

## RESEARCH ARTICLE

# Incidence and Predictors of Inadequate Bowel Preparation before Elective Colonoscopy in Thai Patients

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### Abstract

**Background:** The incidence of inadequate bowel preparation before elective colonoscopy in this region has never been studied. **Materials and Methods:** The authors prospectively described the incidence and factors related to inadequate bowel preparation in Thammasat university hospital. Bowel preparation quality was assessed by using Aronchick scale. Factors associated with inadequate bowel preparation were also recorded. **Results:** Two hundred patients undergoing elective outpatient colonoscopy were enrolled. Inadequate and fair bowel preparation was documented in 9 and 43%, respectively. Factors associated with inadequate bowel preparation were incomplete cleansing agent ingestion (odds ratio 7.7; 95% CI 1.62-36.64) and patient's unrecognition of vegetable avoidance (odds ratio 3.26; 95% CI 1.14-9.28). **Conclusions:** Compared with previous reported, inadequate bowel preparation was seen less in our study, however, more patients with fair bowel preparation was documented. Further study aiming at investigating the type and amount of fiber contained in diet before elective colonoscopy should be commenced.

**Keywords:** Bowel preparation - incidence - predictor - low-fiber diet

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### Introduction

Colorectal cancer (CRC) has been listed as the 3<sup>rd</sup> most prevalent cancer in the Asia-Pacific region (Yang et al., 2004). Additionally, it has been increasing diagnosed over the past few years, possibly, due to the westernization of dietary habit among Asian countries (Kuriki et al., 2006). A recent study showed that the detection of premalignant colorectal lesions or early-stage cancer by CRC screening decreases cost of care (Shin et al., 2012). Thus, CRC screening policy in population at risk has been generally applied all over the world. Currently, colonoscopy is the best procedure for CRC screening, because it provides visualization of all colonic segments, including right-sided colon, which contains 42% of advanced adenomatous polyp (polyp that has a greater chance of becoming a malignant lesion) (Aswakul et al., 2012). Moreover, double contrast barium enema and fecal occult blood test have been proved to have less sensitivity and less cost-effectiveness for CRC screening in this region. (Lohsiriwat, 2012; Wiwanitkit, 2010). Hence, a good quality of bowel preparation before colonoscopy, which eventually leads to a clear visualization of colonic mucosa, is of particular importance. Nevertheless, the rate of inadequate bowel preparation has been reported to be approximately 25% (Harewood et al., 2003; Froehlich et al., 2005; Kazarian et al., 2008), and has been associated with missing adenomatous polyps (Lebwohl et al., 2011;

Chokshi et al., 2012), prolonged caecal intubation time (Hsu CM et al., 2012), reduced colonoscopy completion rate, and increased cost of care (Rex et al., 2002; Hendry et al., 2007).

In general, bowel preparation before elective colonoscopy includes an ingestion of colon-cleansing agent, together with one to three days of low-fiber diet before the procedure. In addition, a patient counseling for promoting adherence to diet and colon-cleansing regimen is a crucial step to achieve a good quality of bowel preparation. The aim of this study was to describe the incidence of inadequate bowel preparation, and its associated factors in patients undergoing elective colonoscopy in this region, which is culturally difference from other regions.

### Materials and Methods

#### *Study design and study population*

This is a prospective study enrolling patient aged 18-90 years old who underwent elective colonoscopy as outpatient setting at Thammasat University Hospital. This study was reviewed and approved by the institutional review board. Patients who had unstable vital signs, or had less than 72h period of preparation before colonoscopy were excluded from the study. All participants were informed consent prior to the study.

### Intervention

A questionnaire was given to each enrolled patient to access patient's perception of preendoscopic bowel preparation. Type of cleansing agent used, volume of cleansing agent ingested, and time of the last dose of cleansing agent ingested were also recorded. Colon-cleansing regimens used in our hospital were low-dose (2 liters) polyethylene glycol (2L-PEG), standard-dose of 4 liters PEG (4L-PEG), and sodium phosphate solution. Two liters of PEG solution (Niflec®) consists of 118g macrogol 4000, 1.485g potassium chloride, 2.93g sodium chloride, 3.37g sodium bicarbonate, and 11.37g anhydrous sodium sulfate.

