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Risk Factors for Early Colonoscopic Perforation Include Non-Gastroenterologist Endoscopists: a Multivariable Analysis

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Abstract

Background & Aims—Bowel perforation is a rare but serious complication of colonoscopy. Its prevalence is increasing with the rapidly growing volume of procedures performed. Although colonoscopies have been performed for decades, the risk factors for perforation are not completely understood. We investigated risk factors for perforation during colonoscopy, assessing variables that included sedation type and endoscopist specialty and level of training.

Methods—We performed a retrospective multivariate analysis of risk factors for early perforation (occurring at any point during the colonoscopy but recognized during or immediately after the procedure) in adult patients using the Clinical Outcomes Research Initiative National Endoscopic Database. Risk factors were determined from published articles. Additional variables assessed included endoscopist specialty and years of experience, trainee involvement, and sedation with propofol.

Results—We identified 192 perforation events during 1,144,900 colonoscopies from 85 centers entered into the database from January 2000 through March 2011. On multivariate analysis, increasing age, American Society of Anesthesia class, female sex, hospital setting, any therapy,

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and polyps >10 mm were significantly associated with increased risk of early perforation. Colonoscopies performed by surgeons and endoscopists of unknown specialty had higher rates of perforation than those performed by gastroenterologists (odds ratio, 2.00; 95% confidence interval, 1.30–3.08). Propofol sedation did not significantly affect risk for perforation.

Conclusions—In addition to previously established risk factors, non-gastroenterologist specialty was found to affect risk for perforations detected during or immediately after colonoscopy. This finding could result from differences in volume and style of endoscopy training. Further investigation into these observed associations is warranted.

Keywords

ASA classification; GI; intestine; quality control; endoscopy training

Introduction

Colonoscopy is a common and safe procedure with a variety of diagnostic and therapeutic applications. Although it remains rare, the most serious and feared complication is bowel perforation. Data series of procedures performed since 1990 place the current worldwide incidence of perforation at 0.07% (1 in 1428) for all colonoscopies and 0.1% for therapeutic colonoscopies (1). Despite improvements in technology and perceived advances in techniques, the incidence of perforation has not changed significantly over time (2, 3). Therefore, although the overall perforation rate remains low, the prevalence of colonoscopy-related perforations is rising as growing demand fuels a rapidly increasing volume of procedures. With the intensification of colorectal cancer screening programs, in which colonoscopy plays a central role, this translates to an increasing number of healthy, asymptomatic individuals being exposed to a procedure with risk of serious harm.

Various risk factors for colonoscopic perforation have been identified. Patient-related factors include advanced age, female gender, multiple comorbidities, and need for therapeutic intervention (1). Once perforation occurs, the management is usually surgical (4). Outcomes after colonoscopic perforation vary but serious sequelae including perioperative complications and death are not infrequent (3, 5). Colonoscopy-related perforation thus has the potential to become an increasingly common cause of preventable morbidity and mortality.

In this era of quality control, much attention has been paid to factors that improve polyp detection and cancer prevention in colonoscopy (6). However, little is known about modifiable factors for colonoscopic perforation risk, namely endoscopist and procedural aspects. While it has been suggested that low-volume endoscopists have more complications such as perforation and bleeding, this has received little attention (7, 8). A difference in complications between endoscopists from different specialties has never been conclusively demonstrated but it has recently been shown that non-gastroenterologist endoscopists have higher rates of missed interval cancers, which suggests a quality gap (9–11). Given growing pressure to recruit more non-GI endoscopists to meet the demand needs for colonoscopy, this question warrants some attention.

