Surgical Care for Women with Endometrial Cancer in Florida

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Abstract

Objective: The goal of this research was to analyze if disparities in route of hysterectomy for endometrial cancer exist in Florida.

Materials and Methods: In this retrospective cohort study, Florida inpatient and ambulatory surgery databases (2014–2016) were examined to find cases of patients with endometrial cancer who underwent hysterectomy in the state. Logistic regression models were used to compare patient- and hospital-level factors associated with having minimally invasive surgery (MIS) versus open surgery, and complications in patients having open hysterectomy versus MIS.

Results: Overall, 6513 patients met the inclusion criteria. MIS was performed in 81.4% of cases. The odds of using a minimally invasive approach to hysterectomy (vaginal, robotic, or laparoscopic) were significantly lower for black women (odds ratio [OR]: 0.41; 95% confidence interval [CI]: 0.34–0.50) as well as for other non-white patients (OR: 0.64; 95% CI: 0.49–0.84). Patients with Medicaid (OR: 0.42; 95% CI: 0.30–0.59) or Medicare managed care (OR: 0.73; 95% CI: 0.59–0.91), or who received care at a teaching hospital (OR: 0.82; 95% CI: 0.68–0.98) or government hospital (OR: 0.50; 95% CI: 0.38–0.65) were also less likely to receive MIS. Patients receiving care at a high-volume (OR: 1.69; 95% CI: 1.30–2.20) or medium-volume (OR: 3.11; 95% CI: 2.37–4.08) hospital, or patients who were located in the Central (OR: 1.71; 95% CI: 1.17–2.48) or Peninsula (OR: 1.73; 95% CI: 1.17–2.56) regions, compared to the Florida Panhandle, had greater odds of receiving MIS.

Conclusions: Although Florida has a high adoption of MIS for treating endometrial cancer, disparities persist. Efforts of state-level entities should focus on improving access to minimally invasive hysterectomy for racial minorities with endometrial cancer. (J GYNECOL SURG 35:163)

Keywords: endometrial cancer, minimally invasive surgery, hysterectomy, health disparities

Introduction

MINIMALLY INVASIVE SURGERY (MIS) was designated as a quality measure for endometrial cancer by the Society of Gynecologic Oncology and the American College of Surgeons Commission on Cancer in 2014.^{1–4} According to data in the National Inpatient Sample database, in 2012–2013, 52.4% of women with endometrial cancer were treated with open surgery versus 47.6% treated with MIS.² In addition, significant disparities were reported in the races of patients receiving minimally invasive approaches to hysterectomy as well as disparities in the volumes, locations, and ownership characteristics of the organizations providing these surgeries.² Furthermore, complications and cost per case were higher in total abdominal hysterectomies, com-

pared to minimally invasive approaches.² Hysterectomies performed in the outpatient setting are not included in the National Inpatient Sample, which limits the generalizability of conclusions regarding hysterectomies performed in the inpatient setting.

Subsequent studies using the SEER-Medicare database and the National Surgical Quality Improvement Project database showed significant increases in minimally invasive hysterectomy for endometrial cancer. Using the SEER-Medicare database, Wright et al. reported that minimally invasive hysterectomy increased from 9.3% in 2006 to 61.7% in 2011 with robotic-assisted procedures accounting for 62.3% of the minimally invasive cases.⁵ Casarin et al.'s analysis from the American College of Surgeons' National Surgical Quality Improvement Project database showed that

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MIS increased from 24.2% in 2008 to 71.4% in 2014, with substantial decreases in 30-day morbidity, readmissions, and reoperations for women treated for endometrial cancer.⁶

Although studies using national datasets have shown pertinent disparities in hysterectomy routes, it is not known if such disparities persist in populations with high adoption of minimally invasive hysterectomy. Florida, a state located in the southeastern United States, has high utilization of MIS techniques. Using contemporary data available for characterizing inpatient and outpatient hysterectomies in Florida, the current study's primary objective was to determine if racial, social, and/or geographic disparities in routes of hysterectomy for endometrial cancer still exist in this state with its high utilization of MIS techniques. Secondary objectives included assessments of complications and associated costs of abdominal hysterectomy versus minimally invasive hysterectomy.

