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Optimizing Bowel Preparation: An Interprofessional Nursing, Radiology, and Health Assistant Approach to Patient Safety and Diagnostic Accuracy

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Abstract

Background: Colonoscopy is the gold standard for detecting colorectal pathology, but its diagnostic accuracy depends on adequate bowel preparation. Poor preparation compromises mucosal visualization, increases procedural risk, and leads to missed lesions and repeat procedures.

Aim: To review bowel preparation strategies, contraindications, and interprofessional roles in optimizing patient safety and diagnostic outcomes.

Methods: A comprehensive literature-based analysis was conducted, synthesizing evidence on preparation regimens, physiologic considerations, contraindications, and team-based interventions. The review emphasizes pharmacologic classifications, dosing strategies, and quality assessment tools such as the Boston Bowel Preparation Scale (BBPS).

Results: Isosmotic polyethylene glycol (PEG)-based regimens remain the safest and most effective, particularly in patients with comorbidities. Low-volume PEG with ascorbic acid improves tolerability but is contraindicated in G6PD deficiency. Hyposmotic PEG-3350 regimens may cause electrolyte disturbances, while hyperosmotic agents like magnesium citrate and sodium sulfate require caution in renal impairment. Sodium phosphate is largely avoided due to nephropathy risk. Split-dose administration consistently improves cleansing quality and adenoma detection rates. Interprofessional collaboration—physicians, nurses, and pharmacists—enhances adherence and safety, while patient education significantly improves outcomes.

Conclusion: Effective bowel preparation is a multidisciplinary process integrating regimen selection, patient-centered education, and objective quality assessment. Individualized planning and team-based interventions reduce incomplete colonoscopies, improve lesion detection, and enhance patient safety.

Keywords: Bowel preparation, colonoscopy, PEG, contraindications, patient safety, interprofessional care, BBPS

Introduction

Clinicians employ a spectrum of bowel preparation strategies with varying regimens, tolerability profiles, and efficacy outcomes to optimize colon cleansing prior to colonoscopy. Colonoscopy remains the contemporary gold standard for direct visualization of colonic mucosa, enabling identification of pathological lesions that may require excision or biopsy, including premalignant polyps and early-stage malignancies. Because the diagnostic and therapeutic yield of colonoscopy is highly contingent on the clarity of mucosal visualization, the adequacy of bowel preparation is not a procedural detail but a central determinant of clinical effectiveness and patient safety. Evidence from reviews indicates that incomplete colonoscopies—commonly defined as failure to achieve cecal intubation and/or inability to perform effective mucosal visualization—occur at

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rates ranging from 10% to 20%.[1][2][3] These incomplete examinations represent a clinically important failure mode because they can necessitate repeat procedures, delay diagnosis, increase healthcare utilization, and diminish patient confidence in screening and surveillance programs. Poor bowel preparation has direct implications for oncologic detection and procedural risk. Inadequate cleansing can obscure mucosal surfaces, reducing the likelihood of detecting subtle or flat lesions that may represent early neoplasia. Consequently, suboptimal preparation has been associated with missed cancerous or precancerous lesions, undermining the preventive capacity of colonoscopy.[3][4] Beyond diagnostic compromise, inadequate preparation can also increase the risk of adverse events during the procedure. When luminal contents remain, endoscopists may need to prolong procedure time, perform more extensive irrigation and suctioning, or apply additional maneuvering to advance the scope, all of which can increase sedation exposure and procedural complexity. In practical terms, the clinical cost of poor preparation is twofold: it can lead to under-detection of clinically significant pathology and may contribute to an elevated likelihood of procedural complications.[3][4]

The variability in bowel preparation quality is not random; rather, it reflects identifiable patient and system-level risk factors that can be anticipated and addressed through targeted interventions. Multiple studies have reported that previous inadequate bowel preparation is a strong predictor of future preparation failure, emphasizing the importance of documenting preparation outcomes and adapting regimens for subsequent procedures.[5][6][7][8][9] Social and communication factors also contribute, with non-English speaking status identified as a risk factor—likely reflecting barriers to understanding preparation instructions, limitations in culturally or linguistically tailored education, and reduced opportunity to clarify questions.[5][6][7][8][9] Insurance status, such as Medicaid coverage, has also been associated with poor preparation, potentially acting as a proxy for broader determinants including access to resources, health literacy, and structural barriers to timely follow-up.[5][6][7][8][9] Additional demographic and clinical predictors include being single, inpatient status, polypharmacy, obesity, advanced age, and male sex, each of which may influence adherence, physiologic response to laxatives, mobility, or the ability to follow complex timed regimens.[5][6][7][8][9] Comorbidities such as diabetes, stroke, dementia, and Parkinson disease further elevate risk, plausibly through effects on gastrointestinal motility, cognitive function, functional status, or medication interactions that complicate bowel cleansing.[5][6][7][8][9] An optimal bowel preparation strategy therefore must balance cleansing efficacy with patient-centered considerations and physiologic safety. Ideal preparation is designed not only to improve mucosal visualization but also to reduce patient discomfort, minimize disruptive shifts in fluid and electrolytes, and support adherence by being understandable and feasible for the patient's circumstances.[10] From a clinical standpoint, bowel preparation should be safe, tolerable, and inexpensive, recognizing that the "best" regimen is one that patients can complete effectively without significant adverse consequences.[10] These principles underscore the importance of individualized preparation planning, particularly for patients with known risk factors for poor preparation, where enhanced education, simplified instructions, regimen adjustments, and proactive support can improve the likelihood of a complete and diagnostically reliable colonoscopy.[5][6][7][8][9][10]

