

Bowel Preparation Instructions for Outpatient Colonoscopy Delivered by a Specialist Endoscopy Nurse was Superior to That Delivered by an Endoscopist

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Abbreviations:

CRC: Colorectal cancer; ADR: Adenoma detection rate; L- liter; BBPS- Boston bowel preparation scale; NS: Not significant

Keywords:

Bowel preparation instructions; Specialist endoscopy nurse; Endoscopist; Adenoma detection rate; Superior

1. Abstract

1.1. Background: Colorectal cancer (CRC) screening with colonoscopy can decrease the incidence of CRC. However, in order to ensure the optimal detection of polyps during colonoscopy, it is of paramount importance to achieve adequate bowel preparation.

1.2. Aim: This retrospective controlled study compared the adequacy of bowel preparation delivered by a specialist endoscopy nurse to that delivered by an endoscopist.

1.3. Results: Four-thousand-eight-hundred-and-seventy-seven subjects (85.0%) were in the Nurse group while 860 subjects (15.0%) were in the Endoscopist group. A total Boston Bowel Preparation Score ≥ 6 was achieved in 4721 of the 4877 (96.8%) subjects in the Nurse group when compared with 807 of the 860 (93.8%) subjects in the Endoscopist group ($p < 0.001$). A total of 1624 of the 5737 (28.3%) subjects had adenomas on colonoscopy. There was no significant difference in the adenoma detection rate in the Nurse group when compared with the Endoscopist group [1388/4877 (28.5%) vs. 236/860 (27.4%), $p = 0.285$]. There was also no significant difference in the total number of adenomas detected in the Nurse group when compared with the Endoscopist group [mean \pm standard deviation 0.48 \pm 1.08 vs. 0.44 \pm 1.18, $p = 0.412$].

1.4. Conclusion: Bowel preparation for colonoscopy was superior when delivered by a specialist endoscopy nurse.

2. Introduction

Colorectal cancer (CRC) is now one of the commonest cancers Worldwide and has an estimated risk of occurring in 1 of 18 persons during their life-time [1, 2]. It is the second leading cause of death in the United States, and is the fifth most common cause of death in China [3, 4].

In view of the high prevalence of CRC Worldwide, the United States Preventive Services Task Force recommended that CRC screening with either colonoscopy, computerized tomography colonography, sigmoidoscopy, double-contrast barium enema, high-sensitivity guaiac fecal occult blood testing or stool DNA testing should be commenced at the age of 50 [5, 6].

At the moment, colonoscopy is the gold standard for CRC screening and is the most widely used method for CRC screening in the United States. This is because colonoscopy has been shown to correlate with decreased CRC incidence and deaths as it allows endoscopists to detect and remove pre-malignant polyps in the same setting [6-11]. However, adequate bowel preparation is one of the most important factors associated with the optimal visualization of bowel mucosa and detection of polyps during colonoscopy [6, 12]. Unsuccessful colonoscopy or failed colonoscopy, defined as a failure to intubate the cecum, can occur in 25-40% of the subjects with inadequate bowel preparation [13-15]. Inadequate bowel preparation is also as-

sociated with a reduced adenoma detection rate (ADR), an increased in procedure time, an increased risk of colonoscopy associated complications and reduced surveillance intervals [14-16].

Multiple factors such as inpatient status, advanced age, poly-pharmacy, co-morbidities and, in particular, subject's compliance with bowel preparation instructions, have been found to be associated with an increased rate of inadequate bowel preparation [14, 17, 18]. One of the reasons why many subjects do not follow bowel preparation instructions was because they were unable to understand the instructions provided to them [19]. They were also more likely to forget the bowel preparation instructions if the interval period between the time when the instructions were given and the colonoscopy appointment was longer than 16 weeks [19-21].

As an acknowledgement of the importance of subjects' compliance to bowel preparation instructions in determining the adequacy of bowel preparation for colonoscopy, guidelines have recommended that both oral and written instructions for all components of the colonoscopy preparation should be provided for all subjects undergoing colonoscopy [22, 23].

In order to further improve bowel preparation, it has also been recommended that all subjects should be made to understand the importance of adequate bowel preparation for colonoscopy [22, 23]. Therefore, in accordance with these recommendations [24], our Center assigned an endoscopist to explain to all subjects the procedure, dietary restrictions, amount of water, and, timing of ingestion of laxatives, to all our subjects undergoing colonoscopy as an outpatient from 2008 to 2011.