Materials and Methods

Data sources

The 2014–2016 Florida Inpatient Discharge Dataset, the 2014–2016 Florida Ambulatory and Emergency Discharge Dataset, the 2014–2016 Hospital Compare dataset, and the 2014–2016 Healthcare Cost Report Information System (HCRIS) dataset were utilized for this analysis.

The Florida Inpatient Discharge dataset provides anonymized patient-level data from all acute-care hospitals within the State of Florida and includes information regarding diagnosis, treatment, patient demographics, and hospital as well as physician characteristics.⁷ Similarly, the Florida Ambulatory and Emergency Discharge dataset includes data from freestanding ambulatory surgical centers, hospitals with outpatient services, cardiac-catheterization centers, and lithotripsy centers, as well as information regarding diagnosis, treatment, patient demographics, and facility and physician characteristics.⁷ The Hospital Compare Dataset provides information from the Centers for Medicare and Medicaid Services (CMS) regarding healthcare-facility characteristics as well as quality and performance metrics.⁸ Finally, the HCRIS includes annual report data from healthcare facilities in CMS. For this study, the HCRIS data were utilized to determine teaching status and cost-to-charge ratios to define cost indicators of interest.⁹ All datasets were linked by CMS hospital-provider identification codes. Due to the publicly available nature of the dataset, as well as the anonymous nature of the patient-level data, the Florida Mayo Clinic, Jacksonville, FL, institutional review board categorized the research as exempt.

Population and variables

The population for this analysis included all patients within the State of Florida who were diagnosed with endometrial cancer as identified by both an International Classification of Diseases (ICD)-9 code (182.0) and an ICD-10 code (C54.10), and who received a related hysterectomy with or without a lymphadenectomy (see Box 1 for the associated ICD-9 and ICD-10 procedure codes). Surgeries that were identified as emergent were excluded, as these populations and circumstances involve significant differences in treatment approaches.

BOX 1. DETAILS OF DIAGNOSTIC CODES AND PROCEDURAL CODES RETRIEVED FROM THE FLORIDA INPATIENT DISCHARGE DATASET AND THE FLORIDA AMBULATORY AND EMERGENCY DISCHARGE DATASET FOR THE TIME PERIOD JUNE 2014–DECEMBER 2016

Primary diagnosis

- International Classification of Diseases, 9th Revision: 182.0
- International Classification of Disease, 10th revision: C54.10

Procedures

- **Minimally invasive**
 - International Classification of Diseases, 9th Revision: 68.31, 68.41, 68.51, 68.61, 68.71, 17.4, 17.41, 17.42, 17.43, 17.44, 17.49, 68.5, 68.59, 68.7, and 68.79
 - International Classification of Disease, 10th revision: 0UT94ZZ, 0UTC4ZZ, 0UT9FZZ, S2900, 8E0W4CZ, 8E0W0CZ, 8E0W3CZ, 8E0W7CZ, 8E0W8CZ, 0UT97ZZ, and 0UT47ZZ
 - Related Current Procedural Terminology codes: 58541, 58542, 58543, 58548, 58550, 58552, 58553, 58554, 58570, 58571, 58572, 58573, 58260, 58262, 58263, 58270, 58280, 58285, 58290, 58291, 58292, and 58294
- **Abdominal**
 - International Classification of Diseases, 9th Revision: 68.3, 68.39, 68.4, 68.49, 68.6, 68.69, and 68.9
 - International Classification of Disease, 10th revision: 0UT90ZZ
 - Related Current Procedural Terminology codes: 58150, 58180, 58200, and 58210

Dependent variable

The dependent variable for this analysis was the surgical procedure each patient received, whether it was classified as MIS (vaginal, robotic, or laparoscopic), or abdominal surgery. ICD-9 and ICD-10 codes were utilized to define the types of procedures (Box 1). However, because this is an administrative dataset it is not always clear when potential transitions between minimally invasive or abdominal occur. As such, categories (Box 1) were utilized to define the opportunities associated with receiving each category of surgery as follows: (1) If a minimally invasive surgery indicator was present the surgery was classified as minimally invasive. (2) If no minimally invasive code was present, but an abdominal code was present, then the surgery was considered to be abdominal surgery.

