



Identifying Factors Associated with Underuse of Adjuvant Chemotherapy for Stage III Colon Cancer

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Abstract

Despite being standard treatment for stage III colon cancer, many patients fail to receive adjuvant chemotherapy. We aimed to describe the benefit of adjuvant chemotherapy for stage III colon cancer and determine factors influencing the likelihood of receiving chemotherapy. We queried the National Cancer Database 2006-2013 for patients with stage III colon adenocarcinoma and defined two groups: patients who did and did not receive adjuvant chemotherapy. Cox proportional Hazard Ratios (HR) were calculated to compare survival. Odds Ratios (OR) were calculated to identify factors associated with failure to receive adjuvant chemotherapy. Geographic and facility type data were also collected to compare adherence to treatment guidelines. Of the 74,588 patients identified, 27.3% did not receive adjuvant chemotherapy. Adjuvant chemotherapy significantly improved survival (HR 0.477, $p < 0.001$), even for patients with comorbidities (HR 0.492, $p < 0.001$) and post-operative complications (HR 0.358, $p < 0.001$). Older age (OR 0.9, $p < 0.001$), black race (OR 0.728, $p < 0.001$), significant comorbidities (OR 0.563, $p < 0.001$), positive surgical margins (OR 0.83, $p < 0.001$), and 30-day readmission (OR 0.605, $p < 0.001$) were associated with a reduced likelihood of receiving chemotherapy. Adjuvant chemotherapy use was lower in community centers and Eastern and Southwestern regions of the U.S. We demonstrate that adjuvant chemotherapy improves survival in stage III colon cancer patients. Patients that are older, black, comorbid, had positive surgical margins, or had post-operative complications are at increased risk for not receiving adjuvant chemotherapy. Quality improvement initiatives should target these high-risk populations particularly in community centers in the Eastern and Southwestern U.S.

Introduction

Every year about 100,000 new colon cancer cases are diagnosed in the United States [1]. The mainstay of treatment is surgical resection of the affected portion of the colon and adjuvant chemotherapy depending on the pathologic stage of the cancer. According to the American Joint Commission on Cancer (AJCC), stage III colon cancer includes all patients with lymph node positive disease but no distant metastasis [2]. The National Comprehensive Cancer Network (NCCN) guidelines recommend that all patients with stage III colon adenocarcinoma receive adjuvant chemotherapy after their colon resection [3].

Adjuvant chemotherapy in stage III colon cancer includes capecitabine-oxaliplatin or 5-FU/leucovorin-oxaliplatin combination treatments or monotherapy with capecitabine or 5-FU/leucovorin in select patients [3]. These regimens have been shown to improve 5-year survival by about 30% compared to those

that fail to receive any adjuvant chemotherapy [4-7]. Despite the strong evidence supporting the use of adjuvant chemotherapy in stage III colon cancer patients, many who are eligible do not receive this standard of care or receive it in a delayed fashion [8]. Indeed, there are several studies that have demonstrated that adjuvant chemotherapy utilization is as low as 66% in stage III colon cancer patients [9-12]. Various patient characteristics have been associated with underuse of adjuvant chemotherapy including age, comorbidities, race, and a lack of insurance [9,10,13]. As our health care system moves toward a pay for performance model, it has become increasingly important to identify and predict gaps in standard of care in order to allocate quality improvement resources more effectively. In this study, we aimed to use data from the National Cancer Database (NCDB) to provide the most contemporary estimates of the number of stage III colon cancer patients that fail to receive appropriate adjuvant chemotherapy and define the benefits of chemotherapy in this population. By analyzing

the demographic, geographic, and facility type data provided in the NCDB, we also aimed to identify vulnerable populations of patients with stage III colon cancer that are at increased risk of not receiving adjuvant chemotherapy to inform future quality improvement initiatives.

Materials and Methods

Study population description and demographic characteristics analyses.

