Original Article

Bowel preparation quality between hospitalized patients and outpatient colonoscopies

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Abstract

Background/Aims: Optimal bowel preparation is essential for a complete high-quality colonoscopy. We sought to determine whether an inpatient, as opposed to an ambulatory setting, would affect the quality of bowel preparation.

Patients and Methods: A retrospective chart review was conducted in a tertiary care university hospital. We collected demographic data from consecutive patients who underwent a colonoscopy for any reason between August 2007 and April 2012.

Results: A total of 2999 patients were included in the study with a mean age of 50.36 (95%CI; 49.79–50.94). Males comprised 58.12%. Ambulatory patients had a higher rate of good bowel preparations (67.23% vs. 56.64%, *P* value < 0.01), a lower rate of poor bowel preparations (18.22% vs. 27.14%, *P* value < 0.01), and a higher rate of colonoscopy completion (86.79% vs. 77.59%, *P* value < 0.01). There was no difference between the rates of polyps detected (18.90% vs. 20.83%, *P* value = 0.22). The univariabe modeling factors associated with a sub-optimal bowel preparation were age OR 1.02 (95% CI, 1.01 to 1.02), chronic kidney disease OR 2.34 (95% CI, 1.12 to 4.88), diabetes mellitus OR 2.00 (95% CI, 1.50 to 2.68), hypertension OR 1.48 (95% CI, 1.11 to 1.97), anemia OR 1.81 (95% CI, 1.33 to 2.47), and weight loss OR 1.41 (95% CI, 1.01 to 1.96). Better bowel preparation was associated with colonoscopies performed in the outpatient setting OR 0.63 (95% CI, 0.54 to 0.73).

Conclusion: Bowel preparation quality is affected by the setting in which it is performed. This result suggests that, when appropriate, colonoscopies should be performed on an outpatient basis. Further studies are required to replicate this finding.

Keywords: Colonoscopy, diverticulosis, endoscopy, gastrointestinal bleeding, lower gastrointestinal bleeding, screening

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INTRODUCTION

High-quality bowel preparation is a fundamental requirement for a complete colonoscopy and poor

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bowel preparation results in repeated procedures, wasted resources, and possible morbidity and lower satisfaction for patients. This is more evident in the inpatient setting, where poor quality preparations potentially result in a prolonged hospitalization and increased costs.[1–3] Furthermore, bowel preparation quality can affect the quality indicators of a colonoscopy, including the adenoma detection rate, withdrawal time, and cecal intubation rate.[4]

We hypothesize that the appropriate setting for a colonoscopy to be performed, if possible, would be in an outpatient basis; this would result in a better quality of bowel preparation, and a decrease in the costs associated with the procedure both due to reduced repeated procedures as well as shortening the duration of hospitalization.

In this study, we aim to determine whether inpatients have a higher probability of having suboptimal bowel preparations, which leads to incomplete or repeat colonoscopies, as well as the predictors of a complete colonoscopy.

PATIENTS AND METHODS

We conducted a retrospective cohort study using an endoscopic reporting database of patients undergoing colonoscopies at a tertiary care university hospital.

Demographic data from consecutive patients who underwent a colonoscopy for any reason between August 2007 and April 2012 was collected in a retrospective manner through the hospital information system, endoscopic electronic reports, and a manual review of the files. We included all patients that were older than 18 years of age. We excluded patients with known inflammatory bowel disease. Data collected included: age, sex, comorbidities, symptoms, indication for the colonoscopy, quality of the bowel preparation, and whether the procedure was performed on an inpatient or outpatient basis. If the colonoscopy was not completed, the reason was documented. The indication for the colonoscopy was based on the endoscopist's documentation. This study design has been described in two prior publications.[5,6]

We defined the quality of the bowel preparation as "good" if no or minimal solid stool was found with some amounts of clear fluid requiring suctioning; "fair" if there were collections of semisolid debris that were cleared with difficulty; and "poor" if solid or semisolid debris were present and could not be cleared.[1] A suboptimal bowel preparation was defined as meeting the definition of either a fair or poor bowel preparation.

The number of gastroenterologists who staffed the endoscopy unit varied over the study period from four to nine, and the number of endoscopies performed in 2013 was about 7000 procedures. No personal identification information or other personal identifiers were recorded. The internal review board of the institution approved the study.

