Bowel preparation for colonoscopy: European Society of Gastrointestinal Endoscopy (ESGE) Guideline

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Bibliography
DOI http://dx.doi.org/10.1055/s-0032-1326186
Published online: 0.0.
Endoscopy 2013; 45: 142–150

ISSN 0013-726X

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Background and aim: This Guideline is an official statement of the European Society of Gastrointestinal Endoscopy (ESGE). It addresses the choice amongst regimens available for cleansing the colon in preparation for colonoscopy.

Methods: This Guideline is based on a targeted literature search to evaluate the evidence supporting the use of bowel preparation for colonoscopy. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) system was adopted to define the strength of recommendation and the quality of evidence.

Results: The main recommendations are as follows. (1) The ESGE recommends a low-fiber diet on the day preceding colonoscopy (weak recommendation, moderate quality evidence). (2) The ESGE recommends a split regimen of 4 L of polyethylene glycol (PEG) solution (or a same-day regimen in the case of afternoon colonoscopy) for routine bowel preparation. A split regimen (or same-day regimen in the case of afternoon colonoscopy) of 2 L PEG plus ascorbate or of sodium picosulphate plus magnesium citrate may be valid alternatives, in particular for elective outpatient colonoscopy (strong recommendation, high quality evidence). In patients with renal failure, PEG is the only recommended bowel preparation. The delay between the last dose of bowel preparation and colonoscopy should be minimized and no longer than 4 hours (strong recommendation, moderate quality evidence). (3) The ESGE advises against the routine use of sodium phosphate for bowel preparation because of safety concerns (strong recommendation, low quality evidence).

Abbreviations

CRC	colorectal cancer
ESGE	European Society of Gastrointestinal Endoscopy
OSP	oral sodium phosphate
PEG	polyethylene glycol
RCT	randomized controlled trial

1. Introduction

Colonoscopy is the current standard method for evaluating the colon. Recent surveys have shown that the proportion of individuals aged 50 years or older who have undergone colonoscopy within the last 10 years is growing and currently ranges from 6%–25% in various European countries to 62% in the United States [1, 2]. Bowel preparation for colonoscopy is a complex undertaking, involving diet modifications and laxative choice according to patient needs. An adequate level of cleansing is critical for the efficacy of colonoscopy. Two key quality indicators of colonoscopy, cecal intubation rate and polyp detection rate, are associated with the quality of bowel cleansing [3, 4]. An inadequate level of bowel cleansing also results in further costs as the examination has to be re-scheduled or alternative investigations have to be organized [5]. Furthermore, the discomfort and inconvenience of bowel preparation may affect the acceptability and uptake of colonoscopy in screening programs [6].

The aim of this evidence-based and consensus-based Guideline commissioned by the European Society of Gastrointestinal Endoscopy (ESGE) is to provide caregivers with a comprehensive review of the various regimens available and with practical advice for bowel preparation before colonoscopy.

2. Methods

The ESGE commissioned this Guideline. The guideline process included meetings, telephone conferences, and online discussions among members of the committee during October 2011 and January 2012. Subgroups were formed, each in charge of a series of clearly defined key questions (**Appendix e1**, available online). The committee chairs (C.H., J.M.D.) worked with the subgroup leaders (M.B., M.F.K., M.P., B.R., B.S.) to identify pertinent search terms that always included, as a minimum, "bowel preparation" as well as terms pertinent to specific key questions. Searches were performed in Medline. Articles were first selected by title; their relevance was then confirmed by review of the corresponding manuscripts, and publications with content that was considered irrelevant were excluded. A repository of selected literature was made available to all members of the guideline development group. Evidence tables were generated for each key question, summarizing the level of evidence of the available studies. For important outcomes, articles were individually assessed by using the Grading of Recommendation, Assessment, Development and Evaluation (GRADE) system for grading evidence levels and recommendation strengths [7]. The GRADE system is clinically orientated as the grading of recommendations depends on the balance between benefits and risks or burden of any health intervention (**Appendix e2**, available online). The different subgroups developed draft proposals that were presented to the entire group for general discussion during a meeting held in February 2012 (Dusseldorf, Germany). Further details on the methodology of ESGE guidelines have been reported elsewhere [8]. In June 2012, a draft prepared by J.M.D. and C.H. was sent to all group members. After agreement on a final version, the manuscript was submitted to the journal *Endoscopy* for publication. The journal subjected the manuscript to peer review, and the manuscript was amended to reflect reviewers' comments. The final revised manuscript was agreed upon by all the authors.

This Guideline was issued in 2013 and will be considered for review in 2016, or sooner if new evidence becomes available. Any updates of the Guideline in the interim period will be noted on the ESGE website: http://www.esge.com/esge-guidelines.html.

3. Recommendations and statements

Evidence statements and recommendations are stated in italics, key evidence statements and recommendations are in bold.

The ESGE recommends a low-fiber diet on the day preceding colonoscopy (weak recommendation, moderate quality evidence).

The potential benefit of a restricted diet before colonoscopy has not been well studied but such diets have been used in most studies. In a retrospective cohort study of 789 patients [9], adherence to the prescribed low-residue diet during the 2 days preceding colonoscopy was an independent predictor of adequate bowel preparation. In a subgroup analysis of a randomized controlled trial (RCT) that allocated patients to low-volume vs. high-volume polyethylene glycol (PEG), patients randomized to low-volume (bisacodyl and 2 liters [L] PEG) more frequently had poor colon cleanliness if they were allowed a normal diet compared with clear fluids only (44.0% vs. 6.8%, respectively; $P<0.001$); no difference was found in patients taking 4 L of PEG [10]. However, this aspect of bowel preparation is likely less important than the timing of bowel preparation as an RCT has found that split-dose 4-L PEG and no dietary restriction provides better quality colon cleansing than single-dose 4-L PEG with a liquid diet on the day preceding colonoscopy [11].

Two RCTs have compared a clear liquid vs. a low-fiber diet on the day preceding colonoscopy in a total of 414 patients taking identical purgatives for bowel preparation [12, 13]. Both RCTs found that a low-fiber diet was better tolerated than a clear liquid diet; furthermore, satisfactory colon cleanliness was more frequent in patients randomized to non-clear-liquid diets compared with a clear liquid diet (in one of the RCTs the difference was statistically significant in the mid colon only) [13].

The ESGE does not make any recommendations regarding the use of low-fiber diet for more than 24 hours prior to the examination (insufficient evidence to make a recommendation).

