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Gynecologic oncologist impact on adjuvant chemotherapy care for stage II-IV ovarian cancer patients

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Abstract

Objective.—We aim to evaluate the impact gynecologic oncologists have on ovarian cancer adjuvant chemotherapy care from their role as surgeons recommending adjuvant chemotherapy care and their role as adjuvant chemotherapy providers while considering rural-urban differences.

Methods.—Multivariable adjusted logistic regressions and Cox proportional hazards models were developed using a population-based, retrospective cohort of stage II-IV and unknown stage ovarian cancer patients diagnosed in Iowa, Kansas, and Missouri in 2010–2012 whose medical records were abstracted in 2017–2018.

Results.—Gynecologic oncologist surgeons (versus other type of surgeon) were associated with increased odds of adjuvant chemotherapy initiation (adjusted odds ratio (OR) 2.18; 95% confidence interval (CI) 1.10–4.33) and having a gynecologic oncologist adjuvant chemotherapy provider (OR 10.0; 95% CI 4.58–21.8). Independent of type of surgeon, rural patients were less likely to have a gynecologic oncologist chemotherapy provider (OR 0.52; 95% CI 0.30–0.91).

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Declaration of Competing Interest

The authors do not have conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.oig/10.1016/j.ygyno.2021.11.001.

Gynecologic oncologist adjuvant chemotherapy providers (versus other providers) were associated with decreased surgery-to-chemotherapy time (rural: 6 days; urban: 8 days) and increased distance to chemotherapy (rural: 22 miles; urban: 11 miles). Rural women (versus urban) traveled 38 miles farther when their chemotherapy provider was a gynecologic oncologist and 27 miles farther when it was not.

Conclusion.—Gynecologic oncologist surgeons may impact adjuvant chemotherapy initiation. Gynecologic oncologists serving as adjuvant chemotherapy providers were associated with some care benefits, such as reduced time from surgery-to-chemotherapy, and some care barriers, such as travel distance. The barriers and benefits of having a gynecologic oncologist involved in adjuvant chemotherapy care, including rural-urban differences, warrant further research in other populations.

Keywords

Ovarian cancer; Adjuvant chemotherapy care; Gynecologic oncologist; Rural

1. Introduction

Ovarian cancer, the deadliest gynecologic cancer, accounts for about 14,000 deaths, or 2.3% of total cancer deaths, among women in the United States annually [1]. Since the early 2000s, the National Comprehensive Cancer Network (NCCN) guidelines for ovarian cancer patients have strongly advocated for receipt of surgical care from a gynecologic oncologist (i.e., a specialist trained in the treatment of gynecologic malignancies) and endorsed the benefits of multiagent adjuvant chemotherapy [2–8]. Unfortunately, one-fifth of ovarian cancer patients continue to not receive surgical care from a gynecologic oncologist [9–14]. Moreover, as many as half of ovarian cancer patients do not receive the appropriate NCCN guideline-recommended treatment [4,5,15,16].

Incomplete compliance with the NCCN chemotherapy guidelines has previously been attributed to patient-level factors, such as comorbid medical conditions and age, as well as system-level factors, such as neighborhood socioeconomic status [4,5,15]. These prior studies have had a limited ability to investigate the impact of physician specialty on outcomes [4,15–17].

Gynecologic oncologists versus other provider types have been shown to achieve superior surgical care and surgical outcomes for ovarian cancer patients [9,14,18–23]. However, little information is available on the impact gynecologic oncologists have on adjuvant chemotherapy care and chemotherapy outcomes [17,24–28]. It is plausible that the improved surgical outcomes achieved by gynecologic oncologists also translate into superior chemotherapy metrics, especially given gynecologic oncologists are high-volume providers (practice-makes-perfect theory) and often work in high-volume Centers of Excellence [8,25,29–31]. However, it is also possible medical oncologists and other chemotherapy providers are able to achieve similar adjuvant chemotherapy outcomes to gynecologic oncologists. Additionally, gynecologic oncologist involvement in the planning and administration of adjuvant chemotherapy may introduce benefits and barriers into care,

including distance, cost, and time [30]. These benefits and barriers may vary significantly by the rurality of a patient's residence at diagnosis [9,18–23].

We aimed to evaluate the impact gynecologic oncologists have on ovarian cancer adjuvant chemotherapy care, both from their role as surgeons recommending adjuvant chemotherapy care and their role as adjuvant chemotherapy providers, while considering rural-urban differences. We investigated gynecologic oncologist surgeons' association with adjuvant chemotherapy initiation and having a gynecologic oncologist as the adjuvant chemotherapy care provider. Second, we investigated the association of the gynecologic oncologist as the adjuvant chemotherapy provider with chemotherapy metrics among ovarian cancer patients who received adjuvant chemotherapy. Our analyses included an examination of the rurality of patient residence at time of diagnosis.

2. Methods

2.1. Patterns of care cohort

The women in this analysis were a part of a Centers for Disease Control and Prevention (CDC) cohort study entitled. Patterns of Ovarian Cancer Care and Survival in the Midwestern Region of the United States—a CDC Investigation [32]. The cohort was assembled from a population-based sample of 1003 women diagnosed with ovarian cancer in 2010–2012 in Iowa, Kansas, and Missouri. The cohort was created to investigate differences in treatment by rurality and provider type. The three Midwestern states were selected because they contain a sizeable rural population and a limited number of gynecologic onoclogists [7].

The inclusion criteria for the CDC cohort study were women with a primary, histologically confirmed malignant tumor of the ovary, fallopian tube or peritoneum, between the ages of 18 and 89 years at diagnosis. Women were excluded if they had a low malignant potential histology (ICD-O-3 codes 8442, 8451, 8462, 8472, 8473), a diagnosis at autopsy or by death certificate, or a synchronous tumor within six months of their ovarian cancer diagnosis.