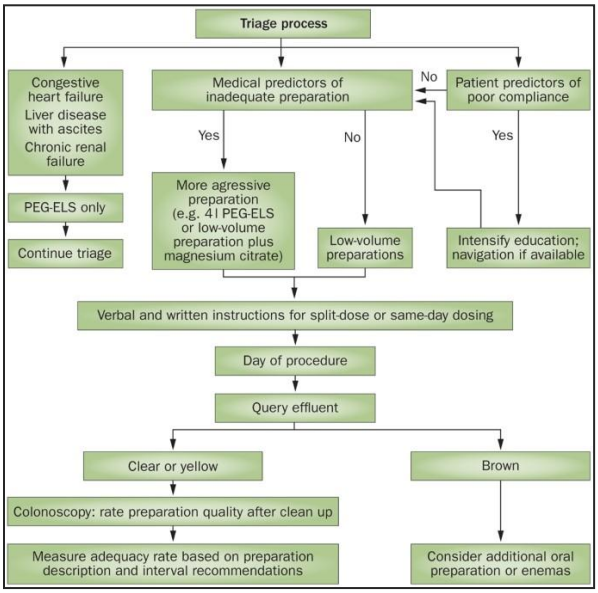

Fig. 1: Optimal Bowel preparation.

Anatomy and Physiology

Adequate bowel preparation is fundamentally linked to the anatomy and physiological function of the lower gastrointestinal tract, as the diagnostic value of colonoscopy depends on unobstructed visualization of the mucosal lining across multiple colonic segments. Colonoscopy is

designed to evaluate the rectum and the entire colon, including the sigmoid colon, descending colon, transverse colon, and ascending colon, culminating in assessment of the cecum, which represents the proximal terminus of the large intestine. In many examinations, the endoscopist may also intubate the ileocecal valve to inspect the terminal ileum, the distal portion of the small intestine, particularly when inflammatory bowel disease, occult bleeding, or other small-bowel–adjacent pathology is suspected. Physiologically, the colon is responsible for water and electrolyte absorption, as well as storage and controlled propulsion of fecal material through coordinated motility patterns. These functions, while essential for homeostasis, also promote the presence of residual stool, mucus, and fluid within the lumen—materials that can adhere to haustral folds and obscure flat lesions or subtle mucosal abnormalities. Effective bowel preparation reduces this intraluminal burden, allowing the endoscope to traverse the curvature and folds of the colon while maintaining clear visualization of the mucosa. By improving the contrast between the mucosal surface and the lumen, high-quality cleansing enhances detection of polyps, inflammatory changes, vascular lesions, and early neoplasia, particularly in anatomically complex regions such as the sigmoid colon and the cecum where folds and angulations can conceal pathology if preparation is inadequate [9][10].

Indications

Bowel preparation is indicated whenever colonoscopic evaluation is planned and accurate mucosal inspection is required for diagnosis, surveillance, or therapeutic intervention. It is essential for colorectal cancer screening and post-polypectomy surveillance, as detection and removal of premalignant lesions depend on clear mucosal visualization throughout the colon. Preparation is likewise indicated for patients undergoing investigation of gastrointestinal bleeding, iron-deficiency anemia, unexplained changes in bowel habits, chronic diarrhea, or suspected inflammatory bowel disease, where subtle mucosal findings may alter diagnosis and management. In addition, bowel preparation supports colonoscopy performed for therapeutic purposes, including polypectomy, endoscopic mucosal resection, stricture evaluation, and hemostatic interventions, because residual stool can impair instrument maneuverability and increase procedural risk. More broadly, any scenario in which colonoscopy is expected to reach the cecum and potentially the terminal ileum requires bowel preparation to maximize completion rates, minimize repeat procedures, and ensure that clinically significant lesions are not missed due to obscured visualization [10][11].

Contraindications

Contraindications to bowel preparation are best understood as regimen-specific restrictions rather than a blanket prohibition on colon cleansing. Most patients require bowel preparation to facilitate safe and diagnostically reliable colonoscopy; however, the osmotic load, electrolyte composition, and pharmacologic actions of commonly used agents can produce clinically meaningful harm in vulnerable populations. Therefore, contraindications generally arise from the interaction between a preparation's mechanism—whether osmotic, stimulant, or electrolyte-shifting—and a patient's underlying metabolic, renal, cardiovascular, or hematologic risk profile. In practice, clinicians must differentiate between absolute contraindications, in which a specific agent should not be used under any circumstance for a given patient, and relative contraindications, where risks can be mitigated through dose modification, enhanced monitoring, or selection of an alternative regimen. The overarching clinical objective is to achieve adequate cleansing without provoking electrolyte derangements, renal injury, hemodynamic compromise, or severe gastrointestinal intolerance. Low-volume 2-L polyethylene glycol electrolyte lavage solutions (PEG-ELS) combined with ascorbic acid represent one commonly used strategy designed to improve tolerability compared with higher-volume PEG regimens. Despite their practical advantages, these preparations should be avoided in patients with glucose-6-phosphate dehydrogenase (G6PD) deficiency. The rationale for this restriction centers on the oxidative potential associated with high-dose ascorbic acid exposure, which can increase the risk of hemolysis in G6PD-deficient individuals. In such patients, red blood cells have reduced capacity to neutralize oxidative stress, and exposure to certain oxidant drugs or high-dose vitamin C–containing products can precipitate hemolytic anemia. As a result, when G6PD deficiency is known or strongly suspected, alternative bowel preparation strategies that do not include ascorbic acid should be selected to minimize avoidable hematologic risk [11][12].

