

Impact of Travel Distance on Quality Outcomes in Colorectal Cancer

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For patients who face a diagnosis of cancer, the ability to access needed care can influence health care outcomes and survival.¹ Because optimal care is often found at specialty regional centers or may be offered at locations that are not convenient to patients' homes, there is a wide differential of travel burden experienced by patients. Although patients expect to receive the same quality of care, variances in measures of health care access and outcomes are often observed for those traveling greater distances for treatment.^{2,3} In addition, disparities in quality measurements have been demonstrated by studies in a variety of care settings.^{1,2,4} For example, in a study utilizing the National Cancer Database, patients with gastrointestinal cancers who traveled farthest for intent-to-cure surgery—regardless of facility or demographic or socioeconomic status—had lower risk of 90-day and 5-year mortality.⁵

Length of stay (LOS) at surgical facility and in-hospital complications are major drivers of health care cost for patients and are commonly used metrics in comparative effectiveness research.^{6,7} Although the impacts of clinical factors on quality metrics of perioperative care have been widely studied in patients with colorectal cancer,⁸ less attention has been dedicated to identifying impacts of nonclinical factors, such as travel and access to care. Identification of the relationship between accessibility of care and LOS and in-hospital complications is crucial because it provides additional insights for proper allocation of resources to bolster services wherever needed. This study was conducted to identify the factors that cause patients with colorectal cancer to travel farther for surgical treatment and to further explore the impact of these factors on LOS and in-hospital complications.

METHODS

This study utilizes data from the 2013-2015 Florida Inpatient Discharge Database. This data set includes deidentified patient-level data from all acute care hospitals within the state of Florida, including information regarding cancer diagnosis, metastatic spread, treatment, and hospital and physician identifiers.⁹ This database does not include protected health information and hence

ABSTRACT

OBJECTIVES: This study sought to examine the impact of distance traveled from place of residence to surgical facility for elective colorectal surgery on surgical outcomes, length of stay, and complication rate.

STUDY DESIGN: Retrospective study.

METHODS: Patients with colorectal cancer were identified from the Florida Inpatient Discharge Database. Distance traveled from primary residence to surgical facility was estimated using zip code. After adjusting for patient and hospital characteristics, multivariate regression models compared bypassed hospitals, the length of stay, and complication rates for patients traveling different distances to receive care.

RESULTS: Patients residing in rural areas and in South (odds ratio [OR], 2.37; 95% CI, 1.55-3.63) and Central Florida (OR, 5.86; 95% CI, 3.86-8.89) were more likely to travel more than 50 miles for treatment. Teaching status of the hospital (OR, 9.99; 95% CI, 6.98-14.31), a hospital's availability of a colorectal surgeon (OR, 1.83; 95% CI, 1.45-2.31), and metastasized cancer (OR, 1.43; 95% CI, 1.17-1.82) influenced the patient's decision to travel farther for treatment. Length of stay was significantly higher for patients traveling farther ($P < .0343$). However, there was no significant difference in the rate of complications among the groups (those traveling 25-50 miles vs < 25 miles [$P = .5766$] and those traveling > 50 miles vs < 25 miles [$P = .4516$]).

CONCLUSIONS: A greater number of patients travel more than 50 miles to the surgical facility at a later stage of disease. These patients do not significantly differ from those traveling less than 50 miles in their rates of complications; however, they stay longer at the surgical facility.

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TAKEAWAY POINTS

This study identified characteristics of patients with colorectal cancer who traveled farther for surgery and found that those who traveled tended to stay longer at the hospital.

- ▶ Patients with colorectal cancer who traveled more than 50 miles to receive elective surgery did not experience significantly more complications, but they stayed longer at the hospital, suggesting the possibility of barriers to timely discharge.
- ▶ Patients with colorectal cancer who traveled more than 50 miles to a surgical facility had greater odds of being seen in medium-sized, higher-volume, teaching hospitals that had colorectal surgeons compared with those who traveled less than 25 miles from their home.
- ▶ Patients with colorectal cancer residing in central, southern, and rural parts of Florida had a higher burden of travel due to the lack of easy access to specialized care in these areas.

the study was exempted from a formal review by the Mayo Clinic Institutional Review Board. All patients receiving inpatient colorectal cancer surgery during the years 2013 to 2015 were included in the evaluation. Patients were excluded if they were admitted urgently or emergently, because these patients are likely to seek care from the nearest surgical facility.

Dependent Variable

The dependent variables for this study were hospital chosen vs bypassed, LOS, and surgical complications. For patients who traveled greater than 50 miles (80.5 km) for care, a binary variable was created identifying the hospital in which they received care compared with the hospitals in the 25-mile (40.2-km) radius of the patient's home zip code that they bypassed. LOS was operationalized as a continuous variable. Surgical complications were operationalized as a binary variable based upon the Healthcare Cost and Utilization Project Clinical Classification Software (CCS) 238 codes, which identify medical and surgical complications. In addition, CCS codes for thromboembolic complications including deep venous thrombosis and pulmonary embolism (415, 415.11-415.19, 4510-4519, 4530-4539) were used to identify postoperative complications.^{10,11} If a patient experienced any of the complications associated with the surgical procedure of interest, they were classified as having a surgical complication.

