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Primary Care Utilization and Colorectal Cancer Outcomes Among Medicare Beneficiaries

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Abstract

Background—Primary medical care may improve colorectal cancer (CRC) outcomes through increased use of CRC screening tests and earlier diagnosis. We examined the association between primary care utilization and CRC screening, stage at diagnosis, CRC mortality, and all-cause mortality.

Methods—We conducted a retrospective cohort study of patients, aged 67 to 85 years, diagnosed as having CRC between 1994 and 2005 in the Surveillance, Epidemiology, and End Results–Medicare–linked database. Association of the number of visits to primary care physicians (PCPs) in the 3- to 27-month period before the CRC diagnosis and CRC screening, early-stage diagnosis,

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Disclaimer: The interpretation and reporting of the SEER-Medicare data are the sole responsibility of the authors. The ideas and opinions expressed herein are those of the authors; endorsement by the State of California Department of Public Health, the National Cancer Institute, and the Centers for Disease Control and Prevention or their contractors and subcontractors is not intended and should not be inferred.

CRC mortality, and all-cause mortality were examined using multivariable logistic regression and Cox proportional hazards models.

Results—The odds of CRC screening and early-stage diagnosis increased with increasing number of PCP visits (*P*<.001 for trend). Compared with persons having 0 or 1 PCP visit, patients with 5 to 10 visits had increased odds of ever receiving CRC screening at least 3 months before diagnosis (adjusted odds ratio, 2.60; 95% CI, 2.48-2.72) and early-stage diagnosis (1.35; 1.29-1.42). Persons with 5 to 10 visits had 16% lower CRC mortality (adjusted hazard ratio [AHR], 0.84; 95% CI, 0.80-0.88) and 6% lower all-cause mortality (0.94; 0.91-0.97) compared with persons with 0 or 1 visit.

Conclusions—Medicare beneficiaries with CRC have better outcomes if they have greater utilization of primary care before diagnosis. Revitalization of primary care in the United States may help strengthen the national efforts to reduce the burden of CRC.

Colorectal cancer (CRC) is the fourth most common cause of new cancers and second leading cause of cancer death sin the United States.[1] In 2010, there were an estimated 142 570 incident cases and 51 370 deaths from CRC. The 5-yearsurvival rate is greater than 90% for localized CRC, decreasing to 70% for regional disease and 11% for distant stage.[1] Screening for CRC prevents cancer, detects early-stage cancer, and decreases cancer-related mortality.[2] However,only 59% of American adults aged 50 years or older have ever received a CRC screening test.[3] Primary care physicians (PCPs) play a critical role in the delivery of CRC screening by ordering fecal occult blood tests (FOBTs) or referring patients for colon endoscopy. Indeed, a PCP's recommendation is one of the strongest predictors of patients' adherence to CRC screening.[4,5]

Population-based studies have found that a higher supply of PCPs is associated with lower incidence of CRC,[6,7] earlier CRC stage at diagnosis,[8] and lower mortality.[8] However, these ecologic studies are limited in that it is not possible to determine whether individuals with better outcomes are the same as those who received care from PCPs. Therefore, the effect of PCPs on CRC outcomes and the degree that it affects stage at diagnosis and mortality are unclear. Understanding the potential effects of PCPs on CRC outcomes is also important because of the anticipated shortage of approximately 44 000 adult PCPs by 2025.[9] Current difficulties in accessing primary care by some populations will be further aggravated by the influx of adults needing primary care resulting from expanded national health coverage in the recently enacted health care reform law.[10,11]

Medicare serves as a universal health insurance system for 39 million elderly Americans.[12] However, use of PCP services varies substantially among Medicare beneficiaries, with many seeing multiple specialists at the exclusion of PCPs.[13] Not using PCPs may limit opportunities to receive CRC screening and create barriers to achieving national cancer control goals. Therefore, we examined the association between utilization of PCPs and CRC outcomes in Medicare beneficiaries. We hypothesized that Medicare beneficiaries with few or no visits to a PCP would be more likely to have CRC diagnosed at the advanced stage and have higher mortality and that these differences would be explained by differences in previous receipt of CRC screening, defined as having a CRC screening test at least 3 months before cancer diagnosis.

METHODS

DATA SOURCE AND STUDY SAMPLE

This study used a retrospective cohort of persons diagnosed as having CRC within the Surveillance, Epidemiology, and End Results (SEER)–Medicare–linked database[14] between 1994 and 2005 (N=225 459). We excluded persons having cancers of the anus, anal canal, or anorectum (n=91); persons diagnosed as having CRC on death certificates or at autopsy (n=2269)[15]; persons diagnosed as having other cancers before or within 1 year after their primary CRC diagnosis (n=1710); and those eligible for Medicare because of end-stage renal disease (n=808). We also excluded persons older than 85 years because CRC screening is not recommended in this age group (n=14 087).[2] To ensure that participants had at least 24 months of Medicare claims before their CRC diagnosis, we excluded those diagnosed as having CRC before age 67 (n=52 166). We further excluded individuals enrolled in Medicare health maintenance organizations with in 2 years before cancer diagnosis through 1 year after diagnosis (n=42 466) because their claims were unavailable. Finally, we excluded patients without continuous Part A and Part B Medicare coverage during this 3-year period (n=28 237). Our final analytic sample included 83 625 persons with CRC. This study was approved by the institutional review boards of the University of South Florida and Beth Israel Deaconess Medical Center.

UTILIZATION OF PRIMARY CARE

To assess primary care services, we examined Medicare claims for the following ambulatory-based evaluation and management services: routine office visits (*Current Procedural Terminology*[16-18] [*CPT*] codes 99201-99205, 99211-99215, and 99354-99359), outpatient consultations (99241-99245, 99271-99275, 99301-99303, 99311, and 99312), ambulatory visits outside the home (99313, 99315-99316, 993211-99323, 99311-99333, and 99341-99350), and visits for preventive or administrative care (99387, 99397, 99401-99404, 99411-99412, 99420, 99429-99450, and 99455-99546).

