Saudi Journal of Medicine and Public Health

Bowel Preparation: Nursing Assessment, Patient Education, and Evidence-Based Perioperative Management

Asya Ali Almuairfi [1] , Murifah Dhahi Aljohani [2] , Norah Muhaysin Sawwan Alanazi [3] , Mona Hamad Ahmad Awaji [4] , Abduallaziz Jarallah Obied Alenzi [5] , Nahed Thani Alruwaili [6] , Jawharah Abdulrhman Hamad Bin Muaddi [7] , Zahra Kadim Ibrahim Alhalal [8] , Joudi Ahmed Zayed Asiri [9] , Eman Abdulmohsen Alsaleh [10] , Raed Naji Alhayder [11]

(1) Al-Murabba Health Center, Riyadh,Ministry of Health, Saudi Arabia,
(2) Al-Madinah Al-Munawara Primary Health Care Center in Baqdo,Ministry of Health, Saudi Arabia,
(3) Mental Health Hospital in Qurayyat, Al-Jawf Health Community – Ministry of Health, Saudi Arabia,
(4) Jazan – Season Primary Care Center,Ministry of Health, Saudi Arabia,
(5) Eradah Mental Health Complex, Hail,Ministry of Health, Saudi Arabia,
(6) King Abdulaziz Specialist Hospital, Sakaka (Al-Jouf),Ministry of Health, Saudi Arabia,
(7) Riyadh Mansoura Primary Health Care (PHC),Ministry of Health, Saudi Arabia,
(8) Fouda Health Center, Abqaiq Region,Ministry of Health, Saudi Arabia,
(9) Muhayil General Hospital (Muhayil),Ministry of Health, Saudi Arabia,
(10) King Fahd Hospital in Al-Hofuf, Al-Ahsa,Ministry of Health, Saudi Arabia,
(11) Ministry Of Health, Saudi Arabia

Abstract

Background: Bowel preparation is essential for high-quality colonoscopy, enabling accurate mucosal visualization and reducing missed lesions. Inadequate cleansing compromises diagnostic reliability, increases procedural risks, and necessitates repeat examinations.

Aim: To review nursing roles in bowel preparation, focusing on assessment, patient education, and evidence-based perioperative management to optimize outcomes.

Methods: This narrative review synthesizes current evidence on bowel preparation regimens, contraindications, risk factors, and nursing interventions. It examines pharmacologic classifications (isosmotic, hypoosmotic, hyperosmotic), dosing strategies, and interprofessional collaboration.

Results: High-volume polyethylene glycol (PEG) remains the safest option for complex patients, while low-volume PEG with ascorbic acid improves tolerability but requires caution in G6PD deficiency. Sulfate-free PEG enhances palatability without compromising efficacy. Hyperosmotic agents (magnesium citrate, sodium sulfate) and sodium phosphate carry significant risks, particularly in renal impairment and electrolyte imbalance. Split-dose regimens consistently outperform single-dose schedules in cleansing quality and adenoma detection. Nursing interventions—risk assessment, education reinforcement, hydration monitoring, and early escalation for intolerance—are pivotal for success.

Conclusion: Effective bowel preparation is a structured, team-based process integrating individualized regimen selection, patient-centered education, and vigilant nursing oversight. Optimizing preparation quality improves diagnostic accuracy, reduces repeat procedures, and enhances patient safety.

Keywords: Bowel preparation, colonoscopy, nursing assessment, patient education, PEG, split-dose regimen, contraindications, perioperative care.

Introduction

Bowel preparation is a foundational component of safe and diagnostically effective colonoscopy and represents a critical domain in which nursing assessment, patient education, and coordinated perioperative planning directly influence clinical outcomes. Clinicians can employ a range of bowel preparation methods that differ in composition, dosing schedules, patient tolerability, and efficacy, and selection is often tailored to the patient's clinical profile, comorbidities, and procedural timing. Regardless of the specific regimen, the overarching objective remains consistent: to achieve adequate cleansing of the colon so that the mucosal surface can be visualized clearly throughout the entire length of the large intestine. Colonoscopy is widely recognized as the gold standard for direct mucosal assessment and enables both diagnostic and therapeutic interventions, including biopsy and polypectomy, which are essential for cancer detection and

prevention. The quality of bowel cleansing is therefore not a minor technicality; it is central to the clinical value of the procedure and to the reliability of its findings. Evidence from reviews indicates that incomplete colonoscopies—commonly defined as an inability to achieve cecal intubation and/or adequate mucosal visualization—occur at clinically meaningful rates, ranging from approximately 10% to 20%.[1][2][3] While incompletion may result from multiple factors (such as anatomic challenges, patient intolerance, or technical limitations), inadequate bowel preparation remains one of the most preventable contributors. Poor preparation can obscure the mucosal surface, mask polyps or subtle neoplastic lesions, and increase the likelihood that clinically significant pathology will be missed. This has direct implications for patient safety and long-term outcomes because the effectiveness of colonoscopy as a cancer prevention tool depends on accurate lesion identification and removal. Inadequate cleansing can also necessitate earlier repeat procedures, thereby increasing patient burden, delaying definitive diagnosis, and amplifying healthcare costs. Moreover, poor bowel preparation has been associated with a higher risk of procedural adverse events.[3][4] Mechanistically, this association may reflect longer procedure times, increased need for instrument manipulation, greater insufflation, and more challenging navigation through a colon containing residual stool and fluid—factors that can compound sedation exposure and procedural complexity.

Given the consequences of suboptimal cleansing, substantial attention has been directed toward identifying patients at higher risk for poor bowel preparation. Multiple studies have described a range of demographic, social, and clinical predictors that can impair preparation quality. These include a history of previous inadequate bowel cleansing, language barriers (including non-English speaking status), Medicaid insurance, and being single—factors that may serve as proxies for reduced access to health literacy resources, limited social support, or challenges in navigating complex instructions.[5][6][7][8][9] Inpatient status has also been associated with poor preparation, likely due to acute illness, competing clinical priorities, reduced mobility, altered diet, and medication schedules that may interfere with timely intake of preparation solutions.[5][6][7][8][9] Polypharmacy is another important risk factor, as multiple medications—particularly those with anticholinergic effects, opioid analgesics, or iron supplements—may contribute to constipation or reduced gastrointestinal motility. Obesity and advanced age have similarly been linked with lower preparation quality, potentially reflecting differences in motility, comorbidity burden, and the ability to tolerate large-volume solutions. Male gender has been identified in some studies as a predictor of poorer preparation, though the underlying reasons likely reflect complex interactions among health behaviors, adherence patterns, and comorbidities rather than a purely biologic effect.[5][6][7][8][9] Comorbid conditions further shape preparation success and require special nursing attention. Diabetes, for example, can be associated with autonomic neuropathy and delayed gastric emptying, which may reduce bowel motility and complicate the timing of preparation. Neurologic disorders such as stroke, dementia, and Parkinson disease are also recognized risk factors, often due to impaired mobility, reduced executive function, swallowing difficulties, and reliance on caregivers for medication administration and adherence to instructions.[5][6][7][8][9] These populations may require enhanced support, simplified communication, and careful monitoring for dehydration, hypoglycemia, or aspiration risk during the preparation period. An ideal bowel preparation regimen should maximize cleansing while minimizing patient discomfort and physiologic disruption. Effective preparation reduces patient distress, limits extreme fluid shifts, and avoids clinically significant electrolyte disturbances, particularly in older adults and those with renal or cardiac disease. The regimen should also be safe, tolerable, and cost-effective, recognizing that tolerability strongly influences adherence and that affordability affects access and completion.[10] From a nursing perspective, bowel preparation is best conceptualized as a structured care process rather than a single prescription. It requires assessment of risk factors, individualized education, proactive management of comorbidities and medications, and continuous reinforcement of instructions to ensure the colonoscopy achieves its intended diagnostic and therapeutic goals [5][6][7][8][9].