Independent Variable

Distance traveled from the primary residence to surgical facility was estimated by calculating the distance between the zip code centroids for the patient's residence and the surgical facility. We created a 3-category exposure variable—travel distance—with categories of (1) less than 25 miles, (2) between 25 miles and 50 miles, and (3) more than 50 miles. The cutoff points for the travel distance were selected based on the knowledge that the median (interquartile range) travel time of the US population to the nearest academic cancer center is 30 (13-72) minutes.¹² Travel time of more than an hour, corresponding to approximately 50 miles (80.5 km) to the surgical facility, was classified as "distant travel," and travel time of less than 30 minutes, corresponding to 25 miles (40.2 km), was classified as "local travel." The third category included patients

who traveled a moderate distance, between 25 miles and 50 miles.

Covariates

Patient covariates included age, sex, race/ethnicity, rural/urban location, residential region in Florida, payer type, and comorbidities. Hospital factors included hospital size, hospital volume, teaching status, and availability of a colorectal surgeon. Race/ethnicity were categorized as White, Black or African American, and Hispanic or Latino. Payer type included commercial, Medicaid, Medicare,

Medicare Managed Care, and other, which comprised self-payers and uninsured. The comorbidity burden was measured using the Elixhauser score, and 4 categories were created indicating the presence of 0, 1 or 2, 3 to 5, or more than 5 comorbidities.¹³ Metastatic status of the cancer and obesity were included separately due to their important influence on a patient's ability to travel. Hospital size was identified using the number of hospital beds: Fewer than 100 indicated a small hospital; 100-299, a medium hospital; and 300 or greater, a large hospital. Hospital volume was analyzed both as a categorical variable, based on the quartile distributions of the number of colorectal surgical procedures performed at each hospital in the data set (0-48, 49-105, 106-149, and 150-277), and as a continuous variable. Teaching status of the hospital was identified based on the presence of an Accreditation Council for Graduate Medical Education residency program.

Statistical Analysis

Bivariate analysis examined associations among patient characteristics, hospital factors, and the 3-category variable travel distance. Pearson's χ^2 test and the Kruskal-Wallis test were used to compare categorical and continuous variables, respectively. Pairwise comparisons were conducted to understand characteristics of patients traveling farther for treatment. Multivariate logistic regression was used to examine hospital-level factors associated with chosen facilities vs those bypassed. Multivariate linear regression was performed to compare the LOS at surgical facilities for patients who traveled farther for surgery with that of those treated locally, after adjusting for other covariates. Due to the nonnormal distribution of the LOS variable, logarithmic transformation was utilized to meet regression assumptions. Multivariate logistic regression was performed to understand the complication rate for patients by the travel groups. Finally, a sensitivity analysis was conducted to examine whether any of the selected covariates was an effect modifier of the association between travel distance and LOS or complication rate.

RESULTS

A total of 8798 patients with colorectal cancer were included in the analysis (Table 1). Of the total, 5.95% of patients traveled more

Travel Distance and Patients With Colorectal Cancer

TABLE 1. Descriptive Characteristics of Patients With Colorectal Cancer and Hospital Facilities by Travel Distance for Surgical Care in Florida