We identified the physician specialty associated with each claim by using the unique physician identification number (UPIN) and the Medicare provider specialty field.[19,20] We defined PCPs as general practice, family medicine, primary care internal medicine, geriatric medicine, and obstetrics/gynecology (OB/GYN). We included OB/GYN as primary care because 64.3% of visits to OB/GYN practitioners are for routine follow-up or preventive care.[21] Because only 2% of claims were from OB/GYN, there was no change in sensitivity analyses that classified an OB/GYN physician as a non-PCP. We identified 160 629 physician UPINs corresponding to primary care specialties and 198 359 physician UPINs corresponding to non–primary care specialties. In addition, there were 7707 physician UPINs (2.1% of all UPINs) with the specialty designated solely as “multi-specialty clinic or group practice.” These were considered non-PCP specialties.

For each participant, we assessed ambulatory care physician claims during the 3- to 27-month period before diagnosis. Because physician visit patterns are likely to change during the time that a potential cancer is being diagnosed, we excluded the 3-month period immediately before diagnosis and assessed physician claims during the 24-month period

before this.[22] We assessed visits to PCPs by calculating the total number of ambulatory care claims to PCPs during this period. We created categories of PCP visits corresponding to quartiles (0 or 1, 2-4, 5-10, and ≥11 visits). Visits to non-PCPs were assessed in a similar fashion.

STAGE AT DIAGNOSIS AND MORTALITY

Stage at diagnosis was classified using the American Joint Commission on Cancer[23,24] staging system (0, I, II, III, and IV), with early-stage CRC defined as stages 0 and I and late stages defined as II, III, and IV. Because distal CRCs are more susceptible to early detection, we created a variable differentiating proximal lesions (proximal to and including the splenic flexure) and distal lesions (the descending colon through the rectum).[25]

The SEER Program conducts follow-up annually to ascertain vital statistics for all cases. Linkages are made to state vital statistics to obtain the date and underlying cause of death. In all-cause mortality analyses, persons who were alive at the end of follow-up (December 31, 2007) were censored; in CRC mortality, those who died of causes other than CRC were also censored.

CANCER SCREENING TESTS

As one probable mechanism by which primary care would lead to an earlier stage at diagnosis and a lower CRC mortality, we examined whether the number of PCP visits was associated with ever having CRC screening. We assessed the following *CPT*[16] codes; International Classification of Diseases, Ninth Revision (*ICD-9*) codes; and *Healthcare Common Procedure Coding System* (*HCPCS*)[26] codes: FOBT (*CPT* codes 82270 and 82273 and *HCPCS* code G0107), sigmoidoscopy (*CPT* codes 45305, 45308, 45309, 45315, 45320, and 45331 and *HCPCS* code G0104), colonoscopy (*CPT* codes 45380, 45384, and 45385 *HCPCS* codes G0105 and G0121), barium enema (*CPT* codes 74270 and 74280 and *HCPCS* codes G0106, G0120, and G0122), and office visits for CRC screening (*ICD-9* codes V76.51 and V76.41). We included any claim for CRC-related services (FOBT, sigmoidoscopy, colonoscopy, and barium enema) for the full study period, excluding the 3 months before the diagnosis, to better capture receipt of colonoscopies. The mean (SD) time for assessment before CRC screening was 6.7 (3.3) years. Consistent with previous studies of preventive care,[22,27,28] we excluded any CRC screening tests in the 3 months before the diagnosis to exclude tests potentially related to the diagnosis of CRC.

STATISTICAL ANALYSIS

The relationship between PCP visits and previous CRC screening was evaluated using multivariable logistic regression. Likewise, we used multivariable logistic regression models to examine the relationship between PCP visits and early-stage diagnosis, excluding persons with unknown stage (n=8049). Odds ratios of early-stage (0 or I) compared with late-stage (II, III, or IV) diagnosis and corresponding 95% CIs were calculated for each category of PCP visits compared with the reference group (0 or 1 visit). To determine whether PCP visits were associated with early-stage diagnosis beyond receipt of previous CRC screening, we fitted logistic models with and without previous CRC screening and examined changes in the estimated odds ratio for PCP visits.

We considered the following potential confounders in multivariable models: number of non-PCP visits, age at diagnosis, sex, race/ethnicity, marital status at diagnosis, census-derived measures of median household income (approximate quin-tiles within each registry), educational levels (approximate quintiles within each registry), metropolitan statistical area, SEER geographic registry (with indicator variables for each registry), Charlson comorbidity index[29] (determined from both inpatient and outpatient physician claims), anatomic site (proximal vs distal lesions), and histologic cancer type (adenocarcinomas, including all subtypes, carcinoid tumors, and other). Medicare reimbursement of CRC screening occurred incre mentally, with no coverage from 1994 to 1997, limited coverage between 1998 and 2000 (FOBT yearly, flexible sigmoidos-copy every 4 years, and colonoscopy only for high-risk persons), and full coverage thereafter (colonoscopy every 10 years for all persons). We therefore created indicator variables corresponding to these 3 periods and included them in the models. To account for healthy behaviors in patients seeking more primary care,[30] we added receipt of an influenza vacciation in the preceding 3 to 27 months as a proxy for healthy behavior.

We examined CRC-specific mortality and all-cause mortality among persons having invasive CRC (excluding 7732 in situ cancers).[8,28] The association between PCP visits and CRC mortality was analyzed using Cox proportional regression models, adjusting for potential confounding factors described in the preceding paragraph in addition to tumor characteristics to control for residual confounding within each stage. To determine whether associations between PCP visits and CRC mortality were primarily the result of previous CRC screening and an earlier stage at diagnosis, models were first performed without previous CRC screening, stage at diagnosis, and tumor characteristics and then repeated including previous CRC screening, stage at diagnosis, and tumor characteristics. Similar analyses were performed to examine the relationship between PCP visits and all-cause mortality. All analyses were performed using commercial software (SAS version 9.2; SAS Institute, Inc, Cary, North Carolina). Data are given as mean (SD) unless otherwise indicated.