An additional question relates to the effect of sedation on performance of colonoscopy. While colonoscopy has traditionally been performed under conscious sedation, typically using a combination of narcotic and benzodiazepine (12), there has recently been a trend toward propofol use (13). Propofol is usually intended to achieve conscious sedation but frequently results in deep sedation instead (14). The benefit of propofol is faster initiation of sedation and quicker recovery, which is hoped to facilitate a higher rate of turnover in the endoscopy unit and thus improve efficiency (13, 15). However, many authors have speculated that propofol sedation has the potential to increase perforation risk (12, 16-18) as deeply sedated patients cannot report discomfort and are difficult to reposition, which may encourage forceful and suboptimal colonoscopy technique. A handful of small studies has shown a nonsignificant trend toward more perforations with propofol use (18, 19). While a recent study of anaesthesia assistance in colonoscopy found increased complications in the deep sedation cohort, this was largely driven by higher rates of aspiration (20).

The purpose of this study was to investigate risk factors for early bowel perforation in colonoscopy, with a special focus on the impact of endoscopist specialty and training as well as the effect of propofol compared with traditional sedation regimens.

Study Design, Methodology & Analysis

Database

This study analyzed prospectively collected data from the Clinical Outcomes Research Initiative (CORI) National Endoscopic Database, a large North American database consisting of diverse practice types. Participating physicians are provided with an electronic health record that is completed at the time of endoscopy and generates procedure reports used for recordkeeping as part of the official medical record. Users are required to document at least 95% of procedures in CORI. Once signed off, these reports cannot be altered. A limited data set from every report is electronically sent to CORI where it is quality tested and then pooled in a central database. Data is collected and stored according to stringent security and health information privacy standards. Over the course of this study, 125 sites from 85 participating practice locations in the United States contributed procedure reports to the database, including 104 community or Health Maintenance Organization (HMO) sites, 11 academic centers, and 10 Veterans Affairs (VA)/military centers. Not all endoscopy providers at each site use CORI. These locations were distributed among the 6 regions of the United States: Northeast (14.6%), Southeast (16.4%), North Central (9.8%), South Central (11.5%), Northwest (12.6%), Southwest (35.1%).

Study Cohort & Design

Using the CORI database, we performed a retrospective analysis of risk factors for early bowel perforation in colonoscopy. We included all complete and incomplete colonoscopies. Flexible sigmoidoscopies were excluded. Only colonoscopies involving patients over 18 years of age entered into the database from the year 2000 up to the study period were included. We excluded procedures performed by Pediatric Gastroenterologists. Because the CORI database contains information generated at the time of endoscopy with no data on delayed complications, we examined only early perforations - those recognized during or

immediately after the procedure. In this study, the term “early perforation” refers to a perforation discovered before the procedure report is signed off at the end of the colonoscopy. Early perforations are known to make up approximately one quarter of all perforation events (1). Information on perforation type and outcomes following perforation was not available.

Data collected included patient age, sex, American Society of Anesthesia (ASA) class, indication for procedure (screening and surveillance versus symptomatic), presence of diverticulosis, established or suspected inflammatory bowel disease (IBD), any therapy (argon plasma coagulation, bipolar electrocoagulation, banding, botox, clips, dilation, heater probe, injection, laser, stent, other), right sided polyp, polyp size and number, quality of bowel preparation, use of propofol, endoscopist years of experience, endoscopist specialty (Gastroenterology, Surgery, Primary Care, Subspecialist), site type and trainee involvement. Inflammatory bowel disease was divided into two variables -established IBD and all IBD, which included both established and suspected IBD cases. With regards to endoscopist specialty, the category of Subspecialist included pulmonologists, radiologists, preventive medicine specialists and obstetrician-gynecologists. Endoscopists whose specialty could not be determined were categorized as having unknown specialty.

This study received approval from the Queen's University Health Sciences and Affiliated Hospitals Research Ethics Board.