The work described in this manuscript was approved by the Institutional Review Board at Duke University Medical Center and has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). The study population was drawn from the NCDB file 2006-2013, and the data were analyzed anonymously. All patients with a single, primary, pathologically diagnosed, stage III colon adenocarcinoma were included in the study. Those with a concurrent diagnosis of adenocarcinoma in the appendix or not otherwise specified as well as those that had resection operations that included a portion of the rectum were excluded from the study. Patients that died within 30 days of their resection operation were also excluded from the analysis. The remaining patients were then split into the following two groups: patients that received adjuvant chemotherapy (Codes 01, 02, 03) and patients that did not receive adjuvant chemotherapy (Codes 82, 86, 87) based on the NCDB chemotherapy utilization codes. Those that died prior to receiving chemotherapy or that were recorded as unknown whether chemotherapy was administered or not (Codes 00, 85, 88, 99) were excluded from analysis.

Demographic characteristics including age, gender, race, Charlson-Deyo Index (a measure of comorbidities), facility type (where the patient was treated), insurance type, income level, education level, primary tumor site, tumor size, tumor grade, extent of resection, surgical margin status, hospital length of stay, and readmission within 30 days of resection surgery were collected and compared between the two groups [14]. Statistical comparisons between demographic variables were performed with the Pearson Chi-squared test for categorical variables and Kruskal-Wallis test for continuous variables. A multivariate regression analysis adjusting for patient (age, gender, insurance type, race, Charlson-Deyo index), facility (facility type), and clinical (tumor site, extent of resection, surgical margin status, and readmission within 30 days of surgery) characteristics in order to calculate Odds Ratios (OR) for their association with receiving adjuvant chemotherapy. Those comparisons with p values <0.05 were considered statistically significant.

Population and Subgroup Survival Analyses

After defining the overall study population, this population was split into three subgroups for analysis of the effects of

receiving adjuvant chemotherapy on overall survival. Subgroup 1 included all patients who were otherwise healthy (Charlson-Deyo Index = 0) with no significant comorbidities other than their colon cancer. Subgroup 2 included the comorbid population of patients (Charlson-Deyo Index \geq 2) with significant comorbidities in addition to their colon cancer. Subgroup 3 included the patients who were readmitted within 30 days of their resection operation, using this as a surrogate indication of a significant postoperative complication. Kaplan-Meier survival curves were generated for those that received chemotherapy and those that did not in each of the subgroups as well as the overall population. Multivariable regression analysis adjusting for variables including tumor site, age, gender, insurance type, race, Charlson-Deyo index, facility type, extent of resection, surgical margin status, and readmission within 30 days of surgery in a Cox-proportional hazard model to calculate Hazard Ratios (HR) of mortality in those that received chemotherapy compared to those that had not. P values <0.05 were considered statistically significant.

Geographic Region and Facility Type Analyses

The NCDB splits the U.S. into 9 different geographic regions. Using this data, we determined the percentage of our stage III colon cancer population within each geographic region who received care that adhered to the guidelines for use of adjuvant chemotherapy (Codes 01, 02, 03, 82, 85, 87) compared to those that received care that did not adhere to the guidelines for adjuvant chemotherapy use (Codes 00, 86, 88). The same analysis was then performed to determine the 5-year change in percent adherence to the guidelines by taking the total percent adherence from the two-year time period 2011-2012 and subtracting the total percent adherence from the two-year time period 2006-2007. This gave an estimate of the improvement in adherence to the guidelines in each geographic region over 5 years. The NCDB splits institutions into three facility types: community (100-500 new cancer cases per year), comprehensive (>500 new cancer cases per year), and academic (>500 new cancer cases per year with active postgraduate medical education, research, and clinical trials). The same analysis of overall percent adherence and 5-year change in percent adherence to guidelines for adjuvant chemotherapy use was performed by splitting the population based on the facility type in which their care was received to give an estimate of the improvement in adherence to guidelines over 5-years by facility type.