However, as the number of subjects requiring colonoscopy increased over the years, our Center started to designate one specialist endoscopy nurse to undertake this role from 2012 onwards. The aim of this study was to determine the adequacy of bowel preparation in a specialist endoscopy nurse delivered bowel preparation instructions when compared with that delivered by an endoscopist.

Table 1A: Written bowel preparation guidelines provided to all subjects.

Bowel Preparation Instructions	
1.	Three days before the colonoscopy/examination, start eating low-fat, low-residue meals (please to Figure 1B).
2.	One day before the colonoscopy/examination, you should change to clear liquid meals. Continue to take medication prescribed by your doctor unless otherwise instructed. <ol style="list-style-type: none"> a. Breakfast and lunch: Only carbohydrate e.g. congee, white bread, rice noodles, macaroni or noodles. Please avoid meat. b. After lunch: Clear fluid diet such as water and broth. Avoid milk, soya milk and congee with meat. Please do not take solid food. (Clear liquid meal includes water, tea, coffee, broth, pulp free fruit juice, squash, carbonated drinks, water or clear soup. Avoid milk and alcohol).
3.	In the evening of the day before the colonoscopy/examination, i.e. at 6 p.m. to 8 p.m. (<i>time</i>) on _____ (<i>date</i>) drink the first dose of Klean-Prep solution (Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland) [laxative] by mixing the laxative in 1 liter of water.
4.	On the morning of the colonoscopy/examination, at around 7 a.m. to 9 a.m. (<i>time</i>) on _____ (<i>date</i>) [timing of the second dose of Klean-Prep solution (Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland) will be adjusted by the staff instructing the subjects to be taken between a runway time of 4 to 6 hours before colonoscopy], drink the second dose Klean-Prep solution (Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland) [laxative] mixed in 1 liter water.
5.	Four hours before the colonoscopy/examination, you should stop eating. Only small sips of water are allowed. Diabetes drugs should be withheld on the day of examination. Other prescribed medicine can continue to be taken.

3. Methods

3.1. Patients

Subjects presented for CRC screening or symptoms of tenesmus, change in bowel habit, per rectal bleeding, abdominal discomfort/pain located in the following abdominal regions: right lumbar, umbilical, left lumbar, right iliac, hypogastrium or left iliac region, mucous in stool, diarrhoea or constipation undergoing outpatient colonoscopy at The Center for Digestive Diseases from January 2008 to December 2016 were included into this retrospective study.

Patients who were under the age of 16, had chronic renal failure, mental impairment, illiteracy, those who were confined to their bed or chairs, those who had previous colonoscopy, or, those who were not medically suitable to undergo outpatient colonoscopy were excluded from this study. In order to exclude any impact or effect of previous experience with colonoscopy had on the adequacy of bowel preparation, only colonoscopy naive subjects were included into this study.

3.2. Bowel Preparation Instructions

The subjects were given verbal and written instructions at the time of their clinic visit. The interview was conducted by the designated staff for 15-30 minutes in the clinic. Those who underwent colonoscopy from January 2008 to December 2011 received their dietary and bowel preparation instructions from an endoscopist (CKH) (Endoscopist group) while those who underwent colonoscopy from January 2012 to December 2016 received their dietary and bowel preparation instructions from a designated specialist endoscopy nurse (Nurse group).

All subjects received identical bowel preparation instructions (Table 1A). They were all provided with written and oral instructions on the required dietary restrictions before the outpatient colonoscopy (Table 1B). All subjects were advised to start eating a low-fat, low-residue meal three days before the colonoscopy (Table 1B).

Table 1B: Written low-residue, low-fat diet sheet provided to all subjects.