	Distance from patient's residence to a surgical facility			Total N = 8798	P
	< 25 miles [< 40.2 km] n = 7552 (85.8%)	25-50 miles [40.2-80.5 km] n = 722 (8.2%)	> 50 miles [> 80.5 km] n = 524 (6.0%)		
Type of surgery					<.0001 ^a
Open	3784 (50.1%)	374 (51.8%)	327 (62.4%)	4485 (51.0%)	
Laparoscopic	3288 (43.5%)	302 (41.8%)	167 (31.9%)	3757 (42.7%)	
Robotic	480 (6.4%)	46 (6.4%)	30 (5.7%)	556 (6.3%)	
Sex					.04281 ^a
Female	3655 (48.4%)	326 (45.2%)	230 (43.9%)	4211 (47.9%)	
Male	3897 (51.6%)	396 (54.8%)	294 (56.1%)	4587 (52.1%)	
Age in years					<.0001 ^b
n	7552	722	524	8798	
Mean (SD)	68.8 (12.5)	66.0 (12.5)	65.2 (12.7)	68.4 (12.6)	
Median	70	67	66	70	
IQR	61.0-78.0	59.0-75.0	57.0-74.0	60.0-78.0	
Range	18.0-99.0	22.0-94.0	17.0-97.0	17.0-99.0	
Race					<.0001 ^a
Missing	175	23	16	214	
White	5424 (73.5%)	556 (79.5%)	455 (89.6%)	6435 (75.0%)	
African American	763 (10.3%)	40 (5.7%)	25 (4.9%)	828 (9.6%)	
Hispanic or Latino	1190 (16.1%)	103 (14.7%)	28 (5.5%)	1321 (15.4%)	
Elixhauser score					<.0001 ^a
0	1335 (17.7%)	146 (20.2%)	112 (21.4%)	1593 (18.1%)	
1-2	3600 (47.7%)	329 (45.6%)	297 (56.7%)	4226 (48.0%)	
3-5	2304 (30.5%)	227 (31.4%)	103 (19.7%)	2634 (29.9%)	
>5	313 (4.1%)	20 (2.8%)	12 (2.3%)	345 (3.9%)	
Length of stay in days					.00692 ^b
n	7552	722	524	8798	
Mean (SD)	6.3 (4.8)	6.5 (5.0)	7.0 (6.0)	6.4 (4.9)	
Median	5	5	5	5	
IQR	4.0-7.0	4.0-7.0	4.0-8.0	4.0-7.0	
Range	0.0-87.0	1.0-47.0	2.0-55.0	0.0-87.0	
Year					.00731 ^a
2013	2789 (36.9%)	233 (32.3%)	166 (31.7%)	3188 (36.2%)	
2014	2731 (36.2%)	269 (37.3%)	192 (36.6%)	3192 (36.3%)	
2015	2032 (26.9%)	220 (30.5%)	166 (31.7%)	2418 (27.5%)	
Payer					<.0001 ^a
Medicare	2727 (36.1%)	261 (36.1%)	192 (36.6%)	3180 (36.1%)	
Medicare managed care	2029 (26.9%)	147 (20.4%)	80 (15.3%)	2256 (25.6%)	
Medicaid	311 (4.1%)	41 (5.7%)	25 (4.8%)	377 (4.3%)	
Commercial	2222 (29.4%)	243 (33.7%)	200 (38.2%)	2665 (30.3%)	
Other	263 (3.5%)	30 (4.2%)	27 (5.2%)	320 (3.6%)	
Patient rural vs urban					<.0001 ^a
Rural	192 (2.5%)	176 (24.4%)	108 (20.6%)	476 (5.4%)	
Urban	7360 (97.5%)	546 (75.6%)	416 (79.4%)	8322 (94.6%)	
Obesity					.11291
No	6558 (86.8%)	611 (84.6%)	464 (88.5%)	7633 (86.8%)	
Yes	994 (13.2%)	111 (15.4%)	60 (11.5%)	1165 (13.2%)	

(continued)

TABLE 1. (Continued) Descriptive Characteristics of Patients With Colorectal Cancer and Hospital Facilities by Travel Distance for Surgical Care in Florida

	Distance from patient's residence to a surgical facility			Total N = 8798	P
	< 25 miles (< 40.2 km) n = 7552 (85.8%)	25-50 miles (40.2-80.5 km) n = 722 (8.2%)	> 50 miles (> 80.5 km) n = 524 (6.0%)		
Metastatic cancer					<.0001 ^{*a}
No	6134 (81.2%)	546 (75.6%)	366 (69.8%)	7046 (80.1%)	
Yes	1418 (18.8%)	176 (24.4%)	158 (30.2%)	1752 (19.9%)	
Patient's region					<.0001 ^{*a}
South Florida	3863 (51.2%)	300 (41.6%)	213 (40.6%)	4376 (49.7%)	
North Florida	1262 (16.7%)	244 (33.8%)	76 (14.5%)	1582 (18.0%)	
Central Florida	2427 (32.1%)	178 (24.7%)	235 (44.8%)	2840 (32.3%)	
Surgeon type					<.0001 ^{*a}
General surgeon	5065 (67.1%)	382 (52.9%)	228 (43.5%)	5675 (64.5%)	
Colorectal surgeon	2487 (32.9%)	340 (47.1%)	296 (56.5%)	3123 (35.5%)	
Hospital size					.00581 ^{*a}
Small	269 (3.6%)	24 (3.3%)	3 (0.6%)	296 (3.4%)	
Medium	1009 (13.4%)	94 (13.0%)	80 (15.3%)	1183 (13.4%)	
Large	6274 (83.1%)	604 (83.7%)	441 (84.2%)	7319 (83.2%)	
Hospital volume					<.0001 ^{*b}
n	7552	722	524	8798	
Mean (SD)	104.9 (69.6)	150.5 (77.9)	178.8 (76.3)	113.0 (73.7)	
Median	88.0	152.0	152.0	93.0	
IQR	48.0-149.0	86.0-183.0	141.5-260.0	52.0-152.0	
Range	1.0-277.0	3.0-277.0	4.0-277.0	1.0-277.0	
Teaching					<.0001 ^{*a}
Missing	13	1	0	14	
Nonteaching	3919 (52.0%)	188 (26.1%)	48 (9.2%)	4155 (47.3%)	
Teaching	3620 (48.0%)	533 (73.9%)	476 (90.8%)	4629 (52.7%)	
Complications					.37931
No	6036 (79.9%)	567 (78.5%)	408 (77.9%)	7011 (79.7%)	
Yes	1516 (20.1%)	155 (21.5%)	116 (22.1%)	1787 (20.3%)	

IQR, interquartile range.