Next, complications were defined by ICD-9 and ICD-10 codes for Surgical Site Infection, Wound Disruption, Sepsis, Pulmonary Embolism and/or Deep Vein Thrombosis, Stroke, Myocardial Infarction, Myocardial Arrest, Pneumonia, Acute Post Hemorrhagic Anemia, and other non-surgical site infections. All complications are restricted by the dataset to during hospital stays or initial outpatient

visits, as patient identifiers are not available to track patient revisits or readmissions. Complication types and frequency are reported; however, for the current study, complications were combined to create a binary variable indicating presence of a complication versus absence of a complication for multivariable models, due to the low number of complications occurring in each category.

Finally, costs associated with each hospital and outpatient visit were calculated by utilizing the reported total charges reported within the Florida Inpatient and Ambulatory datasets. Cost-to-charge ratios available through the HCRIS data were then used, and the facility total-charge datum was multiplied by the cost-to-charge ratio for the corresponding charge year datum to obtain a total-cost variable.¹⁰ All costs were inflated to 2016 using the Gross Domestic Product: Implicit Price Deflator.¹¹

Independent variables

Patient characteristics—sex, age, race and ethnicity, location (including region and rurality), and payer type—were included as covariates. Race was divided into 3 categories (White, African American or Black, and Other). Payer included each patient's identified insurer, including: Medicare; Medicare Managed Care; Medicaid (Medicaid Patient and Medicaid Managed Care Patient); commercial; or other insurance (which included self-pay, or nonpayment). Patient region was divided into six regions as defined by the American College of Obstetricians and Gynecologists, and indications of rurality as defined by the Florida Department of Health.^{12,13} In addition, patient comorbidities were addressed through use of the Elixhauser Score, which is divided into 4 categories indicating the presence of 0, 1–2, 3–5, or >5 comorbidities.¹⁴ Due to their importance, both metastatic cancer and obesity were included as separate variables and not included within the Elixhauser score.¹⁵

The facility characteristics included hospital size, hospital volume, teaching status, and ownership. Hospital volume was classified based upon the distribution of the yearly average number of cases of hysterectomies occurring at each facility between 2014 and 2016 (low, volume: <10; medium volume: >10 but <29; and high-volume: ≥30). Organizational size was defined by the number of staffed beds and was categorized as small (< 100), medium (100–199), and large (> 200 staffed beds). Teaching status was determined by the presence of residency programs. If a hospital had a residency program, the facility was indicated as a teaching hospital.¹⁶ Organizational ownership was categorized as government, for-profit, and not-for profit, and was utilized to provide indications of financial and quality performance.¹⁷ Finally, physician surgical volume was included to provide indications concerning physician experience relating to the surgery. Within the dataset, a sizable proportion of physicians only provided 1 surgery for endometrial cancer during the time period, and, as such, the distribution was segmented into physicians providing 1 versus physicians providing more than 1 surgery for endometrial cancer.

Analysis

Data were described as percentages or means, and a Kruskal–Wallis test was utilized for continuous variables

and χ^2 tests were used to compare categorical variables. In addition, multivariable logistic regression models were utilized to compare differences in patient characteristics, facility characteristics, locations, comorbidities, years, or physician surgical volumes between MIS versus abdominal approaches and between any complication versus no complications. Finally, comparisons between costs associated with MIS versus abdominal approaches, considering complications, were performed. All tests of significance were 2-sided, and both the 95% confidence intervals (CI) as well as the *p*-values are reported later in this article. For logistics-regression models, odds ratios (ORs) were provided and β -coefficients were utilized. Analyses were performed using SAS version 9.4 (SAS Institute Inc.).

Results

There were 6513 patients identified who underwent hysterectomy for the treatment of endometrial cancer between June 2014 and December 2016. During this time period, 5300 (81.4%) patients underwent MIS while 1213 (18.6%) patients underwent abdominal hysterectomy (Table 1). Age was the only variable that was not statistically different between patients who underwent abdominal surgery versus MIS. There were 210 (3.2%) surgeries performed by physicians who only performed 1 hysterectomy for endometrial cancer during the time period. Hospitals providing hysterectomies included 74.5% teaching, 92.4% large-sized, and 66.5% high-volume hospitals. Patients who underwent abdominal hysterectomy were more likely to be obese (41.1% versus 28.7% for MIS; $p < 0.001$), treated for metastatic cancer (23.2% versus 7.6% for MIS; $p < 0.001$), and experience complications (17.2% versus 2.6% for MIS; $p < 0.001$). Patients undergoing minimally invasive hysterectomy were more likely to have lymphadenectomy performed (70.2 % versus 38.8% for abdominal surgery; $p < 0.001$).