Anatomy and Physiology

A clear understanding of gastrointestinal anatomy and physiology underpins the rationale for bowel preparation and explains why cleansing quality is directly linked to the diagnostic yield and safety of colonoscopy. Colonoscopy is designed to provide high-resolution, direct visualization of the intestinal mucosa, enabling detection of subtle abnormalities such as flat adenomas, serrated lesions, inflammatory changes, and early malignant transformations. Because many clinically significant lesions may be small, pale, or minimally raised, even modest residual stool, opaque fluid, or adherent mucus can obscure mucosal detail and reduce the likelihood of identification. Adequate bowel preparation therefore functions as an essential physiologic prerequisite for effective endoscopic examination, increasing the probability that lesions will be detected, characterized accurately, and treated in a timely manner. From an anatomic perspective, colonoscopy typically evaluates the rectum and the entire colon, including the sigmoid colon, descending colon, transverse colon, ascending colon, and the cecum. The cecum

represents the proximal terminus of the large intestine and is a critical landmark because reaching it confirms that the colonoscope has traversed the full length of the colon. In many examinations, the procedure may also include intubation of the terminal ileum, the distal portion of the small intestine that empties through the ileocecal valve into the cecum. Visualization of the terminal ileum may be clinically relevant in selected contexts, such as evaluation of suspected inflammatory bowel disease, chronic diarrhea, or unexplained gastrointestinal bleeding. Because lesions can occur throughout these segments, bowel preparation must facilitate mucosal visualization across a long, variably contoured lumen with multiple folds, flexures, and haustral markings that naturally create recesses where stool and fluid can collect [5][6][7][8][9].

Physiologically, the colon's primary functions include absorption of water and electrolytes, fermentation of undigested carbohydrates by the gut microbiota, and storage and controlled evacuation of fecal material. Water absorption progressively concentrates stool as luminal contents transit from the proximal to distal colon. Consequently, stool consistency becomes increasingly formed in the sigmoid colon and rectum, which can complicate cleansing if colonic motility is slow or if constipation is present. Normal colonic propulsion occurs through a combination of segmental contractions and periodic high-amplitude propagated contractions that move stool toward the rectum. Many factors can impair this motility, including aging, neurologic disease, diabetes-related autonomic dysfunction, opioid use, and dehydration—each of which can reduce preparation efficacy by limiting the ability of laxatives to mobilize stool effectively. The terminal ileum, by contrast, has different motility patterns and absorptive functions, and excessive residual liquid in the colon may reflux through the ileocecal valve or blur the distinction between colonic and ileal effluent during examination. Bowel preparation regimens leverage these physiologic principles by inducing osmotic water retention, stimulating peristalsis, or both, thereby flushing fecal material and particulate debris from the lumen. When cleansing is effective, the endoscopist can inspect the mucosa in each colonic segment with minimal need for suctioning, washing, or repeated passes, which shortens procedure time and reduces mechanical manipulation. Thus, adequate bowel preparation is not merely an administrative requirement; it is an anatomically and physiologically grounded intervention that enables complete examination of the rectum, the full colon (sigmoid, descending, transverse, ascending, and cecum), and, when indicated, the terminal ileum, thereby maximizing diagnostic accuracy and procedural safety [5][6][7][8][9].

Indications

Adequate bowel preparation is indicated whenever colonoscopy is planned, because effective cleansing is a prerequisite for safe, complete, and diagnostically reliable visualization of the colonic mucosa. Colonoscopy is performed for a broad range of clinical purposes, including screening and surveillance for colorectal cancer, evaluation of gastrointestinal bleeding, investigation of iron-deficiency anemia, assessment of chronic diarrhea, and diagnostic workup for suspected inflammatory bowel disease. It is also frequently indicated for the evaluation of abnormal imaging findings, positive fecal immunochemical testing, or unexplained changes in bowel habits. In each of these contexts, the clinical value of colonoscopy depends on the ability to inspect the mucosal surface thoroughly, identify subtle lesions, and perform therapeutic interventions such as biopsy or polypectomy when required. Bowel preparation is therefore indicated not simply as a procedural routine, but as an essential measure to minimize the risk of missed pathology. Residual stool or opaque liquid can obscure flat polyps, serrated lesions, early malignancies, and inflammatory changes, reduce detection rates and undermining diagnostic confidence. Inadequate preparation can also prolong procedure time, increase the need for intraprocedural lavage and suctioning, and raise the likelihood that the examination will be incomplete, requiring rescheduling and repeat exposure to sedation and procedural risks. From a nursing and perioperative standpoint, a clear indication for bowel preparation is present whenever colonoscopy is ordered, and preparation should be delivered in a manner that is individualized, safe, and feasible, considering patient comorbidities, medication use, hydration status, and the practical ability to follow preparation instructions [5][6][7][8][9].
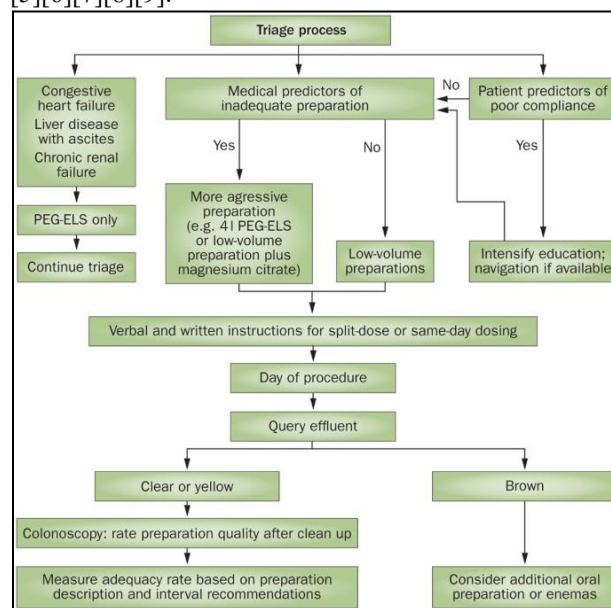
Fig. 1: Bowel Preparation.