RESULTS

Table 1 describes our study cohort. The mean age was 75.8 (6.2) years, and most patients were non-Hispanic white. The mean number of visits to a PCP in the 3- to 27-month period before diagnosis was 7.2 (8.2), with 27.8% of the sample having 0 to 1 visit (25.0% had ≥11 visits). The distribution of visits by specific primary care specialty was general practice, 10.6%; family medicine, 30.5%; internal medicine, 55.9%; OB/GYN, 2.2%; and geriatric medicine, 0.8%. Patients had a mean of 6.9 (9.7) visits to a non-PCP, with 34.1% having 0 to 1 visit (24.7% had ≥11 visits).

RECEIPT OF PREVIOUS CRC SCREENING

Overall, 38 220 persons (45.7%) had at least 1 claim of ever receiving a CRC screening test more than 3 months before the CRC diagnosis. Most claims were for FOBT (40.3%), with other services less common (office visit for CRC, 8.6%; colonoscopy, 11.8%; barium enema, 10.3%; and sigmoidoscopy, 2.0%). The likelihood of having at least 1 claim for

previous CRC screening increased with increasing number of PCP visits (0 or 1 visit, 27.8%; 2-4 visits, 45.9%; 5-10 visits, 53.4%; and ≥11 visits, 58.3%; $P < .001$ for trend). **Table 2** describes predictors of previous CRC screening. The odds of previous CRC screening increased with increasing number of PCP visits. Previous CRC screening was also independently associated with non-PCP visits, influenza vaccination, older age, female sex, non-Hispanic ethnicity, no comorbidity, later year of diagnosis, being married, and residing in areas with higher educational levels.

STAGE AT CRC DIAGNOSIS

Predictors of early stage at diagnosis (American Joint Commission on Cancer stages 0 and 1) are presented in **Table 3**. The likelihood of having early-stage CRC diagnosis increased with increasing number of PCP visits (0 or 1 visit, 29.1%; 2-4 visits, 33.2%; 5-10 visits, 36.0%; and ≥11 visits, 37.5%; $P<.001$ for trend). Compared with persons having 0 or 1 primary care visit, those with 5 to 10 visits had 35% greater odds of receiving an early-stage CRC diagnosis. Early-stage diagnosis was also independently associated with non-PCP visits, influenza vaccination, younger age, male sex, non-Hispanic ethnicity, later year of diagnosis, and distal location of the tumor.

When receipt of previous CRC screening was added to the model, persons having such claims were more likely to be diagnosed as having early-stage cancers (adjusted odds ratio, 1.37; 95% CI, 1.33-1.42). Controlling for previous CRC screening modestly reduced the association of PCP visits and early-stage diagnosis (0 or 1 visit: reference group; 2-4 visits: adjusted odds ratio, 1.16 [95% CI, 1.11-1.22]; 5-10 visits: 1.27 [1.21-1.33]; and ≥11 visits: 1.32 [1.25-1.38]).

CRC AND ALL-CAUSE MORTALITY

Among the 76 712 persons with invasive CRC, there were 43 591 deaths overall and 16 822 deaths from CRC during the follow-up period. **Table 4** describes predictors of CRC-specific mortality. In multivariable analyses adjusting for all factors except previous CRC screening, stage at diagnosis, and tumor characteristics, the number of PCP visits was associated with lower CRC mortality. Persons with 5 to 10 PCP visits had 16% lower CRC mortality compared with the reference group. In analyses that further adjusted for CRC screening, stage at diagnosis, and tumor characteristics, 2 to 10 PCP visits remained associated with lower CRC mortality, although the relationship was attenuated.

In analyses that controlled for all covariates, 2 to 10 PCP visits were associated with reduced all-cause mortality (0 or 1 visit: reference; 2-4 visits: adjusted hazard ratio, 0.94 [95% CI, 0.91-0.97]; 5-10 visits: 0.94 [0.91-0.97]; and ≥11 visits: 1.04 [1.01-1.07]).

EFFECT OF PCP VISITS STRATIFIED BY NON-PCP VISITS

To disentangle the effect of PCP visits from any physician visit, we reanalyzed each outcome stratified by categories of non-PCP visits. Although 10 376 persons (12.4%) had 0 or 1 visit to both a PCP and non-PCP, there was low correlation between visits to PCPs and visits to non-PCPs (Spearman rank correlation coefficient, 0.22; $P<.001$). For example, 28.2% of patients with ≥11 visits to a non-PCP had 0 or 1 visit to a PCP. Among patients

with 5 to 10 visits to a non-PCP, those with 5 to 10 visits to a PCP had 2.18 times increased odds of previous CRC screening, 45% increased odds of early stage at diagnosis, 11% lower CRC mortality, and 7% lower all-cause mortality, compared with patients with 0 or 1 visit to a PCP (**Table 5**).

COMMENT

Medicare beneficiaries with CRC had better outcomes if they had more primary care utilization before diagnosis. Even within this universally insured population, 28% of Medicare beneficiaries with CRC had no or only 1 con tact with PCPs in the 3 to 27 months before the diagnosis. These patients had increased risk of not ever receiving CRC screening and of having CRC of a more advanced stage, higher CRC mortality, and higher overall mortality. Although earlier CRC stage at diagnosis was associated with receipt of CRC screening,[31] the association of earlier stage at diagnosis with higher utilization of primary care was not explained by receipt of CRC screening. In addition, lower CRC mortality with PCP visits was mostly, but not completely, explained by screening and earlier stage at diagnosis. The number of non-PCP visits was also associated with earlier stage and lower mortality, suggesting that access to medical care in general is important for improved CRC outcomes. However, even among patients having many visits to a non-PCP, the effect of a higher number of PCP visits on improved CRC outcomes persisted. This suggests that, regardless of the number of visits to non-PCPs, access to PCPs confers independent and additional benefits. Unfortunately, 28% of Medicare beneficiaries without a PCP report a problem finding such a physician, and 11% report a problem finding a specialist.[10]

This study confirms others in finding that many Medicare beneficiaries do not use the services of PCPs[13] and that low primary care utilization is associated with a lack of CRC screening.[32,33] However, controlling for previous CRC screening did not significantly alter the association between PCP visits and early-stage diagnosis. This suggests that factors other than CRC screening mediate the effect of PCP visits on CRC stage. For example, higher use of PCP services may lead to healthier behaviors (eg, eating less red meat, getting more exercise, not smoking, and drinking less alcohol) and use of medicines (eg, aspirin and nonsteroidal anti-inflammatory drugs) that may affect CRC stage.[34-36] Alternatively, findings may be explained by unmeasured patient factors, such as healthier habits in patients who seek more frequent primary care. This “healthy user effect” has been described as a potential bias in observational outcome studies whereby healthier individuals are more likely to adhere to medications or use preventive services.[30] As a proxy for healthy behavior, we added influenza vaccination in our models but found no appreciable change in results. We also controlled for comorbid illnesses, which were present in more patients with an increased number of visits to PCPs. In addition, we adjusted for socioeconomic status, which is correlated with overall health and health-seeking tendencies.[37] However, these adjustments may not fully account for the healthy user effect.

