CME

Bowel Preparation for Pediatric Colonoscopy: Report of the NASPGHAN Endoscopy and Procedures Committee

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ABSTRACT

Pediatric bowel preparation protocols used before colonoscopy vary greatly, with no identified standard practice. The present clinical report reviews the evidence for several bowel preparations in children and reports on their use among North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition members. Publications in the pediatric literature for bowel preparation regimens are described, including mechanisms of action, efficacy and ease of use, and pediatric studies. A survey distributed to pediatric gastroenterology programs across the country reviews present national practice, and cleanout recommendations are provided. Finally, further areas for research are identified.

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Colonoscopy is a routine endoscopic procedure performed in children to assess for a variety of gastrointestinal conditions. Effective bowel preparation is essential for both optimal diagnostic evaluation and therapeutic intervention. Numerous studies have evaluated safety and efficacy of different bowel preparation protocols, but no standardized regimen exists. Suboptimal preparation can occur in up to one-third of colonoscopies (1) and can be associated with missed diagnoses, procedural risks, and increased costs from repeated procedures. Residual fluid or stool in the colon can impede endoscopists' ability to view the mucosa, assess for pathologic lesions, and, in some cases, complete the procedure.

Bowel preparations adapted for colonoscopy evolved from cleansing enemas and included diet restrictions, laxatives, and large-volume oral bowel lavage. These regimens were time-consuming and uncomfortable, and also caused fluid and electrolyte abnormalities. The early regimens were replaced with various laxative and polyethylene glycol (PEG) solutions. The ideal preparation for colonoscopy would clear the colon of fecal material with no alteration of the colonic mucosa. In addition, the preparation would not cause patient discomfort or fluid and electrolyte shifts and would also be inexpensive. At present, a variety of bowel preparations are used for pediatric colonoscopies; however, none of these preparations meet all of these requirements.

Bowel preparations used in children vary greatly, and uniform standard protocols have not been generally accepted despite the thousands of pediatric colonoscopies performed each year in the United States. Each gastroenterology program or practice generally creates its own unique protocol, which may differ from others. A 2010 article reviewed published pediatric data (2).

The purpose of the present North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition (NASPGHAN) clinical report is to review the evidence for various pediatric bowel preparations and report on their use among the NASPGHAN membership. The published pediatric literature for bowel preparation regimens before colonoscopy is described, including mechanisms of action, efficacy and ease of use, and pediatric studies. A survey distributed to pediatric gastroenterology programs (fellows, NASPGHAN Endoscopy Committee members, Endoscopy Program Directors) across the country reviews present national practice. Cleanout recommendations are provided in a table. We conclude with a discussion of areas for further research.

MECHANISMS OF ACTION, EFFICACY, AND SAFETY

Laxatives are substances that accelerate defecation (Table 1). They have an impact on the transfer of water and electrolytes in the

small and large intestine. They soften hardened feces and stimulate defecation. According to their mode of action, they are divided into osmotic and stimulant laxatives (Table 1).

Osmotic agents that have been used in bowel preparation include magnesium citrate, sodium phosphate, PEG-3350 (a specific PEG product), and PEG with electrolytes (PEG-ELS). Stimulant laxatives include bisacodyl and senna.

Because of the success of PEG-3350 as a treatment for constipation, protocols have used this for colonoscopy preparations. PEG-3350 is safe and effective for bowel preparation in children and has become the most popular bowel preparation.

Clinically insignificant electrolyte changes have been reported with PEG-3350 (3). A study of 2-day colonoscopy preparation in children with PEG-3350 and bisacodyl reported adverse events included nausea (19%), abdominal pain (11%), and occasional vomiting (4%), all rated as mild (4). These adverse events were also similar to those in a prior study evaluating a 4-day bowel regimen by the same authors (3).

One of the risks of oral sodium phosphate regimens includes acute phosphate nephropathy with acute and/or chronic tubular injury. Citing the risk of renal disease, dehydration, abnormal motility, and acute colitis (5), the Food and Drug Administration recommended the avoidance of oral sodium phosphate preparations in patients younger than age 18 years. A ''black box'' warning is now in place on phosphate-based bowel preparation products available by prescription and over the counter.

