Published in final edited form as:
Cancer. 2008 February 15; 112(4): 789–799. doi:10.1002/cncr.23244.

Survival Benefits and Trends in Use of Adjuvant Therapy Among Elderly Stage II and III Rectal Cancer Patients in the General Population

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Abstract

BACKGROUND—This study examined elderly stage II and III rectal cancer patients' adjuvant chemoradiation therapy adherence, trends in adherence over time, and the relation of levels of adherence to mortality.

METHODS—The authors studied 2886 stage II and III rectal cancer patients who had surgical resection and who appeared in 1992–1999 linked SEER-Medicare claims data. The authors compared measures of adjuvant radiation and chemotherapy receipt and completion between stage II and III patients. Adjusted risk of cancer-related 5-year mortality was calculated by multivariate logistic regression for different levels of chemoradiation adherence among stage II and III patients.

RESULTS—Of the 2886 patients, 45.4% received both adjuvant radiation and chemotherapy. Stage III patients were more likely to receive chemoradiation than stage II patients. The receipt of chemoradiation by stage II patients increased significantly from 1992 to 1999. Stage III patients were more likely to complete radiation therapy (96.6%), chemotherapy (68.2%), and both modalities (67.5%) than stage II patients (91.5%, 49.8%, 47.6%, respectively). Only a complete course of both radiation and chemotherapy for both stage II (relative risk [RR] 0.74; 95% CI, 0.54, 0.97) and III (RR 0.80; 95% CI, 0.65, 0.96) decreased the adjusted 5-year cancer mortality risk compared with counterparts with no adjuvant therapy.

CONCLUSIONS—Even though stage II rectal cancer patients were less likely than stage III patients to receive and complete adjuvant chemoradiation, both patient groups in the general population had lower cancer-related mortality if they completed chemoradiation. These patients deserve support and encouragement to complete treatment.

Keywords

rectal cancer; adjuvant therapy; chemotherapy; radiation therapy; cancer mortality

Randomized controlled trials in the late 1980s demonstrated improved survival among stage II and III rectal cancer patients who received a concurrent course of adjuvant chemotherapy

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The views expressed in this article are those of the authors and do not necessarily represent the views of the National Cancer Institute.

and radiation therapy, leading to a 1990 National Institutes of Health consensus statement recommending adjuvant chemoradiation for patients with lymph-node positive or transmural rectal cancer.[1–4] Recent clinical trials have confirmed the survival benefit of this treatment recommendation.[5–8]

Prior observational studies examined initiation rates of combined chemoradiotherapy for stages II and III rectal cancer and the association between initiation of chemoradiation and mortality.[9–13] However, randomized controlled trials demonstrating survival benefit were based on completion of a specified course of chemoradiation rather than initiation alone.[1–4,7,8] We found no published population-based studies that evaluated the degree to which stage II and III rectal cancer patients complete adjuvant chemoradiation or the association between chemoradiotherapy completion and survival.

There are reasons to question whether patients, especially the elderly, are completing a recommended course of chemoradiotherapy, which includes the potential occurrence of acute toxicities.[2,14,15] Recent studies among elderly patients with stage III colon cancer found that increased age and factors suggesting frailty are inversely associated with adjuvant chemotherapy completion.[12,16] Incomplete therapy may be more dramatic among rectal cancer patients, who require both chemotherapy and radiation therapy.

In this study, we examined adherence to the recommended course of chemoradiation, trends in adherence over time, and the relation between different levels of treatment completion and mortality in a general population of elderly stage II and III rectal cancer patients.

