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Many Patients who Undergo Surgery for Colorectal Cancer Receive Surveillance Colonoscopies Earlier than Recommended by Guidelines

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Abstract

Background & Aims—Patients treated with surgery for colorectal cancer (CRC) should undergo colonoscopy examinations 1, 4, and 9 years later, to check for cancer recurrence. We investigated the utilization patterns of surveillance colonoscopies among Medicare patients.

Methods—We used the Surveillance, Epidemiology and End Results (SEER)–Medicare linked database to identify patients who underwent curative surgery for colorectal cancer from 1992 to 2005 and analyzed the timing of the first 3 colonoscopies after surgery. ‘Early surveillance colonoscopy’ was defined as a colonoscopy, for no reason other than surveillance, within 3 months to 2 years after a colonoscopy examination with normal results.

Results—Approximately 32.1% and 27.3% of patients with normal results from their first and second colonoscopies, respectively, underwent subsequent surveillance colonoscopies within 2 years (earlier than recommended). Of patients who were more than 80 years old at their first colonoscopy, 23.6% underwent a repeat procedure within 2 years for no clear indication. In multivariable analysis, early surveillance colonoscopy was not associated with sex, race, or patients’ level of education. There was significant regional variation in early surveillance colonoscopies among the SEER regions. There was a significant trend toward reduced occurrence of 2nd early surveillance colonoscopies.

Conclusion—Many Medicare enrollees who have undergone curative resection for colorectal cancer undergo surveillance colonoscopy more frequently than recommended by the guidelines. Reducing overuse could free limited resources for appropriate colonoscopy examinations of inadequately screened populations.

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Keywords

prevention; early detection; colon cancer screening; cost efficacy

INTRODUCTION

Colorectal cancer is third most common cancer in the United States. In 2012, estimated –143,460 patients will be diagnosed with colorectal cancer.¹ In 76% of these, the disease will be either localized or extending to the regional lymph nodes, qualifying them for curative resection.^{2, 3} Around 30–40% of patients will develop recurrent colorectal cancer after curative surgery.^{2, 4, 5} Studies show that surveillance colonoscopy identifies early recurrences at a stage that allows curative treatment.^{6–11} Hence, the American Cancer Society, American Gastroenterology Association (AGA) and the US Multi-Society Task Force on Colorectal Cancer all recommend surveillance colonoscopy in patients who have undergone curative resection of colorectal cancer.¹¹ The current guidelines call for patients to undergo their first surveillance colonoscopy at one year after the surgery. If the colonoscopy is normal, the next colonoscopy should be performed after three years and then every five years.¹¹ The guidelines of gastroenterology and oncology societies for colorectal cancer surveillance have been changing during the past decade. Table 1 summarizes the guidelines recommended by various societies in the last few years.^{12–14}

Some attention has been paid to underutilization of surveillance colonoscopy in the United States.^{15–19} For example, Cooper et al. showed that only 73.6 % of patients with colorectal cancer who underwent surgery with curative intent received one surveillance colonoscopy within three years.¹⁵ By contrast, data on overutilization of surveillance colonoscopy is limited. Studying overutilization of surveillance of colonoscopy is important because colonoscopy is an invasive test with rare but potentially life-threatening complications.^{20–22} Overuse of colonoscopy can lead to increased toxicities without added benefit. Second, colonoscopy is a limited resource, in terms of facilities and practitioners.^{23, 24} Identifying and decreasing overutilization of surveillance colonoscopy should free up resources for greater use in inadequately screened populations.

The objective of this study is to describe the utilization patterns of surveillance colonoscopy in Medicare patients who underwent curative resection of colorectal cancer during 1992–2005. In this article, we focus on the potential overutilization of surveillance colonoscopy in this setting, in particular the use of colonoscopy at shorter intervals than recommended.