	Recommended	Avoid
Milk/Dairy/Drinks	Water, coffee, tea, squash, pulp free fruit juice, carbonated drinks, broth, clear soups, jelly or cheese	Dairy and alcoholic drinks
Meat/Fish/Eggs	Baked, broiled or boiled fish. Canned salmon or tuna. Tender or minced beef, lamb, veal, turkey, chicken or organ meat. Hard-cooked eggs	Fried meat or fish, shellfish, highly spiced meat, strong cheeses and soft-cooked eggs
Fruit/Vegetables	Pulp free juices only	All fruits, vegetables, salad, mushrooms and nuts
Bread/Cereal/Starches	White bread and rolls, saltine crackers or soda crackers Cooked or cold refined cereals. Potato (no skin), pasta or refined white rice	All breads with seeds, whole grains or nuts. Breads or crackers made with whole grains or bran. Whole grain or bran cereals. Potato skin, brown rice, fried potatoes, potato chips, pancakes or waffles.

A split dose Klean-Prep solution (Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland) was prescribed for all colonoscopies. The Klean-Prep solution (Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland) was divided into two portions, one sachet mixed with 1 liter (L) water administered in the evening prior to the colonoscopy (7 p.m.) and the second sachet of Klean-Prep solution (Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland) mixed with another 1 L water was administered on the morning of the colonoscopy (to be taken between 7 a.m. to 9 a.m.). The timing of the second dose of Klean-Prep solution (Helsinn Birex Pharmaceuticals Ltd., Dublin, Ireland) was adjusted by the staff instructing the subjects to be taken within a runway time of 4-6 hours before colonoscopy appointment. Runway time was defined as the interval between the second dose of laxative to the start of colonoscopy.

All colonoscopies were performed within 4 weeks after their clinic visit. The colonoscopies were performed between 11 a.m. to 3 p.m. in order to maintain an optimal runway time of 4-6 hours after the second dose of laxative. The staff (endoscopist or specialist endoscopy nurse) who conducted the first interview would telephone the subjects 4 days before the procedure to emphasize the dietary and bowel preparation again.

3.3. Colonoscopy

One experienced endoscopist (CKH) performed all the conventional white-light colonoscopy (Olympus, Tokyo, Japan) under conscious sedation with intravenous midazolam and pethidine as previously described [25]. The insertion time was defined as the interval between the start of colonoscopy and intubation into the cecum. Both the terminal ileal and appendiceal orifices were identified. A record of the insertion time, total number of polyps detected, size of polyps detected and location of the polyps were all documented. ADR was defined as the proportion of subjects in which at least one adenoma was detected. This rate was calculated using all subjects undergoing a colonoscopy.

The quality of the bowel preparation was graded according to the Boston Bowel Preparation Scale (BBPS) by one endoscopist (CKH). The BBPS was routinely used scoring system in this Centre because it is a reliable and validated scoring system for assessing the adequacy

of bowel preparation [26-28]. An adequate bowel preparation was defined as a total BBPS score ≥ 6 while a segment BBPS score ≥ 2 was defined as adequate for that segment [28].

The BBPS was only conducted upon withdrawal of colonoscopy after flushing and suctioning of fluid have been completed. The scoring was applied by colonic segments (right colon, transverse colon and left colon) and scored by numbered scores that included features such as staining, liquid and stool fragments [26-28]. The right colon included the cecum and ascending colon while the transverse colon includes the hepatic and splenic flexure. The left colon consisted of the descending colon, sigmoid colon and rectum [26-28].

The Institutional Review Board of the Center for Digestive Diseases approved this retrospective study (Protocol approval number CDD09-00003).

The primary outcome was to determine the adequacy of bowel preparation with a specialist endoscopy nurse delivered bowel preparation instructions. The secondary outcomes were to determine the ADR, the total number of adenomas and failure of cecal intubation with a specialist endoscopy nurse delivered bowel preparation instructions.

3.4. Statistical Analysis

All statistical analyses were performed using the SPSS software (IBM SPSS Statistics for Windows, Version 20.0, IBM Corp, Armonk, New York, USA). Mann-Whitney *U*-test was used for continuous variables with skewed distribution and chi-square with Yates' correction factor or Fisher's exact test for categorical variables. Continuous variables were expressed as mean \pm standard deviation. The effect of a specialist endoscopy nurse delivered bowel preparation instructions on the adequacy of bowel preparation, ADR, total number of adenomas detected and failed cecal intubation when compared with an endoscopist delivered bowel preparation instructions were analyzed in a univariate analysis. All statistics were performed on the intention to treat the population. Statistical significance was defined as $P < 0.05$ (two-tailed).