Statistical analysis

Descriptive statistics were computed for continuous variables, including means, standard deviations (SDs), minimum and maximum values, as well as 95% confidence intervals (CIs), and frequencies for categorical variables. Univariate and multivariate logistical regression analyses were performed to determine the significance, odds ratio (OR), and corresponding 95% CIs of various predictive factors.

When hypothesis testing was conducted, the paired *t*-test and, where appropriate, the Fisher's exact test were used. When comparing more than one group a one-way analysis of variance (ANOVA) was used to test for differences among groups. STATA 11.2 (Stata Corp., College Station, TX, USA) was used for our statistical analysis. A statistical significance threshold of $P = 0.05$ was adopted. No attempt at imputation was made for missing data.

RESULTS

A total of 2999 patients were included in this study with a mean age of 50.36 (95%CI; 49.79–50.94). Males comprised 58.12% and the majority were Saudi nationals (93.76%). Hypertension was the most prevalent co-morbidity (33.25%), followed by diabetes mellitus (29.20%), dyslipidemia (12.99%), chronic kidney disease (3.10%), and coronary artery disease (2.03%). Smoking, when reported, was found in 1.20% of patients, while 18.16% had a prior history of polyps or colorectal cancer.

The most common indications for a colonoscopy were rectal bleeding (24.71%), abdominal pain (20.37%), surveillance colonoscopy (17.97%), constipation (10.56%), diarrhea (8.24%), screening (7.98%), anemia (5.88%), weight loss (5.43%), melena (3.52%), anal pain (2.32%), change in bowel habits (2.02%), perianal fistulas (1.24%), positive occult blood test on stool examination (0.56%), and abdominal bloating (0.34%).

The quality of the bowel preparation was reported as good in 63.42%, fair in 15.15%, and poor in 21.43%.

Table 1: Patient characteristics

Variable	Inpatient *N*=(1080)		Outpatient *N*=(1919)		Total *N*=(2999)		*P* value
	% or mean	95% CI	% or mean	95% CI	% or mean	95% CI	
Age (Years)	52.90	51.86-53.94	48.94	48.26-49.62	50.36	49.79-50.94	<0.01
Gender							
Male	56.85	53.14-59.40	58.83	56.69-61.36	58.12	56.35-59.89	0.29
Female	43.15	40.60-46.86	41.17	38.64-43.31	41.88	40.11-43.65	
Nationality							
Saudi	92.95	91.33-94.57	94.12	93.00-95.24	93.76	92.90-94.63	0.23
Non-Saudi	7.05	5.43-8.66	5.88	4.67-7.00	6.24	5.37-7.10	
Co-morbidities							
Smoker	1.45	0.70-2.21	1.18	0.66-1.69	1.20	0.81-1.59	0.72
Prior polyps or cancer	16.99	14.62-19.37	21.46	19.51-23.41	18.16	16.77-19.56	<0.01
Diabetes mellitus	38.33	32.81-43.85	24.11	20.50-27.74	29.20	26.12-32.28	<0.01
Hypertension	42.67	37.05-48.28	28.01	24.21-31.81	33.25	30.06-36.45	<0.01
Dyslipidemia	15.00	10.95-19.05	11.87	9.14-14.61	12.99	10.71-15.27	0.21
Chronic kidney disease	6.00	3.30-8.70	1.48	0.46-2.51	3.10	1.92-4.27	<0.01
Coronary artery disease	2.33	0.62-4.04	1.86	0.71-3.00	2.03	1.07-2.98	0.64
Indication							
Bleeding per rectum	25.70	22.94-28.46	24.22	22.18-26.26	24.71	23.07-26.35	0.40
Abdominal pain	19.17	16.68-21.66	21.05	19.11-22.99	20.37	18.84-21.90	0.27
Surveillance	14.51	12.28-16.73	19.99	18.09-21.89	17.97	16.51-19.43	<0.01
Constipation	8.08	6.36-9.80	11.99	10.45-13.54	10.56	9.39-11.72	<0.01
Diarrhea	8.39	6.64-10.15	8.17	6.87-9.47	8.24	7.19-9.28	0.84
Screening	9.22	7.40-11.05	7.23	6.00-8.46	7.98	6.95-9.01	0.08
Anemia	9.95	8.06-11.84	3.59	2.70-4.47	5.88	4.99-6.77	<0.01
Weight loss	6.11	4.60-7.63	5.00	3.96-6.03	5.43	4.57-6.29	0.18
Melena	5.91	4.42-7.40	2.18	1.48-2.87	3.52	2.82-4.22	<0.01
Anal pain	1.35	0.62-2.08	2.82	2.03-3.61	2.32	1.75-2.89	0.01
Change in bowel habits	1.24	0.54-1.94	2.47	1.73-3.21	2.02	1.49-2.56	0.03
Perianal fistula	0.93	0.33-1.54	1.41	0.85-1.97	1.24	0.82-1.65	0.28
Occult blood positive	1.24	0.54-1.94	0.18	0.00-0.38	0.56	0.28-0.85	<0.01
Abdominal bloating	0.21	0.00-0.49	0.41	0.11-0.72	0.34	0.12-0.56	0.38