PEDIATRIC STUDIES

A few studies in the literature address bowel preparation before colonoscopy in the pediatric population (Table 2). Only a small number of these were prospective randomized studies. The duration, dosing, and combination of agents were typical independent variables. The efficacy, tolerance, and adverse effects were the usual measured outcomes. Unlike adult studies with a validated colon cleanliness index used for outcome assessment (Ottawa bowel preparation scale), however, pediatric studies did not have a common efficacy measure.

As mentioned, PEG-3350–based bowel preparation protocols are the most popular in children. The first prospective study by Pashankar et al in 2004 (3) included 46 children given PEG-3350 $1.5\,g \cdot kg^{-1} \cdot day^{-1}$ for 4 days. The results from this study were excellent. Another prospective study in 149 children older than 2 years reported using PEG-3350 at doses of $1.5\,g \cdot kg^{-1} \cdot day^{-1}$ up to 100 g/day in 2 to 3 divided doses for 4 days resulted in adequate colonic preparation in 89% of patients (12). The disadvantage of the 4-day protocol is that it required 4 days of preparation before the procedure, affecting compliance and resulting in lost days from school and/or work. As a result, several recent prospective studies have focused on a shorter duration of PEG-3350 preparation (4,13–15).

In 2011, Jibaly et al prospectively examined a 2-day cleanout with PEG-3350 at an average dose of $1.9\,g \cdot kg^{-1} \cdot day^{-1}$, given during 2 consecutive days in 30 children (13), and found that the majority of the parents and children were ''very satisfied'' or ''satisfied'' with the ease of the bowel preparation. The preparation efficacy was evaluated and graded by the principal investigator and by an independent pediatric gastroenterologist. The data for none of the children were cancelled because of inadequate visualization, and in 90% of the children, minimal to no washing was required. The majority of patients in that study (23/30), however, also received bisacodyl and/or an enema because they were considered to be incompletely prepared before the endoscopy. Abbas et al, in a prospective study, found 238 g of PEG-3350 (roughly equivalent to 1 bottle or 14 capfuls) mixed with 1.9 L of Gatorade taken during a few hours had a completion rate of 93.5% (15). The cecum was reached in all 46 patients in the present study. The terminal ileum was intubated 84% of the time.

A retrospective study using 238 to 255 g of PEG-3350 in 1.9 L of sports drink during 2 hours in the afternoon the day before the colonoscopy in 272 children (median age 13.7 years, range 1.08–17.92 years) showed effective cleansing in 93% of patients, regardless of age, history of constipation, or indication for the procedure (16). These patients ate regular breakfast and lunch on the day before the test and took only clear liquids up to 3 hours before the scheduled procedure.

Overall, in assessing these studies, PEG (with or without electrolytes) mixed with a juice or sports drink for bowel preparation before colonoscopy proved to be fairly effective and

TABLE 1. Mechanism of action, efficacy, and safety

Medication	Mechanism of action	Dose	Ease of use/efficacy	Adverse effects	Comments
PEG-3350	Osmotic	1.5–4 g/kg for 1–2 days	Effective in 93% (16) Effective in 89% (12)	None	Potential compliance issues (12) Good tolerance and effective cleansing; recommend electrolyte solutions to prevent electrolyte imbalance
PEG-ELS	Osmotic	$25\,mL \cdot kg^{-1} \cdot h^{-1}$	Poor tolerance because of taste, vomiting, nausea; may need NG tube	None	Not approved for children younger than 6 mo
Magnesium citrate	Osmotic Stimulates CCK (↑ secretion/motility)	1 oz/y, maximum 10 oz	Variable tolerance/efficacy Needs stimulants or PEG for effectiveness	↑ Mg	Use with caution in renal failure
Bisacodyl	Stimulant/secretory/ antiabsorptive/ prokinetic	5 mg tablet 10 mg suppository	Excellent/good cleaning, 92%–93% along with PEG-3350 (4)	None	Poor effectiveness when not used with other agents
Senna	Secretory/prokinetic	15–30 mg	See comment	None	Effective only when used with other agents
Pico-Salax	Osmotic	One-fourth to 1 sachet in 2 divided doses (23)	Well tolerated and effective	↑ Mg (insignificant)	Use with caution in renal failure

CCK = cholecystokinin; NG = nasogastric; PEG = polyethylene glycol; PEG-3350 = a specific polyethylene glycol product; PEG-ELS = PEG with electrolytes.

