

Post-treatment Surveillance in a Large Cohort of Patients With Colon Cancer

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Colon cancer is the third most common malignant neoplasm among men and women in the United States, with an estimated 146,970 incident cases and 49,920 deaths in 2009.¹ At the time of initial diagnosis, approximately 76% of patients are diagnosed as having local or regional disease.¹ Most patients undergo tumor resection with curative intent, but one-third of these patients may experience metachronous recurrences during the subsequent 5 years,²⁻⁵ and some die of recurrent disease. The primary objectives of post-treatment surveillance for colon cancer following potentially curative resection are to detect recurrences at an early stage for which another curative resection is possible or to detect metastases at a pre-invasive stage, thereby reducing mortality among cancer survivors.⁶ Professional societies usually recommend scheduled office visits, determination of carcinoembryonic antigen (CEA) levels, colonoscopies, or computed tomography (CT) of the abdomen and chest. However, current knowledge about the benefits of post-treatment surveillance is mainly derived from the results of small-scale trials or meta-analyses.⁷⁻⁹ Little is known about adherence to guideline-recommended follow-up care for colon cancer in community-based populations.

The objectives of this study were to determine the proportions of patients complying with different components of guideline-recommended colon cancer post-treatment surveillance using the population-based linked Surveillance, Epidemiology, and End Results (SEER)-Medicare database. This data set contains information about a large cohort of patients with colon cancer and provides details on services provided following cancer diagnosis, allowing us to assess the use pattern of post-treatment care.

METHODS

Data Sources

The study used the linked SEER-Medicare database to identify patients diagnosed as having stage I to stage III colon adenocarcinoma between January 2000 and June 2002 and their Medicare claims through December 2005. The SEER registries accounted for approximately 26% of the US population and included Atlanta, Georgia; Connecticut; Detroit, Michigan; Hawaii; Iowa; New Mexico; San Francisco–Oakland, California; Seattle–Puget Sound, Washington; Utah; Los Angeles, California; San Jose–Monterey, California; rural Georgia; greater California; Kentucky; Louisiana; and New Jersey.¹ The SEER program collects information on patient de-

Objectives: To determine how patients complied with different components of guideline-recommended post-treatment surveillance in a large nationwide population-based cohort of patients with colon cancer.

Study Design: Retrospective cohort study.

Methods: We used the linked Surveillance, Epidemiology, and End Results–Medicare database to identify patients 66 years or older diagnosed as having stage I to stage III colon adenocarcinoma between January 2000 and June 2002 with a follow-up duration of at least 3.5 years. After tumor resection, patients who completed at least 2 office visits per year for 3 years, at least 2 carcinoembryonic antigen tests per year (in the first and second years of follow-up), and at least 1 colonoscopy within 3 years were defined as meeting the recommended post-treatment care.

Results: We identified 7348 patients, with a median follow-up duration of 59 months. Adherence to post-treatment surveillance was 83.9% for office visits, 29.4% for carcinoembryonic antigen tests, and 74.3% for colonoscopy. Younger age at diagnosis, white race/ethnicity, married status, advanced tumor stage, fewer comorbidities, and chemotherapy use were significantly associated with guideline adherence.

Conclusions: Adherence to colon cancer post-treatment surveillance was low, although proportions of patients complying with office visits and colonoscopy were reasonably high. Underlying reasons for noncompliance, which varied by type of service, may need further investigation.

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Take-Away Points

Little is known about adherence to guideline-recommended follow-up care for colon cancer in community-based populations. This study identified a nationwide population-based cohort of 7348 patients with colon cancer. Adherence to post-treatment surveillance was low, although proportions of patients complying with office visits and colonoscopy were reasonably high.

