A meta-analysis on timing of bowel preparation in colonoscopy: Same-day versus evening before

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Abstract

Significance: Bowel preparation is fundamental to achieving good quality colonoscopy. However, technological advances and improvement in endoscopy skill are not accompanied by improvement in patient compliance to bowel preparation. To date, there are no guidelines regarding timing of bowel preparation for afternoon colonoscopy. The aim of this study is to compare and clarify issues regarding quality of bowel preparation (primary endpoint), and patient satisfaction and cecal intubation rate (secondary outcomes). *Methodology:* Systematic search was done using PubMed, Cochrane, clinicaltrials.gov and Google Scholar. Randomized clinical trials comparing effects of same-day bowel preparation to evening before in patients undergoing colonoscopy were included. Abstracts were reviewed independently by the authors and study eligibility determined by consensus. Combined data were analyzed using RevMan 5.3 software. *Results:* Six articles were identified from literature search, but two were excluded. Primary outcome shows no significant difference among pooled studies, RR 1.05 (95%, CI 0.96–1.15), with significant heterogeneity. Cecal intubation has RR of 0.99 (95%, CI0.97-1.01) without statistical significance. Patient satisfaction has RR 0.39 (95% CI 0.29-0.54), favoring same-day preparation without statistically significant heterogeneity. *Conclusion:* Benefit of same-day compared with evening-before bowel preparation is suggested but not firmly established based on currently available evidence. Further studies are needed. Overall patient satisfaction and willingness to repeat bowel preparation are factors to be considered for bowel preparation compliance in order to achieve successful colonoscopy.

Keywords: colonoscopy, bowel preparation, same-day preparation, evening-before preparation

Introduction

Bowel preparation is fundamental to achieving good quality colonoscopy. However, technological advances and improvement in endoscopy skill have not been accompanied by improvement in patient compliance with bowel preparation. Dietary restriction, unpalatable purgatives, and large-volume cathartics are some of the barriers to bowel preparation compliance. Longer duration of colonoscopy, decreased rate of cecal intubation and higher rate of patient discomfort are common outcomes of poor preparation. Decreased rate of cecal intubation leads to lower chances of adenoma detection.

Cecal intubation rate, adenoma detection rate, withdrawal time and patient satisfaction are quality indicators of colonoscopy.[1-4] These, in turn, are affected by the type and timing of bowel preparation. In one study, timing of bowel preparation was a predictor of inadequate bowel cleansing.[5] Afternoon colonoscopies tend to have higher rates of poor bowel preparation and, consequently, higher rates of failure of cecal

intubation.[1,6] Some investigators therefore recommend performance of all colonoscopy procedures in the morning instead of in the afternoon.

To date, there are no guidelines regarding timing of bowel preparation for afternoon colonoscopy procedures. A number of studies have shown that oral polyethylene glycol (PEG) solution administered in the morning for colonoscopy procedures scheduled for the afternoon may help improve the quality of the preparation.[1,5,7]

A number of studies compared PEG solution given same-day or in the evening before colonoscopy.[8,9] Chiu et al. randomized 120 patients who underwent screening colonoscopy to those who ingested two liters PEG on the same morning of colonoscopy or on the night before colonoscopy. Results showed significantly better bowel cleansing and adenoma detection rates among patients who received PEG in the morning.[9] Another study by Church randomized 317 patients who underwent elective afternoon colonoscopies. Patients were divided into two: one group ingested four liters of PEG the night before, and another group ingested four liters of PEG at 8:00 am on the day of the procedure.[7] All patients in the group drinking PEG the night before colonoscopy had clear liquid diet the day before the colonoscopy, whereas those consuming PEG in the morning were allowed to have regular breakfast the day before the procedure. Church demonstrated that there was better quality of preparation in the morning group. The limitation of the study, however, was that 25% of the patients had undergone bowel resection, thereby requiring lesser amounts of PEG to achieve a better quality colonoscopy.

Split-dose method has been the standard of care in bowel preparation because of better colonic cleanliness and higher adenoma detection rate. Since preparations are traditionally given the evening before the procedure, sleep disturbance among patients may potentially lead to loss of working hours post-procedure. For this reason, same-day bowel preparation has been recommended to prevent sleep disruption among patients for colonoscopy. Worldwide, there is no standard guideline regarding timing of bowel preparation prior to colonoscopy. Studies have shown conflicting data on same-day bowel preparation versus evening-before bowel preparation.