TABLE 2. Pediatric colonoscopy preparation studies

Medication	Study design	N	Dosage	Duration	Additional medication	Outcome	Reference
PEG-ELS	Prospective	12	1 L/h			Good 58%	Tolia et al (6)
PEG-ELS	Prospective	20	40 mL · kg^{-1} · h^{-1}	Until stools clear (2.6 ± 0.3 h)	Metoclopramide	Optimal or satisfactory 90%	Sondheimer et al (7)
PEG-3350	Prospective	46	1.5 g · kg^{-1} · day^{-1}	4 days		91% right colon; 95% left colon	Pashankar et al (3)
PEG-3350	Prospective	169	1.5 g · kg^{-1} · day^{-1}	4 days		89% adequate to good	Safder et al (12)
PEG-3350	Prospective	30	1.9 g · kg^{-1} · day^{-1}	2 days		100%	Jibaly et al (13)
PEG-3350	Prospective	111	2 g · kg^{-1} · day^{-1}	2 days	5 mg bisacodyl ×2 days	92% right colon; 93% left colon	Phatak et al (4)
PEG-3350	Prospective randomized trial	40	1.5 g · kg^{-1} · day^{-1} (maximum 100 g/day)	4 days		57.5%	Elitsur et al (14)
		38	2 g · kg^{-1} · day^{-1} (maximum 136 g/day)	2 days	5 mg/day bisacodyl ×2 days	73.6%	
PEG-3350 + sports drink	Retrospective	272	238 or 255 g + 1.9 L sports drink	2 h		93%	Adamiak et al (16)
PEG-3350 + sports drink	Prospective	46	238 g + 1.9 L Gatorade	Few hours		100% cecum; 84% TI	Abbas et al (15)
PEG-ELS versus Na phosphate + fluids	Prospective randomized trial	34	4 L/1.7 m^2			40%	Gremse et al (8)
			45 mL/1.7 m^2/dose ×2			95%	
PEG-ELS versus Na phosphate	Prospective randomized trial	29	20 mL · kg^{-1} · h^{-1}			73%	da Silva et al (9)
			22.5–45 mL ×2 doses			71%	
PEG-ELS versus bisacodyl	Prospective randomized trial	98	15 mL/kg po/NG			88%	Shaoul and Haloon (18)
					Na phosphate enemas ×2	95%	
PEG-ELS versus Na picosulfate with magnesium oxide + citric acid	Prospective randomized trial	89	100 mL/y of age/h—up to 1 L or total 4 L 2 times			77%	Turner et al (23)
						80%	
PEG-3350 versus senna	Prospective randomized trial	30	1.5 g/kg divided bid	2 days		88%	Terry et al (19)
				2 days		29%	
PEG-ELS versus magnesium citrate versus bisacodyl	Prospective randomized trial		20 mL/kg (maximum 1 L)			83%	Dahshan et al (1)
			2.5–6 oz		Senna	70%	
			5–10 mg	2 days	Na phosphate enema	21%	
Bisacodyl	Prospective	30	2 doses	2 days	Na phosphate enema	100%	Abubakar et al (10)
Magnesium citrate versus Na phosphate	Prospective randomized trial	62			Bisacodyl pr and po	90%	El-Baba et al (21)
			2 times			73%	
Senna versus magnesium citrate	Prospective randomized trial	140	Prepackaged 10–20 mg	Twice	Na phosphate enema ×2	No difference between senna and magnesium citrate; no difference between full and clear liquid diet, no difference between 1 or 2 enemas	Trautwein et al (20)
			8 oz water + packet		Na phosphate enema ×2		
Na phosphate versus magnesium citrate	Prospective randomized trial	48	2 doses			70%	Sabri et al (11)
			3 days		Na phosphate enema	68%	
Sodium picosulfate versus bisacodyl	Prospective randomized trial	63	Twice			100%	Pinfield and Stringer (17)
			2 days		Na phosphate enema (0.5–1)	71%	
Sodium picosulfate + magnesium oxide + citric acid versus magnesium citrate	Retrospective	68			Both groups received bisacodyl or castor oil (if <6 y old)	97%	Jimenez-Rivera et al (22)
			2 doses			93%	

NG = nasogastric tube; PEG-3350 = a specific polyethylene glycol product; PEG-ELS = PEG with electrolytes; TI = terminal ileum.

tolerable in the pediatric population in conjunction with a clear liquid diet. The duration of that diet and the need for stimulant adjunctive therapy, however, seemed to vary not only between the studies but also within them. The addition of 5 mg of bisacodyl to 2 g/kg of PEG-3350, each given for 2 days before the colonoscopy, also proved to be effective, as noted by Phatak et al in 2011 (4). This study noted 95% compliance with this regimen. In terms of efficacy, the right and left colon were rated as excellent or good in 92% and 93% of children, respectively.

