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Medical and social risk factors for inadequate bowel preparation prior to colonoscopy

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Abbreviations: CRC: Colorectal Cancer; TCA: Tricyclic Antidepressant; BMI: Body Mass Index

Introduction

Colorectal Cancer (CRC) is the third leading cause of death for both men and women in the United States in 2021 [1]. The incidence of CRC in younger adults, age 40-49, has increased from the early 2000s to 2014-16 [2]. This trend prompted the U.S. Preventive Services Task Force to lower the recommended starting age of screening colonoscopies from 50 to 45 years in all average risk individuals. It remains critically important that appropriate screening takes place as incidence rises in a young-

Abstract

Introduction: Screening colonoscopies have been shown to reduce Colorectal Cancer (CRC) incidence and mortality but can be hindered by inadequate bowel preparation. The aim of this study is to identify medical and social risk factors for inadequate bowel preparation prior to colonoscopy.

Methods: The study was a retrospective cohort study reviewing risk factors in patients with inadequate bowel preparation noted during colonoscopy compared to a control group of patients with adequate bowel preparation over a period of 3 years. A Boston Bowel Preparation Scale was used with score of <6 (inadequate preparation) and >6 (adequate preparation).

Discussion: Statistical analysis of our cohort revealed diabetes, constipation, cirrhosis, history of stroke, TCA use, opioid use, smoking status, decreased mobility, white race, Medicaid insurance coverage, Medicare insurance coverage, and no insurance coverage as risk factors for inadequate bowel preparation.

Conclusions: Identifying the medical and social risk factors for inadequate bowel preparation in a patient prior to colonoscopy may lead to individualized bowel preparation plans. Type of preparation and length of time needed to achieve adequate bowel preparation could be reconsidered. With adequate planning, patients with these risk factors may have decreased aborted colonoscopy rates and thus lower CRC incidence and mortality that comes with regular screening.

er subset of patients. This has been shown to add 27 mean-life years per 1000 patients [2]. Colonoscopies have been proven to reduce CRC mortality [2,3]. However, the efficacy of colonoscopies can be hindered by inadequate bowel preparation. Successful screening colonoscopies are dependent on the quality of bowel preparation. Lack of appropriate bowel preparation leads to poor visualization by clinicians, leading to a higher likelihood of missing high-risk polyps and other colonic lesions, including CRC. There have been numerous independent risk factors

that have been shown to be associated with poor colonoscopy preparation such as increased age, male sex, inpatient status, diabetes mellitus, hypertension, cirrhosis, constipation, stoke, Tricyclic Antidepressant (TCA) and narcotic use [4]. The mechanisms of these risk factors vary but likely include patients that are generally more sick, noncompliant, and have comorbidities and medication use that decrease colonic transit time [4]. This retrospective study aims to identify medical and social factors contributing to inadequate bowel preparation in colonoscopies performed at our institution over the past 3 years.

Materials and methods

The study was a retrospective single-center cohort study reviewing risk factors in patients with inadequate bowel preparation noted during colonoscopy compared to a control group of patients with adequate bowel preparation over a period of 3 years. The Boston Bowel Preparation Scale, a previously validated and reliable measure of bowel preparation [5], was used with score of <6 (inadequate preparation) and ≥6 (adequate

preparation). This study specifically examined possible risk factors for poor colonoscopy preparation including diabetes mellitus, hypertension, cirrhosis, constipation, prior history of stroke, TCA use, opioid use, smoking status, mobility status, alcohol use, age, gender, and BMI. Mobility status was determined by obtaining Braden fall risk scores on each patient prior to colonoscopy. Decreased mobility was documented if patient did not report walking frequently. Race and socioeconomic status were also examined as risk factors for inadequate bowel preparation. Socioeconomic status was evaluated through insurance status by categorizing patients into groups including no insurance coverage, Medicaid coverage, Medicare coverage, and private insurance coverage. Poorly prepped colonoscopies from the year 2018-2020 were compared to well-prepped colonoscopies from the year 2019. A total of 980 colonoscopies (293 poor-prepped and 687 well-prepped) were identified and medical and social risk factors for poor bowel preparation were evaluated. Results were analyzed using Fisher's exact test or Chi square tests, and the tests with P-values <.05 were determined to be statistically significant.

