

National disparities in laparoscopic colorectal procedures for colon cancer

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Abstract

Introduction Racial disparity in the treatment of colorectal cancer (CRC) has been cited as a potential cause for differences in mortality. This study compares the rates of laparoscopy according to race, insurance status, geographic location, and hospital size.

Methods The 2009 Healthcare Cost and Utilization Project: Nationwide Inpatient Sample (HCUP-NIS) database was queried to identify patients with the diagnosis of CRC by the International Classification of Diseases, Ninth Revision (ICD-9) codes. Multivariate logistic regression was performed to look at age, gender, insurance coverage, academic versus nonacademic affiliated institutions, rural versus urban settings, location, and proportional differences in laparoscopic procedures according to race.

Results A total of 14,502 patients were identified; 4,691 (32.35 %) underwent laparoscopic colorectal procedures and 9,811 (67.65 %) underwent open procedures. The proportion of laparoscopic procedures did not differ significantly by race: Caucasian 32.4 %, African-American

30.04 %, Hispanic 33.99 %, and Asian-Pacific Islander 35.12 ($P = 0.08$). Among Caucasian and African-American patients, those covered by private insurers were more likely to undergo laparoscopic procedures compared to other insurance types ($P \leq 0.001$). The odds of receiving laparoscopic procedure at teaching hospitals was 1.39 times greater than in nonteaching hospitals (95 % confidence interval [CI] 1.29–1.48) and did not differ across race groups. Patients in urban hospitals demonstrated higher odds of laparoscopic surgery (2.24, 95 % CI 1.96–2.56) than in rural hospitals; this relationship was consistent within races. The odds of undergoing laparoscopic surgeries was lowest in the Midwest region (0.89, 95 % CI 0.81–0.97) but higher in the Southern region (1.14, 95 % CI 1.06–1.22) compared with the other regions.

Conclusions Nearly one-third of all CRC surgeries are laparoscopic. Race does not appear to play a significant role in the selection of a laparoscopic CRC operation. However, there are significant differences in the selection of laparoscopy for CRC patients based on insurance status, geographic location, and hospital type.

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Despite the availability of health insurance to elderly and low-income Americans by Medicare and Medicaid in 1965, racial disparities persist in the use of preventive and life-saving health services [1]. Berry et al. [2] examined the racial disparities in colorectal cancer care in the United States and found treatment disparities among races. African-American colorectal cancer patients had lower rates of tumor resection [3–7], chemotherapy, and radiotherapy utilization [5, 8]. These racial disparities existed even in the use of colorectal diagnostic procedures [9]. The end result of such disparity is reflected on survival rates, as survival in Caucasian colorectal cancer patients is prolonged compared with African-American patients [10–17]. However, no differences in treatment outcomes were identified if patients with different racial background received the same treatment [18, 19]. Poverty, low level of education, and lack of access to screening and treatment are all factors that contribute to the increased mortality among African-American cancer patients [15, 17, 20].

The trend toward performing laparoscopic colorectal procedures has increased during the past 10 years [21]. This has been attributed to both the improvement of laparoscopic surgeons' skills and advances in the technical equipment [22, 23]. Laparoscopic surgery has been associated with enhanced short-term outcomes compared with open procedures [24, 25]. Reduction of postoperative pain [25–27], length of stay, and early mobilization all have been cited as benefits of a laparoscopic surgical colorectal procedure compared with an open approach [21, 28].

The primary objective of the study was to demonstrate how a patient's racial status affects the rates of laparoscopic colorectal procedures performed throughout the country.

Methods

A cross-sectional study was conducted using data from the NIS (Nationwide Inpatient Sample) of 2009, which represents a 20 % sample of United States community hospitals containing data from approximately 8 million hospital stays located in 44 states [29]. The NIS includes data elements for diagnostic and procedural data, admission and discharge status, patient demographics and payment sources, and hospital characteristics [29]. The Johns Hopkins Medical Institutions Institutional Review Board approved the use of NIS data for this study.