Results

Study Population, Demographics, and Adjuvant Chemotherapy Use

There were 74,588 patients with stage III colon adenocarcinoma from the NCDB 2006-2013 included in this study. Of the total population 54,235 (72.7%) received adjuvant

chemotherapy (Yes Chemo) and 20,353 (27.3%) did not (No Chemo). The demographic characteristics of each group are shown in (Table 1). Statistically significant differences between the two groups were identified in age, gender, race, comorbidities (Charlson-Deyo Index), facility type, insurance coverage, income level, tumor site, tumor size, tumor grade, extent of colectomy, contiguous organ resection, surgical margin status, hospital length of stay, and 30-day readmission rate (all with $p < 0.05$). Education level was equivalent between the two groups.

Table 1: Baseline characteristics of the study group.

	N	No Chemo	Yes Chemo	P value
Age	74588			<0.001
Years (Range)		79 (69-85)	63 (53-72)	
Gender	74588			<0.001
% Male (N)		43.0% (8752)	49.3% (26752)	
% Female (N)		57.0% (11601)	50.7% (27483)	
Race	73930			<0.001
% White (N)		83.2% (16790)	81.1% (43574)	
% Black (N)		12.9% (2607)	14.0% (7546)	
% Other (N)		3.9% (777)	4.9% (2636)	
Charlson-Deyo Index	74588			<0.001
% with Index = 0 (N)		62.4% (12695)	74.2% (40220)	
% with Index = 1 (N)		25.1% (5110)	20.1% (10925)	
% with Index \geq 2 (N)		12.5% (2548)	5.7% (3090)	
Facility Type	63895			<0.001
% Community (N)		17.0% (3024)	16.1% (7428)	
% Comprehensive (N)		56.0% (9974)	54.1% (24933)	
% Academic (N)		27.0% (4797)	29.8% (13739)	
Insurance Coverage	74588			<0.001
% Uninsured (N)		2.6% (535)	4.6% (2477)	
% Private Insurance (N)		18.2% (3696)	45.9% (24905)	
% Medicaid (N)		3.8% (782)	5.5% (2971)	
% Medicare (N)		73.3% (14924)	41.9% (22704)	
% Other Government (N)		0.7% (137)	0.9% (509)	
% Unknown (N)		1.4% (279)	1.2% (669)	
Income Level	72080			<0.001
% Below Median (N)		33.9% (6665)	31.2% (16373)	
% Above Median (N)		66.1% (13006)	68.8% (36036)	
Education Level	72072			0.117
% Below Median (N)		42.2% (8301)	41.6% (21776)	
% Above Median (N)		57.8% (11369)	58.4% (30626)	
Primary Tumor Site α	74588			<0.001
% Right Colon (N)		66.3% (13487)	56.2% (30466)	
% Left Colon (N)		33.7% (6866)	43.8% (23769)	
Tumor Size	74588			<0.001
% <1 cm (N)		1.0% (207)	1.5% (791)	

% 1-1.9cm (N)		3.3% (653)	4.7% (2435)	
% 2-4.9cm (N)		49.3% (9746)	52.5% (27419)	
% >4.9 cm (N)		46.4% (9176)	41.3% (21597)	
Tumor Grade ^β	73050			<0.001
% Well differentiated (N)		70.3% (14032)	74.0% (39316)	
% Poorly differentiated (N)		29.7% (5916)	26.0% (13786)	
Extent of Colectomy ^γ	74588			<0.001
% Segmental (N)		33.3% (6776)	38.5% (20885)	
% Hemicolectomy (N)		66.7% (13577)	61.5% (33350)	
Contiguous Organ Resection	74588			0.004
% No (N)		93.1% (18946)	93.7% (50803)	
% Yes (N)		6.9% (1407)	6.3% (3432)	
Surgical Margins	73815			<0.001
% Negative (N)		91.1% (18367)	92.7% (49720)	
% Positive (N)		8.9% (1804)	7.3% (3924)	
Hospital Length of Stay	64698			<0.001
Days (Range)		7 (5-10)	5 (4-7)	
30-day Readmission	72794			<0.001
% No (N)		92.8% (18595)	95.5% (50364)	
% Yes (N)		7.2% (1446)	4.5% (2389)	
^α Right indicates cecum to transverse colon; Left indicates splenic flexure to sigmoid colon ^β Well indicates moderately to well differentiated; Poorly indicates un- or poorly differentiated ^γ Segmental indicates segmental resection; Hemicolectomy indicates hemicolectomy or greater Resection				