In 1999, Pinfield and Stringer showed poor success with the regimen of oral bisacodyl and sodium phosphate enemas (17). In 2007, however, Shaoul and Haloon showed that when combined with dietary restrictions, this combination can be effective and superior to PEG alone (18). Although the difference was not statistically significant, it was at least comparable.

In a direct comparison between PEG-3350 and senna, PEG-3350 was found to be more effective in a study of 30 children. Terry et al compared PEG-3350 dosed at 1.5 g/kg divided twice per day for 2 days and senna 15 mL (26.4 mg sennosides) for children 6 to 12 years of age or 30 mL (52.8 mg sennosides) for patients 12 to 21 years of age, given during 2 days (19). This was done while being on either a clear or a full liquid diet for 1 to 2 days. A total of 88% of patients given PEG-3350 were rated as having a good cleanout versus only 29% of patients given only the senna cleanout. Both regimens were reportedly well tolerated.

Magnesium citrate alone or in combination with a stimulant and/or enemas also proved to be fairly effective, but was less tolerated in the pediatric population. Trautwein et al reported no significant difference between senna and magnesium citrate (20). The combination of magnesium citrate and senna actually fared poorly against PEG-ELS (70%–83%) in a study done by Dahshan et al (1). El-Baba et al reported that magnesium citrate given orally with bisacodyl rectally provided a better cleanout compared with sodium phosphate enemas alone (21).

More recently, in July 2012, the Food and Drug Administration approved Prepopik (Ferring Pharmaceuticals, Parsippany, NJ) in adults. This preparation had been available and in use only in Canada, sold as Pico-Salax. Jimenez-Rivera et al in 2009 found this preparation to have good outcomes in 97% of the patients who received it during 2 days, in conjunction with a 2-day clear liquid diet (22). In 1999, Pinfield and Stringer also found that sodium picosulfate had favorable results in contrast to a preparation with bisacodyl and sodium phosphate enema (17). Turner et al found that Pico-Salax yielded a slightly superior cleanout compared with PEG-ELS (23).

SURVEY OF PRESENT NATIONAL PRACTICE

Methods

The primary aim of the survey was to identify different bowel preparation regimens from a broad spectrum of practitioners to gain understanding of which medications are being used and how they are prescribed. The secondary aims of the survey were to inquire about specific practices of bowel preparation and regimens for different endoscopic procedures. The survey was distributed to pediatric gastroenterology programs in academic, community, and private practice settings across North America. To maximize the variation of regimens, we specifically invited pediatric gastroenterologists who were identified through NASPGHAN as directors of endoscopy or contacts for their respective institutions or groups, with a goal of acquiring 35 or more completed surveys.

The survey was created and distributed electronically, and data were collected and managed using Research Electronic Data Capture tools hosted at Cincinnati Children's Hospital Medical Center (24). Research Electronic Data Capture is a secure, Web-based application designed to support data capture for research studies, providing an intuitive interface for validated data entry, audit trails for tracking data manipulation and export procedures, automated export procedures for seamless data downloads to common statistical packages, and procedures for importing data from external sources.

The survey consisted of multiple-choice and open-ended questions and was divided into 3 parts. The first section of the survey asked participants to select therapy type (monotherapy vs dual therapy vs other), product classes (osmotic laxative vs stimulant laxative), and specific medication with dosage, frequency, and duration before colonoscopy for specific age and weight groups. Participants were asked to select the regimen they use most often in their daily practice. Because of the variation in practices, the most common regimen in terms of product, dose, frequency, and duration was reported. When choices were selected an equal number of times, both or all choices were reported. Participants were also asked what additional therapy is used with laxatives, and what additional instructions are given to patients as part of their regimens. Additional therapy included dietary changes and when changes are initiated before procedure, and rectal therapy and product, dose, frequency, and duration used. For certain rectal therapies, participants were asked