Table 1: Medical and social risk factor analysis for inadequate bowel preparation for all enrolled patients.

Risk Factors	Category	Total N	Poor-Prepped N (%)	Well-Prepped N (%)	P-value
	Sample Size	980	293	687	
Diabetes	No	681	179 (26.3%)	502 (73.7%)	<0.001
	Yes	299	114 (38.1%)	185 (61.9%)	
Hypertension	No	352	102 (29.0%)	250 (71.0%)	0.6902
	Yes	628	191 (30.4%)	437 (69.6%)	
Cirrhosis	No	918	261 (28.4%)	657 (71.6%)	<0.001
	Yes	62	32 (51.6%)	30 (48.4%)	
Constipation	No	895	253 (28.3%)	642 (71.7%)	<0.001
	Yes	85	40 (47.1%)	45 (52.9%)	
History of Stroke	No	903	261 (28.9%)	642 (71.1%)	0.0279
	Yes	77	32 (41.6%)	45 (58.4%)	
TCA Use	No	941	271 (28.8%)	670 (71.2%)	<0.001
	Yes	39	22 (56.4%)	17 (43.6%)	
Opioid Use	No	830	231 (27.8%)	599 (72.2%)	0.0012
	Yes	150	62 (41.3%)	88 (58.7%)	
Race	Black	347	114 (32.9%)	233 (67.1%)	<0.001
	White	497	173 (34.8%)	324 (65.2%)	
	Other	136	6 (4.4%)	130 (95.6%)	
Black	Yes	347	114 (32.9%)	233 (67.1%)	0.1547
	No	633	179 (28.3%)	454 (71.7%)	
White	Yes	497	173 (34.8%)	324 (65.2%)	<0.001
	No	483	120 (24.8%)	363 (75.2%)	
Insurance Coverage	Medicaid	205	83 (40.5%)	122 (59.5%)	<0.001
	Medicare	314	121 (38.5%)	193 (61.5%)	
	No Insurance	205	23 (11.2%)	182 (88.8%)	
	Private	256	66 (25.8%)	190 (74.2%)	

Medicaid	Yes	205	83 (40.5%)	122 (59.5%)	<0.001
	No	775	210 (27.1%)	565 (72.9%)	
Medicare	Yes	314	121 (38.5%)	193 (61.5%)	<0.001
	No	666	172 (25.8%)	494 (74.2%)	
Insurance	Yes	205	23 (11.2%)	182 (88.8%)	<0.001
	No	775	270 (34.8%)	505 (65.2%)	
Private Insurance	Yes	256	66 (25.8%)	190 (74.2%)	0.1108
	No	724	227 (31.4%)	497 (68.6%)	
Age	≤20	2	0 (0.0%)	2 (100.0%)	0.6288
	20-39	71	21 (29.6%)	50 (70.4%)	
	40-59	475	136 (28.6%)	339 (71.4%)	
	≥ 60	432	136 (31.5%)	296 (68.5%)	
Gender	Female	498	151 (30.3%)	347 (69.7%)	0.8224
	Male	482	142 (29.5%)	340 (70.5%)	
BMI	≤25	225	74 (32.9%)	151 (67.1%)	0.3475
	25-30	272	84 (30.9%)	188 (69.1%)	
	30-40	320	84 (26.3%)	236 (73.8%)	
	≥40	154	43 (27.9%)	111 (72.1%)	
Smoking	Current	297	101 (34.0%)	196 (66.0%)	0.0134
	Former	297	97 (32.7%)	200 (67.3%)	
	Never	386	95 (24.6%)	291 (75.4%)	
Alcohol Use	No	556	167 (30.0%)	389 (70.0%)	0.97
	Yes	424	126 (29.7%)	298 (70.3%)	
Mobility Status	Decreased	259	112 (43.2%)	147 (56.8%)	<0.001
	Walks Frequently	721	181 (25.1%)	540 (74.9%)	

A p-value of <0.05 in Table 1 indicates statistical significance.

Table 2: Results from logistic regression model with model selection procedure.

