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Adjuvant therapy for elderly patients with resected gastric adenocarcinoma: population-based practices and treatment effectiveness

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Abstract

Purpose—To determine the survival benefit of postoperative chemoradiation therapy for elderly patients with resected gastric adenocarcimona.

Methods—We identified 1,023 individuals age 65 years and older (median=76) who underwent gastrectomy for non-metastatic stage IB–IV gastric adenocarcioma diagnosed between 2000–2002 in the linked Surveillance, Epidemiology and End Results-Medicare database. We examined factors associated with receiving postoperative chemoradiation and analyzed the survival benefit associated with receiving postoperative chemoradiation.

Results—Thirty percent of patients received adjuvant chemoradiation. On multivariable analysis, younger age ($p<0.0001$), lymph node involvement ($p<0.0001$), and more recent diagnosis ($p=0.0284$) were associated with receiving chemoradiation. There was a trend towards increased use among patients with less comorbidity ($p=0.0515$). The median follow-up was 25.5 months and 62% died. On multivariable survival analysis, older patients ($p< 0.0001$), those with lymph node involvement ($p<0.0001$), T3 or T4 disease ($p=0.0472$), higher grade disease ($p=0.0355$), and more comorbidity ($p=0.0411$) were more likely to die. After adjustment for other factors, receipt of adjuvant chemoradiation therapy did not significantly increase survival (HR 0.90; 95% CI 0.72–1.12; $p=0.3453$) and did not increase survival in a multivariable analysis that included propensity scores ($p=0.2090$).

Conclusion—We did not detect a survival benefit, suggesting some elderly patients with resected gastric adenocarcinoma may not gain a survival benefit from the administration of adjuvant chemoradiation. The analysis had limitations and the results are hypothesis generating.

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Future gastric cancer trials should enroll more elderly patients and stratify patients by age to better understand the impact of treatment regimens on older patients.

Keywords

Gastric cancer; Aged; SEER-Medicare; Chemotherapy; Radiotherapy

Introduction

In a landmark trial, Intergroup (INT) 0116, postoperative chemotherapy and radiation therapy improved survival for patients with resected gastric adenocarcimona.[1] However, the effectiveness of postoperative chemoradiation for elderly individuals treated outside of a controlled clinical trial setting is not known. It is important to understand the potential benefit for older patients because gastric cancer mostly affects older individuals; the average age at diagnosis is 71 years and almost two thirds of those diagnosed with gastric cancer are above 65.[2] Older patients diagnosed with cancer are less likely to receive standard treatment compared to younger patients, even when such treatments are potentially curative.[3–5] Indeed, older patients with gastric cancer are less likely to receive any type of treatment for their cancer compared to younger patients[6] and older patients who undergo gastrectomy for gastric adenocarcinoma are less likely to receive postoperative radiation therapy.[7]

The determination of treatment effectiveness in the elderly may substantially impact postoperative chemoradiation utilization among elderly patients with locally advanced gastric adenocarcinoma. Therefore, this study used the linked Surveillance, Epidemiology and End Results Medicare database (SEER-Medicare) to examine clinical and sociodemographic factors associated with receiving postoperative chemoradiation for resected gastric adenocarcimona among individuals age 65 and older and to evaluate the survival benefit associated with receiving postoperative chemoradiation. We hypothesized that postoperative chemoradiation would confer a survival benefit, but this survival benefit would be less than the benefit demonstrated in the INT-0116 trial.

Methods

Data sources

Patients were identified from the linked SEER-Medicare database. The catchments for the seventeen SEER tumor registries comprise 25% of the US population[8] and the registries participating in the SEER program capture approximately 97% of incident cancers.[9] The registries collect data on patient demographics, primary tumor site, tumor morphology and stage at diagnosis, first course of treatment, and the date and cause of death. The linked Medicare data include inpatient and outpatient medical claims and physician billings[8], and were utilized to determine radiation and chemotherapy treatment, comorbid illnesses, and treatment for metastatic disease. The SEER-Medicare database used for this analysis contained SEER diagnoses through 2002, Medicare claims through 2005, gastric cancer specific mortality through 2003 and vital status follow-up through February 2005.