Some endoscopists routinely prescribe a low-fiber diet during the 3 days preceding colonoscopy rather than on a single day because of the slow transit time in some patients. However, no study has compared the use of a 1-day vs. a 3-day regimen.

The ESGE recommends against the routine use of enemas in addition to oral bowel preparation (strong recommendation, moderate quality evidence).

A single RCT has compared patients who did or did not have an enema routinely added to standard bowel preparation. The addition of an enema did not result in improved bowel cleansing. However, the acceptability to patients of an identical bowel preparation in the future was lower in patients who had received an enema [14]. Another RCT found no significant difference when different purgatives were prescribed in the groups that did or did not receive the enema [15].

The ESGE does not recommend the routine use of prokinetic agents as adjuncts to bowel preparation (weak recommendation, moderate quality evidence).

Several prokinetic agents have been tested in RCTs as adjuncts to bowel preparation:

- Metoclopramide, domperidone, cisapride and tegaserod did not improve the tolerability of bowel preparation or the quality of bowel cleansing [16–20].
- Two other prokinetic agents, mosapride (an agonist for 5-hydroxytryptamine$_4$ [5-HT$_4$] receptors) and itopride (an antagonist for dopamine receptors and acetylcholinesterase) were found to significantly reduce adverse bowel symptoms including nausea, vomiting, bloating, and abdominal pain (the state of bowel cleansing was similar in all groups) [21]. These results, however, should be confirmed by other groups of authors before a recommendation can be made.

The ESGE suggests adding simethicone to standard bowel preparation (weak recommendation, high quality evidence).

Bubbles and foam are frequently encountered during colonoscopy (32%–57% of patients). This may hamper visualization of the mucosa [22, 23]. Simethicone is an inexpensive substance that reduces the surface tension of air bubbles. It is not absorbed into the bloodstream and it is therefore considered safe.

In a meta-analysis [24] of seven RCTs comparing bowel preparation (PEG or oral sodium phosphate [OSP]) with vs. without simethicone [22, 23, 25–29], the amount of bubbles was more frequently unacceptable in patients who had not received simethicone (odds ratio [OR], 39.3; 95% confidence interval [95%CI] 11.4–135.9). No difference in colon cleanliness was found. Be-

cause bubbles can be removed during colonoscopy, it is uncertain how the addition of simethicone to bowel preparation affects the efficacy of colonoscopy for detecting lesions. Only one of the seven RCTs included in the meta-analysis compared the detection of lesions in patients who had received simethicone or not; it was underpowered to detect such a difference [22].

Dosage of simethicone varied between studies, the most common being 120–240 mg or 45 mL of a 30% solution given with the evening and morning doses of a purgative. A compound preparation of PEG and simethicone is available in some countries.

The ESGE recommends a split regimen of 4 L PEG solution (or a same-day regimen in the case of afternoon colonoscopy) for routine bowel preparation. A split regimen (or same-day regimen in the case of afternoon colonoscopy) of 2 L PEG plus ascorbate or of sodium picosulphate plus magnesium citrate may be valid alternatives, in particular for elective outpatient colonoscopy (strong recommendation, high quality evidence). In patients with renal failure, PEG is the only recommended bowel preparation. The delay between the last dose of bowel preparation and colonoscopy should be minimized and no longer than 4 hours (strong recommendation, moderate quality evidence).

Polyethylene glycol (PEG) vs. oral sodium phosphate (OSP)

Six meta-analyses, published over a 14-year period (1998–2012), have compared various purgatives for pre-colonoscopy bowel preparation [30–35]. They included between eight and 104 controlled studies and all but one [30] included RCTs exclusively. Among five meta-analyses of head-to-head comparisons of PEG vs. OSP [30,31,33–35], three concluded that satisfactory (excellent or good) colon cleansing is significantly less frequent with PEG as compared with OSP (70%–77% vs. 75%–82%) [31, 33,34]. The two remaining meta-analyses found no statistically significant difference between PEG and OSP for overall colon cleansing [30, 35]. These two meta-analyses included the highest number of studies because one of them was the most recent [35], and the other one was not restricted to RCTs [30]. A sixth meta-analysis has also included trials that were not head-to-head comparisons. Its main finding was that OSP tablets provide a very high proportion of satisfactory colon cleansing (88%); however no statistically significant difference was found compared with other regimens [32]. Safety concerns prevent us from recommending routine use of OSP (see below). All the meta-analyses found a significant heterogeneity among trials; this is likely explained by various factors, including variations in the timing of bowel preparation, in dietary instructions, in scales used to assess colon cleanliness, and possibly in the use of adjunctive agents.

Magnesium citrate with stimulant laxative

In the UK, magnesium citrate is frequently used as a low-volume bowel preparation in combination with a variety of stimulants. Magnesium citrate combined with sodium picosulphate (Picolax or Picoprep) was compared with PEG and OSP in one meta-analysis (six studies, total of 966 patients) [34]. Compared with PEG, magnesium citrate plus sodium picosulphate provided satisfactory colon cleansing in a similar proportion of patients, with less frequent adverse events (mostly nausea, vomiting, abdominal pain, and sleep disturbances; OR 3.82, 95%CI 1.60–9.15) but OSP produced better colon cleansing than magnesium citrate plus sodium picosulphate.

Various preparations containing magnesium have been tested; **Appendix e3** (available online) summarizes eight RCTs that compared such preparations with OSP or PEG in a total of 1780 patients [36–43]. When the results of all RCTs were pooled, no significant difference was found between the different regimens in terms of colon cleanliness. In those trials comparing magnesium-based bowel preparation with PEG preparation, clinical side-effects were not significantly different but willingness to repeat the same bowel preparation was higher in the magnesium-based group (a single RCT analyzed that outcome) [38]; mucosal inflammation/ulcerations were significantly more frequent with magnesium-based bowel preparation in the single RCT that assessed that outcome [36]. In two single-blinded RCTs, magnesium citrate combined with 2 L PEG provided similar colon cleanliness to 4 L PEG but with higher patient satisfaction and willingness to repeat the same bowel preparation [44, 45].

Low-volume PEG

Various combinations of low-volume (2 L) PEG with an additional laxative have been tested; **Appendix e3** (available online) summarizes 11 RCTs that compared such combinations vs. a standard volume of PEG (4 L). Five RCTs (a total of 1997 patients) used a commercially available formulation of PEG with ascorbate (Moviprep; Norgine Pharmaceuticals) [46–50]. No significant difference was found between the low-volume formulation and 4 L PEG in terms of colon cleanliness for the whole colon. However, cleanliness in the right colon (assessed in a single study) was less frequently satisfactory with 2 L PEG than with 4 L PEG (54% vs. 82% of patients, respectively; $P<0.0001$) [48]. Of note, cleanliness in the right colon may be particularly important in the screening setting [51,52]. Willingness to repeat identical bowel preparation was reported in two RCTs; it tended to be higher with the low-volume formulation as compared with the 4-L PEG (73% vs. 65%, respectively; $P=0.079$) [47, 48]. One of the limitations of these RCTs is that the majority (77.6%) of patients had elective outpatient colonoscopy, which is a predictor of satisfactory colon cleansing.