METHODS

Data Source

We used the SEER-Medicare linked database. The SEER-Medicare data links two large population-based sources of detailed information about Medicare beneficiaries with cancer. The data came from the Surveillance, Epidemiology and End Results (SEER) program of cancer registries that collect clinical, demographic and cause of death information for persons with cancer and the Medicare claims for covered health care services from the time of a person's Medicare eligibility until death. Since 2000, SEER programs were expanded to 16 registries that represent 28% of the United States population.

Study Subjects and Outcome

We formed a cohort of patients aged 66 years and above diagnosed with colorectal cancer during 1992–2005. We included those diagnosed with AJCC Stages 1–3 colorectal cancer.

Patients with a history of inflammatory bowel disease were excluded. We studied the pattern of receipt of the first three colonoscopies after curative surgery in this cohort. To ensure complete information, we excluded patients who were not enrolled in both Part A and B and were members of a health maintenance organization (HMO) for the period under observation. In the analyses of surveillance colonoscopy, we limited our study cohorts to patients diagnosed in 1992–2003 for the 2nd colonoscopy and in 1992–2002 for the 3rd colonoscopy.

We examined the indications for colonoscopy using the diagnosis on the colonoscopy claim (provided in Appendix). We considered the colonoscopies as indicated if the diagnosis was anemia, gastrointestinal bleeding or other relevant diagnosis like change in bowel habits, weight loss, abdominal pain or colostomy problems. If a barium enema or computed tomography of the abdomen or pelvis was performed in the three months before the colonoscopy, we also considered the colonoscopy as indicated. A ‘diagnostic colonoscopy’ was defined as one performed to evaluate a clinical indication or done after radiology. We used the term ‘surveillance colonoscopy’ to refer to procedures done with no clinical indication or evidence of prior radiology. We used the term ‘any colonoscopy’ to refer collectively to both diagnostic and surveillance colonoscopies.

Table 1 summarizes the guidelines of various authorities of the optimal time between surveillance colonoscopies in patients who had undergone curative resection of colorectal cancer.^{12–14} Some of the recommendations changed during the study period (1992–2005). The minimum duration for the second surveillance colonoscopy in all these guidelines is three years after a normal first colonoscopy, and the minimum duration for a third surveillance colonoscopy was 3–5 years after a normal second colonoscopy. Hence, we defined any second or third surveillance colonoscopy performed any time from three months to two years after the previous normal colonoscopy as early surveillance colonoscopy. We defined a normal colonoscopy as one not associated with any procedure like polyp removal, biopsy or any other procedure.

Covariates

Demographic data were collected on age, race, socioeconomic variables and SEER geographic region. Race was divided into White, Black, Hispanic and Other according to the SEER race code classification. For patients diagnosed during 1992–1995, education was defined as the proportion of adults who did not complete high school by census tract, based on the 1990 US Census; for patients diagnosed during 1996–2002, the 2000 US Census was used. Cancer characteristics were taken from SEER data files. Information was collected on AJCC stage (Stage 1, 2 and 3) and grade (well, moderately and poorly differentiated). Comorbidity was assessed using Klabunde's adaptation of the Charlson comorbidity index. Higher scores indicate more comorbidity. This analysis required Medicare inpatient and outpatient claims in the 12 months before the diagnosis of colorectal cancer; therefore, we limited our analysis to subjects < 66 years. Data on physician experience was based on the number of years since their graduation year and was obtained from AMA linkage file. Physician specialty was obtained from Medicare part B claims.

Statistical Analysis

The rate of any colonoscopy following a normal colonoscopy was calculated using the Kaplan-Meier method. Beneficiaries were censored at death, loss of coverage or end of follow-up (12/31/2006). Multivariate analysis of receipt of early surveillance colonoscopy without indications was performed using a modified Poisson regression model. Patients without two full years of follow-up after the first or second colonoscopy were excluded from

analyses of early surveillance colonoscopy. All analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

RESULTS

Table 2 shows the characteristics of our initial study cohort. We then used the Kaplan Meier method to estimate time to follow-up colonoscopies. Figure 1A shows the time from surgery to any initial colonoscopy, either diagnostic or surveillance. Similarly, Figures 1B and 1C show the time to any second and third colonoscopy in patients who underwent a normal first or second colonoscopy, respectively. Two findings are apparent. First, approximately 17.5% of patients never undergo a first surveillance colonoscopy, and an additional 14.8% of patients with a normal first colonoscopy do not undergo subsequent colonoscopies. Second, Figure 1B shows that a substantial proportion of patients undergo follow up colonoscopy within two years after their first normal colonoscopy, with a similar pattern shown in Figure 1C for patients after their second normal colonoscopy.