Table 2 shows factors associated with patients undergoing MIS versus abdominal hysterectomy with ORs and 95% CIs. Patients who had concurrent lymphadenectomy (OR: 3.33; 95% CI: 2.88–3.85), were located in Central Florida (OR: 1.71; 95% CI: 1.17–2.48), or the Florida Peninsula (OR: 1.73; 95% CI: 1.17–2.56), and in high-volume (OR: 1.69; 95% CI: 1.30–2.20) or medium-volume (OR: 3.11; 95% CI: 2.37–4.08) hospitals were significantly more likely to receive MIS than abdominal surgery. African Americans (OR: 0.41; 95% CI: 0.34–0.50), other non-white race patients (OR: 0.64; 95% CI: 0.49–0.84), patients on Medicaid insurance (OR: 0.42; 95% CI: 0.30–0.59), or those who received care at a teaching hospital (OR: 0.82; 95% CI: 0.68–0.98) or government hospital (OR: 0.50; 95% CI: 0.38–0.65) were less likely to undergo MIS.

Table 3 details factors associated with patients experiencing major perioperative complications. Patients who had abdominal hysterectomy (OR: 6.31; 95% CI: 4.81–8.28), metastatic cancer (OR: 2.61; 95% CI: 1.98–3.45), or more comorbidities (OR: 4.56; 95% CI: 1.81–11.49 for >5 comorbidities), or who had received care at not-for-profit hospital ownership (OR: 2.56; 95% CI: 1.68–3.91), or medium-volume (OR: 1.80; 95% CI: 1.07–3.02) or high-volume (OR: 1.75; 95% CI: 1.04–2.93) hospitals were more likely to experience complications. Patients receiving care in Central Florida (OR: 0.42; 95% CI: 0.23–0.77), or West

TABLE 1. DISTRIBUTION OF SELECTED CHARACTERISTICS OF WOMEN IN FLORIDA WITH ENDOMETRIAL CANCER WHO UNDERWENT HYSTERECTOMY IN THE SECOND HALF OF 2014 UNTIL THE END OF 2016 (N=6513)