Table 2: Findings on colonoscopy

Variable	Inpatient *N*=(1080)		Outpatient *N*=(1919)		Total *N*=(2999)		*P* value
	%	95% CI	%	95% CI	%	95% CI	
Preparation quality							
Good	56.64	53.66-59.63	67.23	65.1-69.35	63.42	61.68-65.16	<0.01
Fair	16.21	13.99-18.43	14.55	12.96-16.15	15.15	13.85-16.45	
Poor	27.14	24.47-29.82	18.22	16.47-19.96	21.43	19.95-22.92	
Completion rate							
Complete colonoscopy	77.59	75.05-80.12	86.79	85.24-88.33	83.33	81.78-84.69	<0.01
Terminal ileum	56.03	53.02-59.05	64.35	62.17-66.52	58.56	56.79-60.33	<0.01
Polyps and their location							
Polyps	18.90	16.55-21.24	20.83	19.00-22.65	20.21	18.77-21.65	0.22
Location							
Rectum	4.21	3.00-5.41	4.83	3.86-5.79	4.59	3.84-5.34	0.35
Left-sided	5.89	4.48-7.31	7.03	5.88-8.18	6.67	5.78-7.57	
Transverse	1.40	0.70-2.11	2.20	1.54-2.86	1.94	1.45-2.44	
Right-sided	2.81	1.82-3.80	2.99	2.23-3.76	2.92	2.31-3.52	
More than one location	4.49	3.25-5.73	3.83	2.97-4.69	4.06	3.35-4.76	
Mass	10.29	8.47-12.11	3.83	2.97-4.69	6.23	5.37-7.10	<0.01
Location of the mass							
Rectum	4.21	3.00-5.41	1.73	1.15-2.32	2.65	2.07-3.22	<0.01
Left-sided	2.90	1.89-3.91	0.94	0.51-1.38	1.68	1.22-2.14	
Transverse	0.56	0.11-1.01	0.21	0.00-0.42	0.34	0.13-0.54	
Right-sided	2.25	1.36-3.13	0.84	0.43-1.25	1.34	0.93-1.75	
More than one location	0.37	0.00-0.74	0.10	0.00-0.25	0.20	0.04-0.36	
Hemorrhoids	15.81	13.62-18.00	18.63	16.88-20.37	17.59	16.23-18.96	0.06
Diverticulosis	8.42	6.75-10.09	8.60	7.34-9.86	8.55	7.54-9.55	0.91
Colitis	6.64	5.15-8.14	3.36	2.55-4.17	4.56	3.81-5.31	<0.01
Polypectomy	12.82	10.81-14.82	17.10	15.41-18.80	15.53	14.23-16.83	<0.01

Most colonoscopies were performed under conscious sedation (97.60%) and 83.33% of the procedures were completed. The colonoscopy findings are detailed in Tables 1 and 2.