The timing of any follow-up colonoscopies changed somewhat over the 1992–2002 study period. Table 3 presents the median and 25th and 75th percentiles for months between first normal colonoscopy and the second colonoscopy for any reason, and also between a second normal colonoscopy and any third colonoscopy. Between cancers initially treated in 1992–94 and 2001–03, there was a significant trend for somewhat longer median times between the first normal colonoscopy and any follow up colonoscopy, from 26 months in 1992–94 to 32 months in 2001–03. There was no clear temporal pattern of change over time in the interval between the second and third colonoscopy.

To further investigate the potential use of colonoscopy earlier than recommended, we identified patients who received a second colonoscopy within two years of a normal first colonoscopy and those who received a third colonoscopy within two years of a normal second colonoscopy. Among these, we identified patients with a claim that suggested a diagnostic purpose for the colonoscopy. The remaining patients were considered to have undergone surveillance colonoscopy after a normal prior colonoscopy. Table 4 presents the percentage of patients who had early surveillance colonoscopy, stratified by patient, geographic and tumor characteristics. Overall, 32.1% of patients with a normal first colonoscopy underwent a second colonoscopy within two years for surveillance. Similarly, 27.3% of patients with second normal colonoscopy underwent a third colonoscopy within two years for surveillance. This occurred more often in younger patients, but was still at 20% for patients aged 80 or older. There were also marked variations among the SEER areas, with Seattle having rates approximately one third of those of New Mexico. Patients with previous colonoscopy by a surgeon or by a more recently trained physician were more likely to undergo a subsequent early surveillance colonoscopy.

Table 5 presents the results of multivariable analyses of odds of receiving an early surveillance colonoscopy. Most of the associations found in the bivariate analyses in Table 4 are maintained. There is a clear decline in older patients, with no association with gender, ethnicity, marital status or education. There was a temporal decrease in odds of receiving early surveillance between the early 1990's and the 2000's. Tumor stage and grade had a modest or no effect on odds of receiving early surveillance colonoscopy. Surgeons and more recently trained physicians were more likely to be associated with early surveillance colonoscopy.

DISCUSSION

Our study shows that some patients with colorectal cancer who have undergone curative resection undergo surveillance colonoscopy more frequently than recommended by the guidelines, while other patients never receive any surveillance colonoscopy. We sought to estimate the magnitude and predictors of overutilization of surveillance colonoscopy.

We found that 32% and 27% of patients underwent early second and third surveillance colonoscopy for no clear indication, respectively. This is a conservative estimate, as we defined colonoscopy performed within two years as early surveillance colonoscopy. The current recommendation by most gastroenterology and oncology societies is to perform a second surveillance at three years and a third surveillance colonoscopy at five years.^{11, 13} Further, we included only patients whose prior colonoscopy was not associated with any additional procedure like biopsy or polyp removal. The histologic findings in some of these patients undergoing additional procedures would have been non-adenomatous (e.g., hyperplastic polyps, normal colon mucosa) requiring no need to shorten the surveillance interval. Of interest, potential clinical indications for more frequent surveillance, such as tumor stage or histological grade, had no or minimal association with receipt of early surveillance.

