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Guideline-recommended chemoradiation for rectal cancer patients at large hospitals: a trend in the right direction

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Abstract

Background: Many rectal cancer patients are treated at small, low-volume hospitals despite evidence that better outcomes are associated with larger, high-volume hospitals.

Objectives: Examine trends of rectal cancer patients receiving care at large hospitals, determine patient characteristics associated with treatment at large hospitals, and assess relationships between treatment at large hospitals and guideline-recommended therapy.

Design: This study was a retrospective cohort analysis to assess trends in rectal cancer treatment.

Settings: Data from the National Cancer Institute's Surveillance, Epidemiology, and End Results Patterns of Care studies were used.

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Patients: The study population consisted of adults diagnosed with stages II/III rectal cancer in 1990/1991, 1995, 2000, 2005, 2010, and 2015.

Main Outcome Measures: The primary outcome was treatment at large hospitals (≥ 500 beds). Receipt of guideline-recommended preoperative chemoradiation therapy and postoperative chemotherapy were assessed for patients diagnosed in 2005+.

Results: 2,231 were patients included. The proportion treated at large hospitals increased from 19% in 1990/1991 to 27% in 2015 ($P_{\text{trend}} < 0.0001$). African American race was associated with treatment at large hospitals (vs. white) (OR: 1.73, 95% CI: 1.30–2.31), as was being 55–64 years of age (vs. 75+), and diagnosis in 2015 (vs. 1990/1991). Treatment in large hospitals was associated with twice the odds of preoperative chemoradiation, as well as younger age, and diagnosis in 2010 or 2015 (vs. 2005).

Limitations: The study did not account for the change in the number of large hospitals over time.

Conclusions: Results suggest rectal cancer patients are increasingly being treated in large hospitals where they receive more guideline-recommended therapy. Although this trend is promising, patients receiving care at larger, higher-volume facilities are still the minority. Initiatives increasing patient and provider awareness of benefits of specialized care, as well as increasing referrals to large centers may improve use of recommended treatment and ultimately improve outcomes.

Introduction

Although rectal cancer constitutes only a small portion of all colorectal cancers, it still accounts for substantial cancer burden.¹ Rectal cancer treatment is complex, in part because of the bony pelvic confines, proximity to genitourinary and neurovascular structures, and desire for sphincter preservation when possible.^{2–3} Appropriate rectal cancer care relies on the involvement and skills of a number of specialists, including surgeons, gastroenterologists, pathologists, radiologists, oncologists, and radiation oncologists.⁴ The National Comprehensive Cancer Network (NCCN) publishes clinical practice guidelines for rectal cancer.⁵ In addition to surgery, standards for locally advanced rectal cancer include neoadjuvant chemoradiation (CRT) and adjuvant chemotherapy, which have been found to improve control of stages II/III rectal cancer.⁵

A National Cancer Institute's (NCI) Surveillance, Epidemiology, and End Results (SEER)-Medicare analysis of stages II/III rectal cancer patients found that patients at NCI-designated facilities were more likely to receive guideline-recommended care, and these associations remained significant after adjusting for relevant confounders.⁶ Despite research suggesting that rectal cancer patients treated at low-volume facilities have worse outcomes compared with those treated at large, high-volume facilities, rectal cancer is often treated at small, low-volume hospitals in the US.^{6–33} Our analysis utilized SEER Patterns of Care (POC) data, which uniquely allows for examination of high-quality cancer diagnosis and treatment information, hospital characteristics, and patient comorbidities from a nationally representative sample of rectal cancer patients. Our objectives were to examine trends in the proportion of rectal cancer patients receiving care at larger and presumably high-volume hospitals, determine patient characteristics associated with receiving care at large hospitals,

and assess relationships between treatment at large hospitals and receipt of guideline-recommended therapy.

Methods

Study Sample

SEER POC data were used to identify rectal cancer cases for this study population. In addition to the traditional demographic and tumor characteristics collected by SEER, POC data contain additional information including specific chemotherapy regimens, comorbidities and hospital characteristics on a sample of patients with selected cancers that rotate on an annual basis. Hispanic, American Indian, non-Hispanic African American, Asian/Pacific Islander, and Native Alaskan individuals were oversampled to maintain stable estimates.