Statistical Analysis

Univariate analysis was used to examine the risk of colonoscopic perforation associated with each exposure variable. Continuous variables were described as means and standard deviations and compared by the independent t-test. Categorical variables were described as counts and percentages and compared by the Chi-Squared test unless 25% of the cells had expected counts of less than 5, in which case Fisher's exact test was employed. Odds ratios (OR) and 95% confidence intervals for the relationship between perforation and exposure variables were calculated using logistic regression analysis. All covariates with a univariate p -value < 0.3 were considered for inclusion in the multivariate model. Stepwise backward elimination was used to remove covariates with a Wald test p -value > 0.2 . The Hosmer-Lemeshow Goodness-of-Fit Test was employed to ensure adequate fit of the model. All statistical analyses were performed using Version 9.2 of SAS software (SAS Inc., Cary, NC, USA).

Results

Between January 2000 and March 2011, 192 perforation events were recorded in 1,144,900 adult colonoscopies entered into the CORI database, corresponding to an early perforation rate of 0.017% or 1 in 5882 procedures. Characteristics of the study patients along with the incidence of early colonoscopy-related perforation and univariate analysis appear in Table 1.

On univariate analysis, significantly higher rates of early perforation were observed with increasing patient age and ASA Class, as well as in hospital versus community sites. Patients with any therapeutic intervention and polyp size greater than 10mm also had

increased early perforation rates. There was a significantly greater rate of perforation in procedures involving trainees and compared to gastroenterologists, those performed by surgeons and endoscopists with unknown specialty. More early perforations were observed in female than male patients as well as in those with suspected or established IBD, but these did not meet statistical significance. Patients with diverticulosis, right sided polyps and those receiving propofol did not display increased rates of early perforation. Endoscopist years of experience were not associated with change in perforation rate.

For the purpose of the multivariate analysis, diverticulosis and right sided polyps were excluded due to non-significance, while endoscopist experience was excluded due to excess missing variables. Of the two IBD variables, only established IBD was included due to collinearity with the “any IBD” variable. Because the Subspecialist group was very small (n = 22) and lacked perforations, it was excluded from the multivariate analysis. 437 procedures (0.04%) had to be excluded due to missing values, all non-perforation cases. This left 1,144,443 cases for analysis. Results of the multivariate analysis appear in Table 2.

On multivariable analysis, the relationship between increasing age and corresponding increase in early perforation risk remained. Patients aged 60-74 years had an OR of 2.69 (95% CI, 1.83 - 3.98) and those 75 years and older had an OR of 5.63 (95% CI, 3.73 -8.49) toward increased early perforation compared with those aged 60 years and younger. Increasing ASA class was also associated with increasing early perforation risk, with patients in ASA Class III and above having greatest risk. Female gender was also a significant independent risk factor (OR 2.00).

Any therapy (OR 3.93) and large polyp size (OR 4.14) were highly significant risk factors for early perforation. After adjusting for other covariates, significantly increased early perforation risk persisted for procedures performed by surgeons (OR 2.00 [95% CI, 1.30 - 3.08]) and endoscopists of unknown specialty (OR 2.00 [95% CI, 1.30 – 3.08]) compared with gastroenterologists. Trainee participation was no longer associated with early perforation on multivariate analysis, its effect abolished by controlling for site type. Meanwhile, procedures performed outside of a community setting remained significantly associated with increased early perforation risk after adjusting for the other covariates (OR for University hospitals 2.83 [95% CI, 1.85 - 4.31], OR for VA hospitals 3.74 [95% CI, 2.37 – 5.89]). There was a strong but nonsignificant trend toward more early perforations with presence of established IBD (OR 1.97 [95% CI, 0.92 – 4.20]). Increasing polyp number was associated with significant reduction in early perforation risk (OR 0.68). Propofol as sedation remained nonsignificant.

To control for possible subtle differences among patients not discerned when adjusting for the study variables, such as co-morbidities that may not be captured by the ASA classification, we performed a sub-analysis of colonoscopies for which the indication was screening or surveillance, presumably a healthier population. There were 544,474 screening and surveillance colonoscopies with 62 perforation events in this cohort (see Table 3). In the screening and surveillance colonoscopy cohort, adjusting for the study variables, procedures done by surgeons (OR 2.72 [95% CI, 1.19 – 6.18]) retained a statistically significant increased early perforation risk. VA/Military but not University hospitals being the site of

procedure remained significantly associated with increased early perforation risk. The effects of age, gender, large polyps and increasing ASA Class also persisted in the screening and surveillance cohort.

