Physician follow-up and observation of guidelines in the post treatment surveillance of colorectal cancer

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Background. *Guidelines for post resection surveillance of colorectal cancer recommend a collection of the patient's history and physical examination, testing for carcinoembryonic antigen (CEA), and colonoscopy. No consistent guidelines exist for the use of abdominal computed tomography (CT) and position emission tomography (PET)/PET-CT. The goal of our study was to describe current trends, the impact of oncologic follow-up on guideline adherence, and the patterns of use of nonrecommended tests.*
Methods. *We used Texas Cancer Registry—Medicare-linked data (2000-2009) to identify physician visits, CEA testing, colonoscopy, abdominal CT, and PET/PET-CT scans in patients ≥66 years old with stage I-III colorectal cancer who underwent curative resection. Compliance with guidelines was assessed with a composite measure of physician visits, CEA tests, and colonoscopy use from start of surveillance.*
Results. *In patients who survived 3 years, the overall compliance with guidelines was 25.1%. In patients seen regularly by a medical oncologist, compliance with guidelines increased to 61.5% compared with 8.8% for those not seen by a medical oncologist regularly (P < .0001). The use of abdominal CT and PET/PET-CT increased from 57.5% and 9.5%, respectively, in 2001 to 65.8% and 24.6% (P < .0001) in 2006. Patients who saw a medical oncologist were more likely to get cross-sectional imaging than those who did not (P < .0001).*
Conclusion. *Compliance with current minimum guidelines for post treatment surveillance of colorectal cancer is low and the use of nonrecommended testing has increased over time. Both compliance and use of nonrecommended tests are markedly increased in patients seen by a medical oncologist. The comparative effectiveness of CT and PET/PET-CT in the surveillance of colorectal cancer patients needs further examination. (Surgery 2013;154:244-55.)*

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Colorectal cancer survivors are at high risk of cancer recurrence and development of new primary tumors. The primary goal of post treatment surveillance is to detect recurrences and/or new primary cancers at an early stage when they are potentially curable. Most professional societies recommend a combination of physician visits, serum carcinoembryonic antigen (CEA) measurements, and colonoscopy after curative-intent treatment for early-stage colorectal cancer. Although the benefit of visits to one's physician has yet to be formally investigated, the onset of new symptoms in colorectal cancer survivors is often the first sign of cancer recurrence; consequently, a routine history collection and physical examinations are accepted as an important part of any post treatment cancer surveillance program.

CEA measurement is a cost-effective surveillance modality in patients with CEA-producing tumors.[1,2] In some cases, an increase in CEA may be the first indicator of recurrence.[3,4] Although nearly all professional societies recommend CEA testing, the frequency and duration of testing are not agreed upon (Table I). In addition, the American Society of Clinical Oncology (ASCO) 2006

Supported by Cancer Prevention Research in Texas grant #RP101207-P03, Clinical and Translational Science Award #UL1TR000071, and NIH T-32 Grant #5T32DK007639. The collection of cancer incident data used in this study was supported by the Texas Department of State Health Services and Cancer Prevention Research Institute of Texas, as part of the statewide cancer reporting program, and the Centers for Disease Control and Prevention's National Program of Cancer Registries Cooperative Agreement #5U58/DP000824–05. Its contents are solely the responsibility of the authors and do not necessarily represent official views of the DSHS, CPRIT, or CDC.

Accepted for publication April 4, 2013.

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0039-6060/$ - see front matter

http://dx.doi.org/10.1016/j.surg.2013.04.013

Table I. Professional society post treatment surveillance guidelines

	H&P	*CEA*	*Colonoscopy*	*Chest/abdominal/ pelvic CT**	*PET/PET-CT*
American Society of Clinical Oncology† (2005)	Every 3–6 months for 1st 3 years, every 6 months for next 2 years	Every 3 months for at least 3 years	3 years. If nl, repeat 5 years Flex sig every 6 mo for 5 years for rectal ca if no radiation	Yearly × 3 years for patients at high risk for recurrence	Not recommended
American Gastroenterological Association (1989) (2008)‡	Every 3–6 months for 2 years, every 6–12 months for 2 years, then yearly	Every 2 months for 2 years, then every 4 months for 2 years, then yearly	Preoperatively or 1st year; Repeat in 1 year then every 3 years. Sigmoidoscopy every 6–12 months for rectal ca	Not recommended	Not recommended
American Society of Colon and Rectal Surgeons (2004)	At least 3 times yearly for 2 years	At least 3 times yearly for 2 years	3 years	Not recommended	Not recommended
National Comprehensive Cancer Network (updated yearly)	3–6 months for 2 years then every 6 months for total of 5 years.	3–6 months for 2 years then every 6 months for a total of 5 years for T2 or greater lesions	1 year (except if no preop colonoscopy due to obstructing lesion, then in 3–6 months)	Yearly × 3–5 years for patients at high risk for recurrence (lymphatic or venous invasion or poorly differentiated tumors)	Not recommended
ACS and USMSTF on Colorectal Cancer (2006)	Not recommended	Not recommended	Preoperative or in 3–6 months after resection. 1 year. If nl, repeat 3 years. If nl, repeat 5 years. Rectal examination every 3–6 months for 2–3 years	Not recommended	Not recommended
American Society for Gastrointestinal Endoscopy	Not recommended	Not recommended	Preoperative or 6 months postoperative 1 year. If nl, repeat in 3 years. If nl, repeat in 5 years.	Not recommended	Not recommended

*Recommendations for CT were introduced in 2005.

†Does not apply to patients with stage I colorectal cancer.

‡2008 guidelines follow ACS and USMSTF recommendations for colonoscopy only.