Variables included in the cohort were obtained from patient medical records by trained cancer registrars through an extension of standard state registry protocols. Trained cancer registrars obtained patient information over the course of 18 months in 2017–2018 using abstraction manuals with standardized definitions. When needed, the cancer registrars also contacted medical providers to obtain missing information.

2.2. Our sample

In our study population, we excluded women who did not receive ovarian cancer-directed surgery and who had stage I cancer from the Patterns of Ovarian Cancer Care and Survival in the Midwestern Region of the United States—a CDC Investigation cohort (Image 1). Stage 1 cancer was removed because adjuvant chemotherapy is not a recommended aspect of care. In our study subpopulation, we additionally excluded women who did not receive adjuvant chemotherapy care from our study population (Image l).

2.3. Primary exposures

Our primary exposures of interest were surgeon specialty and adjuvant chemotherapy provider specialty. Surgeon specialty was operationalized as gynecologic oncologist versus other (i.e„ general surgeon, obstetrician-gynecologist, and other). Adjuvant chemotherapy provider specialty was operationalized as having a gynecologic oncologist involved in the planning or administration of adjuvant chemotherapy versus other chemotherapy provider without a gynecologic oncologist involved.

We also placed special attention on rurality of a patient's residence at diagnosis. Rurality of the census tract was created from the 6-category National Center for Health Statistics (NCHS) rural-urban classification scheme framework [33]. In accordance with NCHS's recommended metropolitan classification scheme, census tracts were defined as rural if they were a nonmetropolitan population with an urban cluster of 10,000–49,999 persons, or a nonmetropolitan/noncore population [33]. Urban census tracts were defined as populations greater than 50,000 persons [33].

2.4. Covariates

The Charlson comorbidity score was calculated using the original conditional weighting [34–36]. Histologies were defined in accordance with ICD-O-3 morphology codes, with non-epithelial and epithelial histologies (Supplemental Table 1) [37,38]. Grade was classified according to SEER standards. Site of origin was categorized as ovarian (ICD-O-3 code C56.9) and fallopian tube or peritoneal cancers (C48.1, C48.2, C48.8, C57.0). Race was obtained from the medical record and was categorized as a binary variable (non-Hispanic white versus other nonwhite) due to the limited number of other non-white women. Stage is reported according to the International Federation of Gynecology and Obstetrics (FIGO, www.figo.org).

2.5. Analysis

Descriptive analyses were conducted using Pearson Chi-square tests to determine patient, tumor, and treatment variable differences by surgeon specialty for our study population of women who received cancer-directed surgery, and by adjuvant chemotherapy provider specialty for our subpopulation of women who received cancer-directed surgery and adjuvant chemotherapy.

To investigate the impact that gynecologic oncologists have on ovarian cancer adjuvant chemotherapy care from their role as a surgeon, we created two multivariable logistic regression models investigating the association between gynecologic oncologist surgeons and the initiation of adjuvant chemotherapy (versus no initiation of adjuvant chemotherapy) and adjuvant chemotherapy care provider type (gynecologic oncologist versus other). The covariates included in these multivariable logistic regression models were selected a priori using Andersen's Behavioral Model of Health Services Use (Supplemental Image 1) [39–41].

To investigate the impact that gynecologic oncologists have on ovarian cancer adjuvant chemotherapy care from their role as adjuvant chemotherapy providers, we conducted

bivariate analyses, multivariable analyses, and a multivariable Cox proportional hazard model of our subpopulation. Bivariate comparisons investigated outcomes (i.e,, time from diagnosis-to-chemotherapy, time from surgery-to-chemotherapy, distance to chemotherapy, completion of first-line course of chemotherapy as planned (versus prematurely discontinuing chemotherapy course), tumor growth within 5-years, and 5-year all-cause mortality) by the rurality of a woman's residence at diagnosis among the stratum of women who had a gynecologic oncologist involved in the planning or administration of their adjuvant chemotherapy care and the stratum that did not Rural and urban women were compared across these two strata. Bivariate comparisons used a Pearson Chi-square test for categorical outcomes and a 2-sample independent group t-test for continuous outcomes with an alpha of 0.05.

Three multivariable logistic regression models were used to determine the association between gynecologic oncologist chemotherapy providers and completion of first course of chemotherapy (versus not completing first course of chemotherapy), platinum resistant tumor growth within six months of chemotherapy course completion (versus no tumor growth), and platinum sensitive tumor growth after six months of chemotherapy course completion (versus no tumor growth). Covariates included in the multivariable analyses were selected a priori using directed acyclic graphs.

A multivariable Cox proportional hazard model was used to calculate the adjusted hazard ratios of 5-year all-cause mortality. We censored at death, last known contact with cancer registries, or 5-years from the day of diagnosis, respectively. The proportional hazards assumption was investigated with Martingale residuals and Kolmogorov-type supremum tests. Covariates were selected a priori using a directed acyclic graph.

3. Results

73% (N = 430/588) of the study population of Midwestern women with stage II-IV or unknown stage ovarian cancer that received cancer-directed surgery went on to receive adjuvant chemotherapy. Most women in the study population had Charlson scores of zero at diagnosis, were insured, were non-Hispanic white, had epithelial histologies, had a primary site of ovary, had cytoreductive surgery, had adjuvant chemotherapy, and did not receive neoadjuvant chemotherapy (Table 1). Women in the study population with a gynecologic oncologist surgeon varied from women with another type of surgeon by some patient and treatment characteristics, but not tumor characteristics (Table 1). Women in the study subpopulation with a gynecologic oncologist as the adjuvant chemotherapy provider varied from women with another chemotherapy provider by patient characteristics, tumor characteristics, and visible residual tumor after surgery (Table 1).

