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Factors associated with high-cost hospitalizations in elderly ovarian cancer patients

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Abstract

Objective.—To characterize factors associated with high-cost inpatient admissions for ovarian cancer.

Methods.—Operative hospitalizations for ovarian cancer patients ≥65 years of age were identified using the 2010–2017 National Inpatient Sample. Admissions with *high-cost* were defined as those incurring ≥90th percentile of hospitalization costs each year, while the remainder were considered *low-cost*. Multivariable logistic regression models were developed to assess independent predictors of being in the *high-cost* cohort.

Results.—During the study period, an estimated 58,454 patients met inclusion criteria. 5827 patient admissions (9.98%) were classified as *high-cost*. Median hospitalization cost for this *high-cost* group was $55,447 (interquartile range (IQR) $46,744–$74,015) compared to $16,464 (IQR $11,845–$23,286, $p < 0.001$) for the *low-cost* group. Patients with *high-cost* admissions were more likely to have received open (adjusted odds ratio (AOR) 2.23, 1.31–3.79) or extended (AOR 5.64, 4.79–6.66) procedures and be admitted non-electively (AOR 3.32, 2.74–4.02). Being in the top income quartile (AOR 1.77, 1.39–2.27) was also associated with *high-cost*. Age and hospital factors, including bed size and volume of gynecologic oncology surgery, did not affect cost group.

Conclusion.—*High-cost* ovarian cancer admissions were three times more expensive than *low-cost* admissions. Fewer open and extended procedures with subsequently shorter lengths of stay may have contributed to decreasing inpatient costs over the study period. In this cohort of patients

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largely covered by Medicare, clinical factors outweigh socioeconomic factors as cost drivers. Understanding the relationship of disease-specific and social factors to cost will be important in informing future value-based quality improvement efforts in gynecologic cancer care.

Keywords

National Inpatient Sample; High-cost hospitalizations; Operative admissions; Elderly ovarian cancer patients; Open surgery

1. Introduction

Healthcare expenditures in the United States reached $3.9 trillion in 2017, with inpatient hospitalizations accounting for 33% of such costs. [1]. Akin to wealth distribution, a small percent of the population is generally responsible for a large proportion of healthcare costs [2–5]. In 2017, 10% of the population incurred approximately two-thirds of total U.S. healthcare costs [6]. Further analysis revealed this group to be generally older and accrue cost by more frequent hospitalization. Thus, several approaches focusing on “high-utilizers” have been suggested in order to improve value of care [6].

Recent estimates have demonstrated gynecologic malignancies to be responsible for $3.8 billion in annual healthcare costs [1]. Although uterine cancer is the largest overall contributor, individual cost for ovarian cancer patients is 2 to 6 times higher than their counterparts with uterine and cervical cancer [7]. Inpatient hospitalization – including drug costs – accounts for half of all expenditures for gynecologic cancer patients followed distantly by office-based and outpatient hospital visits, which account for 15% and 13% of expenditures, respectively [7]. Increased cost has been associated with age, race, geographic region, medical comorbidity, private insurance and being low or middle-income [7,8].

Most available studies of ovarian cancer expenditures have focused on determining the economics of specific interventions such as primary debulking surgery versus neoadjuvant chemotherapy, bevacizumab in first-line treatment, and early palliative care consultation [9–11]. Avila, et al. (2019) examined *high-cost* hospitalizations among all cancer patients >65 years and found increasing medical comorbidity, receipt of major procedures, Black race and being cared for at large, metropolitan teaching hospitals to be associated with higher costs [12].

Following the enactment of the Affordable Care Act (ACA), national efforts to decrease healthcare spending while improving access and care quality have intensified [13]. Despite these efforts and advances in technology, the cost of cancer care is expected to rise [7]. In order to provide quality care while mitigating the rise in expenditures for ovarian cancer patients, understanding of costs and their drivers are imperative. A better understanding of inpatient costs specifically – which continue to be a significant factor in overall spending – will be important in informing future value-based quality improvement efforts. The objective of this study was to characterize the largest contributors to inpatient ovarian cancer costs using a national cohort.

2. Methods

The National Inpatient Sample (NIS) database was used to identify patients diagnosed with ovarian cancer between 2010 and 2017. The NIS is the largest publicly available all-payer inpatient database in the United States and is maintained by the Agency for Healthcare Research and Quality (AHRQ) as part of the Healthcare Cost and Utilization Project (HCUP). Data is generated by extracting hospital information and diagnosis and procedure codes from hospital discharge abstracts. In 2012, NIS methodology changed from a random sampling of all admissions from 20% of hospitals to 20% of admissions from all participating hospitals. Sampling probabilities for each stratum were used to obtain survey estimates representative of 97% of all US hospitalizations.