MATERIALS AND METHODS

Data Source

This study used data from the Surveillance, Epidemiology, and End Results (SEER) cancer registries linked with Medicare claims for persons found in both files. The SEER-Medicare database is generated through the cooperative efforts of the Center for Medicare & Medicaid Services (CMS), the National Cancer Institute (NCI), and SEER registries. Our study included data for incident rectal cancer cases reported to SEER registries between 1992 and 1999. SEER-Medicare data allow examination of cancer treatment claims for elderly Americans in fee-for-service care within SEER program areas in 5 states and 8 metropolitan or county-based areas in 5 additional states as follows: Connecticut, Hawaii, Iowa, New Mexico, Utah, Atlanta and rural Georgia, Arizona Indians (which we group with New Mexico), Detroit, Los Angeles, San Francisco, San Jose, and Seattle/Puget Sound. SEER data provided diagnosis date, patient demographics, cancer type and stage, and tumor characteristics. Medicare data provided date and cause of death through December 2004, enrollment dates in parts A and B Medicare, HMO enrollment dates, dates and types of treatment, and diagnosis and procedure codes for services provided by hospitals (MedPAR files), physicians and clinics (Carrier file), and noninstitutional facilities (Outpatient file). The SEER-Medicare database provided US Census data for area socioeconomic status at the ZIP-code level.[11]

Study Population

We identified 5249 patients aged 66 years and older who were diagnosed with primary stage II and III rectal cancer between January 1, 1992 and December 31, 1999, allowing for at least 5 years of follow-up for vital status. Rectal cancers included all adenocarcinomas in the rectum and excluded rectosigmoid cancers. American Joint Committee on Cancer criteria were used to designate cancer stage.[17]

We sequentially excluded patients with prior colorectal cancer (n = 118), simultaneous stage IV colorectal cancer (n = 5), and autopsy or death certificate-based rectal cancer diagnosis (n = 4). To adequately measure baseline comorbidity, we then excluded patients without continuous Medicare Part A and Part B enrollment in fee-for-service Medicare in the 11 months preceding the month before diagnosis (n = 1317). We excluded an additional 658 patients who died and 68 with incomplete enrollment in Medicare Part A and Part B fee-for-service Medicare in the 12 months after diagnosis to ascertain adjuvant chemoradiotherapy receipt. Lastly, we excluded 193 patients without a surgical resection Medicare claim within 6 months of diagnosis. Our final study population included 2886 patients.

Study Variables

Initiation and completion of adjuvant chemoradiotherapy—We defined chemotherapy initiation as at least 1 claim indicating administration of chemotherapy (Current Procedural Terminology [CPT] codes 96408; 96410; 96412; 96414; 96545; 96549; 96520; and 96530; International Classification of Diseases, 9th Edition [ICD-9] procedure code 99.25; ICD-9 diagnosis codes E 0781 and V58.1; and Health Care Common Procedure Codes [HCPCS] J0640, J9190, and Q0083-85). Radiation therapy initiation was defined as at least 1 claim indicating administration or management of radiation therapy (CPT codes 77331-4; 77336; 77370; 77399; 77402-17, 77419-31; and 77499; ICD-9 procedure codes 92.20, 92.23-6, and 92.29; ICD-9 diagnosis code V58.0; and Outpatient Revenue Center code 0333). We defined neoadjuvant chemotherapy and neoadjuvant radiation therapy as receipt of adjuvant chemotherapy or radiation therapy anytime starting in the month of diagnosis up to the day before surgical resection. Time to initiation of adjuvant therapy was defined as the number of weeks from the hospital admission date for surgical resection to the first radiation or chemotherapy administration or management claim. Prior research has documented a high sensitivity of Medicare claims in identifying chemotherapy and radiation initiation.[18–21]

We created variables to denote receipt of a complete course of adjuvant chemotherapy and adjuvant radiation therapy. During our study period (1992–1999), the standard of care for adjuvant chemotherapy shifted from 12 to 6 months, based on research evidence.[22] To avoid underascertainment of completion, we accepted 6 months or cycles of a chemotherapy regimen as the standard for a complete course. Medicare data identified individual dates on which chemotherapy was administered. We defined 5 months of chemotherapy within which there was at least 1 chemotherapy administration claim per month as a complete course.[16] This definition allows for missing claims in our database.

Published recommendations advise 6 weeks of radiation as the standard course of therapy.[3] To allow for missing claims, we defined a complete course as 5 weeks and a week of radiation therapy as having at least 1 claim for radiation administration or management in the week.

