Referrals and decision-making considerations involved in selecting a surgeon for rectal cancer treatment in the Midwest United States

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Abstract

Background: Despite evidence of superior outcomes for rectal cancer at high-volume, multi-disciplinary cancer centers, many patients undergo surgery in low-volume hospitals.

Objectives: Examine former rectal cancer patients' considerations when selecting their surgeon, and evaluate which considerations were associated with surgery at high-volume hospitals.

Design: We surveyed patients about what they considered when deciding on a cancer surgeon to complete this retrospective cohort study.

Settings: Study data were obtained via survey and the statewide Iowa Cancer Registry.

Patients: All eligible individuals diagnosed with invasive stages II/III rectal cancer from 2013–2017 identified through the registry were invited to participate.

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Main Outcome Measures: The primary outcomes were the characteristics of the hospital where they received surgery (i.e., National Cancer Institute-designation, Commission on Cancer accreditation, and rectal cancer surgery volume).

Results: 318 out of 417 (76%) completed surveys. Sixty-nine percent selected their surgeon based on their physician's referral/recommendation, 20% on surgeon/hospital reputation and 11% on personal connections to surgeon. Participants who chose their surgeon based on reputation had significantly higher odds of surgery at National Cancer Institute-designated (OR=7.5, 95% CI: 3.8–15.0) or high-volume (OR=2.6, 95% CI: 1.2–5.7) hospitals than those who relied on referral.

Limitations: This study took place in a Midwestern state with a predominantly White population, which limited our ability to evaluate racial/ethnic associations.

Conclusion: Most rectal cancer patients relied on referrals in selecting their surgeon, and those who did were less likely to receive surgery at a National Cancer Institute-designated or high-volume hospitals compared to those who considered reputation. Future research is needed to determine the impact of these decision factors on clinical outcomes, patient satisfaction and quality of life. In addition, patients should be aware that relying on physician referral may not result in treatment from the most experienced or comprehensive care setting in their area.

Keywords

rectal cancer; decision-making; referral patterns; high-volume; cancer surgery

Category:

Colorectal neoplasia

Introduction

Hospitals and surgeons performing higher volumes of cancer surgeries have been associated with several superior clinical outcomes, including higher survival rates, higher rates of guideline-recommended treatment, and lower rates of surgical complications.[1–11] These volume-outcome disparities are especially apparent for complex cancer surgeries like rectal cancer resections.[1–11] A substantial proportion of rectal cancer patients receive resections at low-volume, smaller hospitals, where the multi-disciplinary meetings across specialties – a key component of high-quality rectal cancer treatment – are typically not available.[2,4,5,12,13]

Prior studies have suggested that many patients select their cancer surgeon and hospital based primarily on the recommendation or referral of their physician.[14–16] A small number of studies have examined considerations, such as family/friend recommendations, internet research, distance from home, and hospital reputation, and their impact on surgeon selection.[14–16] One study found breast cancer patients who reported choosing their surgeon based on reputation were three times more likely to be treated at a National Cancer Institute (NCI)-designated cancer center compared to those who did not consider surgeon reputation.[15] Thus, there is a need to study this important treatment decision, including whether patients who considered factors in addition to physician referral are more likely to receive surgery at large, high-volume, accredited hospitals.

In this survey of Iowans diagnosed with rectal cancer, we examined the considerations involved in selecting a surgeon for rectal cancer treatment. Our second objective was to determine characteristics associated with receiving care at large, accredited, and high-volume hospitals, and to assess the association between these surgeon selection considerations and receipt of surgical care at a large hospital.

Methods

Study Population

Subjects were recruited from the statewide Iowa Cancer Registry (ICR), an original member of the NCI's Surveillance, Epidemiology, and End Results (SEER) Program. ICR data were used to identify individuals meeting the following eligibility criteria: Iowa residents age 18 or older diagnosed with microscopically confirmed stages II/III rectal cancer between 2013 and 2017 who received cancer-directed surgery. In addition, subjects had to be presumed to be alive (based on ICR data) as of October 2018, and cognitively and/or physically able to complete the survey during its administration in February to April 2019. Of note, although participants resided in Iowa, some participants underwent surgery at hospitals in other midwestern states. Study invitations and questionnaires were mailed to 417 eligible persons.