Contraindications

Contraindications in bowel preparation are best understood as regimen-specific limitations rather than a blanket prohibition against colon cleansing. Most patients require bowel preparation to enable safe, high-quality colonoscopy, yet the choice of agent must be individualized because commonly used preparations differ in osmotic load, electrolyte composition, renal handling, and propensity to provoke gastrointestinal intolerance. In practical terms, contraindications typically arise when a preparation poses an unacceptable risk of metabolic disturbance, renal injury, volume depletion, or drug–disease interaction in a given patient. Nursing assessment is central in this process because it often identifies the comorbidities, medication exposures, hydration status, and prior adverse reactions that determine whether a regimen is safe and feasible. The clinical aim is to select the most effective preparation that achieves adequate cleansing while minimizing risk, particularly in vulnerable groups such as older adults, patients with kidney disease, those with baseline electrolyte derangements, and individuals with conditions that predispose them to dehydration or cardiac instability. Low-volume 2-liter polyethylene glycol electrolyte lavage solution (PEG-ELS) with ascorbic acid is an example of a preparation that is effective and often better tolerated due to reduced volume; however, it should be avoided in patients with glucose-6-phosphate dehydrogenase (G6PD) deficiency. In this population, exposure to oxidative stressors can precipitate hemolysis, and ascorbic acid–containing regimens raise concern for oxidative risk. Accordingly, when a patient has known G6PD deficiency—or when clinical history suggests risk and the diagnosis is documented—alternative PEG-based regimens without ascorbic acid are typically preferred. This highlights a broader principle: additives intended to improve efficacy or palatability can introduce unique contraindications that must be screened for explicitly during pre-procedure evaluation [5][6][7][8][9].

Electrolyte-related contraindications also influence regimen choice. PEG-3350–based preparations should be avoided in patients with electrolyte abnormalities, as baseline imbalances may be exacerbated during the cathartic process or may complicate safe monitoring and correction. Although PEG solutions are often regarded as relatively safe, bowel cleansing in general can provoke shifts in sodium, potassium, and fluid balance, particularly when intake is inadequate or when diarrhea is profuse. For patients with preexisting electrolyte disturbances, the priority is to select a regimen and hydration plan that minimizes further derangement and includes appropriate clinical monitoring and correction when necessary. Magnesium citrate is a widely recognized example of an agent that must be used cautiously because magnesium handling depends heavily on renal function. It should be avoided in patients with electrolyte abnormalities and particularly in those with kidney disease or those at increased risk for magnesium toxicity.[3] When renal clearance is impaired, magnesium can accumulate, potentially leading to clinically significant hypermagnesemia with neuromuscular and cardiac effects. Even in patients without diagnosed renal disease, older age, dehydration, and concurrent nephrotoxic medications may reduce renal reserve and increase risk. Therefore, screening for chronic kidney disease, recent acute kidney injury, and risk factors for volume depletion is essential before considering magnesium-containing regimens. Oral sodium sulfate has also been associated with tolerability and safety considerations. A single-dose oral sodium sulfate regimen has been found to increase gastrointestinal adverse events.[11] While GI side effects may not always constitute an absolute contraindication, they become clinically significant in patients for whom vomiting, severe diarrhea, or abdominal pain could lead to dehydration, aspiration risk, inability to complete the regimen, or exacerbation of comorbid conditions. For example, patients with frailty, limited access to hydration support, or prior intolerance to cathartics may be better served by alternative split-dose strategies that reduce symptom burden and improve completion rates.

Sodium phosphate is particularly notable because it is not recommended as a bowel preparation regimen due to its side-effect profile and well-documented risks. It should be avoided in patients with renal dysfunction, dehydration, hypercalcemia, and in those with hypertension treated with an angiotensin-converting enzyme inhibitor (ACE inhibitor) or angiotensin receptor blocker (ARB), because phosphate nephropathy has been reported in these settings.[12] Beyond nephropathy, adverse biochemical outcomes have been documented, including hyperphosphatemia, elevated blood urea nitrogen, increased plasma osmolality, hypocalcemia, hyponatremia, and seizures.[13][14][15][16][17][3] These risks underscore why sodium phosphate has largely fallen out of favor and why careful medication reconciliation is essential: ACE inhibitors and ARBs, commonly used for hypertension and cardiovascular protection, can increase vulnerability to renal hypoperfusion and electrolyte disturbances during bowel cleansing, especially if patients become dehydrated. Combination regimens also carry regimen-specific contraindication considerations, primarily related to GI tolerance. Sodium picosulfate/magnesium citrate is known to have a gastrointestinal side-effect profile that includes abdominal pain, nausea, and vomiting.[3] For patients with prior severe intolerance, baseline nausea, gastroparesis, or high aspiration risk, these symptoms may make the regimen impractical or unsafe. Similarly, the combination of sodium sulfate and sulfate-free PEG-ELS has been associated with

vomiting.[18] Vomiting during bowel preparation is clinically important because it can lead to incomplete cleansing, dehydration, medication malabsorption, and aspiration—particularly in sedated or neurologically impaired individuals. In these cases, clinicians may need to select a more tolerable alternative, adjust dosing schedules, prescribe antiemetic support when appropriate, or consider inpatient preparation for high-risk patients. Overall, contraindications to bowel preparation should be approached as a structured risk-assessment exercise. The goal is not to avoid preparation altogether but to choose the safest effective regimen by considering renal function, baseline electrolytes, comorbidities, medication exposures, and the patient's ability to maintain hydration and complete the protocol. This individualized approach helps prevent avoidable metabolic complications, improves the likelihood of adequate cleansing, and supports safe, high-quality colonoscopy [13][14][15][16][17][3].

Personnel

Effective bowel preparation for colonoscopy depends on coordinated input from multiple healthcare professionals, because the success of cleansing is influenced by clinical risk assessment, regimen selection, patient education, adherence support, and monitoring for adverse effects. Although bowel preparation is often perceived as a routine pre-procedural task, it is best managed as a structured clinical process in which roles are clearly defined and communication is proactive. Poor preparation can compromise diagnostic accuracy and necessitate repeat procedures, while overly aggressive preparation or inappropriate agent selection can precipitate dehydration, electrolyte imbalance, and avoidable harm. For these reasons, personnel involved in bowel preparation must collectively balance efficacy with safety and feasibility, particularly in patients with comorbidities or prior intolerance. The primary care physician (PCP) and the gastroenterologist form the core decision-making partnership in outpatient bowel preparation. The PCP is often best positioned to identify patient-specific contraindications and risk factors because they typically maintain longitudinal knowledge of the patient's comorbidities, medication profile, prior adverse drug reactions, baseline renal function, and functional or cognitive limitations that may affect adherence. For example, chronic kidney disease, heart failure, diabetes, neurologic disorders, and polypharmacy can all influence which bowel regimens are safest and most likely to be tolerated. The PCP may also recognize social and practical barriers—such as low health literacy, limited caregiver support, or language needs—that can predict nonadherence and lead to poor cleansing. This contextual understanding supports individualized preparation planning and can prevent inappropriate

selection of regimens that carry elevated risk in certain clinical conditions [13][14][15][16][17][3].