The lower CRC mortality observed among Medicare beneficiaries with higher utilization of primary care appears to be largely the result of earlier-stage diagnosis and receipt of CRC screening. However, controlling for stage and CRC screening did not eliminate the association. This suggests that PCPs may exert influences on CRC mortality beyond CRC

screening and earlier-stage diagnosis. For example, PCPs may play a role in promoting healthy behaviors and other preventive services,[38] managing comorbid illnesses present in a majority of patients with cancer,[39] and coordinating care to prevent medical, medication, and laboratory errors.[40] The healthy user effect may also confound the association of PCP visits with mortality. The finding that having 11 or more visits to PCPs slightly increased overall mortality may be the result of more comorbidities in these patients.

It was interesting to find a high frequency of FOBT claims compared with colonoscopy claims. Recent studies[41,42] in the general Medicare population have found higher use of colonoscopy than FOBT, whereas an earlier study[43] in Medicare patients with CRC confirms our finding that FOBT is most frequently used preceding the peridiagnostic period. One reason for the high frequency of FOBT in our study may be that we defined CRC screening as ever receiving a CRC screening test more than 3 months before diagnosis. However, even when we included only FOBT within the previous 3 to 27 months, the number of patients receiving FOBT was still almost double the number of those receiving colonoscopy. The more likely reason for our high numbers of FOBT is that we included earlier years before reimbursement and increased use of colonoscopy.

Although this research complements previous ecologic studies[6-8] examining PCP supply and CRC outcomes, our findings are based on observational data and therefore cannot establish causal relationships. Several potential limitations should be considered when interpret ing our results. First, this study only included persons aged 67 to 85 years having Medicare fee-for-service insurance who were predominantly white, were relatively healthy, and had a relatively high mean number of physician visits. Therefore, findings may not apply to other populations. A subanalysis of persons aged 67 to 75 years (those in whom CRC screening is routinely recommended) yields even stronger associations of the number of PCP visits with CRC outcomes. We were not able to include persons in Medicare health maintenance organizations because they lack claims data. Compared with patients enrolled in Medicare health maintenance organizations, those who had Medicarefee-for-serviceinsurancereportlongerandhigher-quality relationships with their PCPs.[44] Second, our study was limited to administrative data contained within the SEER-Medicare database, which omits important patient factors (eg, healthy behaviors, severity of comorbid illness, and medication use) that may be associated with CRC stage at diagnosis or mortality. Third, we did not differentiate CRC tests according to indication (screening vs diagnostic); thus, the rate of previous CRC screening may be lower than the 45.7% found. We excluded any CRC tests performed in the 3 months before diagnosis to exclude those potentially related to the diagnosis of CRC. Fourth, our measure of primary care was limited to number of visits. We did not have detailed information on the content of visits; therefore, it is uncertain what specific aspects of the primary care visit are most important to improve CRC outcomes. We were not able to assess other core primary care attributes, such as first contact, comprehensive care, and coordinated care.[45] Finally, it is uncertain whether some Medicare beneficiaries had difficulty accessing PCPs or chose to have no or limited contact with PCPs. Even relatively small ambulatory care copayments decrease the use of outpatient visits and preventive screenings.[46,47] Medicare's recent expansion of coverage for preventive care benefits and annual wellness visits should help emphasize the importance of PCP visits and preventive screenings.[48] Further research is needed regarding how use of

primary care influences CRC stage and mortality and whether our results hold true for other populations and cancers.

This study adds to the mounting evidence of the benefits of primary care in improving health outcomes[49] and underscores the importance of adequate access to a PCP, particularly for Medicare beneficiaries. The new health care reform law has provisions to expand primary care training programs and health insurance to all Americans[11]; however, reorienting the US health care system toward primary care will need more than just increasing the number of primary care trainees or expanding health insurance. Payment reforms to narrow the specialty–primary care payment gap and reward coordination-of-care activities of PCPs are paramount, as are capital investments to improve the primary care infrastructure and paradigm shifts in public perceptions of primary care and patient expectations.[50,51] Fortunately, there is a growing movement in the private and public sectors of the United States for the revitalization of primary care.[52] This may help strengthen the national efforts on reducing the burden of CRC.

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Table 1

Characteristics of 83 625 Patients With Colorectal Cancer

Characteristic	No. (%)
PCP visits in previous 3-27 mo	
0 or 1	23 206 (27.8)
2-4	20 407 (24.4)
5-10	19 140 (22.9)
≥11	20 872 (25.0)
Non-PCP visits in previous 3-27 mo	
0 or 1	28 480 (34.1)
2-4	17 480 (20.9)
5-10	16 998 (20.3)
≥11	20 667 (24.7)
Receipt of influenza vaccination in previous 3-27 mo	
No	40 996 (49.0)
Yes	42 629 (51.0)
Age at diagnosis, y	
67-75	40 330 (48.2)
76-85	43 295 (51.8)
Sex	
Male	39 821 (47.6)
Female	43 804 (52.4)
Race/ethnicity	
White, non-Hispanic	69 191 (82.7)
Black, non-Hispanic	6278 (7.5)
Hispanic	3738 (4.5)
Asian/American Indian/Pacific Islander	4268 (5.1)
Other	150 (0.2)
Charlson comorbidity index	
0	47 541 (56.9)
1	19 766 (23.6)
≥2	16 318 (19.5)
Year of diagnosis	
1994-1997	19 429 (23.2)
1998-2000	18 605 (22.3)
2001-2005	45 591 (54.5)
Marital status	
Married, including common law	6295 (7.5)
Single, never married	44 805 (53.6)
Separated/divorced	4931 (5.9)
Widowed	23 998 (28.7)
Unknown	3596 (4.3)