PEG-3350 preparations, which are often used as osmotic laxatives, carry additional considerations in patients with baseline electrolyte

abnormalities. PEG-3350 should be avoided in individuals with electrolyte disturbances because the cathartic effect can exacerbate existing imbalances through large-volume stool losses, shifts in free water, and dilutional effects if excessive hypotonic fluids are consumed alongside the regimen. While PEG solutions are generally regarded as among the safer options due to minimal systemic absorption, the clinical context matters: patients with unstable sodium, potassium, bicarbonate, or magnesium levels, or those with conditions that predispose them to rapid electrolyte shifts, may experience worsening abnormalities during aggressive catharsis. Accordingly, in patients with known electrolyte derangements, bowel preparation should be selected and supervised with greater caution, emphasizing regimens with a more predictable electrolyte profile and ensuring appropriate pre-procedure and, when necessary, post-preparation laboratory assessment. Magnesium citrate is another bowel preparation agent that is widely used due to its osmotic effect and patient acceptability, yet it poses particular hazards in patients with renal dysfunction and those at increased risk of magnesium toxicity.[3] Magnesium is primarily cleared by the kidneys; therefore, impaired renal function can lead to reduced excretion and accumulation. When magnesium citrate is administered to patients with chronic kidney disease or other conditions that limit renal clearance, serum magnesium can rise to clinically significant levels, potentially causing neuromuscular depression, hypotension, bradyarrhythmias, and in severe cases, respiratory compromise. Magnesium citrate should also be avoided in patients with existing electrolyte abnormalities because catharsis can compound disturbances in sodium, potassium, and calcium balance, particularly if intake is insufficient or if concomitant diuretics and other medications alter electrolyte handling. Consequently, magnesium-containing regimens are generally approached with caution in older adults, patients with kidney disease, and those receiving medications that affect renal perfusion or electrolyte excretion.

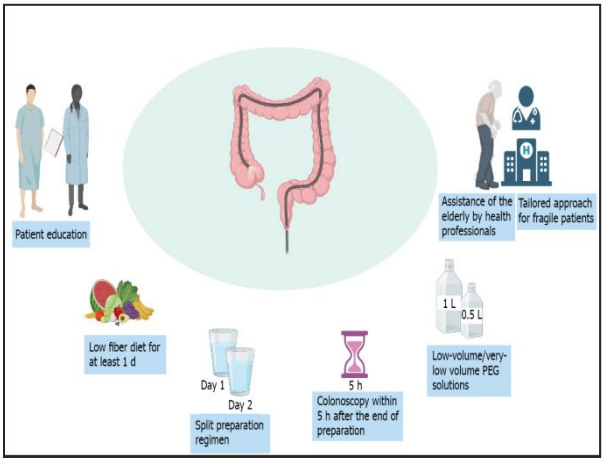

Fig. 2: Optimal bowel preparation.

Oral sodium sulfate regimens, particularly when administered as a single dose, have been associated with an increased frequency of gastrointestinal adverse events.[11] This is clinically relevant because severe nausea, abdominal cramping, or vomiting can lead to incomplete preparation, dehydration, and aspiration risk in susceptible individuals, thereby undermining the procedure's safety and efficacy. Patients with a history of poor tolerance to osmotic cathartics, those with baseline gastrointestinal fragility, and individuals at risk of volume depletion may therefore require alternative approaches or split dosing strategies designed to reduce symptom burden and improve completion rates. The recognition that some regimens predictably provoke gastrointestinal intolerance reinforces the principle that contraindications can include not only organ-specific risks but also patient-specific tolerability limitations that threaten adherence and safety. Sodium phosphate preparations are among the most clearly discouraged regimens due to their adverse effect profile and their established association with phosphate nephropathy.[12] Sodium phosphate is not recommended as a routine bowel preparation because it can cause clinically significant metabolic and renal complications, and it should be avoided in patients with renal dysfunction, dehydration, hypercalcemia, and in those with hypertension treated with an angiotensin-converting enzyme inhibitor or an angiotensin receptor blocker, populations in which phosphate nephropathy has been documented.[12] The mechanism of injury relates to acute phosphate load leading to hyperphosphatemia, calcium-phosphate precipitation, and renal tubular damage, particularly when renal perfusion is compromised or when the ability to excrete phosphate is limited. In addition to phosphate

nephropathy, multiple biochemical disturbances have been reported, including hyperphosphatemia, elevated blood urea nitrogen, increased plasma osmolality, hypocalcemia, hyponatremia, and seizures.[13][14][15][16][17][3] These adverse outcomes illustrate why sodium phosphate is considered high risk and why contemporary recommendations favor alternative regimens with safer electrolyte profiles, especially in patients with comorbidities that amplify renal and metabolic vulnerability.