- Adherence to post-treatment surveillance was 83.9% for office visits, 29.4% for carcino-embryonic antigen tests, and 74.3% for colonoscopy.
- Younger age at diagnosis, white race/ethnicity, married status, advanced tumor stage, fewer comorbidities, and chemotherapy use were significantly associated with guideline adherence.

and then categorized into quartiles (top, second, third, and bottom), with the top quartile representing the highest SES.¹² Seventy patients with missing SES were excluded from analyses. Comorbidity score was calculated using methods by Charlson et al¹³ that were updated by Romano and colleagues¹⁴ and using a statistical program by the National Cancer Institute.¹⁵ Medicare claims from inpatient and outpatient

mographics, primary tumor site, tumor morphology, tumor stage, first course of treatment (radiation therapy and surgery) within 4 months of diagnosis, cause of death, and patient follow-up for vital status.¹⁰ The Medicare program provides health insurance to 97% of individuals 65 years or older in the United States.¹¹ Medicare claims data capture physician office visits and medical services for Medicare beneficiaries regardless of where the services are provided across the country.

Study Population

We identified 7348 patients 66 years or older diagnosed as having *American Joint Committee on Cancer, Sixth Edition* stage I to stage III colon adenocarcinoma (*International Classification of Diseases for Oncology, Third Edition* codes C180-C189 and SEER histology codes 8140, 8210-8211, 8220-8221, 8260-8263, 8470, 8480-8481, and 8490). Subjects were excluded from the study if they were not enrolled in Medicare Part B or were health maintenance organization participants because their claims were not required to be reported to the Centers for Medicare & Medicaid Services. Study subjects were limited to those with tumor resection performed within 3 months after cancer diagnosis. We also excluded the following subjects: patients identified from autopsy or death certificate, patients aged 65 years or less, and patients who died within 3.5 years after tumor resection (to allow ≥ 6 months for postoperative evaluation of therapeutic complications after tumor resection and another 3 years for examination of adherence to follow-up care).

Study Variables

Patient and Tumor Characteristics. Patient demographic information (age at diagnosis, sex, race/ethnicity, and marital status), clinical information (tumor stage and tumor grade), geographic information (residence [metropolitan, urban, or rural] and SEER registry), and year of diagnosis were from the Patient Entitlement and Diagnosis Summary File. Socioeconomic status (SES) was determined based on the annual household median income, the percentage of persons 25 years or older with less than 12 years' education, and the percentage of persons living below the poverty line from the 2000 US Census data. A composite SES was created using these 3 variables, which were equally weighted

physician files were searched for 16 noncancer illnesses between 1 year before and 1 month after the primary diagnosis. Comorbidity score was then coded as 0, 1, or 2 or higher.

Adherence to Guidelines for Post-treatment Surveillance.

As summarized in **Table 1**, our definition of post-treatment care was based on recommendations by the American Society of Clinical Oncology^{16,17} and by the National Comprehensive Cancer Network.⁶ Based on these guidelines, we defined recommended colon cancer post-treatment care as completion of at least 2 office visits per year for 3 years, at least 2 CEA tests per year (in the first and second years of follow-up), and at least 1 colonoscopy within 3 years. These post-treatment care services were identified from Medicare data using *Current Procedural Terminology (CPT)* and *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes (listed in **Table 2**¹⁷⁻²⁰) for office visit, CEA test, and colonoscopy. Medicare files were used to identify tumor resection (ICD-9-CM codes 45.7x and 45.8 or CPT codes 44140-44148, 44150-44153, 44155-44156, and 44160). Although not recommended by professional societies until 2005, the use pattern of 1 or more CT imaging per year (CPT and ICD-9-CM codes listed in **Table 2**) was also examined because of its proven efficacy in identifying lung and liver metastases.^{21,22} Claims for the same services from inpatient, outpatient, and physician files on the same day were counted only once to minimize duplications.