Characteristic	No. (%)
MSA of residence (n = 83 623)	
Large metropolitan	46 423 (55.5)
Metropolitan	22 930 (27.4)
Urban	5407 (6.5)
Less urban	7253 (8.7)
Unknown	1610 (1.9)
Educational level (n = 80 281)	
Quintile 1, lowest	15 996 (19.9)
Quintile 2	15 951 (19.9)
Quintile 3	16 188 (20.2)
Quintile 4	15 921 (19.8)
Quintile 5, highest	16 225 (20.2)
Income level (n = 83 103)	
Quintile 1, lowest	17 224 (20.7)
Quintile 2	16 591 (20.0)
Quintile 3	16 448 (19.8)
Quintile 4	16 562 (19.9)
Quintile 5, highest	16 278 (19.6)
SEER registry[a]	
San Francisco, 1973+	3615 (4.3)
Connecticut, 1973+	8085 (9.7)
Detroit, 1973 +	8443 (10.1)
Hawaii, 1973+	1558 (1.9)
Iowa, 1973+	8863 (10.6)
New Mexico, 1973+	2182 (2.6)
Seattle, 1974+	4912 (5.9)
Utah, 1973+	2292 (2.7)
Atlanta, 1975+	2700 (3.2)
San Jose, 1988+	2164 (2.6)
Los Angeles, 1988+	7586 (9.1)
Rural Georgia, 1992+	268 (0.3)
Greater California, 2000+	9219 (11.0)
Kentucky, 2000+	5418 (6.5)
Louisiana, 2000+	4181 (5.0)
New Jersey, 2000+	11 176 (13.4)
Unknown	963 (1.2)
Histologic type	
Adenocarcinoma	82 177 (98.3)
Carcinoid	974 (1.2)
Miscellaneous	474 (0.6)
Stage at diagnosis	
0, In situ	6913 (8.3)

Characteristic	No. (%)
I	18 624 (22.3)
II	23 028 (27.5)
III	18 389 (22.0)
IV	8622 (10.3)
Unknown	8049 (9.6)
Tumor grade	
Well differentiated	7650 (9.2)
Moderately differentiated	49 189 (58.8)
Poorly differentiated	13188 (15.8)
Undifferentiated	667 (0.8)
Unknown	12 931 (15.5)
Tumor size, mean (SD), cm	40.2 (25.0)
Tumor location	
Rectum	21 512 (25.7)
Colon	62 113 (74.3)
Anatomic site	
Distal	45 276 (54.1)
Proximal	38 349 (45.9)

Abbreviations: MSA, metropolitan statistical area; PCP, primary care physician; SEER, Surveillance, Epidemiology, and End Results.

[a]The year with the "+" sign refers to the year when the site became part of the SEER registry (from that date to the present).

Table 2

Predictors of Prior Colorectal Cancer Screening Test in 83 625 Patients[a]

Characteristic	AOR[b] (95% Wald CI)
PCP visits in previous 3-27 mo	
0 or 1	1.00 [Reference]
2-4	2.07 (1.98-2.16)
5-10	2.60 (2.48-2.72)
≥11	2.96 (2.83-3.10)
Non-PCP visits in previous 3-27 mo	
0 or 1	1.00 [Reference]
2-4	1.57 (1.51-1.64)
5-10	1.87 (1.79-1.95)
≥11	2.74 (2.63-2.86)
Receipt of influenza vaccination in previous 3-27mo	
No	1.00 [Reference]
Yes	1.53 (1.48-1.58)
Age at diagnosis, y	
67-75	1.00 [Reference]
76-85	1.28 (1.24-1.32)
Sex	
Male	1.00 [Reference]
Female	1.26 (1.22-1.30)
Race/ethnicity	
White, non-Hispanic	1.00 [Reference]
Black, non-Hispanic	0.96 (0.90-1.02)
Hispanic	0.79 (0.73-0.86)
Asian/American Indian/Pacific Islander	0.80 (0.74-0.86)
Other	0.92 (0.64-1.32)
Charlson comorbidity index	
0	1.00 [Reference]
1	0.95 (0.92-0.99)
≥2	0.84 (0.80-0.87)
Year of diagnosis	
1994-1997	1.00 [Reference]
1998-2000	1.41 (1.35-1.47)
2001-2005	1.22 (1.17-1.27)
Marital status	
Married, including common law	1.00 [Reference]
Single, never married	0.88 (0.83-0.93)
Separated/divorced	0.83 (0.78-0.89)
Widowed	0.87 (0.84-0.90)
Unknown	0.94 (0.87-1.02)

Characteristic	AOR[b] (95% Wald CI)
MSA of residence	
Large metropolitan	1.00 [Reference]
Metropolitan	0.91 (0.87-0.95)
Urban	0.98 (0.91-1.05)
Less urban	0.84 (0.78-0.91)
Unknown	0.85 (0.75-0.96)
Educational level	
Quintile 1, lowest	1.00 [Reference]
Quintile 2	1.09 (1.04-1.15)
Quintile 3	1.13 (1.07-1.20)
Quintile 4	1.22 (1.15-1.29)
Quintile 5, highest	1.39 (1.29-1.49)
Income level	
Quintile 1, lowest	1.00 [Reference]
Quintile 2	0.93 (0.89-0.98)
Quintile 3	1.01 (0.95-1.06)
Quintile 4	0.96 (0.90-1.02)
Quintile 5, highest	1.01 (0.94-1.08)
SEER registry[c]	
San Francisco, 1973+	1.00 [Reference]
Connecticut, 1973+	1.02 (0.93-1.12)
Detroit, 1973+	0.72 (0.66-0.78)
Hawaii, 1973+	0.97 (0.84-1.12)
Iowa, 1973+	0.82 (0.74-0.91)
New Mexico, 1973+	0.60 (0.53-0.68)
Seattle, 1974+	1.02 (0.93-1.13)
Utah, 1973+	0.59 (0.52-0.67)
Atlanta, 1975+	0.92 (0.82-1.02)
San Jose, 1988+	1.02 (0.90-1.15)
Los Angeles, 1988+	0.79 (0.31-2.02)
Rural Georgia, 1992+	0.75 (0.69-0.82)
Greater California, 2000+	0.90 (0.68-1.18)
Kentucky, 2000+	0.93 (0.85-1.02)
Louisiana, 2000+	0.72 (0.65-0.80)
New Jersey, 2000+	0.52 (0.47-0.58)
Unknown	0.63 (0.58-0.68)