^{*}P < .05.^aChi-squared test.^bKruskal-Wallis test.

than 50 miles; 8.2%, between 25 and 50 miles; and 85.8%, less than 25 miles to receive surgery. The mean age was 68.4 years. The majority of patients were White (75.0%), followed by Hispanic (15.4%) and African American (9.6%). Patients from rural areas made up 5.4% of our study sample, and 19.9% of patients had metastatic colorectal cancer. Patient payer status indicated that 36.1% were covered by Medicare; 25.6%, Medicare managed care; 4.3%, Medicaid; 30.3%, by commercial insurance and that 3.6% were uninsured or self-payers. As seen in the **eAppendix Figure** (eAppendix available at ajmc.com), the proportion of patients traveling more than 50 miles was low in all insurance groups. Finally, 52.7% of patients received surgery at a teaching hospital and 35.5% were operated upon by a general surgeon.

As shown in **Table 2**, compared with White patients, African American (odds ratio [OR], 0.29; 95% CI, 0.18-0.45) and Hispanic

(OR, 0.13; 95% CI, 0.08-0.20) patients had reduced odds of traveling more than 50 miles for surgery. Patients located in urban areas also had reduced odds of traveling farther compared with those in rural areas (OR, 0.02; 95% CI, 0.01-0.03). Compared with patients with commercial insurance, those with Medicare (OR, 1.48; 95% CI, 1.03-2.15) had higher odds of traveling more than 50 miles for surgery. Similarly, patients living in South (OR, 2.37; 95% CI, 1.55-3.63) and Central (OR, 5.86; 95% CI, 3.87-8.89) Florida had higher odds of traveling for surgery compared with patients living in North Florida. Patients with metastasized colorectal cancer had increased odds of traveling farther (OR, 1.43; 95% CI, 1.12-1.82). Finally, hospital characteristics increasing the odds of travel included volume (OR, 1.12; 95% CI, 1.10-1.14), availability of colorectal surgeon (OR, 1.83; 95% CI, 1.45-2.30), and teaching status (OR, 9.96; 95% CI, 6.98-14.31).

The results of the analysis performed to assess bypassed vs chosen hospitals are revealed in **Table 3**. Hospitals chosen had increased odds of being medium sized vs large (OR, 3.08; 95% CI, 1.82-5.22) compared with the hospitals that patients bypassed. There was also a reduced odds of choosing a facility with lower colorectal surgical volume: 0 to 48 vs 150 to 277 surgeries (OR, 0.02; 95% CI, 0.01-0.03), 49 to 105 vs 150 to 277 surgeries (OR, 0.07; 95% CI, 0.04-0.11), and 106 to 149 vs 150 to 277 surgeries (OR, 0.37; 95% CI, 0.25-0.53). Next, patients had reduced odds of choosing a nonteaching hospital compared with a teaching hospital (OR, 0.08; 95% CI, 0.06-0.12). Finally, the chosen hospitals had greater odds of having a greater number of colorectal surgeons vs general surgeons (OR, 3.02; 95% CI, 2.21-4.12).

Table 4 shows the results of the multivariate model predicting the logarithmic transformation of LOS. Patients who traveled more than 50 miles to undergo surgery had a longer LOS compared with those who traveled less than 25 miles ($\beta=0.053$; $P=.03$). Women had shorter LOS ($\beta=-0.053$; $P<.001$). LOS increased progressively with increasing age ($\beta=0.003$; $P<.001$). African American patients had longer LOS compared with White patients ($\beta=0.044$; $P=.02$). Patients with metastasis ($\beta=0.136$; $P<.001$) and those with more comorbidities (1-2 vs 0: $\beta=0.109$; $P<.001$; 3-5 vs 0: $\beta=0.347$; $P<.001$; > 5 vs 0: $\beta=0.648$; $P<.001$) had longer LOS. Compared with those with commercial insurance, patients with Medicaid and with self-pay/no insurance had longer LOS ($\beta=0.150$; $P<.001$; and $\beta=0.127$; $P<.001$, respectively). Patients who underwent surgical procedures at a teaching hospital had a longer LOS ($\beta=0.083$; $P<.001$). In contrast, those at large and medium-sized hospitals had a shorter LOS ($\beta=-0.193$; $P<.01$; and $\beta=-0.149$; $P<.001$, respectively). Similarly, patients operated on by a colorectal surgeon had a shorter LOS ($\beta=-0.077$; $P<.001$).

As reported in **Table 5**, the multivariate model for surgical complications showed that traveling distance was not statistically different. Compared with open surgery, patients having minimally invasive surgery (MIS) had significantly lower odds of complication (OR, 0.76; 95% CI, 0.68-0.85). Patients receiving surgeries in teaching hospitals had higher odds of complication compared with those in nonteaching hospitals (OR, 1.43; 95% CI, 1.26-1.62). Patients with Medicaid (OR, 1.62; 95% CI, 1.24-2.11) or self-pay/no insurance (OR, 1.77; 95% CI, 1.34-2.35) had increased odds of complication. Similarly, female patients had reduced odds of complication compared with male patients (OR, 0.70; 95% CI, 0.63-0.78). Finally, the odds of complication significantly increased with a higher number of comorbidities.