Thereafter, colonoscopy was performed by one of gastroenterologist staffs, gastrointestinal surgeon, or fellows. The quality of colonic preparation was accessed by endoscopy personnel who were trained to be familiar with Aronchick scale. The Aronchick scale has been proposed to access the quality of bowel preparation, and reported as: excellent preparation (more than 90% of mucosa seen, mostly liquid stool, minimal suctioning needed for adequate visualization), good preparation (more than 90% of mucosa seen, mostly liquid stool, significant suctioning needed for adequate visualization), fair preparation (more than 90% of mucosa seen, mixture

of liquid and semi-solid stool, which could be suctioned and/or washed) and poor preparation (less than 90% of mucosa seen, mixture of semi-solid and solid stool, which could not be suctioned and/or washed) (Aronchick CA et al., 2000). Adequate bowel preparation is defined by excellent, good, or fair preparation.

### Statistical analysis

Data were described as mean and percentage for continuous and categorical variables, respectively. Least of Significance Difference (LSD) among means was used for multiple comparisons among types of cleansing agent after significant test from ANOVA. Chi-square test and Fisher's exact test were performed to determine the association between quality of bowel preparation and factors. Statistical significance was set at a p-value of less than 0.05. Adjusted odds ratios by logistic regression were performed for significant factors from univariate analysis. Statistical analysis was performed using SPSS version 16.0 (SPSS Inc, Chicago, IL, USA).

## Results

### Patients' characteristics

This study enrolled two hundred patients. Of which,

**Table 1. Baseline Characteristics of 200 Enrolled Patients**

Characteristics	n=200
Mean age±SD, years (range)	59±12 (18-86)
Male gender, n (%)	84 (42)
Type of laxative	
2L PEG, n (%)	118 (59)
4L PEG, n (%)	17 (8.5)
Sodium phosphate solution, n (%)	6 (3.25)
Adjunctive laxative, n (%)	39 (19.5)
Milk of magnesia, n (%)	3 (1.5)
Senna, n (%)	22 (11)
Lactulose, n (%)	8 (4)
Ispaghula husk, n (%)	6 (3)
Afternoon colonoscopy (after 1PM)	52 (26%)
Preparation-to-colonoscopy interval	
Mean±SD, hours	15.11±5.16
≤4 hours, n (%)	6 (3)
>4 hours, n (%)	194 (97)
Mean fasting time±SD, hours	13±4.54
Person in patient's perspective who explained the bowel preparation method	
Medical practitioner, n (%)	174 (87)
Endoscopic personnel, n (%)	84 (42)
Pharmacist, n (%)	37 (18.5)
Information sheet, n (%)	45 (22.5)
Other, n (%)	4 (2)
Patient's perspective of food to avoid before the procedure (n =199)	
Vegetables, n (%)	139 (69.5)
Fruits, n (%)	169 (84.5)
Fiber, n (%)	97 (48.5)
Meat, n (%)	73 (36.5)
Grains, n (%)	1 (0.5)
High-fiber diet taken during 3 days before colonoscopy, n (%)	194 (97)
Colon preparation quality (graded by Aronchick scale)	
Excellent, n (%)	19 (9.5)
Good, n (%)	77 (38.5)
Fair, n (%)	86 (43)
Poor, n (%)	18 (9)

84 (42%) were male with a mean age of 59 years old. In 52 patients (26%), colonoscopies were performed in the afternoon (after 1 PM). As shown in Table 1, 118 (59%), 17 (8.5%), and 65 (32.5%) patients received 2L-PEG, 4L-PEG, and sodium phosphate solution as cleansing agent, respectively. Adjunctive laxatives were used in 39 patients (19.5%). Most patients received information regarding bowel preparation from their