The aim of this study is to compare and clarify issues regarding timing of bowel preparation by measuring cecal intubation rate, adenoma detection rate, and bowel preparation quality (Ottawa, Boston or Arichnok) and patient satisfaction. Superiority of either schedule using quality of bowel preparation is the primary end point of the study.

Methods

All randomized controlled trials comparing the effects of same-day bowel preparation versus evening-before bowel preparation on adult patients undergoing colonoscopy were included in the study. There was no restriction regarding the date of publication or language. Exclusions included observational studies, non-randomized experimental studies, opinion articles, or abstracts without adequate data. Unpublished studies, local studies, and ongoing trials were also excluded.

Outcomes

The primary outcome analyzed is the quality of bowel preparation. Secondary outcomes examined in this study are cecal intubation rate and patient satisfaction score.

Search Methods for Indentification of Studies

A systematic computerized search was done at PubMed using free text and medical subject headings (MeSH) with the keywords *colonoscopy, bowel preparation, same-day and evening-before*. Free text search using the same key words was also done using Cochrane database, clinicaltrials.gov and Google Scholar.

Selection of Studies

All authors reviewed abstracts independently and identified articles meeting the study's inclusion criteria. Study eligibility was determined by consensus among the authors, based on the determined inclusion criteria.

Data Extraction and Management

Eligible studies were reviewed independently by the authors and data were extracted based on the Cochrane Data Extraction Template (EPOC). The following information were extracted from each eligible study: total number of included and excluded participants, total number of participants observed and those that were lost to follow-up, and reasons for non-follow-up. Trial characteristics were also abstracted such as type of study, inclusion and exclusion criteria, method of allocation and generation and concealment, blinding,

follow-up rate, intention-to-treat analysis, trial intervention and control. Primary outcomes (quality of bowel preparation) and secondary outcomes (cecal intubation rate and patient satisfaction) were recorded.

Assessment of Risk Bias in Included Studies

Study quality was appraised independently by two authors using the Cochrane Assessment of Risk of Bias Tool. Each study was rated as low, unclear, or high risk for bias, based on the six domains (sequence generation, allocation concealment, blinding of participants, personnel and outcome assessors, incomplete outcome data, selective outcome reporting, and other sources of bias. Discrepancies were resolved by consensus. Based on the tool, risk of bias was low when majority of the domains were rated low and bias was unlikely to seriously alter the results. Risk of bias was deemed unclear when at least one domain in the tool was classified as unclear, inferring bias that raised some doubts about the results. Studies were classified as high risk for bias when at least one domain was classified as high risk, inferring that the bias seriously weakened the confidence in the results.

Statistical Analysis

Data were combined and analyzed using Review Manager software (RevMan 5.3). Dichotomous outcomes were combined using risk ratio (RR). Chi square test was used to test for significant heterogeneity ($p > 0.10$); while the I-squared statistic (I^2) was used to measure the degree of heterogeneity. I^2 less than 25% was assessed as minimal heterogeneity, 25-50% as moderate and >50% as substantial heterogeneity.

Results

Description of Studies

A total of six articles were identified from literature search, all of which were eligible studies based on the inclusion criteria (**Figure 1**).