Cohort selection

The cohort contained individuals age 65 and older diagnosed with non-metastatic invasive American Joint Committee on Cancer (AJCC, 6th edition) Stage IB to IV gastric adenocarcioma in a SEER region between January 1, 2000 and December 31 2002 and who underwent gastrectomy as initial therapy. We selected this date range because the results of the INT-0116 trial were disseminated in 2000[10] and the results of the next landmark gastric cancer trial, the MAGIC trial, were initially presented in early 2003.[11] Individuals within our study cohort met basic criteria for enrollment in the INT-0116 trial (resected tumor (T) 2 to T4 disease or lymph node involvement)[1]. We excluded subjects who died within one month of gastrectomy, subjects with a prior cancer diagnosis because prior treatment can impact adjuvant therapy recommendations, and subjects who developed metastatic disease within 6 months of gastrectomy. Subjects who did not have continuous Medicare enrollment (both Part A and Part B) and those who were enrolled in a health maintenance organization (HMO) any time from 13 months before diagnosis (for use in comorbidity assessment) through 6 months after gastrectomy were excluded because they did not have complete claims data. In total, 1,023 subjects met our inclusion criteria.

Variables and their measurement

The primary outcomes were receipt of adjuvant chemoradiation within 6 months post-gastrectomy and overall survival. Medicare claims identified adjuvant chemotherapy administration and have previously been shown to correlate well with chemotherapy receipt.[12] Medicare claims used to capture gastrectomy, general chemotherapy administration and general radiation therapy administration are detailed in Table 1. Both SEER and Medicare were used to identify radiation therapy receipt within 6 months after the first gastrectomy claim to ensure a comprehensive assessment of radiation treatment.[13] In the SEER database, patients are coded as receiving radiation therapy or recommendation for radiation therapy as a component of the first course of treatment.

Explanatory variables evaluated for association with receiving adjuvant chemoradiation therapy and with survival included: diagnosis year, tumor characteristics (size, number of lymph nodes involved), clinical characteristics (age at diagnosis, comorbidities), sociodemographic factors (ethnicity, socioeconomic status, region of the country), type of treating institution (academic vs. community hospital), and distance to nearest radiation treatment facility. Diagnosis year was categorized into six month blocks. Tumor stage was categorized by AJCC 6th edition tumor (T) stage, which is based on the depth of penetration (T1, T2, T3 and T4). The number of involved regional lymph nodes were grouped according to AJCC 6th edition regional lymph node (N) staging as none (N0), 1 to 6 (N1), 7 to 15 (N2), and more than 15 nodes (N3). We identified comorbidties by collecting diagnostic billing codes for specific health conditions during the year before diagnosis of gastric cancer using the Deyo implementation of the Charlson score applied to both inpatient and outpatient claims.[14–16] Subjects were categorized as receiving their gastrectomy in a teaching hospital if there was a bill for indirect medical education during their stay. Distance to nearest radiation treatment facility was determined by an established algorithm that calculated the distance from the zip code of the patient's residence to that of the closest radiation therapy facility.[17]

Statistical Analysis

Descriptive statistics were generated for the study cohort. The study subjects were stratified by adjuvant treatment received: a) no adjuvant chemotherapy or radiation therapy; b) either radiation therapy or chemotherapy; and c) both chemotherapy and radiation therapy. Chi-square tests and kruskal-wallis test were used to compare categorical and continuous variables across treatment groups, respectively. The crude association of each potential explanatory variable with the outcome of receiving chemoradiation therapy was examined using univariate logistic regression. The independent association of an explanatory variable was examined using a multivariable logistic regression model constructed using forward and backward elimination. Subjects with missing data for T stage (n=10), N stage (n=74), grade (n=17) or distance from radiation facility (n=1) were excluded from univariate and multivariable models including these variables. The survival of the subjects who received both adjuvant chemotherapy and radiation therapy was compared to the survival of the subjects who received no adjuvant therapy. Individuals who received either only chemotherapy or only radiation were removed from the survival analysis (n=131). Survival, calculated from date of gastrectomy, was examined using multivariable and propensity-based Cox-proportional hazard regression models that included all explanatory variables. Propensity scores were created to account for unmeasured factors that are associated with receiving chemoradiation that may also influence overall survival. A multivariable logistic regression model with receipt of chemoradiation as the outcome was used to generate the propensity scores. Subjects were stratified into quintiles based on their scores, which were then added as covariates to the multivariable Cox proportional hazards model. In an exploratory analysis, survival outcome among those with stage III or IV disease was examined using a Cox-proportional hazard regression analysis. Interaction terms to test *a priori* hypotheses regarding the receipt of adjuvant chemoradiation therapy (chemoradiation therapy and age, and chemoradiation therapy and nodal involvement) were studied. For illustrative purposes, unadjusted Kaplan-Meier survival curves were constructed comparing patients who received adjuvant combined chemoradiation therapy to those who received neither adjuvant chemotherapy nor adjuvant radiation therapy. In a sensitivity analysis, gastric-cancer specific survival rather than overall survival was examined using multivariable and propensity-based Cox-proportional hazard regression models.