The gastroenterologist, however, is most commonly the clinician who finalizes the bowel preparation strategy because of their specialized expertise in colonoscopy quality, regimen pharmacology, and evidence-based cleansing protocols. Gastroenterologists are familiar with differences in efficacy between high-volume and low-volume preparations, the benefits of split-dose schedules, and strategies for rescue preparation when prior cleansing has been inadequate. They are also responsible for ensuring that the chosen regimen aligns with procedural timing and institutional standards, and for making adjustments based on the indication for colonoscopy and the patient's risk profile. Equally important, gastroenterologists and their clinical teams frequently provide the most detailed patient-facing instruction, including timing of ingestion, dietary restrictions, medication modification guidance, and expectations for stool output. This education is essential because bowel preparation regimens can be complex, and incomplete understanding is a common cause of failure. In many practices, this educational role may be delivered through a combination of clinician counseling, standardized written instructions, and follow-up communication to verify comprehension. In the inpatient setting, nursing staff play a pivotal role in translating the prescribed preparation plan into safe and complete administration. Hospitalized patients often have additional risk factors for inadequate cleansing, including acute illness, mobility limitations, competing diagnostic priorities, and altered oral intake. Nurses therefore function as continuous assessors and facilitators. They monitor for complaints such as nausea, abdominal cramping, dizziness, and fatigue, and they identify early signs of dehydration or electrolyte disturbance. Nurses also evaluate stool output to determine whether the preparation is progressing as expected and communicate concerns promptly when output suggests incomplete cleansing. When patients experience intolerance—such as vomiting or inability to ingest the solution—nurses are often the first to recognize the problem and to coordinate timely modifications with the prescribing team, such as adjusting the ingestion rate, introducing antiemetic support per protocol, or escalating to alternative strategies [13][14][15][16][17][3]. Moreover, inpatient nurses ensure adherence to timing, which is crucial for colonoscopy quality. They coordinate preparation administration around medication schedules, diagnostic tests, and fasting requirements, and they reinforce dietary restrictions that support cleansing. For patients with cognitive impairment or limited capacity to follow instructions independently, nurses provide structured guidance and, when needed, coordinate caregiver involvement. In this

way, bowel preparation becomes a truly interprofessional responsibility: physicians determine and tailor the regimen, gastroenterologists align it with procedural needs and provide specialized instruction, and nurses ensure safe execution through monitoring, education reinforcement, and early escalation when side effects or incomplete preparation threaten procedural success [13][14][15][16][17][3].

Preparation

Bowel preparation for colonoscopy is a structured clinical intervention intended to optimize mucosal visualization and procedural safety by eliminating stool and opaque liquid from the colonic lumen. In contemporary practice, preparations can be classified by their osmotic properties into isosmotic, hypoosmotic, and hyperosmotic agents. This classification is not merely pharmacologic; it provides a practical framework for anticipating tolerability, electrolyte effects, and suitability in patients with comorbid conditions such as renal impairment, heart failure, or baseline electrolyte disturbances. From a nursing and perioperative standpoint, preparation selection must reconcile three competing aims: adequate cleansing to reduce missed lesions and incomplete examinations, patient tolerability to ensure regimen completion, and physiologic safety to prevent clinically meaningful dehydration or metabolic derangement. Isosmotic agents constitute the most widely used class and include high-volume polyethylene glycol (PEG) preparations, low-volume PEG preparations, and sulfate-free PEG–electrolyte solutions (ELS). Their defining feature is an electrolyte-balanced profile intended to minimize net fluid and electrolyte shifts across the intestinal mucosa. High-volume PEG regimens are formulated as osmotically balanced solutions that contain nonfermentable electrolytes. PEG itself is an inert polymer of ethylene oxide designed to pass through the gastrointestinal tract without meaningful absorption, thereby acting primarily as a lavage agent rather than as a systemic osmotic load. Standard high-volume PEG regimens typically involve ingestion of approximately 4 liters of solution, administered either as a single dose or, increasingly, as a split-dose regimen. There is growing evidence that split-dose strategies provide superior cleansing compared with single-dose administration, likely because they reduce the interval between completion of the preparation and colonoscopy, thereby limiting the reaccumulation of colonic secretions and stool.[3][19] Clinically, high-volume PEG is often viewed as a benchmark preparation because of its safety profile in medically complex patients. It does not alter histologic features of the mucosa and is therefore suitable when inflammatory bowel disease is suspected and mucosal assessment must be as unconfounded as possible.[21] It can also be used in patients with preexisting electrolyte imbalance or in those who cannot tolerate high sodium loads, including individuals with renal failure, heart failure, or cirrhosis.[22] The principal limitation is acceptability: despite being generally well tolerated physiologically, approximately 5% to 15% of patients do not complete high-volume PEG regimens because of poor palatability, nausea, or intolerance of large fluid volumes.[20] For nurses and clinicians, this noncompletion rate underscores that "safety" is only clinically meaningful if the regimen can be completed as prescribed.

Low-volume PEG preparations were developed to preserve the cleansing efficacy of high-volume lavage while improving adherence by reducing the total volume ingested. The only Food and Drug Administration (FDA)-approved low-volume PEG product is a 2-liter PEG-ELS formulation that includes ascorbic acid.[3] Ascorbic acid functions as an additional osmotic component, enabling effective cleansing at a lower fluid volume. However, this modification introduces a clinically important caution: because the preparation contains ascorbic acid, it must be used with care in individuals with glucose-6-phosphate dehydrogenase deficiency, given concern that oxidative stress may exacerbate hemolysis in susceptible patients.[23] This example illustrates a recurring theme in bowel preparation: efforts to improve tolerability can introduce new safety considerations that require screening, documentation review, and, when appropriate, selection of alternative regimens. In nursing practice, confirmation of relevant medical history, recognition of documented G6PD deficiency, and escalation to the prescribing clinician when uncertainty exists are essential steps that protect patients from avoidable adverse outcomes. Sulfate-free PEG-ELS represents another adaptation of the PEG platform designed to improve patient acceptance. Traditional PEG-ELS solutions are often described as salty and unpleasant, and taste-related intolerance is a major driver of incomplete preparation. Sulfate-free PEG-ELS was created to improve smell and taste, producing a less salty, more palatable solution while maintaining cleansing performance.[24] Evidence indicates that sulfate-free PEG-ELS is comparable to standard PEG-ELS in colonic cleansing efficacy, overall tolerance, and safety.[3][25] In practical terms, this improves the likelihood that patients will finish the prescribed regimen, which is clinically significant because incomplete ingestion is a common and preventable cause of inadequate mucosal visualization. In education and coaching, nursing staff often focus on strategies to improve completion—such as chilling the solution, using flavor enhancers approved by protocol, and pacing ingestion—yet the baseline palatability of the product can still meaningfully shape adherence.