Data Collection and Management

We utilized a modified Dillman approach to maximize response.[17] Pre-notification postcards were mailed to potential participants 3–7 days prior to survey packets, which informed them about the survey, indicated that a packet from the ICR would be arriving soon with cash inside. Survey materials were mailed in a single packet containing a cover letter, instructions, a 10-page survey, a pre-paid business reply envelope, and a $10 cash incentive. Surveys were mailed in 5 batches over a 9-week period beginning February 18, 2019. The cover letter included a description of the objectives and informed participants they would receive an additional $20 check for completing and returning the survey within 12 days. A second survey packet was mailed approximately 21 days after the initial mailing date to non-responders.

A week after the second survey packet was mailed, a maximum of 8 phone calls were attempted to non-responders. Individuals who were reached by phone and agreed to participate were offered to be mailed another survey or to answer the survey questions over the phone. Participants who could not be reached by phone were considered non-responders. Responders who left pages or important questions blank, or who made other errors, were also contacted by phone to get clarification on their responses. If they could not be reached, they were mailed photo-copied pages with errors/missing answers highlighted and asked to mail corrected responses back in the provided pre-paid envelope or write "skip". Survey responses were entered and managed using RedCap electronic data capture hosted at the University of Kansas Medical Center (Paul, 2009). The study protocol was approved by the University of Iowa Institutional Review Board (IRB).

Survey Instrument Design

The survey instrument was designed based on qualitative information collected from individuals diagnosed with rectal cancer in semi-structured interviews.[18–20] Survey instruments were further vetted and refined based on feedback from colorectal surgeons and survey methodologists. Cognitive testing of the instrument was conducted with 5 individuals diagnosed with rectal cancer who had follow-up appointments for their rectal cancer surgery at a tertiary referral hospital in the month preceding survey implementation. A formal pilot test was conducted with 20 rectal cancer survivors diagnosed in 2012 who were recruited from the ICR.

Measures

The survey captured information about the subject's experience with rectal cancer, including their considerations when choosing their cancer surgeon. The following question was asked twice: "Which of the following statements describe how you decided on the surgeon who did your rectal cancer surgery?" First participants were asked to select all that apply, and next they were asked to select the "ONE most important factor." For the main analysis, the consideration participants selected as the most important was used to classify participants' surgeon selection category as: "Directed", "Personal", or "Reputation".

Participants were categorized as "Directed" to their cancer surgeon if they chose the following: "My doctor recommended (or told me to go to) the surgeon", "The surgeon diagnosed the cancer", or "I had to have emergency surgery and the surgeon was available." If the respondents chose "The surgeon was recommended by a family member, friend, or coworker" or "I knew the surgeon personally or through his/her family", they were categorized as "Personal" due to basing the decision on direct or indirect connections to the surgeon. Participants were categorized as "Reputation" if they chose "The surgeon worked at a large or well-known hospital" or "I got information about the surgeon online." Participants who chose any of the other three response options (n=47) or did not respond to the second question (n=1) were categorized individually by evaluating their responses to the first question (check all that apply), as well as other relevant questions, including whether the person got a "second opinion" and to what extent the physician referral ultimately affected their decision.

The survey captured information regarding annual household income (less than $35,000, $35,001-$50,000; $50,001-$75,000; $75,001-$100,000; greater than $100,000), and highest level of education attained (High school, G.E.D, or less; Some college or 2-year degree; College Graduate or more). Additionally, ICR records captured the following information: age at diagnosis, race/ethnicity, marital status at diagnosis, insurance, residential ZIP code at diagnosis, AJCC 7th edition stage, and receipt of radiation and chemotherapy as part of first course treatment. ICR registrars, with assistance from a general surgery resident, coded the rectal tumor location as high, medium, or low. Registrars followed a hierarchy of available information to categorize the tumor location: 1) distance from anal verge (low: <5 cm, medium: 5–10 cm, high: >10 cm), 2) distance from dentate line, 3) distance from anorectal ring, anal sphincter or rectosigmoid junction, 4) location noted as being "low/

distal", "middle", or "high/proximal", and 5) documentation the tumor was palpable on digital rectal exam (if yes, considered low).