Chemotherapy Use. The combination of 5-fluorouracil plus leucovorin calcium has long been used for treatment of stage III colon cancer to reduce mortality and recurrence.²³ Patients without lymph node metastasis (stage II) but with certain features predicting a higher risk of relapse may also benefit from adjuvant chemotherapy. We included patients who had chemotherapy initiated within 3 months after tumor resection.²⁴ The codes for identifying chemotherapy use were reported elsewhere.¹²

Statistical Analysis

We first reported the proportion of patients who received follow-up care for office visits, CEA tests, colonoscopy, and CT during the first, second, and third years of follow-up. Characteristics of these patients were compared using χ^2 statistic. Multivariate logistic regression modeling was used to adjust

■ **Table 1.** Professional Societies' Recommended Colon Cancer Post-treatment Surveillance Frequencies

Procedure or Service	American Society of Clinical Oncology (2000) ^{16,17}	National Comprehensive Cancer Network (Updated Yearly) ⁶	Definition of Recommended Frequency Used in the Present Study
Office visits	Every 3-6 mo for first 3 y and annually thereafter	Every 3-6 mo for 2 y, then every 6 mo	≥2 Office visits per year for 3 y
CEA tests	Every 2-3 mo in patients with stage II or stage III disease for 2 y	Every 3-6 mo for 2 y, then every 6 mo	≥2 CEA tests per year for the first 2 y
Colonoscopy	Every 3-5 y	At 1 y after resection, at 3 y, then every 5 y	≥1 Colonoscopy within 3 y
CT imaging ^a	Annually for patients with higher risk of recurrence	Annually for patients with higher risk of recurrence	≥1 CT imaging per year

CEA indicates carcinoembryonic antigen; CT, computed tomography.
^aRecommended in 2005.

for covariates, including age at diagnosis, sex, race/ethnicity, marital status, SES, residence, tumor stage, tumor grade, comorbidity score, SEER registry, and year of diagnosis. *P* values were 2-sided and considered statistically significant at .05. We used SAS software (version 9.13; SAS Institute, Cary, NC) for data management and STATA MP (version 10.0; Stata-Corp LP, College Station, TX) for analyses.

RESULTS

Identified were 7348 patients diagnosed as having stage I to stage III colon adenocarcinoma between January 2000 and June 2002. The median follow-up duration for the study cohort was 59 months (interquartile range, 51-67 months). The **Figure** shows the proportions of patients who met the recommended post-treatment care in the first, second, and third years of follow-up. Ninety-three percent of patients met the recommended care for at least 2 office visits per year in the first year of follow-up, but this decreased over time (88.2% in the second year and 84.0% in the third year). For CEA tests, only 42.2% and 29.4% of patients met the recommended guideline (≥2 CEA tests per year) in the first and second years of follow-up, respectively. Only 58.6% of patients had at least 1 colonoscopy in the first year, and this increased to 67.7% in the second year and to 72.3% in the third year of follow-up. Last, 33.1% of patients had at least 1 CT imaging in the first year, but only 15.6% and 9.2% in the second and third years, respectively.

Table 3 gives demographic and clinical characteristics of the cohort. The mean age at diagnosis was 76 years, 59.8% were female, and 88.8% were of white race/ethnicity. Most subjects were married (52.4%) or widowed (30.1%) and resided in metropolitan (27.6%) or large metropolitan (54.5%) areas. The distributions of tumor stage were 30.0% stage I, 44.7% stage II, and 25.3% stage III. Overall, 65.6% of patients did not undergo chemotherapy within 3 months after tumor resection.

Guideline-specified post-treatment care for office visits was met by 83.9% of patients over the 3-year period after resection. Several notable variations across subgroups were observed. For

example, a lower percentage (75.1%) of patients aged 85 to 89 years than younger patients completed office visits. Marital status was significantly associated with adherence to office visits (*P* < .01). Adherence to office visits was higher among patients with stage III tumors (87.4%) than among patients with localized disease (83.9% for stage I and 82.1% for stage II). Patients treated with chemotherapy were more likely than untreated patients to complete office visits (91.9% vs 79.9%).