4. Result

4.1. Study Population

A total of 5753 consecutive Chinese patients underwent outpatient

colonoscopy during the study period (Table 1). However, 16 of the 5753 subjects (0.28%) had incomplete colonoscopy due to a malignant stricture or malignant mass preventing further advancement of the colonoscope, and so were excluded from the final analysis. Therefore, only 5737 subjects were included into the final analysis (Figure 1).

Four thousand eight hundred and seventy seven of these 5737 subjects (85.0%) were in the Nurse group while 860 of these 5737 subjects (15.0%) were in the Endoscopist group (Figure 1). The characteristics of patients in the Nurse group and in the Endoscopist group are shown in (Table 2). There were no significant differences in the baseline characteristics between the two groups [all p=not significant (NS)].

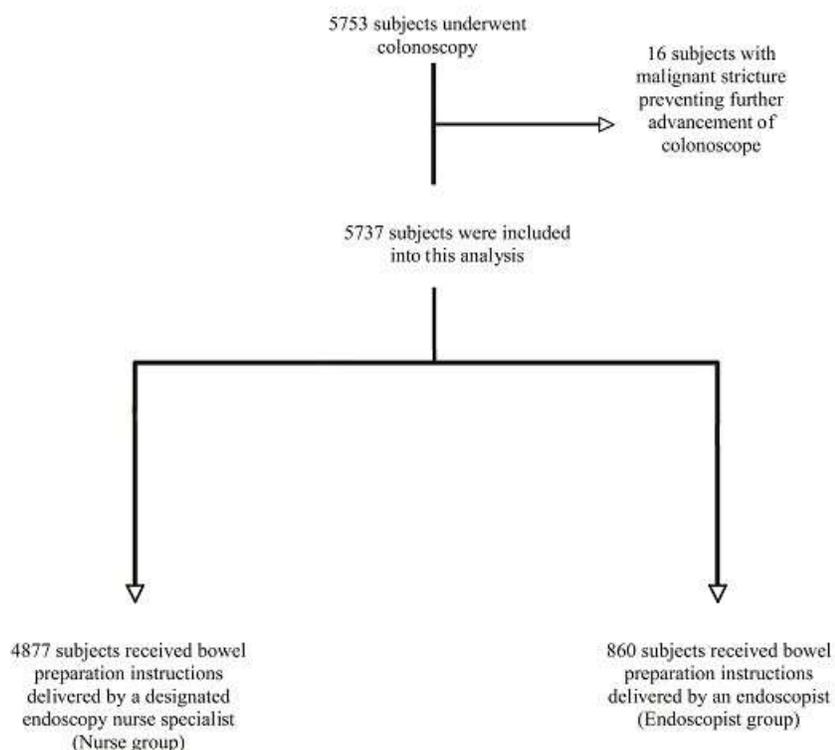


Figure 1: Study population.

Table 2: Baseline characteristics of subjects in the Nurse group and the Endoscopist group.

	Nurse group (n=4877)	Endoscopist group	P-value
Age, years	49.3 ± 10.2	49.2 ± 10.2	0.477
Sex, M: F	2759:2118	478:382	0.307
Presenting symptom:			
Diarrhoea, n (%)	1736 (35.6)	308 (35.8)	0.902
Abdominal pain or discomfort, n (%)	779 (16.0)	131 (15.2)	0.584
Colorectal cancer screening, n (%)	463 (9.5)	80 (9.3)	0.86
Change in bowel habit, n (%)	341 (7.0)	56 (6.6)	0.609
Constipation, n (%)	296 (6.1)	51 (5.9)	0.875
Mucus in stool, n (%)	43 (0.9)	9 (1.0)	0.638
Per rectal bleeding, n (%)	737 (15.1)	144 (16.7)	0.221
Tenesmus, n (%)	482 (9.9)	81 (9.4)	0.673
Body mass index (kg/m ²)	24.0 ± 4.2	23.6 ± 4.0	0.647
Diabetes mellitus:			0.299
Yes	588 (12.1)	93 (10.8)	
No	4289 (87.9)	767 (89.2)	
Ischemic heart disease:			0.407
Yes	481 (9.9)	77 (9.0)	
No	4396 (90.1)	783 (91.0)	
History of abdominal surgery:			0.52
Yes	619 (12.7)	116 (13.5)	
No	4258 (87.3)	744 (86.5)	

Continuous variables were expressed as mean ± standard deviation.