Hypoosmotic agents include PEG-3350–based regimens, sometimes referred to as PEG-SD, which are typically administered with an additional

electrolyte-containing beverage, often a sports drink, and may be combined with stimulant laxatives such as bisacodyl.[3] These preparations are widely used in some outpatient settings because they are perceived as easier to ingest and more palatable than traditional PEG-ELS. Nevertheless, important distinctions exist. The combination of PEG-3350 with an electrolyte beverage is not FDA-approved as a bowel preparation regimen prior to colonoscopy and is not considered equivalent to isosmotic low-volume 2-liter PEG-ELS products.[3] The safety and effectiveness literature has been mixed, with variable findings on cleansing quality and on biochemical effects. Several studies have reported concerns about electrolyte abnormalities, including shifts in sodium, potassium, and chloride, and some evidence suggests PEG-3350 regimens may be more likely to produce hyponatremia compared with low-volume 2-liter PEG-ELS preparations.[26] For clinical teams, these findings highlight the need for careful selection, especially among older adults, patients on diuretics, individuals with baseline hyponatremia risk, and those with limited ability to maintain hydration. Nursing assessment is particularly important because early symptoms of electrolyte derangement—such as weakness, dizziness, confusion, or worsening nausea—can overlap with the expected discomfort of catharsis. Distinguishing "expected" effects from early warning signs requires structured monitoring and awareness of patient-specific risk factors. Hyperosmotic agents include magnesium citrate, oral sodium sulfate, and sodium phosphate. These agents work by drawing water into the intestinal lumen to promote catharsis, but their osmotic effects and systemic handling can introduce clinically significant risks in predisposed patients. Magnesium citrate is a magnesium-containing saline laxative that acts osmotically and also stimulates cholecystokinin release, contributing to intraluminal fluid and electrolyte movement in the small intestine and possibly the colon.[3] Despite its cathartic effect, magnesium citrate is not typically recommended as a primary bowel preparation because of the potential for magnesium toxicity, which can manifest as bradycardia, hypotension, nausea, and drowsiness. Since magnesium is cleared through the kidneys, the preparation should be avoided in patients with kidney disease, in whom accumulation can lead to clinically significant hypermagnesemia.[3] This underscores why pre-procedure evaluation must include renal function review and why nurses should be trained to recognize both dehydration risk and toxicity symptoms, particularly in older adults and inpatients with fluctuating renal reserve.

Oral sodium sulfate has been described as less likely to cause significant fluid or electrolyte shifts, a property attributed to sulfate being a poorly absorbed anion.[3] However, the evidence base is more limited than for PEG solutions. Available studies suggest oral sodium sulfate can be similar to low-volume 2-liter PEG-ELS with ascorbic acid in cleansing effectiveness, and one study noted that a one-day oral sodium sulfate regimen was associated with increased gastrointestinal events compared with 4-liter PEG-ELS, though this increase was not observed in split-dose regimens.[11] This detail is clinically meaningful because it reinforces the broader pattern that split dosing often improves both cleansing and tolerability by moderating acute symptom burden and reducing prolonged exposure to large cathartic loads. When oral sodium sulfate is selected, nurses should anticipate and counsel regarding possible GI adverse effects, monitor hydration, and ensure that patients at risk of intolerance have access to supportive measures. Sodium phosphate is no longer recommended as a bowel preparation regimen because of its serious adverse effects and well-characterized renal toxicity risk. Patients with renal dysfunction, dehydration, hypercalcemia, or hypertension treated with an angiotensin-converting enzyme inhibitor or angiotensin receptor blocker have been reported to develop phosphate nephropathy following sodium phosphate exposure.[12] Beyond nephropathy, sodium phosphate has been associated with hyperphosphatemia, elevated blood urea nitrogen, increased plasma osmolality, hypocalcemia, hyponatremia, and seizures.[14][15][16][17] Given the seriousness of these events, the FDA has issued warnings for the prescription tablet form of sodium phosphate.[3][15] From a nursing and safety perspective, sodium phosphate represents a preparation where contraindication screening is particularly important, and medication reconciliation is essential because common antihypertensive therapies can increase vulnerability to renal injury during periods of dehydration and catharsis. Patient education should emphasize hydration strategies consistent with instructions, and clinicians should favor safer alternatives in at-risk populations.

Combination agents have also been used, blending stimulant and osmotic mechanisms to enhance cleansing while attempting to reduce volume or improve tolerability. Sodium picosulfate/magnesium citrate is one such regimen and functions dually: sodium picosulfate acts as a stimulant laxative that increases the force and frequency of peristalsis, while the magnesium citrate component retains fluid in the colon through osmotic action.[27] Although effective in many patients, side effects are commonly gastrointestinal and include abdominal pain, nausea, and vomiting.[3] These symptoms have practical significance because vomiting can compromise regimen completion, increase dehydration risk, and in rare cases elevate aspiration risk, especially in patients with neurologic impairment or frailty. Nursing counseling about pacing, symptom recognition, and when to seek help

becomes pivotal when these preparations are used. Another combination approach is sodium sulfate with sulfate-free PEG-ELS, typically involving oral sodium sulfate plus 2 liters of sulfate-free PEG-ELS.[3] In comparative work assessing split-dosed administration of this combination versus 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] These findings reinforce that "successful cleansing" must be weighed against tolerability, because higher vomiting rates can reduce adherence, increase distress, and potentially destabilize patients with limited reserve. For nurses, this means preparing patients with anticipatory guidance, ensuring access to fluids, and communicating promptly with prescribing clinicians if intolerance threatens completion.