Only 29.4% of patients met recommended guidelines for CEA tests (≥2 tests per year in the first and second years of follow-up). Noncompliance was age dependent and tumor stage dependent. Adherence to CEA test recommendations decreased with increasing age (*P* < .01). For patients aged 80 to 84 years and 85 to 89 years, adherence rates were 20.6% and 13.0%, respectively. Adherence to CEA testing among patients with stage III disease was 52.4%, which was considerably higher than among patients with stage I (11.1%) and stage II (28.7%). Patients treated with chemotherapy were more likely to undergo CEA tests compared with untreated patients (60.2% vs 13.3%).

The proportion of patients adhering to recommended colonoscopy follow-up care was 74.3% overall. Patients aged 85 to 89 years had a lower adherence rate (48.9%). Other factors associated with decreased use of colonoscopy included female sex, black race/ethnicity, lower SES, and higher comorbidity score (*P* < .01 for all). Adherence to colonoscopy recommendations did not vary significantly by residence (*P* = .41) or by tumor grade (*P* = .23).

Overall, 25.2% of patients met all 3 post-treatment surveillance recommendations. Factors significantly associated with meeting the overall guidelines included age at diagnosis, race/ethnicity, marital status, SES, residence, tumor stage, tumor grade, and chemotherapy use (*P* < .01 for all). The proportions of patients adhering to any 2 of the post-treatment surveillance recommendations were 28.7% for office visits plus CEA tests, 25.6% for CEA tests plus colonoscopy, and 66.4% for colonoscopy plus office visits (data not shown).

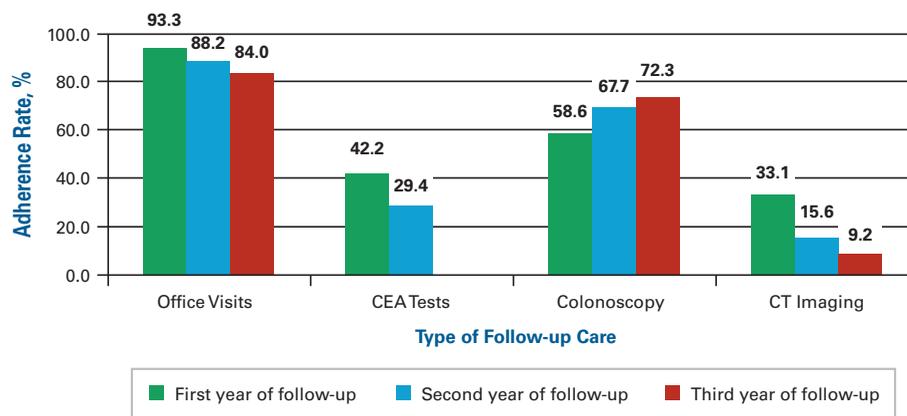
Table 3 gives the proportions of patients undergoing CT imaging. Only 9.2% of patients overall underwent this imag-

■ **Table 2.** International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9 CM) and Current Procedural Terminology (CPT) Codes Used to Identify Colon Cancer Post-treatment Surveillance¹⁷⁻²⁰

Procedure or Service	CPT or ICD-9-CM Codes	Definition
Office visits	CPT physician examination (99201-99215, 99241-99245)	An established patient is one who has received professional services from the physician or another physician of the same specialty who belongs to the same group practice, within the past 3 y
CEA tests	CPT CEA test (82378)	CEA test
CT imaging	CPT thorax (71250, 71260, 71270, 71275), abdomen (74150, 74160, 74170, 74175), pelvis (72191-72194) ICD-9-CM thorax (87.41), abdomen (88.01), pelvis (88.38)	CT of thorax, abdomen, pelvis Computed axial tomography of thorax, abdomen, pelvis
Colonoscopy	CPT 44388-44389, 44392-44394, 45378, 45380, 45382-45385, G105 ICD-9-CM 45.23, 45.25, 45.41, 45.42, 45.43	Colonoscopy Colonoscopy, closed (endoscopic) biopsy of large intestine, excision of lesion or tissue of large intestine, endoscopic polypectomy of large intestine, endoscopic destruction of other lesion or tissue of large intestine

CEA indicates carcinoembryonic antigen; CT, computed tomography.