One of our primary variables of interest was the use of propofol. There were 78,575 patients who received propofol, with 11 perforation events in that group (see Table 4). Propofol use was proportionally greater among non-gastroenterologist endoscopists and those with fewer years of experience. Propofol was not associated with a significant change in risk of early colonoscopy-related perforation on univariate or multivariate analysis.

Discussion

Previous studies of perforation risk factors in colonoscopy have suggested that gastroenterologists may cause fewer perforations than surgeon endoscopists, but these differences were never shown to be significant (2, 21). The current study revealed significantly increased early perforation risk in colonoscopies performed by surgeon endoscopists when controlling for other variables. This suggests there is a difference in quality between procedures performed by gastroenterologists and non-gastroenterologist endoscopists. This is consistent with emerging literature showing higher rates of interval cancers in cases where colonoscopy is performed by a non-gastroenterologist (9-11). Possible explanations for these discrepancies include differences in endoscopy style, training and volume of procedures. This is a critical area in need of further research.

While we do not have the training records of the endoscopists in the present study, differences in volume and intensity of endoscopy training of gastroenterology and surgical trainees are widely described in the literature (10, 22-25). The argument in favour of these differences has been that surgical trainees are more procedurally inclined and thus require less time and practice to achieve competence in endoscopy (23, 26). However, a study looking into speed of acquisition of endoscopy skills found no difference between gastroenterology fellows and surgical residents (27). While gastroenterology trainees undergo rigorous instruction in colonoscopy at the start of their training and are exposed to procedures throughout their fellowship, colonoscopy teaching in surgical programs appears to be more variable (22, 24). Minimum procedural requirements, as set out by the Accreditation Council for Graduate Medical Education (ACGME), also differ for surgical residents compared with gastroenterology fellows (50 vs 140 supervised colonoscopies) (24). A study comparing colonoscopy training of surgical residents to that of gastroenterology fellows found a wide gap between procedure volumes, with gastroenterology fellows completing almost three times more colonoscopies than their surgical colleagues, who on average performed fewer than 100 colonoscopies during their training (22). However, even when controlling for volume of previous procedural experience, the performance of surgical trainees was shown in a recent study to be inferior to that of their gastroenterology counterparts based on a variety of quality indicators including adenoma detection and procedure completion (25). A difference in training may thus partially explain the present study findings.

Some authors have argued that colonoscopy in the elderly carries no increased procedural risks (28). The present study showed patients aged 75 and over to have over five times the early perforation risk of their 60 and younger counterparts when adjusting for other variables. We also found that those in ASA Class III had more than double the early perforation risk compared to those with no comorbidities, while those in Class IV and V had over seven fold the risk of perforation. Recent large series on patient outcomes after colonoscopy-related perforation suggest high perioperative morbidity and mortality rates, ranging from 39% to 49%, and 8% to 25% respectively (3, 5). Risk factors for postoperative morbidity include older age and previous hospitalization (29, 30). Given colonoscopy is already more risky in these subgroups and these patients also have reduced ability to tolerate abdominal sepsis and are at higher operative risk, the outcomes can be quite poor, with greater morbidity and mortality as well as increased frequency of diversion procedures that have a low reversal rate (29).

It has been suggested that propofol sedation may increase the risk of bowel perforation in colonoscopy by encouraging suboptimal technique (12, 16-18). In our study population, propofol use was not found to be associated with increased early perforation risk. The applicability of this study toward current use of propofol in colonoscopy, especially in the hands of less experienced endoscopists, is uncertain given the tendency for high quality centers with highly experienced endoscopists to participate in this database and a changing approach to propofol use.