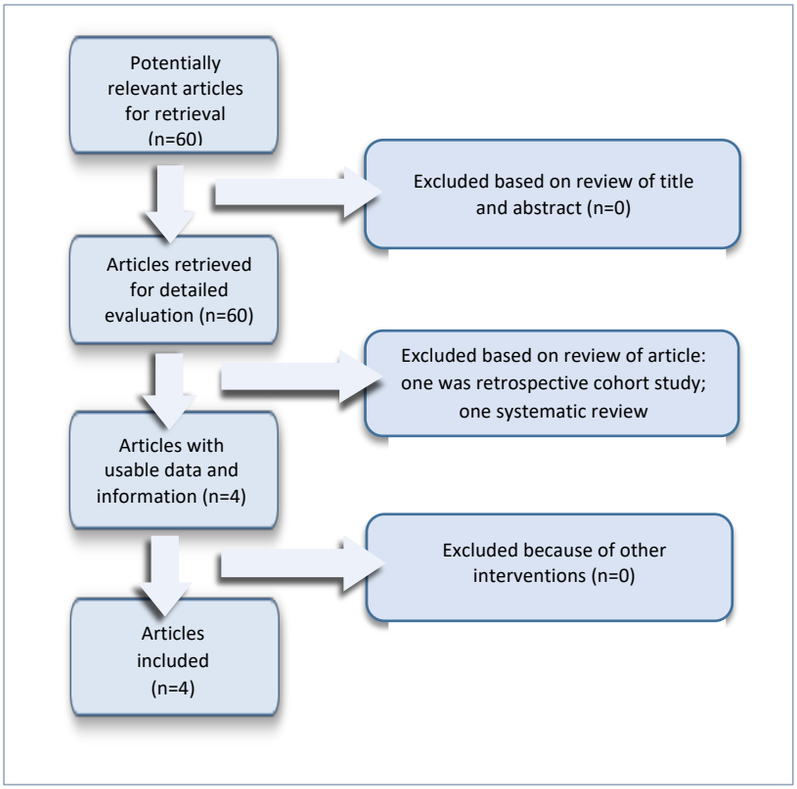


Figure 1. PRISMA flow diagram for selection of studies

Of the six articles, two were excluded. One was a retrospective cohort study (Wen 2017), and the second one was a systematic review (Cheng 2017).

Table 1 summarizes the characteristics of the four articles (Varughese, Gupta, Al, Tao) selected. They used quality of bowel preparation as primary outcomes. All articles reported cecal intubation rate as their secondary outcomes. Only three articles (Varughese, Gupta, Al) included patient satisfaction. Only one article included adenoma detection rate (Varughese).

Table 1. Selected studies and characteristics

Author, Year	N	Population	Bowel Preparation	Outcome Measurement
Varughese 2010	136	**Included:** All adult patients aged >19 years evaluated at the ambulatory gastroenterology clinic at Cleveland Clinic Florida and scheduled for elective colonoscopy at 1 pm onward **Excluded:** Patients who had previous history of colon resection or suspicion of bowel obstruction	**Same-day Bowel preparation**: 1 gallon of PEG between 6 am and 10 am on the day of colonoscopy **Evening-before preparation**: 1 gallon of PEG between 5 pm and 9 pm on the day before colonoscopy	**Primary**: Ottawa scale mean scores **Secondary:** Ottawa scale divided into good and poor preparations; patient questionnaire data; number of polyps detected
Gupta 2007	201	**Included:** Any patient between 18 and 80 years who needed colonoscopy **Excluded:** Patients with prior bowel surgery, suspected bowel obstruction, or any contraindication to phosphate preparation (cardiovascular or renal insufficiency), who were inconvenienced by the timing of bowel preparation	**Same-day bowel preparation**: Sodium phosphate-based preparatory fluid Exelyte® (USV limited, India; 90 ml with 300 ml of lemonade) at 6 am on the day of the colonoscopy **Evening-before preparation**: Sodium phosphate-based preparatory fluid Exelyte® (USV limited, India; 90 ml with 300 ml of lemonade) at 5 pm on the day prior to colonoscopy	**Primary**: Superiority of either schedule in terms of quality of bowel preparation using the Aronchick and Ottawa scales **Secondary:** Loss of working hours and sleep disturbance
Al 2011	150	**Included:** Outpatients aged between 18 and 80 years who were scheduled for elective colonoscopy **Excluded:** Prior bowel surgery and suspected bowel obstruction and known allergy to polyethylene glycol	**Same-day Bowel preparation**: 3 sachets of PEGELS®(Alfares Pharm., Syria; {59 gm polyethylene glycol, 5.68 gm Na2SO4, 1.68 gm NaHCO3, 1.46 gm NaCl, and 0.75 gm KCl} per sachet) on the morning of colonoscopy, starting at 5 am which should be completed before 8am **Evening-before preparation**: 4 sachets of PEGELS®(Alfares Pharm., Syria; {59 gm polyethylene glycol, 5.68 gm Na2SO4, 1.68 gm NaHCO3, 1.46 gm NaCl, and 0.75 gm KCl} per sachet) on the day prior to the procedure starting at 3 pm, which should be completed before bedtime	**Primary:** Ottawa Bowel Preparation Quality Scale **Secondary:** Cecal intubation rate; sleep disturbance