We wanted to ensure that chemotherapy and radiotherapy claims used to determine completion of a course were not claims for treatment of a cancer recurrence. Therefore, we considered only chemotherapy or radiation claims that began with the first claim date for surgery, chemotherapy, or radiation therapy after diagnosis and ended[1] with the claim date after which there were 3 months without any type of rectal cancer treatment,[2] with a cancer recurrence (eg, evidence of metastasis or secondary malignancy according to CPT codes, or ICD-9 diagnosis, or procedure codes), or[3] 12 months after diagnosis, whichever came first. Our analyses confirmed that all patients who completed an adjuvant course of chemotherapy or radiation therapy did so within 12 months of diagnosis.

We identified 5 adjuvant therapy completion options as follows: 1) complete chemotherapy and radiation therapy; 2) complete chemotherapy, but no or incomplete radiation therapy; 3) complete radiation therapy, but no or incomplete chemotherapy; 4) some chemotherapy and/or radiation therapy, but neither therapy complete; and 5) no chemotherapy or radiation therapy. We included any neoadjuvant chemotherapy and radiotherapy that a patient received in the determination of completion.

The recommended chemoradiation treatment includes a 21-day overlap in receipt of chemotherapy and radiation therapy. Among individuals in our study who completed both radiation and chemotherapy, more than 95% had the recommended 21-day overlap. However, because of the potential for missing or incorrectly dated claims records, we did not require patients to have an overlap in therapies.

Mortality—We identified patients who died of cancer within 5 years of their diagnosis to calculate cancer-related mortality rates for the different adjuvant therapy completion groups.

Explanatory variables

Patient sociodemographic, clinical, and tumor characteristics: Age, race, marital status, sex, tumor (T) classification, number of positive nodes, and tumor grade were identified from SEER data. Comorbidity was identified from inpatient and outpatient claims in the 11 months preceding the month before diagnosis by using Romano's adaptation of the Charlson comorbidity index,[23,24] classifying individuals into scores of 0, 1, or 2 or more.

We constructed 2 variables representing clinical factors that may influence adjuvant chemoradiation therapy receipt or completion as follows: rehospitalizations during the postsurgical period (1–6 weeks) and rehospitalizations during the adjuvant treatment period (7 weeks until the end of the treatment period). We excluded hospitalizations focused on receipt of chemotherapy or radiation therapy (Diagnostic Related Groupings [DRGs] 409, 410). These variables are further described in our prior publication.[16]

Contextual variables: Median household income in the patient's residence ZIP code was used as a proxy for socioeconomic status. Other contextual variables included the SEER registries to which patients were reported and residence location as defined by the Rural Urban Commuting Areas (RUCAs).[25,26] RUCAs, based on the patients' plurality residence ZIP code on the Medicare claims during the month of diagnosis or the most proximate claim, were designated as urban-focused, large rural city/town-focused, small rural town-focused, and isolated small rural town-focused.

Analysis

We described demographic, clinical, tumor, and contextual characteristics of eligible rectal cancer patients by cancer stage using chi-square tests to identify significant differences. We used chi-square tests to compare the characteristics of therapies that study patients received by cancer stage. We calculated completion rates for adjuvant chemotherapy, adjuvant radiation therapy, and both overall and by year, then we tested for the association over time of adjuvant chemotherapy and radiation therapy receipt overall and in the neoadjuvant phase by cancer stage by using the Mantel-Haenszel chi-square test.

We report unadjusted 5-year cancer mortality rates among patients at the 5 levels of completeness of adjuvant therapy. We tested for unadjusted differences in mortality across these groups by using chi-square tests. We conducted multivariate logistic regression (SAS, version 9.1) to compute the adjusted relative risk of 5-year mortality among those with various levels of adjuvant therapy completeness compared with those with no adjuvant

therapy. Recognizing that factors besides a complete course of adjuvant therapy could affect cancer mortality rates, we controlled for tumor extent, number of positive lymph nodes, and tumor grade, as well as patient's age, race, sex, marital status, residence location, SEER registry, ZIP code-based median household income, and comorbidity. Because the outcomes were relatively common, odds ratios (ORs) were transformed to Relative Risks (RRs) with 95% confidence intervals (CIs) for the variables retained in the final model by using published methods.[27]

RESULTS

There were few significant differences in the characteristics of stage II and III rectal cancer patients (Table 1). Stage II patients were slightly older and were less likely to be rehospitalized at 7 or more weeks after surgery than stage III patients.