Regardless of the agent chosen, objective assessment of bowel preparation quality is an important part of colonoscopy practice, both for immediate procedural decisions and for quality improvement. The Boston Bowel Preparation Scale (BBPS) is a standardized tool used to evaluate bowel cleansing after all endoscopic cleaning maneuvers have been performed. It assigns a score from 0 to 3 to each of three colonic segments: the right colon, the transverse colon, and the left colon.[28] A score of 0 indicates an unprepared segment in which mucosa is not adequately visualized; a score of 1 indicates that only a portion of the mucosa is visible due to residual stool or staining; a score of 2 reflects minor residual staining or small fragments of stool but generally adequate visualization; and a score of 3 indicates that the entire mucosa is seen well with no residual stool.[28] The segment scores are then summed to produce a total score for the entire colon, with higher scores reflecting better preparation.[28] The BBPS is clinically valuable because it allows consistent documentation of preparation adequacy, supports decisions about surveillance intervals, and provides feedback that can guide regimen modification for future procedures. In nursing-led pre-procedure education programs, knowledge of BBPS principles can also inform patient counseling, reinforcing that the goal is not merely frequent bowel movements but a clear, low-residue effluent that enables complete mucosal inspection. In summary, bowel preparation involves selecting among isosmotic, hypoosmotic, and hyperosmotic agents with careful consideration of efficacy, tolerability, and patient safety. High-volume PEG regimens remain a physiologically stable option, especially for medically complex patients, yet tolerability limits completion for a subset.[20][22] Low-volume PEG-ELS with ascorbic acid improves acceptability but requires caution in G6PD deficiency.[3][23] Sulfate-free PEG-ELS enhances palatability with comparable performance.[24][25] Hypoosmotic PEG-3350

regimens are widely used but may carry greater electrolyte abnormality risk in some populations.[26] Hyperosmotic agents can be effective but require caution, with sodium phosphate specifically discouraged due to serious adverse effects and regulatory warnings.[12][14][15][16][17][3][15] Combination regimens can achieve successful cleansing but may increase GI intolerance such as vomiting.[3][18][27] Standardized scoring systems such as the BBPS provide objective evaluation and support continuous improvement in bowel preparation practice.[28]

Technique or Treatment

Bowel preparation is administered to evacuate fecal material and minimize residual turbid fluid so that the endoscopist can visualize the colonic mucosa with high diagnostic fidelity. Although many bowel-cleansing agents exist, the technique of administration—specifically the dosing schedule—often determines whether a regimen achieves its intended effect. In clinical practice, bowel preparations are typically delivered either as a single dose or as a split-dose regimen. A growing body of evidence supports split dosing as the preferred technique for most patients because it improves cleansing quality and is associated with higher adenoma detection rates, a quality indicator closely linked to colorectal cancer prevention.[3][29] The physiologic rationale is straightforward: the colon continues to secrete fluid and mucus, and proximal colonic content can migrate distally over time. If the entire preparation is completed too early—such as the afternoon or evening before an afternoon procedure—colonic contents can reaccumulate, leaving residual liquid and particulate matter by the time colonoscopy begins. Split dosing reduces this interval, thereby limiting recontamination and improving visibility, particularly in the right colon where incomplete cleansing is common. Operationally, split-dose bowel preparation is generally scheduled with the first dose taken on the day prior to the colonoscopy and the second dose taken on the day of the procedure, typically between 3 and 8 hours before the start time.[3][30][31] This timing reflects a balance between achieving maximal cleansing and maintaining patient safety. Administering the second dose close to the procedure increases the likelihood of clear effluent and improved mucosal visualization, while allowing sufficient time for bowel evacuation to reduce the risk of residual stool during the examination. The time window also accounts for practical considerations such as travel time to the endoscopy unit, institutional fasting policies, and anesthesia requirements. Nursing and gastroenterology teams typically advise patients to complete the final portion within a defined window before check-in so that stool output has diminished and the patient is more comfortable during transport and pre-procedure intake assessments. Single-dose regimens, in

contrast, may be selected when split dosing is impractical—such as in patients with limited ability to wake early, those with rigid work constraints, or in some inpatient scheduling scenarios. However, single-dose administration can be associated with lower overall cleansing quality, particularly for procedures scheduled later in the day, because the interval between dose completion and colonoscopy may be long. In these contexts, clinicians may adjust by using a same-day preparation for afternoon procedures, or by employing adjunct strategies such as intensified dietary restriction, prokinetic or stimulant additions when appropriate, or enhanced education to ensure full completion. Regardless of schedule, the technique requires meticulous patient instruction regarding diet, hydration, and medication management. Clear guidance on what constitutes "adequate output" (for example, progression toward clear or pale-yellow liquid stool) helps patients gauge effectiveness. Nursing staff often reinforce pacing strategies to improve tolerability, such as drinking the solution in divided increments, chilling the solution, and managing nausea early so that incomplete ingestion does not compromise cleansing. Importantly, technique is not limited to the ingestion schedule; it also encompasses proactive monitoring for intolerance, dehydration risk, and safe adherence to pre-procedural fasting rules, particularly in older adults and those with comorbidities that increase vulnerability to fluid and electrolyte shifts [13][14].

Clinical Significance

The clinical significance of bowel preparation is best appreciated by recognizing that colonoscopy is only as effective as its visualization permits. High-quality bowel preparation transforms colonoscopy into a reliable diagnostic and therapeutic procedure by allowing the endoscopist to inspect the mucosal surface systematically, identify subtle lesions, and perform interventions such as biopsy or polypectomy with confidence. When preparation is adequate, the mucosa appears clean and well delineated, folds can be examined thoroughly, and the endoscopist can distinguish clinically important lesions—such as flat adenomas, serrated polyps, or early malignant changes—from benign stool residue or staining. This translates into higher detection rates for polyps and other mucosal abnormalities, improved completeness of the examination, and fewer technical interruptions for washing and suctioning. Efficient visualization also reduces procedural time and may lower sedation exposure, thereby improving safety and patient experience. Conversely, poor bowel preparation is a potentially severe limitation on the usefulness of colonoscopy because it undermines the fundamental purpose of the procedure: accurate mucosal assessment. Inadequate cleansing can obscure lesions, particularly those that are small, flat, or located in the proximal colon. A missed lesion is not merely a documentation issue; it

can represent a missed opportunity for cancer prevention or early diagnosis. Because colorectal cancer often develops through an adenoma–carcinoma sequence, failure to identify and remove adenomatous polyps can allow progression over time, with direct implications for morbidity and mortality. Poor preparation also increases the likelihood of an incomplete colonoscopy, either because the endoscopist cannot safely advance to the cecum or because visualization is insufficient to justify completing the examination. This often results in repeat colonoscopy at a shortened interval, exposing the patient to additional procedural risk, repeat bowel preparation burden, and potential delays in diagnosis. In health systems terms, inadequate preparation increases cost, reduces endoscopy capacity, and contributes to inefficiency—effects that become particularly consequential in high-volume screening programs. In addition, poor preparation may be associated with higher procedural adverse events, partly because inadequate cleansing can prolong the procedure, increase mechanical manipulation, and necessitate repeated insufflation, suction, and lavage. These factors may increase discomfort, raise sedation requirements, and heighten risk in patients with cardiopulmonary comorbidities. For nursing practice, the clinical significance is therefore both patient-centered and system-centered: effective bowel preparation improves detection and safety, reduces repeat procedures, and strengthens the preventive impact of colonoscopy, while inadequate preparation compromises diagnostic accuracy and can have serious downstream consequences for individual outcomes [13][14].