Statistical analyses were conducted using SAS software, version 9.1.3 for windows (SAS Institute, Cary, NC).

This study was reviewed by the Institutional Review Board at the Dana-Farber Cancer Institute and determined to be exempt.

Results

Descriptive characteristics of the study cohort

Among the 1,023 elderly patients with non-metastatic resected Stage IB to IV gastric adenocarcinoma, 5 % had T1, 65% had T2, and 30% had T3 or T4 disease. Sixty-nine percent of the patients had lymph node involvement (Table 2). The median diagnosis age was 76 years (interquartile range 72 to 81) and the majority of patients were White (72%) or Asian (17%). Adjuvant chemoradiation was administered to 30% (n=309) of subjects during the study period, 57% (n=583) of subjects received no adjuvant therapy and the remainder (n=131) received either adjuvant chemotherapy or adjuvant radiation therapy. Thirty-two percent of subjects diagnosed between July and December 2002 received adjuvant chemoradiation therapy, compared to 21% of subjects diagnosed between January and June 2000.

Predictors of receiving adjuvant radiation therapy and chemotherapy

On univariate analysis (Table 3), male sex (p=0.0165), younger age (p <0.0001), lymph node involvement (p <0.0001), less comorbidity (p=0.0019), higher socioeconomic status (p=0.0097), and more recent diagnosis (p=0.0161) were associated with increased receipt of adjuvant chemoradiation after gastrectomy (Table 3). Distance to radiation therapy facility was not associated with receiving chemoradiation (p=0.1032).

On multivariable analysis younger age (p <0.0001), lymph node involvement (p <0.0001), and more recent diagnosis (p=0.0284), were associated with chemoradiation after gastrectomy (Table 4). There was a trend towards the use of chemoradiation among patients with less comorbidity (p=0.0515).

Predictors of survival

The survival of the subjects who received both adjuvant chemotherapy and radiation therapy was compared to the survival of the subjects who received no adjuvant therapy. In total, 62% (554/892) of these subjects died during the follow-up period. The median follow-up was 25.5 months after gastrectomy (range 4 to 62). On Cox proportional hazards multivariable analysis, older patients ($p < 0.0001$) and patients with lymph node involvement ($p < 0.0001$), T3 or T4 disease ($p=0.0472$), higher grade disease ($p=0.0355$), and comorbidity ($p=0.0411$) were more likely to die (Table 5). Additionally, Asian patients were less likely to die than White patients (HR 0.73; 95% CI 0.54–0.97; $p=0.0327$). After adjustment for other factors, receipt of adjuvant chemoradiation therapy did not significantly increase survival among this elderly population (HR 0.90; 95% CI 0.72–1.12; $p=0.3453$). The median survival among individuals who received chemoradiation therapy was 25.4 months versus 25.5 months for those who did not. Receipt of adjuvant chemoradiation therapy also did not significantly increase survival in a multivariable analysis that included propensity scores (HR 0.87; 95% CI 0.69–1.09; $p=0.2090$), or in an analysis limited to patients with stage III or IV disease (HR 0.98; 95% CI 0.70–1.38; $p=0.9115$). A sensitivity analysis evaluating gastric-cancer survival rather than overall survival determined adjuvant chemoradiation therapy was not associated with improved gastric-cancer survival ($p=0.665$)).

No significant interaction between age and receipt of adjuvant chemoradiation ($p=0.4903$) or between nodal involvement and receipt of adjuvant chemoradiation ($p=0.2724$) was noted on survival analysis.