Of the study's 2886 patients, 1766 (61.2%) received some adjuvant therapy (Table 2; Fig. 1). Stage III patients were significantly more likely to receive chemotherapy, radiation therapy, or both than stage II patients. Among stage II patients, but not stage III patients, the receipt rates of both adjuvant chemotherapy and radiation therapy increased significantly between 1992 and 1999 (Fig. 2). Notably, about half of both stage II (51.9%) and stage III (55.5%) patients received 8 weeks or more of radiation therapy (Table 2).

Stage II patients were more likely to receive neoadjuvant chemotherapy and neoadjuvant radiation therapy than stage III patients (Table 2). Both neoadjuvant therapies increased significantly between 1992 and 1999 for stage II and III patients (Fig. 3). Overall, including those who received neoadjuvant therapy, 64.0% initiated radiation therapy and 78.3% initiated chemotherapy before or within 8 weeks of surgery, the standard timeframe for these treatments (Table 2).

Among those who initiated adjuvant radiation, 91.5% of stage II and 96.6% of stage III patients completed it (Table 3). A much lower proportion of patients who initiated adjuvant chemotherapy completed treatment, 49.8% of stage II and 68.2% of stage III patients. Nearly all patients who used adjuvant chemotherapy also completed a course of adjuvant radiation therapy. Stage III patients were significantly more likely than stage II patients to complete adjuvant radiation, adjuvant chemotherapy, and the combination of both.

Stage II and III rectal cancer patients who completed both adjuvant radiation and chemotherapy had significantly lower adjusted 5-year cancer-related mortality than those with no adjuvant therapy (stage II adjusted relative risk [RR] 0.74 [95% CI, 0.54,0.97], stage III adjusted RR 0.80 [95% CI, 0.65, 0.96]) (Table 4). Stage III patients who completed adjuvant chemotherapy but who received incomplete radiation therapy had a reduced risk of cancer-related mortality that approached statistical significance (adjusted RR 0.76 [95% CI, 0.53,1.02]) compared with those with no therapy. Adjusted 5-year mortality rates among patients who received incomplete courses of chemotherapy and/or radiation therapy were comparable to the 5-year mortality rates of patients who received no chemotherapy and radiation therapy.

DISCUSSION

This study demonstrated that fewer than half of stage II (37.5%) and just over half of stage III (54.2%) rectal cancer patients diagnosed from 1992 through 1999 initiated combined chemoradiation therapy. This is consistent with earlier studies of stage II and III rectal cancer patients according to 1992–1996 SEER-Medicare data that reported chemoradiation initiation rates of 37% and 42%.[12,13]

For stage II patients, we found significantly increasing rates of adjuvant chemotherapy from 1992 to 1999 (from 34.0% to 53.0%) and consistently higher rates among stage III compared with stage II patients. Adjuvant radiation therapy use also significantly increased for stage II patients from 44.2% to 59.1% over this study period. Although no statistically significant trend could be detected, adjuvant chemotherapy use by stage III patients increased from 60.7% in 1992 to 75.2% in 1999, and adjuvant radiation therapy increased from 64.4% to 67.9% over that period. This is consistent with a report that used the SEER registry from 2000, wherein about ⅓ of patients with nonmetastatic advanced rectal cancer did not receive adjuvant radiation therapy.[28]

The most dramatic change over the course of our study was the increase in use of neoadjuvant therapy for both stage II and III patients. Although still infrequently received, by 1999, neoadjuvant chemotherapy rates had more than tripled to approximately 20%, and neoradiation therapy more than doubled for stage II patients and increased 4-fold for stage III patients, both to more than 20%. During this period, oncologists recognized that neoadjuvant treatment was more easily tolerated than adjuvant treatment,[29,30] and there were indications that neoadjuvant therapy offered improved disease control.[31,32] Recent studies have confirmed that neoadjuvant therapy offers more favorable local control and an increased likelihood of a sphincter-sparing surgical procedure.[30,33,34] Although neoadjuvant therapy has beneficial aspects, it does not constitute a complete course of adjuvant therapy.