This study was based on SEER POC data collected in 1990/1991, 1995, 2000, 2005, 2010, and 2015, which was a sample of approximately 10% of the total number of microscopically confirmed stage II and III colorectal cancers. Rectal cancer cases were identified using the International Classification of Diseases of Oncology, Third Edition (ICD-O-3) primary site code 20.9, which made up about 30% of the total colorectal POC cases. The sample included patients from 16 SEER regions (San Francisco, Connecticut, Detroit, Hawaii, Iowa, New Mexico, Seattle, Utah, Atlanta, Alaska, San Jose/Monterey, Los Angeles, Greater California, Kentucky, Louisiana, and New Jersey). Of note, not all registries participated in every POC study year (e.g., only the original SEER-9 Registries participated in 1990/1991 and 1995).

Collaborative staging was used, which is a combination of TNM, SEER Extent of Disease (EOD), and SEER Summary Stage (SS) systems.³⁴ The collaborative staging system was developed by the American Joint Committee on Cancer (AJCC) in collaboration with standard-setting organizations, including SEER, and has improved quality by standardizing timing, clinical and pathological assessments, and compatibility across cancer types. The study population was restricted to subjects who underwent rectal cancer-directed surgery. In order to ensure that patients in the study had an opportunity to receive guideline-recommended therapy, only those who survived at least two months after diagnosis were included. Because this was a limited data set, the Human Subjects Office determined that this study was not considered human subjects research.

Measures

Patient demographic characteristics included age at diagnosis, sex, race, and marital status. The dataset used did not contain a direct measure of hospital volume, so bed size was used as an approximation. Larger bed size is often associated with academic medical centers and high-volume hospitals.³⁵ In this study, a large hospital was defined by a bed size of ≥ 500 . This classification was used because it has been found to adequately represent academic health centers and NCI-designated cancer centers.³⁵ Clinical characteristics included stage (II vs. III), Charlson Comorbidity Index (Score of 0 or ≥ 1), and surgery-CRT treatment

sequence (no CRT, preoperative CRT, preoperative CRT & postoperative Chemotherapy, postoperative CRT, postoperative chemotherapy only, and other).

Statistical Analysis

Statistical analyses were carried out using SAS version 9.4 (SAS Institute, Cary, NC). Sample weights were used in all analyses except trend tests to account for the complex sampling design and obtain more accurate parameter estimates. The sample weights were derived from the inverse of the sampling proportion in each sample strata (age, race, cancer stage, and SEER registry). Baseline characteristics, treatment, and facility information for rectal cancer were compared using Student t-test for mean values and Pearson chi-square for proportions.

Multivariate logistic regression models were developed to determine patient factors associated with receiving care at a large hospital. Logistic regression was also used to perform a sub-analysis on patients diagnosed in 2005, 2010, and 2015, to assess the association between hospital size and preoperative CRT, as well as postoperative chemotherapy. These sub-analyses were used to evaluate the association between hospital size and receiving guideline-recommended therapy while controlling for other factors. Additionally, an unweighted 2-sided Cochran-Armitage test for trend was performed to evaluate the change in the proportion of patients receiving care at a large hospital over time.

Results

There were 2,623 patients with stages II/III rectal cancer identified in the SEER POC datasets. Of those, 260 (10%) were excluded because they did not have rectal cancer-directed surgery and 48 (2%) were excluded because they had a missing bed size variable. Additionally, patients from one SEER registry (n=84, 3%) were excluded because there were no hospitals with more than 500 beds in that state until one facility added a significant number of hospital beds in the later years of the study period, leaving 2,231 patients for analysis. To allow for appropriate treatment comparison in the sub-analysis of 1,275 cases diagnosed in or after 2005 (n=1,275), 125 (10%) were excluded because they survived less than two months after diagnosis and 14 (1%) were excluded because they received therapies that did not fit into a treatment category with sufficient number to examine (i.e., radioisotopes), leaving 1,136 patients for the sub-analysis.