The underlying reasons for this pattern of overutilization are probably related to physician practice patterns and patient demands. There is significant variability in physician recommendations as well as physician adherence to the guidelines for surveillance colonoscopy intervals and follow up in colorectal cancer survivors.^{25–27} A survey of colorectal surgeons in the United States on the follow up and surveillance of colorectal cancer survivors revealed that only 49% adhered to guidelines. In that study, the surveillance intervals recommended by the surgeons varied from annually (14% of physicians) to once in five years (10% of physicians).²⁶ Similar variability exists among the primary care providers (PCP) and oncologists, who generally comprise the first point of contact for follow up of colorectal cancer patients.^{25,27} The awareness of and adherence to the guidelines among PCPs and oncologists plays a very important role in the utilization pattern of surveillance colonoscopy. Often, the endoscopist does not see the patient in the clinic prior to performing the colonoscopy. These patients are referred directly for the procedure by either their PCP or oncologist.

Another potential explanation for performance of surveillance colonoscopy at intervals shorter than recommended is imbedded in patient behavior and demands. Colorectal cancer survivor patients may be anxious about tumor recurrence and may request that procedures be performed more frequently than recommended by guidelines.^{28–30}

We observed significant regional variation in the use of early second and third surveillance colonoscopy. Patients in some SEER regions were more than twice as likely to undergo early surveillance colonoscopy than those in other regions. Areas with higher rates of early second surveillance colonoscopy consistently had similarly higher rates of early third surveillance colonoscopy. The regional variation is likely related to variation in practice patterns and health care delivery systems.^{16, 31, 32}

It is troubling that a significant percentage of patients older than 80 years underwent early surveillance colonoscopy. There are no clear recommendations on the age limit for performance of surveillance colonoscopy after curative colorectal cancer resection. Guidelines from American Cancer Society and US Multi-Society Task Force on Colorectal Cancer recommend discontinuing surveillance colonoscopy in patients with a life expectancy less than 10 years.¹¹ In this study, we also found that patients with multiple comorbidities had a higher likelihood of receiving an early surveillance colonoscopy with no

clear indication. It is unclear why these patients undergo surveillance colonoscopy more often. It may be that patients with multiple comorbidities see multiple medical providers, increasing their risk of being recommended for another surveillance colonoscopy.

There was a significant decrease in occurrence of early surveillance colonoscopy during the study period (1992–2003). This was noted for the second surveillance colonoscopy. We analyzed the trend of colonoscopy utilization over the study period and found a significantly increasing interval (Table 3). This decrease in occurrence of early surveillance colonoscopy may be related to increased awareness among physicians about post cancer surveillance guidelines. In 1997, Winawer et al. published guidelines endorsed by major gastroenterology, surgery and oncology societies.¹² In these guidelines, the authors stated there is no evidence to suggest that the rate of progression of adenomatous polyps to cancer was different among patients who have had cancer from those in average-risk individuals.

In our study we also found under-utilization of surveillance colonoscopy (Figure 1). Cooper et al. and others have tried to address the predictors of under-utilization of surveillance colonoscopy.^{15–19} Decreased rates of surveillance colonoscopy were associated with advanced age, African American race and with multiple co-morbidities. It is also likely that the overuse of limited resources may play a role in many patients not receiving the surveillance colonoscopy at the recommended intervals.

Our study had several limitations. Some procedures could be performed sooner than recommended by the guidelines due to suboptimal bowel preparation of the prior examination. Details of the colonoscopy, such as the quality of bowel preparation and the actual procedure findings, were not known from the administrative data. However, to minimize the effect of bowel preparation, we did not include any repeat procedures performed within three months of the surgery or prior colonoscopy. The estimates obtained in this study are for the population greater than 66 years, and cannot be extrapolated to younger populations.

Our study shows that many patients who underwent curative resection for colorectal cancer receive surveillance colonoscopy sooner than recommended by the guidelines. This study provides an estimate of the magnitude of the overuse and is the first step in evaluating this problem. Future studies are required to further assess the influence of physician practice parameters as well as patient behaviors, which lead to more frequent performance of surveillance colonoscopy than recommended by the guidelines.

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Figure 1.