ACS, American Cancer Society; *CEA*, carcinoembryonic antigen; *CT*, computed tomography; *flex sig*, flexible sigmoidoscopy; *H&P*, history and physical; *nl*, normal; *PET*, positron emission tomography; *rectal ca*, rectal cancer; *USMSTF*, U.S. Multi-Society Task Force.

Update of Recommendations for the Use of Tumor Markers in Gastrointestinal Cancer and the 2003 European Group on Tumour Markers recommend surveillance CEA testing only for patients with stage II and III disease.[5,6]

Periodic surveillance of the colon by colonoscopy is useful in identifying new polyps or cancers and localized, asymptomatic recurrences amenable to curative treatment.[7,8] A meta-analysis of eight randomized controlled clinical trials in which the authors compared different intensity surveillance in colorectal cancer survivors demonstrated a survival benefit and a greater proportion of recurrences amenable to surgical resection in patients undergoing colonoscopic surveillance.[9]

Before 2002, there were no published data on the use of computed tomography (CT) scans for post treatment surveillance. Since then, several studies have demonstrated a survival benefit for CT scanning of the abdomen to detect liver metastases. The improved survival has been attributed to the benefit of metastasectomy in patients with isolated liver metastases.[10-14] The efficacy of PET/PET-CT scans in post treatment surveillance has not been evaluated.

Current guidelines based on these data from the ASCO, the American Gastroenterological Association, the American Society of Colon and Rectal Surgeons, the National Comprehensive Cancer Network, the American Society for Gastrointestinal Endoscopy, and the American Cancer Society and U.S. Multi-Society Task Force on Colorectal Cancer are summarized in Table I.[10,15-17]

Our study uses Texas Cancer Registry and linked Medicare claims data to evaluate guideline compliance for physician visits, CEA testing, and colonoscopy. We also evaluate the use of CT scans of the abdomen, where recommendations are more ambiguous, as well as the use of PET and/or PET-CT, which are not currently recommended. Additionally, we analyzed physician follow-up patterns and the use of tests stratified by provider medical specialty to determine if patterns of care were influenced by provider specialty.

METHODS

The Institutional Review Board at the University of Texas Medical Branch determined this study to be exempt from review. The Texas Department of State Health Services approved the study as did the privacy review board of the Centers for Medicare and Medicaid Services.

Data source. We used Texas Cancer Registry (TCR) and linked Medicare data from 2000 to 2009. The TCR is a statewide population-based registry that serves as the foundation for measuring the Texas cancer burden, comprehensive cancer control efforts, health disparities, progress in prevention, diagnosis, treatment, and survivorship, as well as supports a wide variety of cancer-related research.[18] Medicare data include information on inpatient hospital stays, physician services, hospital outpatient services, and hospice use.[19] Data use agreements were signed with both data providers.

Cohort selection. The details of the cohort selection are shown in Fig 1. We selected patients with resected first primary colorectal adenocarcinoma between 2001 and 2006. This allowed us to evaluate claims (2000–2009) in the year before diagnosis to determine comorbidity and to follow all patients for 3 years after definitive resection. A total of 12,381 beneficiaries met the inclusion criteria. Of these, 8,080 survived at least 3 years from the start of the surveillance period.

Incident cancers were identified from TCR. Adenocarcinoma was identified using *International Classification of Diseases for Oncology*, 3rd Edition histology codes 8000, 8050, 8051, 8052, 8010, 8021, 8022, 8140, 8141, 8143, 8145, 8147, 8210, 8211, 8220, 8221, 8230, 8260, 8261, 8262, 8263, 8430, 8440, 8470, 8471, 8480, 8481, 8490, 8550, 8551, 8570, 8571, 8572, 8573, 8574, and 8575. Definitive colorectal resection was identified from the Medicare claims (Medicare Provider Analysis and Review, carrier, outpatient Standard Analytical File) using *International Classification of Diseases*, Ninth Revision Clinical Modification (ICD-9-CM) procedure codes (45.71-45.76, 45.79, 45.81-45.83, 17.31-17.36, 17.39, 48.41-48.43, 48.49-48.52, 48.59-48.65, and 48.69) and Current Procedural Terminology, Fourth Edition (CPT-4) codes (44140-44147, 44150-44153, 44160, 44204-44208, 44210, 44155-44158, 45110-45114, 45116, 45119-45121, 45123, 45126, 45160, 45170, 45171, 45172, 44120-44212, 45395, and 45397). These codes included colon and rectal resections, both open and laparoscopic with or without colostomy. Patients who underwent stoma formation without resection were not included.

Surveillance period and definition of recurrence. The surveillance period began 90 days after definitive colorectal surgery. All patients were followed for 3 years or until death in the claims data. The 90-day lag before the start of the surveillance period was used to exclude tests done for postoperative complications and routine postoperative physician visits not for surveillance purposes. Of the 12,381 patients, 91.2% were alive at the beginning of the surveillance period. A total of 8,080

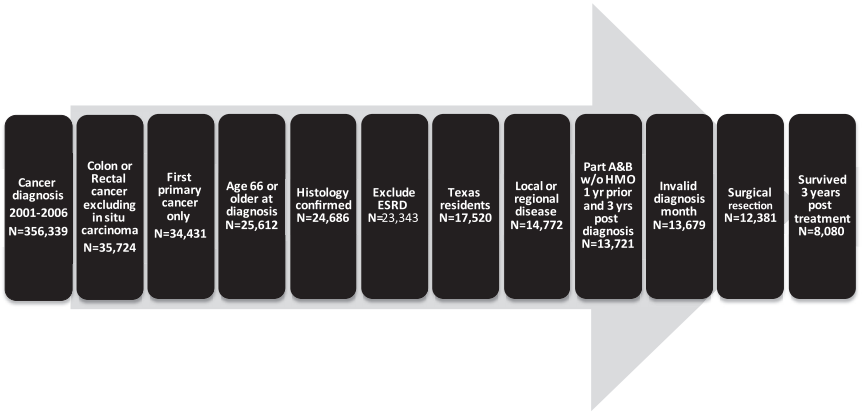

Fig 1. Cohort selection. *HMO*, Health maintenance organization.

patients survived 3 years after the start of the surveillance period. Observation of guidelines and the use of nonrecommended tests were measured in patients surviving for the entire 3-year surveillance period.