■ **Figure.** Proportions of Patients Receiving Recommended Colon Cancer Post-treatment Office Visits (≥2 per Year for 3 Years), Carcinoembryonic Antigen (CEA) Tests (≥2 per Year for the First 2 Years), Colonoscopy (≥1 Within 3 Years), and Computed Tomography (CT) (≥1 Imaging per Year for 3 Years)



therapy use, with a strong association of meeting guidelines observed among patients having chemotherapy within 3 months after tumor resection.

DISCUSSION

Adherence to recommended guidelines following curative-intent surgery for colon cancer may identify a recurrence that is potentially curable or may detect metastases at an early stage. Our study found that a significant proportion of patients did not follow the guidelines. These findings are consistent

with results reported by Cooper et al,²⁵ who found that 17.1% of patients with colorectal cancer overall in 2000-2001 from the SEER-Medicare data complied with recommended follow-up care (≥2 office visits per year, ≥2 CEA tests per year in the first and second years of follow-up, and ≥1 colonoscopy within 3 years). Our study of patients in 2000-2002 from the same data set demonstrated higher overall adherence to guidelines of 25.2%, while findings herein were similar to adherence rates for colonoscopy (73.6%) and lower than adherence rates for office visits (92.3%) and CEA tests (46.7%) observed by Cooper et al. These differences between the 2 studies may be explained by the following reasons. Their study assessed follow-up care received 6 months after the date of cancer diagnosis for patients with colon and rectal cancer, whereas we focused on follow-up care re-

ing, and significant variations by age at diagnosis and tumor stage were observed ($P < .01$ for both). For example, 13.3% of patients aged 66 to 69 years had at least 1 CT imaging in the 3-year follow-up period compared with 2.3% of patients aged 85 to 89 years. Patients with late-stage disease were more likely to undergo CT imaging (3.7% with stage I vs 8.7% with stage II vs 16.6% with stage III).

Table 4 summarizes results of multivariate logistic regression models to assess factors related to overall guideline adherence. Variables that remained significantly associated with meeting recommended post-treatment care included the following: (1) age at diagnosis, with older patients less likely to comply with guidelines; (2) marital status, with greater adherence among married patients ($P < .01$); (3) tumor stage; and (4) chemo-

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■ Table 3. Proportions of Patients Receiving Recommended Colon Cancer Post-treatment Office Visits (≥ 2 per Year for 3 Years), Carcinoembryonic Antigen (CEA) Tests (≥ 2 per Year for the First 2 Years), Colonoscopy (≥ 1 Within 3 Years), and Computed Tomography (CT) (≥ 1 Imaging per Year for 3 Years)^a