TABLE 3. Survey results for 2- to 5-year-old patients (~10–20 kg)

Monotherapy (N = 26)	
Most common product	PEG-3350
Most common regimen	
Age-based	
Dose	4 capfuls in 32 oz of fluids
Frequency	Drink throughout the day
Duration	One day before colonoscopy
Weight-based	
Dose	$1.5\,g \cdot kg^{-1} \cdot day^{-1}$ in 8 oz of fluids for every capful
Frequency	Drink throughout the day
Duration	One day before colonoscopy
Dual therapy (N = 16)	
Most common products	PEG-3350 and senna
Most common regimen	
PEG-3350	
Dose	1 capful or $1.5\,g \cdot kg^{-1} \cdot day^{-1}$ in 8 oz of fluids for every capful
Frequency	Twice per day or drink throughout the day
Duration	Daily for 4 days before colonoscopy
Sennosides	
Dose	4.3–4.4 or 8.6–8.8 mg
Frequency	Once
Duration	One day before colonoscopy
Additional therapy (N = 41)	
No additional therapy (N = 3)	
Dietary changes (N = 40)	
Most common change	''Clear liquids only'' 1 day before colonoscopy
Rectal therapy (N = 11)	
Most common product	Pediatric bisacodyl
Dose	5 mg/suppository
Frequency	Two suppositories/day
Duration	One day before colonoscopy
Rectal therapy day of procedure?	Before and on same day of procedure

PEG-3350 = a specific polyethylene glycol product.

to report whether they used rectal therapies before or on the day of the colonoscopy. The second section inquired about location of bowel preparation (inpatient vs outpatient), administration of bowel preparation for admitted patients, general bowel preparation for specific procedures (flexible sigmoidoscopy and video capsule endoscopy), and bowel preparation failure and adverse events. The last section investigated physician characteristics and inquired about preparation satisfaction.

Results

Participants

Readers should refer to supplementary Table A (*http://links.lww.com/MPG/A340*) for detailed survey results. In brief, of the 78 invited physicians, 44 participants responded to the survey (56.4% response rate). The majority of responders (89%) were physicians from a university or academic institution; however, the size of practice or division was evenly distributed. When asked to report the approximate number of colonoscopies performed at their institution or practice in 1 year, 41% and 39% of physicians reported that 100 to 499 and 500 to 999 were performed, respectively. A total of 89% of physicians reported being satisfied with their present preparation regimen. A total of 80% of physicians reported using PEG-3350 as part of the preparation for each age group.

2- to 5-Year-Old Patients

For 2- to 5-year-old patients (approximately 10–20 kg) (Table 3), 59% of physicians used monotherapy for bowel preparation before colonoscopy. The most common product for monotherapy was PEG-3350. In this age group, 36% of physicians used dual therapy for bowel preparation before colonoscopy. The most commonly used dual therapy with an osmotic laxative and a stimulant laxative was PEG-3350 and senna. In addition to laxative therapy for bowel preparation, 93% used either dietary changes or rectal therapy, and the most common change was implementing a strict clear liquid diet 1 day before the colonoscopy.

6- to 11-Year-Old Patients

For 6- to 11-year-old patients (approximately 20–40 kg) (Table 4), 43% of physicians used monotherapy for bowel preparation before colonoscopy. Of those using monotherapy, 89%

TABLE 4. Survey results for 6- to 11-year-old patients (~20–40 kg)

Monotherapy (N = 16)	
Most common product	PEG-3350
Most common regimen	
Age-based	
Dose	6 or 7 capfuls in 8 oz of fluids for every capful
Frequency	Drink throughout the day
Duration	One day before colonoscopy
Weight-based	
Dose	$1.5\,g \cdot kg^{-1} \cdot day^{-1}$ in 8 oz of fluids for every capful
Frequency	Drink throughout the day
Duration	Daily for 1 or 4 days before colonoscopy
Dual therapy (N = 27)	
Most common products	PEG-3350 and bisacodyl
Most common regimen	
PEG-3350	
Dose	Small bottle (14 capfuls) or $4\,g \cdot kg^{-1} \cdot day^{-1}$ in either 8 oz of fluids for every capful or 32 oz of fluids or 64 oz of fluids
Frequency	Drink throughout the day
Duration	One day before colonoscopy
Bisacodyl	
Dose	One tablet (5 mg)
Frequency	Once
Duration	One day before colonoscopy
Additional therapy (N = 42)	
Dietary changes (N = 42)	
Most common change	''Clear liquids'' only 1 day before colonoscopy
Rectal therapy (N = 9)	
Most common product	Adult bisacodyl
Dose	10 mg/suppository
Frequency	One suppository/day
Duration	One day before colonoscopy
Rectal therapy day of procedure?	Before and on same day of procedure

PEG-3350 = a specific polyethylene glycol product.