The International Classification of Diseases, Ninth and Tenth Revisions (ICD-9 and ICD-10) were used to identify women ≥65 years of age with ovarian, fallopian tube or primary peritoneal cancer – hereafter, referred to as ovarian cancer – in the NIS. Patients missing cost data or key variables, such as age, were excluded. Patients with an associated ICD procedure code for oophorectomy, hysterectomy, omentectomy, pelvic or aortic lymphadenectomy were included for further analysis. ICD code descriptions specifying type of operations were used to distinguish between traditional laparoscopic, robotic and open procedures. Extended procedures were defined by codes involving small bowel, liver, colon, rectosigmoid, bladder, diaphragm and spleen resection, as well as ileostomy or colostomy creation (Supplementary Table 1). Non-elective admission included, but were not limited to, admission for fever, pain or bowel obstruction.

The previously-validated Elixhauser Comorbidity Index was used to characterize patient comorbidities by tabulating the burden of 30 chronic conditions [14]. Hospital characteristics were defined using the HCUP data dictionary and included teaching status, geographic region and bed size [15]. Hospitals were further stratified into low-, medium-, and high-volume tertiles based on annual caseload of gynecologic procedures as defined above.

Hospitalization charges were calculated using hospital-specific cost-to-charge ratio files and overall hospitalization charges provided by the NIS. These were standardized to the 2017 US Gross Domestic Product using US Department of Commerce Consumer Price Indices. Patients were then stratified into a binary *high-cost* (HC) cohort defined as hospitalization cost at or above the 90th percentile of total costs ($41,243) for the hospitalization. The HC cohort was calculated per each year of the study and then summed into a single binary variable to be utilized in analyses. The remaining patients were classified as the *low-cost* (LC) cohort [12]. Patient and hospital-level factors associated with *high-cost* admissions were then analyzed.

2.1. Statistical analysis

Data extraction and calculation were performed with STATA 16.0 software (StataCorp, College Station, TX). Trend analyses were conducted with Cuzick's nonparametric test for trend [16]. Adjusted Wald and Kruskal-Wallis tests were used to compare categorical and continuous variables, respectively. Mann-Whitney *U* tests were utilized to evaluate median costs and LOS. Multivariable logistic regression models were developed to assess independent predictors of being in the *high*-versus *low-cost* cohorts. Following a stepwise backward elimination, additional covariates were added based on clinical significance. Model selection was based on optimization of receiver operating curve (ROC) and Akaike's and Bayesian Information Criteria. A *P*-value less than 0.05 was deemed statistically significant. The study was deemed exempt by the Institutional Review Board at the University of California, Los Angeles.

3. Results

During the study period, a total of 58,454 ovarian cancer patients were hospitalized and underwent gynecologic procedures (Fig. 1); among these, 5827 (9.98%) were classified as *high-cost* (HC) based on hospitalization costs at or above the 90th percentile of total hospitalization costs. The median age of the overall sample was 72 years (interquartile range (IQR) 68–77), and 46,763 (83%) were White. The cohort was distributed evenly among income quartiles, but 88% of patients were covered primarily by Medicare. Most admissions were to large, urban teaching hospitals, and each US region was represented with at least 20% of the total cohort (Table 1).

Compared to the *low-cost* (LC) group, patients in the HC group were more likely to be in the top income quartile (36.1% vs 27.5%, $p < 0.001$) and treated at urban, non-teaching hospitals (21.7% vs 17%, $p < 0.001$) in the Western region of the US (35.1% vs 16.6%, $p < 0.001$). Those in the HC group were also more likely to receive open (96.5% vs 91.1%, $p < 0.001$) or extended surgery (63.7% vs 24.1%, $p < 0.001$) and be non-elective admissions (38.9% vs 15.5%, $p < 0.001$). Conversely, LC patients were more likely to be White, (83.6% vs 77.9%, $p < 0.001$) and have undergone robotic (4.5% vs 1.7%, $p < 0.001$) or traditional laparoscopy (4.4% vs 1.9%, $p < 0.001$) compared to open surgery. LC patients were also more likely to have lower Elixhauser comorbidity scores (3 vs 4, $p < 0.001$). The 2 groups were similar in age, hospital volume of gynecologic procedures and bed size. Table 1 lists the remaining characteristics comparing both groups.