There are several limitations to our study. While underreporting of complications is possible, the current study found an early perforation rate of 0.017%. Allowing that one quarter of perforations are recognized at the time of endoscopy (1), this translates to an estimated total perforation rate in this dataset of 0.067%. This is consistent with the currently accepted overall colonoscopic perforation rate of 0.07% and thus argues against underreporting (1). A second limitation is the possibility of unmeasured confounders, such as differences in patient risk not captured by the study variables; however, we were able to demonstrate the same risk factors in a screening and surveillance cohort, which is presumably a lower risk population. Another possible limitation is the generalizability of our findings to the US population. However, this dataset came from a wide variety of practice types and locations in all the regions of the US. A recent study comparing demographics of CORI patients above the age of 65 with Medicare claims data found that CORI was representative of the American over 65 population (the under 65 population was not studied) (31).

The chief limitation is that we were only able to examine early perforations, which are those recognized at the time of endoscopy and estimated to make up one quarter of all perforation events.. The external validity of this study is supported by the fact that previously known risk factors for perforation were shown to be significant in this data set. Although our study only examined early perforations, there are important differences between early and late perforations. Perforations that present immediately tend to be created by mechanical injury during diagnostic colonoscopy and create larger defects, while those with delayed presentations are more likely to be smaller and associated with therapeutics (1). Because immediately recognized perforations are larger, urgent operative intervention is required in

all but very select cases (5, 29, 32). Although smaller perforations recognized at endoscopy can sometimes be treated with endoscopic clipping, this is not feasible outside of experienced centers, which represent an overwhelming minority of colonoscopy providers. While no outcomes difference has been demonstrated following early versus late-recognized perforation, larger perforations are significantly associated with increased postoperative morbidity (30). Furthermore, some events categorized as late perforations actually represent post-polypectomy syndrome, which is treated conservatively (1). Increasingly, a watch and wait strategy is also being employed in select cases of small, late perforations (1). It may thus be argued that although the current study is limited to early perforation events, these events are disproportionately more serious.

In summary, this was the largest study to date examining predictors of early perforation in colonoscopy. In accordance with previous literature we demonstrated increased risk of colonoscopy-related perforation with increasing age, increasing comorbidity burden, female gender, therapeutics and larger polyps. While many of these cannot be altered, it is important to be vigilant in the face of these risk factors and employ a greater degree of caution when proceeding with colonoscopy in these settings. Consent may also need to evolve to become stratified.

This study did demonstrate that performance of colonoscopy by surgeons and endoscopists of unknown specialty were independent risk factors for early colonoscopy-related perforation. This relationship has not been previously demonstrated at the level of statistical significance and warrants further investigation. It is perhaps time to reassess training in endoscopy for all specialties, with a standardized competency-based curriculum that includes high quality, closely supervised teaching with assessment of changes in quality that may result from this.

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Table 1
Characteristics of study population based on presence of variables of interest and incidence of early colonoscopy-related perforation including results of univariate analysis

Variable	Perforation		Univariate Logistic Regression Results		
	No N = 1,144,708	Yes N = 192	OR	95% CI	p-value
Age, No. (%)					
< 60 years	566913 (49.5)	39 (20.3)	Reference		
60 - 74 yrs	426222 (37.2)	83 (43.2)	2.83	1.94 - 4.14	<0.0001
>= 75 yrs	151140 (13.2)	70 (36.5)	6.73	4.55 - 9.96	<0.0001
Unknown	433 (0.04)	0 (0.0)	N/A	N/A	N/A
Gender, No. (%)					
Male	596220 (52.1)	89 (46.4)	Reference		
Female	548484 (47.9)	103 (53.7)	1.26	0.95 - 1.67	0.11
Unknown	4 (0.0)	0 (0.0)	N/A	N/A	N/A
ASA Class, No. (%)					
I	283808 (24.8)	24 (12.5)	Reference		
II	714170 (62.4)	114 (59.4)	1.89	1.22 - 2.93	0.005
III	75558 (6.6)	34 (17.7)	5.32	3.16 - 8.97	<0.0001
IV/V	1997 (0.17)	4 (2.1)	23.70	8.22 - 68.35	<0.0001
Unknown	69175 (6.0)	16 (8.3)	2.74	1.45 - 5.15	0.002
Site Type, No. (%)					
Community/HMO	904014 (79.0)	109 (56.8)	Reference		
University	95466 (8.3)	34 (17.7)	2.95	2.01 - 4.34	<0.0001
VA/Military	145228 (12.7)	49 (25.5)	2.80	2.00 - 3.92	<0.0001
Propofol Use, No. (%)					
No	1066144 (93.1)	181 (94.3)	Reference		
Yes	78564 (6.9)	11 (5.7)	0.83	0.45 - 1.52	0.54