All patients diagnosed primarily with colorectal cancer who underwent either laparoscopic or open colorectal procedures were included in the study. They were defined

using the International Classification of Diseases, Ninth Revision (ICD-9) codes, which provide codes for dichotomous, all-or-none, variables. The specific (ICD-9) diagnosis codes used for colorectal cancer were 153.0–154.8, 230.3–230.6, and 209.1–209.17. The specific (ICD-9) procedure codes used for open colorectal cancer procedure were 48.52, 48.43, 45.71–79, and 45.82, whereas those used for laparoscopic procedures were 17.31–39, 45.81, 48.42, and 48.51.

The differences in laparoscopic surgical rates between races among colorectal cancer patients were calculated. Gender, age, hospital types in regards to teaching status, settings (rural versus urban), hospital region, and insurance coverage were tested as factors that may contribute to the surgical rate differences between race. Race was grouped as Caucasian, African-American, Hispanic, and Asian. Other races, including those patients not identified with a race were excluded from the analysis. Information of payment methods was aggregated into five categories: Medicare, Medicaid, private, noninsured (which included self-pay and no charge), and others.

Data were available for age, race, gender, and payment methods through data elements in the NIS Inpatient Core File. Adding hospital characteristic variables from data elements in the NIS Hospital Weights File to the core file allowed us to obtain data in a hospital setting, teaching status, and size.

Statistical analysis

All covariates considered in the study were treated as categorical variables. Using Stata 11 software to perform the analysis, χ^2 test was used to explore the data and test for statistically significant results between races. A *t* test was used to calculate the mean and the standard deviation of the age variable before dividing it into categories and was treated as a categorical variable. The differences between races regarding colorectal cancer stage, Charlson comorbidity score, age, gender, and payment methods were adjusted for using propensity score analysis. Later, multivariate logistic regression was used to calculate the adjusted odd ratios for other study covariates. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

Results

There were 14,502 colorectal cancer resections reported in the NIS data of 2009 that were included in the study; 4,691 (32.35 %) underwent laparoscopic colorectal procedures and 9,811 (67.65 %) underwent open resections. The rate of laparoscopic colorectal cancer procedures was greater

among admissions for stage I disease 112 (53.85 %) compared with 3,453 (36.12 %), 678 (30.57 %), and 448 (17.81 %) of colorectal cancer admissions on stage II, III, and IV, respectively ($P \leq 0.001$). Medicare and private insurance payers dominated in all racial groups, (Table 1; Fig. 1). Laparoscopic colorectal resections were performed in 32.4 % of Caucasians, 30.04 % of African-Americans, 33.99 % of Hispanic, and 35.12 % of Asian/Pacific colorectal cancer admissions ($P \leq 0.08$).

In total, 2,326 (32.56 %) males underwent laparoscopic colorectal procedures compared with 2,365 (32.14 %) female patients ($P = 0.592$). The odds of undergoing laparoscopic resection among females was 0.02 % less than that among males (95 % confidence interval [CI] 0.914–1.05; $P = 0.56$). The rates of performing laparoscopic surgeries did not differ between races when stratifying by gender.

Payment methods influenced the rates of performing laparoscopic colorectal surgeries. Medicare and private payment methods constituted the major source of payment in our study. Patients with these insurance plans had the highest rates of laparoscopic colorectal resection performed; 2,679 (31.26 %) and 1,683 (37.36 %), respectively. On the other hand, noninsured patients had the lowest rate of laparoscopic resections, 88 (20.14 %), whereas Medicaid admissions were documented between the other groups with 150 patients (22.19 %) undergoing laparoscopic resections. The odds of undergoing laparoscopic resection in each insurance type compared with Medicare were 0.57 (95 % CI 0.471–0.686, $P \leq 0.001$), 1.53 (95 % CI 1.399–1.663, $P \leq 0.001$), and 0.47 (95 % CI 0.369–0.605, $P \leq 0.001$) among patients covered with Medicaid, private, and noninsured patients, respectively. When stratifying the rates of laparoscopic colorectal surgical procedures in different racial groups by insurance types, Medicare insurance group showed statistically significant disparities among races ($P \leq 0.001$); African-American colorectal cancer admissions had the lowest rates of performing colorectal laparoscopic procedures (28.85 %), whereas other insurance groups did not show statistical significant differences between races. However, when stratifying by race, it appeared that all races, except Asian/Pacific group, showed differences in the rate of performing laparoscopic colorectal procedure between different insurance types. Caucasian and African-American colorectal cancer admissions covered by private insurances were more likely to get laparoscopic colorectal surgery performed compared with other types of insurance coverage ($P \leq 0.001$). Hispanic patients underwent more laparoscopic colorectal procedures performed if they were covered by Medicare or private insurances ($P \leq 0.001$; Table 2).