Discussion

Although a landmark trial demonstrated postoperative chemoradiation improved survival for patients with locally-advanced resected gastric adenocarcimona[1], our population-based analysis of 1,023 patients age 65 and older with resected gastric adenocarcinoma found no significant survival benefit from postoperative chemoradiation therapy.

In our study, elderly patients most likely to clinically benefit from adjuvant therapy: those with fewer comorbidities, more advanced disease, and the younger elderly, were indeed more likely to receive adjuvant chemoradiation. Similar treatment patterns have been demonstrated in elderly patients undergoing cancer treatment for prostate, breast, colon, and ovarian cancer.[18–21] Patients diagnosed with gastric adenocarcinoma during the later months of the study period were more likely to receive adjuvant chemoradiation therapy, reflecting the dissemination of trial results and adoption of adjuvant chemoradiation into clinical practice. An initial report of the INT-0116 trial was presented in May 2000[10] and the findings were published in September 2001.[1] Prior studies, using receipt of radiation therapy as a proxy for receipt of both radiation therapy and chemotherapy, demonstrated an increase in adjuvant radiation therapy administration among patients of all ages after the May 2000 presentation of study results.[7,22] We postulated that patients undergoing gastrectomy at teaching institutions would be more likely to receive adjuvant therapy, potentially reflecting early adoption of the study results at teaching institutions, and that patients living closer to radiation therapy facilities would be more likely to receive adjuvant therapy, since daily travel for radiation treatments would be easier for them. However, neither surgery at a teaching institution nor living closer to a radiation therapy facility were associated with receiving adjuvant therapy.

Studies of patients diagnosed with other types of cancer have demonstrated that older patients are less likely to receive standard cancer treatment than younger patients, even when such treatments are potentially curative.[3–5] During our study period, adjuvant chemoradiation was administered to less than one third of the patients. Cancer stage at diagnosis and the perception of elderly as frail are potential explanations for why such a small proportion of the patients in our study received adjuvant chemoradiation. More than half of the patients in our study had a Charlson comorbidity score of zero since patients must be healthy to tolerate a gastrectomy. However, if these elderly patients had a decrease in functional status due to surgery they may no longer be good candidates for adjuvant therapy. Patients may not have received adjuvant therapy because of physician or patient concern about possible treatment toxicity in this elderly population as the acute toxicity of adjuvant chemoradiation reported in the INT-0116 trial was considerable: fifty-four percent of patients experienced grade three or worse National Cancer Institute-Common Toxicity Criteria (NCI-CTC) hematological toxicity; one-third of patients experienced grade 3 or worse NCI-CTC gastrointestinal toxicity.[1] Early cancer stage at diagnosis is another potential explanation for why such a small proportion of the elderly patients in our study received adjuvant chemoradiation. Patients in our study had earlier stage disease than the patients in INT-0116, 71% had T1 or T2 and 32% had N0 compared to only 32% with T1 or T2 and 15% with N0 disease in INT-0116. The applicability of the INT-0116 results to patients with early stage disease has been questioned because of the small number of study patients with early stage disease and because of the relatively good prognosis among those with early disease.[6,23] The smaller percentage of patients with early-stage disease (T1, T2 or N0) enrolled in the INT-0116 trial compared to our population-based cohort suggests that only a small proportion of such patients were considered for enrollment in INT 0116. This enrollment bias may reflect a preconceived belief that adjuvant therapy is not necessary for early stage patients. Alternatively, the stage distribution in our study may reflect a tendency to forgo surgery in older patients with locally advanced disease.

In our population-based multivariable analysis that adjusted for clinical and demographic differences between treatment groups, the addition of postoperative chemoradiation did not improve survival for elderly patients with resected gastric adenocarcinoma. The median survival was 25.4 months among those who received adjuvant chemoradiation and 25.5 months among those who did not receive combined adjuvant chemoradiation. This is in stark contrast to the nine-month survival benefit, from 26 to 35 months, seen with the addition of chemoradiotherapy in the INT-0116 trial.[1,24] The median follow-up in our study was not as long as the follow-up in INT-0116, but it is well beyond the time when the survival curves in INT-0116 diverged. Prior institutional series and population-based studies that suggested improved survival with the addition of adjuvant chemoradiation studied younger patients[25,26], did not have information on medical comorbidities which can influence the likelihood of receiving adjuvant chemoradiaiton and truncate survival,[25–27] and/or did not have information on chemotherapy administration.[27]

