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Socioeconomic status as a predictor of adherence to treatment guidelines for early-stage ovarian cancer

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Abstract

Objective—Investigate the impact of socioeconomic status and other demographic variables on adherence to the National Comprehensive Cancer Network ovarian cancer treatment guidelines among patients with stage I/II disease.

Methods—Patients diagnosed with stage I/II epithelial ovarian cancer between 1/1/96–12/31/06 were identified from the California Cancer Registry. Univariate analysis and multivariate logistic regression models were used to evaluate differences in surgical procedures, chemotherapy regimens, and overall adherence to the NCCN guidelines according to increasing SES quintiles (SES-1 to SES-5).

Results—A total of 5445 stage I and II patients were identified. The median age at diagnosis was 54.0 years (range = 18–99 years); 72.5% of patients had stage I disease, while 27.5% had stage II disease. With a median follow-up time of 5 years, the 5-year ovarian cancer-specific survival for all patients was 82.7% (SE = 0.6%). Overall, 23.7% of patients received care that was adherent to the NCCN guidelines. Compared to patients in the highest SES quintile (SES-5), patients in the lowest SES quintile (SES-1) were significantly less likely to receive proper surgery (27.3% vs 47.9%, $p < 0.001$) or chemotherapy (42.4% vs 53.6%, $p < 0.001$). There were statistically significant trends between increasing SES and the likelihood of overall treatment plan adherence to the NCCN guidelines: SES-1 = 16.4%, SES-2 = 19.0%, SES-3 = 22.4%, SES-4 = 24.2% and SES-5 = 31.6% ($p < 0.001$). Multivariate logistic regression analysis revealed that compared to SES-5, decreasing SES was independently predictive of a higher risk of non-standard overall care.

Conclusions—For patients with early-stage ovarian cancer, low SES is a significant and independent predictor of deviation from the NCCN guidelines for surgery, chemotherapy, and overall treatment.

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Conflict of interest

The authors report no conflict of interest.

Keywords

Socioeconomic status; NCCN; Ovary cancer; Adherent care

1. Background

Ovarian cancer remains the most deadly gynecologic cancer in the United States, with approximately 22,000 new cases diagnosed in 2014 and 14,000 related deaths [1]. This high mortality rate is largely linked to the disproportionate percentage of women diagnosed with advanced stage disease. While the Surveillance, Epidemiology, and End Results program (SEER) data estimates a 30% five year survival rate for women with advanced stage disease, women with stage I/II cancer have survival rates of 50–90% when they receive appropriate care. Because early stage disease is often curable, it is especially important that these women receive high quality care. Evidence-based treatment guidelines for early stage ovarian cancer have been put forth by the National Comprehensive Cancer Network (NCCN) and include comprehensive surgical staging followed by either chemotherapy or surveillance based on surgico-pathologic characteristics. These guidelines have been validated as correlating with improved disease-specific survival and can be considered a process measure of high-quality cancer care [2].

Despite standardized treatment guidelines, socio-demographic disparities in ovarian cancer survival have been well documented [3–5]. Lower survival rates have been associated with low socioeconomic status (SES), Black race, publicly funded insurance, and lack of insurance [4]. Given these disparities in survival rates, much work has been directed at identifying potentially modifiable variables that determine the quality of care received. Disparities exist in all aspects of ovarian cancer care from access to general gynecologic care to obtaining a diagnosis to receiving comprehensive treatment. The objective of the current study was to investigate the impact of SES, and other demographic variables, on adherence to NCCN ovarian cancer treatment guidelines among patients with stage I/II disease.

2. Methods

This was a retrospective population-based study of stages I and II invasive epithelial ovarian cancer cases reported to the California Cancer Registry (CCR) between January 1, 1996 and December 31, 2006 and received exempt status by the Institutional Review Board of the University of California, Irvine (HS#2011-8317). CCR case reporting is estimated to be 99% for the entire state of California, with follow-up completion rates exceeding 95% [6]. The International Classification of Disease Codes for Oncology (ICD-O) based on the World Health Organization criteria were used for tumor location and histology. Cases were identified using ovarian SEER primary site code (C569).

The study population included women who were older than 18 and diagnosed with first or only invasive epithelial ovarian cancer. A total of 21,044 incident ovarian cancer cases were identified with follow-up through January 2008. Of these, 5445 cases of stage I or II invasive epithelial ovarian cancer were included as the final study population after excluding 13,178

cases with stage III or IV disease, 2030 with incomplete staging information, 179 cases with borderline, germ cell, sex cord–stromal tumors or missing ICD-O-2 morphology code, 69 cases that were prepared from autopsy or death certificate only or had unknown surgery and/or chemotherapy information, 132 with incomplete clinical information and 11 with incomplete hospital information.