The median cost per admission for the HC group was $55,447 (IQR $46,744–$74,015) and for the LC group $16,463 (IQR $11,845–$23,286) – a greater than three-fold difference. The median lengths of stay were 16 and 5 days, respectively ($p < 0.001$).

From 2010 to 2017, length of stay for the HC group decreased from 20 to 12 days ($p < 0.001$), which correlated with a decrease in cost of admission from $61,122 to $48,506 ($p = 0.002$) (Fig. 2). A modest decrease in length of stay for the LC cohort (from 5 to 4 days, $p < 0.001$) did not translate into decreased cost (from $15,569 to $16,557, $p = 0.004$).

Regarding surgical trends, the proportion of open and extended procedures decreased while minimally invasive procedures increased in both the HC and LC groups. In the HC group specifically, the proportion of open and extended surgery trended down over the study period (from 98.7% to 95.1% and 56.7% to 52.1%, respectively). Robotic and traditional laparoscopic procedures increased from 0.6% to 3.5% and 0.6% to 2.8%, respectively, over this same period.

After accounting for baseline differences using a logistic regression model (Table 2), the Western NIS region (Adjusted Odds Ratio (AOR) 1.72, 1.19–2.29) and top income quartile (AOR 1.77, 1.39–2.27) were both associated with increased likelihood of *high-cost* (Fig. 3). Hispanic women were also more likely to be in the HC group (AOR 1.52, 1.11–2.07), as were patients with higher Elixhauser comorbidity indices (AOR 1.21 per 1-unit score increase, 1.15–1.27).

Clinical characteristics were the most significant predictors of *high-cost* admission (Fig. 4). Compared to patients receiving traditional laparoscopic surgery, those who underwent open surgery were more likely to have *high-cost* admissions (AOR 2.23, 1.31–3.79). Robotic surgery did not increase the likelihood of being in the HC group. The strongest predictors of *high-cost* were non-elective admission (AOR 3.32, 2.74–4.02) and undergoing extended surgical procedures, which more than quintupled the likelihood of being in the HC group (AOR 5.64, 4.79–6.66). Age and hospital factors, including bed size, teaching status and volume of gynecologic oncology surgery, did not affect cost group in this model. Results were similar when patients undergoing minimally-invasive procedures were removed from the analysis (Supplementary Table 2).

4. Discussion

Ovarian cancer is the second most common gynecologic malignancy and the most common cause of gynecologic cancer death in the United States [17]. Despite advancing therapeutics, surgical intervention and inpatient hospitalization remain mainstays of treatment for both initial diagnosis and certain recurrences. [18] Costs associated with these inpatient admissions contribute approximately $450 million annually to US healthcare spending [7].

With increasing use of targeted therapy and an aging population, the overall cost of cancer care is expected to rise [19]. Ovarian cancer will be an important entity to consider in cost reduction strategies as these will have implications not only for national healthcare spending but for individual patients, some of whom experience substantial financial hardship due to cancer care [20]. No studies have attempted to characterize factors associated with the greatest expenditures in ovarian cancer inpatient care.

In this analysis of a national hospitalization database, we characterized the highest cost admissions for ovarian cancer patients greater than or equal to 65 years. Our data corroborated previous studies showing that patients with more medical comorbidities and those undergoing more extensive, complex surgery had costlier inpatient stays [12,21]. Undergoing extended surgery, in particular, had the most substantial financial implications in this analysis. We also demonstrated that certain sociodemographic factors previously shown to increase cost (low-income status, non-White race) were less significant in this population, which was nearly universally covered by Medicare health insurance.

Overall, the median cost for *high-cost* hospitalizations decreased over the study period – possibly a result of increasing neoadjuvant chemotherapy use. Although data is mixed, neoadjuvant chemotherapy has previously been shown to provide cost-savings in comparison to primary debulking surgery by leading to less extensive procedures, fewer surgical complications and less expensive hospital stays [22]. Our results are in line with these findings – the decrease in extended procedures correlating with a decrease in length of stay and decreasing cost in this dataset.

Although prior studies have demonstrated increased costs with robotic versus traditional laparoscopic surgery [23,24], robotic surgery was not associated with *high-cost* hospitalization in this analysis. While still experimental in ovarian cancer management, robotic surgery may be cost-effective when used in appropriate scenarios given the substantial costs associated with laparotomy and prolonged inpatient stay for medically complex ovarian cancer patients [25].