Rurality was categorized using residential ZIP code and the Rural-Urban Commuting Area (RUCA) 3-tier scheme developed at the University of Washington (Category B: urban, large rural, small rural).[21] Additionally, ICR data were used to characterize the hospitals where the subjects received surgery. NCI designation of surgery hospital was determined based on the NCI Cancer Center online directory and included both NCI-designated Cancer Centers and Comprehensive Cancer Centers.[22] Similarly, the CoC directory was used to determine CoC-accreditation.[23]

To determine surgery volume, data on rectal surgeries performed in Iowa hospitals between 2012–2017 were obtained from the Iowa Hospital Association. All hospital discharge data records from the IHA with ICD-9 procedure codes (48.31 or 48.4–48.69) or ICD-10 codes (0DT.P0ZZ, 0DT.P4ZZ, 0DT.P7ZZ, 0DT.P8ZZ) were included in our calculation of the number of surgeries each hospital performed. Records that did not have a primary diagnosis of colorectal cancer or only had local excision, destruction, or polypectomy surgeries were excluded.

Analysis

Comparisons of participants' surgeon selection category ("Directed" vs. "Personal" vs. "Reputation") using Chi-squared tests were performed for sex, age, income, insurance status, marital status, education, stage, chemoradiation, and tumor location, as well as the following surgery hospital characteristics: NCI designation, CoC accreditation, and rectal cancer surgery volume. Multinomial logistic regression was used to evaluate factors associated with "Personal" or "Reputation"; as compared with those categorized as "Directed." Additionally, analyses were performed to determine if the participants' surgeon selection category affected the hospital where surgery was received. Multivariable logistic regression was used in three separate models to determine whether the surgeon selection categories were associated with receipt of surgery at a: NCI-designated hospital, CoC-accredited hospital, or a hospital with high rectal cancer surgery volume, when adjusting for confounding factors.

Statistical analyses were carried out using SAS version 9.4 (SAS Institute, Cary, NC). All variables were considered for inclusion in the multinomial model, but covariable selection was guided by univariate analyses (5% significance level). Education was included because it was hypothesized to be associated with the way patients make treatment decisions. Similarly, tumor location was forced into the surgery hospital models given the importance of location in rectal cancer surgery. Interactions between related covariables were considered.

Results

Survey instruments were mailed to 417 people, four of which were returned to the research team as undeliverable. A total of 318 subjects (76%) completed the survey. Of those, 253 (79.5%) responded after the first mailing, 63 (19.9%) responded after the second mailing,

and 2 (0.6%) responded to the survey via telephone. Of those who did not respond, 24 were active refusals (i.e., returned blank survey or refused via telephone), and 75 were passive refusals (i.e., never responded). Individuals who responded to the survey were more likely to be white and/or married (Table 1). Responders were predominately male (62%), under 65 years old (68%), and rural residents (54%). One participant did not answer the first or second question about how the surgeon was selected and was excluded from analyses.

As displayed in Table 2, the most selected consideration was "My doctor recommended (or told me to go to) the surgeon"; 64% said it was a consideration, and 44% said it was the "most important" consideration. The second most common consideration was "The surgeon worked at a large or well-known hospital"; 45% said it was a consideration, and 14% said it was the most important. About 10% of participants wrote-in an "Other" response for the most important consideration (Supplemental Table 1). After categorization of considerations into "Directed", "Personal", and "Reputation" categories, 69% (n=220) were "Directed" to their cancer surgeon, 11% (n=35) made the decision based on personal connections to the surgeon ("Personal"), and 20% (n=62) made the decision based on "Reputation".