The other six RCTs (a total of 1437 patients) used agents other than ascorbate as additional laxatives, including senna, bisacodyl, magnesium, or olive oil [10, 53–57]. Satisfactory colon cleansing was less frequent with the low-volume PEG vs. the 4-L PEG (61% vs. 76%, respectively; $P<0.0001$). The RCT that used magnesium or olive oil as additional laxatives suggested that olive oil combined with 2 L PEG provides better cleansing in the right colon than 4 L PEG (no difference was noted in the left colon), as well as higher patient willingness to repeat identical preparation; these results should be taken with caution as only 80 patients were randomized to one of these two regimens [53].

Split-dose regimen

In general, split dosing of bowel preparation is recommended: a meta-analysis of five RCTs found that, compared with the administration of the full dose of PEG on the day before colonoscopy, a split-dose regimen of PEG significantly improved the percentage of patients with satisfactory colon cleanliness, significantly increased patient compliance, and significantly decreased nausea [58]. It has also been suggested that more flat polyps are detected with split-dose vs. single-dose bowel preparation but the RCT that found this difference used a variety of purgatives (PEG and OSP) [59].

Same-day regimen

Scheduling colonoscopies in afternoon slots facilitates use of same-day preparation. Three RCTs investigating various timings of bowel preparation have shown that: (i) if 4 L PEG is prescribed, taking the whole dose of bowel preparation on the morning of the colonoscopy rather than on the day before colonoscopy provides better colon cleanliness, less sleep disturbance, and less bloating [60, 61], and (ii) if 2 L PEG plus ascorbate is prescribed, patient tolerance (i.e., absence of abdominal pain and of interference with the previous workday, better sleep quality) is increased by taking the whole dose of purgative on the day of colonoscopy rather than in a split-dose regimen (day before and day of colonoscopy); no difference was found in terms of colon cleanliness [62]. A prospective cohort study suggests that similarly, with sodium magnesium citrate plus sodium picosulphate, taking the whole dose of purgative on the day of an afternoon colonoscopy rather than in a split-dose regimen (day before and day of colonoscopy) provides better colon cleansing with fewer side effects, less impact on activities of daily living, and is preferred by patients [63].

Timing of colonoscopy

The length of delay between the last dose of bowel preparation and the start of colonoscopy was found to correlate with the quality of colon cleansing in three prospective studies involving 1546 patients in total (**Appendix e3**, available online) [49,64,65]. Various purgatives and timings of bowel preparation were used in these studies and all of them found that the delay between the last dose of bowel preparation and the start of colonoscopy was shorter in patients with a satisfactory colon cleansing. In one of these studies, it was estimated that for every additional hour that the patient waits between the end of bowel preparation and colonoscopy, the chance of having a good or excellent cleansing in the right colon decreases by up to 10% [65].

There are practical difficulties with the administration of bowel preparation on the morning of an afternoon list. There are risks of incontinence when traveling to the endoscopy unit and of bronchoaspiration if deep sedation is used [66]. Such concerns should not be overemphasized because two prospective studies (total 589 outpatients) have found no significant difference in the proportions of patients who had bowel movement while traveling to the endoscopy unit if bowel preparation was administered on the day preceding colonoscopy, on the day of colonoscopy, or with split dosing (globally, such incidents occurred in 5%–16% of patients) [59,67]. Moreover, a survey of 300 individuals showed that, after having been informed about the advantages of split dosing, approximately 80% of these individuals would be willing to get up during the night to take the second dose of a split-dose bowel preparation before early morning colonoscopy [68]. An RCT that randomized patients scheduled for early morning colonoscopy for single-dose vs. split-dose 4-L PEG found no difference in compliance between these two regimens. Adverse effects (nausea, vomiting, and bloating) were more frequent with the single-dose vs. the split-dose regimen [69]. Patients starting bowel preparation intake at 0500 on the day of colonoscopy usually report no particular difficulties [55,64]. Finally, the American Society of Anesthesiologists recommends 2 hours as the minimum fast from intake of clear liquids before sedation or anesthesia [70].

Other laxatives

Senna and bisacodyl have mainly been used as adjuncts to PEG (**Appendix e3**, available online) or to other regimens [54,57, 71–81]. Senna has also been shown to be effective when used alone at high doses [74]. However, it appeared to be less effective and tolerable than low-volume PEG preparation, and its use was limited by abdominal cramps [74–76,78]. Similarly, high-dose (30 mg) bisacodyl alone has been shown to have a similar effectiveness to PEG, but it was poorly tolerated because of colicky abdominal pain [57, 81]. Mannitol has also been used for bowel preparation; it seems to be as effective and as well tolerated as OSP or PEG [82, 83]. However its use has almost been abandoned because of the explosion risk when diathermy is used during colonoscopy [84].

The ESGE advises against the routine use of oral sodium phosphate for bowel preparation because of safety concerns (strong recommendation, low quality evidence).

The most feared complication following OSP intake is kidney injury. The largest report of kidney injury (21 patients) described the development of acute renal failure within a few weeks after colonoscopy, which modestly improved over time and required renal replacement therapy in four of the patients [85]. A meta-analysis of seven controlled studies (12 168 patients) that compared the effect of OSP vs. another bowel preparation on kidney function found no statistically significant association between OSP and kidney injury [86]. However, these studies were usually not powered to detect rare, serious complications and tended to exclude individuals at risk for complication development by tight control of inclusion criteria. Moreover, between January 2006 and December 2007, 171 cases of renal failure were reported to the United States Food and Drug Administration (FDA) following the use of OSP and 10 following the use of PEG [87]. A retrospective, population-based national analysis in Iceland estimated that the risk of biopsy-proven acute phosphate nephropathy is approximately 1 per 1000 OSP doses sold [88].

Another severe complication of OSP for bowel preparation consists of acute disruption of electrolyte homeostasis, including hyperphosphatemia, hypocalcemia, hypokalemia, and hyper- or hyponatremia. The spectrum of clinical presentation varies from mild symptoms related to hypocalcemia to death [87].