The results of the sensitivity analysis to identify effect modifiers of the association between travel distance and LOS and between travel distance and complications are shown in **eAppendix Tables 1 and 2**. The effect modifiers of the association with LOS found in the analysis were Elixhauser score, payer group, and region of residence within Florida. Similarly, urbanization, obesity, and region of residence were identified to be effect modifiers of the association with complications. Stratified analysis revealed that within 1 or

TABLE 2. Multivariate Logistic Regression Model Predicting the Impact of Patient and Hospital Characteristics on Distant Travel (> 50 miles or 80.5 km) for Surgical Care in Florida

Effect	Odds ratio estimates		
	Odds ratio	95% Wald confidence limit	P
Sex: female vs male	0.842	0.678 1.046	.1207
Age	0.991	0.978 1.005	.1973
Black or African American vs White	0.287	0.181 0.455	<.0001
Hispanic or Latino vs White	0.132	0.085 0.204	<.0001
Elixhauser category: 1-2 vs 0	1.355	1.019 1.801	.0365
Elixhauser category: 3-5 vs 0	0.938	0.661 1.332	.7211
Elixhauser category: > 5 vs 0	0.598	0.270 1.325	.2054
Year: 2014 vs 2013	1.333	1.029 1.726	.0295
Year: 2015 vs 2013	1.401	1.068 1.837	.0147
Teaching vs nonteaching	9.994	6.981 14.31	<.0001
Medicaid vs commercial	0.747	0.442 1.261	.2749
Medicare vs commercial	1.484	1.026 2.148	.0362
Medicare managed care vs commercial	0.833	0.558 1.244	.3722
Other insurance vs commercial	1.257	0.746 2.119	.3897
Urban vs rural	0.020	0.013 0.031	<.0001
Obese: yes vs no	0.920	0.656 1.289	.6268
Metastasis: yes vs no	1.428	1.117 1.824	.0044
Central Florida vs North Florida	5.864	3.867 8.892	<.0001
South Florida vs North Florida	2.372	1.549 3.631	<.0001
Colorectal surgeon vs general surgeon	1.833	1.456 2.307	<.0001
Hospital size: large vs small	1.019	0.298 3.491	.9758
Hospital size: medium vs small	1.103	0.307 3.964	.8805
Hospital volume ^a	1.122	1.104 1.140	<.0001

^aOne unit of the continuous variable covariate "hospital volume" is 10 procedures.

more strata of the identified effect modifiers, the OR/estimates of each outcome were significantly different from each other.

DISCUSSION

Our study focused on understanding what types of hospitals patients choose, as well as the influence of travel distance to surgical facility on the LOS and the rate of complications in patients with colorectal cancer. We found that patients with colorectal cancer who traveled more than 50 miles to a surgical facility were seen in medium-sized, higher-volume teaching hospitals that had colorectal surgeons. In addition, we found that those traveling further stayed longer at the surgical facility compared with those who traveled less than 25 miles. However, there were no differences in the rates of complication between the different travel groups.

Patients residing in the central and southern parts of Florida were observed to travel farther for surgery. Similarly, patients residing in rural areas traveled farther than those in urban areas.

TABLE 3. Multivariate Logistic Regression Model Predicting the Factors Associated With the Hospitals Selected vs Bypassed by Patients With Colorectal Cancer

Odds ratio estimates				
Effect	Odds ratio	95% Wald confidence limit		P
Size: medium vs large	3.08	1.82	5.22	<.0001
Size: small vs large	3.55	0.98	12.80	.05
Volume category ^a : 1 (0-48) vs 4 (150-277)	0.02	0.01	0.03	<.0001
Volume category ^a : 2 (49-105) vs 4 (150-277)	0.07	0.04	0.11	<.0001
Volume category ^a : 3 (106-149) vs 4 (150-277)	0.37	0.25	0.53	<.0001
Teaching status: nonteaching vs teaching	0.08	0.06	0.12	<.0001
Surgeon type: colorectal surgeon vs general surgeon	3.02	2.21	4.12	<.0001

^aVolume categories 1, 2, 3, and 4 are created using quartile and range of distribution of hospital volume as measured by colorectal surgical procedures.