BBPS- Boston Bowel Preparation Scale

4.2. Adequacy of Bowel Preparation

A total BBPS score ≥ 6 was achieved in 4721 of the 4877 (96.8%) subjects in the Nurse group when compared with 807 of the 860 (93.8%) subjects in the Endoscopist group ($p < 0.001$).

When each of the three segments were compared individually, 4662 of the 4877 (95.6%) subjects in the Nurse group when compared with 792 of the 860 (92.1%) subjects in the Endoscopist group had a BBPS score ≥ 2 in the right colon ($p < 0.001$).

And in the transverse colon, 4680 of the 4877 (96.0%) subjects in the Nurse group when compared with 798 of the 860 (92.8%) subjects in the Endoscopist group had a BBPS score ≥ 2 ($p < 0.001$).

Finally, 4780 of the 4877 (98.0%) subjects in the Nurse group when compared with 817 of the 860 (95.0%) subjects in the Endoscopist group had a BBPS score ≥ 2 in the left colon ($p < 0.001$).

4.3. Total and Separate Segments Adrs were Similar in Both Groups

A total of 1624 of these 5737 (28.3%) subjects had adenomas detected on colonoscopy. In the Nurse group, 1388 of the 4877 (28.5%) subjects had adenomas detected on colonoscopy while 236 of the 860 (27.4%) subjects in the Endoscopist group had adenomas detected on colonoscopy. There was no significant difference in the ADR between the Nurse group and the Endoscopist group ($p = 0.285$).

In the right colon, adenomas were detected on colonoscopy in 432 of the 4877 (8.9%) subjects in the Nurse group when compared with 62 of the 860 (7.2%) subjects in the Endoscopist group ($p = 0.114$). Furthermore, 468 of the 4877 (9.6%) subjects in the Nurse group when compared with 69 of the 860 (8.0%) subjects in the Endoscopist group had adenomas detected on colonoscopy in the transverse colon ($p = 0.162$). Finally, 809 of the 4877 (16.6%) subjects in Nurse group when compared with 149 of the 860 (17.3%) subjects in the Endoscopist group had adenomas detected in the left colon on colonoscopy ($p = 0.586$).

4.4. Total Number of Adenomas Detected

A total number of 2710 adenomas were detected in our study population. Two thousand three hundred and twenty-eight adenomas were detected in the 4877 subjects in the Nurse group when compared with 382 adenomas detected in the 860 subjects in the Endoscopist group ($p = 0.073$).

The mean \pm standard deviation number of adenomas detected in the Nurse group was 0.48 ± 1.08 while in the Endoscopist group, the mean \pm standard deviation number of adenomas detected was 0.44 ± 1.18 ($p = 0.412$).

4.5. Failed Cecal Intubation

Cecal intubation was unsuccessful in 16 of the 5737 (0.3%) of the subjects. There was no significant difference in the failed cecal intubation rate when the Nurse group was compared with the Endoscopist group [13/4877 (0.3%) vs. 3/860 (0.3%), $p = 0.722$].

5. Discussion

One of the main reasons for inadequate bowel preparation is the patient's lack of understanding on the importance of adequate bowel preparation for colonoscopy. This lack of understanding also occurs in medical staffs that have never performed or assisted in colonoscopy. This is because they do not understand that an optimal bowel preparation is the most important factor associated with a decreased in the incidence of missed lesions during colonoscopy and a higher rate of ADR [1, 17, 24].

This is why a physician delivered bowel preparation instructions can improve the adequacy of bowel preparation for colonoscopy [18, 20, 24]. However, as more and more countries advocate commencing CRC screening on their population at the age of 50, the demand for colonoscopy will steadily increase. This increased in demand for colonoscopy will make an endoscopist delivered bowel preparation instructions to be cost-inefficient as it would decrease the amount of time available for an endoscopist to perform colonoscopy as he or she would need to spend time delivering bowel preparation instructions.

Therefore, there is an urgent necessity to develop an alternate method to an endoscopist delivered bowel preparation instructions in order to fully utilize the skills and time of an endoscopist to perform colonoscopy, rather than in delivering bowel preparation instructions. This will, hopefully, enable the waiting time for colonoscopy to be shortened while maintaining an optimal bowel preparation in those undergoing colonoscopy.