Overall and Subgroup Analysis of Survival Benefit with Adjuvant Chemotherapy

Patient, facility, and clinical variables from the demographic analysis were then used in our multivariable regression analysis to calculate adjusted HR for death in those that received chemotherapy versus those that did not (Table 2). The HR of mortality demonstrated a significant survival benefit in those that received chemotherapy (HR 0.477, p<0.001). This survival advantage with adjuvant chemotherapy was also true for subgroups of otherwise healthy patients with a Charlson-Deyo Index of 0 (HR 0.485, p<0.001), comorbid patients with a Charlson-Deyo Index ≥ 2 (HR 0.492, p<0.001), and those who were readmitted within 30 days of their resection surgery (HR 0.358, p<0.001). Kaplan-Meier plots of unadjusted overall survival and survival in each of the three subgroups are shown in (Figure 1).

Table 2: Hazard ratios for overall survival and subgroup analyses.

	HR	Lower 95% CI	Upper 95% CI	P value
Overall Survival	0.477	0.463	0.492	<0.001
Subgroup 1: Healthy ^α	0.485	0.467	0.504	<0.001
Subgroup 2: Comorbid ^β	0.492	0.451	0.536	<0.001
Subgroup 3: Readmitted ^γ	0.358	0.317	0.403	<0.001
^α Healthy indicates patients with a Charlson-Deyo Index = 0 ^β Comorbid indicates patients with a Charlson-Deyo Index ≥ 2 ^γ Readmitted indicates patients readmitted within 30 days of their resection surgery				