The weighted proportion of rectal cancer patients receiving treatment at large hospitals increased from 19% in 1990/1991 to 27% in 2015. Patient characteristics by hospital size (<500 vs. ≥500 beds) are displayed in Table 1. The trend analysis revealed a significant increase ($p<0.0001$) in treatment at large hospitals, with the largest increase in recent years (2010 and 2015). Unadjusted analyses showed that receipt of treatment at a large hospital occurred more frequently among those who were diagnosed in later years, of younger age, of African American race, or had no Charlson index comorbidities (Charlson score=0). After controlling for all other variables in Table 1 (61 cases with unknown marital status were dropped from the model), race remained a significant characteristic, with African Americans having higher odds of being treated at a large hospital compared to Caucasians (OR: 1.73, 95% CI: 1.30–2.31), while a race of “Other” had lower odds of being treated at a large

hospital (OR:0.74, 95% CI: 0.55–0.99). Additionally, individuals aged 55–64 (OR: 1.70, 95% CI: 1.03–2.82) or diagnosed in 2015 (OR: 1.74, 95% CI: 1.26–2.41) also had higher odds of receiving treatment at a large hospital in multivariate analysis.

Analyses were also conducted to examine the proportion of patients receiving treatment at large hospitals in each of the SEER registries that had at least one case each year (Figure 1). The weighted proportion of patients from Registry A who received care at a large hospital increased from 51% in 1990/1991 to 88% in 2015, while Registry B's proportion grew from 25% in 1990/1991 to 73% in 2015. In 1990/1991, 12% of Registry C's patients received care at a large hospital in comparison with 65% in 2015. In Registry D the proportion increased from 13% to 28% from 1990/1991 to 2015, and in Registry E the proportion increased from 9% to 19%.

The actual number of patients included in the POC sample who were diagnosed in 2005 or after included 1,136 patients (Table 2), but proportions were again weighted as described in Methods. During this timeframe, 56% received guideline-recommended preoperative CRT; of those, 48% also received postoperative chemotherapy. Among those who did not receive preoperative CRT, 38% received postoperative CRT, 29% received no CRT, 18% received postoperative chemotherapy only, 2% received preoperative RT only, 2% received postoperative RT only, and 10% received some other sequence of treatment. A greater proportion of patients who received preoperative CRT were treated at large hospitals compared to patients who did not receive preoperative CRT (30% vs. 15%, $p<0.0001$). Procedures received included local excision, low anterior resection, Hartmann's procedure, transsacral rectosigmoidectomy, proctectomy with coloanal anastomosis, abdominoperineal resection, total proctocolectomy, and pelvic exenteration. The majority (97%) of patients had a proctectomy, about 3% received a local excision, and <1% of patients were missing a specific surgery code but had some type of procedure to remove their cancer according to SEER Registrars. Greater proportions of those who received preoperative CRT were younger, had a Charlson score of 0, and were diagnosed after 2005. Similarly, the multivariate logistic regression model showed that receipt of preoperative CRT was associated with treatment at a large hospital (OR: 2.06; 95% CI: 1.35–3.13), age younger than 75 years (OR_{18–54}: 3.62; 95% CI: 2.29–5.71, OR_{55–64}: 2.90; 95% CI: 1.70–4.96, OR_{65–74}: 1.74; 95% CI: 1.08–2.82), and diagnosis after 2005 (OR₂₀₁₀: 1.78; 95% CI: 1.12–2.83, OR₂₀₁₅: 1.94, 95% CI: 1.35–2.78). There were 41 cases with unknown marital status who were dropped from this model.

Receipt of postoperative chemotherapy was also examined in the sub-analysis population of 2005+ diagnosis years (Table 3). A greater proportion of patients who received postoperative chemotherapy were treated at large hospitals compared to patients who did not receive postoperative chemotherapy (26% vs. 20%, $p=0.0415$). Greater proportions of those who received postoperative chemotherapy were younger, later stage, had a Charlson score of 0, and were female. The multivariate logistic regression model showed that receipt of postoperative chemotherapy was strongly trending toward a significant association with treatment at a large hospital (OR: 1.34; 95% CI: 0.98–1.84).

Discussion

These findings suggest an overall increase in the proportion of rectal cancer patients receiving care at large hospitals (<500 vs. 500 beds) from 1990 to 2015. A statistically significant trend of rectal cancer surgery was found from small to large hospitals across time in this population-based study, with a particularly large increase after 2005. The findings by individual SEER registries also suggest a general trend toward large hospitals in each of the represented SEER registries, as well as overall (Figure 1).