	Odds Ratio (95% CI)	P-value
(Intercept)	1.59 (0.99, 2.56)	0.0548
Diabetes Yes (Reference: No Diabetes)	0.61 (0.44, 0.83)	0.002
Cirrhosis: Yes (Reference: No Cirrhosis)	0.57 (0.32, 0.99)	0.0457
Constipation: Yes (Reference: No Constipation)	0.48 (0.3, 0.79)	0.0033
TCA use: Yes (Reference: No TCA use)	0.42 (0.21, 0.83)	0.0123
History of Stroke: Yes (Reference: No History)	0.82 (0.49, 1.4)	0.4624
Opioid Use: Yes (Reference: No Opioid Use)	0.73 (0.5, 1.09)	0.1199
Race: White (Reference: Non-White)	0.65 (0.47, 0.88)	0.0062
Insurance: Medicare (Reference: Medicaid)	1.32 (0.89, 1.96)	0.1666
No Insurance (Reference: Medicaid)	4.32 (2.56, 7.52)	<0.001
Private Insurance (Reference: Medicaid)	1.72 (1.12, 2.65)	0.0129
Smoking: Former (Reference: Current Smoking Status)	1.05 (0.72, 1.52)	0.8015
Smoking: Never (Reference: Current Smoking Status)	1.37 (0.94, 1.98)	0.0969
Mobility Status: Walks frequently (Reference: Decreased Mobility)	1.77 (1.28, 2.46)	<0.001

A p-value of <0.05 in Table 2 indicates statistical significance.

Results

Initial analysis of risk factors for patients undergoing colonoscopy was completed using Fisher's exact test and/or Chi-square tests. The results of this initial analysis are presented in Table 1. Presence of diabetes, constipation, cirrhosis, history of stroke, TCA use, opioid use, smoking status, and decreased mobility were found to be statistically significant (p value $<.05$) medical risk factors for inadequate bowel preparation. Statistically significant social risk factors for inadequate bowel preparation included white race, Medicaid insurance coverage, Medicare insurance coverage, and no insurance coverage.

These statistically significant risk factors were then analyzed using a multiple logistic regression model with model selection procedure, and a final parsimonious model is presented in Table 2. Results revealed diabetes decreased the odds of getting a well-prepped colonoscopy by 39% (OR: 0.61, 95%CI [0.44, 0.83]). Cirrhosis decreased the odds of completing a well-prepped colonoscopy by 43% (OR: 0.57, 95%CI [0.32, 0.99]). Constipation decreased the odds of completing a well-prepped colonoscopy by 52% (OR: 0.48, 95%CI [0.30, 0.79]). TCA use decreased the odds of completing a well-prepped colonoscopy by 58% (OR: 0.42, 95%CI [0.21, 0.83]). Patients with normal mobility status (walked frequently) were more likely to be well-prepped than those patients with decreased mobility (OR: 1.77, 95%CI [1.28, 2.46]). When this data was analyzed using a logistic regression model, there was not a statistically significant difference for odds of adequate bowel preparation for patients with history of stroke or opioid use in this population. There was additionally no statistically significant difference in odds of adequate bowel preparation in patients who formerly smoked or never smoked compared to current smokers.

Patients with no insurance were more likely to be well-prepped than those patients with Medicaid insurance (OR: 4.32, 95%CI [2.56, 7.52]). Patients with private insurance were more likely to be well-prepped than those patients with Medicaid insurance (OR: 1.72, 95%CI [1.12, 2.65]). When this data was analyzed using a logistic regression model, there was not a statistically significant difference for odds of adequate bowel preparation for patients with Medicare compared to Medicaid coverage in this population. Logistic regression analysis also revealed patients of white race had statistically significant decreased odds of adequate bowel preparation (OR: 0.65, 95%CI [0.47, 0.88]).

Discussion

Adequate bowel preparation is particularly vital in colonoscopies that require unimpeded inspection of the bowel wall for thorough examination. We analyzed potential determinants of bowel preparation quality in patients who underwent colonoscopies at our institution to determine which medical and socioeconomic risk factors may predispose patients to inadequate bowel preparation. The results showed diabetes, constipation, TCA use, opioid use, decreased mobility, history of stroke, cirrhosis, and smoking status were all medical risk factors for poor bowel preparation in colonoscopies performed at our institution (Table 1). The mechanisms through which these medical conditions hinder bowel preparation are varied.