Table 1 Demographic characteristics of colorectal cancer admissions that underwent either laparoscopic or open colorectal procedure

Characteristic	Number of admissions (%)
<i>Race</i>	
Caucasian	11,403 (78.63)
African-American	1,578 (10.88)
Hispanic	1,074 (7.41)
Asian/Pacific	447 (3.08)
<i>Gender</i>	
Male	7,144 (49.26)
Female	7,358 (50.74)
<i>Type of insurance</i>	
Medicare	8,569 (59.2)
Medicaid	676 (4.67)
Private	4,505 (31.12)
Non-insured	437 (3.02)
Others	287 (1.98)
<i>Hospital teaching status</i>	
Nonteaching	7,758 (54.39)
Teaching	6,505 (45.61)
<i>Age category (year)^a</i>	
≤40	358 (2.47)
(41–50)	1,094 (7.54)
(51–60)	2,464 (16.99)
(61–70)	3,513 (24.22)
(71–80)	3,906 (26.93)
(81–90)	2,844 (19.61)
>90	323 (2.23)
<i>Stage</i>	
I	208 (1.43)
II	9,560 (65.92)
III	2,218 (15.29)
IV	2,516 (17.35)
<i>Surgery</i>	
Open	9,811 (67.65)
Laparoscopic	4,691 (32.35)
<i>Hospital region</i>	
Northeast	3,069 (21.16)
Midwest	2,709 (18.68)
South	5,567 (38.39)
West	3,157 (21.77)
<i>Hospital settings</i>	
Rural	1,548 (10.85)
Urban	12,715 (89.15)
<i>Admission type</i>	
Emergency	4,235 (33.64)
Elective	8,353 (66.35)

^a Mean age was 68.68, SD \pm 13.48, and the median was 70 (range 59–79)

Fig. 1 The proportion of different insurance type coverage in each racial group of colorectal cancer admissions. The differences in insurance types coverage between races was significant, $P \leq 0.001$

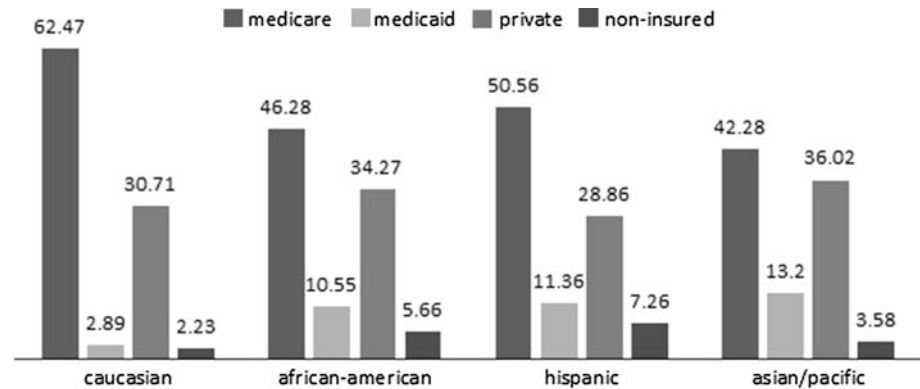


Table 2 Laparoscopic procedures rates among different races of colorectal cancer admissions and payment methods