Tao 2018	133	**Included:** Patients who underwent elective colonoscopy **Excluded:** Patients with symptomatic congestive heart failure (CHF), myocardial infarction, serum creatinine levels greater than 1.5 mg/dL, abnormal liver function defined as glutamic-oxaloacetic transaminase (GOT) and glutamic-pyruvic transaminase (GPT) each greater than 120 U/L, ascites, electrolyte abnormalities, gastro-intestinal obstruction, gastric retention, bowel perforation, toxic colitis, toxic, megacolon, ileus known hypomotility syndrome, uncontrolled hypertension, unstable angina pectoris, clinical evidence of dehydration, or severe chronic constipation, pregnant women or breastfeeding, using investigational drugs, unable to communicate to the study personnel or unable to understand bowel preparation instructions, inability to take oral hydration adequately, or patients with known allergies to the medications used in the study	**Same-day Bowel preparation**: 1 solution of 90 ml sodium phosphate (Fleet®) diluted with a cold clear liquid or water at 6-7 am in the same day of the colonoscopy **Evening-before preparation**: 1 solution of 90 ml sodium phosphate (Fleet®) diluted with a cold clear liquid or water at 6-7 pm in the evening before the day of the colonoscopy	**Primary:** Assessment of bowel cleaning: amount of stool (none, small, moderate, or large), consistency of stool (none, clear lavage, liquid stool, particulate stool, semi-solid stool, and solid stool), and the estimated percentage of the bowel wall visualized (<49%, 50-74%, 75-89%, and ≥90%) at various segments of the colon, as well as the overall assessment of the preparation rated by the colonoscopist (liquid, large volume of clear liquid, some semi-solid stool that could be suctioned or washed away, and semi- solid stool that could not be suctioned or washed away) **Secondary:** Tolerance and acceptability of the bowel preparation

Risk of Bias in Included Studies

The quality of the studies included was assessed using the Cochrane Risk of Bias Tool (**Figure 2**). All studies were rated overall as having low risk of bias. However, it is important to note that one study, Buxbaum *et al.*, had unclear risk of bias because of failure to indicate blinding of participants, personnel, and outcome assessors.

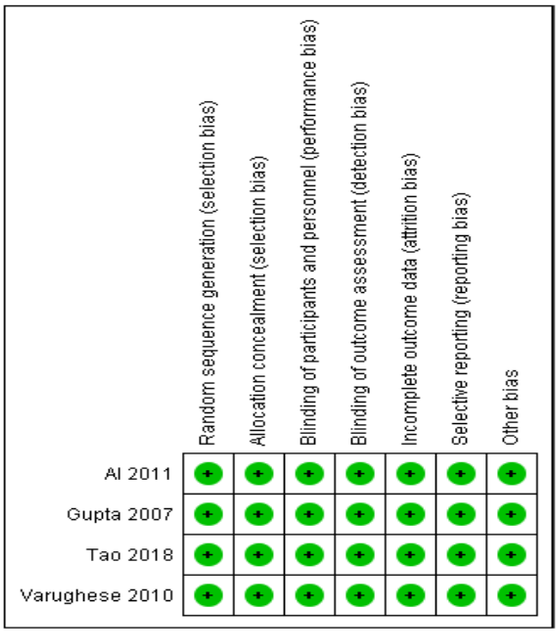


Figure 2. Risk of bias summary

Effects of Interventions

The selected trials included a total of 620 adult patients who underwent colonoscopy: 308 were randomized to same-day bowel preparation (49.7%), and 312 received evening preparation (50.3%). The risk ratio of achieving a good bowel preparation was 1.05 (95% CI 0.96-1.15), which did not show statistical significance. There was statistically significant heterogeneity of the results (Chi^2 = 27.26, p < 0.00001; I^2 = 89%) (**Table 2**). The risk ratio for achieving cecal intubation was 0.99 (95% CI 0.97-1.01), which did not reach statistical significance (**Table 3**).

Table 2. Effect of same-day bowel preparation on quality of bowel preparation using a random effects model.

	Same-day		Evening-before			Risk Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Fixed, 95% CI**
Al 2011	75	75	75	75	37.9%	1.00 [0.97, 1.03]
Gupta 2007	35	99	37	102	18.3%	0.97 [0.67, 1.41]
Tao 2018	59	66	65	67	32.3%	0.92 [0.84, 1.01]
Varughese 2010	39	68	23	68	11.5%	1.70 [1.15, 2.51]
Total (95% CI)		**308**		**312**	**100.0%**	**1.05 [0.96, 1.15]**
Total events	208		200			

Heterogeneity: Chi^2 = 27.26, df = 3 (P < 0.00001); I^2 = 89%
Test for overall effect: Z = 1.05 (P = 0.30)