There are several potential explanations for why our study did not find a survival benefit. First, inadequate radiation therapy may have been administered to patients in our population-based cohort. The radiation field design and treatment planning for gastric cancer is technically challenging. Upon central review of treatment plans in the INT-0116 study, 34% of the radiation treatment plans required a change prior to radiation administration. If these plans were not changed, two-thirds of the deviations would have resulted in undertreatment of patients while one-third had the potential for delivering extremely toxic radiation.[28] If radiation treatment caused serious toxicity that aborted treatment before completion or if the radiation treatment target was missed, the patients would not benefit from radiation therapy. We did not have information regarding radiation treatment plans, radiation treatment dose, or whether chemotherapy and radiation therapy courses were completed after initiation of therapy. A consensus statement on appropriate radiation treatment fields was released in 2002, but was not available during the first half of our study period.[29] Second, as mentioned previously, the patients in our study had earlier stage disease than INT-0116 patients and may not have benefited from chemoradiation because of the relatively good prognosis among those with early disease. Third, margin status may have impacted survival outcomes. Enrollment in INT-0116 required complete resection with negative margins but margin status is not available in SEER-Medicare. However data suggests that the impact of surgical margin involvement on survival among patients with resected gastric adenocarcinoma who receive adjuvant chemoradiation therapy is minimal.[25,30] In our study, the median survival of patients who received no adjuvant treatment in our study was similar to the median survival of patients in the observation arm of INT-0116. Moreover, although margin status can not be examined in our dataset, our results reflect treatment patterns in the U.S. Finally, the demographics of our population-based cohort were different from the INT-0116 trial (median age 60 years); our cohort was older (median age 76) and included a higher proportion of individuals who were Asian. We may not have found a survival benefit in our study because of competing causes of mortality in these elderly patients.

This study has additional limitations common to observational studies using administrative data. The data source only captures Medicare patients and has incomplete data on the roughly 15% of patients in managed care. Previous studies suggest that HMO patients tend to have fewer comorbidites than patients in the general Medicare population[31] and that practice patterns in HMOs can differ significantly from those in a fee-for service setting[32]. However, other studies found few significant differences in cancer diagnosis and treatment between managed care and fee for service patients.[33] Methods for comorbidity adjustment are still undergoing development and revision.[16] Although the SEER-Medicare database is large, gastric cancer is a relatively rare cancer and only 30% of patients received adjuvant chemoradiation therapy; thus our ability to detect significant associations was limited by the size of our study cohort.

We did not detect a survival benefit from the administration of adjuvant chemoradiation therapy in our population-based study. These results suggest that some elderly patients with resected gastric adenocarcinoma may not gain a survival benefit from adjuvant chemoradiation. These findings should be considered hypothesis generating and further investigation is necessary. Randomized trials should enroll more elderly patients with gastric cancer and should stratify patients by age to permit subgroup analysis of the elderly to better understand the impact of treatment regimens on older patients.

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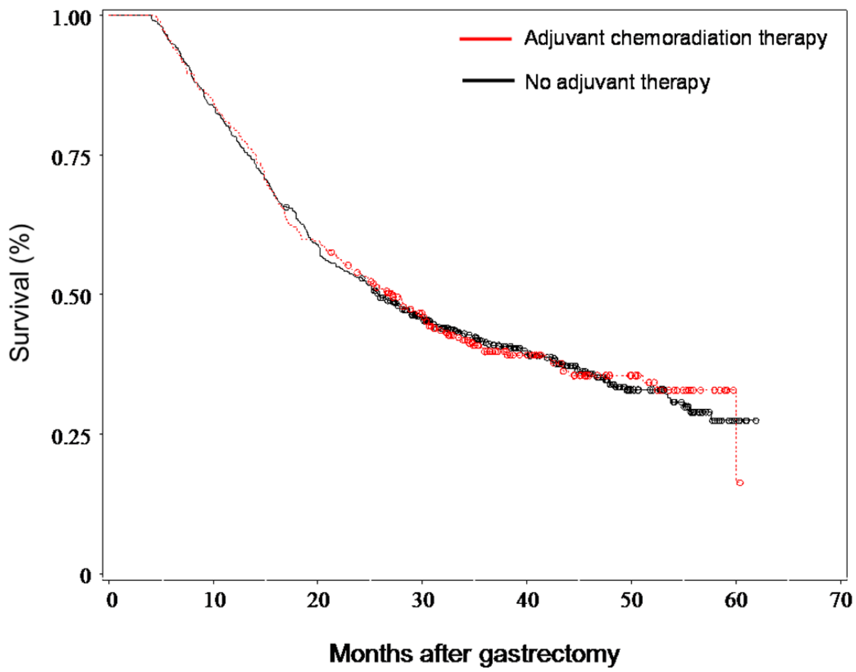

Figure 1.