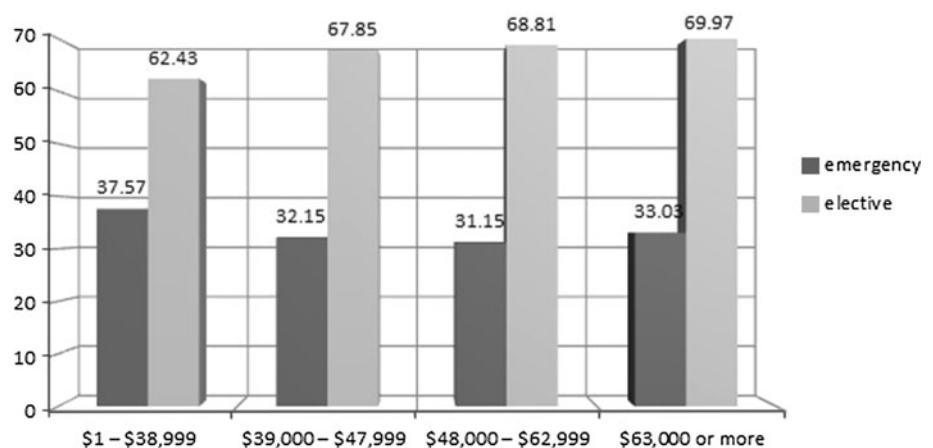
Race/Insurance type	Medicare	Medicaid	Private	Noninsured	Others	P value ^b
Caucasian	2,190 (30.81)	82 (24.92)	1,307 (37.4)	52 (20.47)	61 (31.61)	≤ 0.001
African-American	210 (28.85)	29 (17.47)	199 (36.92)	18 (20.22)	17 (33.33)	≤ 0.001
Hispanic	209 (38.49)	25 (20.49)	116 (37.42)	13 (16.67)	2 (9.52)	≤ 0.001
Asian/Pacific	70 (37.04)	14 (23.73)	61 (37.89)	5 (31.25)	7 (31.82)	0.353
P value ^a	≤ 0.001	0.278	0.996	0.608	0.196	

Data are numbers with percentages in parentheses unless otherwise specified

^a P value of the difference in Laparoscopic procedures rates between racial groups of colorectal cancer admissions when stratified by payment method

^b P value of the difference in Laparoscopic procedures rates between different payment method covering colorectal cancer admissions when stratified by race

Fig. 2 The proportion of emergency versus elective admissions per each median household income, $P \leq 0.001$



The odds of undergoing laparoscopic procedure in colorectal cancer patients was increasing based on median household income. As seen in Fig. 2, NIS database divided median household income into quartiles. Compared with the poorest quartile, median income $< \$39,000$; the odd ratios of undergoing laparoscopic procedure for colon cancer were 0.88 (95 % CI 0.814–0.96, $P = 0.003$), 1.25 (95 % CI 1.15–1.35, $P \leq 0.001$), and 1.39 (95 % CI 1.28–1.5, $P \leq 0.001$) if median income was $\$39,000$ – $\$47,999$, $\$48,000$ – $\$62,999$, and $\geq \$63,000$, respectively.

There were 8,353 (66.35 %) elective admissions in the study and 4,235 (33.64 %) emergency admissions. The laparoscopic procedures constituted 3,233 (38.7 %) of colorectal procedures performed on elective admissions, and 850 (20.07 %) of procedures performed on emergency admissions ($P \leq 0.001$). Elective admissions were higher among colorectal cancer patients of medium and high median household income (69 and 70 %, respectively, $P \leq 0.001$; Fig. 2). They also constituted higher percentages of admission-type among colorectal cancer patients

Fig. 3 The proportion of elective versus emergency admission per each insurance type, $P \leq 0.001$