After adjustment, when comparing "Personal" vs. "Directed" populations (Table 3), those who were single (vs. married) were significantly less likely to make their choice based on knowing the surgeon personally (OR=0.2, 95%CI: 0.1–0.7), and those who were stage III (vs II) were more likely to make their choice based on knowing the surgeon personally (OR=2.6, 95%CI: 1.1–6.5). When comparing "Reputation" vs. "Directed" populations, those who were stage III (vs II) were more likely to make their choice based on reputation (OR=2.2, 95%CI: 1.1–4.4). Of those with low rectal tumors, 28% selected their surgeon based on "Reputation", whereas 14% of people with high and 15% with mid-rectal tumors selected their surgeon based on "Reputation"; this difference did not reach statistical significance (p=0.07).

Overall, 26% of respondents received surgery at NCI-designated cancer centers, 87% at CoC accredited hospitals and 65%, 20% and 14% at high, medium and low volume hospitals, respectively (Table 4). When looking specifically at considerations associated with selection of NCI-designated cancer centers in adjusted analyses, selecting a surgeon/hospital based on "Reputation" (vs. "Directed") (OR=7.5, 95%CI: 3.8–15.0) and having private insurance were significantly associated with surgery at NCI-designated centers. Factors specifically associated with selection of a high-volume hospital included selecting a surgeon/hospital based on "Reputation" (vs. "Directed") (OR=2.6, 95%CI: 1.2–5.7), as well as being a college graduate (vs. high school or less). The only factor significantly associated with selection of a CoC-accredited hospital in adjusted analysis was insurance, where those with Medicare, Medicaid, or other government insurance were less likely to undergo surgery at a CoC-accredited hospital.

Discussion

In our survey of Iowans diagnosed with rectal cancer we found that nearly 7 in 10 reported relying on the referral/recommendation by the physician who diagnosed their cancer to select their surgeon/hospital. Only 2 in 10 based their surgeon/hospital decision on

"Reputation", and 1 in 10 selected their hospital because of "Personal" connections. These findings have significant implications for programs like the American College of Surgeons Commission on Cancer National Accreditation Program for Rectal Cancer (NAPRC), aimed to attract rectal cancer patients to centers that meet volume and quality of care standards for rectal cancer treatment.[24,25] Our findings suggest that addressing existing referral patterns will be critical in efforts to steer patients to high-volume surgeons and hospitals.

Study findings also indicate that respondents who based their decision on "Reputation" were significantly more likely to receive surgery at NCI-designated or high-volume hospitals compared to those who relied on their physician's referral. This finding is consistent with the only previous cancer study evaluating this relationship. That study reported that those who selected their surgeon based on reputation were at least twice as likely to receive surgery from a high-volume surgeon, and over three times more likely to be treated at an NCI-designated cancer center (compared with those who did not consider reputation).[15] Additionally, the patients who said they were referred to their surgeon by another physician (compared to those who did not) were half as likely to be seen at an NCI-designated cancer center.[15] This study involved only breast cancer patients in metropolitan areas, so our study suggests that these patterns may hold true in a population of rectal cancer patients in a rural state.

Adjusted analyses showed the most significant factor associated with selecting a surgeon/ hospital based on reputation (vs. referral) was more advanced stage (III vs. II). Individuals diagnosed at an earlier stage may have perceived the cancer as lower severity, and thus may have been less likely to pursue additional information beyond the direction of the diagnosing physician.

When comparing those who selected their surgeon/hospital based on personal connections vs. those who relied on the referral, marital status was a significant factor. Those who were married were more likely to base their decision on a "Personal" connection to the hospital or surgeon, whereas unmarried individuals were more likely to rely on the referral. One possible explanation is that married people tend to have larger social circles (e.g., dependent minors) that may increase the probability of knowing a surgeon either directly or indirectly.