The ESGE suggests that oral sodium phosphate can only be advised in selected cases of specific needs that cannot be met by alternative products (e.g., patient unable to tolerate other agents) and only in individuals assessed by physicians to be at low risk of oral sodium phosphate-related side-effects. An evaluation of the kidney function should be available before prescribing oral sodium phosphate (weak recommendation, low quality evidence). If oral sodium phosphate is used for bowel preparation, 90 mL (solution) or 32 tablets each containing 1.5 g sodium phosphate (48 g total), both in a split-dose regimen is recommended (strong recommendation, high quality evidence).

Several meta-analyses showed that a higher proportion of patients takes the full amount of the prescribed preparation if OSP is prescribed compared with PEG [31–34]; in the most recent meta-analysis of RCTs, completion rate with OSP was 97% compared with 90% with 4 L PEG (it was 98% with 2 L PEG and 95% with a split-dose 3-L PEG regimen) [32]. Two meta-analyses also compared the tolerability of PEG vs. OSP [30,31]; the largest comparison found that, amongst 25 studies that reported tolerability, 14 studies reported that OSP was superior, 10 reported no signif-

icant difference and only one reported that PEG was better tolerated [30]. The commonly cited reasons for poor tolerability of PEG were its flavor and the requirement to consume a large volume of liquid (3 – 4 L PEG compared with 1.5 – 2 L for OSP).

Generally accepted contraindications specific to OSP for bowel preparation include, as absolute contraindications, pregnancy, age < 18 years, stage 3 – 5 chronic kidney disease (glomerular filtration rate < 60 mL/min/1.73 m^2), inability to maintain adequate fluid intake, pre-existing electrolyte disturbances, ascites, symptomatic congestive heart failure, recent (within < 6 months) symptomatic ischemic heart disease (unstable angina or myocardial infarction). Relative contraindications include active inflammatory bowel disease, parathyroidectomy, and delayed bowel transit [89 – 93]. In addition recognized risk factors for acute phosphate nephropathy following the use of OSP include age > 55 years, hypovolemia, baseline kidney disease, bowel obstruction or active colitis as well as intake of drugs that affect renal perfusion or function such as diuretics, angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers and possibly nonsteroidal anti-inflammatory drugs [89 – 93]. Care should be taken in individuals with presumably normal renal function because unrecognized chronic kidney disease may affect a large proportion of older individuals (up to 23 % – 36 % of people aged 65 years or older) [94, 95]. Strategies recommended to prevent acute phosphate nephropathy include: avoidance of OSP in high-risk patients; screening for unrecognized chronic kidney disease and electrolyte imbalances; avoiding dehydration before, during, and after OSP administration; minimizing the dose of OSP; and maintaining a minimum of 12 hours between the administration of the two OSP doses [96]. It is the prescribers' responsibility to ensure that the patient understands the importance of maintaining an adequate fluid intake [91]. Renal function should be checked as close to the colonoscopy appointment as practically possible, but in any case within 3 months.

If OSP is used, 90 mL solution or 32 tablets each containing 1.5 g sodium phosphate, both in split-dose regimen, is recommended [97 – 101].

The ESGE recommends that oral and written information about bowel preparation should be delivered by healthcare professionals. (strong recommendation, moderate quality evidence).

The delivery of both oral and written instructions for bowel preparation, as opposed to written instructions only, has been shown to be an independent predictor of adequate level of cleansing [102]. Nonadherence to preparation instruction appeared to predict a poor level of bowel preparation [103]. Dedicated booklets or visual aids have also been associated with an improvement in the quality of bowel preparation [104, 105].

Specific scenarios

In patients with inadequate bowel cleansing, the ESGE suggests the use of endoscopic irrigation pumps or repeating colonoscopy on the following day after additional bowel preparation (weak recommendation, low quality evidence). For the first colonoscopy, the use of models to identify patients at increased risk of inadequate cleansing, with the aim of adapting the bowel preparation is not recommended (insufficient evidence to determine net benefits or risks).

Inadequate colon cleanliness at colonoscopy has been reported in up to 30 % of patients undergoing colonoscopy. Identification of risk factors for inadequate colon cleanliness would have the potential benefit of selecting patients who need a more intensive bowel preparation regimen. Overall, six studies attempted to identify such risk factors by multivariate analysis (**Appendix e4**, available online) [102, 106 – 110]. Independent risk factors that were identified in at least three of these studies include male gender, inpatient status, and older age. However, a model based on such factors correctly predicted inadequate colon cleansing in only 60 % of patients [102]. Furthermore, no study attempted to apply a different regimen to patients presenting with risk factors for inadequate colon cleanliness. Previous failure to adequately prepare colon cleansing might be a better predictor [111]. Two studies, one retrospective and one prospective, including a total of 318 patients, have analyzed the outcome of a second bowel preparation after inadequate colon cleansing [111, 112]. One of these studies identified colonoscopy on the day following colonoscopy failure due to inadequate colon cleansing as the only independent factor associated with adequate colon cleansing on repeat colonoscopy. The other study lacked a control group and was limited to outpatients; it showed that an "intensive" strategy of bowel preparation (including multiple diet recommendations, bisacodyl, and a split regimen of PEG) was associated with adequate colon cleansing at repeat colonoscopy in 90 % of the cases [112].

Colonoscopy reporting should include an evaluation of the quality of colon cleansing, with the adoption of a validated scale [113]; we reason that adding information in the report about the likely cause of inadequate colon cleansing would also be useful. However, a recent audit in the Netherlands found that no information was stated about adequacy of colon cleansing in 38 % of colonoscopy reports [114].

In a recent randomized study including 42 participants, an irrigation pump (flow rate 650 mL/minute) connected to a disposable catheter inserted through the working channel of a standard colonoscope has been shown to be more effective than the use of syringes for cleansing in patients with suboptimal bowel preparation [115].

The ESGE found insufficient evidence to determine for or against the use of specific regimens in pregnant/breastfeeding women. However, if total colonoscopy is strongly indicated, PEG regimens may be considered, with tapwater enemas preferred in the case of sigmoidoscopy (insufficient evidence to determine net benefits or risks)

Colonoscopy appears feasible and relatively safe in pregnancy when strongly indicated [116, 117]. PEG has not been extensively studied in pregnancy and it is unknown whether it can cause fetal harm; when used for treating constipation during pregnancy, it is considered relatively safe [118 – 120]. Because full colonoscopy is rarely indicated during pregnancy, tapwater enemas are recommended as bowel preparation for sigmoidoscopy. No reported series allows any evaluation of the role of bowel preparation during lactation. If bowel preparation is strictly recommended, interrupting breastfeeding during and after bowel preparation may be an option.