Explanatory variables included patient, tumor and health care provider characteristics. Race/ethnicity of the patient was categorized into four groups: White, Black, Hispanic and Asian/Pacific Islander. Insurance type was grouped into five categories: Managed care (managed care, HMO, PPO or private insurance), Medicaid, Medicare, other insurance type and not insured. Socioeconomic Status (SES) was classified into five quintiles, lowest (SES-1), lower-middle (SES-2), middle (SES-3), higher-middle (SES-4) and highest (SES-5) based on the Yost score. The Yost score is a composite index of socioeconomic status contained in the CCR that is based on principal component analysis of block group level census variables such as education, income and occupation [7]. Age at diagnosis was used either as a continuous variable or categorical variable with four groups, younger than 45 years old, 45 to 54 years old, 55 to 69 years old, and ages 70 years or older.

Hospital volume was based on the average number of ovarian cancer cases treated annually in each hospital during the study period. Hospitals with 20 or more cases per year were classified as high volume hospital; hospitals with less than 20 cases per year were low volume [8–11]. Hospital type was classified according to whether or not it had an American College of Surgeons (ACoS) approved cancer program. Physician volume was derived as an average of the annual number of cases from the patients' physician (surgeon, medical oncologist or attending physician). Physicians that had 10 or more cases per year were classified as high volume physicians and those with less than 10 cases per year were low volume [8–11]. Based on what type of treatment the patient received, each patient was classified as treated by a high volume physician if any of her physicians was high volume. Physician volume was categorized as unknown if the case had no specific physician information. Tumor characteristic such as grade, histology and size of the tumor were also included as explanatory variables. Of note the grading system used in the tables is taken from the California Cancer Registry dictionary that defines grade I as well differentiated, grade II as moderately well differentiated, grade III as poorly differentiated and grade IV as undifferentiated/anaplastic.

Outcome variables included adherence to the NCCN ovarian cancer treatment guidelines for surgery, chemotherapy, and the overall treatment program (both surgery and chemotherapy) based on the NCCN recommendations for surgery and chemotherapy according to the time period of diagnosis (1997–2005) [12–14]. For FIGO stages I–II, surgical treatment was considered adherent to the NCCN guidelines if it included a minimum of oophorectomy (±hysterectomy), pelvic and/or para-aortic lymph node biopsy, and omentectomy. For cases of stages IA–IB, grade 1–2 disease, no adjuvant treatment was considered adherent to the NCCN guidelines. Administration of multi-agent chemotherapy was considered appropriate for cases of stages IC–II or grade 3 disease. Surgery must have preceded chemotherapy for stages I–II to be considered adherent to the NCCN guidelines. Oophorectomy with

omentectomy and lymph node biopsy was considered complete staging surgery and was used as the referent category.

Overall treatment adherence to the NCCN guideline was analyzed as a dichotomous variable. Differences of characteristics among surgery/chemotherapy/treatment sequence/overall treatment adherence groups were analyzed with χ^2 Test or Fisher's Exact Test for categorical variables. After examining proportion odds assumption and model fit, a multinomial logistic regression model was chosen to perform multivariate analysis for outcomes that had more than two categories. The guideline-adherent treatment category was set up as the referent in the model for each outcome variable. Binary logistic regression was performed for dichotomous outcomes. Odds ratios and their 95% confidence interval were listed. All tests were two-sided. Statistical analysis was performed using SAS 9.2 (SAS Institute Inc., Cary, NC).

3. Results

Subject demographics are shown in Table 1. White patients accounted for 65.0% of cases, followed in frequency by Hispanics (16.6%), Asian/Pacific Islanders (14.5%), and Blacks (3.9%). Managed care was the most common payer category (53.9%), and 19.5% of patients had Medicare. The median age at diagnosis was 54.0 years (range 18–99 years, standard deviation [SD] = 15.8 years). Stage I disease was present in 3947 patients (72.5%), while 1498 patients (27.5%) had stage II disease. A majority of patients (63.9%) were treated by low volume surgical providers compared to high volume surgical providers (16%). With a median follow-up time of 5 years, the 5-year ovarian cancer-specific survival for all patients was 82.7% (standard error [SE] = 0.6).

Among the study population, only 37.2% of patients underwent a complete staging operation. Differences in surgical management were found between patients of various demographic groups. Black and Hispanic patients were less likely to receive complete staging when compared to Asian/Pacific Islander and White women (30%, 31%, 43% and 38% respectively). According to socioeconomic status, 47.9% of patients in the highest socioeconomic status category (SES-5) received staging surgery including lymph node biopsy, while just 27.3% of patients in the lowest socioeconomic status category (SES-1) received the same care ($p < 0.0001$).

Patients in the lowest socioeconomic category were twice as likely to undergo only removal of the primary mass (±hysterectomy) without staging surgery (OR = 2.38, 95% CI = 1.78–3.17, Table 2) compared to the standard of care, which includes oophorectomy with omentectomy or debulking and lymph node biopsy (Tables 3A and 3B). Rates of lymph node dissection also varied significantly by SES, as patients in SES-1 were significantly less likely than those in SES-5 to undergo lymph node biopsy even when surgical staging was performed (OR = 2.3 95% CI = 1.69–3.03). There was a statistically significant linear relationship for receipt of complete staging surgery from SES-1 to SES-5 (SES-1 = 27%, SES-2 = 32%, SES-3 = 35%, SES-4 = 38%, SES-5 = 48%).