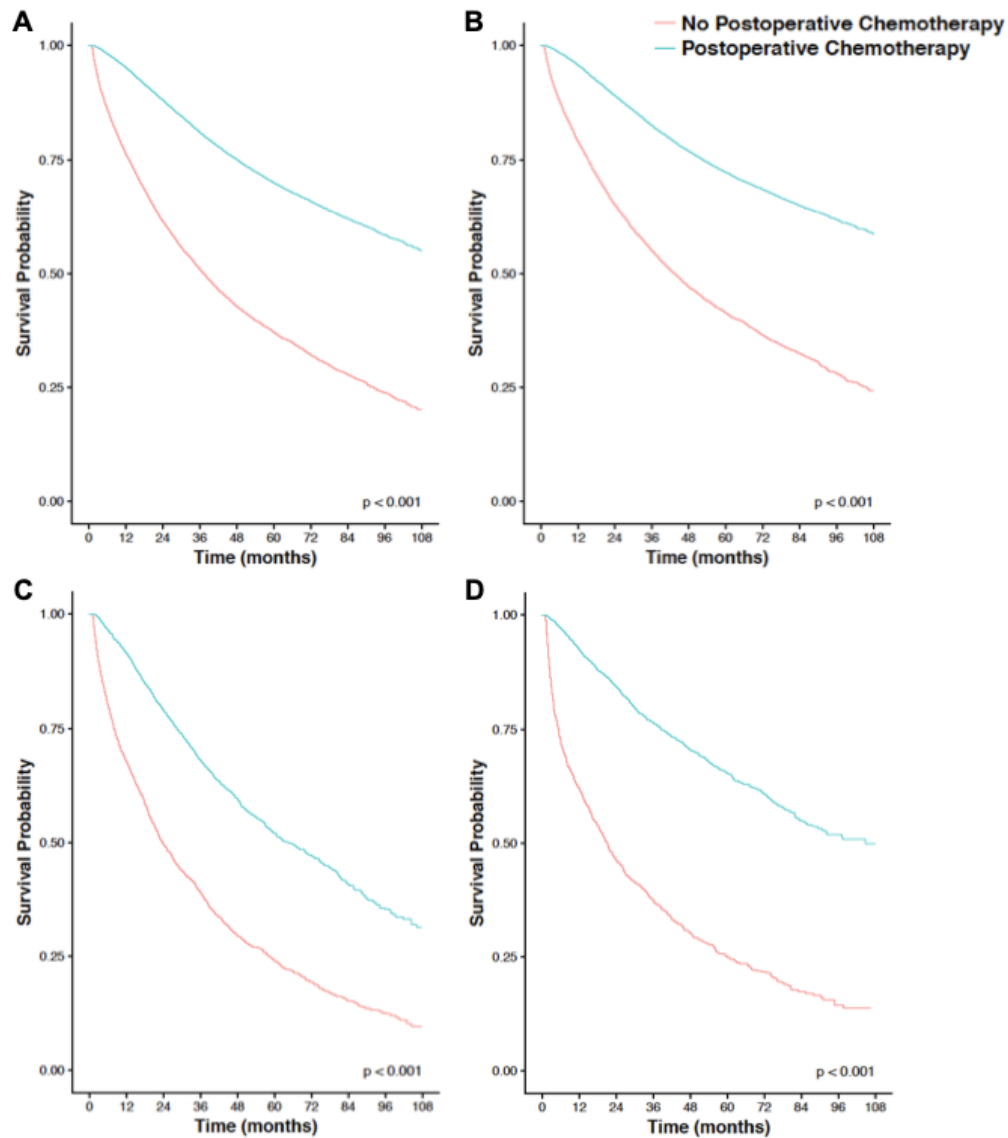


Figure 1: Adjuvant chemotherapy improves survival of stage III colon cancer patients. Kaplan-Meier survival curves comparing survival of stage III colon cancer patients who received adjuvant chemotherapy (blue) to those that did not receive adjuvant chemotherapy (red) in different populations. **(A)** Survival in the total study population. **(B)** Survival in subgroup 1 of healthy patients defined as those with a Charlson-Deyo Score (CD) = 0. **(C)** Survival in subgroup 2 of comorbid patients defined as those with CD ≥ 2 . **(D)** Survival in subgroup 3 of patients who were re-admitted within 30 days of their resection surgery.

Factors Associated with Decreased Utilization of Adjuvant Chemotherapy

In order to determine the demographic factors associated with underutilization of adjuvant chemotherapy in stage III colon adenocarcinoma patients, we performed multivariable regression analysis to calculate ORs of receiving chemotherapy. The variables

tested are listed in (Table 3) along with their associated OR, 95% confidence interval (CI), and p value. Older age (OR 0.9, $p < 0.001$), black race (OR 0.728, $p < 0.001$), Charlson-Deyo Index ≥ 2 (OR 0.563, $p < 0.001$), positive surgical margins (OR 0.83, $p < 0.001$), contiguous organ resection (OR 0.892, $p = 0.006$), and 30-day readmission after surgery (OR 0.605, $p < 0.001$) were all associated with not receiving adjuvant chemotherapy. In contrast, having

private insurance (OR 1.997, p<0.001) or Medicare insurance (OR 2.184, p<0.001) was associated with increased odds of receiving adjuvant chemotherapy.

Table 3: Odds ratios for receiving adjuvant chemotherapy according to patient factors.

	OR	Lower 95% CI	Upper 95% CI	P value
Left-sided Tumor ^a	0.953	0.908	1	0.049
Older Age	0.9	0.898	0.902	<0.001
Female Gender	1.005	0.964	1.047	0.825
Private Insurance	1.997	1.768	2.255	<0.001
Medicaid	1.094	0.94	1.273	0.244
Medicare	2.184	1.93	2.471	<0.001
Black Race	0.728	0.685	0.775	<0.001
Charlson-Deyo Index ≥ 2	0.563	0.525	0.603	<0.001
Comprehensive Facility	0.997	0.943	1.054	0.912
Academic Facility	0.975	0.916	1.038	0.435
Hemicolectomy or Greater	0.993	0.946	1.042	0.773
Contiguous Organ Resection	0.892	0.822	0.967	0.006
Positive Margins	0.83	0.772	0.893	<0.001
Readmitted ^b	0.605	0.556	0.658	<0.001
^a Left-sided indicates primary tumor is located between the splenic flexure and sigmoid colon				
^b Readmitted indicates patients readmitted within 30 days of their resection surgery.				