<i>Variable</i>	<i>Abdominal (n=1213)</i>	<i>MIS (n=5300)</i>	<i>Total</i>	<i>p-Value</i>
Age				0.878 ^a
Mean (SD)	63.7 (11.7)	63.6 (10.8)	63.6 (11.0)	
Range	(21.0–97.0)	(23.0–94.0)	(21.0–97.0)	
Region of Florida (ACOG districts)				<0.001 ^b
Panhandle	62 (5.1%)	193 (3.6%)	255 (3.9%)	
Northern	228 (18.8%)	676 (12.8%)	904 (13.9%)	
Central	166 (13.7%)	1262 (23.8%)	1428 (21.9%)	
West	262 (21.6%)	1247 (23.5%)	1509 (23.2%)	
Eastern	343 (28.3%)	929 (17.5%)	1272 (19.5%)	
Peninsula	152 (12.5%)	993 (18.7%)	1145 (17.6%)	
Race				<0.001 ^b
American Indian or Alaskan Native	0 (0.0%)	7 (0.1%)	7 (0.1%)	
Asian	16 (1.3%)	63 (1.2%)	79 (1.2%)	
Black or African American	288 (23.7%)	473 (8.9%)	761 (11.7%)	
Native Hawaiian or Other Pacific Islander	0 (0.0%)	6 (0.1%)	6 (0.1%)	
White	812 (66.9%)	4392 (82.9%)	5204 (79.9%)	
Other non-white	81 (6.7%)	296 (5.6%)	377 (5.8%)	
Unknown	16 (1.3%)	63 (1.2%)	79 (1.2%)	
Payer				<0.001 ^b
Medicare	270 (22.3%)	1468 (27.7%)	1738 (26.7%)	
Medicare Managed Care	338 (27.9%)	1095 (20.7%)	1433 (22.0%)	
Medicaid/Medicaid Managed Care	78 (6.4%)	131 (2.5%)	209 (3.2%)	
Commercial	449 (37.0%)	2319 (43.8%)	2768 (42.5%)	
Other	78 (6.4%)	287 (5.4%)	365 (5.6%)	
Hospital teaching status				<0.001 ^b
Nonteaching status	233 (19.2%)	1429 (27.0%)	1662 (25.5%)	
Teaching status	980 (80.8%)	3870 (73.0%)	4850 (74.5%)	
Hospital size				0.013 ^b
Small size hospital	7 (0.6%)	56 (1.1%)	63 (1.0%)	
Medium size hospital	100 (8.2%)	330 (6.2%)	430 (6.6%)	
Large size hospital	1106 (91.2%)	4914 (92.7%)	6020 (92.4%)	
Hospital ownership				<0.001 ^b
Government	294 (24.2%)	1008 (19.0%)	1302 (20.0%)	
For-profit	240 (19.8%)	927 (17.5%)	1167 (17.9%)	
Not-for-profit	679 (56.0%)	3364 (63.5%)	4043 (62.1%)	
Complications				<0.001 ^b
Hospital volume				<0.001 ^b
Low-volume hospital	205 (16.9%)	530 (10.0%)	735 (11.3%)	
Medium-volume hospital	225 (18.5%)	1224 (23.1%)	1449 (22.2%)	
High-volume hospital	783 (64.6%)	3546 (66.9%)	4329 (66.5%)	
Metastatic cancer				<0.001 ^b
281 (23.2%)		403 (7.6%)	684 (10.5%)	
Obesity				<0.001 ^b
498 (41.1%)		1519 (28.7%)	2017 (31.0%)	
Elixhauser comorbidity scale				<0.001 ^b
0 Elixhauser	218 (18.0%)	1700 (32.1%)	1918 (29.4%)	
1–2 Elixhauser	644 (53.1%)	2831 (53.4%)	3475 (53.4%)	
3–5 Elixhauser	329 (27.1%)	756 (14.3%)	1085 (16.7%)	
≥ 5 elixhauser	22 (1.8%)	13 (0.2%)	35 (0.5%)	
Physician volume				0.001 ^b
1 surgery for endometrial cancer	57 (4.7%)	153 (2.9%)	210 (3.2%)	
More than 1 surgery for endometrial cancer	1156 (95.3%)	5147 (97.1%)	6303 (96.8%)	
Lymphadenectomy performed				<0.001 ^b
471 (38.8%)		3722 (70.2%)	4193 (64.4%)	

^aKruskal–Wallis test.

^b χ^2 test.

MIS, minimally invasive surgery, SD, standard deviation; ACOG, American College of Obstetricians and Gynecologists.

TABLE 2. ENDOMETRIAL CANCER PATIENT & HOSPITAL CHARACTERISTICS ASSOCIATED WITH UNDERGOING MIS IN THE SECOND HALF OF 2014 UNTIL THE END OF 2016 (N=6513)