- A. Time of first colonoscopy among patients who underwent curative surgical resection (N=70,419). This graph includes patients who underwent first colonoscopy for any indication (either surveillance or diagnostic). The median time between surgery and first surveillance colonoscopy was 18 months (25th–75th percentile 13–72 months).
- B. Time of second surveillance colonoscopy after the first normal colonoscopy for 19,969 patients. This graph includes patients who underwent second colonoscopy for any indication (either surveillance or diagnostic). The median time between first and second surveillance colonoscopy was 29 months (25th–75th percentile 16–54 months).
- C. Time of third surveillance colonoscopy after second normal colonoscopy for 11,666 patients. This graph includes both diagnostic and surveillance colonoscopies. This graph includes both diagnostic and surveillance colonoscopy. The median time between second and third surveillance colonoscopy was 33 months (25th–75th percentile 18–57 months).

Table 1

Guidelines for duration between surveillance colonoscopy.

Society	Recommendation*
American Gastroenterology Association (1997)	1 year, then every 3 years
American Society of Clinical Oncology (2000)	every 3–5 years
American Society of Colon and Rectal Surgeons (2004)	every 3 years
US Multi-Society Task Force on Colorectal Cancer (2006)	1 year, after 3 years and then every 5 years

* In these recommendations, the intervals between the colonoscopy procedures are based on the assumption that the previous procedure was normal.

Table 2

Characteristics of patients who underwent curative surgery for colorectal cancer during 1992–2005.

Characteristics	Category	N	%
Overall		70419	100.0
Age	67 – 69	10754	15.3
	70 – 74	16465	23.4
	75 – 79	17713	25.2
	>= 80	25487	36.2
Gender	Male	31895	45.3
	Female	38524	54.7
Ethnicity	White	59860	85.0
	Black	4541	6.4
	Hispanic	2663	3.8
	Others	3355	4.8
SEER Regions	Connecticut	7178	10.2
	Detroit	7444	10.6
	Hawaii	1213	1.7
	Iowa	8706	12.4
	New Mexico	1867	2.7
	Seattle	4624	6.6
	Utah	1873	2.7
	Atlanta/Rural Georgia	2567	3.6
	Kentucky	4015	5.7
	Louisiana	3210	4.6
	New Jersey	8305	11.8
	California	19417	27.6
Marital Status	Married	36345	51.6
	Not Married	34074	48.4
Census Tract education (% adult less than 12 years education)	< 9.1%	16246	23.4
	9.1 – < 15.3%	17032	24.5
	15.3 – < 23.4%	16712	24.0
	>= 23.4%	19580	28.1
Census Tract poverty (% adults below the poverty line)	< 4.1%	15389	22.1
	4.1 – < 7.7%	16442	23.6
	7.7 – < 15.1%	17168	24.7
	>= 15.1%	20571	29.6
Comorbidity	0	61982	88.0
	1	5209	7.4
	2	1865	2.6

Characteristics	Category	N	%
	≥ 3	1363	1.9
Year of diagnosis	1992	3839	5.5
	1993	3500	5.0
	1994	3581	5.1
	1995	3421	4.9
	1996	3435	4.9
	1997	3413	4.8
	1998	3569	5.1
	1999	3333	4.7
	2000	7295	10.4
	2001	7247	10.3
	2002	7198	10.2
	2003	7213	10.2
	2004	6774	9.6
	2005	6601	9.4
AJCC stage	1	21052	29.9
	2	27680	39.3
	3	21687	30.8
Grade	Well	6604	9.4
	Moderate	47510	67.5
	Poor	12678	18.0
	Unknown	3627	5.2

Table 3

Change overtime in the intervals between the first and second and third colonoscopy during the study period.*

	Year of diagnosis						Log rank P-value***
	Percentile	1992-1994	1995-1997	1998-2000	2001-2003		
Time between first and second colonoscopy (months)	Q1	14*	15 (15 – 16)	17 (16 – 18)	19 (18 – 20)		<0.0001
	Q2	26 (25 – 27)	28 (27 – 30)	31 (29 – 32)	32 (30 – 34)		
	Q3	58 (51 – 66)	52 (48 – 57)	53 (50 – 60)			
Time between second and third colonoscopy (months)	Q1	15 (14 – 15)	18 (17 – 20)	23 (21 – 24)	22 (19 – 23)		0.0106
	Q2	31 (28 – 33)	36 (34 – 37)	36 (35 – 37)	29 (28 – 32)		
	Q3	60 (55 – 63)	60 (56 – 64)	56 (50 – 61)			

* The median and 25th and 75th percentiles for months between a first normal colonoscopy following surgery for colorectal cancer and any follow up colonoscopy are given.