**Table 2. Comparison among Groups Received Different Cleansing Agents**

Parameter	2L PEG n=118	4L PEG n=17	Sodium Phosphate n=65	p-value
Adjunctive laxative, n (%)	21 (17.8)	8 (47.1)	10 (15.4)	0.011* 0.009# 0.677&
Preparation-to-colonoscopy interval				
Mean $\pm$ SD, hours	15.57 $\pm$ 4.599	7.86 $\pm$ 5.914	16.16 $\pm$ 4.460	<0.001*
$\leq$ 4h, n (%)	0	5 (29.4)	1 (1.5)	<0.001# 0.423&
Completion of cleansing-agent ingestion, n (%)	112 (94.9)	16 (94.1)	63 (96.9)	1.000* 0.507# 0.714&
Bowel preparation quality				
Aronchick 1-3, n (%)	107 (90.7)	15 (88.2)	60 (92.3)	0.669*
Aronchick 4-5, n (%)	11 (9.3)	2 (11.8)	5 (7.7)	0.631# 0.709&
Bowel re-preparation	4 (3.4%)	0	0	N/A
Colonoscopic complication				
Bleeding, n (%)	3 (2.5%)	0	0	N/A
Adverse event of laxative				
Bad taste, n (%)	2 (1.7)	0	0	N/A
Vomiting, n (%)	1 (0.8)	0	0	
Syncope, n (%)	1 (0.8)	0	0	
Complaint of large volume ingestion, n (%)	2 (1.7)	1 (5.9)	0	
Severe diarrhea/ fatigue, n (%)	0	1 (5.9)	1 (1.5)	
Unknown, n (%)	5 (4.2)	1 (5.9)	1 (1.5)	

\*Significance (2L PEG compared to 4L PEG) #Significance (4L PEG compared to sodium phosphate solution) &Significance (2L PEG compared to sodium phosphate solution) N/A: Not applicable

**Table 3. Factors Associated with Inadequate Bowel Preparation**

Parameter	Inadequate Preparation (n=18)	Adequate Preparation (n=188)	p-value
Age >60 years, n(%)	11 (61.1%)	89 (48.9%)	0.323
Female, n(%)	11 (61.1%)	105 (57.7%)	0.779
2L PEG, n(%)	11 (61.1%)	107 (58.8%)	0.849
4L PEG, n(%)	2 (11.1%)	15 (8.2%)	0.656
Sodium phosphate solution, n(%)	5 (27.8%)	60 (33.0%)	0.654
Adjunctive Laxative, n(%)	5 (27.8%)	34 (18.7%)	0.355
Prep-to-colonoscopy interval >4hr, n(%)	18 (100%)	176 (96.7%)	1
Person in patient's perspective who explain colon preparation method			
- Physician	15 (83.3%)	159 (87.4%)	0.711
- Endoscopic personnel	9 (50%)	75 (41.2%)	0.618
- Pharmacist	1 (5.6%)	36 (19.8%)	0.205
- Information sheet	5 (27.8%)	40 (22%)	0.561
Unrecognition of specific food avoidance, n (%)	n=17	n=182	
- Vegetable	9 (52.9%)	51 (28%)	0.032
- Fruit	5 (29.4%)	25 (13.7%)	0.146
- Fiber	9 (52.9%)	93 (51.1%)	0.884
- Meat	10 (58.8%)	116 (63.7%)	0.688
- Grain	17 (100%)	181 (99.5%)	1
Incomplete cleansing agent ingestion, n(%)	3 (16.7%)	12 (3.3%)	0.009
Fiber within 3 days, n(%)	15 (88.2%)	182 (100%)	0.059

**Table 4. Multivariate logistic regression analysis of factor associated with inadequate bowel preparation**

Parameter	Odd Ratio	95% Confident Interval	p-value
Incomplete cleansing agent ingestion	7.707	1.621 - 36.638	0.01
Unrecognition of vegetable avoidance	3.257	1.143 - 9.279	0.027

attending physicians. All patients received advice about dietary avoidance. Ninety-seven percent of patients took high-fiber diets within 3 days before their scheduled colonoscopy.

As shown in Table 1, the mean fasting duration prior to colonoscopy was 13 hours, and the mean interval between last dose of cleansing agent and index procedure was 15 hours. Only six patients (3%) had time interval less than 4 hours. Rate of adequate colon preparation was 91 percent; however, almost half of patients had fair preparation. Eighteen patients (9%) had inadequate bowel preparation.

As shown in Table 2, the rates of incomplete cleansing agent ingestion were 5% and 3% for PEG group and sodium phosphate group, respectively. Regarding adverse events, those received standard dose PEG experienced more problem in ingesting large volume and severe diarrhea.