Variable	Perforation		Univariate Logistic Regression Results		
	No N = 1,144,708	Yes N = 192	OR	95% CI	p-value
Any Therapy, No. (%)					
No	1134184 (99.1)	182 (94.8)	Reference		
Yes	10524 (0.9)	10 (5.2)	5.92	3.13 - 11.20	<0.0001
Polyp in Right Colon, No. (%)					
No	908771 (79.4)	156 (81.3)	Reference		
Yes	235937 (20.6)	36 (18.8)	0.89	0.62 - 1.28	0.52
Polyp >= 10 mm, No. (%)					
No	1067671 (93.3)	160 (83.3)	Reference		
Yes	77037 (6.7)	32 (16.7)	2.77	1.90 - 4.05	<0.0001
Number of Polyps, Mean (SD)	0.62 (1.08)	0.53 (1.22)	0.91 ^I	0.78 - 1.06	0.23
Poor Bowel Prep, No. (%)					
No	1017442 (88.9)	159 (82.8)	Reference		
Yes	25379 (2.2)	8 (4.2)	2.02	0.99 - 4.11	0.053
Unknown	101887 (8.9)	25 (13.0)	1.57	1.03 - 2.39	0.036
Diverticulosis, No. (%)					
No	652918 (57.0)	109 (56.8)	Reference		
Yes	491790 (43.0)	83 (43.2)	1.01	0.76 - 1.35	0.94
Established IBD², No. (%)					
No	1117994 (97.7)	185 (96.4)	Reference		
Yes	26714 (2.3)	7 (3.4)	1.58	0.74 - 3.37	0.23
Any IBD³, No. (%)					
No	1112580 (97.2)	184 (95.8)	Reference		
Yes	32128 (2.8)	8 (4.2)	1.51	0.74 - 3.06	0.26
Trainee Involvement, No. (%)					
No	1032258 (90.2)	152 (79.2)	Reference		

Variable	Perforation		Univariate Logistic Regression Results			
	No N = 1,144,708	Yes N = 192	OR	95% CI	p-value	
	Yes	112450 (9.8)	40 (20.8)	2.42	1.71 - 3.42	<0.0001
Endoscopist Specialty, No. (%)						
Gastroenterology	977090 (85.4)	142 (74.0)	Reference			
Surgery	55833 (4.9)	18 (9.4)	2.22	1.36 - 3.62	0.002	
Primary Care	37989 (3.3)	6 (3.1)	1.09	0.48 - 2.46	0.84	
Subspecialist	22 (0.0)	0 (0.0)	N/A	N/A	N/A	
Unknown	73774 (6.4)	26 (13.5)	2.43	1.60 - 3.68	<0.0001	
Years of Experience ⁴ , Mean (SD)	20.6 (9.1)	20.9(10.2)	1.00 ⁵	0.99 - 1.02	0.67	

¹ Odds ratio for perforation per 1 polyp increase

² Established IBD is defined as finding of established ulcerative colitis (UC) or Crohn's disease on exam; procedure indication of surveillance of UC/Crohn's; or evaluation of established UC/Crohn's