3.1. Gynecologic oncologists' impact on adjuvant chemotherapy from their role as surgeons

Gynecologic oncologist surgeons (versus other surgeon types) were associated with greater adjusted odds of initiating adjuvant chemotherapy (odds ratio (OR) 2.18; 95% confidence interval (CI) 1.10–4.33) (Table 2), and of a gynecologic oncologist being involved in the

planning or administration of adjuvant chemotherapy (OR 10.0; 95% CI 4.58–21.8) (Table 2).

The adjusted odds of initiating adjuvant chemotherapy (versus not) were significantly lower in women who were older (76–89 versus 18–45 years old, OR 0.16; 95% CI 0.04–0.65) and greater in women who had census tract incomes of $51,000–65,999 versus $40,000–50,999 (OR 2.54; 95% CI 1.02–6.35), Charlson scores of 1 versus 0 at diagnosis (OR 2.74; 95% CI 1.06–7.05), stage III versus II (OR 5.34; 95% CI 2.47–11.6), stage IV versus II (OR 3.47; 95% CI 1.50–8.02), and residual tumor of ≤1 cm after surgery (OR 1.87; 95% CI 1.04–3.38) (Table 2). The adjusted odds of having a gynecologic oncologist involved in the planning and administration of adjuvant chemotherapy were lower for women who were older (76–89 versus 18–45 years old, OR 0.24; 95% CI 0.08–0.76) and women who had rural residences at diagnosis (OR 0.52; 95% CI 030–0.91).

3.2. Gynecologic oncologists' impact on adjuvant chemotherapy from their role as chemotherapy providers

Among the strata of ovarian cancer patients who had a gynecologic oncologist involved in the planning and administration of their adjuvant chemotherapy, rural versus urban women traveled significantly further for chemotherapy care (means, respectively: 63.8 miles vs. 25.9 miles, $p < 0.001$) (Table 3). Among the strata of ovarian cancer patients who did not have a gynecologic oncologist involved in the planning and administration of adjuvant chemotherapy, rural versus urban women traveled significantly further for chemotherapy care (means, respectively: 41.9 miles vs. 14.7 miles, $p < 0.001$) and had a lower proportion of women complete the first course of chemotherapy (62% vs. 80%, $p = 0.028$). There was no difference between rural and urban patients in either strata for time from diagnosis-to-chemotherapy initiation, time from surgery-to-chemotherapy initiation, tumor growth, or 5-year allcause mortality (Table 3).

Across strata, rural women who had a gynecologic oncologist involved in their chemotherapy care versus not involved had fewer days from surgery-to-chemotherapy (means, respectively: 31.7 days vs. 37.3 days, $p < 0.001$), longer distances to chemotherapy (mean, respectively: 63.8 miles vs. 41.9 miles, $p = 0.002$), greater completion of first course chemotherapy (81% vs. 62%, $p = 0.015$), and higher rates of tumor growth within 5-years (76% vs. 54%, $p = 0.009$) (Table 3). Across strata, urban women who had a gynecologic oncologist involved in their chemotherapy care versus not involved had fewer days from diagnosis-to-chemotherapy initiation (means, respectively: 40.8 days vs. 51.3 days, $p = 0.043$), fewer days from surgery-to-chemotherapy initiation (means, respectively: 32.0 days vs. 40.1 days, $p < 0.001$), and greater distances to chemotherapy (means, respectively: 253 miles vs. 14.7 miles, $p = 0.005$).

In multivariable analysis, the odds of completion of first-line course of chemotherapy as planned (versus prematurely discontinuing chemotherapy course) were lower in women with stage IV versus II (OR 0.28; 95% CI 0.10–0.77) and were not significantly impacted by chemotherapy provider specialty or rurality of a patient's residence at diagnosis (Supplemental Table 2). The adjusted odds of platinum resistant tumor growth in the first 6-months after chemotherapy were significantly greater in women with stage IV versus II

cancer (OR 4.79; 95% CI 1.33–17.2) (Supplemental Table 3). The adjusted odds of platinum sensitive tumor growth 6 months after chemotherapy were lower for women living in a census tract with a higher prevalence of persons with less than a high school education (11–20% versus 0–10% of census tract with less than a high school education:OR 0.47; 95% CI 0.24–0.94) and greater in persons with Giarlson scores of 2+ versus 0 (OR 4.55; 95% CI 1.32–15.7), a gynecologic oncologist chemotherapy provider versus other (OR 2.00; 95% CI 1.10–3.61), and stage IV versus II (OR 2.75; 95% CI 1.06–7.12) (Supplemental Table 3).

The adjusted 5-year all-cause mortality hazard ratios were lower for women with ≤1 cm residual tumor remaining after surgery (OR 0.67; 95% CI 0.51–0.89) and greater for women with stage III versus II (OR 2.74; 95% CI 1.46–5.12), stage IV versus II (OR 4.08; 85% CI 2.11–7.89) ovarian cancer (Table 4). These survival probabilities are displayed in Supplemental Images 2 and 3, respectively. Having a gynecologic oncologist involved in the planning or administration of adjuvant chemotherapy care did not significantly impact 5-year all-cause mortality.