Outcome measures and covariates. Medicare claims data in inpatient, outpatient, and carrier files were examined for receipt of procedures of interest using relevant ICD-9-CM or CPT-4 codes. Procedures included physician office visits (Evaluation and Management CPT-4 codes: 99201-99215, 99241- 99245), CEA (CPT-4: 82378), colonoscopy (CPT-4: 44388, 44389, 44392-44394, 45378, 45380, 45382-45385, G0105; ICD-9-CM: 45.23, 45.25, 45.41, 45.42, 45.43, 48.36), abdominal/pelvic CT scan (CPT-4: 72191-72194, 74150, 74160, 74170, 74175, 75635), PET/PET-CT scan (CPT-4: 78811-78816, G0213, G0214, G0215, G0163, G0231), and abdominal ultrasound (CPT-4 codes: 76700 and 76705; ICD-9-CM codes: 88.76, 88.74, and 88.79). Duplicated claims for the same procedure on the same date of service were deleted such that each test was counted only once.

We had two primary outcome measures: overall compliance with current guidelines and use of nonrecommended surveillance tests (specifically CT abdomen/pelvis, PET/PET-CT, and ultrasound). On the basis of a composite measure previously used by Cooper et al,[20] patients were considered as complying with guidelines if they had: (1) two or more physician visits per year for 3 years, (2) two or more CEA tests per year for 2 years, and (3) at least one colonoscopy in the 3-years surveillance period. We also evaluated compliance with the individual measures included in the composite measure to understand which components contributed to lack of compliance. In addition to obtaining overall physician visits, we evaluated physician visits by specialty using the Medicare Health Care Financing Administration specialty claims codes. We categorized specialty as primary care physician (PCP: included general practitioner [01], family practice [08], internal medicine [11], geriatrician [38]), medical oncologist (medical oncology [90], hematology/oncology [83]), radiation oncologist (92), gastroenterologist (10), and surgeon (general surgeon [02], surgical oncologist [91], colorectal surgeon [28]). We evaluated both "any visit" by a specific specialist in the 3-year surveillance period as well as "regular physician visits" defined as two or more visits by the same type of physician every year for the 3-year surveillance period.

Covariates. Sociodemographic characteristics included age, sex, socioeconomic status, and race/ethnicity. Charlson comorbidity index was used as a measure of patient comorbidity. Tumor characteristics included site (colon vs rectum), stage (local vs regional), tumor size, nodal status, and tumor differentiation. For patients with tumors classified as "rectosigmoid" (8.1% of the cohort) in TCR, we included them as "rectal" if they underwent radiation either before or after surgery and as "colon" if they did not. Localized disease was confined to the bowel wall, whereas regional disease extended to adjacent organs or regional lymph nodes. All patients underwent surgical resection. The percentage of patients receiving adjuvant chemotherapy was determined for the overall cohort. For patients with rectal cancer, the percentage of patients receiving adjuvant or neoadjuvant radiation was determined. Recurrence after surgery was defined as treatment with nonadjuvant chemotherapy and/or radiation (starting more than 6 months after surgery or a new course given after adjuvant therapy was completed), a second colorectal resection for a primary diagnosis of colorectal cancer, or admission to hospice.

Analysis. We calculated summary statistics for the overall cohort and measured the unadjusted association between patient, tumor, and treatment characteristics and receipt of guideline adherent post-treatment surveillance for the composite measure as well as the individual components. Overall and disease-specific survival was calculated for the whole cohort as well as the colon and rectal subgroups. The overall use of nonrecommended tests was evaluated. We used a Cochran-Armitage test for trend to evaluate trends in compliance or use of nonrecommended tests over time. Multivariate logistic regression was used to determine factors independently associated with the receipt of guideline adherent and non-recommended surveillance. Both overall compliance and use of nonrecommended tests were evaluated in the 8,080 patients who survived the entire surveillance period, consistent with the Cooper study.[20]

For colonoscopy and CEA measurements we used a Kaplan-Meier time-to-event analysis to evaluate patterns of regular surveillance. This analysis included all 12,381 patients. We measured the percent of patients undergoing colonoscopy or CEA from the start of the surveillance period. Patients were censored when they recurred or died of any cause without documented recurrence as defined previously as they were no longer "at risk" or eligible for surveillance. This allowed us to measure overall compliance with colonoscopy and CEA until death or recurrence in all 12,381 patients, to evaluate the median time to the first test, and to evaluate the percentage of patients getting the test within the recommended time frame. In addition, it allowed us to assess regular surveillance. Conditional on receiving a first test, we were able to assess the time from the first to second test. All *P* values were from two-sided tests. All analyses were performed with SAS version 9.2 (SAS Inc, Cary, NC).

RESULTS

Patient, tumor, and primary treatment characteristics (Table II). A total of 12,381 patients (mean age 77.1 ± 7.1 years; 53.2% female) met our inclusion criteria; 85.9% of patients were white, 8.1% black, and 4.5% Hispanic. The majority of patients had a Charlson comorbidity score of zero (58.8%). Eighty percent (86.7%) of cancers were in the colon of which 43.1% were in the right colon, 33.0% in the left colon, 6.9% in the transverse colon, and 3.7% were unspecified. The remaining 13.3% were rectal cancers. Surveillance Epidemiology and End Results stage was local in 48.2% and regional in 51.8% of patients. The remaining tumor characteristics are shown in Table II.