Certain sociodemographic factors were also associated with *high-cost* hospitalization including receiving care in the Western US and being in the top income quartile. Geographic variation in both Medicare and private expenditures is well-documented, largely due to variations in inpatient services utilization and highly variable negotiated prices, respectively [26]. There is also significant geographic variability in the delivery of high-value inpatient care [27].

Overutilization is another important driving force behind rising healthcare costs, a component of which is consumer demand. Employed, educated patients with consistent income and insurance may be more willing to pay for interventions even if they have marginal benefit [28]. Patient demand for additional diagnostic or therapeutic interventions may subsequently encourage a culture of overutilization [28].

Interestingly, sociodemographic factors like non-White race and low-income status that have previously been classified as risk factors for *high-cost* [29,30] were less significant in this study. Late diagnosis as a result of being under- or un-insured has been posited as a reason for *high-cost* in non-White cancer patients – higher disease burden requiring more extensive surgery leading to more costly hospitalizations [12]. It is possible that the near-universal coverage of patients ≥65 years by Medicare mitigates some of these effects and reduces the degree of racially, socially-disparate care (Supplementary Table 3). This is an important finding particularly as conversations around healthcare reform, access and health equity continue to evolve.

The present study has several important limitations. The NIS does not record more detailed clinical information including stage of disease, intensive care utilization or rates of readmission. Additionally, the cost and charge variables collected do not include out-of-pocket estimates, which are largely driven by inpatient hospitalizations and have important implications for patients [31]. This study also deals with absolute cost and not cost-effectiveness. Inpatient surgical admissions are one aspect of absolute cost – thus, overall cost of ovarian cancer care was not evaluated. This analysis should be interpreted with the understanding that other variables impact ovarian cancer costs.

Ultimately, further study is needed to explore cost-effectiveness related to outcomes including readmission rate, survival and quality of life measures. Future directions may include collaboration with existing structures like the Center for Medicare and Medicaid Innovation (CMMI), which has developed an Oncology Care Model (OCM) aimed at improving value-based care [32]. A prospective study of the OCM in ovarian cancer care would allow analysis of cost with focus on adherence to nationally-recognized care guidelines, end of life management (i.e. incorporation of palliative care) and care coordination between providers. The data presented in this paper may help inform future decision-making around surgical algorithms designed to maximize the use of appropriate interventions, especially within a population of elderly patients at risk for *high-cost*.

In sum, the top 10% most costly hospitalizations for older ovarian cancer patients had three times higher cost than the remainder of hospitalizations. Those in the *high-cost* group were more likely to have medical co-morbidities, undergo larger, more complex surgery and be of the highest socioeconomic status. Further elucidating the relationships between disease-specific and social factors to cost will be important in informing future value-based care models specific to ovarian cancer patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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HIGHLIGHTS

- The top 10% of operative hospitalizations for ovarian cancer patients are three times more expensive than the remainder
- Clinical factors, including open and extended surgery, are the biggest predictors of high cost
- Non-White race and low-income status are not significant predictors of high cost in this group largely covered by Medicare

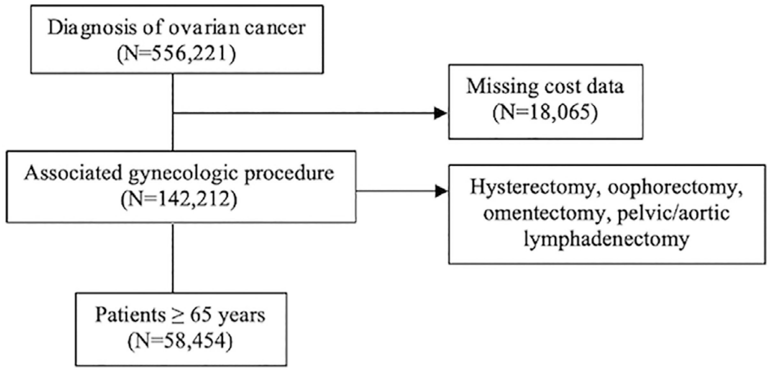

Fig. 1.
Study cohort using the National Inpatient Survey (2010–2017)