TABLE 5. Survey results for 12-year-old to adult patients (>40 kg)

Monotherapy (N = 19)	
Most common product	PEG-3350
Most common regimen	
Age-based	
Dose	Small bottle (14 capfuls) or large bottle (29 capfuls) in 64 oz of fluids
Frequency	Drink throughout the day
Duration	One day before colonoscopy
Weight-based	
Dose	$1.5\,g \cdot kg^{-1} \cdot day^{-1}$ in 8 oz of fluids for every capful
Frequency	Drink throughout the day
Duration	Daily for 4 days before colonoscopy
Dual therapy (N = 22)	
Most common products	PEG-3350 and bisacodyl
Most common regimen	
PEG-3350	
Dose	Small bottle (14 capfuls) in 64 oz of fluids
Frequency	Drink throughout the day
Duration	One day before colonoscopy
Bisacodyl	
Dose	Two tablets (10 mg)
Frequency	Once
Duration	One day before colonoscopy
Additional therapy (N = 41)	
Dietary changes (N = 38)	
Most common change	''Clear liquids'' only 1 day before colonoscopy
Rectal therapy (N = 10)	
Most common product	Adult bisacodyl
Dose	10 mg/suppository
Frequency	One suppository/day
Duration	One day before colonoscopy
Rectal therapy day of procedure?	Before and on same day of procedure

PEG-3350 = a specific polyethylene glycol product.

used an osmotic laxative for bowel preparation, whereas the other 11% used a stimulant laxative. The most common product for monotherapy was PEG-3350. In this age group, 50% of physicians used dual therapy for bowel preparation before colonoscopy. The most commonly used dual therapy with an osmotic laxative and a stimulant laxative was PEG-3350 and bisacodyl. Dosing of PEG-3350 varied significantly in this regimen. In addition to laxative therapy for bowel preparation, 95% of physicians used either dietary changes or rectal therapy. Of those who used additional therapy, 42 (100%) physicians used dietary changes, and 9 (21%) used rectal therapy. Of the 42 physicians who made dietary changes, the most common change was implementing a strict clear liquid diet 1 day before the colonoscopy.

12-Year-Old to Adult Patients

For 12-year-old to adult patients (>40 kg) (Table 5), 36% of physicians used monotherapy for bowel preparation before colonoscopy; most (94%) used an osmotic laxative, whereas 6% used a stimulant laxative. The most common product for monotherapy was PEG-3350. In this age group, 61% of physicians used dual therapy for bowel preparation before colonoscopy. The most commonly used dual therapy with an osmotic laxative and a stimulant laxative was PEG-3350 and bisacodyl. In addition to laxative therapy for bowel preparation, 93% of physicians used either dietary changes or rectal therapy, and the most common change was implementing a strict clear liquid diet 1 day before the colonoscopy.

Additional Regimens and Practices, Preparation Failure, and Adverse Events

Readers should refer to supplementary Table B (*http://links.lww.com/MPG/A341*) for detailed survey results. Participants were asked to describe what regimens they used for infants and children younger than 2 years (data not shown). The question was open-ended, which resulted in significant variation among responders. The majority of participants used no preparation, clear liquids only (including breast milk), PEG-3350, or PEG-3350 with clear liquids. When asked about location of bowel preparation, 54% of physicians always order an outpatient bowel preparation. Physicians who admit patients were asked about how the preparation is administered once the patients are admitted and about continuing the preparation overnight. For physicians who admit any or all of the time, 55% place a nasogastric tube most of the time, and 50% continue the regimen overnight with close supervision. For flexible sigmoidoscopy, 54% of physicians use only rectal therapy, and the most commonly used product is a Fleet (sodium phosphate) enema. For video capsule endoscopy, 45% of physicians use a laxative medication (PEG-3350 was the most commonly used product) and dietary changes (eg, clear liquids only, soft diet, liquid diet) as their preparation regimen.