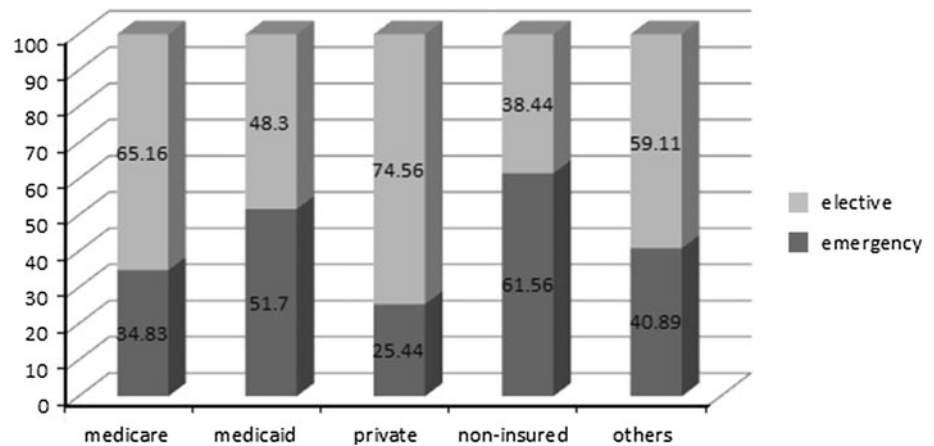


Table 3 Independent predictors of undergoing laparoscopic resection

Variable	Odds ratio ^a	95 % CI	<i>P</i> value
<i>Admission type</i>			
Emergency	1.0		
Elective	2.03	1.888–2.187	≤ 0.001
<i>Hospital type</i>			
Rural	1.0		
Urban	2.24	1.959–2.555	≤ 0.001
<i>Hospital teaching status</i>			
Nonteaching	1.0		
Teaching	1.39	1.292–1.488	≤ 0.001
<i>Hospital region</i>			
Northeast	1.0		
Midwest	0.89	0.812–0.973	0.011
South	1.14	1.059–1.221	≤ 0.001
West	0.93	0.852–1.01	0.084

^a Odds ratios are adjusted age, stage, Charlson comorbidity index, gender, insurance type

covered by Medicare and private insurers (65 and 74.56 %, respectively, $P \leq 0.001$). Emergency admissions dominated admissions covered by Medicaid and those that were not insured (Fig. 3).

Laparoscopic colorectal surgery was performed to a greater extent in urban hospitals compared with rural ones (4,337 (34.11 %) vs. 291 (18.8 %) respectively, $P \leq 0.001$). The adjusted odds of undergoing laparoscopic colorectal procedures performed in urban hospitals was 2.24 compared with rural hospitals (95 % CI 1.959–2.555, $P \leq 0.001$; Table 3). Similarly, when examining each race group, patients in urban hospitals have double the odds of undergoing a laparoscopic colorectal procedure compared with admissions in rural hospitals (Table 4). However, analysis did not show racial discrepancies in the rates of laparoscopic surgery between urban and rural patients.

Laparoscopic colorectal procedures were proportionally more common among colorectal cancer patients treated in teaching hospitals compared with those treated in nonteaching hospitals (36.33 vs. 29.2 %, $P \leq 0.001$). However, no racial discrepancies were found between colorectal cancer patients treated in teaching hospitals. The adjusted odds of undergoing colorectal cancer procedure in teaching hospitals increased by approximately 37 % compared with the odds in nonteaching hospital in all race groups (95 % CI 28–47 %, $P \leq 0.001$). Urban hospitals were more prevalent than rural hospitals in regions (89.15 vs. 10.85 %) in the northeast (84.45 vs. 15.55 %), in the midwest (88.9 vs. 11.1 %), in the south (93.5 vs. 6.5 %), and in the west ($P \leq 0.001$). However, the distribution of teaching hospitals was greater in the northeastern region (59.82 vs. 40.18 %) and in the midwestern region (50.72 vs. 49.28 %), whereas southern and western regions had a higher proportion of nonteaching hospitals: (56.7 vs. 43.3 %) and (68.57 vs. 31.43 %), respectively ($P \leq 0.001$).