Two previous studies also found an increase in rectal cancer surgeries performed at large centers over time.^{32–33} One of these studies analyzed trends from 1999–2007 based on the National Cancer Database, which only contains data from larger hospitals that have been accredited by the American College of Surgeons Commission on Cancer,³² and the other examined trends from 2000–2011 in the state of New York.³³ A third previous study of trends from 1996–2006 in New York, New Jersey and Pennsylvania did not find a significant shift.³¹

The exact cause of this shift we detected remains unclear. It is possible that the increasing body of literature showing volume-outcome benefits in rectal cancer care has influenced physician referral patterns and patient decision making. While it is possible that the shift reflects greater awareness of the volume-outcome relationship, it could also be somewhat influenced by consolidation of small into large hospitals, the closure of small hospitals, or a decrease in the number of surgeons performing these surgeries. A prior study reported an overall decrease in the number of surgeons performing rectal cancer resections, suggesting that some of the general surgeons have increased referrals to specialist surgeons.³³

Unadjusted and multivariate analyses suggested that younger patients were more likely to receive care at a large hospital, reflecting previous findings.^{16–17} It is possible that younger patients are more active in treatment decisions and informed of options, or are more likely to be referred for certain treatments that are anticipated to affect quality of life (i.e., sphincter-preserving surgery).³⁶ Additionally, increased travel time to large hospitals could be an obstacle for older individuals.³⁴ African American patients were significantly more likely to receive care at large hospitals even after adjustment for other covariates. This finding stands in contrast to previous time-trend and volume-outcome studies, where African American patients were less likely to be treated at a large hospital. One potential explanation for this is African American patients being more likely to reside in metropolitan cities where large hospitals are located.³⁷

Receipt of guideline-recommended preoperative CRT was significantly associated with treatment at large hospitals among patients diagnosed in 2005, 2010, and 2015. In addition to the previously described SEER Medicare study¹⁴, the findings from this study are consistent with another population-based study from the Pennsylvania Cancer Registry, which found that hospitals with teaching designations were associated with higher rates of neoadjuvant RT.³⁸ Additionally, we found that postoperative chemotherapy was significantly associated with treatment at large hospitals, and nearly significant when controlling for other factors (OR: 1.34, 95% CI: 0.98–1.84). Our study helps to further establish these

associations in a more representative patient sample including diverse geographic regions as well as younger adults.

This study also has several limitations. First, the measure of bed size was used to approximate hospital volume, which may not be directly correlative. However, previous work has shown that hospitals with larger bed size tend to be large, academic medical centers, with higher patient volume and a larger number of specialized surgeons.³⁵ In addition, we used SEER-Medicare rectal cancer specific volumes as the ‘gold standard’ to which we compared various bed size cutoffs, and found that a cutoff of 500 beds would yield a much higher specificity and positive predictive value (PPV) (Specificity = 97%, PPV = 73%) than when we lower the cutoffs down to 400 beds (Specificity = 90%, PPV = 62%), or 300 beds (Specificity = 82%, PPV = 56%). Given the high specificity, any misclassification would likely result in patients who actually attended a high volume hospital being categorized as small bed size hospital, which would actually bias the result *toward* the null. Thus, our results would actually be an underestimation of the true effect.

Due to data limitations, patients were classified as receiving all of their care and surgical procedures at one hospital, which may not always be the case. The SEER POC data collection protocol states that the hospital assignments are made by “definitive surgery or, if no surgery, the most definitive therapy”, with bed size classification provided by the American Hospital Association Guidebook.³⁹ Therefore, for patients receiving care at multiple institutions, the hospital assignment pertains to the most definitive aspect of treatment and is likely still representative of the patient’s overall treatment, especially in this group of patients who all received rectal cancer-directed surgery. Additionally, the data available through SEER POC are a relatively small proportion of the total colorectal cancer cases in SEER. However, this study is one of the largest studies to examine rectal cancer treatment trends, and SEER POC data sampling still allows for national representation. Lastly, we were unable to account for the change in the number of large and small hospitals over time, and therefore cannot know if the trend is due to this or an actual shift in patient or surgeon decisions.