Our data suggest that completion of therapy had a significant impact on survival for stage II and III patients. These findings confirm the results of clinical trials that have demonstrated that the addition of chemotherapy to external-beam pelvic radiation provides optimal post-treatment survival.[8] The adjusted relative risk of cancer-related death for patients initiating but not completing chemoradiation was comparable to that of patients with no adjuvant therapy, emphasizing the importance of completing adjuvant treatment once it has begun.

Stage III patients in our study who received a complete course of chemotherapy but an incomplete course of radiation therapy had a lower risk of cancer-related death than those with no therapy, but this finding did not achieve statistical significance, perhaps because of the small number in this group (n = 89). Future work with a larger population should explore whether treatment with surgery and only complete chemotherapy is necessary for improved survival of stage III rectal cancer patients. However, this does not take into account the importance of preventing local recurrence, where the role of radiation therapy is, perhaps, most important.[33,35]

Whereas some have argued that meticulous surgical technique may be adequate to provide excellent local rectal cancer control,[36,37] the Dutch rectal cancer trial demonstrated that even with optimal surgical technique, radiation therapy significantly decreased local recurrence rates.[35] Our data do not allow us to examine surgical technique or local recurrence, the outcome most affected by inadequate radiation treatment. Therefore, our findings cannot be interpreted as rationale for changing adjuvant radiation therapy recommendations for these patients.

Our data indicated that only 54.2% of stage III patients and 37.5% of stage II patients initiated both chemotherapy and radiation therapy as indicated by NIH guidelines. Complying with recommended therapy for rectal cancer is challenging because the course for chemotherapy and radiation is lengthy, and there is significant toxicity. The majority of patients who initiated radiation therapy completed the recommended course, but fewer patients who started chemotherapy completed treatment. Of those who initiated chemoradiation, 47.6% of stage II patients and 67.5% of stage III patients completed both treatments. Given the relatively low rates of treatment initiation and significant attrition

from therapy completion, a strikingly low proportion of all rectal cancer patients completed chemoradiation, 22.6% of all stage II and 43.6% of all stage III patients in 1999.

Do these findings reflect physician skepticism about the necessity of these treatments, particularly for elderly patients for whom the survival benefit may be outweighed by treatment toxicity? Although it is difficult to answer this question with the current data set, the higher completion rates for patients with stage III compared with stage II disease suggest that patients and physicians may be using their judgment on the level of disease advancement to decide how vigorously to pursue treatment completion. An alternative explanation is that stage III patients have less treatment-related toxicity than stage II patients, but research suggests similar toxicities for both groups.[14,30]

This study has several limitations. First, this is a retrospective study based on administrative data. We did not have access to detailed clinical records that could provide additional variables influencing treatment, such as severity of comorbidity. Although we used logistic regression modeling techniques to adjust for all confounding variables identifiable in these data, including age, sex, stage of disease, comorbidity, and year of treatment, there may be unmeasured confounders.

Second, we do not have data on treatment rates for populations younger than 65 years of age. Future work could explore treatment in these younger populations, as well as treatment among patients with different characteristics (eg, sex, marital status, residence location) to determine whether there are subpopulations that are more and less likely to receive adjuvant chemoradiation therapy for rectal cancer.