Abbreviations: AOR, adjusted odds ratio; MSA, Metropolitan Statistical Area; PCP, primary care physician; SEER, Surveillance, Epidemiology, and End Results.

[a] Ever received of fecal occult blood test, sigmoidoscopy, barium enema, or colonoscopy more than 3 months before a colorectal cancer diagnosis.

[b] Adjusted for all other variables in the table.

[c] The year with the "+" sign refers to the year when the site became part of the SEER registry (from that date to the present).

Table 3

Predictors of Early-Stage Colorectal Cancer Diagnosis in 75 576 Patients[a]

Characteristic	AOR[b] (95% Wald CI)
PCP visits in previous 3-27 mo	
0 or 1	1.00 [Reference]
2-4	1.22 (1.17-1.28)
5-10	1.35 (1.29-1.42)
≥11	1.41 (1.35-1.48)
Non-PCP visits in previous 3-27 mo	
0 or 1	1.00 [Reference]
2-4	1.19 (1.13-1.24)
5-10	1.38 (1.32-1.44)
≥11	1.61 (1.53-1.68)
Receipt of influenza vaccination in previous 3-27 mo	
No	1.00 [Reference]
Yes	1.12 (1.08-1.15)
Age at diagnosis, y	
67-75	1.00 [Reference]
76-85	0.89 (0.86-0.92)
Sex	
Male	1.00 [Reference]
Female	0.96 (0.92-0.99)
Race/ethnicity	
White, non-Hispanic	1.00 [Reference]
Black, non-Hispanic	1.03 (0.96-1.10)
Hispanic	0.86 (0.79-0.93)
Asian/American Indian/Pacific Islander	0.94 (0.87-1.03)
Other	1.01 (0.70-1.46)
Charlson comorbidity index	
0	1.00 [Reference]
1	0.98 (0.94-1.02)
≥2	1.02 (0.97-1.06)
Year of diagnosis	
1994-1997	1.00 [Reference]
1998-2000	1.15 (1.10-1.21)
2001-2005	1.21 (1.16-1.26)
Marital status	
Married, including common law	1.00 [Reference]
Single, never married	0.96 (0.90-1.03)
Separated/divorced	0.92 (0.86-0.99)
Widowed	0.91 (0.88-0.95)
Unknown	1.53 (1.41-1.66)

Characteristic	AOR[b] (95% Wald CI)
MSA of residence	
Large metropolitan	1.00 [Reference]
Metropolitan	1.10 (1.05-1.16)
Urban	1.16 (1.07-1.25)
Less urban	1.09 (1.01-1.18)
Unknown	1.16 (1.02-1.32)
Educational level	
Quintile 1, lowest	1.00 [Reference]
Quintile 2	0.95 (0.90-1.01)
Quintile 3	0.96 (0.90-1.01)
Quintile 4	0.94 (0.89-1.01)
Quintile 5, highest	0.98 (0.91-1.06)
Income level	
Quintile 1, lowest	1.00 [Reference]
Quintile 2	1.03 (0.97-1.08)
Quintile 3	1.06 (1.00-1.12)
Quintile 4	1.03 (0.96-1.09)
Quintile 5, highest	1.06 (0.98-1.14)
SEER registry[c]	
San Francisco, 1973+	1.00 [Reference]
Connecticut, 1973+	1.11 (1.01-1.22)
Detroit, 1973+	0.95 (0.86-1.04)
Hawaii, 1973+	1.17 (1.00-1.36)
Iowa, 1973+	0.94 (0.85-1.05)
New Mexico, 1973+	0.93 (0.81-1.06)
Seattle, 1974+	0.84 (0.76-0.94)
Utah, 1973+	0.98 (0.86-1.12)
Atlanta, 1975+	1.12 (0.99-1.26)
San Jose, 1988+	0.95 (0.84-1.08)
Los Angeles, 1988+	1.14 (1.04-1.25)
Rural Georgia, 1992+	0.76 (0.56-1.04)
Greater California, 2000+	0.98 (0.89-1.07)
Kentucky, 2000+	1.05 (0.94-1.16)
Louisiana, 2000+	1.01 (0.91-1.13)
New Jersey, 2000+	1.10 (1.00-1.20)
Unknown	0.75 (0.51-1.12)
Anatomic site	
Distal	1.00 [Reference]
Proximal	0.57 (0.55-0.59)

Abbreviations: AOR, adjusted odds ratio; MSA, Metropolitan Statistical Area; PCP, primary care physician; SEER, Surveillance, Epidemiology, and End Results.

[a] American Joint Commission on Cancer stages 0 and 1.

[b] Adjusted for all other variables in the table.

[c] The year with the "+" sign refers to the year when the site became part of the SEER registry (from that date to the present).