TABLE 4. Multivariate Linear Regression Model Predicting the Logarithmic Transformation of the Length of Stay at a Surgical Facility in Florida

Parameter	Estimate	Standard error	t value	P
Intercept	1.458	0.054	27.08	<.0001
Distance traveled: 25-50 miles vs <25 miles	0.000	0.021	0.01	.9932
Distance traveled: > 50 miles vs <25 miles	0.053	0.025	2.12	.0343
Sex: female vs male	-0.053	0.011	-4.93	<.0001
Age	0.003	0.001	4.22	<.0001
Black or African American vs White	0.044	0.019	2.30	.0213
Hispanic or Latino vs White	-0.097	0.016	-5.95	<.0001
Elixhauser category: 1-2 vs 0	0.109	0.015	7.13	<.0001
Elixhauser category: 3-5 vs 0	0.347	0.017	20.11	<.0001
Elixhauser category: >5 vs 0	0.648	0.031	20.91	<.0001
Year: 2014 vs 2013	-0.050	0.013	-3.97	<.0001
Year: 2015 vs 2013	-0.062	0.014	-4.56	<.0001
Medicaid vs commercial	0.150	0.028	5.32	<.0001
Medicare vs commercial	0.008	0.019	0.40	.6898
Medicare managed care vs commercial	-0.021	0.019	-1.07	.2849
Other insurance vs commercial	0.127	0.030	4.23	<.0001
Urban vs rural	-0.045	0.027	-1.67	.0943
Obese: yes vs no	0.029	0.016	1.80	.0723
Metastasis: yes vs no	0.136	0.014	10.01	<.0001
Central Florida vs North Florida	0.090	0.017	5.29	<.0001
South Florida vs North Florida	0.031	0.016	1.88	.0599
Colorectal surgeon vs general surgeon	-0.077	0.013	-6.17	<.0001
Hospital size: large vs small	-0.193	0.033	-5.91	<.0001
Hospital size: medium vs small	-0.149	0.035	-4.31	<.0001
Hospital volume ^a	0.003	0.001	3.88	.0001
Teaching vs nonteaching	0.083	0.012	6.81	<.0001

^aOne unit of the continuous variable covariate "hospital volume" is 10 procedures.

The discrepancies in travel distances to treatment may be attributable to centralization of care in the state of Florida.¹⁴ Further, this study found that patients who traveled more than 50 miles traveled to hospitals that had teaching status, had greater availability of a colorectal surgeon, and were medium-sized or high-volume centers. This finding is important because it helps identify the types of facilities that patients traveling farther are utilizing. It also provides opportunities to reduce travel time for patients by bolstering services in the hospitals that are closer to patients' residences but are frequently bypassed.

The association of increased LOS at a treatment facility following an elective surgery with travel distance demonstrated in this study is consistent with that found in a previous study by Jackson et al.¹⁵ One possible explanation for this association is the type of surgical approach (open vs MIS) selected as the most appropriate for the elective surgery. It has been documented previously that the mean LOS following minimally invasive colectomy is significantly shorter compared with open colectomy (6.2 vs 8.7 days, respectively; $P < .0001$).¹⁶ In the current study, comparatively more patients selected an open surgical approach in the group who traveled farther, possibly explaining the longer LOS found in this group. Longer LOS may also be explained, to some extent, by additional barriers to timely discharge for patients who have to travel significant distances after surgery to reach their residence. Physicians may delay the discharge to ensure that these patients meet the predischARGE requirements to avoid any adverse event during their long commute.¹⁷

Although significant discrepancies in the LOS were observed, our study did not find any significant difference in the rate of complications among the traveling groups. The underlying reason for no difference in the rate of complications, despite the worse metastatic status of the group that traveled farthest, is not well understood. One possible explanation could be the presence of inherent selection bias, as patients who traveled more than 50 miles for cancer care were younger and also had significantly lower comorbidity burden preoperatively. In a previous study, Etzioni et al found that patients who traveled lesser distance were at a lower risk of complication.¹⁸

Additionally, the risk of postsurgical complication is multifactorial. Patients' baseline risk of having a complication, coupled with their ability to afford care to prevent the development of postoperative complications, should be taken into account when comparing the rate of complications between the travel groups.¹⁸ Further, the finding of higher rates of complications at teaching facilities should be interpreted with caution, as there were more patients at later stages of colorectal cancer traveling to these hospitals. The number of patients with colorectal cancer with metastasis was significantly higher in those who traveled more than 50 miles, which may indicate that these patients experienced a delayed diagnosis of colorectal cancer due to their distance from regional care centers and lack of easy access to colorectal cancer screening facilities.¹⁹

From a managed care perspective, patients with more advanced disease are usually best managed at tertiary centers.²⁰ These facilities can provide care by more specialized professionals such as colorectal surgeons, and this is reflected in our analysis of characteristics of patients traveling further to receive care. However, in many cases, these patients are first seen in lower-volume hospitals and only subsequently referred to tertiary centers, which may lead to a delay in the definitive treatment that can potentially affect survival.^{21,22} Previous inquiry has identified colorectal surgical volume as an important consideration for valued outcomes, including procedural time, lower hospitalization cost, and shorter LOS.²³ As such, the findings of the current study provide additional support toward provision of care for patients requiring colorectal surgery at higher-volume centers, as well as by colorectal surgeons. However, unlike previous studies, we found an increased LOS, which could increase financial costs, although this association may be due to procedural selections associated with caring for more advanced cancer stages. Although it is likely that better management of patients seeking colorectal cancer care could improve LOS, additional inquiry into assessing more granular data regarding patient LOS is warranted. Future efforts to improve the quality of patient outcomes in colorectal cancer should also focus on implementation of preventive care services that are better geographically distributed and accessible to diverse populations living in areas with a shortage of health care services.