** Requiring weekly data to estimate 95% confidence interval, the rate of colonoscopy jumped from 21.9% at 13 months to 28.8% at 14 months.

*** The log rank test assesses the rate of colonoscopy at the entire follow-up period between patients diagnosed at different eras.

Table 4

Characteristics of patients who underwent a second or third surveillance colonoscopy within two years of a previous normal colonoscopy. ****

Characteristics	Category	Patients with normal first colonoscopy			Patients normal second colonoscopy		
		N	Received 2nd surveillance colonoscopy* within 2 years after 1st normal colonoscopy	p-value	N	Received 3rd Surveillance colonoscopy* within 2 years after 2nd normal colonoscopy	p-value
Overall		14144	32.1	****	8047	27.3	
Age (years)	67 – 69	1755	45.0	<0.0001	546	46.3	<0.0001
	70 – 74	3775	36.2		2314	30.9	
	75 – 79	4045	32.3		2515	27.7	
Gender	80	4569	23.6		2672	20.0	
	Male	5957	34.2	<0.0001	3457	28.7	0.0146
	Female	8187	30.6		4590	26.3	
Ethnicity	White	12352	32.1	0.3008	7046	27.2	0.3411
	Black	819	33.9		418	29.0	
	Hispanic	435	32.2		252	31.0	
	Other	538	29.0		331	24.8	
	Connecticut	1383	31.0	<0.0001	821	21.7	<0.0001
SEER Regions	Detroit	1801	42.3		1254	35.9	
	Hawaii	214	26.2		131	19.9	
	Iowa	2408	35.1		1567	28.8	
	New Mexico	343	46.7		241	38.2	
	Seattle	938	16.4		532	13.5	
	Utah	425	33.7		238	28.2	
	Atlanta/Rural Georgia	608	28.1		347	22.2	
	Kentucky	784	25.3		307	27.0	
	Louisiana	619	30.4		242	28.9	
	New Jersey	1301	39.1		584	34.9	
Marital Status	California	3320	28.0		1783	24.0	
	Married	8090	34.1	<0.0001	4856	28.5	0.0026

Characteristics	Category	Patients with normal first colonoscopy			Patients normal second colonoscopy		
		N	Received 2nd surveillance colonoscopy* within 2 years after 1st normal colonoscopy	p-value	N	Received 3rd Surveillance colonoscopy* within 2 years after 2nd normal colonoscopy	p-value
Census Tract education (% adult less than 12 years education)	Not Married	6054	29.5		3191	25.5	
	< 9.1%	3398	30.1	0.0012	1932	25.5	0.0023
	9.1 – < 15.3%	3436	31.1		1984	25.4	
	15.3 – < 23.4%	3514	34.4		2029	28.3	
	23.4%	3625	32.9		1978	30.2	
Census Tract below poverty	< 4.1%	3178	35.2	0.0001	1931	28.5	0.6407
	4.1 – < 7.7%	3417	32.3		1962	26.8	
	7.7 – < 15.1%	3578	30.0		2057	26.5	
Comorbidity	15.1%	3800	31.6		1973	27.6	
	0	10810	28.9	<0.0001	5617	27.3	0.0919
	1	2092	43.3		1621	28.9	
	2	743	43.5		506	25.5	
Year of diagnosis	3	499	37.3		303	22.4	
	1992	988	37.7	<0.0001	719	32.1	<0.0001
	1993	870	39.3		646	30.0	
	1994	876	35.8		642	30.5	
AJCC stage	1995	853	39.0		629	25.9	
	1996	839	33.6		689	27.1	
	1997	880	30.1		681	23.9	
	1998	940	33.1		706	23.4	
	1999	887	27.5		578	20.4	
	2000	1913	29.3		1251	23.8	
	2001	1860	30.1		925	27.8	
	2002	1781	28.4		581	39.1	
	2003	1457	31.2				
	1	4762	30.4	0.0004	2838	27.0	0.0297