Patient Characteristic	No. of Patients	%				
		Office Visits	CEA Tests	Colonoscopy	Any of the 3	CT Imaging, %
Overall	7348	83.9	29.4	74.3	25.2	9.2
Age at diagnosis, y	—	<.01	<.01	<.01	<.01	<.01
66-69	1187	85.2	41.0	86.1	37.7	13.3
70-74	1842	84.5	34.9	82.5	30.7	11.8
75-79	2041	86.0	30.5	76.0	26.2	10.1
80-84	1492	84.4	20.6	66.0	15.9	5.2
85-89	786	75.1	13.0	48.9	8.5	2.3
Sex	—	.60	.12	<.01	.14	.01
Male	2954	83.8	30.5	76.9	26.1	10.2
Female	4394	84.2	28.7	72.6	24.6	8.6
Race/ethnicity	—	.01	<.01	.05	<.01	.18
White	6527	84.0	29.3	74.6	25.1	9.2
Black	446	80.9	24.2	69.3	20.6	7.8
Other or unknown	375	88.3	38.4	75.2	32.8	11.5
Marital status	—	<.01	<.01	<.01	<.01	<.01
Unmarried	500	74.6	25.4	68.0	20.8	8.4
Married	3847	87.0	32.9	79.6	28.9	10.4
Separated or divorced	374	78.9	27.8	70.1	23.8	10.7
Widowed	2218	82.2	25.0	68.0	20.3	7.3
Other or unknown	409	81.2	27.1	70.9	23.5	7.8
Socioeconomic status, quartile	—	.09	.02	<.01	.01	<.01
Top	1837	85.0	31.7	76.0	27.4	11.1
Second	1838	85.0	29.9	75.4	26.2	9.1
Third	1836	83.5	27.3	74.5	23.1	8.5
Bottom	1837	82.5	28.9	71.4	24.1	8.2
Residence	—	<.01	.05	.41	.01	.01
Large metropolitan	4008	85.6	30.7	74.6	26.6	10.5
Metropolitan	2029	83.1	28.7	74.0	24.4	7.9
Urban	500	80.0	28.0	74.2	23.0	8.6
Less urban	690	80.4	25.8	75.1	21.7	7.1
Rural	121	84.3	26.4	66.9	19.0	<9.1 ^b
Tumor stage	—	<.01	<.01	<.01	<.01	<.01
I	2206	83.9	11.1	77.0	9.7	3.7
II	3281	82.1	28.7	71.9	24.7	8.7
III	1861	87.4	52.4	75.3	44.5	16.6
Tumor grade	—	.68	<.01	.23	<.01	<.01
Well and moderately differentiated	5868	84.0	28.6	74.6	24.5	8.6
Poorly differentiated and undifferentiated	1249	83.7	35.5	72.7	30.3	12.9
Unknown	231	86.1	16.9	76.2	15.2	<4.8 ^b
Comorbidity score	—	.15	<.01	<.01	.72	.92
0	3935	83.2	32.8	77.5	28.0	9.2
1	2072	84.7	28.0	72.8	24.2	9.1
≥ 2	1341	85.1	21.8	67.3	18.4	9.5

(Continued)

■ **Table 3.** Proportions of Patients Receiving Recommended Colon Cancer Post-treatment Office Visits (≥ 2 per Year for 3 Years), Carcinoembryonic Antigen (CEA) Tests (≥ 2 per Year for the First 2 Years), Colonoscopy (≥ 1 Within 3 Years), and Computed Tomography (CT) (≥ 1 Imaging per Year for 3 Years)^a (Continued)

Patient Characteristic	No. of Patients	%				
		Office Visits	CEA Tests	Colonoscopy	Any of the 3	CT Imaging, %
SEER Registry^c	—	<.76	.01	<.01	.27	<.01
West	2840	84.3	31.5	74.4	26.4	9.1
Midwest	1349	83.0	27.2	77.5	24.7	7.1
Northeast	1768	84.4	28.0	74.3	24.6	11.4
South	1391	83.8	29.2	71.0	23.9	8.7
Year of diagnosis	—	.17	.96	.24	.98	.02
2000	2799	83.6	29.4	75.0	25.2	8.1
2001	2955	83.6	29.3	74.6	25.1	9.8
2002	1594	85.4	29.7	72.6	25.3	10.0
Chemotherapy	—	<.01	<.01	<.01	<.01	<.01
No	4822	79.9	13.3	69.3	10.9	3.7
Yes	2526	91.9	60.2	84.0	52.5	19.8

SEER indicates Surveillance, Epidemiology, and End Results.

^aShaded cells contain *P* values (met recommendations vs did not meet).

^bReported to avoid fewer than 11 cases derived from the percentages, as required by the data user agreement.

^cWest is Hawaii, New Mexico, Seattle, Utah, and California; Midwest is metropolitan Detroit and Iowa; Northeast is Connecticut and New Jersey; South is metropolitan Atlanta, rural Georgia, Kentucky, and Louisiana.

ceived 6 months after tumor resection for colon cancer only. In addition, we excluded claims for services on the same day from different Medicare files to avoid potentially duplicated claims. Furthermore, patients with rectal cancer in their study had a slightly higher overall adherence rate than patients with colon cancer, but rectal cancer was not evaluated in our study. Finally, we evaluated the effect of chemotherapy and found that receipt of chemotherapy was strongly associated with post-treatment surveillance. Other factors that we evaluated included marital status, SES, residence, and year of diagnosis.