Limitations

This study has several limitations. Because the study was conducted using a discharge database, clinical information such as stage of cancer, blood loss, and operating time was not available. These factors could potentially be confounders of the association of travel distance with LOS or complications, but they could not be adjusted for in the multivariate regression models. The discharge database provided information based on a single admission and could not take into account complications that the patients might have experienced after discharge. We measured the distance from patient's primary residence to surgical facility using zip code centroids under the assumption that all the patients used personal modes of transportation. In addition, although zip codes provide a fairly accurate point of measurement, the size of the zip code and

TABLE 5. Multivariate Logistic Regression Model Predicting the Odds of Having a Complication in Patients With Colorectal Cancer in Florida

Effect	Odds ratio estimates			P
	Odds ratio	95% Wald confidence limits		
Distance traveled: 25-50 miles vs < 25 miles	0.942	0.763	1.162	.5766
Distance traveled: > 50 miles vs < 25 miles	0.910	0.712	1.163	.4516
Sex: female vs male	0.698	0.625	0.779	<.0001
Age	1.002	0.995	1.009	.5525
Black or African American vs White	1.031	0.857	1.241	.7450
Hispanic or Latino vs White	0.827	0.698	0.980	.0280
Elixhauser category: 1-2 vs 0	1.461	1.225	1.741	<.0001
Elixhauser category: 3-5 vs 0	2.609	2.164	3.146	<.0001
Elixhauser category: > 5 vs 0	3.739	2.815	4.967	<.0001
Year: 2014 vs 2013	0.845	0.745	0.958	.0087
Year: 2015 vs 2013	0.814	0.709	0.934	.0033
Medicaid vs commercial	1.620	1.242	2.111	.0004
Medicare vs commercial	1.171	0.964	1.421	.1112
Medicare managed care vs commercial	1.205	0.992	1.464	.0599
Other insurance vs commercial	1.773	1.339	2.346	<.0001
Urban vs rural	0.842	0.650	1.090	.1917
Obese: yes vs no	0.998	0.851	1.169	.9753
Metastasis: yes vs no	1.120	0.980	1.279	.0963
Central Florida vs North Florida	1.206	1.015	1.432	.0334
South Florida vs North Florida	1.081	0.914	1.278	.3624
Colorectal surgeon vs general surgeon	1.006	0.887	1.141	.9306
Hospital size: large vs small	0.557	0.411	0.755	.0002
Hospital size: medium vs small	0.731	0.529	1.010	.0578
Hospital volume ^a	1.010	1.001	1.019	.0227
Teaching vs nonteaching	1.429	1.262	1.618	<.0001
Minimally invasive vs open	0.762	0.682	0.850	<.0001

^aOne unit of the continuous variable covariate "hospital volume" is 10 procedures.

the patient's location within it are not accurately established nor adjusted for, which can either over- or underestimate distances to facilities. Our study also failed to adjust the travel distance for patients who used public transport, which may result in longer transportation times or other barriers to seeking care at facilities further away from their home.

CONCLUSIONS

We found that patients with colorectal cancer who traveled more than 50 miles to a surgical facility were more likely to be seen in medium-sized, higher-volume teaching hospitals that had colorectal surgeons. Additionally, patients with more advanced disease tended to travel more to receive treatment at a specialized

center. We also found that those traveling more than 50 miles stayed longer at the surgical facility compared with those who traveled less than 25 miles to surgery. The current study, however, did not find any significant difference in the rates of complication among the different travel groups. Ultimately, the findings in this study may imply specialty regionalization in the state of Florida and a potential lack of preventive care services in areas distant from regional centers. ■

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eAppendix Table 1. Adjusted estimates and standard errors for the associations of ‘travel’ with ‘log of length of stay’, stratified by selected covariates.

	Association between travel>50 miles vs <25 miles and LOS		Association between travel>25-<50 miles vs >25 miles and LOS		p value
	Estimates	Standard error	Estimates	Standard error	
Elixhauser Score					0.0025
0	0.03	0.05	-0.03	0.04	
1-2	-0.02	0.03	0.04	0.03	
3-5	0.13	0.06	-0.02	0.04	
More than 5	0.05	0.23	-0.36	0.17	
Payer					0.0220
Medicare	-0.03	0.04	-0.02	0.03	
Medicare Managed Care	0.12	0.06	0.02	0.05	
Medicaid	0.27	0.14	-0.07	0.11	
Commercial	-0.02	0.04	0.02	0.03	
Other	0.09	0.11	0.05	0.11	
Patients Region					0.0176
South Florida	0.14	0.04	0.00	0.03	
North Florida	-0.07	0.06	-0.02	0.04	
Central Florida	-0.06	0.04	0.01	0.04	

Footnotes: Data are presented as estimates and standard error, unless otherwise stated. Models adjusted for sex, age, race, year, payer (except for stratified analyses by payer), patient region (except for stratified analyses by patient region), Elixhauser Score (except for stratified analyses by Elixhauser category), urbanization, obese, metastasis, type of surgeon, number of patient beds, type of surgery, teaching status of the hospital, volume of patients at the hospital.