Table 4

Predictors of Colorectal Cancer Mortality Among 76 712 Patients[a]

Characteristic	HR (95% CI)		
	Unadjusted	Multivariable Model 1[b]	Multivariable Model 2[c]
PCP visits in previous 3-27 mo			
0 or 1	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
2-4	0.85 (0.81-0.88)	0.89 (0.85-0.92)	0.96 (0.91-1.00)
5-10	0.79 (0.76-0.82)	0.84 (0.80-0.88)	0.94 (0.90-0.99)
≥11	0.82 (0.78-0.85)	0.87 (0.83-0.92)	1.00 (0.95-1.05)
Non-PCP visits in previous 3-27 mo			
0 or 1	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
2-4	0.83 (0.80-0.87)	0.88 (0.84-0.92)	0.93 (0.89-0.97)
5-10	0.73 (0.70-0.76)	0.78 (0.74-0.81)	0.87 (0.83-0.91)
≥11	0.72 (0.69-0.75)	0.75 (0.72-0.79)	0.87 (0.83-0.91)
Receipt of influenza vaccination in previous 3-27 mo			
No	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Yes	0.79 (0.77-0.81)	0.87 (0.84-0.90)	0.92 (0.89-0.96)
Age at diagnosis, y			
67-75	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
76-85	1.17 (1.14-1.21)	1.24 (1.20-1.28)	1.32 (1.28-1.36)
Sex			
Male	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Female	0.98 (0.95-1.01)	0.93 (0.90-0.96)	0.95 (0.91-0.98)
Race/ethnicity			
White, non-Hispanic	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Black, non-Hispanic	1.34 (1.27-1.42)	1.23 (1.16-1.31)	1.15 (1.08-1.23)
Hispanic	1.03 (0.96-1.11)	1.00 (0.92-1.08)	0.95 (0.87-1.03)
Asian/American Indian/Pacific Islander	0.91 (0.84-0.98)	0.92 (0.84-1.00)	0.92 (0.84-1.00)
Other	0.92 (0.63-1.33)	0.84 (0.56-1.26)	0.73 (0.49-1.09)
Charlson comorbidity index			
0	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
1	0.95 (0.91-0.98)	1.04 (1.00-1.09)	1.08 (1.04-1.13)
≥2	1.02 (0.98-1.06)	1.18 (1.12-1.23)	1.25 (1.19-1.31)
Year of diagnosis			
1994-1997	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
1998-2000	0.86 (0.83-0.90)	0.88 (0.84-0.92)	0.90 (0.86-0.93)
2001-2005	0.57 (0.55-0.59)	0.56 (0.54-0.59)	0.70 (0.67-0.73)
Marital status			
Married, including common law	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Single, never married	1.25 (1.18-1.32)	1.14 (1.08-1.22)	1.02 (1.10-1.24)
Separated/divorced	1.19 (1.12-1.27)	1.16 (1.08-1.24)	1.13 (1.05-1.21)
Widowed	1.19 (1.15-1.23)	1.14 (1.09-1.18)	1.10 (1.06-1.15)

Characteristic	HR (95% CI)		
	Unadjusted	Multivariable Model 1[b]	Multivariable Model 2[c]
Unknown	1.03 (0.95-1.11)	0.91 (0.83-0.99)	0.88 (0.80-0.96)
MSA of residence			
Large metropolitan	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Metropolitan	1.03 (1.00-1.07)	0.98 (0.93-1.03)	1.02 (0.97-1.08)
Urban	1.00 (0.93-1.07)	0.94 (0.87-1.01)	0.96 (0.88-1.04)
Less urban	1.02 (0.96-1.08)	0.94 (0.87-1.01)	0.93 (0.85-1.01)
Unknown	1.02 (0.91-1.14)	0.93 (0.82-1.06)	0.93 (0.81-1.06)
Educational level			
Quintile 1, lowest	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Quintile 2	1.08 (1.03-1.14)	0.97 (0.92-1.02)	0.95 (0.90-1.00)
Quintile 3	0.98 (0.94-1.03)	0.98 (0.93-1.04)	0.95 (0.89-1.01)
Quintile 4	0.94 (0.89-0.98)	0.96 (0.90-1.02)	0.93 (0.87-0.99)
Quintile 5, highest	0.93 (0.89-0.98)	1.00 (0.93-1.07)	0.97 (0.90-1.04)
Income level			
Quintile 1, lowest	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Quintile 2	1.05 (1.00-1.10)	1.00 (0.95-1.05)	1.00 (0.95-1.06)
Quintile 3	0.96 (0.92-1.01)	0.98 (0.93-1.04)	1.02 (0.96-1.08)
Quintile 4	0.94 (0.90-0.99)	0.99 (0.93-1.05)	1.02 (0.96-1.09)
Quintile 5, highest	0.89 (0.85-0.93)	0.93 (0.87-1.00)	0.98 (0.90-1.05)
SEER registry[d]			
San Francisco, 1973+	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Connecticut, 973+	0.93 (0.85-1.01)	0.95 (0.86-1.04)	0.89 (0.81-0.98)
Detroit, 1973+	1.00 (0.92-1.09)	0.98 (0.90-1.06)	0.91 (0.83-0.99)
Hawaii, 1973+	0.81 (0.71-0.93)	0.94 (0.80-1.09)	0.89 (0.76-1.05)
Iowa, 1973+	0.91 (0.84-0.99)	0.95 (0.86-1.04)	0.94 (0.85-1.04)
New Mexico, 1973+	1.11 (1.00-1.24)	1.19 (1.05-1.35)	1.11 (0.98-1.27)
Seattle, 1974+	0.94 (0.86-1.02)	0.97 (0.89-1.07)	0.92 (0.83-1.01)
Utah, 1973+	1.05 (0.94-1.17)	1.10 (0.98-1.25)	1.08 (0.95-1.22)
Atlanta, 1975+	0.98 (0.88-1.09)	0.98 (0.88-1.10)	0.94 (0.84-1.06)
San Jose, 1988+	0.90 (0.80-1.01)	0.93 (0.83-1.05)	0.90 (0.80-1.01)
Los Angeles, 1988+	0.83 (0.52-1.35)	1.00 (0.92-1.09)	0.91 (0.84-1.00)
Rural Georgia, 1992+	0.97 (0.89-1.06)	0.93 (0.71-1.22)	0.98 (0.74-1.29)
Greater California, 2000+	0.97 (0.75-1.25)	0.99 (0.90-1.09)	0.93 (0.84-1.02)
Kentucky, 2000+	0.73 (0.67-0.79)	1.19 (1.07-1.32)	1.20 (1.07-1.34)
Louisiana, 2000+	0.84 (0.77-0.93)	1.06 (0.95-1.19)	1.01 (0.89-1.13)
New Jersey, 2000+	0.80 (0.72-0.88)	1.00 (0.91-1.09)	0.92 (0.84-1.00)
Unknown	0.75 (0.69-0.82)	1.30 (0.99-1.71)	0.85 (0.64-1.12)
Tumor location			
Colon	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Rectum	1.19 (1.15-1.23)	1.18 (1.14-1.22)	1.23 (1.19-1.28)