This study also has many strengths. This is one of the largest and most nationally representative population-based studies to examine trends in rectal cancer treatment in the US over a period of 25 years. The study provides evidence that patients shifted to large hospitals for their treatment in more recent years, and also that patients at those large hospitals were more likely to receive preoperative CRT and postoperative chemotherapy, which are the guideline-recommended for stages II/III rectal cancer.⁵ Another strength is the reliability and completeness of the SEER POC data. Additionally, the large, representative population-based sample also allows for generalizability in the US.

Our findings suggest a shift toward large hospitals for rectal cancer care in the US, and thus a trend toward centralization of rectal cancer treatment. Cancer care centralization has been occurring in Canada and many European countries in recent decades.^{17–18,32} The benefits of centralization are extensive, including improved perioperative mortality, consistent receipt of guideline-recommended therapy, and improved overall survival.³² However, there are also challenges associated with centralization. First, centralization may involve longer and more

costly travel to receive care, increasing burden for patients. Centralization may also involve longer wait times, further increasing burden.³¹ While socioeconomic and travel barriers do warrant further study, findings have illustrated that the majority of patients receiving care at small hospitals could reach larger, high-volume hospitals with only a small increase in travel distance.³² Additionally, recent findings indicate that patients who traveled longer distances to large hospitals had better outcomes, including increased receipt of neoadjuvant CRT and 5-year survival rates, compared with those that traveled shorter distances to small hospitals.

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Conclusion

Overall, access to high quality care for all rectal cancer patients should be the goal. Although the trend toward large hospitals is promising, patients receiving care at these facilities are still the minority. Further efforts to increase rectal cancer care at large, high-volume hospitals may increase appropriate use of guideline-recommended preoperative treatment and ultimately improve outcomes. In addition to the previously described NCCN guidelines, the American College of Surgeons Commission on Cancer has recently initiated the National Accreditation Program for Rectal Cancer (NAPRC) Standards. The goal of the NAPRC is to “ensure patients with rectal cancer receive appropriate care using a multidisciplinary approach”, which requires performance of appropriate staging and treatment, including resection performed by a member of the Rectal Cancer Multidisciplinary Team, among other key standards. Future work should include initiatives that increase patient awareness of the volume-outcome relationship, programs to ease patient burden (i.e., transportation aid), surgeon education and adherence to NAPRC standards, and examination of referral patterns to large, high-volume centers.

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Figure 1.

Percent of patients with rectal cancer receiving surgery at large hospitals (≥ 500 beds) by year of diagnosis and SEER Registry. Includes only registries with at least one rectal cancer case each year. Numbers shown in parentheses under registry names represent un-weighted total patients for that registry over the included timeframe. Proportions for Registry B (1995–2005), Registry C (1995, 2005), Registry D (2000), and Registry E (1995–2005) were calculated using numerators <6.

^aTotal category includes all patients in the entire study population.

Table 1.

Characteristics of patients by hospital size, and odds of receiving treatment in a large (500 beds) hospital (n=2,231).

Characteristics	Value	Hospital Size		Unadjusted Chi square p-value	Adjusted ^d Odds Ratio & 95% CI
		Unweighted n (weighted %) ^a <500 Beds (n = 1,687)	500 Beds (n = 544)		
Age	18–54	467 (27.9%)	185 (33.3%)	0.0003	1.47 (0.96 – 2.24)
	55–64	412 (22.9%)	154 (30.6%)		1.70 (1.03 – 2.82)
	65–74	442 (27.0%)	115 (20.5%)		1.12 (0.74 – 1.68)
	75	366 (22.2%)	90 (15.6%)		1.00 (REF)
Gender	Male	914 (56.4%)	290 (54.0%)	0.4765	1.00 (REF)
	Female	773 (43.6%)	254 (46.0%)		1.03 (0.79 – 1.33)
Race	Caucasian	1146 (83.0%)	345 (80.5%)	<0.0001	1.00 (REF)
	African American	262 (6.5%)	108 (11.3%)		1.73 (1.30 – 2.31)
	Other	279 (10.5%)	91 (8.2%)		0.74 (0.55 – 0.99)
Marital Status ^b	Married	998 (55.2%)	308 (58.2%)	0.2190	1.00 (REF)
	Single	221 (14.4%)	93 (14.8%)		0.85 (0.60 – 1.20)
	Separated/Divorced	171 (12.5%)	57 (14.8%)		0.99 (0.64 – 1.53)
	Widowed	258 (17.9%)	64 (12.2%)		0.73 (0.41 – 1.30)
Stage	II	755 (44.5%)	232 (44.6%)	0.9821	1.00 (REF)
	III	932 (55.5%)	312 (55.4%)		1.04 (0.81 – 1.33)
Charlson Score	Score of 0	1224 (69.6%)	414 (75.5%)	0.0268	1.00 (REF)
	Score of 1	463 (30.4%)	130 (24.5%)		0.88 (0.67 – 1.14)
Year ^c	1990/1991	412 (81.5%)	99 (18.5%)	0.0421	1.00 (REF)
	1995	210 (81.8%)	45 (18.2%)		0.95 (0.62 – 1.45)
	2000	149 (77.6%)	41 (22.4%)		1.38 (0.87 – 2.18)
	2005	305 (78.9%)	76 (21.1%)		1.12 (0.77 – 1.64)
	2010	263 (76.7%)	111 (23.3%)		1.10 (0.74 – 1.62)
	2015	348 (73.1%)	172 (26.9%)		1.74 (1.26 – 2.41)