Insurance status and provider and hospital volume were also related to receipt of appropriate surgery. Patients with managed care underwent full staging surgery 40% of the time compared to 30% of women who were not insured. Medicare patients were significantly more likely to undergo only removal of the affected ovary (±hysterectomy) when compared to patients in the managed care group (OR = 1.36, 95% CI = 1.06–1.73). Uninsured patients were also significantly less likely than patients in managed care organizations to undergo lymph node biopsy during staging surgery (OR = 0.74, 95% CI = 0.58–0.94). Women who were treated at high volume hospitals and by high volume physicians received complete surgical staging more often compared to women treated at low volume hospitals and by low volume physicians (46.2% and 50.4% vs 35.3% and 34.1%, respectively) (Table 4).

Appropriate receipt of chemotherapy was stratified based on stage and grade: patients with stage I, grade 1 or 2 disease (for whom no adjuvant treatment is recommended) and patients with stage II or grade 3 stage I disease (for whom adjuvant treatment with multi-agent chemotherapy is recommended). Of 1902 women with stage 1, grade 1 or 2, 60% did not receive chemotherapy. Women in SES-1 were significantly less likely to receive chemotherapy than women in SES-5 (60 vs 62%, p = 0.0068). Women that received care in a high volume hospital were less likely to receive chemotherapy versus those that received care at a low volume hospital, 50 vs 60% respectively. Conversely, patients receiving care by a low volume physician were less likely to receive chemotherapy than a patient receiving care by a high volume physician, 61% vs 54% respectively (p = 0.0073). Medicare patients with stage 1, grade I and II disease were less likely to receive chemotherapy compared to those in the managed care category (OR = 0.58, 95% CI = 0.41–0.83).

Of women with disease greater than stage I, grade 1 or 2, 38% of patients insured by Medicare received multi-agent chemotherapy versus 50% of patients with managed care (p = .001). There was a linear relationship between women with increasing SES and receipt of multi agent chemotherapy (SES-1 42%, SES-5 54%) (p < 0.001). Only 44% of women treated at a low volume hospital received multi-agent chemotherapy compared to 60% at high volume hospitals (p < .001). Racial differences were noted in this group, with 52% of Asian women receiving multiple agent chemotherapy compared to 47% of White women, 44% of Black women and 43% of Hispanic women (p = 0.0034) (Table 5).

Overall, only 24% of patients received both surgery and chemotherapy according to the NCCN guidelines. Significant differences in the NCCN guideline adherence were demonstrated among socioeconomic groups when stage-specific chemotherapy and surgical recommendations were evaluated. While 32.6% of patients in the highest SES category received guideline adherent care, only 16.4% in the lowest SES met these criteria (p = 0.0002). Multinomial logistic regression model for adherence to the NCCN guidelines confirmed that patients of the lowest SES were two times less likely to receive treatment adherent to the guidelines in comparison to the highest SES group.

4. Conclusions

Ovarian cancer remains one of the leading causes of gynecologic cancer-related deaths in women in the United States. Multiple improvements have been made in the care of ovarian

cancer patients, however these improvements have not been equally distributed among women of all races, income levels and SES. The inverse relationship between SES and health outcomes is well established, with lower SES associated with higher all-cause and cancer-specific mortality [15]. In light of recent research linking adherence to evidence-based guidelines to improved survival for patients with early stage ovarian cancer, the results of this study emphasize the disproportionate burden of substandard care experienced by disadvantaged populations [4].

Our data are consistent with previously published research on SES-associated disparities in ovarian cancer survival rates. A 2012 population-based analysis of the National Cancer Data Base records demonstrated that ovarian cancer patients of all stages with no insurance, Medicaid, or median household incomes of less than $35,000 had statistically significant higher mortality rates than those of patients with higher SES [4]. Our analysis identified low SES as a statistically significant and independent predictor of receiving treatment that was not adherent to the NCCN treatment guidelines, which has been shown to be associated with lower survival. Only 16% of patients from the lowest SES had treatment in adherence to guidelines compared to 32% of patients of the highest SES. In addition, surgically staged patients of low SES were two times less likely to receive the appropriate surgical staging procedure, and patients with Medicare were more likely to undergo incomplete surgical procedures at significantly higher rates than their counterparts in managed care organizations.

Although racial disparities exist in regards to care and survival of patients with ovarian cancer, available data that analyzes adherence to care based on the NCCN guidelines in patients with early stage disease is limited. Bristow et al. have previously shown that Black race was independently associated with a 36% increased likelihood of not receiving the NCCN guideline-adherent care in patients with ovarian cancer, not analyzed based on stage [4]. Similar findings were reported by Howell et al., who showed that when controlled for other characteristics, Black women with advanced (stage III or IV) ovarian cancer were significantly less likely to receive complete treatment than White women [5]. Chan studied 24,038 women from the SEER database and found that among patients with early stage disease, only 38.9% of Blacks had lymphadenectomy compared to 46.9% of Whites [3]. Our data demonstrate that this holds true for Black women with stage I ovarian cancer as well. Our paper demonstrated that Black women were less likely to undergo appropriate surgical staging when compared to other racial groups.