As a lack of confidence in the education level of nurses or visiting physicians has been found to affect the education of the subject or patient [20, 24], our Center decided to replace our endoscopist delivered bowel preparation instructions with a specialist endoscopy nurse. This is because we believed that having a specialist endoscopy nurse who is assisting in colonoscopy can help to maintain both the confidence of our subjects and also the quality of the bowel preparation.

Our Center adopted a total BBPS score ≥ 6 and a segment BBPS score ≥ 2 as definition of adequate bowel preparation because this total BBPS score and segment BBPS score have been validated to allow endoscopists to confidently recommend to patients that a next follow-up endoscopy 10 years later should be adequate. Additionally, a total BBPS score ≥ 6 and a segment BBPS score ≥ 2 have also been shown to facilitate the detection of adenomas < 5 mm in size [27, 29, 30].

The 96.8% who achieved a total BBPS score ≥ 6 in the Nurse group was significantly higher than that in the Endoscopist group. This showed that not only is bowel preparation instructions delivered by a specialist endoscopy nurse non-inferior to one delivered by an endoscopist, it is even superior.

Additionally, this 96.8% with adequate bowel preparation in the

Nurse group is comparable to the 97% and 96.7% with adequate bowel preparation determined in two previous studies [24, 31]. This is despite the fact that these studies adopted a less stringent total BBPS score ≥ 5 as a definition of adequate bowel preparation [24, 31]. So, even with a stricter definition of adequate bowel preparation defined as a total BBPS score ≥ 6 rather than ≥ 5 as adopted by Shieh et. al. and Adler et. al., bowel preparation instructions delivered by a specialist endoscopy nurse can still be comparable with the rate of adequate bowel preparation reported previously [24, 31].

Even when each segment BBPS score was analyzed individually, the Nurse group still achieved a significantly higher adequate bowel preparation rate in the right, transverse and left sided colon, respectively (all $p < 0.05$). This has an added importance as studies have shown a lack of difference in the adequacy of bowel preparation in the right colon reflecting the difficulty faced by all endoscopists in achieving an adequate bowel preparation in the right colon despite the multi-modalities employed Worldwide.

This lower incidence of adequate bowel preparation in the right colon may also be the reason why colonoscopy is less effective in decreasing the incidence of tumors in the proximal colon when compared with the distal colon [32]. Hopefully, with an improved rate of adequate bowel preparation in the right colon, endoscopist can increase the detection of adenoma in the right colon.

The reason for a better outcome achieved with a specialist endoscopy nurse delivered bowel preparation instructions may be due to the simple fact that subjects may feel less intimidated by the nurse. They may be more likely to ask the nurse the same question repeatedly without feeling shy or awkward, and, clarify simple points in the bowel preparation instructions that they do not understand.

This study did not show a difference in the total ADR, segment ADR or total number of adenomas detected because the rate of adequate bowel preparation achieved in both groups were high. Even in the Endoscopy group, a total BBPS score ≥ 6 was achieved in 93.8% of the subjects. While in the right colon, 92.1% of those in the Endoscopy group had a segment BBPS score ≥ 2 .

With such a high rate of adequate bowel preparation in the right colon even in the Endoscopy group, the possibility of missing small adenomas in the right colon in this group is low. This may be the reason why this study was unable to demonstrate a difference in total and individual segments ADRs in the two groups, despite achieving a higher whole colon and individual segment adequate bowel preparation rate in the Nurse group.

This study demonstrated that bowel preparation instructions delivered by a specialist endoscopy nurse should be considered as it can help to achieve more adequate bowel preparation while maintaining the ADR and total number of adenomas detected on colonoscopy.

However, this study does have its limitations. Firstly, instead of a randomized controlled study, we only employed a historical control group. As the baseline characteristics between the two groups were

comparable (Table 2), there may not be any obvious bias between the two groups of subjects. Secondly, subjects undergoing CRC screening and symptomatic subjects were both included into the study. Those with symptoms may be more likely to adhere to bowel preparation instructions than asymptomatic subjects undergoing CRC screening. But, as the number of subjects with symptoms, the type of symptoms and number of CRC screening in the two groups were comparable (Table 2), one may assume that no bias had occurred.

