2-day preparation is used after a previous failed preparation and consists of repeating the standard PEG-electrolyte preparation by taking 8 L over 2 days. In 1 study, repeating colonoscopy the next day reduced the risk of repeated failure. When a predictor of not following preparation instructions is present (eg, Medicaid insurance and English not being the patient’s first language), increased educational efforts should be instituted, including a preprocedural visit incorporating instructions in the patient’s primary language. A general stepwise approach to optimizing bowel preparation is outlined in Table 3.

### Special Patient Populations

Specific populations, such as inpatients, the elderly, those suspected of having inflammatory bowel disease, and individuals with previous bariatric surgery, may benefit from a tailored bowel preparation.

#### Hospitalized Individuals

Hospitalized patients spend most of their time in bed, with limited ambulation. Most of the approved bowel preparations were studied in ambulatory outpatients, where upright posture and walking promote gastrointestinal motility and facilitate laxation. Hospitalized patients should receive the gold standard of a 4-L PEG-electrolyte solution in split dosing to ensure adequate colon cleansing.

#### Elderly Patients

Advanced age (>65 years) is a predictor of inadequate bowel preparation. There are no specific bowel preparation regimens for elderly persons. However, NaP preparations should be avoided in this population for concern of nephrotoxicity. In addition, sodium picosulfate preparations can precipitate severe hyponatremia in older adults. Because age is a predictor of inadequate bowel preparation, the gold standard of a 4-L PEG-electrolyte solution should be used instead of low-volume PEG-electrolyte preparations to ensure adequate colon cleansing.

#### Suspected Inflammatory Bowel Disease

The use of NaP-containing preparations can induce endoscopic mucosal abnormalities that mimic Crohn disease. Nonspecific aphthoid-like mucosal lesions occur in approximately 25% of patients. These superficial mucosal changes can lead to diagnostic confusion. Thus, NaP preparations should not be used in patients with unexplained diarrhea and when the diagnosis of inflammatory bowel disease is suspected.

#### Previous Bariatric Surgery

No specific preparation regimens are recommended in persons with a history of bariatric surgery. Patients who have undergone restrictive gastric surgery may better tolerate low-volume preparations. In addition, sugar-free drinks and foods should be consumed to avoid symptoms related to dumping from the high sugar content.

### Conclusion

The goal of bowel preparation for colonoscopy is to clean the colon for effective examination in a safe and tolerable manner. With this goal in mind, several steps can be taken to optimize bowel preparation (Table 3). First, all patients should be provided with simple and convenient

### Table 3. Steps to Optimizing Bowel Preparation

<table>
<thead>
<tr>
<th>Step</th>
<th>Instruction</th>
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<tbody>
<tr>
<td>1.</td>
<td>Provide both verbal and written instructions</td>
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<tr>
<td>2.</td>
<td>Use a split-dosing strategy</td>
</tr>
<tr>
<td>3.</td>
<td>Ensure a preparation-to-colonoscopy interval of &lt;5 h</td>
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<tr>
<td>4.</td>
<td>Intensify the bowel-cleansing regimen if medical predictors of inadequate preparation exist</td>
</tr>
<tr>
<td>5.</td>
<td>Individualize the cleansing regimen and increase education in previous failed preparations</td>
</tr>
<tr>
<td>6.</td>
<td>Recommend adequate hydration during purgative ingestion</td>
</tr>
<tr>
<td>7.</td>
<td>Instruct patient to avoid consuming raw vegetables, seeds, nuts, and corn for 3 d before colonoscopy</td>
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</table>
verbal and written instructions on bowel preparation. These instructions should include the use of a split-dosing regimen, with completion of the preparation less than 5 hours before colonoscopy. A PEG electrolyte preparation is indicated for patients at risk for electrolyte abnormalities or intravascular volume shifts (eg, congestive heart failure, liver disease with ascites, or chronic kidney disease). If medical predictors of inadequate preparation exist, then a more aggressive preparation, such as 4-L PEG-electrolytes or a low-volume preparation plus magnesium citrate, should be provided. When patient predictors of suboptimal preparation are identified, education should be intensified, with emphasis on ensuring understanding of the preparation process and the need for adherence. If no medical or patient factors predictive of inadequate preparation are present, then a high-quality colon cleansing can usually be achieved with a low-volume PEG preparation. Finally, all patients should be advised to avoid consuming raw vegetables, seeds, nuts, and corn for 3 days before colonoscopy and to avoid consuming raw vegetables, seeds, nuts, and corn for 3 days before colonoscopy and to maintain adequate hydration during preparation to minimize adverse effects of volume depletion and electrolyte abnormalities. Following these steps should ensure a safe, tolerable, and adequate bowel preparation.

Abbreviations and Acronyms: ELS = electrolyte lavage solution; NaP = sodium phosphate; OTC = over the counter; PEG = polyethylene glycol; SF = sulfate free

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REFERENCES