Adherence to Adjuvant Chemotherapy Use Guidelines by Location and Facility Type

The above analyses demonstrated the number of patients receiving the standard of care adjuvant chemotherapy for stage III colon cancer. However, the Commission on Cancer defines hospital level compliance with guidelines for stage III colon cancer with the National Quality Forum endorsed measure (#0223), which states: “Adjuvant chemotherapy is considered or administered within 4 months (120 days) of diagnosis of patients under the age of 80 with AJCC Stage III (lymph node positive) colon cancer [15].” Because we wanted to extend our analysis to appropriate measures for quality improvement, we used chemotherapy use codes as described in our methods section to determine adherence versus non-adherence to this guideline. The overall percentage of patients who received care that adhered to the current guidelines for adjuvant chemotherapy utilization was 85%. Figure 2A shows

the percent adherence to adjuvant chemotherapy use across the 9 different regions of the U.S. as defined by the NCDB. Adherence to adjuvant chemotherapy use guidelines was lowest in the West South Central (81%) and Mountain (82%) regions of the U.S. Conversely; adherence to guidelines was highest in the New England (88%), East North Central (88%), and West North Central (88%) regions. Analysis of the change in percent adherence to the guidelines over a five-year period showed that overall adherence to guidelines for adjuvant chemotherapy use in stage III colon cancer improved by 3.8%. Figure 2B gives a graphical representation of the change in percent adherence from 2006-07 to 2011-12 by geographic region. While all regions had at least some improvement in adherence to the guidelines, the New England and Middle Atlantic regions had the least improvement while those in the Mountain and East South Central regions had the greatest improvement in adherence to guidelines for adjuvant chemotherapy use. An analysis of

facility type and adherence to guidelines showed that Community centers had the lowest percent adherence overall as well as the least improvement in adherence over time, while academic centers had the highest percent adherence and greatest improvement in adherence over the five-year time period (Figure 2C and D).