Characteristic	HR (95% CI)		
	Unadjusted	Multivariable Model 1[b]	Multivariable Model 2[c]
Histologic type			
Adenocarcinoma	1.00 [Reference]		1.00 [Reference]
Carcinoid	0.48 (0.40-0.59)		0.53 (0.42-0.66)
Miscellaneous	1.35 (1.13-1.62)		0.93 (0.76-1.13)
Stage at diagnosis			
I	1.00 [Reference]		1.00 [Reference]
II	2.63 (2.44-2.83)		1.29 (1.18-1.40)
III	6.80 (6.34-7.29)		3.54 (3.27-3.84)
IV	32.66 (30.45-35.02)		6.47 (5.79-7.23)
Unknown	5.96 (5.52-6.44)		1.60 (1.42-1.79)
Tumor grade			
Well differentiated	1.00 [Reference]		1.00 [Reference]
Moderately differentiated	1.58 (1.47-1.69)		1.09 (1.02-1.18)
Poorly differentiated	2.76 (2.57-2.96)		1.50 (1.39-1.62)
Undifferentiated	3.13 (2.68-3.66)		1.89 (1.59-2.24)
Unknown	2.27 (2.10-2.46)		1.33 (1.22-1.46)
Tumor size, cm	1.04 (1.04-1.04)		1.02 (1.02-1.03)
Previous colorectal cancer screening test			
No	1.00 [Reference]		1.00 [Reference]
Yes	0.77 (0.75-0.79)		0.91 (0.88-0.94)

Abbreviations: HR, hazard ratio; MSA, metropolitan statistical area; PCP, primary care physician; SEER, Surveillance, Epidemiology, and End Results.

[a] Excludes in situ tumors.

[b] Model 1 is adjusted for number of PCP visits, number of non-PCP visits, influenza vaccination, age at diagnosis, sex, race/ethnicity, Charlson comorbidity index, year at diagnosis, marital status, residence, educational level, income, SEER Registry, and tumor location.

[c] Model 2 is adjusted for all the variables in model 1 plus histologic type, stage at diagnosis, tumor grade, tumor size, and previous colorectal cancer screening test.

[d] The year with the "+" sign refers to the year when the site became part of the SEER registry (from that date to the present).

Table 5

Effect of PCP Visits on Outcomes Stratified by Non-PCP Visits in 76 712 Patients

	Non-PCP Visits[a]			
Characteristic	**0 or 1**	**2-4**	**5-10**	**≥11**
	Adjusted Odds Ratio (95% CI)			
CRC screening[b]				
PCP visits[a]				
0 or 1	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
2-4	3.55 (3.28-3.85)	2.08 (1.89-2.30)	1.84 (1.67-2.03)	1.26 (1.16-1.37)
5-10	4.70 (4.31-5.13)	2.81 (2.54-3.11)	2.18 (1.98-2.41)	1.59 (1.46-1.73)
≥11	5.35 (4.86-5.90)	3.38 (3.03-3.76)	2.62 (2.37-2.89)	1.91 (1.77-2.07)
CRC stage[c]				
PCP visits[a]				
0 or 1	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
2-4	1.37 (1.27-1.47)	1.31 (1.18-1.46)	1.31 (1.18-1.46)	1.31 (1.18-1.46)
5-10	1.54 (1.42-1.68)	1.45 (1.30-1.61)	1.45 (1.30-1.61)	1.45 (1.30-1.61)
≥11	1.55 (1.41-1.71)	1.51 (1.35-1.69)	1.51 (1.35-1.69)	1.51 (1.35-1.69)
	Adjusted Hazard Ratio (95% CI)			
CRC mortality[d]				
PCP visits[a]				
0 or 1	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
2-4	0.96 (0.89-1.02)	1.03 (0.93-1.14)	0.87 (0.78-0.98)	0.97 (0.88-1.08)
5-10	0.89 (0.83-0.97)	1.02 (0.92-1.14)	0.89 (0.80-1.00)	1.01 (0.91-1.12)
≥11	0.93 (0.85-1.02)	1.09 (0.97-1.22)	1.01 (0.90-1.14)	0.99 (0.90-1.09)
All-cause mortality[d]				
PCP visits[a]				
0 or 1	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
2-4	0.94 (0.90-0.99)	0.99 (0.92-1.06)	0.91 (0.85-0.98)	0.94 (0.88-1.00)
5-10	0.89 (0.85-0.94)	0.99 (0.92-1.06)	0.93 (0.87-1.00)	0.98 (0.92-1.04)

	Non-PCP Visits[a]			
Characteristic	**0 or 1**	**2-4**	**5-10**	**≥11**
≥11	1.01 (0.95-1.07)	1.12 (1.04-1.21)	1.05 (0.98-1.13)	1.02 (0.96-1.07)

Abbreviations: CRC, colorectal cancer; PCP, primary care physician; SEER, Surveillance, Epidemiology, and End Results.

[a] Number of visits in previous 3 to 27 months before the diagnosis.

[b] Adjusted for influenza vaccination, age at diagnosis, sex, race/ethnicity, comorbidity, year at diagnosis, marital status, residence, educational level, income level, and SEER registry.

[c] Adjusted for influenza vaccination, age at diagnosis, sex, race/ethnicity, comorbidity, year at diagnosis, marital status, residence, educational level, income level, SEER registry, and tumor location.

[d] Adjusted for influenza vaccination, age at diagnosis, sex, race/ethnicity, comorbidity, year at diagnosis, marital status, residence, educational level, income level, SEER registry, tumor location, previous CRC screening, stage, histologic type, grade, and tumor size.