4. Discussion

After controlling for several patient factors including rurality of a patient's residence, gynecologic oncologist surgeons were associated with increased odds of ovarian cancer patients initiating adjuvant chemotherapy and of a gynecologic oncologist being involved in the planning or administration of adjuvant chemotherapy. Rural patients were significantly less likely to have a gynecologic oncologist involved in the planning or administration of their adjuvant chemotherapy independent of the type of surgeon that performed their cancer-directed surgery. Among rural ovarian cancer patients, having a gynecologic oncologist as the adjuvant chemotherapy provider was associated with a shorter time from surgery-to-chemotherapy, longer distance to chemotherapy, greater completion of first course chemotherapy and higher rates of tumor growth. Gynecologic oncologist involvement in adjuvant chemotherapy care was not associated with 5-year all-cause mortality.

4.1. Gynecologic oncologists' role as surgeons

Gynecologic oncologist singeons were associated with 72% greater odds of ovarian cancer patients initiating adjuvant chemotherapy care. This finding agrees with prior studies [17,24–28,31]. This may indicate gynecologic oncologists are most likely to adhere to adjuvant chemotherapy guidelines, or it could indicate that a selective-referral-pattem exists. Providers may be more likely to refer patients to a gynecologic oncologist surgeon if they believe their patients would benefit from both surgery and chemotherapy. [17,24–28,31] Likewise, patients that want to, are able to, or perceive the need to pursue surgery with a gynecologic oncologist may also be more likely to pursue initiation of chemotherapy. Patient viewpoints on the importance of guideline adherence, specialists, and chemotherapy care may contribute to this association. A potentially selective-referral-pattem arising prior to surgeiy based on perceived treatment needs is concerning given guidelines (i.e. NCCN, Society of Gynecologic Oncology, American College of Obstetrics and Gynecology) recommend all women with stage II-IV ovarian cancer should receive surgery from a gynecologic oncologist versus another surgeon type [2–7]. The initiation of adjuvant

chemotherapy care was also significantly associated with advanced stage at diagnosis, younger age at diagnosis, and greater removal of residual tumor after surgery, which is consistent with prior literature [4,5,8,15,16]. Further research is needed investigating the reasons patients did not initiate chemotherapy by surgeon type.

Gynecologic oncologist surgeons were associated with 10 times greater odds of ovarian cancer patients having a gynecologic oncologist involved in the planning and administration of their adjuvant chemotherapy care. This may indicate that gynecologic oncologists infrequently plan and coordinate adjuvant chemotherapy care for patients they did not perform surgery on. This finding aligns with NCCN guidelines, which advocate for the involvement of a gynecologic oncologist prior to surgical care versus at the point of adjuvant chemotherapy initiation. Further, this finding aligns with the Centers of Excellence model, where gynecologic oncologists usually do not travel to treat patients within the community or conduct outreach.

Independent of surgeon specialty, the odds of having a gynecologic oncologist involved in the planning or administration of adjuvant chemotherapy were 48% lower among rural women and 76% lower among older women (76–89 versus 18–45 years). There may be a rural-urban disparity in receipt of chemotherapy care from a gynecologic oncologist Rural-urban differences in receipt of surgical care from a gynecologic oncologist have been previously reported [14]. A rural-urban difference in receipt of chemotherapy care from a gynecologic oncologist could be created due to differences in referring provider-to-patient recommendations, patient-level barriers such as transportation issues, or system-level barriers such as local provider comfort working with gynecologic oncologists. It is unclear why older women that received adjuvant chemotherapy were less likely to have a gynecologic oncologist involved in their care. It is possible referral differences, perceived patient-level barriers, family/caregiver limitations, and quality of life concerns contribute, and thus, further investigations may be beneficial [42–45].

4.2. Gynecologic oncologists' role as chemotherapy providers

Gynecologic oncologists as adjuvant chemotherapy providers were associated with 6 fewer days from surgery-to-chemotherapy, 22 miles longer distance to chemotherapy care, 19% more women completing their first course of chemotherapy, and 22% more women with tumor growth among rural patients. Among urban patients, gynecologic oncologists serving as adjuvant chemotherapy providers were associated with 10.5 fewer days from diagnosis-to-chemotherapy, 8 fewer days from surgery-to-chemotherapy, and 11 miles longer distance to chemotherapy care.

Gynecologic oncologists may be associated with shorter time between treatments due to a superior ability to manage post-operative surgical complications that could delay or complicate the start of adjuvant chemotherapy, or due to a lower level of care coordination with fewer physicians, health systems, and referrals involved when the same provider performs surgery and provides adjuvant chemotherapy [46,47]. Gaps in time between diagnosis or surgery and chemotherapy can cause patients distress [9]. Thus, while reduced time between surgery-and-chemotherapy may not be clinically significant, it may impact patients' treatment experiences, distress, and satisfaction.

Gynecologic oncologists were likely associated with greater travel distance due to their employment and affiliation primarily with Centers of Excellence, while other chemotherapy providers may be more evenly distributed within communities. Distance has been shown to be a perceived barrier to cancer care [9,48]. Consequently, patterns of care innovations, such as consulting models or telehealth models, could be contemplated [9].

It is unclear why gynecologic oncologists were associated with greater completion of first-line course of chemotherapy as planned (versus prematurely discontinuing chemotherapy course) and higher tumor growth among rural patients. There may possibly be a preferential referral among rural patients to gynecologic oncologists when there is suspicion of recurrence or a worsening of cancer prognosis. Gynecologic oncologists may also be more likely to care for rural patients who live longer and have more time for recurrence to develop [31]. Toward these theories, we found gynecologic oncologist chemotherapy providers (versus other provider types) were more likely to care for women with poorly-undifferentiated cancers, but did not find a difference in patient survival. In multivariable analysis, gynecologic oncologist chemotherapy providers were not associated with greater chemotherapy completion, suggesting measured patient and tumor factors likely account for much of the difference in completion. However, in multivariable analysis, gynecologic oncologists continued to be associated with higher tumor recurrence/progression. Thus, it is likely there are unmeasured treatment factors that contribute to this difference. Future investigations into the association between first-line chemotherapy completion and chemotherapy provider should include variables on timing and frequency of tumor surveillance to assess for ascertainment bias.