Table 3: Variables predicting a complete colonoscopy

Variable	Univariable modeling		Multivariable modeling	
	OR	95% CI	OR	95% CI
Colonoscopy completion				
Age	1.00	0.99-1.00	1.01	1.00-1.01
Gender	1.10	0.93-1.30	1.17	0.95-1.44
Outpatient setting	1.52	1.28-1.79	1.34	1.08-1.67
Sedation	25.00	11.93-52.39	15.84	6.88-36.44
Preparation quality				
Good (Reference)	NA	NA	NA	NA
Fair	0.44	0.34-0.57	0.51	0.38-0.68
Poor	0.09	0.07-0.11	0.09	0.07-0.12
Anemia	0.71	0.50-1.00	0.94	0.62-1.44
Weight loss	0.66	0.46-0.94	0.76	0.49-1.16
History of polyps or cancer	0.84	0.68-1.03	0.65	0.50-0.84
Diverticulosis	2.50	1.17-3.63	2.23	1.41-3.51
Mass	0.76	0.55-1.05	0.66	0.44-0.97
Colitis	0.64	0.44-0.92	0.48	0.30-0.75

Table 4: Variables predicting a worse bowel preparation for a colonoscopy

Variable	Univariable modeling		Multivariable modeling	
	OR	95% CI	OR	95% CI
Age (per year)	1.02	1.01-1.02	1.01	1.00-1.02
Chronic kidney disease	2.34	1.12-4.88	2.00	0.93-4.32
Diabetes mellitus	2.00	1.50-2.68	1.70	1.21-2.39
Hypertension	1.48	1.11-1.97	0.84	0.59-1.20
Anemia	1.81	1.33-2.47	1.43	0.81-2.52
Weight loss	1.41	1.01-1.96	1.42	0.77-2.63
Outpatient setting	0.63	0.54-0.73	0.90	0.67-1.21

Comparison between inpatients and outpatient colonoscopies

Patients who had colonoscopies performed while hospitalized tended to be older when compared to those performed in an ambulatory setting (52.90 vs. 48.94 years of age, *P* value < 0.01), and they had a higher prevalence of hypertension (42.67% vs. 28.01%, *P* value < 0.01), diabetes mellitus (38.33% vs. 24.11%, *P* value < 0.01), and chronic kidney disease (6.00% vs. 1.48%, *P* value < 0.01). The inpatients were less likely to have a prior history of polyps or colorectal cancer (16.99% vs. 21.46%, *P* value < 0.01). The inpatient colonoscopies were more frequently indicated for anemia (9.95% vs. 3.59%, *P* value < 0.01), melena (5.91% vs. 2.18%, *P* value < 0.01), and a positive occult blood stool test (1.24% vs. 0.18%, *P* value < 0.01), while outpatient colonoscopies were indicated for surveillance (19.99% vs. 14.51%, *P* value < 0.01) and constipation (11.99% vs. 8.08%, *P* value < 0.01).

Ambulatory patients had a higher rate of good bowel preparations (67.23% vs. 56.64%, *P* value < 0.01) and a lower rate of poor bowel preparations (18.22% vs. 27.14%, *P* value < 0.01). They also had a higher rate of colonoscopy completion (86.79% vs. 77.59%, *P* value < 0.01) and terminal Ilium intubation (64.35 vs. 56.03, *P* value < 0.01).

There was no difference between the rate of polyps detected between inpatients and outpatients (18.90% vs. 20.83%, *P* value = 0.22), nor was there any difference in the location in which polyps were detected. There was a higher percentage of colonic masses detected in the inpatients (10.29% vs. 3.83%, *P* value < 0.01).

Predictors of colonoscopy completion

The univariabe modeling factors that were associated with a completed colonoscopy were outpatient setting OR 1.52 (95% CI, 1.28 to 1.79), the use of sedation OR 25.00 (95% CI, 11.93 to 52.39), and diverticulosis OR 2.50 (95% CI, 1.17 to 3.36) [Table 3].

While those factors associated with an incomplete colonoscopy included a fair bowel preparation OR 0.44 (95% CI, 0.34 to 0.57), a poor bowel preparation OR 0.09 (95% CI, 0.07 to 0.11), weight loss OR 0.66 (95% CI, 0.46 to 0.94), and colitis OR 0.64 (95% CI, 0.44 to 0.92).