Enhancing Healthcare Team Outcomes

Optimizing bowel preparation outcomes requires interprofessional collaboration because regimen selection, patient education, adherence support, and side-effect management span multiple domains of expertise. A coordinated team typically includes the primary care physician, gastroenterologist, nurses, and a pharmacist, each contributing essential knowledge to tailor preparation safely and effectively. The primary care physician often provides longitudinal insight into the patient's medical history and social context, which may reveal contraindications to specific regimens, baseline risks for electrolyte disturbances, or barriers to adherence such as limited literacy, language needs, or inadequate caregiver support. The gastroenterologist contributes specialized knowledge of preparation efficacy, colonoscopy quality standards, and evidence-based dosing strategies, and is commonly responsible for aligning the regimen with procedural timing and for setting expectations regarding what constitutes successful cleansing. Nurses are central to implementation and quality improvement because they provide practical education, reinforce instructions, and monitor for intolerance,

dehydration, and incomplete preparation—particularly in inpatient settings. Nursing assessment can identify early warning signs that require escalation, such as persistent vomiting, inability to tolerate fluids, dizziness, confusion, or inadequate stool output suggesting incomplete cleansing. Nurses also help adapt technique to patient circumstances, for example by supporting split-dose schedules, clarifying fasting rules, and coordinating medication timing for patients with diabetes or other conditions requiring careful peri-procedural planning. Pharmacists enhance safety by reviewing medication profiles for interactions and risk amplification—for example, diuretics, renin–angiotensin system inhibitors, or nephrotoxic agents that can increase dehydration-related renal injury risk—and by advising on electrolyte-sensitive regimens. They also support selection of antiemetic or supportive therapies when nausea threatens completion. A team-based approach also enables individualized scheduling decisions. Whether a single-dose or split-dose regimen is selected can be adapted to procedural timing and patient lifestyle, recognizing that adherence often determines success more than theoretical regimen efficacy. Importantly, targeted educational interventions have demonstrated measurable benefit. One study reported that telephone reeducation about bowel preparation on the day before colonoscopy significantly improved preparation quality and increased polyp detection rates.[32] This finding illustrates how interprofessional workflows—such as nurse-led reminder calls, structured checklists, scripted education—can translate directly into improved clinical outcomes. When teams implement standardized pathways that include clear written instructions, reinforcement communication, and rapid access to advice for side effects, they reduce preventable preparation failures, improve adenoma detection, decrease repeat procedures, and enhance the overall safety and effectiveness of colonoscopy-based screening and diagnostic care [32].

Conclusion:

Bowel preparation is not a routine pre-procedural step but a critical determinant of colonoscopy quality and patient safety. Inadequate cleansing undermines the diagnostic and therapeutic potential of colonoscopy, increasing the risk of missed lesions, procedural complications, and repeat interventions. Evidence strongly supports split-dose regimens as the preferred technique for most patients, as they enhance mucosal visualization and improve adenoma detection rates. Regimen selection must be individualized, balancing efficacy, tolerability, and safety, particularly in patients with comorbidities such as renal impairment, diabetes, or neurologic disorders. Nursing professionals play a central role in this process by conducting comprehensive risk assessments, reinforcing patient education, monitoring hydration and electrolyte status, and

identifying early signs of intolerance or incomplete preparation. Interprofessional collaboration among physicians, nurses, and pharmacists further strengthens outcomes by aligning regimen choice with patient-specific needs and procedural timing. Ultimately, structured, evidence-based bowel preparation protocols reduce preventable failures, optimize resource utilization, and improve the preventive impact of colonoscopy in colorectal cancer screening and diagnosis.

References:

[1] Mitchell RM, McCallion K, Gardiner KR, Watson RG, Collins JS. Successful colonoscopy; completion rates and reasons for incompletion. The Ulster medical journal. 2002 May:71(1):34-7

[2] Shah HA, Paszat LF, Saskin R, Stukel TA, Rabeneck L. Factors associated with incomplete colonoscopy: a population-based study. Gastroenterology. 2007 Jun:132(7):2297-303

[3] ASGE Standards of Practice Committee, Saltzman JR, Cash BD, Pasha SF, Early DS, Muthusamy VR, Khashab MA, Chathadi KV, Fanelli RD, Chandrasekhara V, Lightdale JR, Fonkalsrud L, Shergill AK, Hwang JH, Decker GA, Jue TL, Sharaf R, Fisher DA, Evans JA, Foley K, Shaukat A, Eloubeidi MA, Faulx AL, Wang A, Acosta RD. Bowel preparation before colonoscopy. Gastrointestinal endoscopy. 2015 Apr:81(4):781-94. doi: 10.1016/j.gie.2014.09.048.

[4] Wexner SD, Beck DE, Baron TH, Fanelli RD, Hyman N, Shen B, Wasco KE, American Society of Colon and Rectal Surgeons, American Society for Gastrointestinal Endoscopy, Society of American Gastrointestinal and Endoscopic Surgeons. A consensus document on bowel preparation before colonoscopy: prepared by a task force from the American Society of Colon and Rectal Surgeons (ASCRS), the American Society for Gastrointestinal Endoscopy (ASGE), and the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). Gastrointestinal endoscopy. 2006 Jun:63(7):894-909

[5] Rex DK, Bond JH, Winawer S, Levin TR, Burt RW, Johnson DA, Kirk LM, Litlin S, Lieberman DA, Waye JD, Church J, Marshall JB, Riddell RH, U.S. Multi-Society Task Force on Colorectal Cancer. Quality in the technical performance of colonoscopy and the continuous quality improvement process for colonoscopy: recommendations of the U.S. Multi-Society Task Force on Colorectal Cancer. The American journal of gastroenterology. 2002 Jun:97(6):1296-308

[6] Rex DK, Petrini JL, Baron TH, Chak A, Cohen J, Deal SE, Hoffman B, Jacobson BC, Mergener K, Petersen BT, Safdi MA, Faigel DO, Pike IM, ASGE/ACG Taskforce on Quality in Endoscopy. Quality indicators for colonoscopy. The

American journal of gastroenterology. 2006 Apr:101(4):873-85

[7] Chokshi RV, Hovis CE, Hollander T, Early DS, Wang JS. Prevalence of missed adenomas in patients with inadequate bowel preparation on screening colonoscopy. Gastrointestinal endoscopy. 2012 Jun:75(6):1197-203. doi: 10.1016/j.gie.2012.01.005.

[8] Hassan C, Fuccio L, Bruno M, Pagano N, Spada C, Carrara S, Giordanino C, Rondonotti E, Curcio G, Dulbecco P, Fabbri C, Della Casa D, Maiero S, Simone A, Iacopini F, Feliciangeli G, Manes G, Rinaldi A, Zullo A, Rogai F, Repici A. A predictive model identifies patients most likely to have inadequate bowel preparation for colonoscopy. Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association. 2012 May:10(5):501-6. doi: 10.1016/j.cgh.2011.12.037.