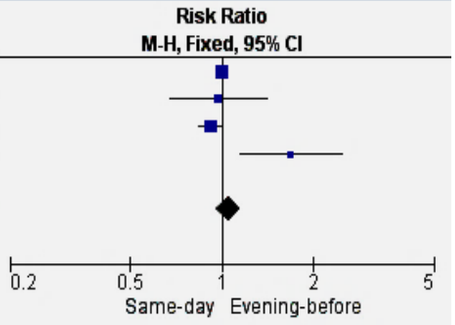
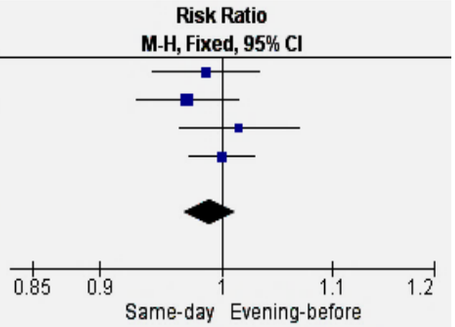


Table 3. Effect of same-day bowel preparation on cecal intubation rate using a random effects model.

	Same-day		Evening-before			Risk Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Fixed, 95% CI**
Al 2011	73	75	74	75	24.1%	0.99 [0.94, 1.03]
Gupta 2007	98	102	98	99	32.5%	0.97 [0.93, 1.01]
Tao 2018	65	66	65	67	21.0%	1.02 [0.96, 1.07]
Varughese 2010	68	68	68	68	22.4%	1.00 [0.97, 1.03]
Total (95% CI)		**311**		**309**	**100.0%**	**0.99 [0.97, 1.01]**
Total events	304		305			

Heterogeneity: Chi^2 = 2.16, df = 3 (P = 0.54); I^2 = 0%
Test for overall effect: Z = 0.86 (P = 0.39)

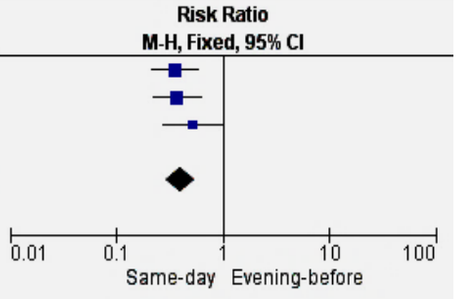


The risk ratio for overall patient satisfaction was 0.39 (95% CI 0.29-0.54) favoring same-day bowel preparation (**Table 4**). The outcome did not show a statistically significant heterogeneity for both cecal intubation rate and patient satisfaction.

Table 4. Effect of same-day bowel preparation on patient satisfaction rate using a random effects model.

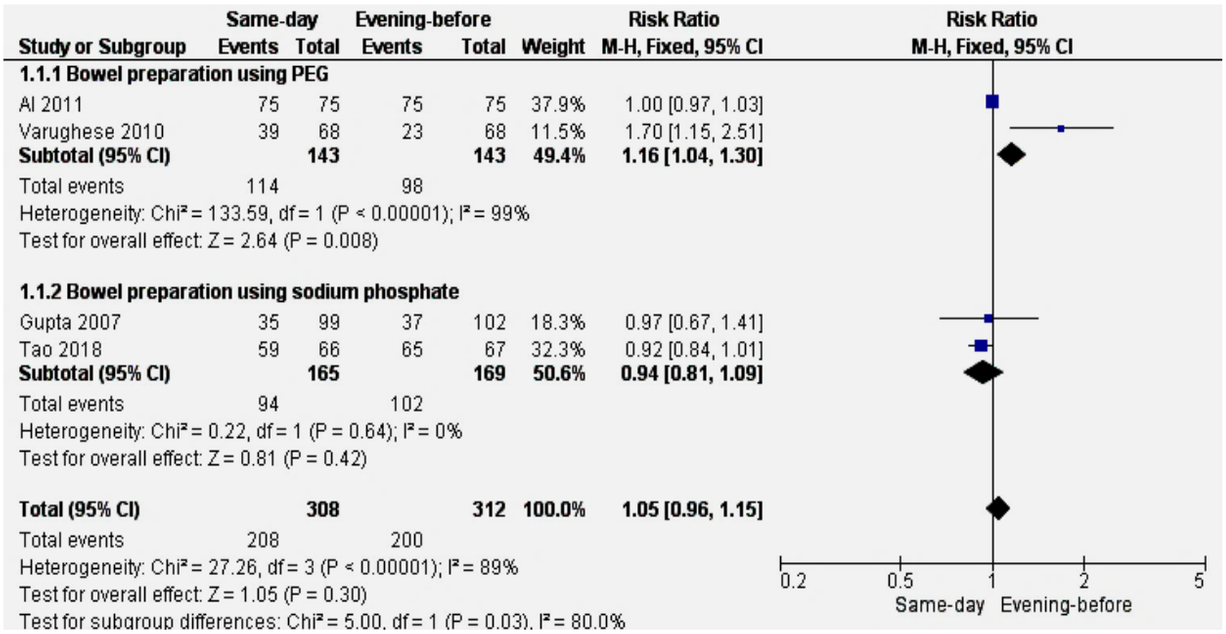
	Same-day		Evening-before			Risk Ratio
Study or Subgroup	**Events**	**Total**	**Events**	**Total**	**Weight**	**M-H, Fixed, 95% CI**
Al 2011	15	75	42	75	40.2%	0.36 [0.22, 0.59]
Gupta 2007	15	99	42	102	39.6%	0.37 [0.22, 0.62]
Varughese 2010	11	68	21	68	20.1%	0.52 [0.27, 1.00]
Total (95% CI)		**242**		**245**	**100.0%**	**0.39 [0.29, 0.54]**
Total events	41		105			