#### *Factors associated with inadequate bowel preparation (Table 3)*

By univariate analysis, patient's unrecognized of avoiding vegetable before the procedure (28% in adequate preparation group compared to 52.9% in inadequate group,  $p=0.032$ ), and incomplete cleansing agent ingestion (3.3% compared to 16.7%,  $p=0.009$ ) were factors related to inadequate colon preparation. In addition, as shown in Table 4, by multivariate logistic regression analysis, both factors were independently associated with inadequate bowel preparation (OR 3.26 (95%CI 1.14-9.28) and 7.7 (95%CI 1.62-36.64), respectively)

## Discussion

Our study demonstrates the incidence of inadequate bowel preparation of 9 percent, which is less than previously reported (Lebwohl et al., 2011). Although adequate bowel preparation was seen in 91% of patients, rate of fair colon preparation was considerably high (46%). Since recently published study has shown the detrimental effect of fair bowel preparation on the rate of missing colonic adenoma (Menees et al., 2013), our study has confirmed the existence of bowel preparation quality problem of in this region.

Current international guideline recommends split-dose, 4-liter, PEG regimen as a routine colon-cleansing agent for colonoscopy, and a split regimen of low-dose (2 liters) PEG with ascorbic acid, sodium picosulfate, or magnesium citrate as an alternative (Hassan et al., 2013). This study has demonstrated that the adherence to this guideline is low, as only 8.5% of patients completed 4 liters of PEG in split regimen as prescribed. This study also showed a variation in adjunctive laxative usage along with main cleansing agent. Indeed, those received 2-liter of PEG plus 144mg of senna the night before procedure had better colonic cleansing quality, patient tolerance, regimen adherence, and less nausea and vomiting (Radaelli F et al., 2005). In 1979, there was a case report of colonic explosion during electrocautery in a patient using mannitol for colonic preparation (Bigard et al., 1979), however, serious adverse event associated with other non-absorbable carbohydrate-containing laxatives such

as lactulose and psyllium has never been documented.

Another important finding in our study is nearly half of those received 2-liter PEG regimen were able to achieve good bowel preparation quality without taking any adjunctive laxative. Interestingly, recently published study using 2-liter PEG without any adjunctive laxative in the morning of the procedure date, together with keeping 2-7h interval between the last dose of cleansing agent and colonoscopy resulted in a similar bowel preparation quality compared to standard split-dose 4-liter PEG regimen (Tellez-Avila FI et al., 2014). These can be concluded that time interval between last dose of cleansing agent and procedure is more important than volume of PEG ingested. Literally, time interval between the last dose of cleansing-agent and colonoscopy has been confirmed to be one of the predictors of inadequate bowel preparation (Seo et al., 2012). Current guideline recommends an interval of less than 4 hours (Hassan et al., 2013). Our study showed that, in real-life scenario, this time interval could not be achieved in the majority of cases, thus, emphasizing the need to inform both physicians and endoscopy-practicing nurses to change their practice.

So far, the patient's perspective of bowel preparation has never been studied. Our study shows that most of practicing gastroenterologists and gastrointestinal surgeons advised patients on their own. Physician-based counseling improves cleansing quality and has been confirmed in prior study (Shieh et al., 2013).

Our study is the first to demonstrate variation in patient's high-fiber diet restriction. Nearly all of patients did not correctly recognize the type of food to avoid. In addition, the rate of taking high-fiber diet during 3 days before colonoscopy was substantially high (97% of patients). Prior study from Taiwan has shown that a significant proportion of patient did not adhere to low-fiber diet (Wu et al., 2011). The result of our study emphasizes an importance of pre-procedural patient counseling.

In previous studies, the reported predictors of inadequate colon preparation were male gender, inpatient status, and older age (Hassan et al., 2012, Borg et al., 2009, Chan et al., 2011, Chung et al., 2009, Lebwohl et al., 2010, Ness et al., 2001). In our study, incomplete cleansing-agent ingestion and patient's unrecognized of vegetable avoidance were independently associated inadequate colonic preparation. These two factors have never been demonstrated in prior studies, and need to be confirmed in future work. These findings could be explained by the fact that Thai food usually contains vegetables as a major component, especially in rural area.