Laparoscopic surgeries occurred at a greater rate in the southern region of United States. The rate was 1.898 (34.09 %) compared with 993 (32.36 %), 818 (30.2 %), and 982 (31.11 %) in northeast, midwest, and western regions, respectively ($P = 0.001$). Racial discrepancies in patients undergoing laparoscopic resection were found among colorectal cancer patients treated in the southern and western regions. In the southern region, rates were more among Hispanic patients 221 (43.68 %) compared with Caucasian, African-American, and Asian/Pacific patients: 1,404 (33.86), 256 (29.98 %), and 17 (28.33 %), respectively ($P \leq 0.001$). In the western region, laparoscopic rates were more among Asian/Pacific (114; 35.74 %) compared with Caucasian, African-American, and Hispanics: 737 (31.46 %), 55 (35.48 %), and 76 (22.35 %), respectively ($P = 0.001$). The adjusted odds of undergoing colorectal cancer procedure were highly variable between different regions of the United States. Odds decreased significantly, by 12 %, if treatment was received

Table 4 Odds of laparoscopic surgery with different study variables among colorectal cancer admissions in each race group

Variable/Race	Caucasian ^a Odds ratio; <i>P</i> value (95 % CI)	African-American ^b Odds ratio; <i>P</i> value (95 % CI)	Hispanic ^c Odds ratio; <i>P</i> value (95 % CI)	Asian/Pacific ^d Odds ratio; <i>P</i> value (95 % CI)
<i>Teaching status of the hospital</i>				
Teaching hospital versus nonteaching	1.372; ≤0.001 (1.278–1.473)	1.379; ≤0.001 (1.285–1.481)	1.372; ≤0.001 (1.278–1.473)	1.369; ≤0.001 (1.275–1.469)
<i>Type of hospital</i>				
Urban hospital versus rural	2.252; ≤0.001 (1.969–2.574)	2.256; ≤0.001 (1.974–2.578)	2.233; ≤0.001 (1.954–2.551)	2.232; ≤0.001 (1.953–2.55)
<i>Hospital location</i>				
Midwest vs. northeast	0.874; 0.004 (0.798–0.958)	0.876; 0.004 (0.799–0.959)	0.879; 0.006 (0.803–0.964)	0.879; 0.006 (0.802–0.963)
South versus northeast	1.15; ≤0.001 (1.07–1.236)	1.159; ≤0.001 (1.079–1.246)	1.146; ≤0.001 (1.067–1.232)	1.155; ≤0.001 (1.0747–1.242)
West versus northeast	0.925; 0.072 (0.849–1.007)	0.915; 0.042 (0.839–0.997)	0.921; 0.058 (0.845–1.003)	0.909; 0.033 (0.833–0.992)

^a Odds ratios in this column are adjusted for age, stage, Charlson comorbidity index, gender, insurance type, and Caucasian race using the propensity score

^b Odds ratios in this column are adjusted for age, stage, Charlson comorbidity index, gender, insurance type and African-American race using the propensity score

^c Odds ratios in this column are adjusted for age, stage, Charlson comorbidity index, gender, insurance type, and Hispanic race using the propensity score

^d Odds ratios in this column are adjusted for age, stage, Charlson comorbidity index, gender, insurance type, and Asian/Pacific race using the propensity score

in a hospital located in the midwest region compared with other regions, (95 % CI 4–20 %, $P = 0.004$), whereas they increased if treatment was received in the southern region by 14 % (95 % CI 6–23 %, $P \leq 0.001$).

Discussion

Surgical care disparities among colorectal cancer patients can be attributed to disease characteristics, such as stage and accompanying comorbidities, patients' demographic factors, such as age, gender, insurance status, and the factors related to the health system, such as hospital settings, hospital teaching status and location, and physician training. In the current study, determining the effect of race in the rate of laparoscopic procedures performed on colorectal cancer patients was our primary objective. Many of the previously mentioned variables were adjusted for. Unfortunately, the NIS database cannot show data related to physicians experience or laparoscopic skills. Performing a literature review, Blase et al. [4] summarized the differences between African-Americans and Caucasians colorectal cancer patients in terms of demography, biological behavior, diagnosing and treating cancer, and

mortality rates. They also identified studies that examined how the characteristics of treatment providers can affect surgical outcome. Surgical experience was one of the factors that affected outcome. Harmon et al. [30] divided surgeons into low, medium, and high case-volume groups. They found that mortality was reduced significantly in the high-volume surgeon group that was different and independent of hospital volume categories. However, race was not an independent factor in determining mortality. Many studies, including randomized control trials, have shown that laparoscopic procedures equivalent or superior to standard open procedures performed for colon cancer. This equivalence, however, is seen after surgeons have ascended the laparoscopic learning curve [31–35]. Interestingly, to our knowledge no studies have ever examined how surgeon demographics, such as race, have influenced the type of procedure offered to patients.