The ESGE suggests the use of PEG for bowel preparation in patients affected by or at risk of inflammatory bowel disease. Other agents may cause mucosal abnormalities that mimic inflammatory bowel disease (weak recommendation, moderate quality evidence).

OSP use may be associated with development of colonic mucosal abnormalities [121]. Endoscopically, mucosal lesions, possibly associated with OSP ingestion, were visible in 24 (erosions in 3,

aphthoid lesions in 21, and ulcer in 1 patient) out of 730 patients (3.3%). Lesions were often multiple. The OSP-associated lesions were predominantly located in the distal sigmoid colon and rectum [122]. In a randomized study including 634 patients, preparation-induced mucosal inflammation was 10-fold more frequent with OSP (3.4%; OR 9.8; $P<0.03$) and sodium picosulphate (3.5%; OR 10; $P<0.03$) compared with PEG (0.3%) [36]. In a study in healthy rats, OSP and PEG caused significantly more colonic mucosal damage compared with a control group and the damage induced by OSP was worse than that caused by PEG [123]. In another study, no significant difference was found either macroscopically or microscopically in terms of the effects of saline, OSP, and PEG solutions in both healthy rats and rats with chemically induced colitis [124].

The ESGE recommends PEG for bowel preparation if urgent colonoscopy is scheduled for lower gastrointestinal bleeding (strong recommendation, moderate quality evidence).

The role of emergency colonoscopy in lower gastrointestinal bleeding remains controversial [125–132]. Although some studies have shown that urgent examinations performed within 12–24 h of admission improve the diagnostic yield and reduce the rebleeding/surgery rates, others have not. Urgent colonoscopy may be defined as an examination performed within 12–24 h of admission following a rapid colon purge; it is safe and may facilitate the identification and treatment of bleeding lesions [125–131]. In a series of 140 patients admitted with acute lower intestinal bleeding, the cecal intubation rate was 41% without full bowel preparation compared with 74% in the PEG group [132].

Use of the guideline

In addition to the legal disclaimer applicable to all ESGE guidelines [8], for the current Guideline, prescribers should adhere to general as well as specific contraindications to bowel preparation (e.g., any oral purgative is contraindicated in the case of ileus, the use of Moviprep is contraindicated in individuals with phenylketonuria, because of the presence of aspartame, and in those with glucose-6-phosphate dehydrogenase deficiency, because of the presence of ascorbate).

ESGE guidelines represent a consensus of best practice based on the available evidence at the time of preparation. They may not apply in all situations and should be interpreted in the light of specific clinical situations and resource availability. Further controlled clinical studies may be needed to clarify aspects of this statement, and revision may be necessary as new data appear. Clinical consideration may justify a course of action at variance to these recommendations.This guideline is intended to be an educational device to provide information that may assist endoscopists in providing care to patients. This guideline is not a rule and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment.

Competing interests: Michael Bretthauer has received bowel preparation materials free of charge for use in clinical trials, from Falk Pharma and Ferring. Dr Rembacken has taken part in Advisory Board Meetings of Ferring and Ibsen. No competing interest has been reported by the other authors.

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Appendix e1 – e4

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Appendix e1 Topics, key questions, and subgroup members.

Key questions		Subgroup members
Low-fiber diet		B. Rembacken
1	What is the evidence on its efficacy?	C. Spada
2	What is the evidence on its appropriate duration (2 – 3 days, etc.)?	T. Kuiper
3	Which foods are allowed?	
4	Is its efficacy related to the laxative adopted or the schedule (split/non-split)?	
5	What is the evidence on patients' compliance with and acceptance of such a diet?	
6	What is the evidence on its safety?	
7	Should it be recommended for bowel preparation in all patients or in a subgroup of patients (i. e. some clinical scenarios)?	
8	Do we need further studies to assess its role in the bowel preparation regimen?	
Liquid diet		B. Rembacken
9	What is the evidence on its efficacy?	C. Spada
10	What is the evidence on its appropriate duration (24 hours vs. 6 hours, etc)?	T. Kuiper
11	Which liquids (or semi-solid foods) are allowed?	
12	Is its efficacy related to the laxative adopted or the schedule (split/non-split)?	
13	What is the evidence on patients' compliance with and acceptance of such diet?	
14	What is the evidence on its safety?	
15	Should it be recommended for bowel preparation in all patients or in a subgroup of patients (i. e. some clinical scenarios)?	
16	Do we need further studies to assess its role in the bowel preparation regimen?	
Enemas		B. Rembacken
17	What is the evidence on their efficacy for colonoscopy?	C. Spada
18	What is the evidence on their efficacy when used alone or in combination with laxatives?	T. Kuiper
19	What is the evidence on the appropriate timing (night before, morning, etc.)?	
20	Which active principles should be used?	
21	What is the evidence on patients' compliance and acceptance?	
22	What is the evidence on their safety?	
23	Should they be recommended for bowel preparation in all patients or in a subgroup of patients (i. e., some clinical scenarios)?	
24	Do we need further studies to assess their role in the bowel preparation regimen?	
Polyethylene glycol (PEG)		C. Hassan
25	What is the evidence on the efficacy of PEG for colonoscopy?	M. F. Kamiński
26	What is the evidence on the efficacy of different volumes (2 L vs 4 L) or types of PEG (i. e. sulphate-free, PEG 3350, etc.)?	M. Polkowski
27	What is the evidence on the appropriate timing (start/stop, split/non-split, time between the end of preparation and colonoscopy, etc.)?	R. Marmo
28	What is the evidence on possible synergies with other components of bowel preparation or laxatives (i. e., low-fiber diet, liquid diet, enemas, cathartic laxatives, etc.)?	
29	What is the evidence on patients' compliance, tolerability and acceptance?	
30	Are there contraindications to its use?	
31	What is the evidence on its safety?	
32	Should it be recommended for bowel preparation in all patients or in a subgroup of patients (i. e. some clinical scenarios)?	
33	Do we need further studies to assess its role in the bowel preparation regimen?	
Sodium phosphate		J. M. Dumonceau
34	What is the evidence on the efficacy of sodium phosphate for colonoscopy?	M. Omar
35	What is the evidence on the efficacy of different doses of sodium phosphate?	C. Spada
36	What is the evidence on the appropriate timing (start/stop, split/non-split, time between the end of preparation and colonoscopy, etc.)?	R. Marmo
37	What is the evidence on its efficacy as compared with PEG or other alternatives?	
38	What is the evidence on possible synergies with other components of bowel preparation or laxatives (i. e., low-fiber diet, liquid diet, enemas, cathartic laxatives, etc.)?	
39	What is the evidence on patients' compliance, tolerability and acceptance?	
40	Are there contraindications to its use (i. e. older age, nephropathy, angiotensin-converting enzyme [ACE]-inhibitors, etc.)?	
41	What is the evidence on its safety? Should it be excluded from bowel preparation (US Food and Drugs Administration [FDA] warning)?	
42	Should it be recommended for bowel preparation in all patients or in a subgroup of patients (i. e., some clinical scenarios)?	
43	Do we need further studies to assess its role in the bowel preparation regimen?	