³ Any IBD is defined as all categories in Established IBD, as well as evaluation of suspected UC/Crohn's, evaluation of UC/Crohn's not otherwise specified (NOS), finding of suspected UC/Crohn's, and finding of UC/Crohn's NOS

⁴ Missing n = 209,245

⁵ Odds ratio for perforation per 1 year increase in experience

Table 2
Multivariate analysis of risk factors for early colonoscopic perforation (N = 1,144,443 including 192 events)

Multivariate Logistic Regression Results				
Variable		OR	95% CI	p-value
Age				
	< 60 years	Reference		
	60 - 74 yrs	2.69	1.83 - 3.98	<0.0001
	>= 75 yrs	5.63	3.73 - 8.49	<0.0001
Gender				
	Male	Reference		
	Female	2.00	1.43 – 2.80	<0.0001
ASA Class				
	I	Reference		
	II	1.16	0.74 – 1.83	0.52
	III	2.14	1.22 – 3.75	0.008
	IV/V	7.20	2.41 - 21.50	0.0004
	Unknown	1.75	0.91 - 3.37	0.095
Site Type				
	Community/HMO	Reference		
	University	2.83	1.85 – 4.31	<0.0001
	VA/Military	3.74	2.37 – 5.89	<0.0001
Propofol Use		0.86	0.46 - 1.61	0.64
Any Therapy		3.93	2.05 – 7.56	<0.0001
Polyp >= 10 mm		4.14	2.58 - 6.65	<0.0001
1 Polyp increase		0.68	0.55 - 0.83	0.0001
Poor bowel prep				
	No	Reference		
	Yes	1.29	0.63 – 2.65	0.48
	Unknown	1.35	0.88 – 2.09	0.17
Established IBD ¹		1.97	0.92 – 4.20	0.082
Trainee Involvement		1.05	0.68 – 1.63	0.81
Endoscopist Specialty ²				
	Gastroenterology	Reference		
	Surgery	2.00	1.30 - 3.08	0.001
	Primary Care	1.25	0.55 - 2.83	0.60

Multivariate Logistic Regression Results			
Variable	OR	95% CI	p-value
Unknown	2.00	1.30 – 3.08	0.002

¹ Established IBD is defined as finding of established ulcerative colitis (UC) or Crohn's disease on exam; procedure indication of surveillance of UC/Crohn's; or evaluation of established UC/Crohn's

² Subspecialists removed from analysis (22 procedures with 0 events)

Table 3

Multivariate analysis of risk factors for early colonoscopic perforation in surveillance and colorectal cancer screening cohort (N = 544,474 including 62 events).

Multivariate Logistic Regression Results				
Variable	OR	95% CI	p-value	
Age				
< 60 years	Reference			
60 - 74 yrs	1.80	0.94 - 3.43	0.077	
>= 75 yrs	3.35	1.64-6.87	0.001	
Gender				
Male	Reference			
Female	3.08	1.68 - 5.64	0.0003	
ASA Class				
I	Reference			
II	0.91	0.44 - 1.87	0.80	
III	2.24	0.87 - 5.73	0.093	
IV/V	29.10	5.97 - 141.93	<0.0001	
Unknown	0.82	0.22 - 3.08	0.77	
Site Type				
Community/HMO	Reference			
University	1.29	0.52 – 3.17	0.59	
VA/Military	3.06	1.32 – 7.09	0.009	
Propofol Use	0.69	0.24 - 1.99	0.49	
Any Therapy	3.97	0.93 - 16.96	0.063	
Polyp >= 10 mm	2.49	1.27 – 4.88	0.008	
Established IBD ^I	5.89	0.81 – 42.75	0.080	
Trainee Involvement	1.51	0.65 – 3.47	0.34	
Endoscopist Specialty				
Gastroenterology	Reference			
Surgery	2.72	1.19 – 6.18	0.017	
Primary Care	N/A	N/A	N/A	
Unknown	2.05	0.94 - 4.47	0.072	