The only sociodemographic factor that remained significantly associated with surgery at a CoC-accredited facility after adjustment was insurance. It appeared individuals with Medicare, Medicaid, or other governmental insurance were less likely to receive surgery at a CoC-accredited hospital than those who were covered by private/employer insurance. Additionally, those residing in rural areas had non-significantly lower odds of surgery at CoC-accredited hospitals. Most CoC-accredited hospitals in Iowa are in urban areas, and nearly all the urban areas in Iowa have a CoC-accredited hospital. Conversely, there were only two CoC-accredited hospitals located in rural areas of Iowa.[23]

The location of the rectal tumor (high/middle/low) was not significantly associated with patients' decisions, though it was more common for patients with low tumors to select their surgeon based on reputation compared to those with high/medium tumors. The location of the rectal tumor was also not associated with the type of hospital where patients received

surgery. Given that higher-volume surgeons are likely to consider newer sphincter preserving surgical options for lower rectal tumors, it is notable that those with low tumors were not more likely to undergo surgery at high-volume cancer centers where they have the best opportunity for sphincter preservation.[26,27]

The 76% response rate in our population-based survey was a significant strength of this study. The survey development process included iterative drafting and testing of all questions, which increases our confidence in the validity of the responses. Importantly, the results of the study fill a critical gap in the body of evidence on rectal cancer decision-making, which have clinical implications given that a minority of patients receive care at a large hospital despite the strong volume-outcome relationship.[2,5,11] Our findings fill this gap and highlight the critical role of physician referrals in directing patients to surgical care. Our findings could also inform the development of resources for patients and/or physicians.

The main limitation of this study was that it took place in a single Midwestern state with a predominantly White population of respondents and underrepresentation of non-White patients, which limited our ability to evaluate racial/ethnic relationships and limits generalizability to more diverse populations. However, the results of this study may be particularly pertinent to many other primarily rural states or states with similar demographics. In addition, respondents were asked to recall how they made a decision that occurred 2–5 years ago, so misclassification likely occurred in some cases.

Over two-thirds of a study population of individuals living in Iowa diagnosed with rectal cancer reported being "Directed" to their cancer surgeon – meaning they relied on physician referral or other circumstances necessitating that they see a specific surgeon without considering other information (i.e., hospital reputation or searching for information online). Those who did consider "Reputation" were significantly more likely to receive surgery at an NCI-designated hospital and/or a hospital with a high rectal cancer surgery volume. Our findings indicate the importance of developing strategies to influence referral patterns in addition to educating patients. Recent approaches, such as the one used by the University of Kentucky Markey Cancer Center Affiliate Network, provide promising mechanisms for building trust-based relationships across high- and low-volume hospitals whereby patients can receive complex surgical care from high-volume providers and then transition back to local providers for adjuvant therapy.[28] This approach has been shown to make providers from low-volume hospitals more comfortable with referring complex surgical patients to high-volume hospitals,[28] with the ultimate goal of providing patients with higher quality care and superior outcomes. An additional strategy used by the University of Kentucky Markey Cancer Center Affiliate Network and other cancer centers throughout the US includes training general surgeons at community hospitals to improve their skills (e.g., TME) and prioritizing multi-disciplinary care.[28]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding:

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Table 1.

Demographic differences between responders and non-responders

Patient Characteristics	Respondents		Non-Respondents		
Sex	**n=318**	**Col. %**	**n=99**	**Col. %**	**p value**
Male	196	61.6%	63	63.6%	0.7200
Female	122	38.4%	36	36.4%	
Age at Diagnosis					
Average age (SD)	59.4	(11.7)	57.8	(12.7)	
<65	217	68.2%	68	68.7%	0.9333
65	101	31.8%	31	31.3%	
Race					
White	310	97.5%	91	91.9%	**0.0118**
Non-white	8	2.5%	8	8.1%	
Rurality					
Urban	147	46.2%	54	54.6%	0.2504
Large Rural	49	15.4%	10	10.1%	
Small Rural	122	38.4%	35	34.4%	
Health Insurance					
Private/Employer	163	51.3%	42	43.3%	0.3274
Medicare/Medicaid/National	124	39.0%	42	43.3%	
Uninsured or Unknown	31	9.8%	13	13.4%	
Marital Status at Diagnosis					
Married	215	67.6%	49	49.5%	**0.0011**
Single/Divorced/Widowed	103	32.4%	50	50.5%	
Year of Diagnosis					
2013	57	17.9%	25	25.3%	0.1978
2014	70	22.0%	24	24.2%	
2015	59	18.6%	13	13.1%	
2016	67	21.1%	24	24.2%	
2017	65	20.4%	13	13.1%	
Stage					
II	105	33.0%	27	27.3%	0.2831
III	213	67.0%	72	72.7%	
Tumor Location					
High	70	22.2%	22	22.2%	0.6956
Mid	125	39.7%	35	35.4%	
Low	120	38.1%	42	42.4%	

Some numbers do not sum to totals due to missing data.