^a All percentages were calculated using sample weights as described in Methods. Unweighted numbers of patients were shown to reflect actual sample size.

^b 61 individuals had unknown marital status, and these subjects were not included in the model

^c Year categories display row %, while the rest of the variables display column %.

^d Odds ratios adjusted for all other variables included in the table.

Table 2.

Characteristics of study population diagnosed in 2005, 2010, and 2015 by receipt of preoperative CRT, and odds of receiving preoperative CRT (n=1,136).

Characteristics	Value	Preoperative CRT Unweighted n (weighted %) ^a		Unadjusted	Adjusted ^c
		Yes (n = 669)	No (n = 467)	Chi square p-value	Odds Ratio & 95% CI
Hospital Size	<500 Beds	453 (70.4%)	372 (84.8%)	<0.0001	1.00 (REF)
	500 Beds	216 (29.6%)	95 (15.2%)		2.06 (1.35 – 3.13)
Stage	II	291 (39.0%)	225 (48.9%)	0.0045	1.00 (REF)
	III	378 (61.0%)	242 (51.1%)		1.35 (0.97 – 1.88)
Age	18–54	295 (42.4%)	126 (22.0%)	<0.0001	3.62 (2.29 – 5.71)
	55–64	183 (29.3%)	128 (21.1%)		2.90 (1.70 – 4.96)
	65–74	127 (18.7%)	107 (28.9%)		1.74 (1.08 – 2.82)
	75	64 (9.7%)	106 (28.0%)		1.00 (REF)
Gender	Male	384 (60.8%)	219 (51.2%)	0.0108	1.00 (REF)
	Female	285 (39.2%)	248 (48.8%)		0.71 (0.51 – 0.97)
Race	Caucasian	374 (82.0%)	262 (81.1%)	0.8637	1.00 (REF)
	African American	128 (7.2%)	99 (7.7%)		0.77 (0.53 – 1.12)
	Other	167 (10.7%)	106 (11.1%)		0.84 (0.60 – 1.18)
Marital Status ^b	Married	386 (56.4%)	239 (48.3%)	<0.0001	1.00 (REF)
	Single	132 (17.7%)	80 (15.4%)		0.85 (0.55 – 1.32)
	Separated/Divorced	79 (17.0%)	62 (13.9%)		0.90 (0.55 – 1.48)
	Widowed	48 (8.8%)	69 (22.5%)		0.66 (0.41 – 1.04)
Charlson Score	Score of 0	511 (77.6%)	313 (61.8%)	<0.0001	1.00 (REF)
	Score of 1	158 (22.4%)	154 (38.2%)		0.70 (0.49 – 1.00)
Year	2005	179 (21.4%)	191 (31.7%)	0.0047	1.00 (REF)
	2010	230 (31.2%)	132 (25.7%)		1.78 (1.12 – 2.83)
	2015	260 (47.4%)	144 (42.6%)		1.94 (1.35 – 2.78)
Treatment Sequence	No CRT	-	130 (29.2%)	<0.0001	Not included in model
	Preop CRT	341 (52.2%)	-		
	Preop CRT & Postop Chemo	328 (47.8%)	-		
	Postop CRT	-	189 (38.0%)		
	Postop Chemo Only	-	70 (17.9%)		
	Preop RT Only	-	14 (2.3%)		
	Postop RT Only	-	13 (2.2%)		
	Other	-	51 (10.4%)		