Variable	MIS vs. abdominal model			p-Value
	OR	LCL	UCL	
Lymphadenectomy	3.330	2.883	3.847	<0.001
Race (white is referent)				
Black or African American	0.411	0.340	0.497	<0.001
Other non-white	0.644	0.494	0.841	0.001
Age (10-year increase)	0.990	0.907	1.080	0.819
Obesity	0.709	0.609	0.826	<0.001
Metastatic cancer	0.239	0.197	0.290	<0.001
Physicians performing more than 1 surgery (less than 1 is referent)	1.321	0.925	1.887	0.126
Elixhauser comorbidity scale (0 is referent)				
Elixhauser 1–2	0.637	0.530	0.767	<0.001
Elixhauser 3–5	0.404	0.324	0.505	<0.001
Elixhauser >5	0.168	0.078	0.363	<0.001
Teaching hospital (Nonteaching is referent)	0.815	0.677	0.980	0.030
Region (Panhandle is referent)				
Central Florida	1.706	1.173	2.480	0.005
Eastern Florida	0.687	0.472	1.000	0.050
Northern Florida	0.576	0.399	0.833	0.003
Peninsula	1.730	1.171	2.556	0.006
West Florida	1.014	0.708	1.450	0.941
Hospital size (small is referent)				
Large-size hospital	1.280	0.497	3.297	0.610
Medium-size hospital	1.247	0.468	3.317	0.659
Insurance (commercial is referent)				
Medicare	1.105	0.882	1.386	0.386
Medicare Managed Care	0.729	0.585	0.910	0.005
Medicaid	0.416	0.296	0.585	<0.001
Other Insurance	0.809	0.598	1.095	0.171
Hospital ownership (For-profit is referent)				
Government owner	0.498	0.382	0.648	<0.001
Not-for-profit owner	0.990	0.796	1.231	0.929
Hospital volume (low is referent)				
High-volume hospital	1.691	1.300	2.200	<0.001
Medium-volume hospital	3.111	2.372	4.081	<0.001

MIS, minimally invasive surgery; OR, odds ratio; UCL, upper confidence limit; LCL, lower confidence limit.

Florida (OR: 0.55; 95% CI: 0.32–0.96), or at a teaching hospital (OR: 0.46; 95% CI: 0.35–0.61) were less likely to experience complications.

Table 4 presents the costs of the procedures and their associations with complications. Costs were significantly increased for abdominal surgery versus MIS (mean difference: \$2,035.20; $p < 0.001$) and for abdominal procedures with complications versus MIS with complications (mean difference: \$4,541.50; $p < 0.001$). Costs were similar for non-complicated abdominal surgery and MIS.

Discussion

Evidence published in the last 2 years suggests that, while the overall rate of hysterectomies had decreased from 2000 to 2014, a large proportion of hysterectomies have been performed in outpatient settings.^{18,19} Thus, inpatient-only data might not capture changing treatment patterns for gynecologic conditions accurately,¹⁹ including endometrial cancer. In addition, it was not known if disparities persist in hysterectomy routes in populations with high adoption of

minimally invasive hysterectomy. The present study was performed to address this critical gap by examining inpatient and outpatient hysterectomies in a state with a high utilization of MIS techniques to determine if disparities persisted in the routes, complications, and costs of hysterectomy for endometrial cancer. The study showed that certain patient populations, including African Americans, Medicaid-insured, and obese individuals, were more likely to undergo abdominal hysterectomy than MIS. In contrast, high- and medium-volume hospitals, those with nonteaching status, and those with nongovernment hospital ownership were associated with greater use of MIS. Of note, abdominal hysterectomy was more expensive and associated with increased complication rates. Together, these findings have important implications for clinicians, payers, and policy makers.

Encouragingly, Florida has a high adoption of MIS for endometrial cancer, compared to previous national studies,^{2,20} with a large proportion of minimally invasive hysterectomy noted (81.4%). The inclusion of outpatient cases likely explains why the proportion of hysterectomies performed in a

TABLE 3. ENDOMETRIAL CANCER PATIENT & HOSPITAL CHARACTERISTICS ASSOCIATED WITH DEVELOPING COMPLICATIONS FOLLOWING HYSTERECTOMY FOR ENDOMETRIAL CANCER IN THE SECOND HALF OF 2014 UNTIL THE END OF 2016 (N=6513)