Table 2.

Patient considerations – all versus most important -- reported to affect decision on where to receive surgery

Decision Considerations	A1. All That Apply[a]		A2. Most Important[b]	
	N	%	N	%
Directed				
My doctor recommended (or told me to go to) the surgeon	202	63.5	140	44.3
I had to have emergency surgery and the surgeon was available	16	5.0	8	2.5
The surgeon diagnosed the cancer	84	26.4	42	13.3
Personal				
I knew the surgeon personally or through his/her family	12	3.8	5	1.6
The surgeon was recommended by a family member, friend, or coworker	49	15.4	27	8.5
Reputation				
The surgeon worked at a large or well-known hospital	142	44.7	44	13.9
I got information about the surgeon online	18	5.7	3	1.0
The surgeon worked at a hospital close to where I lived[c]	98	30.8	5	1.6
The surgeon was likeable[c]	106	33.3	10	3.2
Other (please describe)[c]	65	20.4	32	10.1

[a]Question A1 asked participants to check all that apply: "Which of the following statements describe how you decided on the surgeon who did your rectal cancer surgery?"

[b]Question A2 asked participants to mark one answer: "Which ONE statement below was the most important factor in deciding who would do your surgery?" Two individuals did not answer Question A2.

[c]For subsequent analyses, participants who chose one of these response options for A2 were categorized as Directed, Personal, or Reputation based on their answers to A1, A2, and other questions.

Table 3.

Characteristics associated with surgeon decision categories

Patient Characteristics	Overall (N=317)	Directed[a] (N=220)	Personal (N=35)	Reputation (N=62)	χ² p-value	aOR Personal & 95%CI	aOR Reputation & 95%CI
	N	N (row %)					
Sex					p=0.3569		
Female	122	79 (64.8%)	16 (13.1%)	27 (22.1%)			
Male	195	141 (72.3%)	19 (9.7%)	35 (18.0%)			
Age at Diagnosis					**p=0.0428**		
<65	216	141 (65.3%)	25 (11.6%)	50 (23.2%)		1.00 (REF)	1.00 (REF)
65	101	79 (78.2%)	10 (9.9%)	12 (11.9%)		1.41 (0.41–4.81)	0.7 (0.28–1.92)
Rurality [b]					p=0.6088		
Urban	147	100 (68.0%)	19 (12.9%)	28 (19.1%)			
Rural	170	120 (70.6%)	16 (9.4%)	34 (20.0%)			
Annual Household Income					p=0.0553		
<$35,000	104	80 (76.9%)	8 (7.7%)	16 (15.4%)			
$35,001 – $75,000	109	77 (70.6%)	13 (11.9%)	19 (17.4%)			
>$75,000	85	48 (56.5%)	14 (16.5%)	23 (27.1%)			
Missing	19	15 (79.0%)	0	4 (21.1%)			
Health Insurance					**p=0.0038**		
Private/Employer	163	102 (62.6%)	18 (11.0%)	43 (26.4%)		1.00 (REF)	1.00 (REF)
Medicare/Medicaid/Government	123	97 (78.9%)	10 (8.1%)	16 (13.0%)		0.61 (0.18–2.09)	0.57 (0.23–1.38)
Uninsured or Unknown	31	21 (67.7%)	7 (22.6%)	3 (9.7%)		2.36 (0.83–6.72)	0.37 (0.10–1.32)
Marital Status					**p=0.0130**		
Married	214	140 (65.4%)	31 (14.5%)	43 (20.1%)		1.00 (REF)	1.00 (REF)
Single/Divorced/Widowed	103	80 (77.7%)	4 (3.9%)	19 (18.5%)		**0.24 (0.08–0.72)**	0.84 (0.45–1.59)
Highest Level of Education					p=0.0796		
High School, GED, or Less	150	115 (76.7%)	12 (8.0%)	23 (15.3%)		1.00 (REF)	1.00 (REF)
Some College or 2-year Degree	100	65 (65.0%)	14 (14.0%)	21 (21.0%)		2.02 (0.85–4.83)	1.39 (0.70–2.77)
College Graduate or More	66	39 (59.1%)	9 (13.6%)	18 (27.3%)		2.00 (0.75–5.35)	1.94 (0.92–4.11)
AJCC Stage							