Adherence to care in patients with early stage ovarian cancer has been examined, however few studies discuss the relationship between adherent care and SES. Early stage ovarian cancers represent a diagnostic dilemma in many cases, with a less than obvious clinical presentation and potentially a higher likelihood of being operated on by provider that has not been trained to care for patients with cancer. Adherence to appropriate guidelines may be more challenging in this population as evidenced by our overall low rate of adherence (24%). A 2003 study by Harlan et al. examined patterns of care between 1991 and 1996 and demonstrated that patients with stage I and II ovarian cancer received the appropriate surgical adherence staging procedure only 38% of the time in 1991 and 59% in 1996 [16]. In another study by Harlan et al. in 2005, patients from the SEER Patterns of Care database

were studied. The proportion of patients receiving guideline-adherent care ranged from 23.9% to 35.2%, depending on insurance status, this study however did not look at SES specifically as an indicator [17].

A recent study examined the reasons for failure to deliver NCCN adherent care in the treatment of ovarian cancer at an NCCN care center. Erickson et al. examined 367 patients between 2004 and 2009 and found that 22% of these patients did not receive adherent care. The most common reason to fail adherence to care was failure to receive the appropriate chemotherapy. This study also demonstrated that patients with stage I or II disease were more likely to receive adherent care [18]. These data, as well as the current study, highlight the importance of adherence to care. Providers can easily access the current treatment guidelines and help improve the care patients receive therefore every effort should be made to attempt to adhere to guidelines. A recent spatial analysis was performed by Bristow et al. in patients with advanced stage ovarian cancer and demonstrated that geographic location was an important predictor of advanced stage ovarian cancer overall mortality and this effect was primarily related to access to a high volume hospital and adherence to the NCCN guidelines [19]. For patients with suspected early stage ovarian cancer, patients and third party payers will be increasingly interested in quality measures that are associated with improved outcomes such as access to care and access to high volume hospitals. A standardized referral system would ensure that patients are likely to get care from physicians who are more likely to administer the standard of care such as high volume hospitals and high volume physicians. Additional research is needed to define the financial implications of a more structured referral system for patients with suspected early stage ovarian cancer.

There are several strengths and limitations of the current study. Strengths include the proven reliability of the California Cancer Registry, the large number of patients, the ability to study multiple data points and the innovative findings of this paper that have not been studied in the literature prior. There are also several limitations that must be considered. First, this was a retrospective study design using a population-based data set. This study design is subject to selection bias. Second, and perhaps most importantly, we were unable to control for potentially important unreported variables that could influence both survival outcome as well as the likelihood of administration of recommended care. Such variables include the presence of medical comorbidities, the extent of initial disease and amount of residual tumor, cumulative chemotherapy dose and dose intensity, and management of recurrent disease.

In conclusion, among patients with early-stage ovarian cancer, low SES is a significant and independent predictor of deviation from the NCCN guidelines for surgery, chemotherapy, and overall treatment. It is important that such healthcare disparities are identified in order to add to the ongoing dialogue about the individual, system and society-level factors that impact women’s survival. Adherence to the NCCN guidelines is a tangible goal that can significantly impact survival rates of cancer patients, and the identification of specific deviations from these guidelines may serve as a catalyst for developing interventions to reduce disparities. Additional research is needed to further identify reasons for deviation from recommended care and to develop appropriate risk-adjusted measurement models,

interventions and policies that encourage provision of high-quality standards of care to all women.

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HIGHLIGHTS

- Disadvantaged populations experience substandard ovarian cancer care.
- Specifically, lower socioeconomic status is an independent predictor of receiving sub-optimal ovarian cancer treatment that deviates from the NCCN guidelines.
- Adherence to the NCCN guidelines has the potential to improve ovarian cancer survival rates among all populations of women.

Table 1

Patient, tumor and provider characteristics in study population.

Characteristics	n	%
Total	5445	100
Race		
White	3540	65.0
African American	211	3.9
Hispanic	903	16.6
Asian/Pacific Islander	791	14.5
Insurance		
Managed care	2932	53.9
Medicare	1061	19.5
Medicaid	454	8.3
Other ins	800	14.7
Not insured	198	3.6
SES		
Lowest SES	671	12.3
Lower-middle SES	996	18.3
Middle SES	1190	21.9
Higher-middle SES	1267	23.3
Highest SES	1321	24.3
Age		
<45	1284	23.6
45–54	1483	27.2
55–69	1527	28.0
≥70	1151	21.1
Stage		
I	3947	72.5
II	1498	27.5
Grade		
Grade I	1007	18.5
Grade II	1387	25.5
Grade III	1272	23.4
Grade IV	355	6.5
Grade not stated	1424	26.2
Histology		
Serous	1188	21.8
Mucinous	806	14.8
Endometrioid	1314	24.1
Clear cell	625	11.5
Adenocarcinoma, NOS	281	5.2
Other	1231	22.6