Diabetes is a likely a risk factor for inadequate bowel preparation due to decreasing gastrointestinal tract transit time and slowing down gastric emptying [6]. These patients are also more inclined to develop gastroparesis which may not allow

them to adhere to the full volume of bowel preparation. Constipation may logically adversely affect bowel preparation, and it has indeed been shown that as the number of daily reported bowel movements increase, the quality of colonoscopy bowel preparation also increases [7]. It is well known that certain medications can induce constipation and slow overall colonic transit time. Other studies have previously investigated the impact of numerous medications on the quality of bowel preparation prior to colonoscopy and support the finding that both the use of tricyclic antidepressants and opioids decrease the quality of preparation. Of note, these studies have taken analyses one step further and revealed a dose-dependent association of opioid use and the decreased quality of colonoscopy preparation. It was additionally noted that the use of psychoactive drugs such as TCAs in combination with opioids potentiate the decrease in bowel preparation quality [8]. The effect of various levels of patient mobility on quality of colonoscopy preparation has been largely unstudied. However, there is a significantly higher rate of inadequate bowel preparation for patients with spinal cord injuries and disorders undergoing screening colonoscopies, supporting our findings that decreased mobility may lead to an increased risk of poor bowel preparation [9]. The presence of prior stroke has been identified as a risk factor for poor bowel preparation prior to colonoscopy in other large-scale studies [4] and may be related to decreased mobility as well.

Cirrhotic patients have also been shown in other studies to have significantly worse bowel preparation compared to non-cirrhotics [10]. However, the severity of cirrhosis, as assessed by MELD score, did not predict worse bowel preparation in these studies. The suggested mechanism for this phenomenon is intestinal dysmotility and dysbiosis seen in cirrhotic patients. Although alcohol use was not found to be a risk factor for inadequate bowel preparation in our study, tobacco use was. Tobacco use has been noted to be a risk factor for poor bowel preparation in other studies but the mechanism for this phenomenon is again likely multifactorial [11]. Effects of nicotine in the gastrointestinal tract include damage to the mucosal integrity of the bowel wall and changes in the mucus and microbiota of the bowel lumen [12].

Possible social risk factors for inadequate bowel preparation were also analyzed in the patients undergoing colonoscopies at our institution. Patients with no medical insurance and private medical insurance had higher odds of adequate bowel preparation in comparison to Medicaid patients. There was not a statistically significant difference in odds of an adequately prepared colonoscopy between patients with Medicaid and Medicare insurance coverage. It was found that white race was a statistically significant social risk factor for poor bowel preparation compared to non-white race patients. A clear understanding of why has yet to be determined. While race did play a role in achieving adequate bowel preparation in our study, age, sex, and body mass index (BMI) were not determined to be statistically significant risk factors for poor bowel preparation. Additional studies have similarly shown that increased BMI is not predictive of inadequate bowel preparation [13]. However, age and male sex have been reported to be risk factors for poor bowel preparation in other studies [4].

Our analysis of socioeconomic factors effecting adequate bowel preparation is consistent with previous overarching studies that have shown individuals with public insurance (Medicare or Medicaid) report significantly worse health and increased number of chronic conditions compared to privately insured

and uninsured patients [14]. However, it is worth noting that one of the limitations of our study may be that insurance coverage is not the best proxy for socioeconomic status. Patients may have individualized reasons for carrying no insurance or for having private insurance when they could have qualified for public insurance coverage (i.e., Medicaid and Medicare). It is also common for many individuals to switch to Medicare insurance at age 65 despite their income, prior financial standing, or current socioeconomic status. Therefore, future studies may focus on current patient income when evaluating the effect of socioeconomic status on endoscopic procedure outcomes.

Conclusion

It is important to consider medical and social risk factors that may lead to poor bowel preparation prior to determining type of bowel preparation and length of time needed to achieve adequate bowel preparation. In patients with identified risk factors for inadequate preparation, an individualized plan may need to be arranged. With adequate planning, patients with these risk factors may have decreased aborted colonoscopies and thus lower rates of CRC incidence and mortality that comes with regular screening. Future prospective studies will be needed to address how to best alter bowel regimens for patients with risk factors for poor bowel preparation.

Declarations

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