Variable	Complications model			p-Value
	OR	LCL	UCL	
Abdominal hysterectomy	6.311	4.813	8.276	<0.001
Lymphadenectomy	0.981	0.762	1.263	0.883
Race (white is referent)				
Black or African American	1.004	0.726	1.387	0.983
Other non-white	0.942	0.568	1.563	0.818
Age (10-year increase)	1.124	0.972	1.300	0.115
Obesity	0.894	0.687	1.163	0.404
Metastatic cancer	2.611	1.977	3.447	<0.001
Physicians performing more than 1 surgery (less than 1 is referent)	0.889	0.464	1.702	0.723
Elixhauser comorbidity scale (0 is referent)				
Elixhauser 1–2	1.457	1.020	2.080	0.038
Elixhauser 3–5	3.968	2.708	5.814	<0.001
Elixhauser >5	4.557	1.808	11.485	0.001
Teaching hospital (nonteaching is referent)	0.459	0.346	0.610	<0.001
Region (Northeast is referent)				
Central Florida	0.420	0.230	0.767	0.005
Eastern Florida	1.720	0.972	3.045	0.063
Northern Florida	1.051	0.606	1.821	0.860
Peninsula	1.034	0.554	1.929	0.917
West Florida	0.550	0.315	0.961	0.036
Hospital size (small is referent)				
Large-size hospital	2.875	0.362	22.813	0.318
Medium-size hospital	1.923	0.227	16.287	0.549
Insurance (Commercial is referent)				
Medicare	0.880	0.607	1.275	0.498
Medicare Managed Care	0.973	0.666	1.420	0.885
Medicaid	1.131	0.624	2.052	0.685
Other insurance	1.523	0.925	2.508	0.098
Hospital ownership (For-profit is referent)				
Government owner	0.806	0.479	1.357	0.417
Not-for-profit owner	2.562	1.677	3.914	<0.001
Hospital volume (low is referent)				
High-volume hospital	1.749	1.044	2.931	0.034
Medium-volume hospital	1.796	1.070	3.016	0.027

OR, odds ratio; UCL, upper confidence limit; LCL, lower confidence limit.

TABLE 4. COSTS OF MINIMALLY INVASIVE & OPEN SURGERY WITH & WITHOUT COMPLICATIONS

Procedure	Costs			p-Value ^a
	Population	Mean (\$)	Range (\$)	
Abdominal	1213	13,334.90	1,486.00–265,615.00	<0.001
MIS	5300	11,299.70	500.00–152,204.10	
Difference	—	2,035.20	14,360.00–11,3410.90	
Abdominal with complication	209	20,922.50	6,467.40–265,615.00	<0.001
MIS with complication	140	16,381.00	5,714.50–152,204.10	
Difference	—	4,541.50	752.90–113,410.90	
Abdominal without complication	1004	11,831.40	1,486.0–97,737.00	0.942
MIS without complication	5160	11,154.60	500.00–42,834.60	
Difference	—	676.80	986.00–54,902.40	

^ap-Values are reported using a Kruskal–Wallis test.

MIS, minimally invasive surgery.

minimally invasive manner was so much higher than in previous studies, which utilized inpatient-only data.^{2,20} The dissemination of minimally invasive technologies, including laparoscopy—especially robotics—has resulted in a shift from inpatient hysterectomies toward outpatient hysterectomies.²¹ MIS appears to lead to shorter lengths of stay and fewer complications even among high-risk populations, such as obese and morbidly obese women.^{22–25} This supports MIS appropriateness for outpatient hysterectomies and likely explains its increasing use in outpatient settings, given that early ambulation and discharge is a desired goal in these settings.

It has also been suggested that the adoption of MIS in outpatient settings might improve access for disadvantaged patient groups.²¹ Although all patient groups have benefited from the increased prevalence of MIS in Florida, significant disparities still persist. Racial minorities, such as African American patients and those of other non-white races were less likely to undergo minimally invasive hysterectomy than white patients. This finding is consistent with previous research that has reported racial disparities in patients undergoing minimally invasive hysterectomy among women receiving inpatient treatment for endometrial cancer in the United States.^{2,20}

In addition, Medicaid insurance, government-owned hospitals, and teaching hospitals were associated with increased use of abdominal hysterectomy, which calls for considerations of systematic aspects contributing to disparities, such as bias against poorer patients, reduced access to care among minority patients, and uneven distribution of hospital resources or technical expertise. For example, teaching and government hospitals are likely to have more African American patients whose payers are CMS-based, and these women often have less access to care and thus present with more advanced disease and with more comorbidities (e.g., obesity). Given how tangled these relationships are, providing more minimally invasive procedures in teaching and government hospitals, without efforts to improve access to care among African American women with endometrial cancer, could prove to be unhelpful.