Appendix e1 (Continuation)

Key questions		Subgroup members
Other osmotic laxatives (magnesium salts, etc.)		B. Saunders
44	What is the evidence on the efficacy of these laxatives for colonoscopy?	S. Green
45	What is the evidence on the appropriate timing (start/stop, split/non-split, time between the end of preparation and colonoscopy, etc.)?	T. Kuiper
46	Which active principles should be used?	
47	What is the appropriate volume?	
48	What is the evidence on their efficacy as compared with PEG or sodium phosphate?	
49	What is the evidence on possible synergies with other components of bowel preparation or laxatives (i. e. low-fiber diet, liquid-diet, enemas, cathartic laxatives, etc.)?	
50	What is the evidence on patients' compliance, tolerability, and acceptance?	
51	Are there contraindications to their use?	
52	What is the evidence on their safety?	
53	Should they be recommended for bowel preparation in all patients or in a subgroup of patients (i. e., some clinical scenarios)?	
54	Do we need further studies to assess their role in the bowel preparation regimen?	
Other cathartic laxatives (bisacodyl, sennosides, etc.)		B. Saunders
55	What is the evidence on the efficacy of these laxatives for colonoscopy?	S. Green
56	What is the evidence on the appropriate timing (start/stop, split/non-split, time between the end of preparation and colonoscopy, etc.)?	T. Kuiper
57	Which active principles should be used?	
58	What is the evidence on their efficacy as compared with PEG?	
59	What is the evidence on possible synergies with other components of bowel preparation or laxatives (i. e., low-fiber diet, liquid diet, enemas, PEG, etc.)?	
60	What is the evidence on patients' compliance, tolerability and acceptance?	
61	Are there contraindications to their use?	
62	What is the evidence on their safety?	
63	Should they be recommended for bowel preparation in all patients or in a subgroup of patients (i. e., some clinical scenarios)?	
64	Do we need further studies to assess their role in the bowel preparation regimen?	
SPECIFIC CLINICAL SCENARIOS		
Previously failed preparation		M. Bretthauer
65	What is the frequency of inadequate cleansing?	A. Zullo
66	What are the consequences of inadequate cleansing?	L. Petruzziello
67	What should be recommended to these patients (i. e., colonoscopy repetition, anticipation of following examination)?	
68	What preparation regimen should be recommended at the next endoscopy (switch from PEG to sodium phosphate or vice versa, over-preparation with PEG)?	
69	Do we need further research?	
Patients with co-morbidities		M. F. Kaminski
70	Which co-morbidities may affect the choice of preparation regimen (i. e. kidney, heart, or liver disease, electrolyte disturbance)?	M. Polkowski R. Benamouzig
71	Which regimens should be recommended in these patients?	C. Hassan
Patients with inflammatory bowel disease (IBD)		M. F. Kaminski
72	Which laxatives may alter the assessment of IBD?	M. Polkowski
73	Which regimens should be recommended in these patients?	R. Benamouzig C. Hassan
Other scenarios		M. F. Kaminski
		M. Polkowski R. Benamouzig C. Hassan

Appendix e2a Levels of evidence according to the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system [7].

Evidence level	
High quality	One or more well-designed and well-executed randomized controlled trials (RCTs) that yield consistent and directly applicable results. This also means that further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality	RCTs with important limitations (i. e. biased assessment of the treatment effect, large loss to follow-up, lack of blinding, unexplained heterogeneity), indirect evidence originating from similar (but not identical) populations of interest, and RCTs with a very small number of participants or observed events. In addition, evidence from well-designed controlled trials without randomization, well-designed cohort or case – control analytic studies, and multiple time series with or without intervention are in this category. It also means that further research will probably have an important effect on our confidence in the estimate of effect and may change the estimate.
Low quality	Observational studies would typically be rated as low quality because of the risk for bias.[1] It also means that further research is very likely to have an important effect on our confidence in the estimate of effect and will probably change the estimate.
Very low quality[2]	Evidence is conflicting, of poor quality, or lacking, and hence the balance of benefits and harms cannot be determined. Any estimate of effect that is very uncertain as evidence is either unavailable or does not permit a conclusion.

[1] Quality of evidence based on observational studies may be rated as moderate or even high, depending on circumstances under which evidence is obtained from observational studies. Factors that may contribute to upgrading the quality of evidence include a large magnitude of the observed effect, a dose – response association, or the presence of an observed effect when all plausible confounders would decrease the observed effect.

[2] Insufficient evidence to determine for or against routinely providing a service.

Appendix e2b Strength of recommendations according to the Grading of Assessment, Development and Evaluation (GRADE) system [7].

Strength of recommendation	
Strong	Benefits clearly outweigh risks and burden or vice-versa. Usually stated as “we recommend”.
Weak	Benefits closely balanced with risks and burden. Usually stated as “we suggest”.

Appendix e3 Supporting evidence for several statements (i. e., addition of simethicone to bowel preparation, low-volume polyethylene glycol (PEG) bowel preparation, impact of the delay between the end of bowel preparation and the start of colonoscopy, magnesium-based bowel preparation) is provided in an Excel file: "Supporting evidence: ESGE Guideline on bowel preparation for colonoscopy".

a RCT of Low-vol PEG vs 4 L PEG.