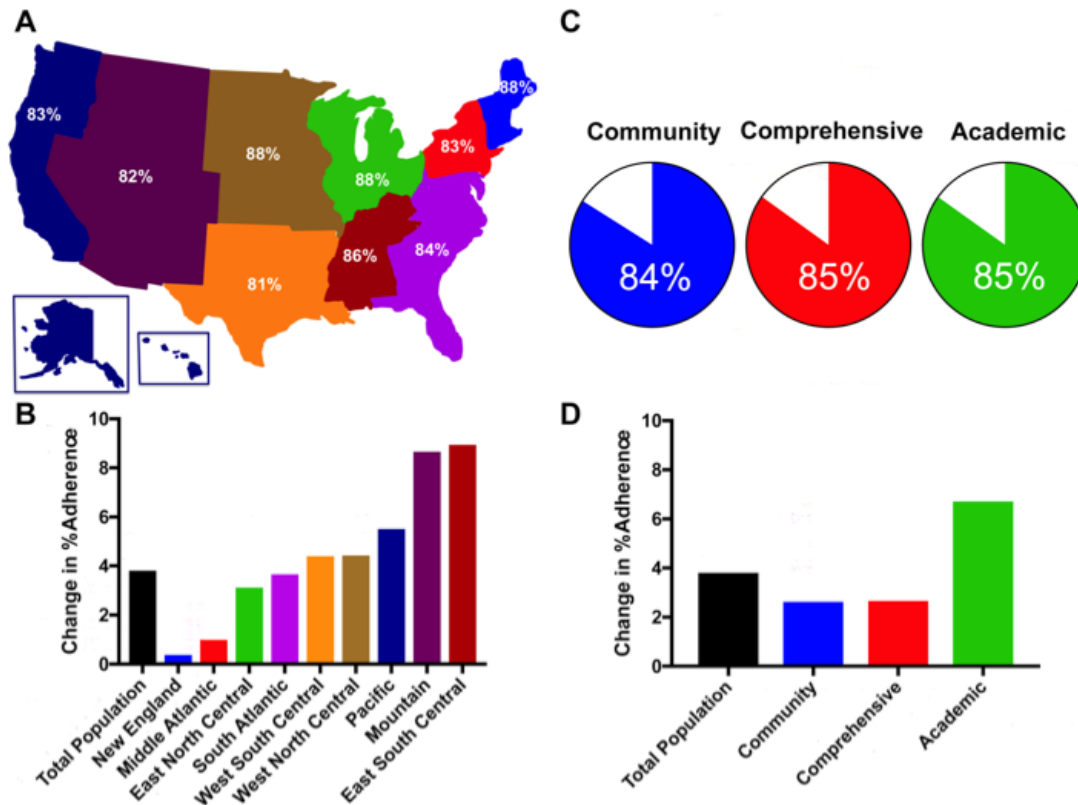


Figure 2: Changes in adherence to guidelines for use of adjuvant chemotherapy in stage III colon cancer over time by geographic region and facility type. (A) Map of the U.S. divided into the 9 distinct geographic regions defined in the NCDB with percentages indicating the percent of stage III colon cancer cases that adhered to the guidelines for use of adjuvant chemotherapy over the total time period 2006-2013. (B) Bar graph showing the change in percent adherence to guidelines for use of chemotherapy in stage III colon cancer from the two-year time periods 2006-2007 to 2011-2012 by geographic region. (C) Pie charts indicate the percent adherence to guidelines for use of chemotherapy in stage III colon cancer by facility type. (D) Bar graph showing the change in percent adherence to guidelines for use of chemotherapy in stage III colon cancer from the two-year time periods 2006-2007 to 2011-2012 by facility type.

Discussion

In this large national analysis, we demonstrate that 27.3% of patients with stage III colon cancer fail to receive adjuvant chemotherapy. Concurrently, we also show a clear benefit of adjuvant chemotherapy, as significant improvements in both adjusted and unadjusted survival were seen overall and in subgroups of patients with significant co-morbidities and post-operative complications. Furthermore, our results identified several factors that were independently associated with a higher risk of not receiving guideline recommended adjuvant chemotherapy including older age, black race, Charlson-Deyo Index ≥ 2 , positive margins, contiguous organ resection, readmission within 30 days of

surgery, and a lack of insurance. Overall, adherence to guidelines for adjuvant chemotherapy was higher with 85% patients being treated according to guidelines. When broken down into regions of care the lowest performing regions with the lowest overall adherence and least improvement in adherence to treatment guidelines were the Middle and South Atlantic and West South Central regions of the U.S. Community centers had lower percent adherence to the guidelines and the least 5-year improvement in adherence. These data represent the most recent and comprehensive analysis of adjuvant chemotherapy use in stage III colon cancer patients and demonstrates how vulnerable populations can be identified in regions of poor adherence, which can be the target of future quality improvement efforts.

The survival benefit of adjuvant chemotherapy in patients with stage III colon cancer is clear. Several clinical trials using different regimens using different combinations of 5-FU, leucovorin, oxaliplatin and capecitabine have been demonstrated [16]. However, these trials include highly selected populations of participants that are generally younger with fewer comorbidities than the typical population in which the disease process occurs. Thus, further work was aimed at defining the limits of the survival benefit of adjuvant chemotherapy. A pooled analysis of the original clinical trials of 5-FU-based adjuvant chemotherapy regimen showed that patients >70 years old benefited equally from receipt of adjuvant therapy and had similar incidences of toxicities with these therapies [17]. This was true even in patients who were older and had significant co-morbidities. Additionally, Gross et al. described that in elderly patients (≥ 67 years) having significant co-morbidities decreased 5-year survival rates by about 20% compared to those that had no significant co-morbidities [18]. Despite the overall decrease in survival, elderly stage III colon cancer patients with ≥ 3 chronic conditions still benefited from receiving adjuvant chemotherapy as 5-year survival rates increased by about 10% compared to those that did not receive adjuvant chemotherapy [18]. After introduction of oxaliplatin as part of combination adjuvant chemotherapy regimens, further analysis of patients ≥ 75 years of age by Abraham et al. showed that even in the extreme age group there is a significant survival benefit of adjuvant chemotherapy after resection [19]. Despite the noted benefits to adjuvant chemotherapy, these studies also highlight the fact that older patients with stage III colon cancer are as much as 35% less likely to receive this treatment [17-20].