Patient Characteristics	Overall (N=317)	Directed[a] (N=220)	Personal (N=35)	Reputation (N=62)	χ² p-value	aOR Personal & 95%CI	aOR Reputation & 95%CI
	N	N (row %)					
II	104	84 (80.8%)	7 (6.7%)	13 (12.5%)	**p=0.0090**	1.00 (REF)	1.00 (REF)
III	213	136 (63.9%)	28 (13.2%)	49 (23.0%)		**2.60 (1.05–6.45)**	**2.20 (1.11–4.39)**
Tumor Location							
High	70	50 (71.4%)	10 (14.3%)	10 (14.3%)	p=0.0781		
Mid	125	93 (74.4%)	13 (10.4%)	19 (15.2%)			
Low	119	74 (62.2%)	12 (10.1%)	33 (27.7%)			
Treatment/Hospital Characteristics (Not considered for model)							
Chemoradiation							
Preop CRT and Postop Chemo	145	97 (66.9%)	17 (11.7%)	31 (21.4%)	p=0.6132		
Preop CRT	86	61 (70.9%)	9 (10.5%)	16 (18.6%)			
Postop Chemo	44	28 (63.6%)	5 (11.4%)	11 (25.0%)			
Other treatment combination	42	34 (81.0%)	4 (9.5%)	4 (9.5%)			
Surgery Hospital NCI-Designated							
Yes	79	35 (44.3%)	6 (7.6%)	38 (48.1%)	**p<0.0001**		
No	226	177 (78.3%)	29 (12.8%)	20 (8.9%)			
Surgery Hospital CoC-Accredited							
Yes	265	183 (68.9%)	28 (10.6%)	54 (20.5%)	p=0.1752		
No	40	29 (72.5%)	7 (17.5%)	4 (10.0%)			
Surgery Hospital Volume							
High (≥16 per year avg.)	199	132 (66.3%)	19 (9.6%)	48 (24.1%)	**p=0.0205**		
Medium (4 – 15 per year avg.)	61	44 (72.1%)	9 (14.8%)	8 (13.1%)			
Low (≤3 per year avg.)	44	35 (79.6%)	7 (15.9%)	2 (4.6%)			

[a] The Directed category served as the referent group for the multinomial model.

[b] Rural-Urban Commuting Area (RUCA) - rurality categorization (RUCA Category B) condensed due to small cell counts. Some numbers do not sum to total due to missing data.

Table 4.

Odds of surgical care at a National Cancer Institute (NCI)-designated hospital, Commission on Cancer (CoC)-accredited hospital, and a hospital with a high surgery volume