The benefits of post-treatment surveillance are well recognized.^{7,9} Available randomized clinical trials reported a 20% to 33% overall risk reduction (or 7% absolute risk reduction) for trial participants receiving more intensive follow-up.¹⁸ However, study participants in clinical trials are often monitored closely; therefore, reported benefits may differ from those among patients in community settings. In this study, we examined a large community-based cohort of older patients to assess the proportion of patients adhering to minimal follow-up care after colon cancer treatment. We found that a considerable proportion of patients did not receive routine surveillance, especially CEA testing. The underlying reasons for this low compliance are unclear. A protein molecule found in many different cells of the body, CEA is frequently used as a tumor marker in oncology. However, CEA is not specific for colon cancer. An elevated CEA level may suggest the occurrence of cancer in the breast, lungs, and other organs of the digestive system, as well as in some noncancerous conditions, such as chronic liver disease or pancreatitis. Also, some tumors never cause an abnormal el-

evated CEA level, even in advanced diseases. Studies^{26,27} have reported that the CEA assay has a low sensitivity in detecting recurrence, although this depends largely on the definition of abnormal CEA levels. For example, Moertel and colleagues²⁸ reported a CEA sensitivity of 34% (>5 ng/mL [to convert CEA level to micrograms per liter, multiply by 1.0]) in detecting surgically curable recurrence of colon cancer and concluded that a small survival gain could not justify the cost and patient stress associated with using the assay. A 2009 meta-analysis²⁹ reported a CEA sensitivity of 64% in detecting recurrence.

In addition to variations in adherence to colon cancer post-treatment surveillance across clinical factors, there were significant differences by age at diagnosis, race/ethnicity, and marital status. Age-associated factors, such as transportation to receive healthcare, stress resulting from treatments, and patient-physician communication, may influence attitudes about the value of follow-up care. Adherence variation seemed to suggest racial/ethnic disparities in the receipt of follow-up care. Moreover, married patients had significantly higher compliance than unmarried patients. This indicates that a spouse may have an important role in follow-up care, such as making and keeping appointments with specialists, providing social support in times of distress, and facilitating transportation to follow-up care. In contrast to nonmodifiable factors, such as age at diagnosis or disease stage (also important predictors herein), roles performed by a spouse may be substituted by social workers or relatives, thereby improving compliance with follow-up care. However, potential surveillance bias should be noted in interpreting our results, as the patients described herein received chemotherapy

prescription and administration at their physician offices or outpatient clinics. Therefore, they were more likely to complete office visits or other post-treatment procedures, leading to higher adherence rates.

Our finding that patients treated with chemotherapy were more likely to comply with post-treatment follow-up care has not been previously reported to our knowledge, and several hypotheses may be generated. For example, it is recommended that patients with stage II colon cancer should receive chemotherapy if they are at a high risk for systemic recurrence (eg, lymphatic or vascular invasion, bowel obstruction, T4 stage, T3 stage with localized perforation, or indeterminate or positive margins).⁶ Treating physicians may endorse chemotherapy for these high-risk patients having stage II disease as part of the follow-up plan. Similarly, because patients having stage III disease (usually treated with chemotherapy) have regional lymph node metastases and are at considerably higher risk of local or regional recurrence, they may be more likely to receive counseling about the importance of post-treatment follow-up.