In conclusion, a specialist endoscopy nurse delivered bowel preparation instructions is not only non-inferior to one delivered by endoscopist, it can be superior in improving the overall quality of bowel preparation in outpatients undergoing colonoscopy.

References

1. Torre LA, Bray F, Siegel RL, Felay J, Lortet-Tieulent J, Jemal A et al. Global cancer statistics. *CA Cancer J Clin.* 2012; 65: 87-108.
2. Siegel R, Naishadham D, Jemal A. Cancer statistics. *CA Cancer J Clin.* 2012; 62: 10-29.
3. Siegel RL, Miller KD, Fedewa SA, Ahnen DJ, Meester RGS, Barzi A et. al. Colorectal cancer statistics. *CA Cancer J Clin.* 2017; 67: 177-193.
4. Chen W, Zheng R, Baade PD, Zhang S, Zeng H, Bray F et. al. Cancer statistics in China, 2015. *CA Cancer J Clin.* 2016; 66: 115-32.
5. Bibbins-Domingo K, Grossman DC, Curry SJ, Davidson KW, Epling JW Jr, Garcia FAR et. al. US Preventive Services Task Force. Screening for colorectal cancer. US Preventive Services Task Force recommendation statement. *JAMA.* 2016; 315: 2564-2575.
6. Lieberman D, Ladabaum U, Cruz-Correa M, Ginsburg C, Inadomi JM, Kim LS et. al. Screening for colorectal cancer and evolving issues for physicians and patients: a review. *JAMA.* 2016; 316: 2135-45.
7. US Preventive Services Task Force. Screening for colorectal cancer: US Preventive Services Task Force recommendation statement. *Ann Intern Med.* 2008; 149: 627-637.
8. Austin H, Henley SJ, King J, Richardson LC, Ehemann C. Changes in colorectal cancer incidence rates in young and older adults in the United States: what does it tell us about screening. *Cancer Causes Control.* 2014; 25: 191-201.
9. Chen C, Stock C, Hoffmeister M, Brenner H. Public health impact of colonoscopy use on colorectal cancer mortality in Germany and the United States. *Gastrointest Endosc.* 2018; 87: 213-221.
10. Murphy CC, Sandler RS, Sanoff HK, Yang YC, Lund JL, Baron JA et al. Decrease in incidence of colorectal cancer among individuals 50 years or older after recommendations of population-based screening. *Clin Gastroenterol Hepatol.* 2017; 15: 903-909. e6.
11. Zauber AG, Winawer SJ, O'Brien MJ, Lansdorp-Vogelaar I, van Ballegooijen M, Hankey BF et. al. Colonoscopic polypectomy and long-term prevention of colorectal-cancer deaths. *N Engl J Med.* 2012; 366: 687-696.
12. Johnson DA, Barkun AN, Cohen LB, Dominitz JA, Kaltenbach T, Martel M et. al. US Multi-Society Task Force on Colorectal Cancer. Optimizing adequacy of bowel cleansing for colonoscopy: recommen-