Our study has several limitations. First, we used Aronchick scale as a tool for bowel preparation quality assessment. Aronchick scale does not focus on assessing individual segment of colon, and does not allow endoscopists to suction and clear colonic content before assessment. Moreover, new colonic preparation rating scale, Boston Bowel Preparation Scale (BBPS), has been shown to have good validity and reliability (Calderwood AH et al., 2010). Second, the number of 200 patients in the present study may not be enough to evaluate all factors that are associated with inadequate colon preparation. Third, given a low rate of inadequate preparation despite



low adherence to low-fiber diet, we did not collect any data according to particular type and amount of high-fiber diet taken by patients. Fourth, we did not evaluate the reliability of endoscopy personnel in assessment of preparation quality. Finally, some patients received telephone call from endoscopic personnel one day before the procedure to confirm the schedule and assure the bowel preparation process. This telephone call has been shown to improve the quality of preparation, and increase the adenoma detection rate (Liu et al., 2014).

In summary, the present study demonstrates that incidence of inadequate colon preparation was 9%, however, a significant proportion of patient was classified as fair preparation. Patient's knowledge to avoid vegetable before the procedure and completion of cleansing agent are associated with adequate colon preparation quality. Future studies aiming at evaluating type and amount of fiber contained in diet should be carried out to clarify more specific character of food that patients can take in order to optimize their bowel preparation quality.