A study examining colonic cancer resection from 1981 to 1986 the Department of Veterans Affairs hospital system demonstrated that African-American patients had a lower rate of resection compared with Caucasians [3]. This finding confirmed that of others [5–7] arising interest as to why these racial discrepancies exist. Blase et al. [4] demonstrated that African-American patients have a lower rate

of resection and were more likely to be treated in high-volume centers compared with Caucasians. They also found that colorectal cancer treatment is offered similarly to both races but accepted differently; African-American patients are more likely to refuse standard surgical treatment. However, more recent studies using NIS patient population data bases between 1998 and 2004 demonstrated different results regarding the impact of race on colorectal surgical treatment [36–38]. Steele et al. [36] utilized 2003–2004 NIS databases to examine factors that affected the types of colon resection procedure performed on colorectal cancer patients who were admitted electively. They identified 98,923 admissions eligible for review and found that race was not a predictive variable for colorectal surgery. Similarly, Guller et al. [38] compared the effectiveness of laparoscopic sigmoidal resection with open resection in the treatment of diverticulitis and found that race was not a deterrent factor for providing the laparoscopic technique. In contrast, Kemp et al. [37] using the NIS database, found a racial impact in providing surgical care.

Our study was designed to determine the affect of race and insurance status on the use of laparoscopic surgery for resection of colorectal cancer in a large national wide patient sample. After adjusting for age, stage, Charlson comorbidity index, gender, and insurance type, race was not significantly associated with undergoing a laparoscopic resection compared with an open resection in the study group with colorectal cancer. However, when examining differences based on insurance status, significant disparities were found with patients who were not insured or who were covered by Medicaid being significantly less likely to undergo laparoscopic treatment compared with those who were covered by private insurance or Medicare. We utilized the 2009 NIS database which contains greater accuracy of coding for laparoscopic procedures compared with earlier NIS databases.

Insurance plays an important role in many health care outcomes. Card et al. [39] studied Medicare as an example for a nearly universal insurance coverage system, as all patients older than 65 years are eligible for Medicare coverage. They concluded that access to medical care disparities was reduced but had no direct impact on mortality rates. The annual doctor visits and routine checkups, and some elective procedures, such as knee replacement and bypass surgeries, were increased. However, the rise in the elective admissions and procedures were larger in Caucasian patients than African-Americans or Hispanics. In the current study, among colorectal cancer patients who were covered by Medicare, African-Americans still had the lowest rates of laparoscopic procedures. This may predict that a universal insurance coverage program may not solve the disparities seen in colorectal cancer surgical care, or

even surgical care in general. Significant negative disparities in the rate of laparoscopic procedures were found in those patients who were not insured or who were covered by Medicaid. Similar findings were documented by Steele et al. [36] who also identified private insurance as a predictor of undergoing a laparoscopic colon resection. However, private and Medicare had higher rates of laparoscopic procedures compared with other insurance coverage plans.

The impact of median household income was evident in the study. The laparoscopic procedures rates of colorectal cancer increased by the median income. We found that a colorectal cancer patient whose income was \geq \$39,000 per year had a greater chance of undergoing laparoscopic procedure than a patient with lower median income. Similar findings have been reported in the literature [36]. This phenomenon may be explained by greater access to health care facilities and maintenance health care procedures, such as screening colonoscopy, in those patients with incomes $>$ \$39,000, thereby, allowing for earlier detection of cancers and elective resection.