Table II. Patient, tumor, and primary treatment characteristics

Patient demographics	n = *12,381*	n = *8,080*
Age (y), mean ± SD	77.1 ± 7.1	75.7 ± 6.5
Female sex*	6,590 (53.2)	4,337 (53.7)
Race (*n* = 12,365)		
White	10,621 (85.9)	6,985 (86.5)
Black	998 (8.1)	614 (7.6)
Hispanic	550 (4.5)	339 (4.2)
Other	196 (1.6)	134 (1.7)
Charlson comorbidity score		
0	7,284 (58.8)	5,197 (64.3)
1	2,867 (23.2)	1,786 (22.1)
2	1,202 (9.7)	661 (8.2)
3	1,028 (8.3)	436 (5.4)
Tumor characteristics		
Colon cancer	10,734 (86.7)	6,427 (79.5)
Rectal cancer	1,647 (13.3)	1,653 (20.5)
Local	5,970 (48.2)	4,422 (54.7)
Regional	6,411 (51.8)	3,658 (45.3)
Tumor size (*N* = 10,095), mean, mm	44.3	42.3
Lymph node status (*N* = 11,342/7,405)		
Positive	3,862 (34.1)	2,050 (27.7)
Negative	7,480 (66.0)	5,355 (72.3)
Poorly differentiated	2,164 (17.5)	1,161 (14.4)
Site		
Right	5,339 (43.1)	3,439 (42.6)
Left	4,081 (33.0)	2,864 (35.5)
Transverse	854 (6.9)	528 (6.5)
Unspecified	460 (3.7)	292 (3.6)
Treatment		
Adjuvant chemotherapy (yes)	3,760 (30.4)	2,656 (32.9)
Adjuvant radiation (rectal cancer only)	310 (21.2)	200 (20.9)
Neoadjuvant chemotherapy (yes)	665 (5.4)	456 (5.6)
Neoadjuvant radiation (rectal cancer only)	717 (29.2)	505 (30.5)

*Values are *n* (%) unless otherwise indicated.

All patients underwent resection of the primary tumor. Adjuvant chemotherapy was administered to 30.4% of patients. A total of 46.1% of those with regional disease received adjuvant chemotherapy compared with 13.5% for local disease ($P < .0001$). In rectal cancer patients, 46.5% were treated with adjuvant chemotherapy and 30.2% received adjuvant radiation. Neoadjuvant chemoradiation was administered to only 4.0% of rectal cancer patients.

Survival and recurrence. The overall 5-year survival rate for the cohort (N = 12,381) was 53.0%. The 5-year survival was 52.9% and 53.6% for colon and rectal primaries, respectively. The

5-year disease specific survival was 78.0% for colon and 76.2% for rectal primaries. A total of 11,290 patients (91.2%) survived to the beginning of the surveillance period and 8,080 patients (65.3%) survived 3 years from the start of the surveillance period, which began 90 days after surgery. The patient, tumor, and treatment characteristics for the 8,080 patients surviving three years are also shown in Table II. As would be expected, patients who survived 3 years were more likely to be younger, healthier, and had localized disease. A total of 39.4% of patients experience a recurrence of disease during the study period. Most recurrences (76.9%) were identified by treatment with nonadjuvant chemotherapy and/or radiation (starting more than 6 months after surgery or a new course given after adjuvant therapy was completed), 21.4% were identified upon referral to hospice, 1% were identified when they underwent a second surgical resection of colorectal cancer, and less than 1% were identified when they died from colon cancer, without previous evidence of recurrence and likely represent untreated recurrences.

Compliance with current guidelines (Table III). *Overall compliance (composite measure).* In patients surviving 3 years, compliance with the composite measure based on current guideline recommendations was 25.1% (Table III). Although it was statistically significant, overall compliance only improved from 20.8% in 2001 to 25.7% in 2007 (Fig 2, $P = .018$).

Physician visits. Of the three components, compliance with office visits was the highest (Table III), with 85.4% of patients seeing a physician at least twice a year for the 3-year surveillance period. A physician evaluated 98.9% of patients at least one time in the surveillance period. Beneficiaries most commonly saw PCPs, medical oncologists, surgeons, and gastroenterologists in the follow-up period (Table IV), and many patients were co-followed with 50.4% of patients seeing both an oncologist and a PCP. A PCP alone saw 36.6% of patients and a medical oncologist alone saw 7.0% of patients. Regular physician visits (two visits per year for 3 years for individual specialist/physician types) were most common for medical oncologists and PCPs. A total of 30.9% of patients were regularly seen by a medical oncologist, 46.7% by a PCP, 3.9% by a surgeon, 1.5% by a gastroenterologist, and less than 1% by a radiation oncologist (Table IV).

CEA. Measurement of serum CEA twice a year for 2 years was low at 29.5% (Table II) and was relatively stable over time. A total of 62.1% of patients had at least one CEA in the 3-year surveillance period, and 34.6% had one per year for the 3 years.

Table III. Compliance with recommended guidelines

Compliance	*Overall,* N = *8,080*	*PCP (regular follow-up),** n = *3,775*	*Medical oncologist (regular follow-up),** n = *2,498*
Composite measure†	2,029 (25.1)	1,046 (27.7)	1,537 (61.5)
Office visits	6,898 (85.4)	3,775 (100)	2,498 (100)
CEA	2,382 (29.5)	1,201 (31.8)	1,761 (70.5)
Colonoscopy	6,080 (75.3)	2,998 (79.4)	2,166 (86.7)

*Two visits per year for 3 years.
†Values are *n* (%) unless otherwise indicated.
CEA, Carcinoembryonic antigen.