Compared to their urban counterparts, rural women traveled 38 miles farther when they had a gynecologic oncologist as their chemotherapy provider. When they did not, rural women traveled 27 miles farther than their urban counterparts and 18% fewer women completed their first course of chemotherapy. This finding indicates that regardless of their chemotherapy provider type, rural ovarian cancer patients are faced with a greater distance barrier, which may result in a greater cost barrier and possible travel time barrier. The difference in rural and urban chemotherapy course completion among non-gynecologic oncologist chemotherapy providers could be due to differences in patient preference, patient demographics, or volume difference among providers. Rural versus urban ovarian cancer patients are diagnosed at older ages, with higher comorbidities, and more advanced staged disease, all of which may reduce chemotherapy completion [47]. Further investigations are needed into survival differences by rurally and factors influencing patterns of care among patients without a gynecologic oncologist involved in their care.

In the adjusted models, gynecologic oncologist and other chemotherapy providers did not vary in 5-year all-cause mortality. Prior studies including all ovarian cancer patients that could have initiated adjuvant chemotherapy have found all-cause mortality differences between those treated at academic comprehensive cancer centers versus community care centers or based on chemotherapy provider volume largely due to differences in chemotherapy initiation [8]. Future studies comparing all-cause survival by chemotherapy providers should control for chemotherapy variables beyond initiation and completion, including recurrence, agents used, and lines of treatment needed. Future studies could

also investigate other end points by whether a gynecologic oncologist is involved in chemotherapy care, such as palliative service access, access to clinical trials, recurrent/progressing case treatment differences, recurrent/progressing case survival differences, and health-related quality of life (HRQoL) metrics. Until we have a more thorough understanding of the benefits and barriers to gynecologic oncologist involvement in adjuvant chemotherapy care, there continues to be a need for open and straightforward care discussions about individual patient's goals of care, available options, patient-level barriers, and physician recommendations.

5. Strengths and limitations

The strengths of this paper include the representativeness of the population obtained from statewide population-based cancer surveillance and the quality of the data abstracted by highly trained cancer registrars. Standardized tool and quality control checks ensured the consistency and accuracy of abstracted values. Treatment guidelines toward gynecologic oncologist referrals have not substantially changed since the dates of diagnosis in this study. However, antiangiogenic agents, such as bevacizumab, now have a level 2A recommendation by the NCCN as a single agent or with chemotherapy in platinum-resistant recurrent cancer. As well, several PARP inhibitors have recently been used in combination with chemotherapy. Further research investigating recent patterns of chemotherapy care are needed to understand how immunologic agents and neoadjuvant chemotherapy have impacted patterns of care.

Our dataset was limited by a lack of information on patient-level wealth, patient attitudes, reasons for not initiating chemotherapy, and chemotherapy facility size. Great circle distance served as a proxy for driving distance, which may have made our estimates conservative. Further, we were unable to evaluate qualitative outcomes, such as HRQoL. The date of recurrence was not captured in our dataset Cause-specific mortality was not available in the dataset. The findings of this study may not be generalizable to all women diagnosed with ovarian cancer in the United States. Our study population was mostly white, and we were unable to detect important racial/ethnic differences that may exist in chemotherapy care for ovarian cancer.

6. Conclusion

Gynecologic oncologist surgeons were associated with increased adjusted odds of adjuvant chemotherapy initiation, a finding that adds to the surgical outcome evidence supporting the importance of referring ovarian cancer patients to gynecologic oncologists for surgical care. Gynecologic oncologist surgeons were also associated with increased adjusted odds of having a gynecologic oncologist involved in the planning and administration of adjuvant chemotherapy care, suggesting patterns of chemotherapy care coordination may vary based on surgeon type. Similar to the rural/urban disparity seen in surgical care, rural versus urban patients were less likely to have a gynecologic oncologist involved in their chemotherapy care. Gynecologic oncologists serving as adjuvant chemotherapy providers were associated with increased distance to chemotherapy care, decreased time from surgery-to-chemotherapy care, and were not significantly associated with differences in 5-year all-cause mortality.

There remains uncertainty about whether it is best practice to have a gynecologic oncologist involved in the planning and administration of chemotherapy care. Further research is needed into the barriers and benefits of gynecologic oncologist involvement, models of gynecologic oncologist involvement, and value at various points in the treatment process, such as during first line treatment, during surveillance, and after recurrence.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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HIGHLIGHTS

- Gynecologic oncologist surgeons were associated with increased odds of initiating adjuvant chemotherapy.
- Gynecologic oncologist surgeons were associated with greater odds of a gynecologic oncologist chemotherapy provider.
- Gynecologic oncologist adjuvant chemotherapy providers were associated with decreased time from surgery-to-chemotherapy.
- Rural and urban women traveled farther to receive chemotherapy care with gynecologic oncologist
- Rural women (versus urban) had a gynecologic oncologist involved in their adjuvant chemotherapy less and traveled farther.