The introduction of larger databases of cancer outcomes such as the NCDDB led to additional studies investigating the benefits of adjuvant chemotherapy in stage III colon cancer patients and what factors influence the likelihood of receiving it. Overall, chemotherapy utilization in these studies was between 66-71% in this population, which is slightly lower than our own estimate of 73%, which may be a result of improvements in adherence to the treatment guidelines over time [10,12]. In these more recent analyses of larger populations, factors associated with a failure to receive adjuvant chemotherapy included older age, black race, increased comorbidity, and lack of insurance [10,12]. Our analysis confirmed these factors to be associated with underuse of chemotherapy in stage III colon cancer and identified additional factors related to surgery including positive margins and readmission within 30 days. Readmission within 30 days likely translates to increased risk of not receiving adjuvant chemotherapy due to significant delays and specific complications that hinder the application of chemotherapy in these patients [8]. The finding of positive margins was surprising, but may be related to the fact that many of the patients with positive margins had urgent resections for obstructing cancers and were later lost to follow up due to a lack

of coordinated care between surgery and medical oncology [21]. Indeed, the lack of receiving adjuvant chemotherapy or significant delays in its implementation in colon cancer patients have been linked to health system delays [22].

Our analysis of adherence to guidelines for adjuvant chemotherapy use in stage III colon cancer patients showed 85% overall adherence to the guidelines similar to previous reports from other databases such as the Cancer Program Practice Profile Reports file, which estimated 91% adherence in 2010 and the 2010 NCDDB rate of 87% [23]. While previous reports demonstrated no significant improvement in chemotherapy utilization over time [12], our analysis showed overall adherence to guidelines improved by about 4% over the most recent 5-year interval from 2006-07 to 2011-12. Stratifying these data by location showed that some regions such as the Mountain and East South Central have improved their adherence to guidelines by as much as 9%, while others lag behind. These data provide insight into which regions need more attention focused on adherence to adjuvant chemotherapy use in stage III colon cancer patients.

This study was a retrospective analysis of data from the NCDDB 2006-2013, as such it suffers from the same limitations as other large database retrospective analyses. A lack of granularity in the data such as specific comorbidities, categories of post-operative complications, and the specific chemotherapy regimens limit the multivariate analysis to include only more broad surrogates of these data. The lack of clinical variables such as measures of quality of life and physical performance also limit our analysis of factors influencing chemotherapy use and adherence to guidelines for adjuvant chemotherapy use in this population. Overall survival is a common endpoint in retrospective trials, however, many studies examining the impact of chemotherapy use disease-free survival as the endpoint of choice. Our analysis is limited to overall survival, as the NCDDB does not provide adequate reports of disease recurrence to calculate disease-free survival. Human error in data reporting both at the level of the providers at each of the participating centers as well as the data entry specialists who are the final handlers of data. For example, in this study, a small proportion of patients had unknown utilization of chemotherapy. The strengths of this study also stem from the collection of data from the NCDDB, a nationwide database, which includes data from over 1500 accredited institutions [24]. The homogeneity of the data collected as well as the large sample size make our results generalizable to the U.S. population suffering from stage III colon cancer and allowed for more robust thresholds for statistical significance.

Conclusions

In summary, we have demonstrated a consistent survival benefit with adjuvant chemotherapy for patients with stage III

colon cancer, even for comorbid patients and those with early post-operative complications. Older, black, comorbid, uninsured patients with positive margins and post-operative complications are less likely to receive standard of care adjuvant chemotherapy. Community facilities in the Eastern and Southwest regions of the U.S. have the lowest adherence to guidelines for adjuvant chemotherapy use in stage III colon cancer. These data highlight the disparities in care received by vulnerable populations with stage III colon cancer. Recognizing these vulnerable populations particularly in the Eastern and Southwest regions of the U.S. and allocating more resources to improve adherence to guidelines at community centers in these regions may improve quality of care for stage III colon cancer patients.

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