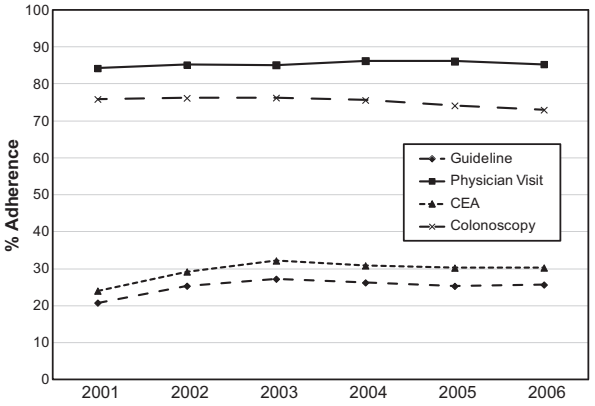

Fig 2. Trends in compliance with composite measure guidelines, physician visits, serum CEA measurements, and colonoscopy from 2001 to 2006.

Table IV. Physician visits during 3-year follow-up, $N = 8,080$

Physician specialty	*Any visit*	*Regular visits**
Any physician	7,998 (98.9)†	6,898 (85.4)
Medical oncologist	4,642 (57.5)	2,498 (30.9)
PCP	7,032 (87.0)	3,775 (46.7)
Surgeon	4,554 (56.4)	313 (3.9)
Radiation oncologist	5,83 (7.2)	18 (0.2)
Gastroenterologist	3,340 (41.3)	123 (1.5)

*Regular visits = ≥2 visits per year.
†Values are *n* (%) unless otherwise indicated.
PCP, Primary care physician.

Of the 5,059 patients who had a serum CEA drawn during the first year, 80.0% received a second within a year of the first. The median time between the first and second measurement was 3.7 months, suggesting regular surveillance in those who were tested.

Colonoscopy. During the 3-year surveillance period, 75.3% of beneficiaries had at least one colonoscopy (Table III). Colonoscopy rates decreased slightly over the time period from 75.9% in 2001 to 73.0% in 2006 (Fig 2, $P = .037$). In a Kaplan-Meier analysis, from the start of surveillance, the median time to first colonoscopy was 11.3 months, with 53.7% of patients having a colonoscopy by the end of the first year and 75.3% by the end of the third year of surveillance (Fig 3, *A*). In the patients who had a first colonoscopy after curative intent treatment, the median time from first colonoscopy to second was 27.6 months, and 58.0% of patients had a second colonoscopy within 3 years as recommended by most societies (Fig 3, *B*). After the first colonoscopy, there are peaks in colonoscopy rates at the 1-, 2-, and 3-year time points, suggesting that practice patterns may differ from the guidelines.

Factors predicting compliance with guidelines (Table V and Table VI). Table V shows the unadjusted guideline compliance (composite and individual measures) by patient and tumor characteristics. Patients who were younger, presented with regional disease, and had seen a medical oncologist were more likely to comply with the composite guidelines. Compliance increased to 61.5% in patients who were followed regularly by a medical oncologist compared with 8.8% in patients who were not followed regularly ($P < .0001$).

Compliance with CEA serum testing (twice a year for 2 years) was more likely to occur in younger, healthier patients, those with poorly differentiated tumors, regional disease, rectal cancers, and in those who were followed regularly by a medical oncologist or PCP. Our study shows double the rate of guideline-compliant CEA testing in patients with regional disease, but even in this group, CEA testing twice annually for 2 years was only achieved in 41.0% of patients. Patients younger than 70 years of age were more than twice as likely to have regular CEA measurements compared with those 85 years and older. CEA testing showed the greatest improvement in compliance with regular medical oncology visits. Those who were seen regularly received CEA testing 70.5% of the time compared to 11.1% in those who did not see an oncologist regularly ($P < .0001$).

Factors associated with compliance with colonoscopy recommendations were younger age, white race, Charlson comorbidity score of 0 or 1, and physician follow-up. Similar to CEA testing, compliance improved more dramatically when a medical oncologist was involved in follow-up care. Compliance with colonoscopy improved to 86.7% when a medical oncologist saw patients regularly. Patients not seen regularly by an oncologist received colonoscopy only 70.1% of the time ($P < .0001$). On multivariate analysis, male sex, younger age, regional disease, regular medical oncology visits, and regular PCP visits were associated with overall guideline compliance (Table VI).

Use of nonrecommended tests. The use of CT of the abdomen, PET and/or PET-CT increased sharply from 2001 to 2006. In 2001, the use of CT and PET/PET-CT was 57.5% and 9.5% respectively. This increased to 65.8% and 24.6% in 2006 ($P < .0001$; Fig 4). Factors associated with use of these imaging modalities were similar to those associated with guideline compliance (Table VI). Patients evaluated by a medical oncologist at any point were more likely to obtain CT scans and PET/PET-CT scans. Patients with regular PCP visits were more likely to have CT scans, but not PET/PET-CT (Table VI). CT and PET/PET-CT were also more common with increasing year of diagnosis, in patients with rectal primaries, in patients with regional disease, and for PET/PET-CT, in those with poorly differentiated tumors.

We found evidence of regular use of abdominal CT and PET/PET-CT. 50.5% of patients who received a CT scan received a second one within a year and 33.0% of patients who received a PET/PET-CT scan received a second one within a year. Only 15.9% ($n = 1,287$) had an abdominal ultrasound in the 3-year surveillance period. Of those patients who had one abdominal ultrasound, a second abdominal ultrasound was performed in 19.8% of patients.