Third, our findings of a more favorable mortality rate associated with completion of therapy may be related to other unexplored factors. Recent studies suggest that mortality is related to tumor characteristics, such as size, number of nodes, location of the primary tumor, surgical method, and complete pathologic response to neoadjuvant therapy.[38–44] Although we controlled for tumor extent (T classification) and number of nodes, we were unable to control for other tumor and treatment factors. Needed is future analysis of the association of these variables with cancer-specific mortality. The lower mortality rate associated with completion of therapy may also be related to patient selection rather than to therapeutic benefit, although we used cancer-specific survival to minimize potential confounding from noncancer-related medical conditions.

Our results demonstrate clear, cancer-specific, survival benefit for a general population of elderly stage II and III rectal cancer patients who complete a full course of recommended therapy yet who have low rates of chemoradiation completion. Although the past decade has brought refinements in surgical technique and a move toward neoadjuvant therapy, this study underscores the importance of a complete course of adjuvant chemoradiotherapy for patients with stage II and III rectal cancer. This study's findings provide large-scale, real-world confirmation of the clinical trial data that has shaped our practice patterns in rectal cancer therapy and should serve as encouragement for primary care physicians, medical oncologists, radiation oncologists, and oncology nurses to make all possible efforts to support rectal cancer patients through a full course of adjuvant therapy.

Acknowledgments

This research was supported by grant R01CA089544 from the National Cancer Institute, National Institutes of Health, Bethesda, Maryland.

The authors would like to thank Yong Cai, PhD and Pam Green, PhD for their expertise and role on the study database design and development team and for their assistance in creating several the database variables; Denise Lishner for her assistance in literature review and manuscript editing; Marie Topor and Angela Fahey at

Information Management Services for their assistance in understanding the linked SEER-Medicare database; and Jason Dominitz, MD, William Barlow, PhD, and George Wright, PhD for their insight into the analytical questions.

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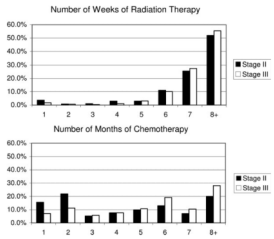

FIGURE 1.
Length of therapy.

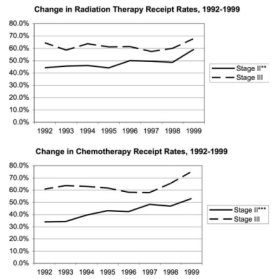

FIGURE 2.

Adjuvant therapy receipt among stage II and III rectal cancer patients, 1992–1999. Mantel Haenszel chi-square test of trend in radiation and chemotherapy receipt over the study period, **P* ≤ .05, ***P* ≤ .01, ****P* ≤ .001.

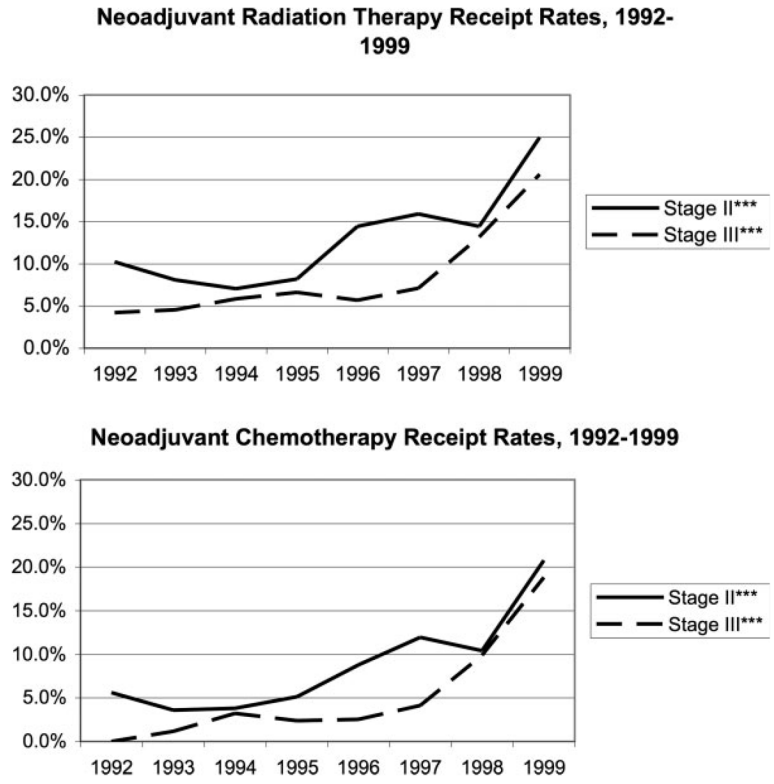

FIGURE 3.