Table 1

Medicare Billing Codes

Variable	Billing Codes
Gastrectomy	ICD-9-CM procedure 43.5x-43.99
	CPT 43620–43622, 43631–43634
General chemotherapy administration	ICD-9-CM diagnosis V58.1
	ICD-9-CM procedure 99.25
	HCPCS C1166, C1167, C1178, C9110, C9205, C9207, C9213–C9216, C9411, C9414–C9419, C942x, C9430–C9438, G0355, G0356, G0359–G0362, J7150, J85xx–J87xx, J8999, J9xxx, Q0083–Q0085, S9325–S9329, S933x–S937x, S9494–S9497
	CPT 9651x–9654x, 964xx
	Revenue center 0331, 0332, 0335
	DRG 410
	BETOS O1D
Radiation therapy administration	ICD-9-CM diagnosis V58.0
	ICD-9-CM procedure 92.2x
	HCPCS S8049
	CPT 77xxx, 79xxx; revenue center 0330, 0333, 0339.
	DRG 409
	BETOS P7A
	Inpatient (MEDPAR) indicator for receipt of radiology oncology services, and MEDPAR indicator for receipt of radiology therapeutic services.
Diagnosis of metastatic disease	ICD-9-CM diagnosis 196–199

BETOS: Berrenson-Eggers Type Of Service

CPT: Current Procedural Terminology

DRG: Diagnosis Related Groups

HCPCS: Health Care Financing Administration Common Procedure Coding System

ICD-9-CM: International Classification of Diseases 9th Revision Clinical Modification

Table 2

Characteristics of the 1,023 subjects who underwent gastrectomy for non-metastatic Stage IB–IV gastric adenocarcinoma, stratified by adjuvant treatment.

Characteristic	All subjects, n=1,023	No adjuvant therapy, n=583	Either chemotherapy OR radiation therapy, n=131	Chemotherapy AND radiation therapy, n=309	p-value[b]
Age at diagnosis (median (IQR))	76.3 (71.6–81.0)	78.8 (73.7–83.6)	75.1 (69.9–79.0)	73.0 (70.0–76.7)	**<0.0001**
Gender (n, (%))					0.0503
Male	561 (54.8)	303 (52.0)	71 (54.2)	187 (60.5)	
Female	462 (45.2)	280 (48.0)	60 (45.8)	122 (39.5)	
Race (n, (%))					0.0811
White	737 (72.0)	419 (71.9)	96 (73.3)	222 (71.8)	
Asian	173 (16.9)	93 (16.0)	17 (13.0)	63 (20.4)	
Other (including black)	113 (11.1)	71 (12.2)	18 (13.7)	24 (7.8)	
SES Quintile (n, (%))					**0.0185**
0	220 (21.5)	145 (24.9)	23 (17.6)	52 (16.8)	
1	214 (20.9)	118 (20.2)	33 (25.2)	63 (20.4)	
2	197 (19.3)	119 (20.4)	17 (13.0)	61(19.7)	
3	182 (17.8)	91 (15.6)	31 (23.7)	60 (19.4)	
4	210 (20.5)	110 (18.9)	27 (20.6)	73 (23.6)	
Six month diagnosis block (n, (%))					0.1393
Early 2000	189 (18.5)	118 (20.2)	32 (24.4)	39 (12.6)	
Late 2000	160 (15.6)	87 (14.9)	19 (14.5)	54 (17.5)	
Early 2001	179 (17.5)	105 (18.0)	21 (16.0)	53 (17.2)	
Late 2001	148 (14.5)	85 (14.6)	19 (14.5)	44 (14.3)	
Early 2002	176 (17.2)	95 (16.3)	17 (13.0)	64 (20.7)	
Late 2002	171 (16.7)	93 (16.0)	23 (17.6)	55 (17.8)	
T category[a] (n, (%))					**0.0002**
T1 or T2	705 (69.6)	432 (74.6)	77 (59.7)	196 (64.3)	
T3 or T4	308 (30.4)	147 (25.4)	52 (40.3)	109 (35.7)	
N category[a] (n, (%))					**<0.0001**