DISCUSSION

Compliance with the minimal recommendations for post treatment surveillance of colorectal cancer occurred in only 25% of patients with resected primary colorectal cancer. The poorest compliance occurred with serum CEA measurements, with better compliance for physician visits and colonoscopy. Although underuse of recommended testing is evident, there is also a pattern of testing in excess of the recommended guidelines in this patient population. The use of PET scans and PET/CT scans increased during the study period despite no professional society recommendations for PET/PET-CT use in post treatment surveillance. Similarly, CT scan use increased over time, although it was not recommended for post treatment surveillance until near the end of our study period in 2005. The use of nonrecommended tests correlates with guideline compliance, with patients adhering to

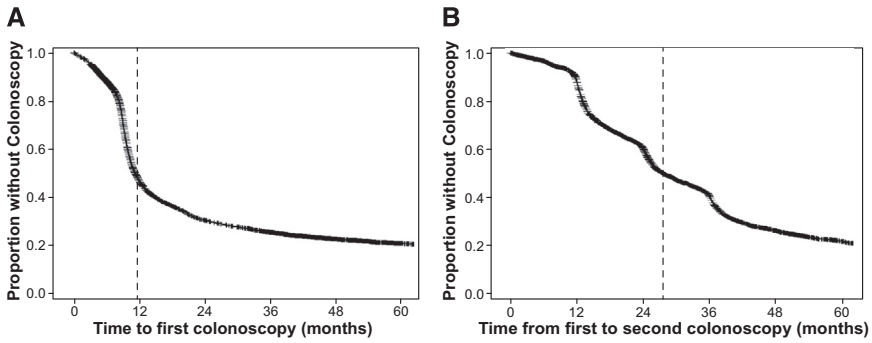

Fig 3. Time to first and second colonoscopies. (*A*) Time to first colonoscopy. (*B*) Time from first to second colonoscopy.

guidelines being more likely to undergo additional testing. Additionally, there was a difference in guideline compliance on the basis of which medical specialist provided post treatment surveillance care. Evaluation by a medical oncologist during the follow up period had the strongest association with improvement of guideline compliance. However, medical oncologist follow-up was also associated with the greatest increase in the use of nonrecommended tests.

Our results show minimal improvement over previous population-based data on guideline compliance. An earlier population based study, using Surveillance Epidemiology and End Results−Medicare-linked data and an identical composite measure of guideline compliance, found that in patients diagnosed between 2000 and 2001, overall guideline compliance was only 17.1%.[20] The authors also evaluated the use of cross-sectional imaging studies in this population. Imaging in excess of guidelines was defined, by the authors, as the receipt of ≥1 CT scan and/or ≥1 PET scan in patients who met overall guideline recommendations. Guideline recommendations were exceeded in 22.7% of patients. Similar to our results, younger age and regional tumors were found to be predictors of both compliance and overuse of imaging studies.[20] Our study demonstrates further increase in the use of nonrecommended tests.

There is disagreement regarding the benefit of serial CEA measurements in surveillance. Although some studies suggest it is a cost-effective surveillance strategy,[1,2] others have documented negligible improvements in survival.[21-23] Our study demonstrated overall rates of CEA testing compliance to be only 29.5%. This is lower than the 46.7% demonstrated in the earlier population-based study by Cooper et al[20] and the 32.8% documented in a Swiss cohort study.[24] Although initially recommended in all patients, the 2006 ASCO guidelines recommended CEA testing only in stage II-III colorectal cancers.[6] Our study includes stage I cancers and therefore may overestimate noncompliance. However, compliance was <50% even in patients with regional disease. Serial CEA measurements may not be useful for surveillance in patients whose primary tumor was a non-CEA−producing tumor. Since we could not identify these patients in TCR-Medicare data, we may be overestimating noncompliance. However, the percentage of non-CEA−producing tumors should be low, as it is estimated that approximately 60–90% of recurrent colon cancers produce CEA.[24,25]

Screening for liver metastases may be performed with abdominal ultrasonography, CT, or PET/PET-CT. In Europe, abdominal ultrasound has proven an effective imaging modality in the detection of hepatic metastases amenable to surgical resection.[26-28] However, in their 2005 update, the American Society of Clinical Oncology did not find sufficient evidence supporting the recommendation for abdominal ultrasound in post treatment surveillance.[10] Only 16% of patients in our study underwent abdominal ultrasound in the 3-year surveillance period.

Three meta-analyses and one prospective randomized trial identified a benefit in the detection of resectable liver metastases and improved survival in patients undergoing periodic abdominal CT scans.[11-14] Currently, CT scanning of the chest, abdomen, and pelvis is recommended for patients at high risk for recurrence, such as those with poorly differentiated tumors or those whose pathology demonstrates lymphovascular invasion. Because cross-sectional imaging was not recommended during most of our study period, we considered the use of CT in post treatment surveillance in excess of the recommended guidelines. However, it is possible that the increase we observed in CT scan use may be due to the initial findings of benefit first published in 2002 and may represent indicated studies.