Neoadjuvant therapy receipt among stage II and III rectal cancer patients, 1992–1999. Mantel-Haenszel chi-square test of trend in radiation and chemotherapy receipt over the study period, **P* ≤ .05, ***P* ≤ .01, ****P* ≤ .001.

TABLE 1

Sociodemographic, Clinical, Tumor, and Contextual Characteristics of Stage II and III Rectal Cancer

Characteristic	% Stage II* n = 1524	% Stage III* n = 1362
Age, y†		
66–70	23.3	27.0
71–75	26.4	30.2
76–80	23.7	21.9
81–85	16.5	14.1
≥86	10.2	6.8
Race		
Caucasian	85.2	85.9
African American	3.9	4.6
Asian or Pacific Islander	5.1	4.4
Hispanic	4.4	4.5
Other, unknown	1.4	0.7
Men	52.9	55.7
Marital status		
Married	55.7	58.6
Divorced, separated, or single	11.9	12.4
Widowed	31.0	27.8
Unknown	1.3	1.2
Median household income in ZIP code of residence		
≤$25,000	13.0	13.6
$25,001–$35,000	25.8	25.8
$35,001–$45,000	27.6	25.6
≥$45,001	33.7	35.0
Residence location		
Isolated small rural town-focused	6.1	6.5
Small rural town-focused	6.3	7.2
Large rural city/town-focused	7.2	5.4
Urban-focused	80.3	80.9
Comorbidity score		
0	54.6	56.2
1	20.3	21.2
≥2	25.1	22.6
Year of diagnosis		
1992	14.1	14.0
1993	14.6	12.9
1994	12.1	11.3
1995	12.8	12.3
1996	12.7	11.6

Characteristic	% Stage II* n = 1524	% Stage III* n = 1362
1997	11.6	12.4
1998	11.4	13.4
1999	10.8	12.1
SEER registry		
Atlanta/Rural Georgia	4.1	5.2
Connecticut	16.1	14.8
Detroit	15.0	17.8
Hawaii	2.5	2.5
Iowa	17.3	17.1
Los Angeles	10.6	11.2
New Mexico/Arizona Indians	4.0	3.7
San Francisco	8.1	6.6
San Jose	5.9	4.7
Seattle/Puget Sound	10.8	11.2
Utah	5.5	5.1
Hospital readmission in 1st–6th wk after surgery	13.5	12.0
Hospital readmission in 7th wk after surgery to end of treatment period‡	39.6	43.8
Tumor extent†,§		
T1	—	3.5
T2	—	17.6
T3	91.9	73.9
T4	8.1	5.0
Tumor grade†		
G1 (well differentiated)	7.2	5.3
G2 (moderately differentiated)	74.4	67.2
G3 (poorly differentiated)	13.5	22.7
G4 (undifferentiated)	0.4	0.4
Unknown	4.5	4.5
No. of positive nodes†		
N0 (no nodes)	81.1	0.6
N1 (1–3)	—	62.6
N2 (4–96)	—	31.9
Nx (no nodes examined)	18.9	1.8
Ny (positive nodes, number not specified)	—	3.1

All chi squares are overall, comparing stage II and stage III with different characteristics.

*Percentages do not always add to 100 due to rounding.

†$P \leq .001$.

‡$P \leq .05$.

[§]T1 is tumor confined to mucosa, muscularis mucosa, head or stalk of polyp, or submucosa. T2 is tumor with muscularis propria invaded or localized, not otherwise specified. T3 is invasion through muscularis propria, wall, or invasion through perimuscular or subserosal tissue, or extension into fat, adjacent tissue, or through peritoneum. T4 is extension into bladder, prostate, vagina, pelvic wall, uterus, ureter, colon, ductus deferens, or other structure.