Surprisingly, there are quite a few cases of hysterectomy performed by surgeons who only operated on 1 endometrial cancer case per year (3.2% overall). Further analysis is required to determine why such a surprisingly high proportion of hysterectomies are performed by surgeons who only perform surgery on 1 case of endometrial cancer per year. It could be that these cases were handled by surgeons who had a gynecologist–oncologist or a general surgeon as a backup. It is also possible that these endometrial cancers were not diagnosed preoperatively, as a surprisingly high rate of unsuspected uterine malignancies (1.44%) has been reported among women undergoing hysterectomies, particularly among patients who were age 55 or older.^{26,27} This latter possibility should be considered by the Centers for Disease Control and Prevention, which might soon be reviewing the preoperative evaluation of women scheduled for hysterectomies or myomectomies to treat uterine sarcomas.²⁸ Additional research is needed to understand factors contributing to the high proportion of hysterectomies performed by surgeons who only operate on 1 case of endometrial cancer per year, and to assess the impact this could be having on clinical outcomes for patients with endometrial cancer.

When considering complications and associated costs, the open approach to hysterectomy appears to be more expensive,^{29,30} and this is more so when the procedure is accompanied by complications.^{2,20} In this regard, the current study showed that patients undergoing abdominal hysterectomy were six times more likely to experience complications. It also appears that patients who underwent abdominal hysterectomy in the current study were sicker, which was evidenced by a greater number of comorbidities and a greater proportion of metastatic disease. This has serious ramifications for clinicians and other parties involved in clinical decision-making regarding the route of hysterectomy. While the higher rate of complications following abdominal hysterectomy might be due to the invasiveness of the open approach, this could be compounded further by the tendency for patients with metastatic disease and greater comorbidities to be treated with abdominal hysterectomy.

Of note, the risk of complications appeared to be independently increased by the presence of metastatic disease and comorbidities. Overall, these findings indicate that the occurrence of complications are more likely to be affected by clinical characteristics, such as route of hysterectomy and patient disease burden, rather than demographic characteristics such as race, age, or insurance status. This also has important implications for payers and hospital administrators, as the difference in costs between abdominal and minimally invasive hysterectomy was significantly increased by the presence of complications. Thus, the costs of hysterectomy for endometrial cancer could be significantly reduced if stricter criteria were applied regarding the appropriateness of hysterectomy route, if needed at all, considering the patient's clinical state and risk for complications.

The current study had important limitations. The findings might not be generalizable to other populations with significantly different demographics. However, the population of Florida is geographically and socioeconomically diverse, which makes it appropriate for studying disparities associated with provision and utilization of health services, including cancer treatment. In addition, the administrative and retrospective nature of the data limited the ability to assess certain aspects of the care-delivery process, and disease progression. This nature of the data also limited the ability to discover more granular detail about the patients, procedures, and disease states. These limits constrained the ability to account accurately for all possible factors that might have affected the choice of hysterectomy route. For example, the current authors were unable to define patients who had had multiple hospitalizations or outpatient visits over time.

In addition, there are other anatomical or historical factors that could influence surgeon choice for route of hysterectomy, such as uterine size or past surgical history, that were not captured in this administrative data, although these confounders were unlikely to account fully for the differences reported here. In addition, the analysis of complications associated with the route of hysterectomy was limited to complications encountered during hospital stays or initial outpatient visits, as patient identifiers were not available to track patient revisits or readmissions.

Conclusions

Although Florida has a high adoption of MIS for endometrial cancer, disparities persist regarding surgical route

chosen for certain patients. Consistent with national studies, African American, Medicaid-insured, obese, and sicker patients are less likely to undergo minimally invasive hysterectomy. Additional differences in hysterectomy routes were noted by geographic regions as well as hospital volumes, teaching status, and ownership. It is important for individual practices to review policies and hospital procedures to determine if there are systematic aspects contributing to these disparities. Regions with low adoption of MIS should be scrutinized closely to determine if surgeon expertise, availability of minimally invasive technologies, physician training, or unmeasured patient characteristics are reducing the odds of patients receiving minimally invasive hysterectomy. Efforts by state-level entities should also focus on improving access to care and minimally invasive hysterectomy for African American women with endometrial cancer. These efforts should include getting minimally invasive technologies to areas with low utilization of MIS or creating a better referral system for patients who would otherwise go to low-volume hospitals.

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