Table V. Bivariate analysis of factors predicting compliance with composite guidelines, CEA measurements, and colonoscopy

Factor (P value)	*Guideline compliance*	*Serum CEA measurement compliance*	*Colonoscopy compliance*
Age, years*,†,‡			
66–69	530 (32.5)§	597 (36.6)	1,385 (84.9)
70–74	642 (29.6)	739 (34.0)	1,774 (81.7)
75–79	527 (25.8)	619 (30.3)	1,586 (77.6)
80–84	249 (18.3)	301 (22.1)	925 (68.0)
≥85	81 (9.3)	126 (14.4)	410 (46.8)
Sex			
Male	927 (24.8)	1,095 (29.3)	2,851 (76.2)
Female	1,102 (25.4)	1,287 (29.7)	3,229 (74.5)
Race‡			
White	1,789 (25.6)	2,083 (29.8)	5,335 (76.4)
Black	138 (22.5)	163 (26.6)	434 (70.7)
Hispanic	70 (20.7)	93 (27.4)	214 (63.1)
Other	31 (23.1)	41 (30.6)	92 (68.7)
Cancer type*,†			
Colon	1,578 (24.6)	1,842 (28.7)	4,854 (75.5)
Rectal	451 (27.3)	540 (32.7)	1,226 (74.2)
Differentiation*,†			
Poorly differentiated	363 (31.3)	429 (37.0)	860 (74.1)
Well differentiated	1,666 (24.1)	1,953 (28.2)	5,220 (75.4)
Stage*,†,‡			
Local	763 (17.3)	882 (20.0)	3,375 (76.3)
Regional	1,266 (34.6)	1,500 (41.0)	2,705 (74.0)
Charlson comorbidity score*,†,‡			
0	1,380 (26.6)	1,610 (31.0)	3,997 (76.9)
1	430 (24.1)	507 (28.4)	1,348 (75.5)
2	141 (21.3)	171 (25.9)	457 (69.1)
≥3	78 (17.9)	94 (24.6)	278 (63.8)
Medical oncologist visits*,†,‡			
Regular medical oncologist	1,537 (61.5)	1,761 (70.5)	2,166 (86.7)
No regular medical oncologist visit	492 (8.8)	621 (11.1)	3,914 (70.1)
PCP visits*,†,‡			
Regular PCP visits	1,046 (27.7)	1,201 (31.8)	2,998 (79.4)
No regular PCP visits	983 (22.8)	1,181 (27.4)	3,082 (71.6)
Year of diagnosis*,†			
2001	281 (20.8)	325 (24.0)	1,026 (75.9)
2002	361 (25.4)	416 (29.2)	1,085 (76.2)
2003	390 (27.2)	461 (32.2)	1,092 (76.3)
2004	353 (26.3)	415 (30.9)	1,017 (75.6)
2005	338 (25.3)	404 (30.3)	990 (74.2)
2006	306 (25.7)	361 (30.3)	870 (73.0)
Education*,†,‡			
Quartile 1	440 (23.0)	520 (27.2)	1,362 (71.2)
Quartile 2	444 (22.9)	545 (28.1)	1,447 (74.6)
Quartile 3	543 (26.8)	621 (30.7)	1,547 (76.5)
Quartile 4	585 (27.3)	676 (31.6)	1,674 (78.2)
Income*,†,‡			
Quartile 1	406 (21.4)	497 (26.2)	1,354 (71.3)
Quartile 2	452 (22.9)	536 (27.2)	1,456 (73.8)
Quartile 3	560 (27.7)	647 (32.0)	1,551 (76.7)
Quartile 4	594 (28.1)	682 (32.2)	1,669 (78.8)

*$P < .02$ for guideline compliance.
†$P < .02$ for CEA compliance.
‡$P < .02$ for colonoscopy compliance.
§Values are *n* (%) unless otherwise indicated.
P values for χ^2 analysis representing any difference within categories.
CEA, Carcinoembryonic antigen; *PCP*, primary care physician.

Table VI. Multivariate analysis of factors predicting compliance with guidelines and use of CT and PET/PET-CT

Factor (Ref)	*Guideline compliance OR (95% CI)*	*CT use OR (95% CI)*	*PET/PET-CT use OR (95% CI)*
Age (≥85 years)			
66–69	2.80 (2.09–3.74)	1.85 (1.54–2.21)	2.54 (1.89–3.42)
70–74	2.55 (1.92–3.39)	1.71 (1.44–2.03)	2.46 (1.84–3.29)
75–79	2.47 (1.85–3.28)	1.59 (1.34–1.88)	2.27 (1.69–3.04)
80–84	1.84 (1.36–2.50)	1.28 (1.07–1.53)	1.72 (1.26–2.35)
Sex (male)	1.14 (1.00–1.29)	0.99 (0.90–1.09)	0.84 (0.75–0.96)
Race (Hispanic)			
Black	1.40 (0.94–2.07)	0.95 (0.70–1.28)	0.87 (0.60–1.26)
White	1.31 (0.94–1.82)	0.88 (0.69–1.14)	0.94 (0.69–1.28)
Other	1.13 (0.63–2.03)	0.92 (0.59–1.44)	1.14 (0.67–1.95)
Cancer (rectum)	1.03 (0.87–1.22)	0.60 (0.51–0.69)	0.61 (0.52–0.71)
Poorly differentiated (no)	1.09 (0.92–1.29)	1.17 (1.01–1.35)	1.25 (1.06–1.47)
Stage (local)	1.48 (1.30–1.68)	1.69 (1.53–1.87)	1.69 (1.49–1.91)
Charlson comorbidity score (0)			
1	0.96 (0.83–1.12)	1.12 (1.00–1.27)	0.94 (0.81–1.10)
2	0.76 (0.60–0.96)	1.18 (0.98–1.41)	1.11 (0.88–1.38)
≥3	0.75 (0.55–1.01)	1.01 (0.82–1.25)	0.83 (0.62–1.12)
Medical oncologist visit (no)	14.22 (12.49–16.18)	3.75 (3.31–4.25)	4.30 (3.79–4.88)
PCP visit 2×/3 years (no)	1.51 (1.33–1.72)	1.27 (1.15–1.40)	1.07 (0.94–1.21)
Year of diagnosis (per year)	1.02 (0.98–1.06)	1.07 (1.04–1.10)	1.23 (1.18–1.27)
Education (Q1)			
Q2	1.03 (0.86–1.24)	1.06 (0.92–1.22)	0.72 (0.61–0.87)
Q3	1.28 (1.07–1.54)	0.99 (0.86–1.14)	0.81 (0.68–0.97)
Q4	1.38 (1.15–1.65)	1.00 (0.87–1.15)	0.89 (0.74–1.05)

95% CI, 95% confidence interval; *CT*, computed tomography; *OR*, odds ratio; *PCP*, primary care physician; *PET*, positron emission tomography.