Several limitations of our study should be noted. First, according to the study by Cooper et al,³⁰ concordance of post-treatment procedures between claims data and medical records is excellent, with κ statistics of 0.80 and 0.78 for colonoscopy and CEA, respectively, but is only moderate ($\kappa = 0.48$) for office visits. Therefore, the accuracy of Medicare coding remains a concern for certain services, possibly resulting in overestimated or underestimated adherence rates. Second, in our assessment of follow-up care using Medicare claims, it may have been difficult to differentiate reliably between procedures performed for diagnostic purposes and proce-

Table 4. Factors Associated With Adherence to Recommended Colon Cancer Post-treatment Surveillance From Multivariate Logistic Regression Analysis Among 7348 Patients

Patient Characteristic	Odds Ratio (95% Confidence Interval)
Age at diagnosis, y	
66-69	1 [Reference] ($\chi^2 = 91.0, P < .01$)
70-74	0.78 (0.66-0.93)
75-79	0.73 (0.61-0.87)
80-84	0.48 (0.39-0.59)
85-89	0.29 (0.22-0.40)
Sex	
Male	1 [Reference] ($\chi^2 = 1.6, P = .20$)
Female	1.08 (0.95-1.24)
Race/ethnicity	
White	1 [Reference] ($\chi^2 = 5.8, P = .05$)
Black	0.72 (0.55-0.96)
Other or unknown	1.10 (0.84-1.43)
Marital status	
Unmarried	1 [Reference] ($\chi^2 = 11.5, P = .02$)
Married	1.39 (1.08-1.80)
Separated or divorced	0.99 (0.69-1.42)
Widowed	1.25 (0.95-1.64)
Other or unknown	1.31 (0.90-1.89)
Socioeconomic status quartile	
Top	1 [Reference] ($\chi^2 = 2.9, P = .41$)
Second	0.97 (0.82-1.15)
Third	0.86 (0.72-1.03)
Bottom	0.91 (0.75-1.11)
Residence	
Large metropolitan	1 [Reference] ($\chi^2 = 4.4, P = .35$)
Metropolitan	0.98 (0.85-1.14)
Urban	0.82 (0.63-1.06)
Less urban	0.84 (0.65-1.07)
Rural	0.73 (0.43-1.24)
Tumor stage	
I	1 [Reference] ($\chi^2 = 52.1, P < .01$)
II	1.81 (1.51-2.17)
III	2.05 (1.66-2.54)
Tumor grade	
Well and moderately differentiated	1 [Reference] ($\chi^2 = 2.3, P = .32$)
Poorly differentiated and undifferentiated	1.02 (0.87-1.19)
Unknown	0.74 (0.49-1.11)
Comorbidity score	
0	1 [Reference] ($\chi^2 = 20.2, P < .01$)
1	0.94 (0.81-1.08)
≥ 2	0.67 (0.56-0.80)
SEER registry	
West	1 [Reference] ($\chi^2 = 2.9, P = .40$)
Midwest	1.06 (0.88-1.27)
Northeast	0.93 (0.79-1.09)
South	0.91 (0.75-1.10)
Year of diagnosis	
2000	1 [Reference] ($\chi^2 = 2.1, P = .35$)
2001	1.04 (0.90-1.19)
2002	1.12 (0.95-1.32)
Chemotherapy	
No	1 [Reference] ($\chi^2 = 564.2, P < .01$)
Yes	5.79 (4.99-6.73)

SEER indicates Surveillance, Epidemiology, and End Results.

dures specifically used for post-treatment surveillance. Third, we did not assess information on providers, such as physicians and hospitals, which might have affected adherence rates among these patients. Fourth, a greater proportion of patients did not undergo annual CT imaging before 2005, when practice guidelines for this follow-up care were introduced,²² and limited information may have been available in recent Medicare claims. Fifth, it is unknown if lack of compliance in later years occurred in patients who had already been diagnosed as having a cancer recurrence or occurred after 3.5 years.

In conclusion, adherence to colon cancer post-treatment surveillance was low, although proportions of patients complying with office visits and colonoscopy were reasonably high. Further investigation may be warranted to determine underlying reasons for noncompliance, which varied by type of service. Because of the recommendation since 2005 for serial CT imaging as part of colorectal cancer surveillance, it may be relevant to study how this service is being disseminated in actual practice.

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