First author, year	Inclusion criteria	Centers, n	Blinding?	Adjuvant in 2-L arm	Number of patients		Split?		Right colon satisfactorily clean			Whole colon satisfactory cleanliness			Side effects			Willing to repeat same preparation			Scale used	Remark
					2-L	4-L	2-L	4-L	2-L	4-L	Remark	2-L	4-L	Remark	2-L	4-L	Remark	2-L	4-L	Remark		
MOVIPREP																						
Jansen, 2011	Outpatient elective	1	Single-blind	Ascorbate (Moviprep)	182	188	Yes	Yes	NA	NA		149	141		21	18	"severe/many" cramps considered as side effect (Table 5)	NA	NA		Non-validated scale, results "good" were as satisfactory (moderate, bad and not reached considered unsatisfactory)	
Pontone, 2011	Outpatient elective	1	Single-blind	Ascorbate (Moviprep)	72	72	No (Preparation on day before colonoscopy)	No (Preparation on day before colonoscopy)	NA	NA		63	54	3 vs 11 drop-out in 2-L vs 4-L group; results in intent-to-colonoscopy, because of nausea and vomiting	14	21		44	27		Aronchik scale (1,2, and 3 considered satisfactory)	Residual stool score was significantly lower with 4 L PEG
Corporaal, 2010	Outpatient elective	1	Single-blind	Ascorbate (Moviprep)	149	158	Yes	Partial (Split only in case of afternoon colonoscopy)	81	130	P < 0.0001 (Pearson chi square)	135	151		38	21	"much" and "very much" considered as side effects in Table 5	117	123		Non-validated scale, results "good" or excellent were considered as satisfactory poor and bad considered unsatisfactory)	
Marmo, 2010	84 % inpatients and 16 % outpatients	3	Single-blind	Ascorbate (Moviprep)	435	433	Half of patients (randomized)	Half patients (randomized)	NA	NA		258	255	Calculated (77 % of 217 + 41.7 % of 218 for Moviprep; 73.4 % of 218 + 44.3 % of 215 for 4-L)	184	173	cf Table 3: calculated from "no adverse event"	NA	NA		Modified Ottawa scale	Taste was rated as good or acceptable by 54 % of patients versus 47 % of those allocated to 2 L vs. 4 L PEG respectively (P = 0 .04)
Ell, 2008	Hospitalized patients	15	Single-blind	Ascorbate (Moviprep)	153	155	Yes	Yes	NA	NA	No significant difference in the mean scores of right colon cleansing between 2-L and 4-L (Fig. 3)	136	147		47	57	Calculated from "69 % in the PEG + Asc group and 63 % in the PEG + E group) reported none of these symptoms"	NA	NA	Better acceptability for 2-L (VAS of 27.6 vs. 19.2 for 2-L vs 4-L); also better taste for 2-L using a VAS	Nonvalidated scale (but made by 3 persons on video tapes of all colonoscopies)	
Total	447 in-hospital patients				991	1006						741	748	P = 0.823 (Pearson chi square)	304	290	P = 0.365 (Pearson chi square)	161 of 221 patients	150 of 230 patients	P = 0.079 (Pearson chi square)		
OTHER																						
Abut, 2009	Outpatient elective	1	Single-blind	15 g magnesium hydroxide (40 patients) or 60 mL olive oil (41 patients)	81	39	No (Preparation on day before colonoscopy)	No (Preparation on day before colonoscopy)	69	29	P = 0.151 (Pearson chi square) BUT: in the 2-L group, only olive oil, not magnesium, was associated with better cleanliness than 4 L PEG	NA	NA	The study only states separate results for right and left colon	NA	NA	"No significant difference" but data not shown	73	11		Aronchik	Adequate cleansing was considered as "excellent, good, and fair results" according to the authors
Haapamaki, 2011	Outpatient elective	1	Single-blind	36 mg senna	203	196	No (Preparation on colonoscopy day)	Partial (Split only in case of afternoon colonoscopy)	NA	NA		145	144		NA	NA		NA	NA	Significantly more patients in the low-volume arm rated the bowel preparation as easy to take (Table 2, P < 0.001).	Ottawa	Excellent or good grouped as satisfactory. Poor or inadequate cleanliness was less frequent with 4-L (4 %) vs. 2-L (10.8 %, P = 0.01); remaining patients had "fair" cleanliness, using Ottawa scale
Enestvedt, 2011	Outpatient elective	1	Single-blind	20 mg bisacodyl	87	103	Yes	Yes	NA	NA	Could not be calculated (state that BBPS of 2 [1.9 L] vs. 3 [4 L], NS	59	85	Excellent or good preparation pooled as satisfatory	NA	NA	No significant difference	83	85	P = 0.006	Boston Bowel Preparation Scale	2-L PEG was prepared by mixing Miralax in 1.9 L Gatorade or Powerade; "Excellent" prep more frequent with 4-L (79 % vs 52 %)
Hookey, 2006	Outpatient elective	1	Single-blind	120 mg sennoside	79	81	No (Preparation on day before colonoscopy)	No (Preparation on day before colonoscopy)	NA	NA		18	45	Excellent or good preparation pooled as satisfatory	NA	NA	No significant difference	NA	NA	Better tolerance with 2-L vs. 4-L (P = 0.001)	Ottawa bowel preparation score	Poor results with 2-L maybe due to poor timing of sennosoides
DiPalma 2003	Outpatient elective	2	Single-blind	20 mg bisacodyl	93	93	No (Preparation on day before colonoscopy)	No (Preparation on day before colonoscopy)	NA	NA		81	86	Excellent or good preparation pooled as satisfatory	16	30	P = 0.017 (Pearson Chi square) "Distressing" and "severely distressing" nausea and vomiting only taken into account to avoid double counting	NA	NA		Unvalidated score	
Adams, 1994	Outpatient elective	2	Single-blind	15 mg bisacodyl	191	191	No (Preparation on day before colonoscopy)	No (Preparation on day before colonoscopy)	NA	NA		178	173	Prep grade 1 or 2 or 3 considered as satisfactory	NA	NA		NA	NA			
Total					734	703	1437					481	533					156 of 168	96 of 142	P < 0.0001 (Pearson chi square)		

Appendix e3 **b** Delay end BP-start colo.

First author, year	Study type	n	Bowel preparation	Patients	Cleanliness scale	Finding
Eun, 2011	Prospective cohort	300	4 L PEG	Outpatient elective	Ottawa scale	Better colon cleansing if interval between bowel preparation and colonoscopy ≤ 7 h vs. > 7 h ($P = 0.03$), and if ≤ 4 h vs. > 4 h ($P = 0.02$)
Marmo, 2010	RCT (of split vs. non-split and 4 L vs. 2 L PEG)	868	4 L PEG (50 %) or Moviprep (50 %)	84 % inpatients and 16 % outpatients	Ottawa scale	Better colon cleansing if interval between bowel preparation and colonoscopy ≤ 8 h vs. > 8 h ($P = 0.001$)
Siddiqui, 2009	Prospective cohort	378	20 mg bisacodyl plus 4 L PEG plus 45 ml OSP (71 %); PEG plus magnesium citrate (23 %); or OSP alone (6 %)	Outpatient elective	Unvalidated scale	Association between excellent/good colon cleansing and interval between end of bowel preparation and start of colonoscopy < 14 h ($P = 0.013$, calculations unclear to me). The authors estimated that for every additional hour that the patient waits between the last preparation and colonoscopy, the chance of having a good or excellent quality rating decreases by almost 10 %.