Characteristics	Category	Patients with normal first colonoscopy			Patients normal second colonoscopy		
		N	Received 2nd surveillance colonoscopy* within 2 years after 1st normal colonoscopy	p-value	N	Received 3rd Surveillance colonoscopy* within 2 years after 2nd normal colonoscopy	p-value
	2	5587	31.9		3147	26.3	
	3	3741	34.5		2035	29.5	
Grade	Well	1361	31.5	0.7045	765	25.1	0.1824
	Moderate	9735	32.0		5528	27.9	
	Poor/Unknown	2283	32.8		1284	26.3	
Physician specialty**	Gastroenterology	6542	29.8	<0.0001	3748	25.5	0.0041
	Generalist	987	32.9		594	26.1	
	Surgeon	5703	34.7		3134	29.3	
	Other	317	31.3		187	27.3	
Years since graduation of the colonoscopist***	< 10	536	41.8	<0.0001	369	30.4	0.5395
	10 – 19	3921	34.0		2450	26.9	
	20 – 29	4658	30.6		2625	26.8	
	>=30	2731	30.4		1346	27.1	

* Surveillance colonoscopy is defined as a colonoscopy with no diagnosis or prior procedure suggesting it was done for diagnostic reasons. Among all the patients who underwent a colonoscopy within 2 years after the first and second any colonoscopy diagnostic indication was found in 21% and 23% patients, respectively.

** Data on physician specialty was missing for 595 patients (4.2%) and 384 patients (4.8%) for 1st and 2nd colonoscopy, respectively.

*** Data on year of graduation was missing for 2298 patients (16.3%) and 1257 patients (15.6%) for 1st and 2nd colonoscopy, respectively. Specialty and experience were all characteristics of the previous colonoscopy; for example in the analysis of early second surveillance colonoscopy, these are the characteristics related to first colonoscopy.

**** These analyses are limited to patients with a normal colonoscopy, with at least two years of follow-up data after that colonoscopy, to assess receipt of early subsequent surveillance colonoscopy. Surveillance colonoscopy is a colonoscopy lacking a diagnosis indicating it might be done to evaluate a specific symptom.

Table 5

Multivariable analysis of patient characteristics associated with odds of receiving an early second or third surveillance colonoscopy within two years after a normal colonoscopy.

Characteristics	Category	Second Surveillance Colonoscopy within 2 years after the 1 st normal colonoscopy *		Third Surveillance Colonoscopy within 2 years after the normal 2 nd colonoscopy *	
		OR	95% CI	OR	95% CI
Age	67 – 69	1.00		1.00	
	70 – 74	0.80	(0.73, 0.87)	0.69	(0.60, 0.80)
	75 – 79	0.73	(0.67, 0.80)	0.63	(0.55, 0.73)
	80	0.55	(0.50, 0.60)	0.47	(0.40, 0.54)
Gender	Male	1.00		1.00	
	Female	0.97	(0.91, 1.03)	0.96	(0.88, 1.05)
Ethnicity	White	1.00		1.00	
	Black	0.95	(0.84, 1.09)	0.96	(0.79, 1.17)
	Hispanic	0.93	(0.78, 1.11)	0.98	(0.77, 1.25)
	Other	1.02	(0.85, 1.23)	1.08	(0.84, 1.40)
SEER Regions	Connecticut	1.92	(1.59, 2.31)	1.62	(1.23, 2.14)
	Detroit	2.45	(2.05, 2.92)	2.55	(1.99, 3.28)
	Hawaii	1.61	(1.15, 2.25)	1.29	(0.79, 2.10)
	Iowa	2.09	(1.76, 2.49)	2.15	(1.67, 2.76)
	New Mexico	2.83	(2.26, 3.55)	2.73	(1.99, 3.75)
	Seattle	1.00		1.00	
	Utah	2.02	(1.61, 2.53)	1.99	(1.43, 2.79)
	Atlanta/Rural Georgia	1.70	(1.36, 2.12)	1.58	(1.15, 2.19)
	Kentucky	1.69	(1.35, 2.11)	1.93	(1.38, 2.71)
	Louisiana	2.02	(1.61, 2.52)	1.97	(1.39, 2.79)
	New Jersey	2.79	(2.31, 3.36)	2.52	(1.89, 3.35)
	California	1.84	(1.55, 2.19)	1.78	(1.38, 2.29)
	Married	1.06	(0.99, 1.13)	1.03	(0.94, 1.13)