Guller et al. [38] found that elective admission was a predictive of laparoscopic sigmoid resection. Emergent resections of colorectal cancers are often performed for colonic obstruction or perforation at the tumor site or other locations of the colon. Both factors are relative contraindications for proceeding with a laparoscopic approach [40]. However, in this study, laparoscopic colorectal procedures were more common among patients admitted electively compared with those admitted on an emergent basis. Elective admission increased the odds of undergoing colorectal cancer laparoscopic procedures twice. Elective admissions among colorectal cancer patients covered by Medicare and private constituted more than two-thirds of the admissions, whereas two-thirds of the admissions for noninsured patients were emergency admissions. This may explain the discrepancy in the rates of laparoscopic procedures between different insurance plans as higher proportion of elective admissions in the Medicare and private insurers groups were found compared to those patients with Medicaid plan or noninsured patients. The higher rate of elective admissions also was seen in wealthy patients. This may account for the higher laparoscopic colorectal procedure rate in wealthy individuals compared with those grouped in the low median household income bracket. In essence, higher elective admissions were observed among colorectal cancer patients whose median household income was \geq \$39,000. One may speculate that with the coming universal health coverage in the United States, there will be a greater percentage of elective colon resections performed for colon cancer, and based on our data, a higher percentage of laparoscopic procedures will be performed.

Performing colorectal surgery in a teaching hospital increased the odds of undergoing a laparoscopic resection in a significant number of patients of all race groups in our analysis as well as performing surgery in an urban hospital location. Kemp et al. [37] showed similar results when measuring laparoscopic rates among the electively admitted patients. In contrast to our findings, Robinson et al. [41] examined the trend and outcome of minimal invasive procedures performed for colon cancer using NIS database from 2005 to 2007 and found that hospital teaching status was not a determinant factor for patients undergoing a laparoscopic procedures. However, they also documented an increased likelihood of undergoing a laparoscopic procedure in an urban location compared with the rural hospitals [41]. Laparoscopic colorectal resections often require two skilled laparoscopic surgeons to facilitate completing the procedure. The availability of a skilled assistant may be more prevalent in urban settings with the availability of more surgeons. Teaching hospitals, with the institution of the fundamentals of laparoscopic surgery requirements in general surgery training programs, also may have a larger pool of trained laparoscopic assistants to help with these resections be they senior residents or fellows.

The geographic differences in the rates of performing laparoscopic colorectal procedures were evident. We found that treatment in the southern regions of the United States increased the odds of undergoing laparoscopic procedures significantly. Conversely, patients in the midwest regions were less likely to undergo laparoscopic procedures. In trying to identify reasons for this discrepancy we examined the distribution of teaching and urban hospital in different regions of United States as found in the 2009 NIS database. Although there were more urban hospitals than rural ones in all the geographic regions, there were more teaching hospitals in the midwest region than nonteaching hospitals, whereas the southern region contained less teaching facilities. It appeared that patients in the southern region are more likely to undergo a laparoscopic colorectal procedure despite hospital teaching status. Others have documented a higher rate of laparoscopic procedures in the midwestern and western regions, which contrasts with our findings [36].

Some limitations are associated with this cross-sectional observational study using administrative data. The NIS database is discharge specific and does not allow long-term follow-up at the patient level and does not include information on surgeon experience. ICD-9-CM diagnostic and procedure codes were used to identify disorders and procedures examined in the study and to create the Charlson comorbidity index. The possibility of miscoding exists. Therefore, in order to have the findings of this study be comparable with current literature, we attempted to define our population and outcomes using methods and ICD-9-

CM codes that have been identified in other studies using NIS data base [37, 38].

Conclusions

In our nationally representative study sample, racial disparities in the likelihood of undergoing laparoscopic versus open interventions were not found. However, patients covered by private insurance or Medicare who underwent surgery for colorectal cancer were more likely to have had their procedure done laparoscopically than those who either did not have insurance coverage or who were covered by Medicaid. Other independent predictors of undergoing laparoscopic resection included teaching hospital status, urban location, hospital location in the southern region, and an elective procedure.

Disclosures This is an original work by Monirah AlNasser, Eric B. Schneider, Susan L. Gearhart, Elizabeth C. Wick, Sandy H. Fang, Adil H. Haider, and Jonathan Efron who have no conflict of interest or financial ties to disclose.

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