Combination preparations also carry regimen-specific contraindication considerations largely driven by gastrointestinal tolerance and electrolyte effects. Sodium picosulfate/magnesium citrate, for example, has a known gastrointestinal side-effect profile that includes abdominal pain, nausea, and vomiting.[3] While these symptoms may be mild and manageable in many patients, they can become clinically problematic in individuals with high aspiration risk, those who are unable to maintain oral hydration, or patients in whom vomiting could worsen esophageal pathology or precipitate significant discomfort and nonadherence. Similarly, the combination of sodium sulfate and sulfate-free PEG-ELS has been associated with vomiting.[18] Vomiting is not a trivial adverse effect in bowel preparation; it can lead to incomplete dosing, inadequate cleansing, dehydration, and, in sedated or neurologically impaired patients, potential aspiration risk. Therefore, for patients with a history of severe emesis with bowel preparations, those with gastroparesis, or individuals with conditions where volume depletion is particularly dangerous, clinicians may prefer alternative regimens, split dosing, or enhanced antiemetic strategies, balancing preparation adequacy with patient safety. In summary, contraindications to bowel preparations are anchored in the predictable physiologic effects of different cathartic agents and the patient's capacity to tolerate those effects safely. Low-volume 2-L PEG-ELS with ascorbic acid should be avoided in G6PD deficiency, PEG-3350 should be avoided when electrolyte abnormalities are present, and magnesium citrate should be avoided in kidney disease and other contexts that increase magnesium toxicity risk.[3] Sodium phosphate is not recommended due to risks of phosphate nephropathy and a broad range of serious electrolyte and neurologic complications, particularly in patients with renal dysfunction, dehydration, hypercalcemia, and those receiving ACE inhibitors or ARBs.[12][13][14][15][16][17][3] Additionally, some sulfate- and picosulfate-containing regimens are limited by gastrointestinal intolerance, including increased GI events and vomiting.[11][18][3] Recognizing these contraindications supports safer regimen selection, individualized planning, and improved colonoscopy outcomes by preventing avoidable harm while still achieving effective bowel cleansing.

Personnel

Effective bowel preparation for colonoscopy is rarely achieved through prescribing alone; rather, it depends on coordinated roles across clinicians and nursing staff to ensure the selected regimen is medically appropriate, clearly communicated, and successfully completed. The primary care physician (PCP) and the gastroenterologist are central to determining the most suitable bowel preparation strategy, with each contributing distinct clinical perspectives that improve safety and adherence. The PCP is often positioned to recognize patient-specific factors that may not be fully apparent at the time of procedural scheduling, including longitudinal comorbidity patterns, prior intolerance to laxatives, recurrent electrolyte abnormalities, medication adherence challenges, and social determinants that influence the feasibility of timed dosing. Because certain bowel preparation agents carry contraindications in renal disease, electrolyte disturbances, and specific metabolic conditions, the PCP's detailed familiarity with the patient's history can help avoid regimens that pose disproportionate risk and can prompt early laboratory assessment or medication reconciliation when necessary. The gastroenterologist typically serves as the definitive decision-maker regarding bowel preparation selection because they possess specialized expertise in bowel cleansing regimens, procedural requirements, and the relationship between preparation quality and colonoscopy outcomes. Their role extends beyond regimen selection to include ensuring that the preparation aligns with the clinical purpose of colonoscopy, such as screening, evaluation of bleeding, or inflammatory bowel disease assessment, where the threshold for "adequate" cleansing may be higher due to the need to detect subtle mucosal lesions. The gastroenterologist also plays a critical educational role, translating technical instructions into patient-centered guidance that supports accurate timing, appropriate fluid intake, and completion of split-dose regimens when prescribed. Clear counseling is particularly important for patients with risk factors for poor preparation, such as older age,

polypharmacy, diabetes, or prior inadequate cleansing, because these individuals may require enhanced instruction, modified dosing, or additional support to achieve sufficient mucosal visualization. In the inpatient setting, nursing staff assume a pivotal operational and safety role that directly influences preparation success. Nurses are often responsible for administering or supervising the administration of bowel preparation, ensuring that doses are taken at the correct intervals and that the prescribed volume is completed. Because hospitalized patients may have limited mobility, cognitive impairment, nausea, swallowing difficulties, or competing diagnostic and therapeutic priorities, adherence to bowel preparation protocols can be challenging without active nursing coordination. Nursing staff also monitor patients for intolerance and adverse effects, including abdominal pain, vomiting, dehydration symptoms, dizziness, and changes in vital signs that may suggest hemodynamic instability. Additionally, nurses are frequently the first to identify evolving complications such as hypoglycemia in diabetic patients whose intake is restricted, or electrolyte-related symptoms that may warrant laboratory reassessment. By relaying these findings promptly to the medical team, nursing staff support timely intervention and regimen modification when needed. Collectively, these interprofessional roles ensure that bowel preparation is not only prescribed appropriately but also implemented safely and effectively, thereby improving colonoscopy completion rates, diagnostic accuracy, and overall patient experience.