Participants were asked to select any and all reasons for outpatient bowel preparation failure in their experience, including their experience with prolonged procedure time and/or procedure cancellation because of inadequate preparation. The most commonly reported reason (77%) for outpatient preparation failure was

TABLE 6. Oral bowel cleansing solutions

Bowel cleansing solution (commercial name)	Dosing	Flavoring strategy	Adverse effects	Double therapy in combination with a laxative[†]
PEG-ELS (CoLyte, GoLYTELY)	$25\,mL \cdot kg^{-1} \cdot h^{-1}$ (children older than 6 mo) (recommended maximum rate 450 mL/h)	Flavor packs or use ''sugar free'' flavoring to taste (eg, Crystal Light)	Hyponatremia[*]	Bisacodyl 5–10 mg on day 1; fleet or saline enemas before cleanout dose 100–500 mL same day of procedure if stool not clear
Sulfate-free PEG-ELS (NuLYTELY, TriLYTE)	$25\,mL \cdot kg^{-1} \cdot h^{-1}$ (children older than 6 mo)	Flavor packs or use ''sugar free'' flavoring to taste (eg, Crystal Light)	Hyponatremia[*]; hypokalemia[*]; allergy	Same
PEG-3350 (MiraLax, Movicol)	$2\,g \cdot kg^{-1} \cdot day^{-1}$ (2-day regimen) or $4\,g \cdot kg^{-1} \cdot day^{-1}$ (1-day regimen, <50 kg); 238 g in 1.5 L of sports drink (1-day regimen, >50 kg)	In flavored sports drinks; large amount of free water not recommended	Hyponatremia[*]; hypokalemia[*]; allergy (rare)	Bisacodyl 5 mg orally (<50 kg) or 10 mg (>50 kg) on day 1; bisacodyl rectal suppository 5 mg (<50 kg) or 10 mg (>50 kg) on day 1; or senna 15 mg (<50 kg) or 30 mg (>50 kg) orally on day 1
Saline laxatives (magnesium citrate, milk of magnesia)	(For children older than 6 y) $4–6\,mL \cdot kg^{-1} \cdot day^{-1}$ (1-day regimen in single or divided doses)	Mixed with citrus drink or flavored	Hyponatremia[‡]; hypermagnesemia[§]	Same
Oral sodium phosphate—not recommended (5)				

Patients at risk for hypovolemia should be evaluated before receiving a bowel cleansing solution. Use of solutions containing high concentration of sucrose to mix in a bowel-cleansing agent increases risk of combustible gas production when using electrocautery devices. PEG-3350 = a specific polyethylene glycol product; PEG-ELS = PEG with electrolytes.

[*] Hyponatremia and other electrolyte abnormalities associated with lower electrolyte concentrations leading to net water absorption. Higher electrolyte containing solutions such as standard PEG-ELS solutions have lower risk of these occurrences.

[†] Weight-based dosing for children not well established. Use with caution and consult pharmacy before using.

[‡] Higher risk of hyponatremia compared with other solutions. Food and Drug Administration approved for children older than 6 y.

[§] Elevated serum magnesium levels in patients with impaired renal function.

TABLE 7. NASPGHAN best practices cleanout regimens

Option 1: PEG-3350, 1-day cleanout	$<50\,kg = 4\,g \cdot kg^{-1} \cdot day^{-1}$* + bisacodyl 5 mg
	$>50\,kg = 238\,g$ in 1.5 L sports drink* + bisacodyl 10 mg
Option 2: PEG-3350, 2-day cleanout	$<50\,kg = 2\,g \cdot kg^{-1} \cdot day^{-1}$* + bisacodyl 5 mg
	$>50\,kg = 2\,g \cdot kg^{-1} \cdot day^{-1}$* + bisacodyl 10 mg
Option 3: NG cleanout	PEG-ELS: $25\,mL \cdot kg^{-1} \cdot h^{-1}$, maximum 450 mL/h†
	Sulfate-free PEG-ELS: $25\,mL \cdot kg^{-1} \cdot h^{-1}$, maximum 450 mL/h†
Option 4: non-PEG cleanout	Magnesium citrate $4–6\,mL \cdot kg^{-1} \cdot day^{-1}$ + bisacodyl 5–10 mg

The vast majority (>90%) of children should not need NG cleanout and inpatient stay unless persistent vomiting or history of failed procedure because of poor bowel preparation. Patients with significant stool burden may benefit from modified regimen, that is, doubling duration of cleanout in option 1. NG = nasogastric tube; PEG = polyethylene glycol; PEG-3350 = a specific polyethylene glycol product; PEG-ELS = PEG with electrolytes.