- dations from the US multi-society task force on colorectal cancer. *Gastroenterology*. 2014; 147: 903-924.
13. ASGE Standards of Practice Committee, Saltzman JR, Cash BD, Pasha SF, Early DS, Muthusamy VR, Khashab MA, et. al. Bowel preparation before colonoscopy. *Gastrointest Endosc*. 2015; 81: 781-794.
 14. Baker FA, Mari A, Nafrin S, Suki M, Ovadia B, Gal O et. al. Predictors and colonoscopy outcomes of inadequate bowel cleansing: a 10-year experience in 28,725 patients. *Ann Gastroenterol*. 2019; 32: 457-462.
 15. Nam JH, Hong SB, Lim YJ, Lee S, Kang HW, Kim JH et. al. Comparison of oral sulfate solution and polyethylene glycol plus ascorbic acid on the efficacy of bowel preparation. *Clin Endosc*. 2020; 53: 568-574.
 16. Spadaccini M, Frazzoni L, Vanella G, East J, Radaelli F, Spada C et. al. Efficacy and tolerability of high- vs low-volume split-dose bowel cleansing regimens for colonoscopy: a systematic review and meta-analysis. *Clin Gastroenterol Hepatol*. 2020; 18: 1454-1465.
 17. Gimeno-Garcia AZ, Baute JL, Hernandez G, Morales D, Gonzalez-Pérez CD, Nicolás-Pérez D. Risk factors of inadequate bowel preparation: a validated predictive score. *Endoscopy*. 2017; 49: 536-543.
 18. Elvas L, Brito D, Areia M, Carvalho R, Alves S, Saraiva S et. al. Impact of personalized patient education on bowel preparation for colonoscopy: prospective randomized controlled trial. *GE Port J Gastroenterol*. 2017; 24: 22-30.
 19. Chan WK, Saravanan A, Manikam J, Goh KL, Mahadeva S. Appointment waiting times and education level influence the quality of bowel preparation in adult patients undergoing colonoscopy. *BMC Gastroenterol*. 2011; 11: 86-94.
 20. Modi C, Depasquale JR, Digiacoimo WS, Malinowski JE, Engelhardt K, Shaikh SN et al. Impact of patient education on quality of bowel preparation in outpatient colonoscopies. *Qual Prim Care*. 2009; 17: 397-404.
 21. Nguyen DL, Wieland M. Risk factors predictors of poor quality preparation during average risk colonoscopy screening: the importance of health literacy. *J Gastrointest Liver Dis*. 2010; 19: 369-372.
 22. Hassan C, Brethauer M, Kaminski MF, Polkowski M, Rembacken B, Saunders B et. al. Bowel preparation for colonoscopy. European Society of Gastrointestinal Endoscopy (EGSE) guideline. *Endoscopy*. 2013; 45: 142-150.
 23. Johnson DA, Barkun AN, Cohen LB, Dominitz JA, Kaltenbach T, Martel M et al. Optimizing adequacy of bowel cleaning for colonoscopy: recommendations from the US multi-society task force on colorectal cancer. *Gastrointest Endosc*. 2014; 80: 543-562.
 24. Shieh TY, Chen MJ, Chang CW, Huang CY, Hu KC, Kuo YC et. al. Effect of physician-delivered patient education on the quality of bowel preparation for screening colonoscopy. *Gastroenterol Res Pract*. 2013; 2013: 570180.
 25. Hui CK, Hui NK. A prospective study on the prevalence, extent of disease and outcome of eosinophilic gastroenteritis in those presenting with lower abdominal symptoms. *Gut Liver*. 2018; 12: 288-296.
 26. Lai EJ, Calderwood AH, Doros G, Fix OK, Jacobson BC. The Boston Bowel Preparation Scale: a valid and reliable instrument for colonoscopy-oriented research. *Gastrointest Endosc*. 2009; 69: 620-625.
 27. Clark BT, Protiva P, Nagar A, Imaeda A, Ciarleglio MM, Deng Y et. al. Quantification of adequate bowel preparation for screening or surveillance colonoscopy in men. *Gastroenterology*. 2016; 150: 396-405.
 28. Guo R, Wang YJ, Liu M, Ge J, Zhang LY, Ma L et al. The effect of quality of segmental bowel preparation on adenoma detection rate. *BMC Gastroenterol*. 2019; 19: 119-126.
 29. Calderwood AH, Schroy PC 3rd, Lieberman DA, Logan JR, Zurfluh M, Jacobson BC et al. Boston Bowel Preparation Scale scores provide a standardized definition of adequate for describing bowel cleanliness. *Gastrointest Endosc*. 2014; 80: 269-276.
 30. Kluge MA, Williams JL, Wu CK, Jacobson BC, Schroy PC 3rd, Lieberman DA et al. Inadequate Boston Bowel Preparation Scale scores predict the risk of missed neoplasia on the next colonoscopy. *Gastrointest Endosc*. 2018; 87: 744-751.
 31. Adler A, Wegscheider K, Lieberman D, Aminimalai A, Aschenbeck J, Drossel R et al. Factors determining the quality of screening colonoscopy: a prospective study on adenoma detection rates, from 12,134 examinations (Berlin colonoscopy project 3, BECOP-3). *Gut*. 2013; 62: 236-241.
 32. Belsey J, Crosta C, Epstein O, Fischbach W, Layer P, Parente F et. al. (Meta-analysis: the relative efficacy of oral bowel preparations for colonoscopy 1985-2010. *Aliment Pharmacol Ther*. 2012; 35: 222-237.