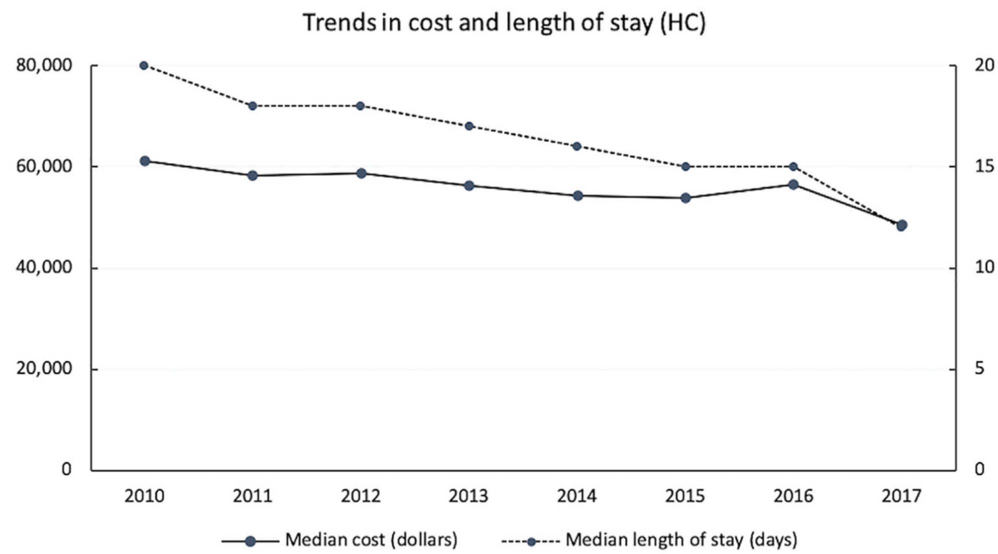

Fig. 2.

Yearly trends of median cost (dollars) and length of stay (days) for the HC cohort.

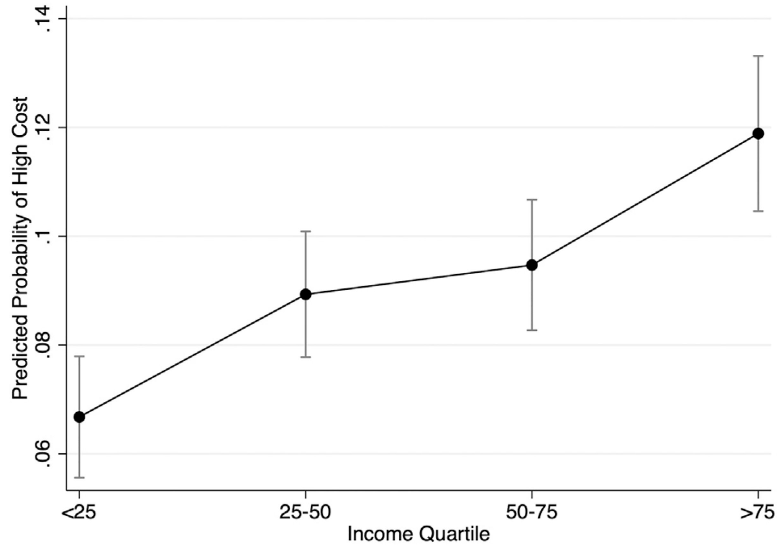

Fig. 3.

Probability of high-cost admission by income quartile.

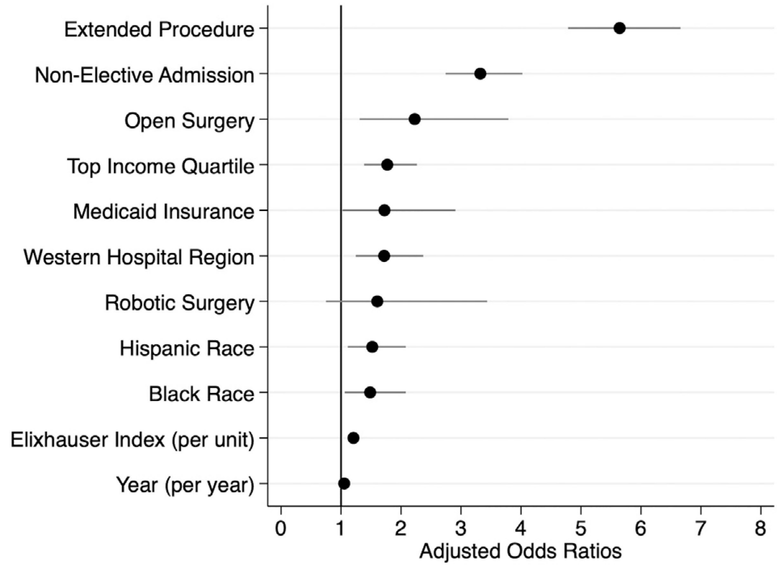

Fig. 4.

Independent risk factors for high-cost admission.

Table 1

Sample demographics stratified by cost group, 2010–2017.