^a All proportions are column % and were calculated using sample weights as described in Methods. Unweighted numbers of patients were shown to reflect actual sample size. Only patients diagnosed in 2005, 2010, or 2015 were included because preoperative CRT was first recommended by NCCN guidelines in 2003.

^b 41 individuals had unknown marital status, and these subjects were not included in the model.

^cOdds ratios adjusted for all other variables included in the table unless otherwise noted.

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Table 3.

Characteristics of study population diagnosed in 2005, 2010, and 2015 by receipt of postoperative chemotherapy, and odds of having postoperative chemotherapy (n=1,136).

Characteristics	Value	Postoperative Chemotherapy Unweighted n (weighted %) ^a		Unadjusted	Adjusted ^c
		Yes (n = 587)	No (n = 549)	Chi square p-value	Odds Ratio & 95% CI
Hospital Size	<500 Beds	419 (74.0%)	406 (79.7%)	0.0415	1.00 (REF)
	500 Beds	168 (26.0%)	143 (20.3%)		1.34 (0.98 – 1.84)
Stage	II	228 (39.0%)	288 (47.9%)	0.0022	1.00 (REF)
	III	359 (61.0%)	261 (52.1%)		1.43 (1.10 – 1.85)
Age	18–54	246 (32.6%)	175 (34.2%)	0.0001	1.38 (0.90 – 2.12)
	55–64	178 (31.7%)	133 (19.3%)		2.87 (1.80 – 4.57)
	65–74	104 (20.8%)	130 (25.7%)		1.10 (0.70 – 1.73)
	75	59 (14.9%)	111 (20.8%)		1.00 (REF)
Gender	Male	303 (53.2%)	300 (60.1%)	0.0444	1.00 (REF)
	Female	284 (46.8%)	249 (39.9%)		1.50 (1.12 – 2.02)
Race	Caucasian	330 (81.0%)	306 (82.3%)	0.4538	1.00 (REF)
	African American	109 (7.3%)	118 (7.6%)		0.87 (0.62 – 1.21)
	Other	148 (11.7%)	125 (10.1%)		1.10 (0.82 – 1.47)
Marital Status ^b	Married	339 (51.5%)	286 (54.4%)	0.7428	1.00 (REF)
	Single	109 (17.9%)	103 (15.5%)		1.24 (0.84 – 1.82)
	Separated/Divorced	65 (15.1%)	76 (16.2%)		0.82 (0.54 – 1.26)
	Widowed	57 (15.5%)	60 (13.9%)		1.49 (0.89 – 2.49)
Charlson Score	Score of 0	445 (74.5%)	379 (66.5%)	0.0099	1.00 (REF)
	Score of 1	142 (25.5%)	170 (33.5%)		0.69 (0.49 – 0.97)
Year	2005	188 (25.1%)	182 (26.8%)	0.6183	1.00 (REF)
	2010	183 (28.1%)	179 (29.5%)		1.05 (0.70 – 1.57)
	2015	216 (46.8%)	188 (43.7%)		1.04 (0.73 – 1.47)
Treatment Sequence	No CRT	-	130 (26.5%)	< 0.0001	Not included in model
	Preop CRT	-	341 (60.0%)		
	Preop CRT & Postop Chemo	328 (52.0%)	-		
	Postop CRT	189 (32.7%)	-		
	Postop Chemo Only	70 (15.4%)	-		
	Preop RT Only	-	14 (2.1%)		
	Postop RT Only	-	13 (2.0%)		
	Other	-	51 (9.4%)		

^a All proportions are column % and were calculated using sample weights as described in Methods. Unweighted numbers of patients were shown to reflect actual sample size. Only patients diagnosed in 2005, 2010, or 2015 were included.

^b 41 individuals had unknown marital status, and these subjects were not included in the model.

^c Odds ratios adjusted for all other variables included in the table unless otherwise noted.