Patient Characteristics	Model 1 NCI-Designated			Model 2 CoC-Accredited			Model 3 High Surgery Volume		
	Col. %	χ^2 p-value	aOR & 95%CI	Col. %	χ^2 p-value	aOR & 95%CI	Col. %	χ^2 p-value	aOR & 95%CI
Surgeon Selection		**p<0.0001**			p=0.1752			**p=0.0055**	
Directed	44.3%		1.00 (REF)	69.1%		1.00 (REF)	66.3%		1.00 (REF)
Reputation	48.1%		**7.51 (3.77–14.96)**	20.4%		1.57 (0.50–4.92)	24.1%		**2.64 (1.21–5.77)**
Personal	7.6%		0.82 (0.29–2.31)	10.6%		0.39 (0.14–1.11)	9.6%		0.56 (0.25–1.24)
Age at Diagnosis		**p=0.0019**			**p=0.0463**			**p=0.0156**	
<65	82.5%		1.00 (REF)	70.7%		1.00 (REF)	73.5%		1.00 (REF)
65	17.5%		0.56 (0.22–1.47)	29.3%		1.48 (0.55–3.96)	26.5%		0.99 (0.48–2.04)
Race		p=0.4701			p=0.2993			p=0.7415	
White	98.8%		Not included in model	97.4%		Not included in model	97.5%		Not included in model
Non-White	1.3%			2.6%			2.5%		
Rurality		p=0.9805			**p=0.0326**			p=0.7318	
Urban	46.3%		Not included in model	48.5%		1.00 (REF)	47.5%		Not included in model
Large Rural	15.0%			14.3%		0.44 (0.16–1.24)	15.5%		
Small Rural	38.8%			37.2%		0.46 (0.19–1.10)	37.0%		
Annual Household Income		**p=0.0027**			p=0.0707			**p=0.0125**	
<$35,000	22.5%		1.00 (REF)	30.5%		1.00 (REF)	25.5%		1.00 (REF)
$35,001 – $75,000	28.8%		0.96 (0.40–2.31)	35.3%		0.80 (0.32–1.99)	37.0%		1.55 (0.79–3.02)
>$75,000	42.5%		2.36 (0.91–6.12)	29.0%		1.32 (0.37–4.64)	31.5%		1.83 (0.81–4.14)
Missing	6.3%		1.75 (0.43–7.17)	5.3%		0.55 (0.14–2.19)	6.0%		1.42 (0.45–4.46)
Health Insurance		**p=0.0002**			**p=0.0174**			**p=0.0085**	
Private/Employer	71.3%		1.00 (REF)	55.3%		1.00 (REF)	57.5%		1.00 (REF)
Medicare/Medicaid/Government	26.3%		0.80 (0.32–2.02)	35.0%		**0.35 (0.12–0.99)**	31.5%		0.67 (0.32–1.39)
Uninsured or Unknown	2.5%		**0.18 (0.04–0.84)**	9.8%		0.73 (0.20–2.65)	11.0%		1.51 (0.59–3.86)
Marital Status		p=0.3127			p=0.9451			p=0.8753	
Married	72.5%		1.00 (REF)	68.1%		1.00 (REF)	68.5%		1.00 (REF)
Single/Divorced/Widowed	27.5%		0.98 (0.48–2.00)	32.0%		0.81 (0.35–1.89)	31.5%		1.19 (0.65–2.16)

Patient Characteristics	Model 1 NCI-Designated		Model 2 CoC-Accredited		Model 3 High Surgery Volume	
Highest Level of Education	p=0.1249		p=0.0983		p=0.0006	
High School, GED, or Less	37.5%	1.00 (REF)	44.7%	1.00 (REF)	40.5%	1.00 (REF)
Some College or 2-year Degree	36.3%	1.09 (0.53–2.25)	33.1%	1.42 (0.60–3.26)	33.0%	1.36 (0.75–2.45)
College Graduate or More	26.3%	0.98 (0.42–2.28)	22.2%	1.79 (0.52–6.12)	26.5%	**2.92 (1.26–6.75)**
Tumor Location	p=0.3665		p=0.7424		p=0.8078	
High	17.5%	Not included in model	23.6%	Not included in model	24.0%	Not included in model
Mid	41.3%		38.8%		38.5%	
Low	41.3%		37.6%		37.5%	
AJCC Stage	p=0.0565		p=0.3628		p=0.2932	
II	25.0%	1.00 (REF)	32.7%	1.00 (REF)	35.5%	1.00 (REF)
III	75.0%	1.50 (0.76–2.97)	67.3%	1.27 (0.60–2.67)	64.5%	0.64 (0.37–1.13)

The above table contains statistics for the three hospital characterization variables. For each model, the col. % represents the proportion of participants who underwent surgery at a hospital represented by "Yes" for that variable (e.g. % who underwent surgery at an NCI-designated hospital, etc.)