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## References

- Aronchick CA, Lipshutz WH, Wright SH, Dufrayne F, Bergman G (2000). A novel tableted purgative for colonoscopic preparation: efficacy and safety comparisons with Colyte and Fleet Phospho-Soda. *Gastrointest Endosc*, **52**, 346-52.
- Aswakul P, Prachayakul V, Lohsiriwat V, Bunyaarunnate T, Kachintorn U (2012). Screening colonoscopy from a large single center of Thailand - something needs to be changed? *Asian Pac J Cancer Prev*, **13**, 1361-4.
- Bigard MA, Gaucher P, Lassalle C (1979). Fatal colonic explosion during colonoscopic polypectomy. *Gastroenterol*, **77**, 1307-10.
- Borg BB, Gupta NK, Zuckerman GR, Banerjee B, Gyawali CP (2009). Impact of obesity on bowel preparation for colonoscopy. *Clin Gastroenterol Hepatol*, **7**, 670-5.
- Calderwood AH, Jacobson BC (2010). Comprehensive validation of the Boston Bowel Preparation Scale. *Gastrointest Endosc*, **72**, 686-92.
- Chan W-K, Saravanan A, Manikam J, Goh KL, Mahadeva S (2011). Appointment waiting times and education level influence the quality of bowel preparation in adult patients undergoing colonoscopy. *BMC Gastroenterol*, **11**, 86.
- Chokshi RV, Hovis CE, Hollander T, Early DS, Wang JS (2012). Prevalence of missed adenomas in patients with inadequate bowel preparation on screening colonoscopy. *Gastrointest Endosc*, **75**, 1197-203.
- Chung YW, Han DS, Park KH, et al (2009). Patient factors predictive of inadequate bowel preparation using polyethylene glycol: a prospective study in Korea. *J Clin Gastroenterol*, **43**, 448-52.
- Froehlich F, Wietlisbach V, Gonvers JJ, Burnand B, Vader JP (2005). Impact of colonic cleansing on quality and diagnostic yield of colonoscopy: the European Panel of Appropriateness of Gastrointestinal Endoscopy European multicenter study. *Gastrointest Endosc*, **61**, 378-84.
- Hassan C, Bretthauer M, Kaminski MF, et al (2013). Bowel preparation for colonoscopy: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. *Endoscopy*, **45**, 142-50.
- Hassan C, Fuccio L, Bruno M, et al (2012). A predictive model identifies patients most likely to have inadequate bowel preparation for colonoscopy. *Clin Gastroenterol Hepatol*, **10**, 501-6.
- Harewood GC, Sharma VK, de Garmo P (2003). Impact of colonoscopy preparation quality on detection of suspected colonic neoplasia. *Gastrointest Endosc*, **5**, 76-9.
- Hendry PO, Jenkins JT, Diamant RH (2007). The impact of poor bowel preparation on colonoscopy: a prospective single centre study of 10,571 colonoscopies. *Colorectal Dis*, **9**, 745-8.
- Hsu CM, Lin WP, Su MY, et al (2012). Factors that influence cecal intubation rate during colonoscopy in deeply sedated patients. *J Gastroenterol Hepatol*, **27**, 76-80.
- Kazarian ES, Carreira FS, Toribara NW, Denberg TD (2008). Colonoscopy completion in a large safety net health care system. *Clin Gastroenterol Hepatol*, **6**, 438-42.
- Kuriki K, Tajima K (2006). The increasing incidence of colorectal cancer and the preventive strategy in Japan. *Asian Pac J Cancer Prev*, **7**, 495-501.
- Lebwohl B, Kastrinos F, Glick M, et al (2011). The impact of suboptimal bowel preparation on adenoma miss rates and the factors associated with early repeat colonoscopy. *Gastrointest Endosc*, **73**, 1207-14.
- Lebwohl B, Wang TC, Neugut AI (2010). Socioeconomic and other predictors of colonoscopy preparation quality. *Dig Dis Sci*, **55**, 2014-20.
- Liu X, Luo H, Zhang L, et al (2014). Telephone-based re-education on the day before colonoscopy improves the quality of bowel preparation and the polyp detection rate: a prospective, colonoscopist-blinded, randomised, controlled study. *Gut*, **63**, 125-30.
- Lohsiriwat V, Prapasrivorakul S, Suthikeeree W (2012). Colorectal cancer screening by double contrast barium enema in Thai people. *Asian Pac J Cancer Prev*, **13**, 1273-6.
- Menees SB, Kim HM, Elliott EE, et al (2013). The impact of fair colonoscopy preparation on colonoscopy use and adenoma miss rates in patients undergoing outpatient colonoscopy. *Gastrointest Endosc*, **78**, 510-6.
- Ness RM, Manam R, Hoen H, Chalasani N (2001). Predictors of inadequate bowel preparation for colonoscopy. *Am J Gastroenterol*, **96**, 1797-802.
- Radaelli F, Meucci G, Imperiali G, et al (2005). High-dose senna compared with conventional PEG-ES lavage as bowel preparation for elective colonoscopy: a prospective, randomized, investigator-blinded trial. *Am J Gastroenterol*, **100**, 2674-80.
- Rex DK, Imperiale TF, Latinovich DR, Bratcher LL (2002). Impact of bowel preparation on efficiency and cost of colonoscopy. *Am J Gastroenterol*, **97**, 1696-700.
- Seo EH, Kim TO, Park MJ, et al (2012). Optimal preparation-to-colonoscopy interval in split-dose PEG bowel preparation determines satisfactory bowel preparation quality: an observational prospective study. *Gastrointest Endosc*, **75**, 583-90.
- Shieh TY, Chen MJ, Chang CW, et al (2013). Effect of physician-delivered patient education on the quality of bowel preparation for screening colonoscopy. *Gastroenterol Res Pract*, 570180.
- Shin JY, Kim SY, Lee KS, et al (2012). Costs during the first five years following cancer diagnosis in Korea. *Asian Pac J Cancer Prev*, **13**, 3767-72.
- Tellez-Avila FI, Murcio-Perez E, Saul A, et al (2014). Efficacy and tolerability of low-volume (2L) versus single- (4L)

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versus split-dose (2L+2L) polyethylene glycol bowel preparation for colonoscopy: Randomized clinical trial. *Dig Endosc.* [Epub ahead of print]

Wiwanitkit V (2010). Colonoscopy with and without occult blood test pre-screening: which is more cost effective for implementation for screening for colon cancer? *Asian Pac J Cancer Prev*, **11**, 823-4.

Wu KL, Rayner CK, Chuah SK, et al (2011). Impact of low-residue diet on bowel preparation for colonoscopy. *Dis Colon Rectum*, **54**, 107-12.

Yang BH, Parkin DM, Cai L, Zhang ZF (2004). Cancer burden and trends in the Asian Pacific Rim region. *Asian Pac J Cancer Prev*, **5**, 96-117.