Characteristic	All subjects, n=1,023	No adjuvant therapy, n=583	Either chemotherapy OR radiation therapy, n=131	Chemotherapy AND radiation therapy, n=309	p-value[b]
N0	294 (31.0)	234 (43.5)	21 (17.7)	39 (13.4)	
N1	453 (47.7)	231 (42.9)	60 (50.4)	162 (55.5)	
N2 or N3	202 (21.3)	73 (13.6)	38 (31.9)	91 (31.2)	
Grade[a] (n, (%))					**0.0046**
1 or 2	329 (32.7)	211 (36.8)	32 (24.8)	86 (28.3)	
3 or 4	677 (67.3)	362 (63.2)	97 (75.2)	218 (71.7)	
Charlson (n, (%))					**<0.0001**
0	575 (56.2)	301 (51.6)	90 (68.7)	184 (59.6)	
1	273 (26.7)	154 (26.4)	23 (17.6)	96 (31.1)	
2+	175 (17.1)	128 (22.0)	18 (13.7)	29 (9.4)	
Gastrectomy at teaching hospital (n, (%))					0.4688
Yes	552 (54.0)	306 (52.5)	76 (58.0)	170 (55.0)	
No	471 (46.0)	277 (47.5)	55 (42.0)	139 (45.0)	
Distance to RT facility[a] (miles, median (IQR))	5.1 (2.5–12.2)	5.2 (2.5–12.0)	5.0 (2.5–13.5)	5.3 (2.9–13.1)	0.7486
SEER Region (n, (%))					0.3798
Northeast	277 (27.1)	160 (27.4)	35 (26.7)	82 (26.5)	
South	134 (13.1)	85 (14.6)	15 (11.5)	34 (11.0)	
Midwest	106 (10.4)	63 (10.8)	17 (13.0)	26 (8.4)	
West	506 (49.5)	275 (47.2)	64 (48.9)	167 (54.1)	

[a]Sample size does not add to 1,023 due to missing responses.

[b]Comparison across treatment groups.

Abbreviations: SES=socioeconomic status, T=tumor, N=lymph node, RT=radiation therapy.

Table 3

Univariate predictors of receiving adjuvant combined chemoradiation therapy among the 1,023 subjects who underwent gastrectomy.

Covariate	Chemoradiation therapy (%)	Odds Ratio (95% CI)	p-value
Age at diagnosis (per year increase)	30.2	0.88 (0.85, 0.90)	**<0.0001**
65 to 75	45.7	1.0	---
75 to 85	22.1	0.34 (0.25, 0.45)	**<0.0001**
85 and older	3.3	0.04 (0.02, 0.11)	**<0.0001**
Gender			
Male	33.3	1.39 (1.06, 1.83)	**0.0165**
Female	26.4	1.0	---
Race			
White	30.1	1.0	---
Asian	36.4	1.33 (0.94, 1.88)	0.1089
Other (including black)	21.2	0.63 (0.39, 1.01)	0.0542
SES Quintile (per quintile increase)	30.2	1.13 (1.03. 1.24)	**0.0097**
Six month diagnosis block (per 6 month increase)		1.10 (1.02, 1.19)	**0.0161**
Early 2000	20.6	1.0	---
Late 2000	33.8	1.96 (1.21, 3.17)	**0.0061**
Early 2001	29.6	1.62 (1.01, 2.61)	**0.0478**
Late 2001	29.7	1.63 (0.99, 2.68)	**0.0555**
Early 2002	36.4	2.20 (1.38, 3.51)	**0.0010**
Late 2002	32.2	1.82 (1.13, 2.94)	**0.0135**
T category			
T1	38.0	1.0	---
T2	27.0	0.60 (0.33, 1.10)	0.0977
T3/T4	35.4	0.89 (0.48, 1.66)	0.7209
N category			
N0	13.3	1.0	---
N1	35.8	3.64 (2.47, 5.36)	**<0.0001**
N2	41.8	4.69 (2.96, 7.45)	**<0.0001**
N3	56.8	8.60 (4.34, 17.07)	**<0.0001**
Grade			
1	25.0	1.0	---
2	26.3	1.07 (0.44, 2.61)	0.8860
3/4	32.2	1.43 (0.60, 3.40)	0.4254
Charlson comorbidity score (per score increase)	30.2	0.81 (0.71, 0.93)	**0.0019**
0	32.0	1.0	---
1	35.2	1.15 (0.85, 1.56)	0.3600