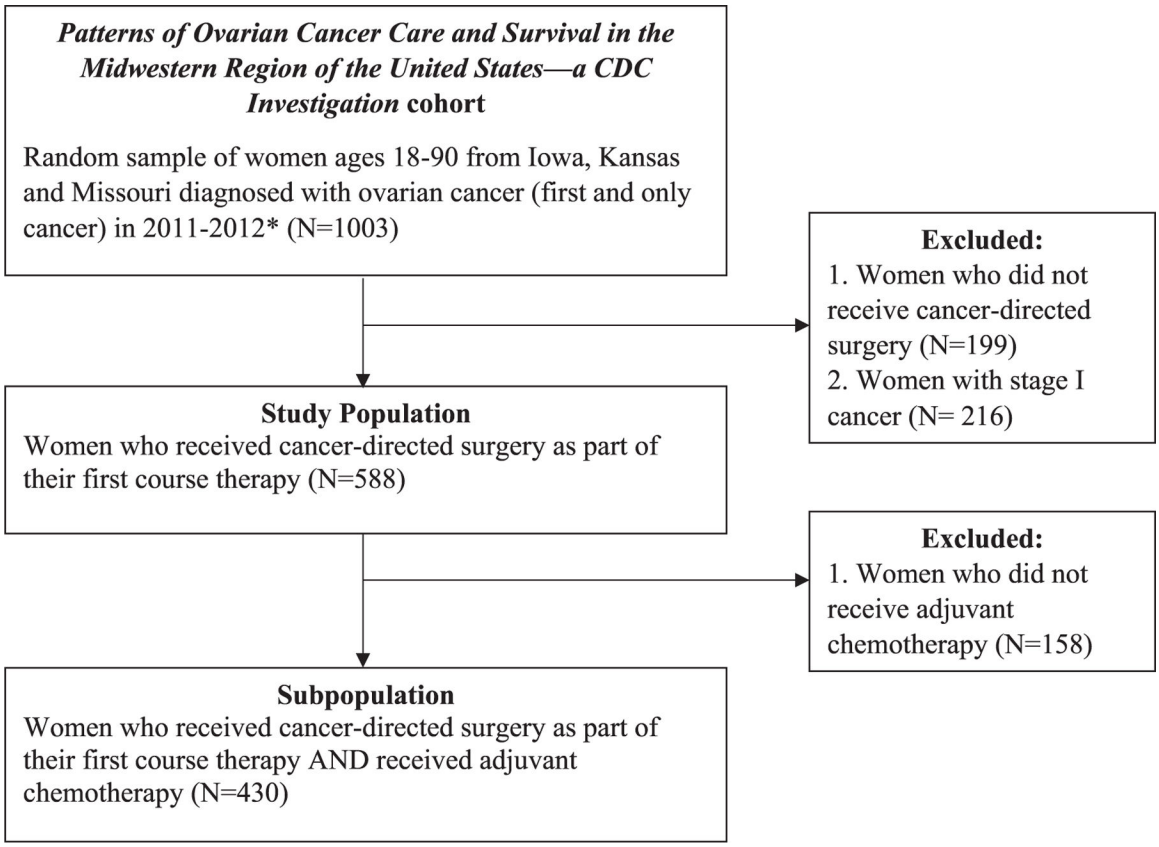

Image 1.

Flow chart study population and subpopulation.

*In order to meet desired sample size, Kansas included 178 cases diagnosed in 2010.

Table 1

Patient tumor, and treatment characteristics of the study population by the type of surgeon and of the study subpopulation by type of adjuvant chemotherapy provider.

		Study population: Ovarian Cancer Patients that had Cancer-directed Surgery *N* = 588			**Study subpopulation: Ovarian Cancer Patients that had Cancer-directed Surgery AND Adjuvant Chemotherapy *N* = 430**		
		Surgeon		**P value**	**Adjuvant Chemotherapy Provider**		**P value**
		Gynecologic oncologist *N* = 510	**Other *N* = 78**		**Gynecologic Oncologist *N* = 300**	**Other *N* = 130**	
		N(%)	**N(%)**		**N(%)**	**N(%)**	
Patient Characteristics							
Age at Diagnosis (Years)	18–45	37 (7)	4 (10)	**<0.001**	27 (9)	8 (6)	**<0.001**
	46–60	170 (33)	14 (18)		112 (37)	37 (28)	
	61–75	234 (46)	33 (42)		133 (44)	53 (41)	
	76–89	69 (14)	27 (28)		28 (9)	32 (25)	
Census Tract Median Income	$l-39,999	108(21)	14(18)	**0.037**	57 (19)	27 (21)	**<0.001**
	$40,000–50,999	129 (25)	32 (41)		62 (21)	51 (39)	
	$51,000–65,999	141 (28)	17 (22)		86 (29)	32 (25)	
	$66,000+	132 (26)	15 (19)		95 (32)	20 (15)	
Charlson Score at Diagnosis	0	409 (80)	62 (79)	0.660	240 (80)	104 (80)	0.757
	1	74 (15)	10 (13)		44 (15)	17 (13)	
	2+	27 (5)	6 (8)		16 (5)	9 (7)	
Insurance Status	Insured	494 (97)	76 (97)	0.784	292 (97)	123 (95)	0.158
	Uninsured	16 (3)	2 (3)		8 (3)	7 (5)	
Percentage of Census Tract Residents with Less Than a High School Education	0–10%	333 (65)	39 (50)	**0.020**	211 (70)	70 (54)	**0.001**
	11–20%	147 (29)	30 (38)		76 (25)	45 (35)	
	21%+	30 (6)	9 (12)		13 (4)	15 (12)	
Race/Ethnicity	Non-Hispanic White	481 (94)	74 (95)	0.842	283 (94)	124 (95)	0.656