RCT, randomized controlled trial; PEG, polyethylene glycol; OSP, oral sodium phosphate

Appendix e3

c RCT of Mg-based bowel prep.

First author, year	Inclusion criteria	Centers, n	Blinding?	Magnesium preparation	Comparator	Number of patients		Split?		Right colon satisfactory cleansing		Remark	Whole colon satisfactory cleanliness		Comparison of whole colon cleanliness	Side effects		Comparison	Willing to repeat same prep		Remark	
Compared with sodium phosphate						Magnesium	Comparator	Magnesium	Comparator	Magnesium	Comparator		Magnesium	Comparator		Magnesium	Comparator		Magnesium	Comparator		
Berkelhammer, 2001	Outpatient elective	1	Single-blind	No adjuvant (300 ml magnesium citrate)	90 ml sodium phosphate	140	160	No	No	132	117		NA	NA							Magnesium better than sodium phosphate	Sodium phosphate
Schmidt, 2004	Outpatient elective	1	Single-blind	Picoprep (10 mg sodium picosulphate, 3.5 g magnesium oxide, and 12.0 g citric acid per sachet), 3 sachets	90 ml sodium phosphate	182	190	Yes	Yes	NA	NA		170	179							Similar cleanliness	
Tjandra, 2006	Outpatient elective < 65 years old	1	Single-blind	Picoprep (10 mg sodium picosulphate, 3.5 g magnesium oxide, and 12.0 g citric acid per sachet), 3 sachets	90 ml sodium phosphate	120	102	Yes only for afternoon colonoscopy	Yes only for afternoon colonoscopy	NA	NA		88	91							Magnesium poorer than sodium phosphate	Sodium phosphate
Renaut, 2008	NA	1	Single-blind	Picoprep (10 mg sodium picosulphate, 3.5 g magnesium oxide, and 12.0 g citric acid per sachet), 3 sachets	Sodium phosphate (amount not reported)	32	41	NA	NA	NA	NA		30	32							Low quality study, difference in favor of Picoprep is not significant (P = 0.1)	
Lawrance, 2011 (part 1)	Outpatient elective	1	Single-blind	Partial Picoprep (10 mg sodium picosulphate, 3.5 g magnesium oxide, and 12.0 g citric acid per sachet), TWO sachets only	Partial sodium phosphate (30 ml)	169	177	No	No	162	145	Cleanliness considered satisfactory if bowel preparation score in the right colon is < 4	143	120							Volume of sodium phosphate is too low (Lawrance contacted by email on April 30, 2012 answered that this is the standard protocol in their hospital)	
Total excluding Lawrance et al (cf remark for Lawrance)													**86 % (288 of 334)**	**91 % (302 of 333)**	**P = 0.07 (Pearson chi)**							
Compared with PEG																						
Hamilton, 1996	NA	2	Single-blind	Picolax (10 mg sodium picosulphate, 15 g magnesium citrate per sachet), 2 sachets	4 L PEG	35	20	No	No	NA	NA		28	14		NA	NA		NA	NA	Data for colonoscopy only here (the article also analyzed data for barium enema)	
Regev, 1998	Outpatient elective < 65 years old	1	Single-blind	Picosalax (5.0 g sodium picosulphate, 3.5 g magnesium oxide, and 12.0 g citric acid per sachet)	3 L PEG	39	29	No	No	NA	NA		26	13		10	12		NA	NA	If mean scores of cleansing are used for comparison, Mg-SPS is better (P = 0.04); if "good" and "excellent" are grouped as satisfactory, P value is 0.09	
Worthington, 2008	All ("patient referred for colonoscopy")	1	Single-blind	Sodium picosulphate 10 mg and magnesium citrate 13.1 g per sachet; two sachets for prep	2 L Moviprep	33	32	No	Yes	21	11		24	27		18	18		Better with pico (P = 0.035) but no number of patients stated		No significant difference	
Lawrance, 2011 (part 2)	Outpatient elective	1	Single-blind	Partial Picoprep (10 mg sodium picosulphate, 3.5 g magnesium oxide, and 12.0 g citric acid per sachet), TWO sachets only	4 L PEG	169	279	No	Partial	162	259	Cleanliness considered satisfactory if BP score in the right colon is < 4	143	231		NA	NA		NA	NA	Cleanliness considered satisfactory if total bowel preparation score is < 7	
Total excluding Rapier et al. 2006*			**80 % (221 of 276)**	**79 % (285 of 360)**	**P = 0.77 (Pearson chi)**	**39 % (28/72)**	**49 % (30/61)**	**0.23 (Pearson chi)**														

* because the laxative tested is not specified ("laxative kit containing magnesium citrate, oral bisacodyl tablets to be administered on the day prior to colonoscopy, and a bisacodyl suppository to be administered on the day of the procedure").

Appendix e4 Independent clinical risk factors for inadequate colon cleanliness

First author, year	n	Study design	Bowel preparation	Risk factors
Hassan, 2012 [102]	2811	Prospective	PEG/OSP	Male gender; older age; higher BMI; previous colorectal surgery; cirrhosis; Parkinson disease or diabetes requiring active treatment; positive fecal occult blood test
Borg, 2009 [106]	1577	Retrospective	PEG/OSP	Male gender; inpatient status; BMI ≥ 25 kg/m^2; smoking or alcohol consumption; use of antidepressant or narcotic; diabetes mellitus; decreased mental capacity
Chan, 2011 [107]	501	Prospective	PEG	Education level ≤ primary; appointment waiting time > 16 weeks
Chung, 2009 [108]	362	Prospective	PEG	Age > 60 years; diabetes; previous appendectomy, colorectal resection or hysterectomy
Lebwohl, 2010 [109]	12430	Retrospective	PEG	Male gender; inpatient status; age ≥ 70 years; married status; indication for colonoscopy (diarrhea, constipation, abdominal pain, inflammatory bowel disease)
Ness, 2001 [110]	649	Prospective	PEG/OSP	Male gender; inpatient status; history of cirrhosis, stroke or dementia; indication for colonoscopy (constipation, history of polyps)

PEG, polyethylene glycol; OSP, oral sodium phosphate; BMI, body mass index