Preparation

Bowel preparation is a foundational prerequisite for high-quality colonoscopy because the procedure's diagnostic accuracy and therapeutic effectiveness depend on unobstructed visualization of the colonic mucosa. Contemporary practice recognizes that bowel preparation is not a single uniform intervention but rather a family of pharmacologic regimens and solution types that differ in osmotic properties, electrolyte composition, volume requirements, tolerability, and safety profiles. A clinically useful framework divides bowel preparation agents into three broad categories based on their osmotic characteristics: isosmotic, hypoosmotic, and hyperosmotic agents. This classification is not merely descriptive; it directly reflects the physiologic mechanisms by which each regimen produces catharsis and, correspondingly, the patient populations in which each regimen is preferred or should be avoided. Importantly, regimen selection must integrate patient comorbidities, prior preparation outcomes, renal and hepatic function, baseline electrolyte status, expected adherence, and the endoscopist's need for optimal mucosal visualization, particularly when subtle lesions are anticipated. Isosmotic agents include high-volume polyethylene glycol (PEG) preparations, low-volume PEG preparations, and sulfate-free PEG-electrolyte solutions (ELS). High-volume PEG regimens have historically served as the benchmark for bowel cleansing. Their defining characteristic is that they are osmotically balanced with nonfermentable electrolyte solutions, which helps reduce clinically significant fluid and electrolyte shifts.[3] PEG itself is an inert polymer of ethylene oxide designed to traverse the gastrointestinal tract with minimal absorption, thereby functioning primarily as a lavage agent rather than a systemically active osmotic load. High-volume PEG preparations typically consist of approximately 4 liters of solution and may be administered as a single-dose regimen or as a split-dose regimen. A growing body of evidence supports the superiority of split-dose administration, which improves the quality of bowel cleansing and enhances mucosal visualization by shortening the interval between completion of preparation and colonoscopy.[3][19] Split dosing also aligns more closely with the physiologic reality that colonic secretions and residual stool can accumulate rapidly after preparation is completed; therefore, dividing the dose—often into an evening and morning portion—helps ensure that the colon is clean at the time of endoscopy.

Although high-volume PEG preparations are often described as safe and typically well tolerated, a clinically important limitation is completion failure related to palatability and volume burden. Approximately 5% to 15% of patients do not complete the regimen, often because the solution's taste is unpleasant or because consuming four liters is physically challenging, especially for patients with nausea, early satiety, or impaired mobility.[20] Incomplete consumption predictably leads to suboptimal cleansing and increased risk of incomplete colonoscopy or missed lesions, underscoring that tolerability is not secondary to efficacy but rather a determinant of real-world effectiveness. High-volume PEG has additional advantages that influence regimen selection in complex patients. It does not alter histological

features of the mucosa, making it suitable in patients suspected of having inflammatory bowel disease, where mucosal assessment and biopsy interpretation are central to diagnosis.[21] It is also considered appropriate in patients with preexisting electrolyte imbalances and in those who cannot tolerate high sodium loads, such as individuals with renal failure, heart failure, or cirrhosis.[22] These features reflect the value of an isosmotic, electrolyte-balanced lavage solution in minimizing physiologic perturbations in patients with limited capacity to buffer fluid shifts or electrolyte changes. Low-volume PEG preparations were developed to preserve the cleansing effectiveness of high-volume regimens while improving patient acceptance by reducing the total volume that must be consumed. The only FDA-approved low-volume PEG preparation described in this context is a low-volume, 2-liter PEG-ELS solution that includes ascorbic acid.[3] The addition of ascorbic acid contributes to cathartic effectiveness in a smaller volume, but it introduces a specific safety consideration: because the formulation contains ascorbic acid, it must be used cautiously in patients with glucose-6-phosphate dehydrogenase (G6PD) deficiency, as ascorbic acid exposure can exacerbate hemolysis in susceptible individuals.[23] This point illustrates a broader clinical principle: reducing volume and improving palatability may require formulation changes that introduce new contraindications, and therefore "low volume" should not be interpreted as universally safer. For many patients, however, low-volume PEG regimens offer a practical compromise—maintaining acceptable cleansing while improving the likelihood of completion.

Sulfate-free PEG-ELS represents another refinement aimed at improving tolerability without sacrificing efficacy. This product was developed to improve the smell and taste of PEG-ELS by removing sulfate components that contribute to an unpleasant sensory profile.[24] Clinically, sulfate-free PEG-ELS is described as less salty and more palatable, while remaining comparable to PEG-ELS with respect to colonic cleansing, overall tolerance, and safety.[3][25] Such improvements are not trivial; palatability and taste fatigue are common drivers of nonadherence, and even small changes in sensory acceptability can translate into higher completion rates and better cleansing outcomes. From a systems perspective, improving tolerability can also reduce the need for repeat procedures, enhance patient satisfaction, and minimize delays in diagnosis, particularly in screening programs. Hyposmotic agents include a low-volume PEG regimen known as PEG-3350 (PEG-SD), which is typically administered with an additional electrolyte-containing solution such as a sports drink and is frequently combined with bisacodyl.[3] The hyposmotic designation reflects the fact that this approach does not inherently provide a balanced electrolyte lavage in the way that PEG-ELS does; instead, its effectiveness and safety depend on coadministration with an external electrolyte solution and on patient-specific fluid intake patterns. Importantly, the combination of PEG-3350 and an electrolyte solution is not FDA approved for bowel preparation prior to colonoscopy and is not considered equivalent to the isosmotic low-volume 2-liter PEG-ELS preparation.[3] This regulatory and equivalence distinction matters in clinical decision-making, because it signals that the evidence base and standardized formulation controls differ from those of approved PEG-ELS products. Moreover, studies have reported mixed outcomes with respect to cleansing efficacy and electrolyte stability when PEG-3350 regimens are used. Some investigations have identified electrolyte abnormalities, including changes in sodium, potassium, and chloride concentrations, raising concern that this strategy may be less predictable in patients with baseline vulnerability to electrolyte shifts.[26] Notably, some studies suggest PEG-3350 may be more likely to precipitate electrolyte disturbances such as hyponatremia compared with low-volume 2-liter PEG-ELS.[26] Hyponatremia is clinically significant because it can cause confusion, seizures, or worsening of comorbid neurologic conditions in severe cases; therefore, even if such outcomes are uncommon, the possibility requires heightened caution in older adults, patients on diuretics or selective serotonin reuptake inhibitors, and individuals with conditions that impair water excretion. In this way, hyposmotic regimens highlight the trade-off between convenience and physiologic predictability, reinforcing why patient selection and monitoring remain essential.