[9] Nguyen DL, Wieland M. Risk factors predictive of poor quality preparation during average risk colonoscopy screening: the importance of health literacy. Journal of gastrointestinal and liver diseases : JGLD. 2010 Dec:19(4):369-72

[10] DiPalma JA, Brady CE 3rd. Colon cleansing for diagnostic and surgical procedures: polyethylene glycol-electrolyte lavage solution. The American journal of gastroenterology. 1989 Sep:84(9):1008-16

[11] Di Palma JA, Rodriguez R, McGowan J, Cleveland Mv. A randomized clinical study evaluating the safety and efficacy of a new, reduced-volume, oral sulfate colon-cleansing preparation for colonoscopy. The American journal of gastroenterology. 2009 Sep:104(9):2275-84. doi: 10.1038/ajg.2009.389.

[12] Markowitz GS, Stokes MB, Radhakrishnan J, D'Agati VD. Acute phosphate nephropathy following oral sodium phosphate bowel purgative: an underrecognized cause of chronic renal failure. Journal of the American Society of Nephrology : JASN. 2005 Nov:16(11):3389-96

[13] Gremse DA, Sacks AI, Raines S. Comparison of oral sodium phosphate to polyethylene glycol-based solution for bowel preparation for colonoscopy in children. Journal of pediatric gastroenterology and nutrition. 1996 Dec:23(5):586-90

[14] Lieberman DA, Ghormley J, Flora K. Effect of oral sodium phosphate colon preparation on serum electrolytes in patients with normal serum creatinine. Gastrointestinal endoscopy. 1996 May:43(5):467-9

[15] Clarkston WK, Tsen TN, Dies DF, Schratz CL, Vaswani SK, Bjerregaard P. Oral sodium phosphate versus sulfate-free polyethylene glycol electrolyte lavage solution in outpatient preparation for colonoscopy: a prospective comparison. Gastrointestinal endoscopy. 1996 Jan:43(1):42-8

[16] Holte K, Nielsen KG, Madsen JL, Kehlet H. Physiologic effects of bowel preparation. Diseases of the colon and rectum. 2004 Aug:47(8):1397-402

[17] Frizelle FA, Colls BM. Hyponatremia and seizures after bowel preparation: report of three cases. Diseases of the colon and rectum. 2005 Feb:48(2):393-6

[18] Rex DK, McGowan J, Cleveland Mv, Di Palma JA. A randomized, controlled trial of oral sulfate solution plus polyethylene glycol as a bowel preparation for colonoscopy. Gastrointestinal endoscopy. 2014 Sep:80(3):482-91. doi: 10.1016/j.gie.2014.03.043.

[19] Enestvedt BK, Tofani C, Laine LA, Tierney A, Fennerty MB. 4-Liter split-dose polyethylene glycol is superior to other bowel preparations, based on systematic review and meta-analysis. Clinical gastroenterology and hepatology : the official clinical practice journal of the American Gastroenterological Association. 2012 Nov:10(11):1225-31. doi: 10.1016/j.cgh.2012.08.029.

[20] Marshall JB, Pineda JJ, Barthel JS, King PD. Prospective, randomized trial comparing sodium phosphate solution with polyethylene glycol-electrolyte lavage for colonoscopy preparation. Gastrointestinal endoscopy. 1993 Sep-Oct:39(5):631-4

[21] Pockros PJ, Foroozan P. Golytely lavage versus a standard colonoscopy preparation. Effect on normal colonic mucosal histology. Gastroenterology. 1985 Feb:88(2):545-8

[22] Marschall HU, Bartels F. Life-threatening complications of nasogastric administration of polyethylene glycol-electrolyte solutions (Golytely) for bowel cleansing. Gastrointestinal endoscopy. 1998 May:47(5):408-10

[23] Rees DC, Kelsey H, Richards JD. Acute haemolysis induced by high dose ascorbic acid in glucose-6-phosphate dehydrogenase deficiency. BMJ (Clinical research ed.). 1993 Mar 27:306(6881):841-2

[24] Fordtran JS, Santa Ana CA, Cleveland MvB. A low-sodium solution for gastrointestinal lavage. Gastroenterology. 1990 Jan:98(1):11-6

[25] DiPalma JA, Marshall JB. Comparison of a new sulfate-free polyethylene glycol electrolyte lavage solution versus a standard solution for colonoscopy cleansing. Gastrointestinal endoscopy. 1990 May-Jun:36(3):285-9

[26] Matro R, Daskalakis C, Negoianu D, Katz L, Henry C, Share M, Kastenberg D. Randomised clinical trial: Polyethylene glycol 3350 with sports drink vs. polyethylene glycol with electrolyte solution as purgatives for colonoscopy--the incidence of hyponatraemia.

Alimentary pharmacology & therapeutics. 2014 Sep:40(6):610-9. doi: 10.1111/apt.12884.

[27]   Hoy SM, Scott LJ, Wagstaff AJ. Sodium picosulfate/magnesium citrate: a review of its use as a colorectal cleanser. Drugs. 2009:69(1):123-36. doi: 10.2165/00003495-200969010-00009.

[28]   Lai EJ, Calderwood AH, Doros G, Fix OK, Jacobson BC. The Boston bowel preparation scale: a valid and reliable instrument for colonoscopy-oriented research. Gastrointestinal endoscopy. 2009 Mar:69(3 Pt 2):620-5. doi: 10.1016/j.gie.2008.05.057.

[29]   Gurudu SR, Ramirez FC, Harrison ME, Leighton JA, Crowell MD. Increased adenoma detection rate with system-wide implementation of a split-dose preparation for colonoscopy. Gastrointestinal endoscopy. 2012 Sep:76(3):603-8.e1. doi: 10.1016/j.gie.2012.04.456.

[30]   Bryant RV, Schoeman SN, Schoeman MN. Shorter preparation to procedure interval for colonoscopy improves quality of bowel cleansing. Internal medicine journal. 2013 Feb:43(2):162-8. doi: 10.1111/j.1445-5994.2012.02963.x.

[31]   Seo EH, Kim TO, Park MJ, Joo HR, Heo NY, Park J, Park SH, Yang SY, Moon YS. Optimal preparation-to-colonoscopy interval in split-dose PEG bowel preparation determines satisfactory bowel preparation quality: an observational prospective study. Gastrointestinal endoscopy. 2012 Mar:75(3):583-90. doi: 10.1016/j.gie.2011.09.029

[32]   Liu X, Luo H, Zhang L, Leung FW, Liu Z, Wang X, Huang R, Hui N, Wu K, Fan D, Pan Y, Guo X. Telephone-based re-education on the day before colonoscopy improves the quality of bowel preparation and the polyp detection rate: a prospective, colonoscopist-blinded, randomised, controlled study. Gut. 2014 Jan:63(1):125-30. doi: 10.1136/gutjnl-2012-304292..