The multivariable modeling factors associated with a completed colonoscopy were the outpatient setting OR 1.34 (95% CI, 1.08 to 1.67), the use of sedation OR 15.84 (95% CI, 6.88 to 36.44), and diverticulosis OR 2.23 (95% CI, 1.41 to 3.51).

While those factors associated with an incomplete colonoscopy included a fair bowel preparation OR 0.51 (95% CI, 0.38 to 0.68), a poor bowel preparation OR 0.09 (95% CI, 0.07 to 0.12), a history of polyps or cancer OR 0.65 (95% CI, 0.50 to 0.84), the finding of a mass OR 0.66 (95% CI, 0.44 to 0.97), and colitis OR 0.48 (95% CI, 0.30 to 0.75).

Predictors of suboptimal bowel preparation

The univariabe modeling factors that are associated with a suboptimal bowel preparation were age OR 1.02 (95% CI, 1.01 to 1.02), chronic kidney disease OR 2.34 (95%CI, 1.12 to 4.88), diabetes mellitus OR 2.00 (95% CI, 1.50 to 2.68), hypertension OR 1.48 (95% CI, 1.11 to 1.97), anemia OR 1.81 (95% CI, 1.33 to 2.47), and weight loss OR 1.41 (95% CI, 1.01 to 1.96). A better bowel preparation was associated with the outpatient setting OR 0.63 (95% CI, 0.54 to 0.73) [Table 4].

The only multivariable modeling factor associated with a suboptimal bowel preparation was diabetes mellitus OR 1.70 (95% CI, 1.21 to 2.39).

DISCUSSION

For a colonoscopy to achieve its intended benefits a high-quality bowel preparation is a necessity. High-quality preparations result in a shorter cecal intubation time,

shorter withdrawal time, better adenoma detection rates, a decrease in repeated procedures, and higher patient satisfaction.[1,7,8] All of these factors should result in an increase in patient throughput in endoscopy units and hopefully costs. Capitalizing on factors that will optimize bowel preparation would be favorable; this is evidenced by the fact that the US multi-society task force on colorectal cancer has devoted a complete document addressing optimal bowel cleansing for colonoscopies.[9]

The preparation for a colonoscopy requires that the patient consume a volume of cleansing material, as well as liquids, that result in frequent washroom visits. This is understandably difficult when a patient is hospitalized and often attached to different monitoring devices, intravenous solutions, and in a crowded emergency department or hospital ward where washroom facilities may be shared or patient access is limited. Also, when a patient is hospitalized for ailments unrelated to the indication for the colonoscopy, yet the procedure is performed out of convenience, it is difficult to obtain an optimum bowel preparation due to the patient's suboptimal health and the difficulties associated with the hospital setting. In such situations, deferring the colonoscopy to a later time when the patient is out of the hospital might be a better option.

Most of the cases that were referred for colonoscopy as inpatients in our study were for gastrointestinal bleeding. We could not characterize the nature of these bleeds whether they were acute lower gastrointestinal bleeds or were more of a low-risk type of bleeds. The number of patients who received a colonoscopy due to a positive fecal occult blood test was low, nonetheless, deferring these until the procedure could be performed in an outpatient setting might be a better option, especially since testing for occult blood during inpatient care has not been proven to impact clinical management.[10]

Numerous bowel preparation scales have been developed. Although the bowel preparation scale that was used in this study was not a standardized one, it resembled the Aronchick Score as our scale used a global quality score for the preparation instead of a five-point scale. We combined both the "excellent" and "good" categories of the Aronchick score into the category "good", while the "poor" and "inadequate" categories were combined into the category "poor". A number of other studies have reported using ordinal scales of bowel preparation quality,[8,11–13] these scales resemble the one we used in this study. More recently, due to its validity and reliability, we adopted the Boston Bowel Preparation Scale.[14] In our study population, the preparation procedure during the study period was a standard PEG solution (Cololyt) that was administered once and this was used in both the inpatients as well as outpatients. We have since adopted a split dose protocol that will hopefully improve bowel preparation quality.[15]