Hyperosmotic agents include magnesium citrate, oral sodium sulfate, and sodium phosphate. These regimens rely more heavily on osmotic gradients that draw water into the intestinal lumen, thereby promoting catharsis but also increasing the risk of fluid and electrolyte shifts. Magnesium citrate is a magnesium-containing saline solution that acts osmotically and also stimulates the release of

cholecystokinin, promoting intraluminal fluid and electrolyte movement in the small intestine and potentially the colon.[3] Despite its cathartic effectiveness, magnesium citrate is not typically recommended as a primary bowel preparation regimen because of concerns regarding magnesium toxicity, which can manifest as bradycardia, hypotension, nausea, and drowsiness.[3] The risk is amplified in patients with kidney disease because magnesium is cleared renally; impaired clearance can lead to accumulation and symptomatic hypermagnesemia. This risk profile is particularly important in older adults and in patients with chronic kidney disease, where subclinical reductions in glomerular filtration may not be immediately apparent but may nonetheless increase susceptibility to magnesium accumulation. Oral sodium sulfate represents a hyperosmotic option that has not been associated with significant fluid or electrolyte shifts, an effect attributed to sulfate being a poorly absorbed anion.[3] Although research on oral sodium sulfate remains limited, at least one study reported that oral sodium sulfate demonstrated bowel preparation quality similar to low-volume 2-liter PEG-ELS with ascorbic acid.[3] At the same time, when compared with 4-liter PEG-ELS, a 1-day oral sodium sulfate regimen was associated with increased gastrointestinal events, although this increase was not observed when sodium sulfate was administered using split-dose regimens.[11] These observations align with a recurring theme in bowel preparation: dosing strategy can materially influence tolerability. Split dosing can reduce peak symptom burden, improve adherence, and enhance cleansing, thereby offsetting some adverse gastrointestinal effects seen with single-day or single-dose strategies.

Sodium phosphate has largely fallen out of favor and is no longer recommended as a bowel preparation regimen due to the seriousness of its adverse effects.[12] Certain patient groups—including those with renal dysfunction, dehydration, hypercalcemia, and individuals with hypertension treated with an angiotensin-converting enzyme inhibitor or an angiotensin receptor blocker—have developed phosphate nephropathy after sodium phosphate exposure.[12] Phosphate nephropathy is clinically consequential because it represents renal injury associated with phosphate load and precipitation phenomena, potentially causing sustained impairment of renal function. Beyond nephropathy, sodium phosphate has been associated with a range of metabolic disturbances including hyperphosphatemia, elevated blood urea nitrogen, increased plasma osmolality, hypocalcemia, hyponatremia, and seizures.[14][15][16][17] Given these risks, and recognizing that safer alternatives exist, the FDA has issued a warning for the prescription tablet form of sodium phosphate.[3][15] The decline of sodium phosphate illustrates the evolution of bowel preparation practice toward regimens that provide comparable cleansing with a more favorable safety margin, particularly in populations with cardiovascular, renal, or metabolic comorbidity. In addition to single-agent regimens, combination agents have been developed to exploit synergistic mechanisms and to reduce total volume while preserving cleansing quality. Sodium picosulfate/magnesium citrate is one such combination. It acts dually as a stimulant laxative—through sodium picosulfate, which increases the force and frequency of peristalsis—and as an osmotic laxative—through magnesium citrate, which retains fluid in the colon.[27] While this dual mechanism can improve cathartic efficacy, its side-effect profile is frequently gastrointestinal, including abdominal pain, nausea, and vomiting.[3] These symptoms can compromise completion, increase dehydration risk, and reduce overall patient acceptability, especially in those who already have gastrointestinal fragility or who have experienced intolerance to prior preparations. Therefore, when this regimen is considered, clinicians must evaluate not only its cleansing effectiveness but also the patient's ability to tolerate stimulant-associated cramping and the magnesium-related risks in renal impairment.