¹ Established IBD is defined as finding of established ulcerative colitis (UC) or Crohn's disease on exam; procedure indication of surveillance of UC/Crohn's; or evaluation of established UC/Crohn's

Table 4
Characteristics of patients receiving propofol sedation

		Propofol		
Variable		No	Yes	p-value
		n = 1,066,325	n = 78,575	
Perforation, No. (%)				
	No	1066144 (99.98)	78564 (99.99)	0.53
	Yes	181 (0.02)	11 (0.01)	
Age, No. (%)				
	< 60 years	525577 (49.3)	41375 (52.7)	<0.0001
	60 - 74 yrs	398148 (37.3)	28157 (35.8)	
	>= 75 yrs	142428 (13.4)	8782 (11.2)	
	Unknown	172 (0.02)	261 (0.3)	
Gender, No. (%)				
	Female	504271 (47.3)	44316 (56.4)	<0.0001
	Male	562050 (52.7)	34259 (43.6)	
	Unknown	4 (0.0)	0 (0.0)	
ASA Class, No. (%)				
	I	272190 (25.5)	11642 (14.8)	<0.0001
	II	668991 (62.7)	45293 (57.6)	
	III	61930 (5.8)	13662 (17.4)	
	IV/V	1566 (0.2)	435 (0.6)	
	Unknown	61648 (5.8)	7543 (9.6)	
Site Type, No. (%)				
	Community/HMO	827974 (77.6)	76149 (96.9)	<0.0001
	University	93149 (8.7)	2351 (3.0)	
	VA/Military	145202 (13.6)	75 (0.1)	
Any Therapy, No. (%)				
	No	1058066 (99.2)	76300 (97.1)	<0.0001
	Yes	8259 (0.8)	2275 (2.9)	
Polyp in Right Colon, No. (%)				
	No	849527 (79.7)	59400 (75.6)	<0.0001
	Yes	216798 (20.3)	19175 (24.4)	
Polyp >= 10 mm, No. (%)				
	No	994510 (93.3)	73321 (93.3)	0.60
	Yes	71815 (6.7)	5254 (6.7)	
Number of Polyps, Mean (SD)		0.62 (1.08)	0.70 (1.08)	<0.0001
Poor Bowel Prep, No. (%)				

Propofol				
Variable	No	Yes	p-value	
	n = 1,066,325	n = 78,575		
	No	943133 (88.5)	74468 (94.8)	<0.0001
	Yes	23675 (2.2)	1712 (2.2)	
	Unknown	99517 (9.3)	2395 (3.1)	
Diverticulosis, No. (%)				
	No	607681 (57.0)	45346 (57.7)	<0.0001
	Yes	458644 (43.0)	33229 (42.3)	
Established IBD ^I , No. (%)				
	No	1041293 (97.7)	76886 (97.9)	0.0004
	Yes	25032 (2.4)	1689 (2.2)	
Any IBD ² , No. (%)				
	No	1036427 (97.2)	76337 (97.2)	0.47
	Yes	29898 (2.8)	2238 (2.9)	
Trainee Involvement, No. (%)				
	No	955219 (89.6)	77191 (98.2)	<0.0001
	Yes	111106 (10.4)	1384 (1.8)	
Endoscopist Specialty, No. (%)				
	Gastroenterology	916160 (85.9)	61072 (77.7)	<0.0001
	Surgery	49057 (4.6)	6794 (8.7)	
	Primary Care	36149 (3.4)	1846 (2.4)	
	Subspecialist	21 (0.0)	1 (0.0)	
	Unknown	64938 (6.1)	8862 (11.3)	
Years of Experience ³ , Mean (SD)		20.8 (9.1)	17.3 (8.2)	<0.0001

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² Any IBD is defined as all categories in Established IBD, as well as evaluation of suspected UC/Crohn's, evaluation of UC/Crohn's not otherwise specified (NOS), finding of suspected UC/Crohn's, and finding of UC/Crohn's NOS

³ Missing n = 209,245