		Study population: Ovarian Cancer Patients that had Cancer-directed Surgery *N* = 588			Study subpopulation: Ovarian Cancer Patients that had Cancer-directed Surgery AND Adjuvant Chemotherapy *N* = 430		
		Surgeon		P value	Adjuvant Chemotherapy Provider		P value
		Gynecologic oncologist *N* = 510	Other *N* = 78		Gynecologic Oncologist *N* = 300	Other *N* = 130	
		N(%)	N(%)		N(%)	N(%)	
	Non-White	29 (6)	4 (5)		17 (6)	6 (5)	
Rurality	Urban	361 (71)	35 (45)	**<0.001**	226 (75)	69 (53)	**<0.001**
	Rural	149 (29)	43 (55)		74 (25)	61 (47)	
Tumor Characteristics							
Grade	Well-Moderately Differentiated	59 (12)	13 (17)	0.199	30 (10)	28 (22)	**0.003**
	Poorly-Undifferentiated	394 (77)	53 (68)		247 (82)	89 (68)	
	Unknown	57 (11)	12 (15)		23 (8)	13 (10)	
Histology	Epithelial	507 (99)	76 (97)	0.077	300 (100)	126 (97)	**0.002**
	Non-Epithelial	3 (1)	2 (3)		0 (0)	4 (3)	
Primary Site	Ovary	383 (75)	61 (78)	0.552	219 (73)	107 (82)	**0.038**
	Fallopian Tube and Peritoneum	127 (25)	17 (22)		81 (27)	23 (18)	
Stage	II	51 (10)	9 (12)	0.063	30 (10)	13(10)	0.195
	III	331 (65)	39 (50)		213 (71)	82 (63)	
	IV	122 (24)	28 (36)		55 (18)	32 (25)	
	Unknown	6 (1)	2 (3)		2 (1)	3 (2)	
Tumor Sequence	Only Primary	491 (96)	77 (99)	0.268	287 (96)	128 (98)	0.147
	First Primary	19 (4)	1 (1)		13 (4)	2 (2)	
Treatment Characteristics: Surgery							
Type of Surgeon	Gynecologic Oncologist	510 (100)	0 (0)	**<0.001**	300 (100)	88 (68)	**<0.001**
	General Surgeon	0 (0)	30 (38)		0 (0)	15 (12)	
	Obstetrician-Gynecologist	0 (0)	31 (40)		0 (0)	18 (14)	
	Other/Unknown	0 (0)	17 (22)		0 (0)	9 (7)	
Type of Surgery Received	Cytoreduction	485 (95)	68 (87)	**0.006**	287 (96)	125 (96)	0.211
	Other	25 (5)	10 (13)		13 (4)	5 (4)	

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		Study population: Ovarian Cancer Patients that had Cancer-directed Surgery *N* = 588			**Study subpopulation: Ovarian Cancer Patients that had Cancer-directed Surgery AND Adjuvant Chemotherapy *N* = 430**		
		Surgeon		**P value**	**Adjuvant Chemotherapy Provider**		**P value**
		Gynecologic oncologist *N* = 510	**Other *N* = 78**		**Gynecologic Oncologist *N* = 300**	**Other *N* = 130**	
		N(%)	**N(%)**		**N(%)**	**N(%)**	
Visible Residual Tumor After Surgery	≤1 cm	138 (27)	22 (28)	**<0.001**	80 (27)	44(34)	**0.006**
	>1 cm	280 (55)	25 (32)		169 (56)	52 (40)	
	unknown	92 (18)	31 (39)		51 (17)	34 (26)	
Treatment Characteristics: Adjuvant Chemotherapy							
Adjuvant Chemotherapy Receipt	No Adjuvant Chemotherapy	125 (25)	22 (28)	0.189	0	0	-
	Adjuvant Chemotherapy	378 (74)	53 (68)		100	100	
	Unknown	7 (1)	3 (4)		0	0	
Neoadjuvant Chemotherapy Receipt	No Neoadjuvant Chemotherapy	427 (84)	73 (94)	**0.023**	100	100	-
	Neoadjuvant Chemotherapy	83 (16)	5 (6)		0	0	

Bolding indicates a significance at 0.05.

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Table 2

Gynecologic oncologists' impact on adjuvant chemotherapy from their role as surgeons: adjusted odds of initiating adjuvant chemotherapy and having a gynecologic oncologist chemotherapy provider.

		Adjuvant chemotherapy initiated (versus not given)[A]		Gynecologic oncologist involved in adjuvant chemotherapy (versus not involved)[B]	
		OR*	95% CI	OR*	95% CI
Age at Diagnosis (Years)	18–45	Reference			
	46–60	0.99	0,25–4.07	0.62	0.22–1.73
	61–75	0.53	0.14–2.06	0.51	0.18–1.45
	76–89	**0.16**	**0.04–0.65**	**0.24**	**0.08–0.76**
Census Tract Median Income	$1–39,999	Reference			
	$40,000–50,999	2.06	0.92–4.61	0.53	0.25–1.12
	$51,000–65,999	**2.54**	**1.02–6.35**	0.92	0.40–2.11
	$66,000+	2.00	0.77–5.20	1.38	0.55–3.47
Charlson Score at Diagnosis	0	Reference			
	1	**2.74**	**1.06–7.05**	1.57	0.75–3.26
	2+	2.26	0.59–8.74	1.04	0.36–3.02
Insurance Status	Insured	Reference			
	Uninsured	0.43	0.10–1.80	0.33	0.10–1.08
Percentage of Census Tract Residents with Less Than a High School Education	0–10%	Reference			
	11–20%	1.42	0.70–2.87	0.95	0.52–1.77
	21%+	1.44	0.48–4.28	0.50	0.17–1.50
Race/Ethnicity	Non-Hispanic White	Reference			
	Non-White	1.26	0.37–4.24	0.92	0.30–2.84
Rurality	Urban	Reference			
	Rural	0.99	0.53–1.87	**0.52**	**0.30–0.91**
Stage	II	Reference			
	III	**5.34**	**2.47–11.6**	1.13	0.51–2.53
	IV	**3.47**	**1.50–8.02**	0.91	0.37–2.27
	unknown	1.55	0.24–9.95	0.43	0.05–3.62
Tumor Sequence	Only Ovarian Primary	Reference			
	First Ovarian Primary	1.24	00.24–6.28	2.68	0.54–13.2
Type of Surgeon	Other	Reference			
	Gynecologic Oncologist	**2.18**	**1.10–4.33**	**10.0**	**4.58–21.8**
Visible Residual Tumor After Surgery	>1 cm or Unknown	Reference			
	≤1 cm	**1.87**	**1.04–3.38**	1.57	0.96–2.56