Another combination strategy involves oral sodium sulfate paired with 2 liters of sulfate-free PEG-ELS.[3] This approach attempts to combine the benefits of sodium sulfate's cleansing effect with the tolerability improvements associated with sulfate-free PEG-ELS, while keeping total PEG volume relatively low. In a study comparing split-dose administration of this combination with low-volume 2-liter PEG-ELS with ascorbic acid, both regimens achieved successful bowel preparation, but the sodium sulfate plus sulfate-free PEG-ELS combination was associated with higher rates of vomiting.[3][18] Vomiting is clinically important because it directly threatens regimen completion and increases the risk of dehydration and aspiration in vulnerable patients. Thus, even when cleansing efficacy is comparable, tolerability differences may drive regimen selection,

particularly for patients with prior emesis, gastroparesis, or high aspiration risk. Assessing bowel preparation quality is as important as selecting and administering the regimen, because objective assessment guides decisions about whether colonoscopy findings can be trusted and whether surveillance intervals should be adjusted. The Boston Bowel Preparation Scale (BBPS) was developed to standardize evaluation of bowel cleanliness after all cleaning maneuvers have been performed during colonoscopy.[28] The BBPS divides the colon into three segments—right colon, transverse colon, and left colon—and assigns each segment a score from 0 to 3 based on the degree of mucosal visualization.[28] A segment score of 0 indicates an unprepared colon with mucosa not seen; a score of 1 indicates that only a portion of the mucosa is visible due to residual stool or staining; a score of 2 indicates minor residual staining or small fragments of stool but with adequate visualization of most mucosa; and a score of 3 indicates excellent visualization of the entire mucosa with no residual stool.[28] These segment scores are then summed to produce a cumulative total score for the entire colon, with higher scores indicating better preparation.[28] The BBPS has practical value beyond documentation: it supports consistent reporting between providers and institutions, informs decisions about the need for early repeat colonoscopy when preparation is inadequate, and provides a framework for quality improvement initiatives aimed at reducing incomplete colonoscopies and improving lesion detection.

Overall, bowel preparation is an integrative clinical process that combines pharmacologic regimen selection, patient-centered dosing strategies, and objective post-preparation assessment. Isosmotic PEG-based regimens, particularly high-volume PEG-ELS and its lower-volume or sulfate-free variants, offer a strong balance of safety and efficacy and are especially useful in patients with comorbidities that heighten sensitivity to electrolyte shifts.[3][20][21][22][24][25] Hyposmotic approaches such as PEG-3350 combined with sports drinks and bisacodyl can be appealing for volume reduction but introduce concerns regarding regulatory status and potential electrolyte abnormalities such as hyponatremia.[3][26] Hyperosmotic regimens such as magnesium citrate and sodium sulfate may provide effective cleansing but require careful patient selection due to risks of magnesium toxicity or gastrointestinal intolerance, while sodium phosphate is largely avoided due to serious renal and metabolic adverse effects and FDA warnings.[3][11][12][14][15][16][17] Combination regimens offer additional options but must be evaluated for vomiting and other tolerability limitations.[3][18][27] Finally, standardized assessment tools such as the BBPS provide a structured method for judging preparation adequacy and guiding subsequent clinical decisions.[28]

Technique or Treatment

Bowel preparation regimens for colonoscopy are typically administered either as a single-dose regimen or as a split-dose regimen, and the choice of dosing strategy is now recognized as a major determinant of cleansing quality and diagnostic yield. A single-dose regimen generally involves consuming the entire prescribed preparation solution within a defined period on the day before colonoscopy. This approach can be convenient from a scheduling perspective; however, it is physiologically vulnerable to the “recontamination” phenomenon, in which colonic secretions and residual stool progressively accumulate after completion of the cathartic process. As the interval between the end of preparation and the start of colonoscopy increases, the likelihood of residual fluid, bile staining, and particulate matter within the lumen rises, particularly in the right colon. This can obscure flat lesions and small polyps and can increase the need for intra-procedural lavage and suction. In contrast, split-dose bowel preparation divides the total regimen into two portions, thereby aligning dosing with colonic physiology and optimizing mucosal visualization at the time of endoscopy. Evidence indicates that split dosing produces higher-quality bowel preparation and is associated with improved adenoma detection rates compared with single-dose administration.[3][29] These outcomes are clinically meaningful because adenoma detection rate is a key quality metric for colonoscopy and correlates with reduced risk of interval colorectal cancer. In typical split-dose scheduling, the first dose is administered the day before the procedure, while the second dose is taken within a defined window prior to colonoscopy—commonly 3 to 8 hours before the start time.[3][30][31] This timing is designed to maximize cleansing while maintaining patient safety and comfort, ensuring that the colon remains clear when endoscopic inspection begins. The 3–8 hour interval also helps balance competing concerns: if the second dose is taken too early, reaccumulation may compromise cleanliness; if taken too late, it may

increase the risk of residual liquid stool during the procedure or create logistical challenges for transportation and facility check-in. Implementing split dosing requires clear patient education regarding start times, allowable clear liquids, and adherence to fasting instructions for sedation safety, as well as individualized planning for patients with diabetes, limited mobility, or long travel distance to the endoscopy unit. When operationalized effectively, split dosing functions as both a pharmacologic and behavioral intervention, improving completion rates, reducing the burden of repeat procedures, and enhancing the overall quality of colonoscopic evaluation.[3][29][30][31]