Covariate	Chemoradiation therapy (%)	Odds Ratio (95% CI)	p-value
2+	16.6	0.42 (0.27, 0.65)	**0.0001**
Gastrectomy at teaching hospital			
Yes	30.8	1.06 (0.81, 1.39)	0.6554
No	29.5	1.0	---
Distance to RT facility (per additional mile)		1.00 (1.00, 1.00)	0.1032
Less than 45	29.6	1.34 (0.85, 2.11)	0.2118
45 or more	36.0	1.0	---
SEER Region			
Northeast	29.6	0.85 (0.62, 1.17)	0.3287
South	25.4	0.69 (0.45, 1.06)	0.0918
Midwest	24.5	0.66 (0.41, 1.07)	0.0893
West	33.0	1.0	---

Abbreviations: SES=socioeconomic status, T=tumor, N=lymph node, RT=radiation therapy.

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Table 4

Factors significantly associated with receipt of adjuvant combined chemoradiation therapy on multivariable analysis among the subjects who underwent gastrectomy[a].

Covariate	Adjusted Odds Ratio (95% CI)	p-value
Age at diagnosis per year increase	0.87 (0.85, 0.90)	**<0.0001**
N category		
N0	1.0	---
N1	3.69 (2.45, 5.56)	**<0.0001**
N2	4.26 (2.61, 6.96)	**<0.0001**
N3	7.44 (3.58, 15.47)	**<0.0001**
Charlson comorbidity score (per score increase)	0.87 (0.75, 1.00)	0.0515
Six month diagnosis block (per six month block increase)	1.10 (1.01, 1.21)	**0.0284**

Abbreviations: N=lymph node.

[a]Model n=949.

Table 5

Multivariable predictors of all cause mortality among the subjects who received either combined chemoradiation therapy or no adjuvant therapy[a].

Covariate	Hazard Ratio (95% CI)	p-value
Treatment		
No adjuvant therapy	1.0	---
Chemotherapy and radiation therapy	0.90 (0.72, 1.12)	0.3453
Age at diagnosis (per year increase)	1.03 (1.01, 1.04)	**0.0002**
Gender		
Male	1.02 (0.85, 1.23)	0.8396
Female	1.0	---
Race		
White	1.0	---
Asian	0.73 (0.54, 0.97)	**0.0327**
Other (including black)	1.13 (0.84, 1.53)	0.4243
SES Quintile (per quintile increase)	1.00 (0.93, 1.06)	0.9277
Six month diagnosis block (per block increase)	0.97 (0.92, 1.03)	0.3190
T category		
T1	1.0	---
T2	1.27 (0.81, 1.98)	0.3023
T3 orT4	1.60 (1.01, 2.55)	**0.0472**
N category		
N0	1.0	---
N1	2.04 (1.62, 2.57)	**<0.0001**
N2	3.48 (2.62, 4.63)	**<0.0001**
N3	3.73 (2.38, 5.84)	**<0.0001**
Grade		
1	1.0	---
2	1.44 (0.75, 2.75)	0.2720
3/4	1.98 (1.05, 3.75)	**0.0355**
Charlson comorbidity score (per score increase)	1.08 (1.00, 1.16)	**0.0411**
Gastrectomy at teaching hospital		
Yes	0.90 (0.74, 1.08)	0.2555
No	1.0	---
Distance to RT facility (per additional mile)	1.00 (1.00, 1.00)	0.9661
SEER Region		
Northeast	0.96 (0.76, 1.22)	0.7536
South	1.18 (0.89, 1.59)	0.2548
Midwest	1.15 (0.83, 1.58)	0.3984
West	1.0	---

[a]Model n=809.

Abbreviations: SES=socioeconomic status, T=tumor, N=lymph node, RT=radiation therapy.

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