* Should be administered for 4 to 6 hours.

† Until effluent is clear or up to 4 L and then reassess.

the patient could not drink any or the entire product (ie, ''too much volume''). A total of 29% of participants reported prolonged procedures and 20% reported cancelling and/or rescheduling procedures. Physicians were asked to select which adverse events they experienced with outpatient bowel preparation requiring intervention, and 75% reported no adverse events requiring interventions. The most commonly reported adverse event requiring intervention, however, was dehydration (23%).

CLEANOUT SUGGESTED REGIMENS AND DOSING

Based on the survey responses, the NASPGHAN Endoscopy and Procedures Committee has attempted to offer practical dosing suggestions and best practices recommendations (see Tables 6–8). These suggestions should not be a substitute for clinical judgment, and, in fact, alternative dosing regimens may be entirely reasonable. Additional considerations include having the availability to manage patient bowel preparation questions the night before colonoscopy.

TABLE 8. Clear liquid guidelines

Examples of clear liquids	Water
	Jell-O
	Soda
	Clear juice drinks without pulp
	Ice
	Popsicles
	Clear broth
	Pedialyte
	Sports drink
Avoid	Red liquids
	Solid foods
	Milk or milk products
	Juice with pulp

DISCUSSION

Colonoscopy in children and adults requires effective bowel cleansing for both diagnostic and therapeutic purposes. The safety of the procedure is directly affected by the quality of the bowel preparation. The present NASPGHAN clinical report has reviewed the available pediatric literature and, more important, provided comprehensive information on the present state of practice at many pediatric centers across the United States.

Based on the earlier studies, it is clear that PEG-3350 works well. PEG-ELS is also effective; however, an inpatient admission is often required for nasogastric tube administration or the volume is limited by taste. Evidence for laxative stimulants alone (or with enemas) is inconclusive. Oral phosphate regimens are not recommended because of adverse effects. Magnesium citrate is effective, however less so than PEG-3350, and taste may limit its use.

Themes from the survey results indicate that PEG-3350 ± stimulant is the most common cleanout regimen (used by 80% of responders) and there is a wide range of PEG-3350 dosing regimens.

It is evident that bowel preparation regimens vary significantly. The reported results are the most common regimens in terms of individually reported product, dose, frequency, and duration of therapy. Although greatly variable, we are able to make some conclusions. In terms of monotherapy, for the youngest age group (2–5 years old), age-based dosing provides more than double the amount of PEG-3350 that weight-based dosing provides; yet both methods prescribe a 1-day preparation. We found similar results for the middle age group (6–11 years old) in that age-based dosing provides significantly more laxative than weight-based dosing for a 1-day preparation, but some physicians using weight-based dosing prescribed the therapy during 4 days, which equals or exceeds the age-based 1-day preparation. This phenomenon was also seen in the oldest age group (12-year-old to adult). More variability regarding dual therapy practices (osmotic and stimulant laxative) was found in the 2 younger age groups compared with the older age group, especially for dosing and volume of fluid for mixture.

The efficacy of PEG-3350, safety profile, and ease of use (taste) are the primary reasons this was chosen as the recommendation. Recommendations for the PEG-3350 1-day preparation of $4\,g \cdot kg^{-1} \cdot day^{-1}$ were derived from adult studies demonstrating efficacy at 238 g for 1 day (25) and from the 2 pediatric studies on 238/255 g PEG-3350 (15,16).

Few clinical studies in pediatrics have evaluated the use of the various bowel preparation regimens. Potential areas for future research should include development of new pediatric-friendly preparations, split dosing preparation in children, short- and long-term safety including electrolyte measurements, validation of pediatric cleanliness score (the Ottawa score is a simple and effective score for adults), and comparison of various sports drinks with preparation and their safety.

Further prospective randomized trials and safety studies will be welcomed to determine optimal use of existing regimens or even develop better preparations.

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