Characteristics	n	%
Tumor size		
≤5 cm	805	14.8
5–10 cm	1090	20.0
>10 cm	1845	33.9
Unknown	1705	31.3
Hospital volume		
High volume	977	17.9
Low volume	4468	82.1
Hospital type		
ACoS approved	1778	32.7
Not ACoS approved	2192	40.3
Unknown	1475	27.1
Physician volume		
High	869	16.0
Low	3480	63.9
Physician unknown	1096	20.1
Hospital volume and physician volume		
High volume hospital & high volume physician	226	4.2
High volume hospital & low volume physician	489	9.0
Low volume hospital & high volume physician	643	11.8
Low volume hospital & low volume physician	2991	54.9
High volume hospital & unknown volume physician	262	4.8
Low volume hospital & unknown volume physician	834	15.3
Surgery type		
1 = no surgery	254	4.7
2 = removal of ovary ± hysterectomy	2035	37.4
3 = oophorectomy with omentectomy	2666	49.0
4 = Debulking	490	9.0
Lymph node biopsy		
Had biopsy	2865	52.6
No biopsy	2580	47.4
Surgery and lymph node biopsy		
1 = no surgery, no biopsy	254	4.7
2 = oophorectomy ± hysterectomy, had biopsy	838	15.4
3 = oophorectomy ± hysterectomy, no biopsy	1197	22.0
4 = oophorectomy with omentectomy (or debulking), had biopsy	2027	37.2
5 = oophorectomy with omentectomy (or debulking), no biopsy	1129	20.7
Chemo type		
1 = No chemo — other reason	2538	46.6
2 = Recommended, but no chemo	360	6.6
3 = Had chemo, not multiple agent	303	5.6
4 = Had chemo-multiple agent	2244	41.2

Characteristics	n	%
Treatment sequence		
0 = No trt	153	2.8
1 = Only surgery	2736	50.3
2 = Only chemo	91	1.7
3 = Both surgery and chemo, unknown date	57	1.1
4 = surgery + neoadjuvant chemotherapy	2340	43.0
5 = neoadjuvant chemotherapy + surgery	68	1.3
Treatment plan adherence		
Adherence	1288	23.7
Non-adherence	4157	76.4

Table 2

Multinomial logistic regression analysis on surgery and lymph node biopsy.

Characteristics	1 = no surgery, no biopsy (n = 254, 5%)			2 = oophorectomy ± hysterectomy, had biopsy (n = 838, 15%)			3 = oophorectomy ± hysterectomy, no biopsy (n = 1197, 22%)			5 = oophorectomy with omentectomy (or debulking), no biopsy (n = 1129, 21%)		
Race												
White	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
African American	1.75	0.77	3.97	0.94	0.59	1.50	1.27	0.86	1.88	1.06	0.69	1.62
Hispanic	1.07	0.63	1.82	1.16	0.91	1.48	1.09	0.87	1.36	1.16	0.92	1.47
Asian/Pacific Islander	0.62	0.32	1.20	0.86	0.68	1.09	0.84	0.67	1.06	0.97	0.77	1.22
Insurance												
Managed care	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
Medicare	1.42	0.90	2.23	1.01	0.76	1.34	1.36	1.06	1.73	1.18	0.94	1.50
Medicaid	1.57	0.74	3.35	0.96	0.69	1.34	1.27	0.96	1.69	1.05	0.77	1.42
Other ins	0.53	0.22	1.27	1.11	0.88	1.39	0.93	0.75	1.17	0.74	0.59	0.94
Not insured	1.66	0.56	4.91	1.36	0.87	2.13	1.37	0.91	2.07	1.28	0.83	1.96
SES												
Lowest SES	2.48	1.24	4.99	1.48	1.07	2.05	2.38	1.78	3.17	2.26	1.69	3.03
Lower-middle SES	2.61	1.45	4.73	1.42	1.09	1.85	1.93	1.51	2.47	1.94	1.52	2.48
Middle SES	1.87	1.05	3.36	1.39	1.09	1.77	1.83	1.45	2.30	1.74	1.38	2.20
Higher-middle SES	2.61	1.47	4.62	1.42	1.13	1.78	1.47	1.17	1.85	1.51	1.21	1.90
Highest SES	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
Age	1.08	1.06	1.09	1.00	0.99	1.00	1.00	1.00	1.01	1.01	1.01	1.02
Stage												
I	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
II	2.09	1.42	3.06	0.57	0.47	0.70	0.57	0.47	0.69	1.08	0.90	1.28
Grade												
Grade I	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
Grade II	1.84	0.49	6.95	0.82	0.64	1.05	0.67	0.53	0.84	0.99	0.78	1.26
Grade III	1.79	0.51	6.37	0.95	0.72	1.23	0.71	0.56	0.91	1.09	0.84	1.41
Grade IV	1.84	0.44	7.75	1.10	0.76	1.58	0.64	0.44	0.92	0.87	0.60	1.26
Grade not stated	30.56	9.09	102.67	1.25	0.95	1.64	1.50	1.17	1.91	1.46	1.12	1.92