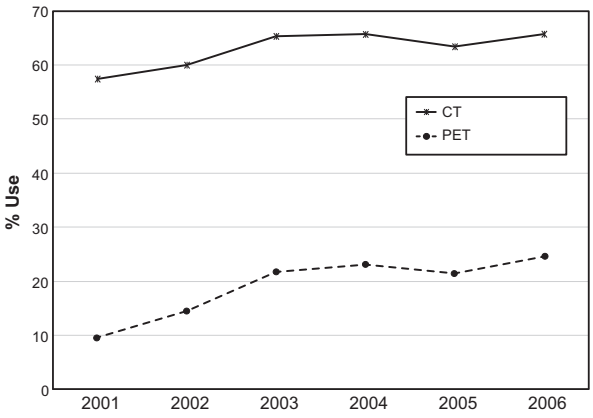

Fig 4. Trend in use of CT and PET/PET-CT from 2001 to 2006.

In a study evaluating the changes in use and the costs of diagnostic imaging studies among Medicare beneficiaries with cancer, researchers found that imaging studies contribute less than 6% of total health care expenditure but the costs for CT scans, PET, and MRI are increasing twice as fast as the overall cost of cancer care.[29] Consistent with these findings, the use of PET/PET-CT increased sharply during the study period and in 2007 was performed in nearly a quarter of survivors. Although PET-CT has been found to be more sensitive compared with CT in the detection of recurrence, new primary tumors, and metastatic disease in several trials,[30-33] there is a paucity of published data on the added value of PET/PET-CT in the detection of recurrence or metastatic disease in patients being followed in a surveillance program.[34]

Further studies are needed to determine the comparative effectiveness of various post treatment surveillance strategies on overall and disease-specific survival, disease-free survival, and cost. The data generated in our study are the first step in using observational data to evaluate the comparative effectiveness of CT and/or PET-based surveillance strategies as well as other less expensive modalities, such as abdominal ultrasonography. However, studying the comparative effectiveness of these strategies in an observational dataset presents many challenges. A simple comparison of the percent of patients with detected recurrence in the compliant and noncompliant groups is subject to significant selection bias. Advanced statistical methods such as propensity score analyses or instrumental variable

analyses will be needed to control for selection bias when evaluating outcomes such as overall survival, time to recurrence, and disease-free survival.

Involvement of both medical oncologists and PCPs in the care of colorectal cancer patients has been shown to improve the receipt of non-cancer related health care for chronic medical conditions.[35,36] It has also been demonstrated that colorectal cancer survivors who did not see a medical oncologist were less likely to undergo surveillance colonoscopy when compared to patients seen by an oncologist (27.6% vs 46.7%).[36] In our study, compliance with surveillance guidelines was markedly improved in patients followed regularly by a medical oncologist compared with patients not followed regularly by a medical oncologist (61.5% vs 8.8%).

Although our study highlights the importance of involvement of a medical oncologist in the follow-up of colorectal cancer survivors, we hesitate to conclude that a medical oncologist should follow all colorectal cancer patients. Compliance with guidelines is improved with medical oncology follow-up; however, the use of nonrecommended tests is also increased. Moreover, with the increasing number of older patients and prolonged survival of colorectal cancer survivors, it is not feasible for medical oncologists to follow all patients long-term. We need to educate providers caring for colorectal cancer patients and improve the communication between oncologists and primary care providers in the transfer of survivorship care back to the PCPs. In the current era of highly specialized medicine, PCPs may erroneously assume that an oncologist is involved and consequently do not take on post treatment surveillance care.

Our study has several limitations. We did not investigate the indication for medical services. Compliance with physician visits may be overestimated because these services may have been rendered as part of care not related to the patient's diagnosis of colorectal cancer. Likewise, specific billing claims for physical examination components, such as digital rectal exams are not available; therefore, we cannot evaluate the completeness or thoroughness of the physical examinations performed. Similarly, imaging may have been prompted by symptoms or may have been obtained to diagnose complications related to treatment. Therefore, the use of CT and PET/PET-CT may be overestimated. Despite this limitation, we would not expect the proportion of symptomatic patients to change over time, so the increasing trend remains striking. Clinically, a PET scan may be obtained to work-up an elevated CEA when a CT scan does not demonstrate a recurrence. We did not analyze the number of PET/PET-CTs obtained after a CT scan. In addition, there may be reasons for lack of surveillance in older patients. Some patients may be deemed too frail or have too many comorbid conditions to undergo retreatment of a recurrent cancer and therefore post treatment surveillance is not viewed to be of benefit. Likewise, older patients may decline surveillance because they may be unwilling to undergo retreatment even if it is recommended by their physician.

Our study demonstrates inadequate post treatment surveillance in older patients after resection for early stage primary colorectal cancer. Given the prevalence of colorectal cancer and recurrence rates of 30–40%, assurance of appropriate post-treatment surveillance is an important health care issue. Improved compliance can be achieved through standardization of guidelines across societies. Such standardization needs to be driven by quality studies evaluating the comparative effectiveness of current and newer surveillance strategies and may vary based on initial tumor stage. Improved education for nononcologic physicians following colorectal cancer survivors, improved communication, and transition of care from medical oncologists to PCPs after completion of adjuvant therapy may improve the quality of surveillance in this vulnerable population.

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