Missing values: median household income (58 stage II, 41 stage III), residence location (4 stage II, 4 stage III), race (3 stage II included in American Indian/other category).

TABLE 2

Description of Adjuvant Therapy Received by Stage II and III Rectal Cancer Patients

	Total		Stage II		Stage III	
	No.	**%**	**No.**	**%**	**No.**	**%**
Total	2886	100.0	1524	100.0	1362	100.0
Rates of						
Radiation therapy receipt*	1573	54.5	732	48.0	841	61.8
Chemotherapy receipt*	1502	52.0	641	42.1	861	63.2
Both radiation therapy and chemotherapy receipt*	1309	45.4	571	37.5	738	54.2
Among those receiving adjuvant radiation therapy						
Receiving neoadjuvant radiation therapy*	306	19.4	191	26.1	115	13.7
Initiation of radiation therapy before or within 8 wk of resection*	1006	64.0	509	69.5	497	59.1
Among those receiving adjuvant chemotherapy						
Receiving neoadjuvant chemotherapy*	198	13.2	127	19.8	71	8.2
Initiation of chemotherapy before or within 8 wk of resection†	1176	78.3	483	75.4	693	80.5

All chi-square overall, comparing stage II with stage III with different characteristics of therapy. (No statistics for testing duration of therapy.)

*$P \leq .001$.

†$P \leq .05$.

Cancer. Author manuscript; available in PMC 2011 May 27.

TABLE 3

Completion Rates for Stage II and III Rectal Cancer Patients Who Initiated Adjuvant Radiation Therapy and/or Chemotherapy

	Stage II		Stage III	
	No. of patients initiating treatment	**Completion rate**	**No. of patients initiating treatment**	**Completion rate**
Radiation therapy*	732	91.5%	841	96.6%
Chemotherapy*	641	49.8%	861	68.2%
Both radiation therapy and chemotherapy*	571	47.6%	738	67.5%

All chi squares overall comparing stage II with stage III for completion of therapies.

* $P \leq .001$.

TABLE 4

Relation Between 5-Year Cancer-specific Mortality and Level of Adjuvant Radiation Therapy and Chemotherapy Completion by Stage II and III Rectal Cancer Patients

	Stage II, n = 1524			Stage III, n = 1362		
	No. (%)	Unadjusted cancer-related mortality rate,* %	Adjusted RR of cancer-related death† (95% CI)	No. (%)	Unadjusted cancer-related mortality rate, %	Adjusted RR of cancer-related death† (95% CI)
Radiation therapy and chemotherapy completed	272 (17.9)	22.1	0.74 (0.54,0.97)	498 (36.6)	41.0	0.80 (0.65,0.96)
Chemotherapy completed, no radiation therapy or incomplete course	47 (3.1)	25.5	0.94 (0.54,1.48)	89 (6.5)	40.4	0.76 (0.53,1.02)
Radiation therapy completed, no chemotherapy or incomplete course	398 (26.1)	33.9	0.92 (0.73,1.14)	314 (23.1)	48.7	0.95 (0.78,1.13)
Initiated radiation therapy and/or chemotherapy, without completion of either	85 (5.6)	32.9	1.02 (0.68,1.45)	62 (4.6)	46.8	0.90 (0.62,1.21)
Neither radiation therapy nor chemotherapy initiated	722 (47.4)	29.1	1.00	398 (29.2)	47.7	1.00

RR indicates relative risks; 95% CI, confidence interval.

Missing values for logistic regressions: median household income (58 stage II, 41 stage III), residence location (4 stage II, 4 stage III), missing date of death (1 stage III).

Chi squares for unadjusted mortality by 5 levels of completion.

*$P \leq .05$.

†Adjusted for patients' age, race, sex, marital status, residence location, SEER registry, median household income, comorbidity, extent of tumor, grade of tumor, and number of positive nodes.