Characteristics	1 = no surgery, no biopsy (n = 254, 5%)			2 = oophorectomy ± hysterectomy, had biopsy (n = 838, 15%)			3 = oophorectomy ± hysterectomy, no biopsy (n = 1197, 22%)			5 = oophorectomy with omentectomy (or debulking), no biopsy (n = 1129, 21%)		
Histology												
Serous	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
Mucinous	0.77	0.32	1.86	0.92	0.69	1.24	1.18	0.91	1.54	0.84	0.64	1.09
Endometrioid	0.76	0.32	1.82	0.97	0.76	1.25	0.87	0.69	1.11	0.77	0.62	0.97
Clear cell	0.10	0.02	0.47	0.76	0.56	1.02	0.46	0.34	0.63	0.62	0.46	0.82
Adenocarcinoma, NOS	24.74	13.26	46.14	1.35	0.83	2.20	1.45	0.93	2.28	0.92	0.59	1.45
Other	3.52	2.07	5.99	0.94	0.72	1.22	1.60	1.27	2.02	0.80	0.63	1.02
Tumor size												
≤5 cm	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
5–10 cm	0.60	0.30	1.23	1.01	0.76	1.33	0.51	0.40	0.66	0.89	0.67	1.16
>10 cm	0.39	0.20	0.77	0.89	0.68	1.15	0.43	0.34	0.54	0.98	0.76	1.25
Unknown	2.58	1.43	4.65	0.95	0.73	1.25	0.76	0.61	0.96	1.09	0.84	1.41
Hospital volume												
High volume	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
Low volume	1.49	0.85	2.61	0.74	0.61	0.90	1.97	1.58	2.46	1.81	1.45	2.25
Hospital type												
ACoS approved	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
Not ACoS approved	1.04	0.66	1.63	1.02	0.84	1.23	1.09	0.91	1.32	0.75	0.62	0.92
Unknown	1.92	1.19	3.11	0.82	0.64	1.05	2.42	1.96	2.97	3.69	3.04	4.50
Physician volume												
High volume	1.00	–	–	1.00	–	–	1.00	–	–	1.00	–	–
Low volume	9.68	3.59	26.07	1.50	1.19	1.89	2.43	1.92	3.09	1.25	1.02	1.53
Physician unknown	7.13	2.47	20.63	1.98	1.50	2.61	2.27	1.71	3.02	1.00	0.77	1.31

Outcome referent group is “4 = oophorectomy with omentectomy or debulking, had lymph node biopsy”.

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Table 3A

Multinomial logistic regression analysis on chemotherapy type.

	Recommended, but no chemo (n = 104, 6%)			Had chemo, single or multiple agent (n = 664, 35%)		
Characteristics	**O.R.**	**95%**	**C.I.**	**O.R.**	**95%**	**C.I.**
Race						
White	1.00	–	–	1.00	–	–
African American	2.64	1.13	6.17	1.02	0.56	1.84
Hispanic	1.31	0.73	2.37	1.18	0.87	1.60
Asian/Pacific Islander	0.92	0.47	1.82	1.13	0.83	1.54
Insurance						
Managed care	1.00	–	–	1.00	–	–
Medicare	0.76	0.40	1.46	0.58	0.41	0.83
Medicaid	0.84	0.38	1.88	0.90	0.61	1.33
Other ins	0.84	0.44	1.58	0.91	0.68	1.23
Not insured	0.98	0.33	2.91	1.08	0.64	1.82
SES						
Lowest SES	1.23	0.49	3.08	0.91	0.61	1.36
Lower-middle SES	1.56	0.71	3.43	0.73	0.52	1.03
Middle SES	2.39	1.18	4.83	0.90	0.66	1.22
Higher-middle SES	2.74	1.37	5.48	1.02	0.76	1.38
Highest SES	1.00	–	–	1.00	–	–
Age	1.01	0.99	1.02	1.00	0.99	1.00
Grade						
Grade I	1.00	–	–	1.00	–	–
Grade II	1.77	1.16	2.70	3.17	2.55	3.93
Histology						
Serous	1.00	–	–	1.00	–	–
Mucinous	0.51	0.28	0.93	0.41	0.29	0.57
Endometrioid	0.56	0.32	0.98	0.80	0.59	1.08
Clear cell	1.10	0.29	4.16	2.51	1.29	4.89
Adenocarcinoma, NOS				0.33	0.13	0.88

	Recommended, but no chemo (n = 104, 6%)			Had chemo, single or multiple agent (n = 664, 35%)		
Characteristics	**O.R.**	**95%**	**C.I.**	**O.R.**	**95%**	**C.I.**
Other	0.35	0.16	0.76	0.62	0.43	0.90
Tumor size						
≤5 cm	1.00	–	–	1.00	–	–
5–10 cm	1.71	0.85	3.43	2.01	1.40	2.91
>10 cm	1.25	0.66	2.38	1.89	1.36	2.64
Unknown	1.06	0.54	2.05	1.37	0.98	1.93
Hospital volume						
High volume	1.00	–	–	1.00	–	–
Low volume	0.88	0.50	1.55	0.56	0.43	0.73
Hospital type						
ACoS approved	1.00	–	–	1.00	–	–
Not ACoS approved	0.92	0.53	1.60	0.70	0.54	0.91
Unknown	1.68	0.99	2.86	0.95	0.73	1.24
Physician volume						
High volume	1.00	–	–	1.00	–	–
Low volume	1.36	0.69	2.67	0.77	0.58	1.01
Physician unknown	2.03	0.95	4.35	0.85	0.60	1.22

Outcome referent group is “No chemo — other reason”) on subset 1 of patients with stage IA or IIB and grade I or II tumor, (n = 1902).