We found that inpatients had a higher rate of poor bowel preparation and a lower rate of colonoscopy completion and terminal ileum intubation. These findings have also been found in other studies.[16] Ness *et al.* found that inpatient status was associated with a poor bowel preparation OR 3.13 (95% CI; 1.15 to 8.50).[17] Another study found that the rate of poor bowel preparation was higher in inpatient colonoscopies (31.1% vs. 8.5%, *P* value = <0.01) and they tended to have incomplete (80.8% vs. 90.0%, *P* value = <0.01) and repeated colonoscopies (19.1% vs. 4.6%, *P* value = <0.01) compared to those performed in an ambulatory setting[1]. A poor bowel preparation has been found to be a predictor of prolonged cecal intubation time (>20 minutes), as well as prolonged insertion time (>10 minutes), a decreased cecal intubation rate, and an incomplete colonoscopy.[4] In our study, multivariable analysis showed that colonoscopies performed in an outpatient setting were a predictor of colonoscopy completion. This would suggest that performing a colonoscopy on an outpatient basis, when feasible, is the preferred strategy. Although this study only looked at completion rates as an endpoint, we speculate that such a strategy would optimize the utilization of healthcare resources as well as costs. In an Italian multicenter study, there was no difference in the colonoscopy preparation quality between the inpatient and outpatient setting. This may have been due to the fact that, in that study, about 48% of the inpatient colonoscopies were performed for screening or surveillance purposes.[18]

Although the colonoscopy completion rates in our study were lower than those that have been advocated by professional societies, the rates do reflect real-life data and are similar to those reported in other studies.[8] The rate of failed procedures found in this study was similar to other studies, ranging from 10% in an outpatient setting to 19.2% for hospitalized patients.[1] We speculate that the outpatient colonoscopy failures might be the result of the patient receiving an inadequate explanation of the preparation process, possibly due to overreliance on written patient instructions.[19] Furthermore, we only started using a split bowel preparation protocol recently.

We also found that diabetes was a predictor of poor bowel preparation quality; a result that has been observed in other

studies,[18,20] whether this is a true predictor of a poor bowel preparation quality or a marker of overall co-morbidity is not clear, also whether autonomic dysfunction would play a role in this finding via affecting bowel motility is a possibility but to draw such a conclusion from this study would be premature as we do not have details about the duration of diabetes, nor the medications used or the adequacy of glycemic control. Other investigators found that predictors of a good bowel preparation were adherence to the preparation instructions, and the use of sodium phosphate preparations.[1]

Interestingly, similar to previous work, we did not find any difference in the polyp detection rates between inpatients and outpatients despite the differences in bowel preparation quality.[1] This might be explained by the fact that the comparison between outpatients and inpatients was not powered enough to detect a difference. A meta-analysis comparing the adenoma detection rates between high-quality and intermediate-quality bowel preparations found no difference in the detection of adenomas OR 0.94 (95% CI; 0.80 to 1.10).[7] A difference was found between those with a low-quality bowel preparation and the others groups.

One of the limitations of our study is that we could not discern whether the incomplete colonoscopies were related to the endoscopists willingly ending the procedures and rescheduling the patients for a repeat procedure, due to the belief that completing the procedure with the current bowel preparation quality would be futile, or due to prolonged insertion times and forgoing the colonoscopy. In either case, the end result is in conjunction with the recommendations of the US multi-society task force which states that "if the indication is screening or surveillance and the preparation clearly is inadequate to allow polyp detection greater than 5 mm, the procedure should be either terminated and rescheduled or an attempt should be made at additional bowel cleansing strategies that can be delivered without cancelling the procedure that day."[9] Also, this study depended on the information that was documented in the endoscopy reports, for example we could not quantify the amount of weight loss when it was recorded as an indication. These have been found to frequently have missing or incomplete data that might introduce some bias.[12] Nevertheless, the documentation did reflect routine daily practice. Other limitations include variables that we could not account for e.g., incomplete purge intake and a long runway time,[18] BMI, or if the patients had a physical disability or were bedbound which would affect the quality of the bowel preparation. Also, controlling for the variability between the endoscopists would have been of value. Unfortunately those details were not obtained.

In conclusion, this study demonstrates that bowel preparation quality is affected by the setting. This suggests that, when appropriate, colonoscopies should be performed on an outpatient basis. Nonetheless, there remain numerous factors that were not accounted for in this study that should be explored in further research.

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Conflicts of interest

There are no conflicts of interest.

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