Heterogeneity: Chi^2 = 0.96, df = 2 (P = 0.62); I^2 = 0%
Test for overall effect: Z = 5.81 (P < 0.00001)



Subgroup analysis based on bowel preparation was also done to determine other causes for the observed heterogeneity (**Table 5**). The risk ratio for good bowel preparation using PEG was estimated at 1.16 (95% CI 1.04-1.30), while that of bowel preparation using sodium phosphate was 0.94 (95% CI 0.81-1.09). Studies using PEG, however, displayed significant heterogeneity. Studies using sodium phosphate did not have significant heterogeneity.

Table 5. Subgroup analysis based on bowel preparation.



Discussion

The timing of bowel preparation is an important factor for a successful colonoscopy procedure.[9-12] Various meta-analyses comparing same-day bowel preparation and the standard split-dose method have shown no significant difference in terms of adenoma detection rate, quality of bowel preparation and cecal intubation rate. However, patients were shown to favor same-day bowel preparation due to tolerability, less need for repeat colonoscopy, and less sleep disturbance.[13,14] The results of this meta-analysis also showed the advantage of same-day bowel preparation, with a trend towards significance in terms of quality of bowel preparation and cecal intubation rates. The advantage of same-day bowel preparation in terms of overall patient satisfaction was consistently seen among studies in this meta-analysis.

The overall benefit of same-day bowel preparation in achieving good quality bowel preparation, which is the outcome of interest, may not be firmly established due to the statistically significant heterogeneity among the studies included in this meta-analysis. One identified cause of heterogeneity was the difference in the bowel preparation solution used. PEG and sodium phosphate solution were used evenly among the included studies. Both solutions showed no significant difference in the quality of bowel preparation. However, the PEG solution demonstrated a statistically significant heterogeneity. Possible causes include the differences in the scoring system, dosage, and time of administration of the solution. Sodium phosphate solution demonstrated a trend towards benefit in the same-day bowel preparation regimen.

Summary and Conclusion

This meta-analysis included four articles, all of which used quality of bowel preparation as their primary outcomes and reported cecal intubation rate as

secondary outcomes, and a total of 620 patients. The risk ratio of achieving a good bowel preparation is not statistically significant. The same outcome is observed on achieving cecal intubation. Overall patient satisfaction favors same-day bowel preparation; however, results do not show a statistically significant heterogeneity.

The risk ratio for good bowel preparation using PEG is not statistically significant. Sodium phosphate solution demonstrates a trend towards benefit in the same-day bowel preparation regimen.

In conclusion, higher chances of successful colonoscopy involve patient compliance in bowel preparation, which in turn depends upon the type of solution given and timing of bowel preparation. Factors such as patient satisfaction, decreased sleep disturbance, and willingness to repeat the bowel preparation should be considered. This meta-analysis suggests the benefit of same-day preparation compared to evening-before preparation, but this study could not firmly establish the evidence.

Acknowledgement

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Conflicts of Interest

The authors declare no conflicts of interest or financial disclosures.

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