Table 3B

Multinomial logistic regression analysis on chemotherapy type.

	1 = No chemo – other reason (n = 1404, 40%)			2 = Recommended, but no chemo (n = 256, 7%)			3 = Had chemo, not multiple agent (n = 217, 6%)		
Characteristics	**O.R.**	**95%**	**C.I.**	**O.R.**	**95%**	**C.I.**	**O.R.**	**95%**	**C.I.**
Race									
White	1.00	–	–	1.00	–	–	1.00	–	–
African American	1.15	0.77	1.72	0.63	0.27	1.43	1.04	0.49	2.20
Hispanic	1.20	0.95	1.51	0.71	0.45	1.10	0.97	0.62	1.54
Asian/Pacific Islander	0.92	0.73	1.16	1.06	0.72	1.57	1.09	0.73	1.64
Insurance									
Managed care	1.00	–	–	1.00	–	–	1.00	–	–
Medicare	1.06	0.84	1.35	1.46	1.00	2.14	1.17	0.77	1.78
Medicaid	0.74	0.55	1.02	1.45	0.87	2.43	0.90	0.50	1.62
Other ins	1.06	0.84	1.34	1.54	1.02	2.31	1.04	0.67	1.62
Not insured	0.94	0.60	1.46	1.14	0.49	2.61	0.41	0.13	1.36
SES									
Lowest SES	1.51	1.13	2.03	1.61	0.98	2.64	0.98	0.56	1.73
Lower-middle SES	1.40	1.09	1.80	1.56	1.03	2.36	1.57	1.03	2.37
Middle SES	1.43	1.13	1.80	1.45	0.98	2.15	0.89	0.58	1.39
Higher-middle SES	1.50	1.20	1.88	1.01	0.66	1.53	0.87	0.57	1.33
Highest SES	1.00	–	–	1.00	–	–	1.00	–	–
Age	1.02	1.02	1.03	1.03	1.02	1.04	1.01	1.00	1.02
Stage									
I	1.00	–	–	1.00	–	–	1.00	–	–
II	0.37	0.30	0.45	0.95	0.70	1.30	0.87	0.62	1.23
Grade									
Grade I	1.00	–	–	1.00	–	–	1.00	–	–
Grade II	0.49	0.31	0.78	0.59	0.27	1.29	1.34	0.56	3.23
Grade III	0.36	0.24	0.55	0.71	0.35	1.45	0.83	0.36	1.95
Grade IV	0.40	0.25	0.64	0.72	0.32	1.62	1.21	0.49	3.03
Grade not stated	1.16	0.75	1.79	1.42	0.68	2.95	1.48	0.62	3.55

	1 = No chemo – other reason (n = 1404, 40%)			2 = Recommended, but no chemo (n = 256, 7%)			3 = Had chemo, not multiple agent (n = 217, 6%)		
Characteristics	**O.R.**	**95%**	**C.I.**	**O.R.**	**95%**	**C.I.**	**O.R.**	**95%**	**C.I.**
Histology									
Serous	1.00	–	–	1.00	–	–	1.00	–	–
Mucinous	1.47	1.07	2.01	1.34	0.77	2.33	0.53	0.25	1.12
Endometrioid	0.97	0.76	1.25	1.06	0.69	1.62	0.79	0.50	1.24
Clear cell	0.39	0.29	0.51	0.65	0.40	1.05	0.60	0.37	0.98
Adenocarcinoma, NOS	0.82	0.58	1.16	1.16	0.69	1.94	1.53	0.91	2.57
Other	1.24	0.99	1.55	1.05	0.71	1.56	0.81	0.53	1.24
Tumor size									
≤5 cm	1.00	–	–	1.00	–	–	1.00	–	–
5–10 cm	0.79	0.61	1.03	0.89	0.54	1.47	0.54	0.33	0.89
>10 cm	0.66	0.52	0.85	1.09	0.69	1.71	0.70	0.45	1.08
Unknown	0.84	0.66	1.08	1.13	0.72	1.78	0.80	0.52	1.25
Hospital volume									
High volume	1.00	–	–	1.00	–	–	1.00	–	–
Low volume	2.19	1.76	2.73	1.41	0.97	2.04	1.20	0.84	1.73
Hospital type									
ACoS approved	1.00	–	–	1.00	–	–	1.00	–	–
Not ACoS approved	1.17	0.96	1.41	1.40	1.00	1.95	1.23	0.86	1.76
Unknown	0.70	0.56	0.86	0.95	0.66	1.36	0.65	0.43	0.99
Physician volume									
High volume	1.00	–	–	1.00	–	–	1.00	–	–
Low volume	0.88	0.70	1.10	1.12	0.75	1.69	0.89	0.58	1.37
Physician unknown	0.74	0.56	0.98	0.89	0.54	1.45	1.40	0.87	2.27

Outcome referent group is “4 = Had chemo-multiple agent” on subset 2 of patients excluding stage I and grade I or II tumor (n = 3543).