	All (*N* = 58,336)	High Cost (*N* = 5827)	Lower Cost (*N* = 52,509)	*P*-Value
Age (year, median, IQR)	72 (68–77)	72 (68–77)	72 (68–77)	0.901
Elixhauser score (median, IQR)	4 (3–5)	4 (3–5)	3 (2–5)	<0.001
Age Range (%)				0.877
65–80	82.9	82.7	82.9	
≥80	17.1	17.3	17.1	
Admission Type (%)				<0.001
Non-elective	17.8	38.9	15.5	
Race (%)				<0.001
White	83.0	77.9	83.6	
Black	5.9	6.4	5.9	
Hispanic	5.7	7.8	5.5	
Asian	2.6	4.6	2.4	
Other	2.8	3.3	2.7	
Income quartile (%)				<0.001
0–25	21.6	16.6	22.1	
26–50	24.3	22.2	24.5	
51–75	25.8	25.1	25.9	
76–100	28.4	36.1	27.5	
Insurance Status (%)				<0.001
Medicare	87.6	86.0	87.8	
Medicaid	1.1	2.4	1.0	
Private	10.3	10.5	10.3	
Other	1.0	1.1	1.0	
Hospital location, teaching status (%)				<0.001
Rural, Non-teaching	2.0	2.1	2.0	
Urban, Non-teaching	17.4	21.7	17.0	
Urban, Teaching	80.5	76.2	81.0	
Hospital bed size (%)				0.677
Small	8.0	8.8	8.0	
Medium	21.5	21.6	21.4	
Large	70.5	69.6	70.6	
Hospital region (%)				<0.001
Northeast	19.6	22.0	19.3	
Midwest	22.7	16.4	23.4	
South	36.6	26.5	37.7	
West	21.1	35.1	16.6	
Hospital procedural volume (%)				0.093
Low	32.6	36.8	32.2	
Medium	33.8	31.6	34.0	

	All (*N* = 58,336)	High Cost (*N* = 5827)	Lower Cost (*N* = 52,509)	*P*-Value
High	33.6	31.6	33.8	
Type of surgery				<0.001
Open	91.6	96.5	91.1	
Robotic	4.2	1.7	4.5	
Traditional laparoscopic	4.2	1.9	4.4	
Additional procedures				
Extended procedure	28.0	63.7	24.1	<0.001

Table 2

Multivariate analysis – model includes age, Elixhauser comorbidity index, admission type, race, insurance, income quartile, hospital location, teaching status, size and region, hospital procedural volume and type of procedure *AOR: adjusted odds ratio.

	AOR	95% CI	P-Value
Age Range		Referent	
65–80		Referent	
≥80	0.94	0.76–1.15	0.528
Elixhauser Index (per 1-point increment)	1.21	1.15–1.27	<0.001
Admission Type			
Elective		Referent	
Non-Elective	3.32	2.74–4.02	<0.001
Race			
White		Referent	
Black	1.49	1.06–2.08	0.021
Hispanic	1.52	1.11–2.07	0.009
Asian	1.51	1.00–2.26	0.049
Other	1.53	0.98–2.37	0.061
Income Quartile			
0–25		Referent	
26–50	1.40	1.09–1.81	0.009
51–75	1.54	1.19–1.99	<0.001
76–100	1.77	1.39–2.27	<0.001
Insurance Status			
Medicare		Referent	
Medicaid	1.72	1.02–2.01	0.041
Private	1.02	0.79–1.31	0.860
Other	1.00	0.42–2.40	0.996
Hospital location, teaching Status			
Rural, Non-teaching		Referent	
Urban, Non-teaching	1.23	0.60–2.53	0.567
Urban, Teaching	1.13	0.56–2.28	0.736
Hospital Region			
Northeast		Referent	
Midwest	0.55	0.41–0.82	<0.001
South	0.53	0.40–0.73	<0.001
West	1.72	1.19–2.29	<0.001
Hospital Size			
Small		Referent	
Medium	1.15	0.81–1.63	0.426
Large	0.95	0.69–1.30	0.737
Hospital Volume			

	AOR	95% CI	P-Value
Low		Referent	
Medium	0.95	0.75–1.21	0.697
High	1.18	0.90–1.54	0.230
Type of procedure			
Robotic Referent			
Traditional laparoscopic	1.60	0.75–3.44	0.223
Open	2.23	1.31–3.79	0.003
Additional procedures			
No extended procedure	5.64	Referent	<0.001
Extended procedure		4.79–6.66	