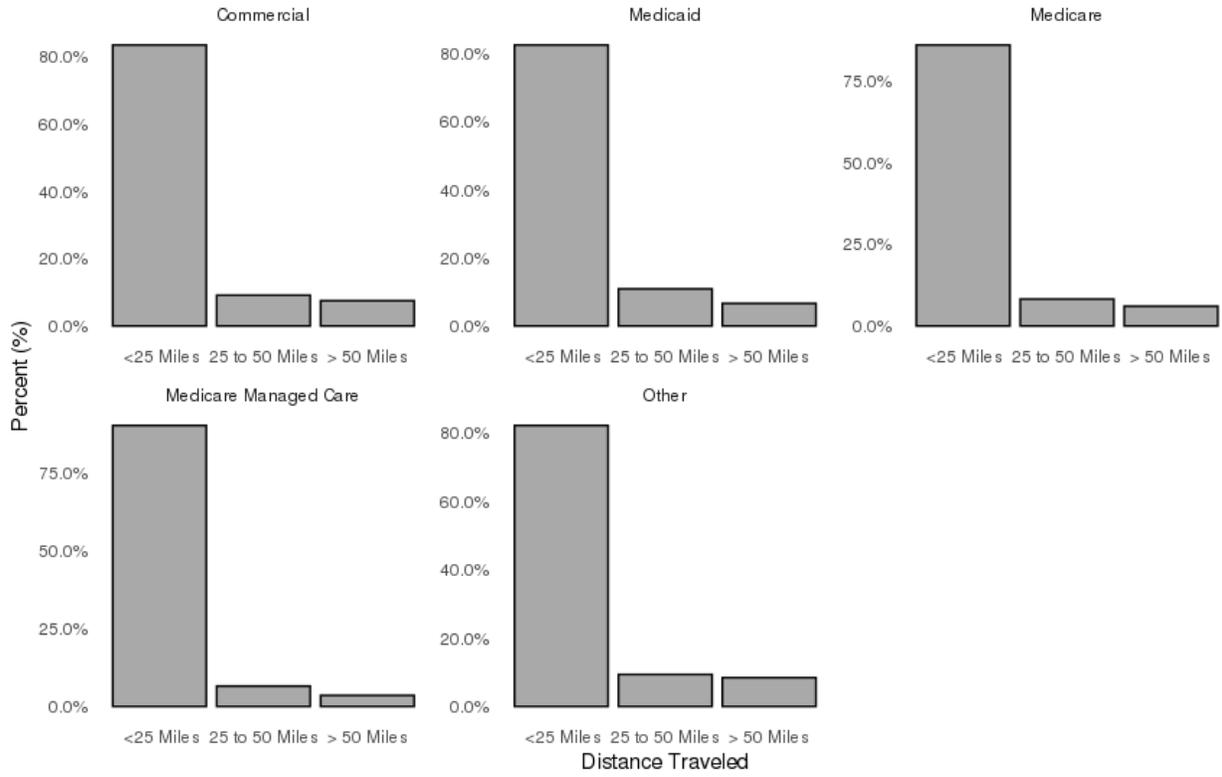
eAppendix Table 2. Adjusted estimates and 95% confidence intervals for the associations of ‘Travel’ and ‘Complications, stratified by selected covariates.

	Association between travel>50 miles vs <25 miles and complications	Association between travel>25-<50 miles vs >25 miles and complications	Joint test
	Odds Ratio (Confidence Interval)	Odds Ratio (Confidence Interval)	p value for effect modification
Urbanization			0.0448
Rural	2.49 (1.11, 5.60)	1.67 (0.86, 3.23)	
Urban	0.85 (0.65, 1.11)	0.98 (0.78, 1.23)	
Obesity			0.0368
Obese	0.87 (0.43, 1.76)	1.63 (1.01, 2.64)	
Non-obese	0.96 (0.74, 1.25)	0.85 (0.67, 1.08)	
Patients Region			0.0457
South Florida	1.20 (0.82, 1.75)	0.83 (0.59, 1.15)	
North Florida	0.84 (0.42, 1.66)	1.00 (0.66, 1.52)	
Central Florida	0.98 (0.65, 1.49)	1.28 (0.88, 1.87)	

Footnotes: Data are presented as Odds Ratio (Confidence Interval), unless otherwise stated.

Models adjusted for sex, age, race, year, urbanization (except for stratified analyses by urbanization), patient region (except for stratified analyses by patient region), obesity (except for stratified analyses by obesity), Elixhauser score, payer type, urbanization, obese, metastasis, type of surgeon, number of patient beds, type of surgery, teaching status of the hospital, volume of patients at the hospital.

eAppendix Figure. Percent of colorectal cancer patients traveling to surgical facility by different payer groups.



This figure shows the proportion of patients in each insurance group travelling <25 miles, 25-50 miles and >50 miles to treatment facility.