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Table 4

Patient, tumor and provider characteristics by overall treatment adherence.

	Treatment plan non-adherence (n = 4157, 76%)		Treatment plan adherence (n = 1288, 24%)		
Characteristics	**n**	**%**	**n**	**%**	**Chi square test p-value**
Race					<0.0001
White	2679	75.7	861	24.3	
African American	168	79.6	43	20.4	
Hispanic	737	81.6	166	18.4	
Asian/Pacific Islander	573	72.4	218	27.6	
Insurance					<0.0001
Managed care	2174	74.1	758	25.9	
Medicare	895	84.4	166	15.6	
Medicaid	359	79.1	95	20.9	
Other ins	568	71.0	232	29.0	
Not insured	161	81.3	37	18.7	
SES					<0.0001
Lowest SES	561	83.6	110	16.4	
Lower-middle SES	807	81.0	189	19.0	
Middle SES	924	77.6	266	22.4	
Higher-middle SES	961	75.8	306	24.2	
Highest SES	904	68.4	417	31.6	
Age					<0.0001
<45	967	75.3	317	24.7	
45–54	1085	73.2	398	26.8	
55–69	1098	71.9	429	28.1	
> = 70	1007	87.5	144	12.5	
Stage					0.9629
I	3014	76.4	933	23.6	
II	1143	76.3	355	23.7	
Grade					<0.0001
Grade I	746	74.1	261	25.9	

Characteristics	Treatment plan non-adherence (n = 4157, 76%)		Treatment plan adherence (n = 1288, 24%)		Chi square test p-value
	n	%	n	%	
Grade II	935	67.4	452	32.6	
Grade III	969	76.2	303	23.8	
Grade IV	252	71.0	103	29.0	
Grade not stated	1255	88.1	169	11.9	
Histology					<0.0001
Serous	926	77.9	262	22.1	
Mucinous	595	73.8	211	26.2	
Endometrioid	944	71.8	370	28.2	
Clear cell	437	69.9	188	30.1	
Adenocarcinoma, NOS	252	89.7	29	10.3	
Other	1003	81.5	228	18.5	
Tumor size					<0.0001
≤5 cm	638	79.3	167	20.7	
5–10 cm	815	74.8	275	25.2	
>10 cm	1346	73.0	499	27.0	
Unknown	1358	79.6	347	20.4	
Hospital volume					<0.0001
High volume	655	67.0	322	33.0	
Low volume	3502	78.4	966	21.6	
Hospital type					<0.0001
ACoS approved	1301	73.2	477	26.8	
Not ACoS approved	1624	74.1	568	25.9	
Unknown	1232	83.5	243	16.5	
Physician volume					<0.0001
High volume	610	70.2	259	29.8	
Low volume	2712	77.9	768	22.1	
Physician unknown	835	76.2	261	23.8	

Table 5

Binary logistic regression analysis on the probability of non-standard overall care.

Characteristics	O.R.	95% C.I.	
Race			
White	1.00	–	–
African American	0.98	0.68	1.41
Hispanic	1.23	1.00	1.51
Asian/Pacific Islander	0.94	0.78	1.13
Insurance			
Managed care	1.00	–	–
Medicare	1.30	1.04	1.62
Medicaid	1.04	0.80	1.35
Other ins	0.90	0.75	1.08
Not insured	1.29	0.88	1.90
SES			
Lowest SES	2.01	1.55	2.62
Lower-middle SES	1.78	1.44	2.20
Middle SES	1.55	1.28	1.87
Higher-middle SES	1.51	1.26	1.81
Highest SES	1.00	–	–
Age	1.01	1.01	1.02
Stage			
I	1.00	–	–
II	0.88	0.75	1.03
Grade			
Grade I	1.00	–	–
Grade II	0.71	0.59	0.86
Grade III	1.09	0.88	1.35
Grade IV	0.93	0.69	1.25
Grade not stated	2.73	2.15	3.48
Histology			
Serous	1.00	–	–
Mucinous	0.88	0.70	1.12
Endometrioid	0.91	0.75	1.11
Clear cell	0.54	0.43	0.69
Adenocarcinoma, NOS	1.72	1.13	2.63
Other	1.19	0.96	1.47
Tumor size			
≤5 cm	1.00	–	–
5–10 cm	0.82	0.65	1.04
>10 cm	0.74	0.60	0.91
Unknown	0.99	0.79	1.22

Characteristics	O.R.	95% C.I.	
Hospital volume			
High volume	1.00	–	–
Low volume	1.58	1.35	1.86
Hospital type			
ACoS approved	1.00	–	–
Not ACoS approved	1.04	0.89	1.22
Unknown	1.87	1.56	2.25
Physician volume			
High volume	1.00	–	–
Low volume	1.24	1.04	1.48
Physician unknown	1.23	0.98	1.53