		Second Surveillance Colonoscopy within 2 years after the 1 st normal colonoscopy*		Third Surveillance Colonoscopy within 2 years after the normal 2 nd colonoscopy*	
Characteristics	Category	OR	95% CI	OR	95% CI
Not Married		1.00		1.00	
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Census Tract education (% adult < 12 years education)	< 9.1%	1.00		1.00	
	9.1 – < 15.3%	0.99	(0.91, 1.09)	0.98	(0.86, 1.11)
	15.3 – < 23.4%	1.03	(0.94, 1.12)	1.03	(0.91, 1.17)
	23.4%	1.00	(0.91, 1.09)	1.08	(0.95, 1.24)
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Comorbidity	0	1.00		1.00	
	1	1.46	(1.35, 1.57)	1.09	(0.98, 1.21)
	2	1.49	(1.32, 1.67)	0.96	(0.80, 1.15)
	3	1.29	(1.11, 1.50)	0.85	(0.66, 1.08)
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Year of diagnosis	1992	1.00		1.00	
	1993	1.03	(0.89, 1.19)	0.94	(0.77, 1.13)
	1994	0.95	(0.82, 1.11)	0.98	(0.81, 1.18)
	1995	1.04	(0.90, 1.21)	0.82	(0.67, 1.00)
	1996	0.91	(0.78, 1.06)	0.89	(0.74, 1.09)
	1997	0.81	(0.69, 0.95)	0.78	(0.64, 0.96)
	1998	0.89	(0.76, 1.04)	0.77	(0.63, 0.94)
	1999	0.76	(0.64, 0.89)	0.68	(0.55, 0.85)
	2000	0.77	(0.67, 0.88)	0.74	(0.62, 0.89)
	2001	0.77	(0.67, 0.88)	0.82	(0.68, 1.00)
	2002	0.73	(0.63, 0.84)	1.15	(0.95, 1.41)
	2003	0.80	(0.69, 0.92)		
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AJCC stage	1	1.00		1.00	
	2	1.05	(0.98, 1.13)	0.96	(0.87, 1.06)
	3	1.10	(1.02, 1.19)	1.06	(0.95, 1.18)

Second Surveillance Colonoscopy within 2 years after the normal 2 nd colonoscopy*		Third Surveillance Colonoscopy within 2 years after the normal 2 nd colonoscopy*	
Characteristics	Category	OR	95% CI
Grade	Well	1.00	1.00
	Moderate	1.03	(0.93, 1.14)
	Poor/Unknown	1.07	(0.94, 1.20)
Physician Specialty	Gastroenterology	1.00	1.00
	Generalist	1.06	(0.94, 1.20)
	Surgeon	1.14	(1.07, 1.22)
	Other	0.96	(0.79, 1.17)
Years since graduation of the colonoscopist	< 10	1.00	1.00
	10 – 19	0.83	(0.72, 0.96)
	20 – 29	0.77	(0.67, 0.89)
	≥30	0.77	(0.67, 0.90)

* Surveillance colonoscopy is defined as a colonoscopy with no diagnosis or prior procedure suggesting it was done for diagnostic reasons.