Bolding indicates a significance at 0.05.

[*] Adjusted for all other exposures in the first column above.

[A] This analysis is of the patients in the study population of ovarian cancer patients who had cancer-directed surgery ($N = 588$).

[B] This analysis is of the patients in the subpopulation of ovarian cancer patients who had cancer-directed surgery AND adjuvant chemotherapy ($N = 430$).

Table 3

Gynecologic oncologists' impact on adjuvant chemotherapy from their role as chemotherapy providers: investigating adjuvant chemotherapy differences ($N = 430$).

		Gynecologic oncologist involved in the planning or administration of adjuvant chemotherapy			Gynecologic oncologist not involved in the planning or administration of adjuvant chemotherapy			Gynecologic oncologist involved (versus not)	
								Rural	Urban
		Rural *N*= 74	**Urban *N* = 226**	***P* value**	**Rural *N* = 61**	**Urban *N* = 69**	***P* value**	***P* value**	***P* value**
Time from Diagnosis-to-Chemotherapy (Days)	Mean (95 * CI)	43.0 (38.4–47.6)	40.8 (37.9–43.8)	0.198	45.3 (38.4–52.1)	51.3 (44.6–57.9)	0.566	0.052	**0.043**
	Range(SD *)	6–124 (19.8)	7–225 (22.5)		10–168 (25.3)	14–147 (27.3)			
Time from Surgery-to-Chemotherapy (Days)	Mean (95% CI)	31.7 (28.5–34.9)	32.0 (29.9–34.2)	0.089	37.3 (30.9–43.7)	40.1 (34.1–46.1)	0.811	**<0.001**	**<0.001**
	Range(SD *)	6–79 (13.8)	0–125 (16.3)		9–168 (26.0)	4–147 (25.2)			
Distance to Chemotherapy[A] (Miles)	Mean (95% CI)	63.8 (56.0–71.6)	25.9 (21.9–29.9)	**<0.001**	41.9 (27.6–56.2)	14.7 (9.2–20.2)	**<0.001**	**0.002**	**0.005**
	Range(SD *)	0–155 (33.6)	0–176 (30.3)		1–248 (49.7)	0–154 (22.1)			
Completion of First-line Course of Chemotherapy as Planned: *N* (%)		60 (81)	172 (76)	0.375	38 (62)	55 (80)	**0.028**	**0.015**	0.534
Tumor Growth in 5-Years: *N* (%)		56 (76)	155 (67)	0.246	33 (54)	45 (65)	0.197	0.009	0.600
All-Cause Mortality in 5-Years (%)		44 (59)	112 (50)	0.139	36 (59)	39 (57)	0.774	0.958	0311

Bolding indicates a significance at 0.05.

*SD = standard deviation.

[A]Distance to chemotherapy care was calculated using the latitudes and longitudes of patients' residences and the medical centers/hospitals where chemotherapy was received. Great Circle Distance in ArcGIS (environmental systems research institute, Redlands, CA) was used to calculate the straight mile distance between coordinates.

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Table 4

Adjusted cox proportional hazard ratios for 5-year all-cause mortality.

		5-year HR*	95% CI
Age at Diagnosis (Years)	18–45	Reference	
	46–60	1.09	0.61–1.94
	61–75	1.38	0.77–2.44
	76–89	1.76	0.92–3.34
Census Track Median Income	$1–39,999	Reference	
	$40,000–50,999	1.19	0.78–1.81
	$51,000–65,999	0.91	0.57–1.45
	$66,000+	0.80	0.48–1.32
Charlson Score at Diagnosis	0	Reference	
	1	0.91	0.62–1.33
	2+	1.13	0.65–1.95
Gynecologic Oncologist Involved in Chemotherapy	No	Reference	
	Yes	1.05	0.78–1.43
Insurance Status	Insured	Reference	
	Uninsured	1.11	0.53–2.30
Percentage of Census Tract Residents with Less Than a High School Education	0–10%	Reference	
	11–20%	0.92	0.64–1.30
	21%+	0.69	0.36–1.32
Race/Ethnicity	Non-Hispanic White	Reference	
	Non-white	0.59	0.31–1.15
Rurality	Urban	Reference	
	Rural	1.00	0.73–1.37
Stage	II	Reference	
	III	**2.74**	**1.46–5.12**
	IV	**4.08**	**2.11–7.89**
	unknown	0.62	0.08–4.86
Tumor Sequence	Only Ovarian Primary	Reference	
	First Ovarian Primary	0.73	0.35–1.51
Type of Surgery Received	Other	Reference	
	Cytoreduction	0.79	0.41–1.53
Visible Residual Tumor After Surgery	>1 cm/ Unknown	Reference	
	≤1 cm	**0.67**	**0.51–0.89**

Bolding indicates a significance at 0.05.

*Adjusted for all other exposures in the first column that have value.