Clinical Significance

Bowel preparation quality is central to the clinical value of colonoscopy because the procedure's primary purpose—accurate mucosal assessment—cannot be achieved when residual stool, opaque fluid, or adherent debris obscures the lumen. Poor bowel preparation is therefore not a minor inconvenience but a potentially severe limitation that diminishes the usefulness of colonoscopy as a screening, diagnostic, and therapeutic tool. When preparation is inadequate, mucosal visualization becomes incomplete or unreliable, particularly in anatomically complex regions characterized by folds and angulations. This can lead to prolonged procedure time, increased patient discomfort, higher sedation requirements, and in some cases an incomplete examination in which the cecum is not reached or the mucosa cannot be adequately inspected. As a consequence, the colonoscopy may fail to achieve its intended purpose and may need to be repeated—creating additional cost, procedural risk, and burden on both the patient and healthcare system. From a patient-outcome perspective, the most consequential implication of poor bowel preparation is the risk of missed pathology. Proper bowel preparation produces clean, well-visualized mucosa that enables the endoscopist to identify and characterize polyps, early neoplastic changes, inflammatory lesions, and vascular abnormalities with greater confidence. High-quality cleansing increases the likelihood that small or flat lesions—those most easily concealed by residual material—will be detected and appropriately treated through excision or biopsy. Conversely, poor bowel preparation can lead to missed identification of polyps or lesions, undermining the preventive promise of colonoscopy and potentially allowing progression of premalignant lesions into invasive malignancy. In this sense, inadequate preparation may translate into morbidity and mortality consequences at the individual level, particularly when missed lesions are clinically significant and the opportunity for early intervention is lost. The clinical significance of bowel preparation is therefore inseparable from colonoscopy quality metrics and cancer prevention goals: effective preparation improves diagnostic accuracy and therapeutic success, while inadequate preparation compromises both and may expose patients to avoidable harm through delayed diagnosis and repeat procedural exposure [31][32].

Enhancing Healthcare Team Outcomes

Optimizing bowel preparation and colonoscopy outcomes depends on interprofessional collaboration because preparation success is influenced by medical appropriateness, regimen tolerability, patient understanding, and logistical feasibility. A coordinated team approach typically involves the primary care physician, gastroenterologist, nurses, and pharmacist, each contributing expertise that collectively improves safety and effectiveness. The primary care physician often provides critical longitudinal insight into the patient's comorbidities, medication profile, and prior preparation history, allowing identification of risks such as renal dysfunction, electrolyte abnormalities, heart failure, or previous intolerance that may contraindicate certain agents or necessitate enhanced monitoring. The gastroenterologist contributes specialized knowledge regarding bowel regimen efficacy, timing strategies, and the procedural implications of preparation quality, and is often responsible for selecting the regimen most likely to achieve adequate cleansing while aligning with the colonoscopy's clinical goals. Nursing professionals play a pivotal role in translating plans into successful execution, particularly in inpatient settings where adherence can be compromised by competing clinical priorities, nausea, reduced mobility, or cognitive impairment. Nurses monitor for adverse symptoms such as vomiting, dizziness, dehydration, and intolerance, and they ensure that dosing is completed as prescribed, which is essential for achieving adequate cleansing. Pharmacists add value by evaluating potential medication-related barriers to preparation success, identifying drug-induced constipation risk, assessing for interactions that may heighten electrolyte disturbances, and advising on safe regimen selection in high-risk patients.

Pharmacists also support patient counseling, particularly around the importance of completing the full preparation volume, maintaining appropriate hydration, and safely adjusting selected medications when necessary under clinician guidance. Team-based care also enables personalization of regimen scheduling to maximize adherence. For example, selecting a single-dose versus split-dose strategy can be tailored to the patient's lifestyle, travel constraints, work obligations, and ability to wake early for the second dose. Importantly, interprofessional interventions that reinforce education have demonstrated measurable clinical benefits. One study found that telephone reeducation about bowel preparation on the day before colonoscopy significantly improved preparation quality and increased the rate of polyp detection.[32] This finding highlights that preparation outcomes are not solely determined by the chemical properties of laxatives; they are also shaped by communication, reinforcement, and behavioral support. When the healthcare team actively coordinates education, addresses barriers in advance, and follows up to confirm understanding, the probability of high-quality bowel preparation increases, thereby improving colonoscopy completion, diagnostic accuracy, and patient safety.[32]

Conclusion:

Bowel preparation is not a procedural formality but a critical determinant of colonoscopy's diagnostic and therapeutic success. Inadequate cleansing compromises mucosal visualization, prolongs procedure time, and increases the risk of missed pathology, repeat procedures, and patient harm. Evidence strongly supports the use of isosmotic PEG-based regimens as the safest and most effective option, particularly for patients with renal, cardiac, or metabolic vulnerabilities. While low-volume and combination regimens improve tolerability, they introduce regimen-specific contraindications that require careful patient selection. Hyperosmotic agents, though effective, pose electrolyte and renal risks, and sodium phosphate is largely obsolete due to severe adverse effects.

Beyond pharmacology, dosing strategy—especially split-dose administration—emerges as a key predictor of preparation quality and adenoma detection. Equally important is the role of interprofessional collaboration: physicians ensure appropriate regimen selection, nurses facilitate adherence and monitor safety, and pharmacists mitigate drug-related risks. Patient education and reinforcement, including pre-procedure counseling and follow-up, significantly improve outcomes.

Ultimately, optimizing bowel preparation demands a personalized, team-based approach that balances efficacy, safety, and patient experience. By integrating evidence-based regimens, proactive risk assessment, and structured quality evaluation, healthcare teams can enhance colonoscopy performance, reduce complications, and advance colorectal cancer prevention.

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